BROILER PERFORMANCE: AN EVALUATION OF METABOLIC CONSIDERATIONS RELATED TO STRESS TOLERANCE AND TISSUE ACCRETION METHODOLOGY

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CHAPTER I

INTRODUCTION

Interactions between high ambient temperature-relative humidity distress and reduced broiler performance has long been recognized. During high ambient temperature distress, bird survival and productivity are dependent on the bird's ability to maintain homeostasis. Heat distress is characterized, in homeotherms, by elevated body temperature and occurs when heat production exceeds the bird's ability to dissipate heat. The elevated body temperature perturbs homeostasis and therby reduces growth rate, feed efficiency and frequently survival ability.

Various management practices have been recommended to alleviate heat distress prostration in broilers. Such procedures include fasting, utilization of electrolytes in water to increase water consumption and provide needed minerals, altering calorie:protein ratio to impact heat production, feeding probiotics, and acclimation.

Acclimatizing broilers to mild heat distress has been suggested to improve bird survivability, feed efficiency, and growth rate of birds subjected to acute heat distress. The direct fed microbials have been reported to enhance growth rate, feed efficiency and survival during heat distress when used in both the starter and grower rations. The affect is thought to be the result of intestinal health through an improved population of gut microflora.

Todays consumer is becoming increasingly interested in the fat content of products purchased for consumption. Therfore, it is in the poultry industries best interest to produce products that contain little fat. Factors known to influence gain composition include bird age, ration composition (Macleod, 1992; Belay and Teeter, 1992;), meal size (Lefebvre, Leanness in domestic birds), light pattern (Charles et. al., 1992) and ambient temperature. As a result, for the poultry industry to produce birds with a specific carcass composition it is becoming increasingly important that the interactive effects of ration composition, environment and age be dynamically related.

The studies reported herein were conducted to: further develop and refine the theories and hypotheses regarding broiler heat distress acclimitization, direct fed microbial application and further to develop a technique whereby bird fat and protein accretion may be determined using a short term non-invasive procedure.

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CHAPTER II

REVIEW OF LITERATURE

Introduction

In birds and other homeotherms, heat distress is characterized by an elevated body temperature occuring when heat production exceeds bird ability to dissipate heat. Heat distress occurs most frequently in tropical regions, but is also a seasonal problem in many overall regions. This review deals with the bird thermobalance, therapeutic methodologies to reduce heat distress and discuses energy systems and methods used to monitor bird gain and composition.

BIRD THERMOBALANCE

Several investigators (Howlider and Rose, 1987; Deaton et. al., 1986; DeAndrade et al., 1974, 1976, 1977; and Smith, 1972) have reported that heat distress decreased growth rate, average body weight and feed consumption. In addition Bray (1983) observed that the growth reduction of broilers kept at high temperatures was greater in males than females implying that male broilers are more susceptible to heat prostration than females.

Bird thermobalance is critical during both thermoneutral and low as well as high ambient temperature distress periods. Bird thermobalance may be defined as the relationship between bird heat production and bird heat losses. Bird heat loss through radiation, convection and conduction may be lumped together as nonevaporative or sensible heat loss while heat loss through respiratory and cutaneous water evaporation may be referred to as evaporative or insensible heat loss. All poultry classes utilize nonevaporative heat loss (NHL) as the major means of heat dissipation when housed below and within the thermoneutral ambient temperature environments (Arieli et al., 1980; Van kampen, 1981b). Nonevaporative heat loss is more effective in thermoneutral environments because the differential between the birds body temperature and the ambient temperature is large. When birds are exposed to an increasing ambient temperature the NHL becomes less efficient and the birds must increase their evaporative cooling mechanisms to help dissipate heat.

The amount of feathering may also affect heat production in a thermoneutral environment (O'Neill et al., 1971). At a temperature of 20 C a fully feathered bird produces heat at half the rate of a naked bird, making feathered birds more efficient in feed utilization. Further thermal insulatory effectiveness of the feathers is enhanced by posturally increasing the effective surface area (Freeman, 1971).

Vasodialation during high ambient temperatures may increase nonevaporative heat loss. The vasodilation reduces peripheral resistance to blood flow allowing more heat to be transported to peripheal tissues. This is particulaly effective when vasoconstriction to the viscera shunts blood and hence heat to peripheral tissues (Bottje and Harrison, 1984). Thus increased blood flow to the comb and wattles is an important mechanism to dissipate core body heat (Michael and Harrison, 1987).

Since fowl have no sweat glands, H_2O loss via evaporation occurs through the moist respiratory tract surfaces. Inspired air which is "saturated" with water vapor at body temperature (Kerstens, 1964). Heat lost through evaporation at lower temperature represents only a fraction, of that at high temperatures, but increases dramatically to as much as 80% of the total heat loss through 26-35°C (Kerstens, 1964; Van Kampen, 1981; Wiernusz et al., 1991) Arieli et al., (1980) estimated 4 mg/Kg min°C of evaporative water loss from heat distressed birds housed at ambient temperature of above 26°C which represents an 8 fold increase over the 2-26°C temperature range.

Romijn and Lokhorst (1966), reported that at ambient temperature of 34°C and relative humidity of 40%, an adult hen dissipates over 80% of total heat by evaporative means. This was reduced to only 39% by increasing the relative humidity to 90% with the bird becoming hyperthermic.

MANAGEMENT METHODS USED DURING HEAT DISTRESS

Heat Distress

Avian species, are homeotherms and must consequently maintain deep body temperature relatively constant over a wide range of ambient temperatures (Meltzer, 1987). The deep body temperature of a mature chickens is generally higher than mammals, being in the range of 41-42 vs 38°C (Freeman, 1965). Bird heat production normally results in a thermal gradient from the warm interior (core) to the cooler surface (shell).

Fasting

Full and Mora (1973) reported that as ambient temperature approaches bird body temperature both the heat loss and energy requirement declines. As a result birds reduce nutrient intake. The result is usually seen in depressed growth rate and production. It has been reported (Squib et al., 1959: Cowan and Michie, 1978) that the growth rate depression observed in heat distressed broilers is partially related to reduced feed intake. Though birds decrease feed intake during heat distress periods it is often not enough to mazimally impact HP. During periods of rapid ambient temperature rise feed intake will remains normal for some time as a result the maximum thermogenic effect of the feed often coincides with the period of maximum heat distress (Van Kampen, 1977). Thus the additional heat of the environment and the added heat from the feed becomes more than the bird can dissipate and heat distress symptoms occur.

Fasting has been evaluated as a management tool to combat heat distress (McCormick et al., (1979; Teeter et al., 1987a). McCormick et al., (1979), noted that fasting chicks for up to 72 hours resulted in progressively increased survival time when exposed to heat distress. Such fasting times, however are unpractical. Teeter et al., (1987a) observed that fasting broilers 6 hours prior to or during heat distress reduces heat distress mortality. This is similar to Van Kampen (1977) who reported that to be certain the thermogenic effect of feed does not coincide with highest air temperature, the last feed intake should occur at least 3-8h before maximum temperature is expected. The time feed is withdrawn prior to the onset of heat distress is very important and may be easily manipulated by the producer to reduce the effect of heat distress with out adversely affecting the birds growth and production.

ACCLIMATION

Acclimatization is defined as the physiological adjustment of an individual to a different climate, especially to a change in environmental temperature or altitude (Stedman's, 1990). Under conditions of elevated respiratory rate, a rise in body temperature, and an increase in water consumption (Deetz and Ringrouse, 1976; Sturkie, 1965). The increase in heat tolerance resulting from acclimatization is due to a decrease in body temperature, decreased insensible heat loss, decreased oxygen consumption, and increased panting rates (Sykes and Fataftah, 1986a). Researchers have attempted to use artificial acclimatization by exposing birds to an artificially induced stress prior to the onset of the naturally occurring event. As such, the acclimation represents an attempt to accustom the birds to the expected stress prior to its natural and more severe occuance. This allows the bird to make necessary physiological adaptations to decrease the severity of the expected stress. The obvious concern with this technique is the possibility that the expected natural stress might not occur. If this becomes the case, the producer will have decreased his profits because of the decreased weight gain associated with the birds being exposed to the artificial stress. However, if the natural stress does occur the producer may benefit from an increased bird survival.

Classical Acclimation

A great deal of work has been done on poultry in the area of acclimatization to high temperatures. Hutchinson and Sykes laid the ground work for the area of acclimation (in poultry) in 1953. They acclimated birds for 24 days to

4 h exposures of elevated (38^{o}C) temperatures. Their results indicate that both control and acclimatized layers had increased body temperature (Tb) during exposure to high environmental temperature. However, the Tb of the acclimatized layers increased to a plateau, whereas the Tb of the control layers continued to increase. Similarly, Sykes and Fatafitah (1980) reported acclimatized hens Tb increased .4^{o}C/h compared with 4.6^{o}C/h for the controls.

Reece et. al., (1972) conducted 2 trials to assess the effect of acclimation. In the first trial (broiler type) birds were acclimated during weeks 4 - 8. At the end of the eighth week, the temperature was increased from 23.9 to 40.6^{o}C over a 6 h period, held at 40.6^{o}C for 2 hours and then decreased to 26.7^{o}C. The control birds had 29% mortality while acclimated birds had a 10% mortality. Bird body weight was lower ($P<.05$) for the acclimated birds than the controls. However the data on the interaction between body weight and acclimation treatment indicates that acclimation, as a physiological process, is more important than body weight in determining susceptibility to heat prostration for a specific stress condition. In the second experiment, Reece reported that a 3 day exposure to high cyclic temperatures (23.9 - 35^{o}C) gave broilers significant protection against heat prostration when compared to the control environment (21^{o}C).

May et al (1986) conducted a trial to evaluate the effect of acclimation on bird survival during a subsequent heat distress exposure. Control birds were held at 21^{o}C while acclimated birds were exposed to a 24-35-24^{o}C (linear cycle) for 3 days. On the fourth day the temperature was gradually increased to 41^{o}C and maintained until 50% of the control broilers died. Under these conditions only 5% of the acclimated broilers died of heat prostration. May et al., (1987) conducted two similar trials using the same temperatures during a 4 day acclimation period. At the end of Trial 1, total mortality was 30 % for controls and 10 % for acclimated broilers ($P>.05$). In Trial 2, mortality was 60 and 10% for control and acclimated broilers, respectively ($P<.05$). Pooling the trials resulted in acclimation significantly ($P<.05$) reducing mortality. The data also indicated that acclimated broiler's Tb rises upon exposure to heat, but that acclimation gives the capacity to stabilize Tb after an initial rise in contrast to the unacclimated birds.

The work of Hutchinson and Sykes (1953) and recent results have shown that acclimatization is not accompanied by increased evaporative heat loss, a situation opposite to that found in man and other sweating animals. Furthermore, there is limited capacity for increasing heat loss by vasodilation since only the lower legs and the comb offer a heat exchange surface (Van Kampen, 1984). Thus, without additional avenues of heat loss it is likely that acclimatization is achieved by reducing heat production not increased heat loss (Sykes and Fataftah, 1986b).

EI-Hadi et. al., (1980) conducted a trial using laying hens exposed to a hot climate of 38°C either intermittently (4 hours/day for 13d) or continuously (24 h/d for 12d). They monitored blood acid-base values before and after acclimatization and reported a fall in mean rectal temperature following acclimatization. Since respiratory rate, blood pH, pCO_2 and HCO_3 were the same on day one as on day 13, it was concluded that heat acclimatization is not accompanied by changes in the pattern of respiratory ventilation.

There is no clear connection between metabolic rate and heat tolerance except that it has been shown that acclimatization is accompanied by reduced metabolic rate, at acclimatization and thermoneutral temperatures (Sykes and Fataftah, 1986a). The observation (Hutchinson and Sykes, 1953) that heart rate was lower after acclimatization is also consistent with a reduced metabolic rate.

Acclimation and Hormones

It has been demonstrated that exogenous thyroid hormone admistration shortens bird survival time during heat stress (Fox, 1980; May 1982; Bowen et al., 1984). In contrast, reducing thyroid activity tends to lengthen survival time (Fox, 1980; Bowen et al., 1984). The secretion of T3 is reported to be dependent on ambient temperature (Freeman, 1983). Thus the effect of environmental temperature on thyroid activity may affect a birds ability to withstand heat distress.

Rudas and Pethes (1984) reported reduced thyroxine (T4) concentration after exposure to 35°C for 1 hr, but triiodothyronine (T3) concentration was unchanged. They concluded conversion of T4 to T3 played a major role in the early phase of temperature acclimation. Kittok et al., (1982) observed increased sensible heat loss in adult chickens following administration of triiodothyronine (T3) or Thyroxine (T4). Oxygen consumption of chickens between 1-8 weeks of age is correlated with the circulating concentration of T3 but not T4 (Bobek et al., 1977; Klandorf et al., 1981), suggesting that T3 is the metabolically active thyroid hormone.

May et. al., 1986 reported that neither acclimation nor severe heat exposure consistently affected triiodothyronine (T3) or thyroxine (T4) concentration. They concluded that the mechanism of short-term acclimation involves endocrine or physiological responses other than changes in circulating thyroid hormone concentration. This is consistent with results reported by Bowen and Washburn (1985).

The role of the thyroid hormones in the response of heat tolerance to higher energy intakes has yet to be determined. However, metabolic rate is increased by exogenous thyroxine (Arieli and Berman, 1979) and there is a good correlation between metabolic rate and the concentration of plasma thyroid hormones (Klandorf et al., 1981: Williamson et al., 1985). The relationship between food or energy intake and thyroid hormone activity is less well defined, but it is clear that plasma T3 concentration is reduced by fasting and rises again on refeeding (May, 1978: Harvey and Klandorf, 1983).

Day-5 Acclimation

Arjona et al (1988) conducted studies to evaluate the feasibility of acclimating chicks to heat distress on day 5 posthatching. The acclimation period consisted of holding the birds between 35-38°C for a 24 h period. Results indicated that exposure to 35.0 to 37.8°C for 8 h/day on days 44 and 45 reduced mortality (12.3% vs. .8%) for day 5 acclimated chicks compared to the control birds on days 44 and 45.

Acclimation And Bird Mineral Status

Since many body functions change during environmental stress and during acclimation to different environments (Euler, 1961; Bland, 1963; Dill et al., 1964; Leithead and Lind, 1964), blood electrolytes may also change. Huston (1977) indicated that blood potassium decreased significantly shortly after transferring birds to an increased environmental temperature of 30°C. The lowered potassium was observed as early as six hours following transfer to the 30°C environment. Deetz et. al., (1976) also reported that increasing ambient temperature decreased plasma potassium at all dietary levels. However ambient temperature did not significantly affect the percentage of potassium in excreta or in the egg. Likewise potassium retention was not affected by temperature. Urine potassium goes up as temperature goes up at lower dietary levels of potassium. At high dietary levels (1% in the diet) of potassium, urine potassium levels were nearly equivalent. This effect may be related to urine production as Van Kampen (1981a) reported a 200% increase in urine output for laying hens exposed to heat distress.

It has been reported that decreased egg production and shell quality may be accompanied by reduced plasma calcium concentration (De Andrade et al., 1974, 1976, 1977; Smith, 1974; Wolfenson et al., 1979). Lowered concentration may be associated with reduced availability of this ion for egg formation. Other studies have suggested that blood is moved to the periphery during heat stress for evaporative cooling while the flow to core organs is reduced (De Andrade et. al., 1977; Wolfenson et al., 1978). Husseny and Creger (1981) also reported that broilers exposed to 32°C ambient temperature for 42 days had lower calcium, copper, iron, potassium, magnesium, manganese, sodium, phosphorus, and zinc retention. Similarly Belay et al., (1993) observed reduced mineral retention for potassium, phosphorus, sulfur, sodium, zinc, selenium, molibdomin, magnesium, manganese, and copper.

Potassium chloride, NaCl and NaHCO3 drinking water supplementation has been reported to increase gain (Reece et al., 1972; Riley et al., 1976; Teeter et al., 1985) and survivability (Branton, et al., 1986; Teeter et al., 1987b) of heat distressed broilers. The effects are correlated with increased water consumption and similar body temperature rise during heat distress (Teeter et al., 1987b). Belay, (1993) suggested that the effect is likely due to elevated evaporative cooling.

Water Consumption

A nutritional factor often overlooked during heat stress is the metabolism of water. Water consumption increases during high ambient temperatures (NRC, 1981). Smith and Teeter, (1987b) reported that increasing water consumption during heat distress increased gain when compared to control birds. In addition, temperature can have a profound affect on water consumption as elevating ambient temperature from 21 to 37^{o}C, increased water consumption by 250% (NRC, 1981). Miller and Sunde (1975) suggested that layers are more tolerant to heat stress when provided cool drinking water. Leeson and Summers (1975) exposed layers to 35^{o}C and offered them drinking water at either 35 or 2^{o}C. Birds offered the cold water consumed 15% more feed and produced 10% more eggs during a 38d test period. Teeter et al. (1987b) reported that heat distressed broilers offered drinking water maintained at 15.6^{o}C had greater growth rate compared to those offered water at higher temperatures. They suggested that cold water may serve as heat sink enabling the bird to lower body heat load and increase its feed consumption. Also, Arad (1983) reported hydrated birds exposed to high ambient temperature (44 C) had lower metabolic heat production and higher cooling efficiency (evaporative heat loss / total heat production) than the dehydrated birds.

Teeter (1986) suggested that the increased heat distress tolerance of using electrolytes in water is not a product of the electrolyte altering the birds physiology. However, Belay and Teeter (1993) reported that increased water consumption during heat distress via drinking water electrolyte supplementation improved evaporative heat loss and Joules of heat dissipated per breath. During high ambient temperature, birds increase respiration rate (Michael and Harricon, 1987) and, as a result, a considerable quantity of water is evaporated from the mucous membrane lining of the upper respiratory tract. Thus, panting is the main route for dissipating heat during high ambient temperature distress. Indeed, heat distressed birds dissipate over 80% of heat production via evaporative cooling (Van Kampen, 1974; Wiernusz, et al., 1991).

Since water intake is correlated with feed intake, factors affecting feed consumption indirectly affect water intake (Zeigler, et al., 1971). High levels of dietary constituents such as molasses (Ross, 1960) and salt (Herrick, 1971; Teeter, 1988) are known to stimulate water consumption, presumably because urine production increases.

Ration Formulation

MacLead et al., (1979) and Wiernusz et al., (1991) demonstrated that heat production of birds exposed to heat distress is elevated with increased feed consumption. Thus feeding high calorie rations to increase nutrient intake may also increase oxygen consumption and metabolic heat production. According to Sykes and Salih (1986), even under conditions of mild heat distress an increased energy intake by birds consuming a fat fortified ration leads to reduced heat tolerance. The data also indicates that the birds had increased rectal temperature. Therefore, during heat distress, feeding high caloric density diets potentially increases the bird's heat load and mortality.

Reducing dietary protein while maintaining essential amino acids lowers ration heat increment (Waldroup et al., 1976; Baghel and Pradhan, 1989) while Sinurat and Balnave, (1985 and 1986) demonstrated that feed intake and feed efficiency of broilers in heat distress is correlated with caloric density and reduced amino acid to calorie ratio. The use of high energy rations with lower protein to form high calorie/protein ratios improves performance of heat distressed broilers since it reduces heat increment. The study of McNaughton and Reece (1984) with heat distressed broilers indicates that a high protein diet is advantageous for reducing carcass fat but can be deleterious due to higher heat increment.

Diet composition may directly or indirectly affect adipose tissue growth and fat deposition. An important factor is the effect of diet composition and texture on food intake during ad libitum feeding. Dietary manipulations favoring energy intake such as pelleting or changes in energy concentration are accompanied by an increase in fatness (Fisher and Wilson, 1974; Picard, 1981; Pesti, Whiting and Jensen, 1983). The ratios of E:P or energy to balanced amino acids are also considered important regulators of food intake and of carcass fat content (Fraps, 1943). Neupert and Harfiel (1978) reported that the carcass lipid concentration was more closely correlated with metabolizable energy density (r=0.69) than with the E:P ratio (r=0.47).

ENERGETIC SYSTEMS

The birds nutrient requirement for the desired production level and the composition of feed stuffs to be used must be known to properly feed poultry classes . The first consideration when formulating a ration is its energy content because 75 to 85% of the ration is devoted to satisfying the bird's energy requirement. Though several energetic systems are available the poultry industry uses the apparent metabolizable energy (AME) system for most ration balancing computations.

Farrell (1978) defined AME as the difference between the energy intake as feed and the energy output as excreta.

The AME is popular with the poultry industry because the chicken excretes urine and feces together making the AME system easy to apply. However, in order for a system describing the energetic content of feedstuffs to be considered reliable, values obtained using the respective assay must be reproducible (Dale and Fuller, 1986).

For a specific feedstuff at constant input, the metabolic urinary energy (Ume) varies according to tissue catabolism, tissue synthesis, and the utilization of absorbed nitrogenous compounds. The metabolic urinary energy also varies with feedstuffs, intake and nitrogen balance. Wolynetz et al. (1984) suggested that differences in AME may be large at low intakes, but that such variation decreases curvilinearly as intake increases. In addition, Sibbald (1975) demonstrated that at very low feed intakes AME values are negative because the output of metabolic plus endogenous energy exceeds the energy input.

The true metabolizable energy (TME) bioassay was developed in response to the finding that AME varies with feed intake (Sibbald, 1975, 1976). In the TME assay, fasted birds are used to provide an estimate of the endogenous and metabolic excreta energy losses. Thus the TME is calculated by taking the AME value and subtracting the value of endogenous losses (estimated by the fasted birds) which gives a more accurate value of the energy balance of the animal. Engster et al. (1981) reported that TME values proved to be better predictors of weight gain, feed intake, and feed efficiency than conventional AME values. Dale et al., (1982) also reported that TME values more closely reflect the observed chick response to varying levels of energy density than did the corresponding AMEn (apparent metabolizable energy adjusted to zero nitrogen balance) values. It was concluded that the TME system provided a satisfactory measure of the caloric content of the feedstuffs used in experiments and also that the values obtained using the assay are applicable to broilers.

Several modifications have been suggested and adopted since the bioassay for true metabolizable energy (TME) was first described. Extension of the excreta-collection period to 48 h (Sibbald, 1978) and adjustment of TME to zero nitrogen balance (TMEn) (Shires et al., 1980; Sibbald and Morse, 1983) are two such modifications. Adjusting TME to zero nitrogen balance provides the nitrogen corrected TME or TMEn and allows us to compare animals that are gaining weight with animals that are maintaining body weight or even losing weight.

The accuracies of AME, AMEn, and TME as estimates of bioavailable energy are affected by feed intake and nitrogen retention while TMEn is not so affected (Wolynetz et al., 1984). At low levels of intake TME overestimates bioavailable energy, particularly for high-protein feedingstuffs (Wolynetz et al., 1984). TMEn however is a less variable estimate of bioavailable energy than is TME (Sibbald and Morse, 1983b). The theoretical and experimental results indicate that TMEn is the most useful estimate of bioavailable energy for practical purposes (Wolynetz et al., 1984).

Researchers in ruminant nutrition are presently working with a energetic system called the net energy (NE) system which takes into account the heat increment of feedstuffs. Heat increment is the quantity of heat produced by an animal during fermentation in the gastrointestinal tract and during the processing and use of nutrients by the body. The heat increment is larger for proteins than for fats and utilizable carbohydrates, as it is for high as opposed to low fiber diets (Animal energetics and thermal environment chap. 8). Nitrogen corrected true metabolizable energy minus the heat increment of the ration equals the net energy of the ration. Thus, for a constant level of metabolizable energy intake, the greater the heat increment, the less the net energy available (Animal energetics and thermal environment chap. 8). The NE system offers nutritionists the ability to calculate rations on an available energy basis, referring to the energy that is available to the animal for tissue accretion and maintenance. The NE system may allow nutritionists to select a feedstuff for a ration based on its heat increment to provide, for example, heat for body temperature maintenance or maximum energy for production.

The NE system is a more useful bioassay for calculating rations than is the metabolizable energy system. However, the NE system has its greatest advantage when a large portion of the rations energy is ultimately lost as heat. This is the case in ruminant animals where ruminal fermentation is responsible for a great deal of heat production. Monogastric animals have relatively little fermentation taking place during digestion or absorption, thus the NE system loses some of the advantages seen in the ruminant animals. However, the NE system has the potential to increase the efficiency of ration formulation and utilization, thus benefiting the producer.

FAT DEPOSITION

Dietary Fat

The poultry industry has recently become increasingly interested broiler fat accretion as it is of major consumer concern. Therefore, interest has developed in producing broilers with less total fat. This has posed a problem for producers because diets containing supplemental fat increase broilers body weights, which increase their profits, but also increase the total body fat.

Fats are the most concentrated source of available energy in poultry diets and there are several advantages to using fat in a ration. The most important of which is to increase the caloric density of the diet and subsequently improve body weight gain and feed efficiency. Waibel (1978) attainment of a more nearly optimum available energy to amino acid balance for metabolism, resulting in an improvement of protein utilization.__The addition of fat to poultry diets is reported to increase the metabolizable energy (ME) of the diets more than expected from the additivity of the ME's of the individual ingredients (Cullen et al., 1962; Jensen et al., 1970; Sell, 1977; Sell et al., 1979; Mateos and Sell, 1980). Gomez and Polin (1974) and Sibbald and Kramer (1978) reported that fat supplementation seemed to improve the utilization of nonlipid constituents of diets.

Unfortunately, while most fats have similar gross energy values, their available energy concentrations vary widely (Cullen et al., 1962; Sibbald and Kramer, 1977). The availability and utilization of dietary fat energy is dependent on the composition of the diet (Cullen et al., 1962), the age of the bird (Whitehead and Fisher, 1975) and the level of inclusion of fat in the diet (Sibbald and Kramer, 1978).

It is well demonstrated that as the dietary fat supplementation is increased, both the amount of abdominal fat (Deaton et al., 1981) and the percent body ether extract increase (Deaton et al., 1981). Deaton reported that under moderate and high temperature regimens, as dietary fat level increased, body weight and the amount of abdominal fat increased.

It is thought that fats depresses feed intake by a general energy-related effect. The injection of small amounts of individual long-chain fatty acids intraperitoneally (Cave, 1978), or through inclusion in the feed (Sunde, 1956; Renner and Hill, 1961), do not depress intake to a significant extent. However, some short- and medium-chain fatty acids do depress intake when given intraperitoneally (Cave, 1978) or in the diet (Cave, 1982).

Contradictory reports regarding the effect of dietary fat supplementation on body fat content exist. Many studies indicate that as dietary fat is added to the diet at the expense of carbohydrates and at constant E:P ratio, the addition has no significant effect on carcass fat (Bartov, 1979; Laurin et. al., 1985). It appears that the dietary fat effect on total body fat is dependent upon diet energy density, since fat supplementation reduced body fat when supplemented at 12.3 MJ/Kg. In contrast, supplemental fat had no effect when supplemented at a higher energy level (13.4 MJ/Kg) (Bartov, 1979). The effect of dietary fat addition was much greater on adipose tissue than on total body fat as it reduced the weight of adipose tissues at both energy levels

Body Fat Accretion

The liver is the major site for lipogenesis (Goodridge, 1968; O'Hea and Leveille, 1969) although adipose tissue and skin make minor contributions (Yeh and Leveille, 1973). Accumulation of fat is due to hypertrophy and hyperplasia of adipose cells. In commercial birds the number of adipose cells increases in the abdominal fat pad to about 14 weeks; beyond this time cell numbers remain constant at about 270 X 10^6 cells per fat pad (Hood, 1982). It has been reported that the total DNA-deoxyribose content of pullet adipose tissue plateaus at 12 to 15 weeks of age (Pfaff and Austic, 1976). Hypertrophy of adipose cells, rather than hyperplasia, is more important in the determination of adiposity of the mature chicken (Hood, 1982b; March et al., 1982). Growth rate, however, can influence the number of abdominal fat pad adipose cells in the 9-week-old chicken (Hood and Pym, 1982). Nevertheless, adipose cell size remains the dominant factor which influences the size of the fat pad in young birds.

The fatty acid composition of meat is determined by the fatty acid composition of the diet the animal has consumed, as well as by de novo fatty acid synthesis (Marion et al., 1963; Schuler et al., 1971). Breed, sex, and ambient temperature have only minor effects on the fatty acid distribution pattern (Marion and Woodroof, 1965; Balnave, 1973; Otake et al., 1973). Nonruminants tend to deposit dietary fatty acids in the same form as ingested, that is, they neither saturate nor desaturate them. Ruminants on the other hand, have microoganisms that increase the saturation of the fatty acids ingested (CAST 1991). Therefore, the dietary lipids markedly influence the fatty acid composition deposition of ruminants.

The assembled data on the lipid content of fowl indicate that both poultry and game birds contain greater amounts of unsaturated than saturated fatty acids (Fristrom and Weihrauch 1976). The total fat content of individual tissues and total edible portion increases with age (Fristrom and Weihrauch 1976). Oleic acid is the dominant fatty acid in all tissues of all birds studied (Fristrom and Weihrauch 1976). White meat of the chicken and turkey contains the least amount of fat, with the skin containing the largest amount, especially in duck and goose skin (Fristrom and Weihrauch 1976). The skin of all birds contains more fat than the flesh and is the major contributor of fat to the edible portions (Fristrom and Weihrauch 1976).

COMMON METHODS OF CARCASS COMPOSITION DETERMINATION

Direct Carcass Composition Determination

Comparative slaughter is frequently the method used to calibrate indirect calorimetry values. Carbon and nitrogen balance has been used to estimate fat and protein deposition. The comparative slaughter technique estimates energy gain by contrasting initial and final carcass weight and composition. The technique requires animals that have similar initial composition. A portion of the animals are sacrificed at the beginning of the trial and the rest at the end of the trial following consumption of the desired feedstuffs. By comparing the initial group to the final group the retention of energy may be determined by difference. Since no two animals are exactly alike, the accuracy of this technique is strongly influenced by homogeneity of the initial population. Davidson and Mathieson (1965) reported that birds killed at the beginning of the experiment are probably representative of the remainder when very young chickens are used. When older birds are used ( ) this assumption may be incorrect because of the wide variation existing in the fat content of individual birds (Fraps and Carlyle, 1939; Hanlan, 1939).

Indirect Carcass Composition Determination

Carcass composition can be determined using respiratory chambers and indirect calorimetry without sacrificing an animal. Energy retained and the partitioning of that energy into fat and protein can be determined in conjunction with calorimetric observations. The difference between heats of combustion of feed consumed and excreta voided plus heat produced during an experimental period constitute an estimate of retained energy (Farrell, 1974). Retained carbon vay be partitioned between ??? and fat using carbon and nitrogen balance. The partitioning is based on the assumption that fat and protein are of constant chemical composition and are the only C and N materials retained (Zaniecka, 1969). Energy balance can be partitioned into retention (as protein or fat) or loss (as heat) using the assumption that all of the nitrogen stored is in the form of protein (N x 6.25) with a fixed energy content of about 27.2 kJ (Fraps and Csrlyle, 1939).

The use of indirect calorimetry has the advantages of being noninvasive, requiring quick and easy laboratory assays, experimental trials of short duration, and the capability of using the same experimental animal for multiple experiments. In addition, the use of coupled C-N balance and indirect calorimetry allows us to look at body composition, fat and protein accretion while simultaneously gaining insight into the metabolic processes used during fat and protein deposition under differing environmental and nutritional regimes.

RESPIRATORY QUOTIENT

The ratio of the volume of CO2 produced to the volume of O2 consumed is defined as the respiratory quotient (RQ). The RQ can be used as an indicator of substrate catabolism (Richardson, 1929; Kleiber, 1961). Heat production can be calculated from the thermal equivalents of O2 or CO2 at a particular RQ from tables of published values (Broody, 1945).

Provided the substrates used to supply energy are carbohydrate, protein and fat, then theoretically the RQ should not be higher than 1.0 or lower than 0.70. However, the RQ ranges above and below .80. There are a number of possible reasons why unusually low RQ's may occur. Wash outs of CO2 (Krogh, 1916) may be an explanation during short-term experiments, although this is likely to be of little significance in studies of more than 24 h in duration. The incomplete combustion of fat and the production of ketone bodies may occur in starved birds (Farrell 1974). respiratory quotients greater than 1 are usually explained by the synthesis of fat from carbohydrate when birds are fed very large amounts of food, particularly following a period of starvation (Romijn and Lokhorst, 1966).

PROBIOTICS AND COMPETITIVE EXCLUSION

Microbials are often fed to animals. The term which has commonly been used to describe these microbials is "probiotics". There are many definitions of probiotics but Fuller (1989) presented a more precise definition as "a live microbial feed supplement which beneficially affects the host animal by improving its intestinal balance". Probiotics are bacterial or yeast in origin (Fox, 1988).

Direct fed microbials (DFM) are microbes fed to animals in feed or water to promote the establishment of an "ideal digestive tract microbial population". The animal's digestive tract must supply all factors necessary for microorganism colonization. Such factors include a favorable temperature, a constant supply of nutrients, essential fluids and a proper pH. In this symbiotic situation the microorganisms benefit from the environment and the animal benefits by maintaining a microflora that does not cause any disease state.

Newly hatched healthy chicks have sterile gastrointestinal tracts (Jayne-Williams and Fuller, 1971). However, from the moment of hatching exogenous bacteria rapidly enter the chick and colonize the intestine. Milner and Shaffer (1952) observed day old chicks to be extremely susceptible to salmonellas that may result in chronic intestinal infection. However the susceptibility appears to decline with increasing age.

Nurmi and Rantala (1973) demonstrated that oral introduction of cecal bacterial flora from adult birds into newly hatched chicks increased the chicks' resistance to salmonella infection as well as improved bird growth rate and feed conversion (Nurmi, 1985). Nurmi and Rantala (1973) orally inoculated 1 to 2 day-old chicks with a 1:10 dilution of normal intestinal contents from healthy adult birds one day prior to oral challenge with Salmonella infantis. The inoculation reduced salmonella by 77% compared to a 100% infection rate in the controls. Their results have been confirmed in several laboratories. Today the efficacy is known as the Nurmi concept or as competitive exclusion (CE). Competitive exclusion may be defined as the inability of one population of microorganisms to establish in the gut due to the presence of another population. Lloyd et al., (1974) suggested that alien salmonella may be excluded from essential microhabitats through competition from the rapidly developed native gut flora. In this process, the intestinal wall is a prerequisite for excluding pathogens. Salmonellas must first attach to intestinal epithelial cells in order to colonize the host (Savage, 1987). Lloyd et al. (1977) originally suggested that if paratyphoid salmonellas are to establish in the intestinal tract the organisms must compete for nutrients and suitable colonization sites in an environment which has already been made unfavorable by the stable indigenous flora. Since the newly-hatched chick may not be fully colonized by an indigenous flora less antagonism from the micro-organisms may be present, thus preferred microsites as well as nutrients may be available allowing salmonellas to invade and colonize.

Thus far investigations on the mechanism of protection by adult intestinal microflora strongly supports the theory that direct competition for the site of attachment is probably the primary mechanism of competitive exclusion. Recent electron microscopic studies by Soerjadi et al., (1982) supports the attachment mechanism theory for competitive exclusion.

Soerjadi et al., (1978) determined that the effective component in cecal contents had bacteria-like properties in that the protective qualities could not pass through a range of antibiotics as well as the ability to be stored aerobically and anaerobically.

Many reports have shown that pretreatment with either fresh adult intestinal contents or artificially cultured microflora significantly increase the resistance of the chick to salmonella infection; yet it does not entirely prevent infection (Barnes et al., 1980; Rigby and Pettit, 1980; Snoeyenbos et al., 1979). The pretreatment of one day old chicks does provide a significant reduction in the numbers of salmonellas colonizing any location of the chick alimentary tract (Reid and Barnum, 1983; Soerjadi et al., 1981). Pretreated birds also have decreased mortality rates from salmonella infection (Rigby and Pettit, 1980; Raevuori et al., 1978 and Lloyd et al., 1977). Snoeyenbos et al., (1979) demonstrated that chickens remained resistant to challenge up to 11 weeks post-treatment.

Miles et al. (1981b) conducted two experiments on Bobwhite quail and indicated that no significant differences existed in growth, feed efficiency of mortality when quail fed the DFM were compared to those fed the unsupplemented control diet. Whereas Crawford (1979) reported results from nine trials with commercial egg-type layers. Overall egg production and kilograms of feed required to produce a dozen eggs were both improved for the DFM groups compared to the control groups.

Meynell (1963) and Bonhoff et al. (1964) demonstrated that volatile fatty acids (VFA) produced by the metabolism of anaerobes in the caeca of mice could inhibit salmonellas when tested at concentrations normally found. VFA apparently exert inhibitory activity in the undissociated state, thus inhibition is greater if the pH is less than 6.0. Barnes et al. (1979) found that the cecal flora of the hatching chick produced a VFA concentration that was too low and the pH too high to prevent the multiplication of any salmonellas reaching the caecum. A rapid increase in the VFA and a decrease in the pH of the caeca occurs during the first 7 days of life. As non-sporeforming anaerobes are a main source of VFA in the caeca and their populations are at a minimum during the first days of life, the protective effect of adult intestinal flora with high concentrations of anaerobes can be realized (Impey, et al., 1982).

In anaerobic culture, with various combinations of VFA, Barnes et al., (1979) found that complete inhibition of S. typhimurium was obtained when the pH was in the medium region of 5.5. But a pH value of 6.0 afforded only temporary salmonella growth inhibition. The pH of intestinal contents of older birds has been found to be consistently above 6.0 (Farmer, 1943)

Bailey (1987) reviewed all of the factors affecting microbial competitive exclusion in poultry and concluded that the production of volatile fatty acids was less important than the physical occupation of intestinal sites to which bacteria might attach and colonize.

Lactobacillus

Several workers have proposed that Lactobacillus is the protecting organism and day old chicks, which are most susceptible to salmonellas, have low populations of lactobacilli in the crop and caeca (Barnes et al., 1972 and 1980; Mead and Adams, 1975). Lactobacillus sp. have been reported to have an inhibitory effect on E. coli multiplication in the chicken gut (Fuller, 1977 and 1978). Lactobacillus (spp.) are capable of producing large amounts of lactate from simple carbohydrates and concomitantly can withstand high degrees of acidity which is usually fatal to other bacteria.

In vivo studies using lactobacillus cultures for pretreatment have not been successful in protecting chicks from salmonella colonization of the intestinal tract (Barnes et al., 1980; Soerjadi et al., 1981). Adler and DaNassa (1980) reported that feeding a lactobacillus culture to chicks resulted in an improvement in body weights and reduced the occurrence of pasted vents. Protection against salmonella infection has not been obtained in conventionally reared chicks pretreated with lactobacilli isolated from the caeca of adult fowls (Adler and DaMassa, 1980). Even a Lactobacillus species isolated from a microflora known to be consistently salmonella-protective has not proven to be protective (Barnes et al., 1980; Soerjadi et al., 1981; Watkins and Miller, 1983). According to Leeson and Major

(1990), a healthy animal has a preponderance of lactic acid-producing bacteria. These authors stated that it is only under a situation of "stress", when coliforms often increase in numbers, that a DFM will be of measurable benefit.

There is increasing evidence that optimal protection against salmonella requires the use of relatively complex bacterial mixtures when treating newly hatched birds. The product developed by Nurmi and his colleagues appears to contain strains belonging to at least seven bacterial genera (Nurmi, 1985). A mixture containing 23 strains was described by Barnes et al. (1980) but was subsequently found to provide less consistent protection for experimental groups of chicks than the same mixture supplemented with a further 25 strains (Impey et al., 1982).

Mead and Impey (1986) reported that only a few lactobacilli, whether administered alone or included in mixtures, have been considered as potentially protective. Dilworth and Day (1978) conducted experiments designed to evaluate two lactobacillus cultures as supplements in broiler diets. Adding the DFM to the diet resulted in a significant improvement in growth and feed efficiency.

Damron et al. (1981) reported results from two experiments which were each conducted for 112 days. Broad breasted Large White turkey hens were housed individually in wire cages in experiment 1. In experiment 2, floor pens that contained 5 hens each were used. Each diet was fed to 5 replicate pens. Treatments consisted of a control corn-soybean meal diet and a similar diet containing 625 mg of a DFM per kg of diet. The DFM used in the experiments was a mixed lactobacillus culture. Egg production, egg specific gravity, daily feed intake, body weight change, fertility and hatchability were not influenced by the addition of DFM to the diet in either experiment.

Al-Zubaidy and Sullivan (1977) using Large White female turkeys on diets containing a live culture of lactic acid-producing bacteria. The DFM fed birds had increase gains at 4,8, and 12 weeks of age compared to nontreated turkeys.

Han et al., (1984a,b) studied the effect of supplementing broilers with lactobacillus sporagenes, an aerobic sporeformer, and Clostridium butyricum. These DFM's significantly improved weight gain and feed conversion of broilers. Both of these microorganisms suppressed the counts of staphylococci and coliforms in the birds.

Fethiere and Miles (1987) reported that feeding a DFM consisting of Lactobacillus acidophilus and other lactobacilli did not influence the body weight of broilers housed in battery cages.

Burkett et al., (1977) supplemented a control broiler diet with a lactobacillus, a yeast, or a combination of lactobacillus and yeast. Birds were raised under commercial conditions. After four weeks, birds fed the DFM had better feed efficiency. At 8 weeks no significant differences in body weight gain among treatment groups were found. However birds fed the combination of lactobacillus and yeast had greater pigmentation and fat deposition.

Arends et al. (1981) administered a strain of Lactobacillus acidophilus via the drinking water to broilers which were housed under commercial conditions. In the four trials conducted, an average improvement in weight gain of 25.5g and feed conversion of .0635 points was observed in the birds fed the DFM.

Yeast as a Protein Source

Yeast contains 57-65% crude protein, has a digestibility of 83-86%, and an ME value of 2.85-3.38 Kcal/g on a dry matter basis. Yeast is an excellent source of protein, energy and phosphorous for poultry, but the levels of sulphur amino acids and vitamin B12 is low, resembling that of soybean meal. When yeast was fed to chicks as the only dietary source of protein, sulphur-containing amino acids were found to be the first limiting amino acids, followed by arginine and phenylalanine (Tajina et al. 1971). In the first hatchability test in this experiment a surprising result was that hatchability of the eggs on the diet containing yeast was lower than 50%. Most of the chicks died in the shell before hatching due to a dietary deficiency of vitamin B12.

Yeast and Digestion

It is known that certain emulsifying agents increase and chicks (Fedde et al., 1960).

The Oklahoma Agricultural Experiment station indicated that when yeast culture was added to rations fed to growing turkeys there was an increased growth rate. It was postulated that the increased growth might have resulted from improved fat digestion due to yeast culture lipase activity.

Five experiments were conducted to test the effect of .yeast culture and lecithin on the fat digestibility in rations fed to laying hens. Corn oil, tallow and sifteen were the three types of fat added to the rations in various experiments. The results indicate that yeast culture and lecithin had beneficial effects upon the digestibility of tallow, both separately and in combination. In the rations which contained corn oil, there was no effect on fat digestibility due to yeast culture (Tonkinson et. al., 1965).

Kim et al., (1988) fed diets containing 10% moldy corn supplemented with either proprionic acid or a DFM to broilers and reported that the digestibility of crude fat in the moldy-corn diet was increased significantly in the presence of DFM. The digestibility of crude protein tended to be higher for the diets containing the DFM than those not containing the DFM.

Yeast as a Direct Fed Microbe

Nelson et al., (1971) demonstrated that a mold-produced phytase enzyme can cause in vivo hydrolysis of phytate phosphorus. The use of a live yeast culture (LYC) has been reported to free 75 to 80% of phytate phosphorous within 4 h in vitro (Thayer and Jackson, 1975). Thayer et al. (1978) reported an improvement in egg production, egg weight, and hatchability for turkey hens fed diets containing 2.5% LYC. Day et al., (1987) reported the addition of .25 or .50% LYC to layer hen diets containing either .40 or .60% TP did not exert any beneficial effects on performance. Guevara (1977) observed an adverse effect of dietary yeast on the performance of growing broiler chicks. He also observed the poorest broiler performance with diets containing the lowest available phosphorus level (.25%) and the highest yeast level (3.0%).

Thayer and Jackson (1975) concluded that using a live yeast culture was an efficient way of utilizing phytate phosphorus through the synthesis, of phytase which resulted in hydrolyzing the phytate phosphorus in the digestive tract. In addition, Thayer et al. (1978) studied the efficiency of utilization of dietary phosphorus by caged turkey breeder hens when fed diets supplemented with a live yeast culture. The overall results indicated that the efficiency with which dietary phosphorus was utilized by turkey breeder hens was significantly increased by the addition of the LYC to the diet.

Based on the literature reviewed, competitive exclusion appears to have many advantages. It provides a safe innocuous method of protecting susceptible chicks and poults from salmonella infection and other enteric pathogens as well as in some cases increased growth, egg production, and survivability. Competitive exclusion also offers producers a means of increasing production naturally, instead of using antibiotics, which will be more readily accepted by the consumer. However the effectiveness of CE to benefit an animal seems to be related to mixtures of DFM as in most cases a single strain of bacteria is ineffective in producing beneficial effects for the animal. This leads of to believe that more research is needed in the area of CE to find products that will yield optimal benefit at reasonable prices to the producer.

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CHAPTER III

INITIAL BROODING TEMPERATURE, DAY-5 HEAT DISTRESS ACCLIMATION AND FEED RESTRICTION EFFECTS ON BROILER PERFORMANCE DURING HEAT DISTRESS

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ABSTRACT

One study utilizing 1,280 male Cobb x Cobb broilers was conducted to evaluate relationships between initial brooding temperature and the day-5 acclimation procedure on bird weight yield during simulated summer heat distress. Feed restriction was used as a positive control in the low brooding temperature group. Birds were housed initially at either 29.5°C or 35°C with ambient temperature reduced such that at 3 weeks posthatching all birds were housed at 24°C. Acclimation at five days posthatching consisted of exposing birds to 35-38°C for 24 hours. On day 38 chicks were randomly assigned to grower batteries housed within an environmental chamber and exposed to a simulated summer heat distress. Feeders for the feed restricted group were covered 6 hours prior to heat distress initiation. Feed restricted birds had higher (P<.01) survivability (98%) than both the cool (87.7%) and warm (69.3%) brooded birds with the brooded birds having greater (P<.05) survivability than the warm. Bird live weight was 3.6% greater (P<.05) for the cool brooded birds. In this study the day-5 heat distress acclimation procedure failed (P=.89) to impact bird survival during heat distress at 45 days posthatching.

(Key Word: acclimation, heat distress, broilers, fasting, survivability)

INTRODUCTION

Broiler acclimatization to heat distress may be defined as physiological adaptations made to maintain homeostasis during a high ambient temperature distress. The process has been studied since the early 1950's when Hutchinson and Sykes (1953) reported that birds acclimated for 24 days at 38°C (4 hrs/day) exhibited increased heat tolerance when exposed to 42°C. Similarly, Reece et al. (1972) and May et al. (1986) observed that prior exposure to elevated ambient temperatures increased bird survivability during subsequent acute heat distress exposure.

Though the precise mode of action of acclimation and time frame required to produce a beneficial effect are not known, many parameters have been evaluated. Heat distress acclimatization has been suggested to occur through a reduction in bird heat production rather than an increased heat loss (Sykes and Fataftah, 1986, Wiernusz et al. 1991). May et al. (1986) reported that acclimation had no effect on T3 or T4 levels and speculated that any thyroid hormone involvement must be within the tissue. In a subsequent study, May et al. (1987) observed that heat distress acclimation reduced bird mortality and body temperature rise during subsequent exposure to high ambient temperature. Birds acclimated to heat distress naturally reduce their feed intake (Squibb 1959). The reduced feed consumption, however, only accounts for 50% of acclimation effects on lowering body temperature as indicated by pair feeding acclimated and nonacclimated birds subjected to acute heat distress (Teeter, 1988).

Fasting broilers has been demonstrated to reduce heat distress induced prostration (McCormick et al., 1979; Teeter et al., 1987) and is widely used in Central and South America. Indeed ambient temperature has an additive effect on bird body temperature. Removing feed prior to heat distress reduces bird heat production (Teeter et al., 1987).

A novel approach to inducing heat distress acclimation effects has been proposed by Arjona et al. (1988). The approach, termed the day-5 acclimation procedure, involves exposing chicks to heat distress (35-37.8°C) on day five posthatching for 24 hours followed by normal management practices. Arjona reported that the technique increased ($P<.05$) bird yield by enhancing survivability from 87.7 to

99.2% when the birds were subsequently exposed to acute heat distress on days 44 and 45 posthatching. However, the day-5 acclimation temperature overlaps with brooding temperature recommended by the Cobb brooding manual suggesting that the effect could be an artifact of cool brooding. In addition, Arjona increased the ambient temperature from 24°C to 35°C over a 1 hour time frame which is not consistent with a typical heat distress occurrence.

The objective of our study was to evaluate the applicability of the day-5 acclimation procedure to increase live weight yield under a more normal ambient temperature curve and also to evaluate its interaction with brooding temperature of birds reared under low brooding temperatures and to further utilize feed restriction as a positive control.

MATERIALS AND METHODS

In experiment one, twelve hundred and eighty Cobb x Cobb broilers were placed at hatching in grower batteries housed within 2 environmental chambers. Both feed (Table 1) and water were available for ad libitum consumption. Environmental chamber facilities and general procedures have been described by Smith (1983). The chamber temperature was adjusted (Table 2) to provide brooding temperatures mimicking either the Cobb brooding manual (warm) or Arjona (cool) (1988). Treatments within brooding environment consisted of both control and day-5 acclimated birds. In addition, one group of fasted birds was included in the cool brooding temperature to serve as a positive control. Treatment groups consisted of 32 compartments of 8 birds per compartment for a total of 256 birds per treatment.

The day-5 acclimation was accomplished by exposing birds to 36.5^{o}C for 24 hours, mimicking Arjona (1988).

On day 21 the two brooding temperatures converged at 24^{o}C and the birds, toe web notched by treatment, were combined in a common pen and reared at 24^{o}C to day 38. On day 38 birds were resorted by treatment and transferred to grower batteries in the environmental chamber. Following a 7 day adjustment to the chamber environment, the ambient temperature was increased from 24^{o}C to 35^{o}C mimicking Arjona with the exception that a 6 hour time interval was used to reach the peak temperature in contrast to 1 hour used by Arjona. Relative humidity was maintained at 50%. Feed intake was not determined until two days before the initiation of the heat distress. The feeders for treatment 3 were covered 6 hours prior to heat distress to initiate the fasting period thus influencing the feed consumption values.

During the heat distress period the birds were maintained at 35.0^{o}C for one hour and then the temperature was reduced to 24.0^{o}C over the next 4 hours. The temperature was held high for only one hour because the birds were exhibiting extreme heat distress and were beginning to show signs of phase II breathing. The process was repeated on days 46 and 47. The heat cycle for days 45-47 are shown in Figure 2.

Upon completion of the experiment, the data was evaluated using the general linear model procedure of the statistical analysis system (SAS, 1985). When a significant F statistic was detected, means were separated using least square analysis of variance (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Brooding temperature and acclimation effects on day 43 posthatching, live weight gain and yield, and survivability are displayed in Table 3. Brooding chicks at the higher ambient temperature reduced ($P<.01$) live weight gain by 3.6%. The day-5 acclimation procedure did not improve ($P<.01$) live weight gain within brooding environment. No interaction was detected between day-5 acclimation and brooding temperature. Feed consumption per metabolic body weight for days 42 and 43 was similar for all treatments with the exception of the birds fasted 6 hours prior to heat distress which were lower ($P<.05$; table 2). During the acute heat distress phase bird survivability for fasted birds was increased ($P<.05$) 98.0% over all other treatments. The cool and warm brooded acclimated and nonacclimated survivability were similar ($P>.1$). However, the cool brooded birds exhibited greater ($P<.01$) survivability than the warm brooded birds (Table 2).

This cool brooding effect may be related to the lack of a temperature gradient in our warm brooding environment. The Cobb manual suggests a 32.5°C to 35°C temperature should be maintained directly under the brooder allowing a declining temperature gradient to the edge of the room. This allows the birds to find their own comfort zone during brooding. In our experiment the room temperature for the warm brooded birds was strictly held with no temperature gradient, while the cool brooded birds were brooded according to Arjona. The warm brooding in our experiment was a stress on the chicks and may account for the decrease in live weight gain and survivability in the warm verses cool brooded birds.

Based on the data reported herein it is concluded that the day-5 posthatching acclimation technique does not benefit the birds in terms of coping with heat distress later in life. Feed restriction 6 hours prior to heat distress has a beneficial effect on survivability while not reducing live weight gain significantly.

Table 1. Composition of grower ration used for the experiment

Ingredients	Percent
Ground corn	59.80
Soybean meal (44%)	36.00
Dicalcium phosphate	2.35
Calcium carbonate	.90
Sodium chloride	.50
Vitamin mix[1]	.25
D-methionine	.10
Trace mineral mix[2]	.10
Total	100.00
Calculated Analysis:	
ME Kcal/Kg	3137
Crude protein (%)	21.1

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[1] Mix supplied per kilogram of diet: vitamin A, 14,109 I.U.; cholicalciferol, 5291 I.U.; vitamin E, 47.62 I.U.; vitamin B_{12}, .014 mg; riboflavin, 8.82 mg; niacin, 26.5 mg; d-pantothenic acid, 28.2 mg; choline, 705.5 mg; menadione, 1.16 mg; folic acid, 1.176 mg; pyridoxine, 3.52 mg; thiamine, 3.52 mg; d-biotin, .176 mg.

[2] Mix supplied per kilogram of diet: Ca, 160 mg; Zn, 100 mg; Mn, 120 mg; Fe, 75 mg; Cu, 10 mg; Iodine, 2.5 mg.

Table 2. Rearing ambient temperature used at different ages by different investigators.

			McDonald	
Age (weeks)	Arjona	Cobb	Warm	Cool
1	29.4	35.0	35.0	29.4
2	27.7	32.2	32.0	27.7
3	26.0	29.4	28.0	26.0
4	24.3	26.6	24.0	24.0
5	22.6	23.9	24.0	24.0
6	20.9	21.1	24.0	24.0

Table 3. Treatment effects on bird weight, feed consumption and survivability.

	Treatment				
Variables	Cool		Fasted	Warm	
Body WT, (g)	1380^{a}	1391^{a}	1375^{b}	1326^{b}	1338^{b}
Feed/MBW, (g)	3.9^{ab}	4.2^{a}	3.3^{b}	3.8^{ab}	3.9^{ab}
Surv., %	87.5^{b}	87.9^{b}	98.0^{a}	67.5^{c}	71.0^{c}

$^{a-c}$ Means within a row with unlike superscript differ ($P<.05$)

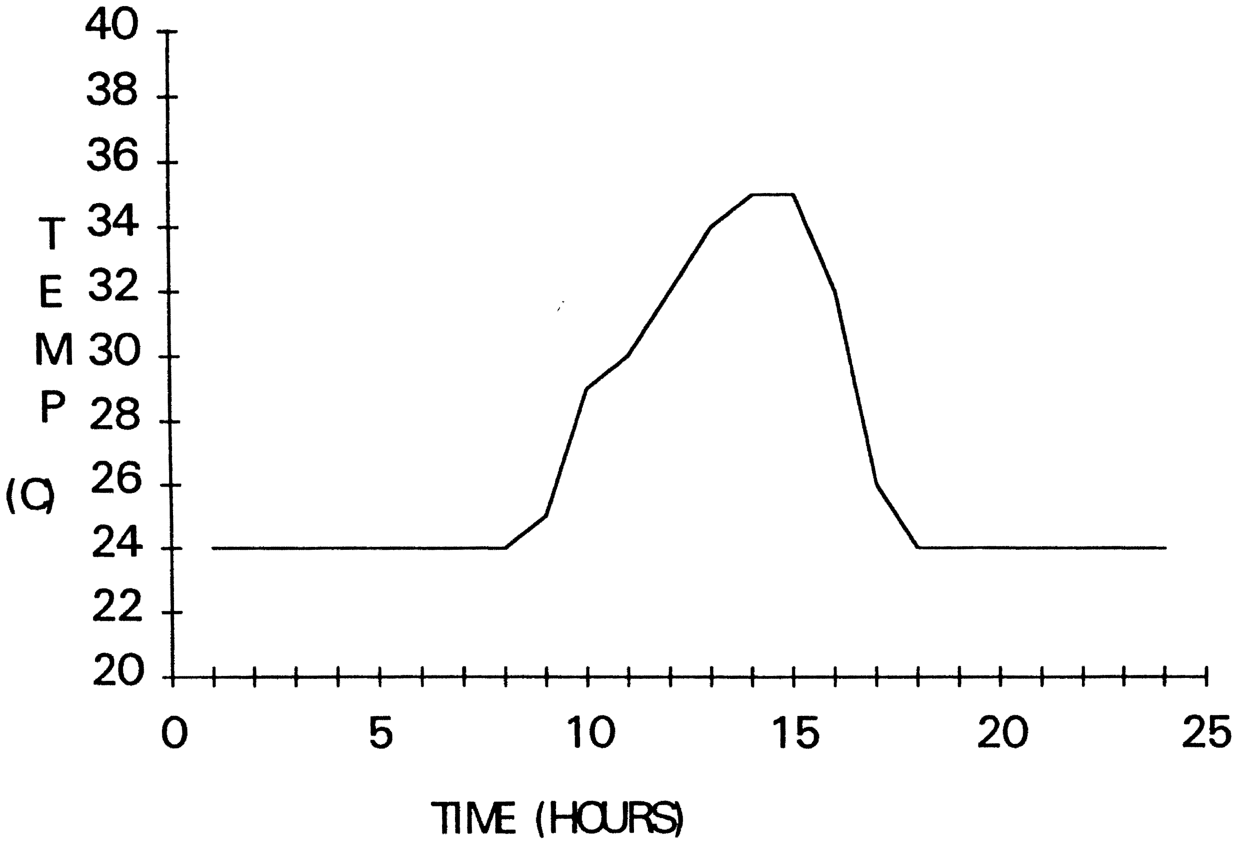

Figure 1. Heat Distress schedule for broilers during days 45 -47

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CHAPTER IV

AN EVALUATION OF BROILER GAIN COMPOSITION METHODOLOGY USING CLASSICAL AND NEW APPROACHES

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ABSTRACT

One study was conducted to validate classical carbon-nitrogen (CNB) and indirect calorimetry for ability to predict protein, fat and energy gain as well as heat production (HP). Further, the study sought to relate a number of variables including N retention, total C retention, energy retention, respiratory quotient, CO_2 production, C consumption, O_2, Me, and ME_n consumption as well as heat production with gain composition. Composition of tissue gain, quantified by comparative slaughter (CS), was used as the reference standard to judge accuracy and as the basis for the additional modeling. Tissue carbon(C) and nitrogen (N) in broiler protein and fat tissue was determined to be 52.96, 15.85, 77.1, and 0.2%, respectively, which differed slightly from classical values. During the study, birds gained 388g dry matter as 239g protein, 119g fat and 30g ash. Energy gain averaged 2,455 Kcal with 4,713 Kcal being dissipated as heat. The CNB system, using classical composition values for C and N, yielded 228g protein, 124g fat and 2,478 Kcal energy, while CNB using revised values yielded protein fat and energy gain estimates of 244g, 122g and 2,514 Kcal, respectively. Over 1,925 equations, composed of 1 to 9 components, were formed via the various variable combinations. The best 3 (and up) component equations appeared more quantitative than the classical or revised CNB with protein, fat, and energy gain predicted at 239g, 119g and 2455 Kcal, respectively and 4,656 Kcal heat production. Utilization of the proposed relationships should enable gain composition studies to be dynamically related with narrow age ranges.

INTRODUCTION

Nutrition studies frequently necessitate that composition of gain, accrued as protein and fat, be defined in short duration age dependent functions. This is becoming more important due to consumer demand for high protein-low fat products and the tendancy of birds to gain more fat as they age (Frostrom and Weihrauch, 1976). Other factors known to influence fat gain include, ration composition

(Hardy and Denman, 1975; Macleod, 1992; Belay and Teeter, 1992), meal size (Lefebvre, Leanness in domestic birds), light pattern (Charles et. al., 1992) and ambient temperature. Considerable margin does indeed exist for lowering broiler carcass fat as such carcasses typically range from 38 to 50% fat (Jackson et al., 1982). For the poultry industry to produce birds with progessivly less carcass fat it is imperative that the interactive effects of ration composition, environment and age be dynamically related in short time intervals.

The determination of gain composition, partitioned by growth curve segment, has classically been estimated using comparative slaughter techniques (Davidson et al., 1964). Comparative slaughter procedures utilize differences between bird initial and final carcass composition to partition gain, during the feeding period specified, into its various components. The feeding period must be long enough to make initial carcass composition variability small, relative to tissue gains, or considerable error will result. Bird composition variability increases with age, averaging about 20% at 4 weeks (Davidson and Mathieson, 1965), making gain composition estimates uncertain. Consequently, progressive day to day changes in carcass tissue gain have not been studied.

Carcass composition determination classically involves processing and grinding birds to yield samples which are then analyzed for nitrogen and fat content by a process that is laborious, time consuming and expensive. Alternatively, indirect methodologies to estimate carcass composition have been proposed including specific gravity (Fortin and Chambers, 1981; Chambers and Fortin, 1984) and carcass dry matter (Hulan et. al., 1983). The disadvantage of these techniques is that the bird is destroyed making it necessary to utilize many birds. Other indirect procedures, not requiring bird sacrifice, include total serum triglyceride and impedance (Harter-Dennis et al. 1992). However, correlations of these methods with carcass fat are typically low.

An indirect method for estomating gain composition with better accuracy uses carbon-nitrogen balance (CNB) to estimate protein and fat accretion rate (Blaxter, 1967; Farrell, 1974). Though the CNB system is labor intensive and costly, it has the advantage of not requiring bird sacrifice thereby enabling multiple observations on the same bird over time under a variety of nutritional and/or environmental conditions.

The CNB technique is based on the assumptions that carcass protein contains 16% N and that protein and fat contain 52 and 76.7% C, respectively. Carbon and nitrogen gain are tallied by summing nitrogen mass balance of intake minus losses in excreta and respiratory gases. Once the quantity of C and N gain is known, fat and protein accretion are predicted as: nitrogen retention (g) x 6.25 = protein gain (in grams); 2) protein gain x 0.52 = carbon retention as protein; 3) total carbon gain - carbon retained as protein = carbon retained as fat; 4)grams fat retained = carbon retained as fat / 76.7 (Blaxter et. al., 1967; Farrell, 1974; McDonald et. al., 1988). However, data substantiating the C and N tissue content, as well as estimate comparisons with comparative slaughter for validation are extremely limited. Other variables, in addition to CNB, that might also be useful in predicting gain composition either alone, or in combinations include energy retention, repiratory quotent, CO_2 production, C intake, O_2, ME and ME_n consumption and heat production. However, no comparitive slaughter data has been utilized to relate combinations of these variables with gain composition.

The objective of the study described herein was to add additional validation to the CNB system by direct comparison with CS data and by establishing the nitrogen and carbon content of isolated protein and fat. Further, objectives of this study include relating the 16 to 42 day posthatching comparative slaughter data with all combinations of variables including C, N, and energy retention, repiratory quotent, CO_2 production and C, O_2, ME and ME_n consumption and heat production with CS protein, fat and energy gain and heat production estimates so that new methodologies might be proposed.

MATERIALS AND METHODS

GENERAL: Twenty four Cobb x Cobb male broiler chicks were brooded as specified by Cobb-Vantress (1987) to day 16 posthatching. On day 16 all birds were deprived of feed and water for 16h and weighed to the nearest gram. Twelve birds were selected at random from the fasted population, sacrificed by cervical dislocation, placed in Ziplock freezer bags, and frozen for later analysis. The remaining birds were randomly allocated to 12 individual respiratory chambers, described in detail by Belay and Teeter (1992) with the exception that 20% of the air exiting the respiratory chambers was diverted through a 71.5% sulfuric acid trap. The acid trap was utilized to estimate NH_3 lost to the atmosphere during the trial. Feed (table 1) and water were continuously provided for ad libitum consumption. Excreta was collected in fecal trays, collected every 2 days to day 30 and daily from day 30 to the end of the trial. All collected excreta was placed in ziplock bags and frozen for later analysis. On day 42, birds were individually weighed, sacrificed by servical dislocation and placed in plastic bags for freezing at -20 C untill analysis. Feed and water consumption measurments were recorded daily (table 5).

BIRD HOMOGENATION: A preleminary test was conducted to determine if nitrogen would be lost from samples autoclaved at $240^{o}C$ and 11 psi. Minced broiler breast meat was anaylzed for N in unautoclaved and autoclaved forms using a micro Kjeldahl procedure (Karasawa, 1989). Results indicated that the autoclaving did not impact (P=.70) tissue N with both samples containing 14.1% N on a dry matter basis. Thus, when tissue samples are autoclaved at 240°F and 11 psi for 24 hours there should be no nitrogen loss. However, in other tests samples that were autoclaved under sterilization conditions (240°C, 11psi) for 24 hrs exhibited 5% N loss.

Carcasses of initial and final slaughter groups were homogenized for laboratory assays as follows: birds were removed from the freezer, feathers on the frozen birds were cut into approximately one quarter inch lengths, birds and feathers were placed in individual 7" X 11" autoclave safe plastic pans covered with aluminum foil weighed and autoclaved (240°F, 11 psi) for 24 hours. Following autoclaving the pans plus birds were reweighed, the tissue homogenized and divided into 2 sample bags for refreezing or analysis. Collected excreta was composited and homogenized without autoclaving as described for the carcasses.

LABORATORY ASSAYS: Carcass, feed, and fecal samples were analyzed for N, fat, energy, ash, (AOAC, 1990), and C (Harjo, 1993). In order to estimate the C and N content of bird proteinaceous and lipid components, bird tissues fractionated by ether extraction into proteinaious and lipid fractions were also analyzed for carbon, nitrogen and ash content. In all cases, a minimum of six subsamples were used in laboratory tests.

Ration AMEn and NE were computed as described by Wolynetz and Sibbald (1989). Bird heat production was estimated using the comparative slaughter data by determining AME consumtion and subtracting the bird energy gain and by using liters of O_2 consumed and liters of CO_2 produced as described by Brouwer (1965): HP = 16.18 (O_2) consumption + 5.02 (CO_2) production.

STATISTICAL ANALYSIS: Data were subjected to ANOVA using general-linear-models (GLM) procedure of Statistical Analysis System (SAS Institute, 1985). When a significant F statistic was indicated, means were separated using Duncan's multiple range test (Steel and Torrie, 1960). Gas response variables, including O_2 consumption and CO_2 production were regressed against time utilizing SAS (SAS, 1995) such that time dependent polynomial equations could be used to describe the data. Bird response variables were then quantified by integrating the polynomial equations under specific time constraints created by the opening of respiratory chambers to either feed birds or collect excrement. All resulting data and integrated values were analyzed by analysis of variance using Proc GLM (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Bird growth rate and feed efficiency (table 5) differed slightly from that projected by the NRC (1984) for 42 day old birds at 1,535 vs 1,690 g gain and .64 vs .56 gain/feed ratio. The determined gross, AME, AMEn and NE values (Kcal/Kg dry matter) for the test ration are 3,114 and 1,129 respectivly. Dietary AMEn at 3.114 deviated slightly from that estimated using tabular values. The efficiency of AMEn utilization (NE/AMEn) averaged 36% which falls in the range of values reported by Jackson et al. (1982; 28.2%), MacLeod (1990; 34-55%) and DeGroote (1974; 35.5%). Differences in efficiency of AMEn use and gain may be due to bird strain or depressed feed consumption while the gain/feed ratio is likely a combination of strain and reduced energy needed for activity.

Homogenized tissues of the 42 day old birds averaged 67.6, 20.1, 9.6 and 2.6% moisture, protein, fat and ash, respectively accounting for 99.9% total mass. Similarly, component summation for the initial slaughter group at 70.9, 18.7 , 7.5 and 2.9% for the moisture protein, fat and ash fractions, respectively, totaled 100.03% of dry matter. Since analet summation accounted for nearly all of bird tissue mass, it may be assumed that the carbohydrate (CHO) contribution to total fasted bird weight mass was negligible. Evidently the fasting periods employed were sufficient to enable the bulk of the CHO to be oxidized.

Bird weight gain partitioned into protein, fat, and energy fractions for individual birds is shown in table 2. The fractions varied considerably among birds with total weight ranging from 985 to 1,307g, protein gain from 195 to 265g, fat gain from 64.4 to 154.1g and energy gain from 2,089 to 2,772 Kcal. Correlation coeffients between bird weight gain with protein, fat, ash and energy were r^2= 0.83, r^2= 0.32, r^2= 0.74, and r^2= 0.69, respectively. Carcass dry matter averaged 29.1% for the initial carcass composition and 32.4% for birds at the conclusion of the trial. Carcass fat content and dry matter of the final slaughter group were well correlated at r^2= 0.82 adding credence to dry matter use as a means to predict carcass fat. In contrast, the initial slaughter group had uniform composition indicating that this was a good age to begin the study.

Tissue carbon and nitrogen composition were determined for whole, ether extracted, and ether extract fractions (table 4). Whole tissue averaged 59.4% C and 10.51% N and 2.58% ash. The ether extracted fraction contained 13.8% ash and 45.12% C per unit dry matter, or 52.96% C on an ash free basis. The 52.96% value used to estimate protein carbon is similar to data reported by Farell (1974) at 52.0% and Argutinsky (1894) at 52.33%. The N content of this protein fraction averaged 15.85%, similar to the 16.0% used for most species (Argutinsky, 1894; Blaxter, 1967; Farrell 1974). The ether extract contained 77.7% C and only 0.2% N. Based on these determined tissue composition values, Blaxter's

(1967) CNB system would be modified as follows:

1) protein gain (g) = nitrogen retention x 6.69

2) protein C gain (g) = protein gain x 0.5296

3) carbon retained as fat = total carbon gain -carbon retained as protein

4) fat gain (g) = carbon retained as fat / 77.1

Overall N, C and energy gains, determined by CS are listed in table 3 with N, C and energy averaging 36.4g, 213.7g and 2455 Kcal per bird. This compares very closely with values of 35.8, 221.5g and 2455 Kcal/Kg (table 5) obtained by summing intake with excreta and respiratory losses. Total liters O_2 consumed and CO_2 produced, RQ and AME and AME_n for individual birds are also listed in table 5.

A summary of possible variable combinations in predictive equations, composed of 1 to 6 variables, for protein, fat and energy gain as well as HP is presented in the appendix. The best of the three component equations for protein, fat, energy and heat production are:

$$\text{grams protein gain} = CO_2*0.14570 + ME*0.82240 + ME_n*-0.84025$$

$$\text{grams fat gain} = CO_2*1.37157 + O_2*-1.22718 + E_{gain}*0.08535$$

$$\text{Kcal energy gain} = N_{gain}*-2.1212 + C_{gain}*12.2063 + RQ*-93.65$$

$$\text{Kcal heat production} = T_{carb}*7.3699 + CO_2*4.77736 + COMPF*-58608$$

To test Farrell's CNB approach and the revised CNB version proposed herein, as well as the best of the three component models for accuracy, CS birds were separated into the top and bottom six values for protein, fat and energy gains and HP. Composition of birds within the two groups was then estimated using the three predictive methods. The estimates along with appropriate CS values were merged into common data sets and evaluated by AOV for technique and technique x group interactions.

The CS and three component equations reported herein agree very closely for the variables tested. The three component equations separated the high and low CS groups at similar values. The two techniques agree so closely that it can be concluded that the two methods may be used interchangeably. However, it is recognized that a better test would utilize independent data sets. All four techniques separated the protein, fat and HP groups with the three component equations being the most accurate when compared to results from CS (table 7). However, the modified CNB was better ($P<.01$) than the Farrell CNB technique for protein gain. But, the Farrell CNB technique did a better ($P<.01$)job predicting energy gain compared to the modified version. The three component technique estimated protein gain better ($P<.01$) than the Farrell CNB method, but was not different from the modified version. There was no significant difference between the four techniques for fat gain.

The deviation of predicted from CS values (table 7) substantiated that the three component estimates fit the data better than the CNB approach, and that the revised CNB estimates are similar to CNB for fat and HP. However, before conclusion related to the three component model may be finalized, it is necessary to utilize independent data sets.

In summary, the data presented herein has been used to validate and revise Blaxter's (1967) CNB system and further to propose over 1,900 predictive equations to estimate either protein, fat and energy gain or heat production of growing broilers. Based on the standard errors of predicted equations, the revised Blaxter procedure proposed herein predicted the protein gain more accurately than did the classical method, although no advantage was observed for fat and energy gain or HP. The three component and higher models resulted in estimates that better fit the CS data. It is anticipated that the large number of predictive equations provided will assist researchers, depending on available facilities, in dynamically evaluating short term age, diet and environmental effects on gain composition and energetic efficiency.

Table 1. Composition of diet used to feed broilers during the 16 to 42 day experimental period

Ingredient	Percent
Corn	48.58
Soy bean meal (48.5%)	42.57
Fat	5.51
Dical	2.00
Limestone	0.60
Vitamin mix [1]	0.25
Salt	0.20
Methionine (99%)	0.15
Trace mineral mix [2]	0.10
Coban	0.04
Total	100.00
Metabolizable energy (Kcal/Kg)	3076
Crude Protein (%)	25
Lysine	1.46
Methionine and cystine	0.93
Phosphorus	0.77

[1] Mix contained Vit A. 3.968.280 I.U.; Vit D_3. 1.102.300 I.U.; Vit E, 13,228 I.U.; Vit B_{12}, 7.9 mg; Riboflavin, 2,646 mg; Niacin. 17,637 mg; d-Pantothenic Acid. 4,409 mg; Choline, 200,178 mg; Menadione, 728 mg; Folic Acid, 441 mg; Pyridoxine. 1.587 mg; Thiamine, 794 mg; d-Biotin, 44 mg per Kg.

[2] Mix contained Manganese. 12.0%; Zinc, 10.0%; Iron. 7.5%; Copper,1.0%; Iodine, .25%; Calcium. 13.5%

Table 2. Comparative slaughter estimates of carcass weight, protein, fat and energy gains during the 16 to 42 day experiment as well as percent bird dry matter

	Bird Number													
	1	2	3	4	5	6	7	8	9	10	11	12	MEAN	SEM
Carcass weight (g)														
Initial	227	247	211	204	245	208	216	215	228	213	231	223	222.3	4.0
Final	1368	1364	1329	1422	1508	1455	1439	1196	1305	1612	1500	1464	1414	31.6
Gain [4]	1190	1108	1156	1227	1248	1168	1238	985	1100	1232	1307	1243	1184	25.1
Carcass protein (g) [1]														
Initial	45.2	49.2	42.0	40.6	48.8	41.4	43.0	42.8	45.4	42.4	46.0	44.4	44.3	.79
Final	279.7	299.3	282.7	297.3	292.2	282.2	309.1	245.2	271.5	282.8	310.4	303.8	288.0	5.3
Gain [4]	234	250	234	253	234	233	261	195	218	240	265	250	238.9	5.5
Carcass fat (g) [2]														
Initial	17.1	18.6	15.9	15.4	18.5	15.7	16.3	16.2	17.2	16.1	17.4	16.8	16.8	.3
Final	125.5	83.1	128.2	134.1	172.6	138.3	147.5	129.1	161.6	148.9	151.8	109.1	135.8	6.9
Gain [4]	108.4	64.4	112.2	118.7	154.1	122.6	131.3	112.8	144.4	132.9	134.4	92.3	119.1	6.9
Carcass energy (kcal) [3]														
Initial	402.7	438.1	374.3	361.9	434.6	369.0	383.1	381.4	404.4	377.8	409.7	395.6	394.4	7.1
Final	2821	2527	2819	2941	3207	2780	3022	2486	2949	2945	3056	2638	2849	62.4
Gain [4]	2419	2089	2445	2579	2772	2411	2639	2105	2545	2568	2646	2243	2455	62.3
Initial carcass (dm)	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	------	---
Final carcass (dm)	32.1	30.6	32.9	32.6	32.0	31.1	34.0	33.1	35.0	28.9	33.3	30.4	32.2	.45

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[1] Grams protein in initial carcass = grams nitrogen in carcass x 6.69
Grams protein in final carcass = bird dry matter gain - fat gain - ash gain

[2] Grams fat in initial carcass = grams bird dry matter x (% carcass fat / 100)
Grams fat in final carcass = ((% carcass fat / 100) x (bird weight x (bird dry matter / 100)))

[3] Grams energy in initial carcass = grams bird dry matter x (Kcal carcass energy / 1000)
Grams energy in final carcass = ((Kcal carcass energy / 1000) x (bird weight x (bird dry matter / 100)))

[4] Gain = final - initial

Table 3. Comparative slaughter estimates of nitrogen, carbon and energy gains during the 16 to 42 day experimental period

	Bird Number													
	1	2	3	4	5	6	7	8	9	10	11	12	MEAN	SEM
Initial weight	227	247	211	204	245	208	216	215	228	213	231	223	222	4.0
Final weight	1368	1364	1329	1422	1508	1455	1439	1196	1305	1612	1500	1464	1414	31.6
Nitrogen (g)[1]														
Initial	6.8	7.4	6.3	6.1	7.3	6.2	6.4	6.4	6.8	6.3	6.9	6.6	6.6	.11
Final	41.8	44.7	42.3	44.4	43.7	42.2	46.2	36.7	40.6	42.3	46.4	45.4	43.0	.78
Gain[4]	35.1	37.4	36.0	38.4	36.4	36.0	39.8	30.0	33.8	35.9	39.5	38.8	36.4	.75
Carbon (g)[2]														
Initial	35.2	38.3	32.7	31.6	38.0	32.2	33.5	33.3	35.3	33.0	35.8	34.5	34.4	.61
Final	245.8	223.0	245.5	258.1	278.1	241.4	263.4	216.8	255.1	255.6	263.3	231.5	248.1	5.14
Gain[4]	210.7	184.7	212.8	226.5	240.2	209.2	230.0	183.5	219.7	222.6	227.5	196.9	213.7	5.14
Energy (Kcal)[3]														
Initial	402.7	438.1	374.3	361.9	434.6	368.9	383.1	381.4	404.4	377.8	409.7	395.6	394.4	7.07
Final	2821	2527	2819	2941	3207	2780	3022	2486	2949	2945	3056	2638	2849	62.4
Gain[4]	2419	2089	2445	2579	2772	2411	2639	2105	2545	2568	2646	2243	2455	62.27

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[1] Initial nitrogen = initial bird grams dry matter x (9.88 / 100)
Final nitrogen = ((% tissue nitrogen dry matter/ 100) x (bird weight x (% tissue dry matter of a wet sample / 100)))

[2] Initial carbon = initial bird grams dry matter x (51.4 / 100)
Final carbon = ((% bird carbon dry matter/ 100) x (bird weight x (% tissue dry matter of a wet sample / 100)))

[3] Initial energy = initial bird grams dry matter x (5885.18 / 1000)
Final energy = ((% bird energy dry matter / 1000) x (bird weight x (% tissue dry matter of a wet sample / 100)))

[4] Gains = final - initial

Table 4. Moisture free whole bird carbon and nitrogen content and moisture and ash free ether extracted tissue and ether extract of birds completing the 28 day study

	Bird Number													
	1	2	3	4	5	6	7	8	9	10	11	12	Mean	SEM
Whole carcass [1]														
Carbon (%)	61.0	58.8	61.1	60.6	61.2	58.5	58.5	59.2	60.1	59..3	57.0	57.5	59.40	0.41
Nitrogen (%)	10.9	12.4	11.0	10.8	9.6	10.2	10.3	10.0	9.6	9.9	10.0	11.3	10.51	0.24
Ether extracted tissue [2]														
Carbon (%)	52.9	53.4	52.9	52.5	53.6	52.6	52.2	53.6	52.5	53.5	52.7	53.3	52.96	0.14
Nitrogen (%)	15.5	15.9	15.9	15.7	16.0	15.7	15.6	16.3	16.0	15.9	15.9	15.8	15.85	0.06
Ether extract [3]														
Carbon (%)	80.0	79.9	79.5	78.9	74.3	70.6	71.6	69.9	72.9	71.0	65.3	68.9	73.56	1.4
Nitrogen (%)	0	0	0	0	0	0	0	0	0	0	0	0	------	-----

[1] % Carbon = tissue carbon / ((% tissue dry matter - % tissue ash) / 100)
% Nitrogen = % tissue dry matter nitrogen / ((% tissue dry matter - % tissue ash) / 100)

[2] % Carbon = ether extracted carbon / ((% extracted tissue dry matter - % extracted tissue ash) / 100)
% Nitrogen = % extracted tissue dry matter nitrogen / ((% extracted tissue dry matter - % extracted tissue ash) / 100)

[3] % Carbon = (((nitrogen gain x 6.69) x 0.5231) / ((grams bird dry matter - total bird ash / grams bird dry matter)))

Table 5. Bird feed consumption, water consumption, gain and gain/feed ratio as well as nitrogen,caarbon and energy gain estimated by a summation of intake and excretion along with ration AME and AMEn values

	Bird Number													
	1	2	3	4	5	6	7	8	9	10	11	12	Mean	SEM
Initial weight (g)	227	247	211	204	245	208	216	215	228	213	231	223	222	4.0
Final weight (g)	1368	1364	1329	1422	1508	1455	1439	1196	1305	1612	1500	1464	1414	31.6
Feed cons (g dm)	2511	2328	2238	2463	2595	2288	2475	2041	2312	2550	2787	2381	2397	47.5
Water cons (mL)	5640	4800	4670	6390	6180	4930	6355	5290	5760	6070	6810	5940	5736	198.2
Gain (g)	1190	1108	1156	1227	1248	1168	1238	985	1100	1232	1307	1243	1184	25.1
Gain/Feed	.47	.48	.52	.50	.48	.51	.50	.48	.48	.48	.51	.52	.49	0.018
NITROGEN [1]														
Intake (g)	92.7	85.9	82.6	90.9	95.7	84.4	91.3	75.3	85.3	94.1	95.5	87.9	88.5	1.8
Excreta (g)	58.3	50.5	50.5	46.1	63.4	50.0	49.5	46.8	56.3	58.5	56.9	45.3	52.7	1.6
Respiratory (g)	0	0	0	0	0	0	0	0	0	0	0	0	------	-----
Gain (g)	34.4	35.4	32.1	44.8	32.3	34.4	41.8	28.5	29.0	35.6	38.6	42.6	35.8	1.51
CARBON [2]														
Intake (g)	1015	941	904	996	1049	925	1000	825	935	1031	1046	963	969.1	19.2
Excreta (g)	355.5	318.7	310.3	303.8	369.1	322.4	303.6	304.4	310.1	348.9	343.2	296.3	323.9	6.9
Respiratory (g)	442.5	424.8	379.6	447.7	450.6	392.3	444.5	327.8	405.9	464.6	474.1	430..9	423.8	11.92
Gain (g)	217.0	197.5	214.1	244.5	229.3	210.3	251.9	192.8	219.0	217.5	228.7	235.8	221.5	5.1
ENERGY [3]														
Intake (Kcal)	10974	10177	9779	10766	11340	9999	10815	8922	10104	11145	11308	10408	10478	207.6
Excreta (Kcal)	3676	3230	3104	3130	3745	3320	3113	3090	3151	3588	3528	3044	3310	73.5
Respiratory (Kcal)	4857	4725	4217	4929	4919	4293	4856	3584	4431	5067	5183	4780	4653	129.5
Gain (Kcal)	2419	2089	2445	2579	2772	2411	2639	2105	2545	2568	2646	2243	2455	62.3
O_2 Consumption (L)	999.6	975.7	870.5	1015.4	1010.9	882.9	998.4	737.0	910.8	1041.3	1065..6	986.5	957.9	26.6.
CO_2 Consumption (L)	826.1	793.0	708.6	835.7	841.2	732.4	829.7	612.0	757.8	867.3	885.1	804.4	791.1	22.2
Respiratory Quotient	0.83	0.81	0.81	0.82	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.82	0.83	0.002
AME (dm) [4]	3.2	3.2	3.2	3.4	3.2	3.2	3.4	3.1	3.3	3.2	3.3	3.4	3.25	0.03
AMEn (dm) [5]	3.0	3.1	3.1	3.2	3.1	3.0	3.2	3.0	3.1	3.1	3.1	3.2	3.12	0.02

[1] Nitrogen gain = grams nitrogen consumed - grams nitrogen excreted - nitrogen lost during respiration

[2] Carbon gain = grams carbon consumed - grams carbon excreted - carbon lost as CO_2

[3] Energy gain = Kcal energy consumed - Kcal energy excreted - energy lost as heat

[4] AME (dm) = (energy intake - fecal energy)/ dry matter intake

[5] AMEn (dm) = (energy intake - fecal energy-(8.22 x nitrogen gain))/ dry matter intake

Table 6. Protein , fat , energy and heat production values as estimated by both direct and indirect methodologies

	Treatments[1]		
	Low Group	High Group	SEM
Carcass protein gain (g) [2]			
Comp slaughter	226.9	255.7	5.51
Farrell	217.3	242.2	4.79
Modified Farrell	232.6	259.3	5.1
3-variable equation	227.5	255.0	5.4
Carcass fat gain (g) [3]			
Comp slaughter	101.5	136.1	6.9
Farrell	111.6	136.8	6.1
Modified Farrell	118.1	125.5	4.6
3-variable equation	102.1	136.1	6.7
Carcass energy gain (Kcal) [4]			
Comp slaughter	2285.1	2624.7	62.3
Farrell	2308.0	2648.5	62.3
Modified Farrell	2390.0	2639.6	52.7
3-variable equation	2286.3	2623.6	62.0
Carcass heat prod (Kcal) [5]			
Comp slaughter	4158.8	4990.6	129.6
Farrell	4131.3	4914.5	129.5
Modified Farrell	4178	4978	130.5
3-variable equation	4156.4	4906.6	123.1

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[1] Birds for each category were separated into the lowest and highest six birds based on comparative slaughter values so that the ability of predictive equations to separate treatment means could be judged.

2 Comp slaughter = bird dry matter - fat gain - ash gain
Farrell = nitrogen gain x 6.25
Modified Farrell = nitrogen gain x 6.69
3-variable equation = (0.1457 x CO_2) + (0.8224 x AME consumption) - (0.84025 x AMEn consumption)

3 Comp. slaughter = total bird gram fat - grams fat in initial birds
Farrell = (carbon gain - ((nitrogen gain x 6.25) x 0.52)) / 0.767
Modified Farrell = (total bird carbon - % carbon in protein) / 0.77
3-variable equation = (1.37157 x CO2) - (1.22718 x O2) + (0.08535 x energy gain)

4 Comp. slaughter = total bird Kcal energy - Kcal energy in initial birds
Farrell = (51.83 x carbon gain - 19.38 x nitrogen gain)/ 4.184
Modified Farrell = energy intake - fecal energy - heat production
3-variable equation = -2.1212 x bird nitrogen gain + 12.2063 x carbon gain - 93.65 x respiratory quotient

5 Comp. slaughter = apparent metabolizable energy consumption Kcal - energy gain Kcal
Farrell = (16.18 x O2 + 5.02 x CO2)/4.184
Modified Farrell = (12.2472 x O2) + (-8.87268 x CO2)
3-variable equation = 7.36988 x carbon gain + 4.77736 x CO2 pod. - 5.8608 x (total bird fat - initial bird fat)

Table 7. Difference of Farrell and modified Farrell carbon-nitrogen balance methods and the three component equation technique from comparative slaughter values for protein, fat, energy and heat production values

	Deviation from CS values [1,2]			
	Protein (g)	Fat (g)	Heat prod (Kcal)	Energy (Kcal)
Farrell	11.3 ^{a}	5.2	59.1	23.3 ^{b}
Modified Farrell	4.8 ^{b}	2.8	1.4	59.4 ^{a}
3-component equation	0.01 ^{c}	0.07	56.7	0.03 ^{c}

[1] The difference between CS values and the specified method appear in the table

[2] Values within a column with unlike superscripts differ ($P<.01$)

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CHAPTER V

EFFICACY OF YEAST AS A SOURCE OF DIETARY PROTEIN AND TO AMELIORATE NONSPECIFIC ANTIGEN CONSEQUENCES IN BROILERS REARED IN HEAT DISSTRESSED AND THERMONEUTRAL ENVIRONMENTS

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ABSTRACT

Two experiments were conducted to evaluate the efficacy of supplemental dietary yeast on body weight, feed efficiency and survivability of male and female broilers reared in thermoneutral (TN, 24 C) and heat distress (HD, 24 -35 C) environments. In Experiment 1, at TN environment, irrespective of sex, yeast substitution for soybean meal linearly increased (P<.01) chicks body weight and numerically improved (P>.1) feed consumption and feed efficiency. In Experiment 2, HD decreased (P<.05) body weight, feed efficiency and survivability. Irrespective of environment, when the grower diet was supplemented with 0 or

1% poultry litter, yeast supplementation numerically ($P>.1$) improved body weight, survival rate, and increased feed efficiency ($P = .062$). In conclusion, yeast substitution for soybean meal improved bird growth rate and when supplemented to the complete ration it improved survival rate.

Key words: yeast, broilers, heat distress, litter

DESCRIPTION OF PROBLEM

Direct fed microbials (DFM) have been included in feed or water to enhance gastrointestinal tract health (Hutchinson et al., 1991). The term "probiotics" is frequently used to describe these microbials (Fuller, 1989).

Bird responses to DFM is controversial. Miles et al. (1981b) was not able to observe DFM effects on growth, feed efficiency, or mortality in quail. Burkett et al.(1977), however, reported that in broilers yeast supplementation improved feed efficiency during the first four weeks posthatching. Guevara (1977) reported that increased dietary supplemental yeast level lowers growth rate and feed utilization in broilers. Plavnik and Scott (1980) reported in one experiment that brewer's yeast at a 10% level has no effects on body weight or efficiency of feed utilization of broilers, while in the second experiment, they observed that dietary supplemented brewer yeast at 2.5, 5%, or 10% level increased growth and feed efficiency in chicks raised at 32^{o}C environmental temperature. Elbert et al. (1987)

reported that caged layer performance was not effected when birds were fed .25 or .50% dietary yeast. Thayer et al. (1978) reported an improvement in egg production, egg weight, and hatchability in turkeys fed diets containing 2.5% yeast. The discrepancy in results may have been due to the level of dietary yeast used.

Poultry litter effects on broiler performance, like DFM, is also controversial. Flegal and Zindel (1970a; 1970b) reported an inverse relationship between increased dietary poultry waste and broiler's weight gain, feed efficiency and egg production. In contrast, Lee and Blair (1972; 1973) observed improved weight gain and feed efficiency in broilers and increased egg weight and egg mass in layers fed poultry litter. However, Trakulchang and Balloun (1975) reported that feeding 10 and 20% poultry waste does not affect broiler weight gain and feed efficiency. Coon et al. (1978) also reported no weight gain, feed efficiency, and feed consumption effects when poultry waste ranging from 2.5 to 7.5% was included in broiler diets. The objective of this study was to: 1) evaluate yeast (Pichia pastoris) substitution effects for soybean meal and 2) evaluate Diamond V Mills dried yeast culture efficacy on growth, feed efficiency and survivability of broilers during thermoneutral and heat distress environments.

MATERIAL AND METHODS

Experiment 1

An experiment utilizing one thousand Tatum x Tatum broiler males and females was conducted to evaluate efficacy of Pichia pastoris yeast as a partial protein substitute. Treatments (trt) evaluated included: 1. basal ration with 0% yeast; 2. basal ration plus 2.5% dietary yeast; 3. basal ration plus 5% dietary yeast; 4. basal ration plus 10% dietary yeast. Each trt was replicated 10 times such that there were 25 birds per replication, five of which were female. Birds received their respective trt starting on Day 1 posthatching. Starter (1-21 days) and grower diets (21-42 days) were formulated to be isocaloric, isonotrogenous, and isosulfarrous while exceeding National Research Council (NRC, 1984) recommendations. Feed (Table 1.) and water were provided for ad libitum consumption. Weight gain, feed consumption, feed efficiency and survivability were determined per pen at 21 and 42 days posthatching. Feed efficiency was adjusted for mortality by weighing birds that died and adding the weight to the appropriate pen weight.

Data were analyzed for yeast, sex and block main effects and interactions using analysis of variance in the General Linear Models (GLM) procedure of SAS (SAS Institute, 1985). When significant differences were noted for the *F* statistics, means were separated using Duncan's (1955) multiple range test.

Experiment 2

A total of 1,296 Cobb x Cobb male broilers were randomly divided at hatching into 3 groups and fed diets composed of: 1. basal corn-soy diet; 2. as 1 plus .25% yeast supplementation; and 3. as 1 plus 1.25% supplemented yeast (Saccharomyces cerevisiae obtained from Diamond V Mills) . Birds were reared in floor pens and fed the starter ration to 28 days posthatching with feed and water available for ad libitum consumption. On day 28 birds were switched to a similarly fortified finisher diet (Table 1), with 1% rice hulls or 1% poultry litter, and transferred to 61 X 82 grower batteries for thermoneutral (TN, 24 C) and cyclic temperature (24 - 37 C) heat-distressed (HD) exposure. Days 28 through 30 posthatch were used to adjust birds to chamber surroundings with ambient temperature maintained at 24 C. Following the 2 day acclimation period to environmental chambers the chicks were fasted overnight and their individual body weights recorded

The six trt groups consisted of twelve replicates of six birds per replicate randomly assigned to TN and 24 replicates of six birds per replicate assigned to HD. On day 30 the ambient temperature of the environmental chamber designated for HD was increased such that by Day 32 the chamber provided 6 h daily in excess of 32 C peaking at 35 to 37 C and environmental chamber designated for TN was maintained at 24 C.

Variables evaluated at day 49 included final body weight, feed efficiency, feed efficiency adjusted for mortality, and survivability. Data were subjected to ANOVA using general-linear-models (GLM) procedure of Statistical Analysis system (SAS Institute, 1985). When a significant *F* statistic was indicated for treatment, environment, or interactions means were separated using Duncan's multiple range test (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Experiment 1.

The data are presented on Table 2 and 3. Since there were no trt by sex interactions observed, the data were pooled. As expected no block effects for any of the production parameters were observed.

At 21 and 42 days posthatching, there was a sex effect ($P<.05$) on body weight and feed consumption being higher for males than females. At 21 and 42 days of age, birds fed 10% dietary yeast had greater ($P<.05$) body weight while there was a numerical improvement in body weight with 2.5 and 5% dietary supplemented yeast as compared with the control group.

At 21 days of age, feed consumption numerically increased as dietary yeast was elevated. While, at Day 42 posthatching, there was a numerical but non-significant decrease in feed consumption as dietary percentage yeast increased.

There was no sex effects associated with feed efficiency adjusted for mortality at either 21 or 42 days of age. At Day 21 posthatching, feed efficiency adjusted for mortality was improved with increased yeast supplementation trt (1 vs. 3) or trt (1 vs. 4) and there was no significant feed efficiency effects for trt 2 (2.5% yeast) compared with trt 1 (0% yeast).

At 42 days of age, feed efficiency was not influenced with 2.5 and 5% yeast supplementation. While, feed efficiency increased (P<.05) with 10% yeast supplementation as compared with control group. However, total feed efficiency adjusted for mortality numerically improved with yeast supplementation. No survivability differences between two sex noted at either 21 and 42 days posthatching. At Day 21 posthatching, survivability was noted different among trt investigated. At 42 days of age, 2.5, 5, and 10% supplemental yeast did not influence survival percentage.

Experiment 2.

Compared to the thermoneutral chamber, exposing control birds to heat distress reduced (P<.05) final bird weight 6% (1975 vs 1856g), efficiency of gain unadjusted for survivability ability (.50 vs .47) and bird survivability 12.7% (94 vs 82%). The reduced bird survivability resulted in a 3.5% increase in the feed consumption attributed to each bird surviving the study. Adjusting feed efficiency for survivability by including the weight gain of birds dying of heat prostration improved feed efficiency of heat distressed birds to .49 which did not differ from the thermoneutral controls. Overall the environmental impact upon growth rate and feed efficiency if typical of what might be encountered by poultry producers.

Several main effects and interactions were significant for litter and yeast addition to the basal ration. Overall, litter addition to the basal ration reduced (P<.01) final bird weight by 4.9% (Table 1). However, the litter suppression was more apparent in the thermoneutral environment (6%) than the heat distressed (2%) where performance was already suppressed. Litter effects on the feed consumption, feed efficiency and survival were not significant. Yeast supplementation numerically increased final bird weight from 1848 to 1884 and 1872g for the 0, .25 and 1.25% inclusion levels, respectively. The response was consistent across litter and temperature criteria. Yeast supplementing main effects, averaged across both litter and temperature treatments, resulted in feed efficiency increasing from .475 to .490 (P=.062) for the 1.25% supplementation level with the .25% level being intermediate. The yeast X litter interaction for feed efficiency borderlined on significance (P=.15) with the data suggesting that the yeast is more efficacious in birds consuming litter as the product hat a 5% improvement in litter fortified rations and just .6% in rations without litter.

Neither the main affect for yeast culture or litter on bird survivability was significant (P>.02). However, the interaction between yeast and litter supplementation for bird survivability was significant (P=.078). Within the thermoneutral environment yeast supplementation numerically improved bird survivability consistently within litter fortification averaging 90.7, 96.5 and 95.4% for the 0, .25 and 1.25% levels, respectively. Within the heat distressed environment, without litter, yeast supplementation had no impact on the temperature suppressed survivability. Within the heat distressed litter fortified groups yeast supplementation linearly improved survivability at 73.5, 79.2 and 84.4% for the 0, .25 and 1.25% fortification levels, respectively (Table 2). The bird survivability response was significant (P<.01) for the 73.5 vs 84.4 contrast. This affect fits with our hypothesis that increased immune challenge during heat distress will increase heat production and thereby elevate bird mortality.

Table 1. Composition of starter and grower rations used for experiment 1.

	Dietary Yeast Supplementation (%)							
	0		2.5		5		10	
Ingredient	Starter	Grower	Starter	Grower	Starter	Grower	Starter	Grower
Ground corn	54.20	64.60	54.20	64.60	54.20	64.60	54.20	64.60
Soybean meal	29.56	24.01	19.63	36.75	29.85	24.38	34.41	37.82
Animal fat	2.00	------	2.23	0.23	2.46	0.46	2.92	0.92
Dical [1]	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
Limestone	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vit. mix . [2]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
D-L-meth	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Trace min.[3]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Yeast	--------	--------	2.50	2.50	2.50	2.50	2.50	2.50
Glutamic acid	0.96	0.76	0.72	0.74	0.48	0.65	--------	-------
Urea	--------	0.14	0.10	--------	0.07	--------	--------	-------
Polyethylene	--------	--------	0.01	0.05	0.02	--------	0.60	-------
Rumensin	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04

	MEn (Kcal/Kg)	Crude Protein
Corn	3350	8.8
Soybean meal	2440	48.5
Fat	8800	------
Glutamic acid	4000	9.52 (60% N)
Yeast	2160	61.4

[1] Dical = Dicalcium phosphate

[2] Vit. mix = Vitamin

[3] Trace min. = Trace mineral mix

Table 2. Yeast supplementation effects on body weight, feed consumption, feed efficiency, mortality adjusted feed efficiency (FEA) and survivability (Surv) of broiler chickens at 21 and 42 days posthatching.

	DIETARY YEAST (%) SUPPLEMENTATION			
Variables	0	2.5	5	10
Body weight (g)				
Day 21	622 ± 6.5b	638 ± 6.5ab	640 ± 6.5ab	654 ± 6.5a
Day 42	1660 ± 14.9b	1681 ± 14.9b	1701 ± 14.9ab	1741 ± 14.9a
Feed Cons (g)				
Day 21	861 ± 10.2	885 ± 10.2	875 ± 10.2	887 ± 10.2
Day 42	2367 ± 38.7	2362 ± 38.7	2342 ± 38.7	2343 ± 38.7
FEA				
Day 21	.73 ± .01ab	.725 ± .01b	.747 ± .01ab	.749 ± .01a
Day 42	.513 ± .01b	.516 ± .01b	.521 ± .01ab	.536 ± .01a
Surv (%)				
Day 21	97	98	95	96
Day 42	96a	96a	90b	94ab

Table 3. Sex effects on body weight, feed consumption, feed efficiency, mortality adjusted feed efficiency (FEA) and survivability of broiler chickens at 21 and 42 days posthatching.

Variables	Male	Female
Body weight (g)		
Day 21	682 ± 4.57a	595 ± 4.57b
Day 42	1834 ± 10.54a	1558 ± 10.54b
Feed cons (g)		
Day 21	929 ± 7.2a	824 ± 7.2b
Day 42	2543 ± 27.3a	2164 ± 27.3b
FEA		
Day 21	.74 ± .01	.73 ± .01
Day 42	.54 ± .01	.53 ± .01
Surv (%)		
Day 21	97	96
Day 42 96a	93	95

Neither the main affect of yeast culture or litter on bird survival was significant (P>.2). A significant yeast X litter interaction was detected for bird survivability (P=.078).

Table 4. Dietary yeast supplementation effects on body weight, feed efficiency, and survivability of fed 1% poultry litter (Experiment 2).

Variables	Treatment				
	Basal diet	.25 % yeast	1.25 % yeast	Mean	Pooled SE
Body weight (g)					
Rice hull	1893^{x}	1909	1918^{x}	1907^{x}	18.46
Poultry litter	1804^{y}	1858	1825^{y}	1829^{y}	18.46
Mean	1848	1884	1872		12.26
Feed efficiency					
Rice hull	$.49^{x}$	.48	.50	.49	.01
Poultry litter	$.46^{by}$	$.49^{a}$	$.49^{a}$	.48	.01
Mean	.48	.49	.50		.01
Survivability (%)					
Rice hull	88^{x}	87	88	88	1.3
Poultry litter	82^{by}	88^{a}	90^{a}	87	1.3
Mean	85^{b}	87^{ab}	89^{a}		1.3

[a,b] Means within a row with no common superscripts are significantly different ($P<.05$).
[x,y] Means within column with no common superscripts are significantly different ($P<.05$).

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CHAPTER VI

SUMMARY AND CONCLUSIONS

The interaction between high ambient temperature-relative humidity distress and reduced broiler performance has long been recognized. The problem of reduced growth rate, feed efficiency and survival is compromised due to the combination of environmental heat and metabolic heat production. Various management practices have been recommended to aleviate heat distress prostration in broilers. Acclimatizing birds to heat disstress has been sugested to improve bird survivability, feed efficientcy, and growth rate, when subjected to acute heat distress as compared to non-acclimated birds. In addition, direct fed microbials have been reported to enhance growth rate, feed efficiency and survival during heat distress when used in rations both the starter and grower rations. The affect is believed to be a result of increased intestinal health through development and establishment of a population of beneficial microflora in the gut. Nutrition studies frequently necessitate that composition of gain, accrued as protein and fat, be defined in short duration-age dependent functions. There are numerous methods to determine compostion but none are without assumptions that make them less than appealing. Thus a study was conducted to develop/modify and validate a method to determine gain composition while eleminating needless assumptions.

The first study, was conducted to (1) evaluate the ability of the day-5 posthatching acclimation technique to licrease live weight gain (2) determine if the day-5 acclimation technique has an interaction effect on cool and warm brooding temperatures and (3) to use a 6h fasting technique as a positive control to test the intensity of the heat distress. The results of the study indicated that brooding chicks at the higher ambient temperature reduced live weight gain, while the feed effencincy was similar for both the brooding and acclimation treatments (trts). However, the cool brooded trts had a better survivablity than the warm brooded trts which may be explaned by the fact that the warm brooded birds were induring a heat distress due to their brooding environment as shown by the reduced growth rate. Note the fasted trt had the highest survivability while maintaining a similar feed effencicy and body weight. These results indicate that the day-5 posthatching acclimation technique does not benefit the birds when heat distress is incured, while fasting birds 6h prior to heat distress exposure will beneficially affect bird survivability without reducing weight gain.

The second study was conducted to validate a carbon and Nitrogen technique by direct comparison with comparative slaughter by establishing the nitrogen and corbon content of isolated protein and fat. In addition, it was a objective to relate comparative slaughter data with all combinations of variables including C, N, and energy retention, repiratory quotent, CO_2 production and C, O_2, ME and ME_n comsumption and heat production. Tissue C and N in broiler protein and fat was determined to be 52.96, 15.85, 77.1 and .2% respectively which differed slightly from classical values. Over 1925 equations, composed of 1-9 components were formed via various variable combinations. The best 3 components equations appeared more quantitative than the classical or revised CNB with protein, fat, and energy gain predicted at 239, 119, and 2455, respectively and 4,656 Kcal heat production. Utilization of the proposed relationships should enable gain composition studies to be dynamically related with narrow age ranges.

The third study had two experiments the first was conducted to evaluate the effects of substituting yeast (*Pichia pastoris*) for soybean meal; the second experiments was conducted to evaluate Diamond V Mills dried yeast culture for efficacy to increase growth, feed efficiency and survivability of broilers during thermoneutral and heat distress environments. The results of experiment 1 indicated that yeast (*Pichia pastoris*) supplementation increased body weight at a 10% inclusion level but only numarically improved body weight at 2.5 and 5% levels. Feed efficiency followed a similar patter as body weight as only yeast inclusion at the 10% level resulted in an improvement.

However, there was no improvment on survivability with any of the yeast inclusion levels.

The results of experiment two indicated that the addition of poultry litter to the basal ration as a non-specific antigen reduced the final bird weight of those birds recieving the ration. While the litter effects on feed consumption, feed efficiency and survival were not significant. Yeast supplementation numerically increased final bird weight across litter and temperature criteria. Yeast also numerically improved (within the thermoneutral environment) bird survivability consistently within litter fortificaition with the highest inclusion level providing the best survivalability. Within the heat distress environment yeast improved bird survivability for those treatments that consumed the poultry litter but had no effect on the other treatments. The results reported suggest that yeast can be subsituted for soybean meal without decreasing productivity. In addition it is suggested that yeast supplemented to broiler rations has a benificial effect when the birds immunologically challenged during an acute heat distress.

APPENDIX

PREDICTIVE EQUATIONS FOR MULTIPLE VARIABLE COMBINATIONS

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                                         total fat gain predictive equations

OBS    _RMSE_   _ANGAIN_    _CGAIN_       _RQ_      _CO2_       _O2_    _MECON_   _MENCON_    _EGAIN_    _COMPP_   _P_      _RSQ_      _CP_

151    7.0952      .          .          -16.741      .         -0.03314      .          .          0.11822   -0.52546     4    0.99743    47.178
152    7.0978    0.46686      .            .          .            .          .       -0.00548    0.12095   -0.65645     4    0.99743    47.216
153    7.0979    0.46885      .            .          .            .       -0.00552      .          0.12104   -0.64980     4    0.99743    47.218
154    7.1016      .          .            .          .         -0.06689      .        0.00931    0.10815   -0.61207     4    0.99743    47.273
155    7.1051      .          .            .          .         -0.06453    0.00886      .          0.10836   -0.62178     4    0.99743    47.324
156    7.1135      .       -5.97737        .          .         -0.16630    0.01312      .          0.59541      .         4    0.99742    47.448
157    7.1151      .          .            .          .         -0.13473   -0.48478    0.50357    0.10766      .         4    0.99742    47.472
158    7.1681    0.36113      .            .       -0.01702        .          .          .          0.11592   -0.69027     4    0.99738    48.255
159    7.2020    0.33181      .           -4.197      .            .          .          .          0.11471   -0.71534     4    0.99735    48.761
160    7.2142      .          .          -12.171      .            .          .       -0.00414    0.11892   -0.56245     4    0.99735    48.943
161    7.2160      .          .          -12.031      .            .       -0.00410      .          0.11889   -0.55856     4    0.99734    48.970
162    7.2211      .          .          -13.871   -0.02186        .          .          .          0.11678   -0.58110     4    0.99734    49.046
163    7.2251    0.10778   -5.41416        .          .         -0.10559      .          .          0.55943      .         4    0.99734    49.107
164    7.2407      .          .            .          .            .        0.08938   -0.09246    0.11495   -0.70586     4    0.99733    49.340
165    7.2516      .          .            .        0.00623        .          .       -0.00463    0.11681   -0.58893     4    0.99732    49.504
166    7.2531      .          .            .        0.00444        .       -0.00432      .          0.11668   -0.58516     4    0.99732    49.526
167    7.4677    0.53985      .            .          .            .       -0.48151    0.47040    0.13045      .         4    0.99716    52.800
168    7.5546      .       -5.15810      -26.870   -0.11645        .          .          .          0.54405      .         4    0.99709    54.153
169    7.5578      .          .            .       -0.06814        .       -0.46560    0.46864    0.11876      .         4    0.99709    54.204
170    7.6387      .          .          -7.9190      .            .       -0.40302    0.39393    0.12576      .         4    0.99702    55.478
171    7.7178      .       -5.36418        .       -0.08581        .       -0.00538      .          0.55881      .         4    0.99696    56.737
172    7.7358      .       -5.90455        .       -0.12941        .          .        0.00200    0.59860      .         4    0.99695    57.026
173    7.7374    0.02979   -5.82278        .       -0.11896        .          .          .          0.59328      .         4    0.99695    57.051
174    7.7601      .       -4.09021     -19.3104      .            .       -0.01834      .          0.46457      .         4    0.99693    57.416
175    7.7603    0.37579   -4.89993        .          .            .       -0.02141      .          0.53207      .         4    0.99693    57.420
176    7.7608   -1.94732      .            .        1.64060     -1.75973      .        0.08394      .            .         4    0.99693    57.427
177    7.7704   -2.01846      .            .        1.74098     -1.82967    0.07906      .          .            .         4    0.99692    57.582
178    7.8932      .       -4.20584     -21.3160      .            .          .       -0.01863    0.47390      .         4    0.99682    59.576
179    7.9489    0.28968   -4.98683        .          .            .          .       -0.02114    0.53752      .         4    0.99678    60.489
180    8.3561      .        1.28980        .          .         -0.13131   -0.53563    0.55451      .            .         4    0.99644    67.371
181    8.3617      .        1.42004     -20.3897      .         -0.02852      .          .          .         -0.58670     4    0.99643    67.469
182    8.4085      .        1.29513        .          .         -0.05699      .        0.00838      .         -0.67198     4    0.99639    68.281
183    8.4123      .        1.29907        .          .         -0.05411    0.00779      .          .         -0.67990     4    0.99639    68.348
184    8.4343      .        1.43058     -16.7276      .            .          .       -0.00372      .         -0.61616     4    0.99637    68.732
185    8.4348      .        1.43078     -16.6279      .            .       -0.00372      .          .         -0.61199     4    0.99637    68.740
186    8.4422    0.09295    1.37562        .          .         -0.02179      .          .          .         -0.65808     4    0.99636    68.870
187    8.4546      .        1.43201        .        0.04378        .          .       -0.01025      .         -0.63228     4    0.99635    69.088
188    8.4574      .        1.43023        .        0.04091        .       -0.00979      .          .         -0.62216     4    0.99635    69.136
189    8.4614      .        1.39422     -16.5120   -0.01253        .          .          .          .         -0.64984     4    0.99635    69.206
190    8.4775    0.01671    1.37387     -13.6614      .            .          .          .          .         -0.68549     4    0.99633    69.490
191    8.4785    0.15820    1.40284        .          .            .       -0.00349      .          .         -0.67489     4    0.99633    69.507
192    8.4789    0.15659    1.40172        .          .            .          .       -0.00344      .         -0.67937     4    0.99633    69.514
193    8.4937      .        1.38813        .          .            .       -0.02046    0.01745      .         -0.63075     4    0.99632    69.774
194    8.5108    0.09525    1.35771        .       -0.00595        .          .          .          .         -0.71013     4    0.99631    70.077
195    8.7298   -0.82144      .         -64.5011      .         -0.10021      .          .          0.12130      .         4    0.99611    73.989
196    8.7328    0.24286    1.52778        .          .            .       -0.50762    0.49830      .            .         4    0.99611    74.043
197    8.7406      .        1.52330     -11.5678      .            .       -0.45449    0.44565      .            .         4    0.99610    74.184
198    8.7453      .        1.45762        .       -0.03576        .       -0.50150    0.49948      .            .         4    0.99610    74.270
199    9.1069   -0.47262      .         -52.9181      .            .       -0.02091      .          0.13426      .         4    0.99577    80.961
200    9.1549      .          .         -42.3899    0.06942        .       -0.03535      .          0.14363      .         4    0.99573    81.870
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                                              total fat gain predictive equations

OBS      _RMSE_    _ANGAIN_     _CGAIN_        _RQ_       _CO2_        _O2_     _MECON_    _MENCON_     _EGAIN_     _COMPP_   _P_       _RSQ_        _CP_

201      9.2025       .           .        -57.4442       .        -0.04604    -0.01735       .         0.13648       .         4     0.99568      82.775
202      9.2395    -0.56530       .        -56.2895       .           .           .        -0.02056     0.13323       .         4     0.99565      83.483
203      9.3014    -1.00257       .        -70.7308    -0.10632       .           .           .         0.12120       .         4     0.99559      84.671
204      9.3293       .           .        -63.4369       .        -0.07419       .        -0.01245     0.13365       .         4     0.99556      85.210
205      9.4036       .           .        -49.2343     0.05488       .           .        -0.03441     0.14366       .         4     0.99549      86.653
206      9.5150     0.06228       .           .         0.13086       .        -0.04683       .         0.14225       .         4     0.99538      88.837
207      9.6325    -0.98187    -4.61424    -40.6940       .           .           .           .         0.47816       .         4     0.99527      91.169
208      9.7418    -1.10954     1.45215    -72.7126       .        -0.09543       .           .           .           .         4     0.99516      93.363
209      9.7476    -0.61794       .           .           .        -0.04574    -0.01515       .         0.11972       .         4     0.99515      93.481
210      9.8276    -0.93886       .           .           .        -0.10462       .        -0.00170     0.10790       .         4     0.99507      95.104
211      9.8738    -0.21581       .           .         0.09726       .           .        -0.04141     0.13627       .         4     0.99503      96.049
212     10.1448    -0.84004     1.59214    -63.6989       .           .        -0.01931       .           .           .         4     0.99475     101.670
213     10.1964       .           .           .         1.84383    -1.88493     0.07837       .           .        -0.40177     4     0.99470     102.758
214     10.2538    -0.92631     1.57976    -66.7772       .           .           .        -0.01895       .           .         4     0.99464     103.976
215     10.2768       .           .           .         1.82827    -1.88193       .         0.07994       .        -0.30942     4     0.99461     104.465
216     10.2964    -1.30551     1.44230    -78.6684    -0.09779       .           .           .           .           .         4     0.99459     104.883
217     10.3206       .         1.79963    -46.5824     0.12260       .        -0.04519       .           .           .         4     0.99457     105.399
218     10.5312       .           .           .         1.90687    -1.96995    -0.17170     0.25158       .           .         4     0.99434     109.952
219     10.5771       .         1.69326    -64.8430       .        -0.02572    -0.02295       .           .           .         4     0.99429     110.956
220     10.6061       .           .         24.0064     2.21455    -2.16458       .         0.06124       .           .         4     0.99426     111.593
221     10.6247       .         1.80171    -54.3930     0.10866       .           .        -0.04468       .           .         4     0.99424     112.001
222     10.6867    -0.22928     1.70129       .         0.15653       .        -0.05021       .           .           .         4     0.99418     113.370
223     10.7436       .         1.64890    -71.6004       .        -0.05941       .        -0.01706       .           .         4     0.99411     114.634
224     10.7734       .           .         23.3822     2.30407    -2.22405     0.05682       .           .           .         4     0.99408     115.299
225     10.9199    -1.40289     1.16038       .           .        -0.14190       .         0.00839       .           .         4     0.99392     118.593
226     10.9213    -1.08118     1.32595       .           .        -0.07306    -0.00770       .           .           .         4     0.99392     118.624
227     11.0417    -0.53456     1.61388       .         0.11573       .           .        -0.04338       .           .         4     0.99378     121.365
228     11.8847    -2.40330       .           .           .        -0.55399    -0.47722     0.60517       .           .         4     0.99280     141.398
229     12.0400    -3.71480       .         -99.690       .        -0.63556       .         0.13732       .           .         4     0.99261     145.250
230     12.1633    -2.40015       .           .           .        -0.49106       .         0.11818       .        -0.56983     4     0.99245     148.341
231     12.2637    -2.38664       .           .           .        -0.47373     0.11565       .           .        -0.71362     4     0.99233     150.884
232     12.5449    -4.02065       .        -113.801       .        -0.63468     0.13462       .           .           .         4     0.99197     158.114
233     13.9013    -0.28728       .         124.050     2.59048    -2.11146       .           .           .           .         4     0.99014     195.295
234     13.9515       .           .         123.079     2.66067    -2.18222       .           .           .         0.01155     4     0.99007     196.744
235     14.5664       .           .          42.029       .        -0.53131    -0.88115     1.00594       .           .         4     0.98918     214.919
236     14.7250       .           .          33.923       .        -0.42201       .         0.10992       .        -1.08675     4     0.98894     219.733
237     14.7518       .           .           .           .        -0.53576    -0.54104     0.66912       .        -0.35801     4     0.98890     220.553
238     14.7858       .           .          33.356       .        -0.40692     0.10774       .           .        -1.21754     4     0.98885     221.593
239     14.8316    -2.46281       .           .        -0.49844       .           .         0.11495       .        -0.78622     4     0.98878     222.999
240     14.8536    -2.44302       .           .        -0.47719       .         0.11216       .           .        -0.91999     4     0.98875     223.678
241     14.8562    -2.61491       .           .        -0.61474       .        -0.63503     0.76450       .           .         4     0.98874     223.757
242     15.6399    -1.48606       .           .         2.96655    -2.46169       .           .           .         0.76550     4     0.98752     248.527
243     16.0719    -4.27950       .         -97.373    -0.66506       .           .         0.12796       .           .         4     0.98683     262.726
244     16.5539    -1.99729       .           .           .           .         1.72952    -1.67755       .        -2.86374     4     0.98602     279.026
245     16.6604    -4.49894       .        -104.054    -0.63635       .         0.12132       .           .           .         4     0.98584     282.694
246     16.7425       .           .          64.182    -0.33542       .         0.09367       .           .        -1.42270     4     0.98570     285.537
247     16.7454       .           .          64.964    -0.35105       .           .         0.09568       .        -1.31425     4     0.98570     285.636
248     17.1460       .           .          70.976    -0.53391       .        -1.08342     1.20095       .           .         4     0.98501     299.708
249     17.1847       .           .           .        -0.39167       .         0.30999    -0.20541       .        -1.60035     4     0.98494     301.086
250     17.3526       .           .          79.464       .           .         1.21814    -1.16827       .        -2.73641     4     0.98464     307.097
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                                                      total fat gain predictive equations

OBS     _RMSE_    _ANGAIN_     _CGAIN_       _RQ_      _CO2_       _O2_    _MECON_   _MENCON_    _EGAIN_    _COMPP_  _P_     _RSQ_      _CP_

251    17.7507    -1.19507      .          95.029     .          .         0.04982     .          .        -1.14549    4   0.98393   321.581
252    17.8339    -1.17575      .          97.674     .          .          .         0.04955     .        -1.08728    4   0.98378   324.649
253    19.4956    -1.77886      .          95.618     .          .        -0.61718    0.65921     .          .         4   0.98061   388.940
254    21.5198    -0.40321      .         184.903    0.24921     .          .          .          .        -0.90517    4   0.97638   474.994
255    22.7163    -0.51059      .         191.648     .         0.18208     .          .          .        -0.81710    4   0.97368   529.852
256     4.1759      .         -1.74459       .       0.84409   -0.74887     .          .         0.24129   -0.21339    5   0.99921    13.066
257     4.2338     1.50975    -5.60426     49.908     .          .          .          .         0.57339   -0.77975    5   0.99919    13.514
258     4.2509      .         -5.16308       .        .        -0.20839    0.04162     .         0.50998   -0.53733    5   0.99918    13.648
259     4.2646      .         -5.13211       .        .        -0.21306     .         0.04223    0.50754   -0.48659    5   0.99918    13.756
260     4.5321      .           .            .       1.07103   -0.98160    0.01016     .         0.08524   -0.29325    5   0.99907    15.924
261     4.5482      .           .            .       1.06777   -0.97772     .         0.00977    0.08572   -0.27910    5   0.99906    16.058
262     4.5922      .         -2.84731       .       1.04916   -1.02432     .         0.01506    0.31577     .         5   0.99904    16.429
263     4.6231      .         -4.98684       .        .        -0.25937   -0.37267    0.42007    0.49659     .         5   0.99903    16.691
264     4.6504     0.12531      .            .       1.05523   -0.92603     .          .         0.09374   -0.26516    5   0.99902    16.925
265     4.6687      .           .          -2.374    1.06210   -0.93257     .          .         0.09338   -0.23101    5   0.99901    17.081
266     4.6818      .         -2.63829       .       1.07591   -1.02856    0.01093     .         0.30084     .         5   0.99901    17.195
267     4.6885     1.07000    -4.55450       .        .        -0.03521     .          .         0.49635   -0.54781    5   0.99900    17.252
268     4.7921     1.08967    -4.63496       .      -0.03527     .          .          .         0.50330   -0.57467    5   0.99896    18.157
269     4.8015      .         -1.87927     -7.391    1.06726   -0.96790     .          .         0.24828     .         5   0.99895    18.240
270     4.8250    -0.01562    -1.96387       .       1.08513   -0.98236     .          .         0.25328     .         5   0.99894    18.448
271     4.9316      .           .            .       1.09309   -1.02053   -0.17927    0.18986    0.08669     .         5   0.99890    19.407
272     4.9588     1.12640    -4.41082       .        .          .          .        -0.00411    0.48606   -0.60218    5   0.99889    19.655
273     4.9679     1.12337    -4.40700       .        .          .        -0.00394     .         0.48558   -0.59994    5   0.99888    19.738
274     5.0529      .         -5.26981       .      -0.20072     .         0.03443     .         0.52748   -0.57678    5   0.99884    20.523
275     5.0719      .         -5.25207       .      -0.20516     .          .         0.03490    0.52623   -0.53546    5   0.99883    20.700
276     5.1186    -0.29059      .         -16.644    1.23478   -1.10199     .          .         0.09040     .         5   0.99881    21.138
277     5.1239    -0.55221      .            .       1.33191   -1.23935     .         0.01324    0.07390     .         5   0.99881    21.189
278     5.1659    -0.51569      .            .       1.34192   -1.23604    0.01029     .         0.07585     .         5   0.99879    21.587
279     5.2716      .           .         -17.534    1.30192   -1.17628     .         0.00163    0.08924     .         5   0.99874    22.603
280     5.2749      .           .         -16.667    1.29643   -1.16384    0.00002     .         0.09037     .         5   0.99874    22.635
281    5.32711      .          1.00963       .       1.23278   -1.10330    0.00710     .          .        -0.27634    5   0.99871   23.1451
282    5.33721      .          1.01639       .       1.23099   -1.09972     .         0.00652     .        -0.26531    5   0.99871   23.2443
283    5.34984      .         -4.49539       .        .          .         0.66762   -0.66317    0.47166   -1.29226    5   0.99870   23.3686
284    5.36738    -0.10173     1.06615       .       1.24014   -1.08020     .          .          .        -0.21558    5   0.99869   23.5419
285    5.37142      .          1.08726    -4.7642    1.22704   -1.07055     .          .          .        -0.22864    5   0.99869   23.5818
286    5.51617      .         -5.28382       .      -0.27290     .        -0.42032    0.46214    0.53061     .         5   0.99862   25.0337
287    5.57289    -0.43885     1.05906   -19.6538    1.35372   -1.19667     .          .          .          .         5   0.99859   25.6132
288    5.60099    -0.69913     0.83835       .       1.44420   -1.33495     .         0.01474     .          .         5   0.99858   25.9025
289    5.63540    -0.67512     0.85712       .       1.45914   -1.33718    0.01209     .          .          .         5   0.99856   26.2587
290    5.66356      .          1.02847       .       1.26552   -1.14749   -0.16401    0.17077     .          .         5   0.99855   26.5518
291    5.82419      .         -3.56425     5.9615     .        -0.03118     .          .         0.40763   -0.39792    5   0.99846   28.2519
292    5.88468      .          1.07944   -17.0871    1.44182   -1.26991   -0.00303     .          .          .         5   0.99843   28.9045
293    5.89240      .          1.06643   -17.9544    1.45004   -1.28373     .        -0.00168     .          .         5   0.99843   28.9882
294    5.93177      .         -3.62575     7.9150   -0.02631     .          .          .         0.41206   -0.43304    5   0.99840   29.4171
295    6.04439      .         -3.60946    13.2589     .          .         0.00045     .         0.40660   -0.51053    5   0.99834   30.6598
296    6.04508      .         -3.60013    13.0807     .          .          .         0.00024    0.40610   -0.50654    5   0.99834   30.6674
297    6.20140     1.01815    -3.92313       .        .          .        -0.40067    0.38993    0.45399     .         5   0.99826   32.4311
298    6.94631      .         -3.27714    10.1897     .          .        -0.32882    0.32254    0.38799     .         5   0.99781   41.4543
299    7.06589      .         -5.83653   -30.4235     .        -0.22141     .         0.02572    0.58119     .         5   0.99774   42.9981
300    7.23641    -0.41034    -6.14540       .        .        -0.24160     .         0.03222    0.59358     .         5   0.99763   45.2450
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                                             total fat gain predictive equations

OBS     _RMSE_   _ANGAIN_    _CGAIN_       _RQ_      _CO2_       _O2_    _MECON_   _MENCON_    _EGAIN_    _COMPP_ _P_     _RSQ_      _CP_

301    7.28845     .        -5.52680   -30.1877     .        -0.18351    0.01701     .         0.56168     .        5   0.99759   45.9414
302    7.42591     .          .        -20.1837     .        -0.08215     .         0.01139    0.11066   -0.56682   5   0.99750   47.8049
303    7.42911     .          .        -20.2600     .        -0.07987    0.01098     .         0.11083   -0.57930   5   0.99750   47.8487
304    7.43914    0.68314     .           .        0.06611     .          .        -0.01722    0.12857   -0.64894   5   0.99749   47.9860
305    7.44876    0.66879     .           .        0.06031     .        -0.01624     .         0.12812   -0.63080   5   0.99748   48.1180
306    7.46051    0.29403     .        -11.6605     .        -0.03167     .          .         0.11882   -0.59920   5   0.99748   48.2794
307    7.47887     .          .        -16.4253     .        -0.14248   -0.45327    0.47296    0.10984     .        5   0.99746   48.5321
308    7.48611     .          .           .         .        -0.09968   -0.22926    0.24355    0.10761   -0.33072   5   0.99746   48.6319
309    7.48912    0.29740     .           .         .        -0.04104     .         0.00313    0.11426   -0.64526   5   0.99746   48.6734
310    7.49001    0.30474     .           .         .        -0.03921    0.00272     .         0.11456   -0.64857   5   0.99746   48.6858
311    7.50128    0.03224   -4.75068   -24.1241     .        -0.10201     .          .         0.50946     .        5   0.99745   48.8414
312    7.51615   -0.22872   -5.89087      .         .        -0.18521    0.01838     .         0.58325     .        5   0.99744   49.0471
313    7.51879    0.43557     .         -6.0496     .          .          .        -0.00562    0.12194   -0.63726   5   0.99744   49.0837
314    7.51953    0.43833     .         -5.8580     .          .        -0.00564     .         0.12199   -0.63123   5   0.99744   49.0940
315    7.52824    0.46430     .           .         .          .         0.00678   -0.01221    0.12082   -0.66471   5   0.99743   49.2148
316    7.54261    0.08892     .           .         .        -0.12784   -0.49160    0.50859    0.10953     .        5   0.99742   49.4143
317    7.58575    0.31455     .         -8.4741   -0.02032     .          .          .         0.11743   -0.65864   5   0.99739   50.0155
318    7.61540     .          .        -16.2064     .          .         0.16012   -0.16348    0.11738   -0.75572   5   0.99737   50.4308
319    7.64891     .          .           .        0.05012     .         0.24628   -0.25666    0.11673   -0.87681   5   0.99735   50.9020
320    7.65098     .          .        -12.7299   -0.00583     .          .        -0.00320    0.11856   -0.56435   5   0.99735   50.9311
321    7.65220     .          .        -12.7936   -0.00757     .        -0.00289     .         0.11842   -0.56233   5   0.99735   50.9484
322    7.90347    0.45825     .           .       -0.03134     .        -0.49318    0.48786    0.12699     .        5   0.99717   54.5495
323    7.91047   -2.30820     .        -39.3040    1.59926   -1.76727    0.09232     .          .          .        5   0.99716   54.6515
324    7.91902    0.55907     .          2.7891     .          .        -0.48969    0.47861    0.13014     .        5   0.99716   54.7762
325    7.98158     .          .        -12.1566   -0.07569     .        -0.44457    0.44842    0.12047     .        5   0.99711   55.6926
326    7.99065     .        -5.52408   -28.8497   -0.15141     .          .         0.00609    0.57080     .        5   0.99711   55.8261
327    8.01052   -0.05162   -5.05437   -27.3714   -0.11455     .          .          .         0.53533     .        5   0.99709   56.1190
328    8.01163     .        -5.07329   -26.3083   -0.10875     .        -0.00129     .         0.53778     .        5   0.99709   56.1354
329    8.02577   -2.15583     .        -30.1537    1.52161   -1.70355     .         0.09451     .          .        5   0.99708   56.3443
330    8.16278   -1.90698     .           .        1.64125   -1.74868    0.08278     .          .        -0.12287   5   0.99698   58.3878
331    8.16302    0.20635   -5.40436      .       -0.06726     .        -0.00974     .         0.56605     .        5   0.99698   58.3915
332    8.17331    0.29818   -4.50500   -15.3357     .          .        -0.02055     .         0.50146     .        5   0.99697   58.5462
333    8.20509   -0.00274   -5.90380      .       -0.12966     .          .         0.00206    0.59848     .        5   0.99695   59.0258
334    8.22350   -1.97693     .           .        1.68003   -1.78750    0.03159    0.05046     .          .        5   0.99693   59.3045
335    8.22808   -1.92267     .           .        1.62001   -1.74273     .         0.08468     .        -0.02506   5   0.99693   59.3739
336    8.34513    0.20231   -4.49665   -18.7833     .          .          .        -0.02016    0.49969     .        5   0.99684   61.1611
337     8.7947     .         1.32277    -17.976     .        -0.13821   -0.50131    0.52079     .          .        5   0.99649    68.261
338     8.8075     .         1.33463    -22.594     .        -0.07194     .         0.01018     .        -0.62125   5   0.99648    68.468
339     8.8114     .         1.33784    -22.638     .        -0.06923    0.00965     .          .        -0.63173   5   0.99648    68.532
340     8.8296   -0.26899    1.21931      .         .        -0.15327   -0.51293    0.53748     .          .        5   0.99647    68.827
341     8.8324     .         1.28811      .         .        -0.10477   -0.33920    0.35473     .        -0.25459   5   0.99646    68.873
342     8.8685   -0.02693    1.41962    -20.892     .        -0.02869     .          .          .        -0.57986   5   0.99643    69.461
343     8.8848    0.42089    1.52340      .        0.08387     .          .        -0.01857     .        -0.67088   5   0.99642    69.728
344     8.8921    0.40729    1.51800      .        0.07788     .        -0.01757     .          .        -0.65093   5   0.99642    69.848
345     8.9142   -0.10080    1.26927      .         .        -0.06627     .         0.01059     .        -0.65987   5   0.99640    70.210
346     8.9195   -0.08457    1.27758      .         .        -0.06157    0.00959     .          .        -0.67187   5   0.99639    70.297
347     8.9251     .         1.45823    -14.128    0.03185     .          .        -0.00896     .        -0.60470   5   0.99639    70.390
348     8.9282     .         1.45612    -14.126    0.02901     .        -0.00849     .          .        -0.59634   5   0.99639    70.439
349     8.9326     .         1.43099      .        0.08658     .         0.24057   -0.25642     .        -0.91353   5   0.99638    70.513
350     8.9423    0.07660    1.43602    -15.579     .          .          .        -0.00394     .        -0.63004   5   0.99637    70.673
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total fat gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_EGAIN_	_COMPP_	_P_	_RSQ_	_CP_
351	8.9426	0.07847	1.43651	-15.451	.	.	-0.00396	.	.	-0.62579	5	0.99637	70.678
352	8.9428	.	1.42362	-17.901	.	.	0.05132	-0.05476	.	-0.67841	5	0.99637	70.681
353	8.9746	0.00171	1.39425	-16.480	-0.01252	.	.	.	.	-0.65027	5	0.99635	71.206
354	8.9801	-1.40769	.	-79.831	.	-0.22571	.	0.03019	0.09949	.	5	0.99634	71.297
355	8.9898	0.17598	1.41452	.	.	.	-0.05326	0.04939	.	-0.61462	5	0.99634	71.457
356	9.1431	-1.25382	.	-77.021	.	-0.18374	0.01967	.	0.10699	.	5	0.99621	74.018
357	9.2395	.	1.48309	-13.452	-0.04270	.	-0.47804	0.47661	.	.	5	0.99613	75.651
358	9.2517	0.19055	1.53971	-7.790	.	.	-0.48518	0.47571	.	.	5	0.99612	75.859
359	9.2578	0.19561	1.50189	.	-0.01862	.	-0.51393	0.50808	.	.	5	0.99611	75.962
360	9.6535	-0.38718	.	-49.718	0.02207	.	-0.02486	.	0.13636	.	5	0.99578	82.856
361	9.7905	-0.66509	.	-59.840	-0.02869	.	.	-0.01532	0.13046	.	5	0.99565	85.310
362	9.8971	-1.82840	1.09539	-90.074	.	-0.26300	.	0.04030	.	.	5	0.99556	87.245
363	10.0996	-1.71640	1.18676	-89.360	.	-0.22188	0.02976	.	.	.	5	0.99538	90.976
364	10.2166	.	.	.	2.15096	-1.97409	1.17776	-1.12723	.	-1.63874	5	0.99527	93.165
365	10.5390	.	.	37.709	1.85317	-1.84753	0.06975	.	.	-0.45386	5	0.99496	99.331
366	10.6072	.	.	38.922	1.83961	-1.84362	.	0.07087	.	-0.37372	5	0.99490	100.659
367	10.7530	-0.74161	1.62388	-60.168	0.02645	.	-0.02407	.	.	.	5	0.99476	103.529
368	10.8686	-1.01677	1.54654	-69.823	-0.02720	.	.	-0.01394	.	.	5	0.99464	105.831
369	10.9254	.	.	36.474	1.89381	-1.92343	-0.23111	0.30424	.	.	5	0.99459	106.972
370	12.2349	-2.92844	.	-57.322	.	-0.60772	-0.31638	0.45442	.	.	5	0.99321	134.914
371	12.4140	-3.03088	.	-65.778	.	-0.57801	.	0.13326	.	-0.33357	5	0.99301	138.980
372	12.5212	-3.01914	.	-66.138	.	-0.55934	0.13056	.	.	-0.49503	5	0.99289	141.443
373	12.5286	-2.49787	.	.	.	-0.60631	-0.84916	0.98377	.	0.49850	5	0.99288	141.615
374	14.6955	-0.51344	.	112.247	2.66080	-2.18686	.	.	.	0.14414	5	0.99021	195.964
375	15.4308	.	.	40.820	.	-0.50396	-0.67196	0.79329	.	-0.26827	5	0.98920	216.372
376	15.6636	-2.74107	.	-27.620	-0.54513	.	.	0.12219	.	-0.70291	5	0.98888	223.043
377	15.6844	-2.88680	.	-28.650	-0.65039	.	-0.56525	0.70064	.	.	5	0.98885	223.642
378	15.6867	-2.72111	.	-27.723	-0.52279	.	0.11927	.	.	-0.84493	5	0.98884	223.710
379	15.7088	-2.50811	.	.	-0.54621	.	-0.26106	0.38223	.	-0.47317	5	0.98881	224.349
380	17.4773	-1.74646	.	29.540	.	.	1.53779	-1.48722	.	-2.72264	5	0.98615	278.419
381	17.7581	.	.	64.119	-0.33401	.	0.10195	-0.00847	.	-1.43227	5	0.98570	287.536
382	3.2613	.	-3.41394	.	0.64646	-0.71319	0.03131	.	0.35996	-0.36765	6	0.99958	7.574
383	3.3279	.	-3.38539	.	0.64024	-0.70945	.	0.03130	0.35816	-0.32965	6	0.99956	7.928
384	3.9537	.	-3.34302	.	0.65063	-0.74553	-0.22778	0.26087	0.35591	.	6	0.99938	11.601
385	3.9773	0.64794	-2.78091	.	0.65545	-0.59022	.	.	0.33421	-0.34996	6	0.99937	11.753
386	4.1682	.	.	.	1.29616	-1.06756	0.73416	-0.74021	0.08265	-1.10882	6	0.99931	13.006
387	4.2392	0.56425	-5.30482	.	.	-0.16545	0.03115	.	0.53248	-0.58460	6	0.99929	13.487
388	4.2639	0.56003	-5.27230	.	.	-0.16838	.	0.03148	0.52996	-0.54567	6	0.99928	13.657
389	4.3481	1.46652	-5.52766	43.808	.	-0.02275	.	.	0.57008	-0.69546	6	0.99925	14.241
390	4.4109	1.49291	-5.61076	45.459	-0.02144	.	.	.	0.57679	-0.72001	6	0.99923	14.684
391	4.4453	.	-1.82697	6.320	0.84452	-0.74731	.	.	0.24682	-0.22596	6	0.99922	14.930
392	4.4745	1.54571	-5.54060	48.413	.	.	.	-0.00267	0.57162	-0.74189	6	0.99921	15.140
393	4.47962	1.54478	-5.54141	48.5494	.	.	-0.00255	.	0.57155	-0.74094	6	0.99920	15.1769
394	4.53139	.	-5.21460	.	.	-0.19657	0.13178	-0.09187	0.51427	-0.64629	6	0.99919	15.5530
395	4.54001	.	-5.19999	3.0643	.	-0.20710	0.04154	.	0.51248	-0.54315	6	0.99918	15.6160
396	4.54455	1.03705	-5.29449	.	.	.	0.58593	-0.58539	0.54818	-1.30456	6	0.99918	15.6493
397	4.55342	.	-5.17462	3.4797	.	-0.21164	.	0.04215	0.51042	-0.49335	6	0.99918	15.7144
398	4.73327	-0.40750	-2.63818	.	1.04883	-1.05699	.	0.02462	0.28962	.	6	0.99911	17.0608
399	4.78948	0.81454	-5.41932	.	-0.13850	.	0.02102	.	0.55307	-0.63212	6	0.99909	17.4923
400	4.81320	0.81809	-5.39033	.	-0.13901	.	.	0.02087	0.55110	-0.60592	6	0.99908	17.6759

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                                              total fat gain predictive equations

OBS     _RMSE_    _ANGAIN_     _CGAIN_       _RQ_      _CO2_       _O2_    _MECON_   _MENCON_    _EGAIN_    _COMPP_   _P_      _RSQ_      _CP_

401    4.82799    -0.14183      .           .         1.08481   -1.00519    0.01303     .          0.08206   -0.27656     6    0.99908   17.7909
402    4.82968      .           .         -5.8338     1.06124   -0.97764    0.01076     .          0.08616   -0.28402     6    0.99907   17.8040
403    4.84056      .         -2.74578   -12.0100     1.01808   -1.00527     .          0.01652    0.30946     .          6    0.99907   17.8888
404    4.84690     0.32439    -5.06957      .           .       -0.23631   -0.39568    0.43701    0.50986     .          6    0.99907   17.9383
405    4.84840      .           .         -5.5499     1.05828   -0.97382     .          0.01034    0.08661   -0.26962     6    0.99907   17.9500
406    4.84936    -0.12419      .           .         1.07906   -0.99814     .          0.01236    0.08293   -0.26172     6    0.99907   17.9576
407    4.87214    -0.37270    -2.45533      .         1.08944   -1.07022    0.01948     .          0.27730     .          6    0.99906   18.1361
408    4.93391      .         -5.03591     4.4759       .       -0.25849   -0.38015    0.42759    0.49982     .          6    0.99903   18.6244
409    4.93961      .         -2.54932   -11.9343     1.04718   -1.01234    0.01253     .          0.29536     .          6    0.99903   18.6697
410    4.97145     0.12352      .         -0.3378     1.05480   -0.92577     .          .          0.09381   -0.26401     6    0.99902   18.9241
411    5.03532      .          0.97893      .         1.46824   -1.19002    0.78560   -0.79599     .        -1.15364     6    0.99899   19.4394
412    5.13076    -0.03804    -1.80340    -7.7635     1.06845   -0.96773     .          .          0.24191     .          6    0.99896   20.2215
413    5.13594    -0.75816      .        -29.3698     1.21664   -1.18570     .          0.02368    0.07375     .          6    0.99895   20.2644
414    5.18060    -0.77527      .        -30.5117     1.24111   -1.20129    0.02217     .          0.07410     .          6    0.99894   20.6359
415    5.19528    -0.30459      .           .         1.12377   -1.06899   -0.14734    0.16385    0.07970     .          6    0.99893   20.7587
416    5.24642      .           .         -7.9357     1.08450   -1.01731   -0.16645    0.17753    0.08791     .          6    0.99891   21.1891
417    5.33381      .         -5.26681      .        -0.15626     .          0.27771   -0.24918    0.52730   -0.85994     6    0.99887   21.9345
418    5.39058      .         -5.32743     5.3517    -0.19794     .          0.03425     .          0.53124   -0.58624     6    0.99885   22.4253
419    5.40952      .         -5.31440     5.6814    -0.20229     .          .          0.03473    0.53031   -0.54580     6    0.99884   22.5902
420    5.57881    -0.38718     0.90621      .         1.25424   -1.15569    0.01530     .          .        -0.23256     6    0.99877   24.0898
421    5.59072     0.60161    -5.39658      .        -0.22896     .        -0.45557    0.48723    0.55020     .          6    0.99876   24.1970
422    5.60091    -0.37023     0.91731      .         1.24911   -1.14916     .          0.01459     .        -0.21485     6    0.99876   24.2890
423    5.61343    -0.91336     0.84372   -32.1375     1.31612   -1.27235     .          0.02556     .          .          6    0.99875   24.4021
424    5.63387    -0.94924     0.84196   -33.9635     1.34166   -1.29197    0.02473     .          .          .          6    0.99874   24.5875
425    5.67842      .          1.02325    -6.5982     1.22291   -1.09930    0.00765     .          .        -0.26553     6    0.99872   24.9937
426    5.69038      .          1.02971    -6.3627     1.22131   -1.09573     .          0.00704     .        -0.25422     6    0.99872   25.1034
427    5.71603      .         -4.52699     2.9803       .          .          0.65868   -0.65412    0.47372   -1.28721     6    0.99870   25.3393
428    5.71926    -0.14266     1.08378    -7.3657     1.23166   -1.07539     .          .          .        -0.19103     6    0.99870   25.3690
429    5.83981    -0.52662     0.88438      .         1.29495   -1.21412   -0.11094    0.12851     .          .          6    0.99865   26.4923
430    5.88241      .         -5.35336     6.4569    -0.27159     .        -0.43089    0.47280    0.53512     .          6    0.99863   26.8949
431    6.02524      .          1.04696    -9.1519     1.25727   -1.14438   -0.14897    0.15610     .          .          6    0.99856   28.2660
432    6.08947     1.44814    -4.82367    46.4722       .          .        -0.51828    0.50818    0.52306     .          6    0.99853   28.8932
433    7.22631    -0.73527    -5.25433   -42.2797       .       -0.28587     .          0.04419    0.51870     .          6    0.99793   41.0966
434    7.59234    -0.62700    -5.11313   -42.0174       .       -0.24208    0.03295     .          0.51510     .          6    0.99771   45.4692
435    7.82253     0.80445      .           .         0.15194     .          0.42190   -0.45120    0.13054   -1.15277     6    0.99757   48.3297
436    7.91411      .           .        -18.1917       .       -0.10409   -0.16394    0.17868    0.11003   -0.37010     6    0.99752   49.4915
437    7.93761     0.05303      .        -18.8938       .       -0.07656     .          0.01015    0.11159   -0.57563     6    0.99750   49.7919
438    7.94050     0.06501      .        -18.6633       .       -0.07326    0.00950     .          0.11195   -0.58837     6    0.99750   49.8288
439    7.94609     0.75067      .          5.8242     0.07755     .          .        -0.01912    0.12894   -0.66612     6    0.99750   49.9004
440    7.95742     0.73048      .          5.3593     0.07050     .        -0.01794     .          0.12844   -0.64457     6    0.99749   50.0456
441    7.97551     0.23583      .           .           .       -0.07297   -0.18584    0.19428    0.11256   -0.41033     6    0.99748   50.2780
442    7.98665    -0.14665      .        -20.0134       .       -0.15553   -0.43514    0.45799    0.10723     .          6    0.99747   50.4213
443    8.03457     0.40791      .         -7.7104       .          .          0.05047   -0.05575    0.12126   -0.69343     6    0.99744   51.0403
444    8.11534      .           .        -15.3551     0.04426     .          0.29495   -0.30475    0.11883   -0.90406     6    0.99739   52.0917
445    8.43770    -2.38556      .        -43.7400     1.64880   -1.80557    0.14486   -0.05426     .          .          6    0.99718   56.3934
446    8.44887     0.44468      .         -1.2613    -0.03321     .        -0.49019    0.48519    0.12692     .          6    0.99717   56.5455
447    8.45570    -2.28787      .        -38.3015     1.59130   -1.75945    0.09241     .          .        -0.01427     6    0.99716   56.6386
448    8.47800    -1.78126      .           .         1.82685   -1.80766    0.69904   -0.63217     .        -0.83497     6    0.99715   56.9430
449     8.5023    -0.27489    -5.38416   -33.7496    -0.18072     .          .          0.01295    0.55452     .          6    0.99713    57.276
450     8.5408    -2.29576      .        -37.3328     1.56872   -1.75245     .          0.09430     .          0.09179     6    0.99711    57.805
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total fat gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_EGAIN_	_COMPP_	_P_	_RSQ_	_CP_
451	8.5636	-0.05003	-5.05235	-27.3214	-0.11414	.	-0.00008	.	0.53521	.	6	0.99709	58.119
452	9.2542	-0.63425	1.18451	-33.2220	.	-0.19585	-0.41869	0.45205	.	.	6	0.99660	68.038
453	9.3254	-0.52045	1.22276	-34.9770	.	-0.12807	.	0.02255	.	-0.53094	6	0.99655	69.105
454	9.3364	-0.49810	1.23179	-34.6139	.	-0.12115	0.02119	.	.	-0.55897	6	0.99654	69.270
455	9.3584	.	1.32329	-19.3251	.	-0.10806	-0.27171	0.28736	.	-0.29425	6	0.99653	69.603
456	9.4218	0.52022	1.54347	.	0.15623	.	0.35355	-0.38231	.	-1.09333	6	0.99648	70.563
457	9.4233	-0.20718	1.23426	.	.	-0.12864	-0.37319	0.39397	.	-0.18787	6	0.99648	70.585
458	9.4872	.	1.46186	-16.7572	0.08183	.	0.29344	-0.30899	.	-0.94263	6	0.99643	71.559
459	9.4936	0.36220	1.52044	-5.2678	0.07383	.	.	-0.01693	.	-0.65522	6	0.99642	71.657
460	9.5008	0.34491	1.51489	-5.6373	0.06747	.	-0.01586	.	.	-0.63622	6	0.99642	71.768
461	9.5584	0.05804	1.42988	-16.6704	.	.	0.03557	-0.03926	.	-0.66982	6	0.99638	72.652
462	9.8753	0.07579	1.49676	-11.6147	-0.03511	.	-0.48606	0.48307	.	.	6	0.99613	77.617
463	10.7473	.	.	28.7447	2.12934	-1.93723	1.06829	-1.02173	.	-1.56267	6	0.99542	92.113
464	12.9736	-3.04860	.	-58.8857	.	-0.66774	-0.72824	0.87402	.	0.55789	6	0.99332	134.686
465	16.7257	-2.77307	.	-26.7566	-0.58659	.	-0.23457	0.36213	.	-0.42423	6	0.98890	224.520
466	2.7480	.	-3.17047	.	0.86418	-0.80389	0.63258	-0.61628	0.33822	-1.04136	7	0.99974	6.218
467	3.4543	0.23302	-3.59449	.	0.60136	-0.66024	0.02770	.	0.37972	-0.39900	7	0.99959	9.245
468	3.5110	.	-3.45989	4.0620	0.64756	-0.71234	0.03118	.	0.36302	-0.37507	7	0.99958	9.518
469	3.5223	0.24281	-3.56998	.	0.59487	-0.65490	.	0.02741	0.37847	-0.36639	7	0.99958	9.573
470	3.5813	.	-3.43607	4.3981	0.64137	-0.70853	.	0.03117	0.36153	-0.33792	7	0.99956	9.862
471	3.8499	1.00384	-3.76859	32.1032	0.55399	-0.49518	.	.	0.41334	-0.48878	7	0.99950	11.241
472	4.2664	.	-3.37599	2.6682	0.64915	-0.74390	-0.23257	0.26571	0.35815	.	7	0.99938	13.578
473	4.2701	0.01831	-3.35704	.	0.64693	-0.74146	-0.22990	0.26273	0.35746	.	7	0.99938	13.599
474	4.2811	0.96077	-5.75563	29.1534	.	-0.12299	0.02298	.	0.57207	-0.67321	7	0.99938	13.664
475	4.3025	0.96459	-5.73404	29.5011	.	-0.12407	.	0.02299	0.57054	-0.64568	7	0.99937	13.791
476	4.3356	1.38767	-5.96735	37.9876	.	.	0.44428	-0.44373	0.60030	-1.24438	7	0.99936	13.989
477	4.4256	.	.	-11.7370	1.28710	-1.06364	0.76957	-0.77519	0.08438	-1.12879	7	0.99933	14.533
478	4.4800	0.65937	-5.46659	.	.	-0.12657	0.27063	-0.24584	0.54775	-0.88412	7	0.99932	14.868
479	4.5009	0.03668	.	.	1.29456	-1.06221	0.73972	-0.74665	0.08345	-1.12024	7	0.99931	14.998
480	4.6452	1.27920	-5.92651	39.1810	-0.08264	.	0.01208	.	0.59522	-0.73293	7	0.99927	15.910
481	4.6608	1.29033	-5.90479	39.6195	-0.08081	.	.	0.01159	0.59389	-0.71869	7	0.99926	16.010
482	4.8807	0.95973	-5.44017	.	-0.04158	.	0.48827	-0.48103	0.55728	-1.18861	7	0.99919	17.460
483	4.8899	-0.57474	-2.36856	-21.7416	0.99243	-1.03590	.	0.03119	0.26746	.	7	0.99919	17.522
484	4.8920	.	-5.23802	2.2466	.	-0.19646	0.12533	-0.08537	0.51580	-0.64284	7	0.99919	17.536
485	5.0351	-0.58505	-2.17910	-23.0694	1.04163	-1.06260	0.02743	.	0.25332	.	7	0.99914	18.518
486	5.1149	0.56916	-5.34794	19.6969	.	-0.21502	-0.44598	0.48289	0.53410	.	7	0.99911	19.077
487	5.1554	-0.30861	.	-13.1731	1.07891	-1.02397	0.01776	.	0.08039	-0.23609	7	0.99910	19.365
488	5.1877	-0.27843	.	-12.1283	1.07233	-1.01498	.	0.01681	0.08141	-0.21941	7	0.99908	19.596
489	5.3605	.	1.00449	-13 1164	1.46029	-1.18637	0.82532	-0.83549	.	-1.17569	7	0.99902	20.856
490	5.4018	-0.20306	0.92619	.	1.46808	-1.21329	0.75216	-0.75741	.	-1.08815	7	0.99901	21.163
491	5.4662	-0.55471	.	-21.1830	1.12602	-1.10018	-0.08690	0.10959	0.07721	.	7	0.99898	21.646
492	5.7557	0.94828	-5.79798	31.2371	-0.19727	.	-0.52702	0.55325	0.58332	.	7	0.99887	23.891
493	5.7568	.	-5.30200	3.2568	-0.15639	.	0.26760	-0.23893	0.52960	-0.85405	7	0.99887	23.899
494	5.8793	-0.64472	0.88270	-21.9321	1.23568	-1.17725	0.02256	.	.	-0.16752	7	0.99882	24.885
495	5.9165	-0.61722	0.89503	-20.9412	1.22935	-1.16904	.	0.02169	.	-0.14470	7	0.99881	25.188
496	6.0537	-0.84719	0.85588	-29.3114	1.28643	-1.24471	-0.03044	0.05582	.	.	7	0.99875	26.323
497	8.4444	0.85884	.	4.7717	0.16065	.	0.41865	-0.44942	0.13082	-1.16297	7	0.99758	50.272
498	8.5482	0.01168	.	-17.9220	.	-0.10270	-0.16276	0.17720	0.11023	-0.37346	7	0.99752	51.491
499	8.8213	-2.17602	.	-40.4728	1.78547	-1.82267	0.74708	-0.67100	.	-0.76395	7	0.99735	54.770
500	9.9868	-0.58367	1.19577	-32.6185	.	-0.17756	-0.32106	0.35156	.	-0.13357	7	0.99661	69.916

total fat gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_EGAIN_	_COMPP_	_P_	_RSQ_	_CP_
501	10.1696	0.45145	1.54021	-6.2971	0.14524	.	0.35848	-0.38543	.	-1.08050	7	0.99648	72.462
502	2.7582	0.37770	-3.44108	.	0.81080	-0.72629	0.68119	-0.67208	0.36827	-1.15319	8	0.99978	7.380
503	3.0080	.	-3.15072	-1.5566	0.86567	-0.80502	0.63791	-0.62169	0.33686	-1.04443	8	0.99974	8.210
504	3.6417	0.49404	-3.99286	17.3356	0.55555	-0.59730	0.02311	.	0.41490	-0.46583	8	0.99962	10.637
505	3.70353	0.51775	-3.98907	18.2319	0.54814	-0.58929	.	0.02249	0.41545	-0.44227	8	0.99961	10.8980
506	4.56499	1.06452	-5.92919	29.5286	.	-0.08213	0.27123	-0.25495	0.58842	-0.98496	8	0.99941	14.9996
507	4.66759	0.09045	-3.47581	5.1418	0.62951	-0.72230	-0.24750	0.27940	0.36789	.	8	0.99938	15.5450
508	4.74717	1.41447	-5.93990	38.6439	0.01115	.	0.46802	-0.46928	0.59876	-1.27444	8	0.99936	15.9765
509	4.82884	-0.15374	.	-15.2676	1.29110	-1.08489	0.75691	-0.75869	0.08155	-1.08693	8	0.99934	16.4268
510	5.70023	-0.48138	0.90085	-24.1101	1.45324	-1.23849	0.77933	-0.77711	.	-1.03892	8	0.99908	21.7099
511	2.94674	0.58106	-3.76135	13.7604	0.76889	-0.67458	0.66024	-0.65430	0.39650	-1.18628	9	0.99980	9.0000

best fat predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_EGAIN_	_COMPP_	_P_	_RSQ_	_CP_
1	3.26128	.	-3.41394	.	0.64646	-0.71319	0.03131	.	0.35996	-0.36765	6	0.99958	7.5741
2	3.32793	.	-3.38539	.	0.64024	-0.70945	.	0.03130	0.35816	-0.32965	6	0.99956	7.9282
3	3.95367	.	-3.34302	.	0.65063	-0.74553	-0.22778	0.26087	0.35591	.	6	0.99938	11.6013
4	3.97734	0.64794	-2.78091	.	0.65545	-0.59022	.	.	0.33421	-0.34996	6	0.99937	11.7526
5	2.74805	.	-3.17047	.	0.86418	-0.80389	0.63258	-0.61628	0.33822	-1.04136	7	0.99974	6.2181
6	3.45427	0.23302	-3.59449	.	0.60136	-0.66024	0.02770	.	0.37972	-0.39900	7	0.99959	9.2448
7	3.51104	.	-3.45989	4.0620	0.64756	-0.71234	0.03118	.	0.36302	-0.37507	7	0.99958	9.5180
8	3.52234	0.24281	-3.56998	.	0.59487	-0.65490	.	0.02741	0.37847	-0.36639	7	0.99958	9.5729
9	3.58131	.	-3.43607	4.3981	0.64137	-0.70853	.	0.03117	0.36153	-0.33792	7	0.99956	9.8624
10	3.84987	1.00384	-3.76859	32.1032	0.55399	-0.49518	.	.	0.41334	-0.48878	7	0.99950	11.2414
11	4.26644	.	-3.37599	2.6682	0.64915	-0.74390	-0.23257	0.26571	0.35815	.	7	0.99938	13.5776
12	4.27008	0.01831	-3.35704	.	0.64693	-0.74146	-0.22990	0.26273	0.35746	.	7	0.99938	13.5991
13	4.28111	0.96077	-5.75563	29.1534	.	-0.12299	0.02298	.	0.57207	-0.67321	7	0.99938	13.6643
14	4.30253	0.96459	-5.73404	29.5011	.	-0.12407	.	0.02299	0.57054	-0.64568	7	0.99937	13.7913
15	4.33565	1.38767	-5.96735	37.9876	.	.	0.44428	-0.44373	0.60030	-1.24438	7	0.99936	13.9890
16	2.75815	0.37770	-3.44108	.	0.81080	-0.72629	0.68119	-0.67208	0.36827	-1.15319	8	0.99978	7.3805
17	3.00803	.	-3.15072	-1.5566	0.86567	-0.80502	0.63791	-0.62169	0.33686	-1.04443	8	0.99974	8.2102
18	3.64173	0.49404	-3.99286	17.3356	0.55555	-0.59730	0.02311	.	0.41490	-0.46583	8	0.99962	10.6366
19	3.70353	0.51775	-3.98907	18.2319	0.54814	-0.58929	.	0.02249	0.41545	-0.44227	8	0.99961	10.8980
20	4.56499	1.06452	-5.92919	29.5286	.	-0.08213	0.27123	-0.25495	0.58842	-0.98496	8	0.99941	14.9996
21	4.66759	0.09045	-3.47581	5.1418	0.62951	-0.72230	-0.24750	0.27940	0.36789	.	8	0.99938	15.5450
22	4.74717	1.41447	-5.93990	38.6439	0.01115	.	0.46802	-0.46928	0.59876	-1.27444	8	0.99936	15.9765
23	2.94674	0.58106	-3.76135	13.7604	0.76889	-0.67458	0.66024	-0.65430	0.39650	-1.18628	9	0.99980	9.0000

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                                         balanced based energy gain predictive equations

OBS    _RMSE_   _ANGAIN_    _CGAIN_       _RQ_      _CO2_       _O2_    _MECON_   _MENCON_    _INDHP_      _CIN_   _P_      _RSQ_       _CP_

  1    17.803      .        11.4924         .          .          .          .          .          .          .         1    0.99995      12.30
  2   140.888      .          .             .          .          .          .          .          .      2.53255     1    0.99673    1447.91
  3   151.292      .          .             .          .          .          .      0.35692        .          .         1    0.99623    1671.33
  4   152.407      .          .             .          .          .      0.34202        .          .          .         1    0.99617    1696.23
  5   190.924      .          .             .       3.0912        .          .          .          .          .         1    0.99399    2668.18
  6   195.161      .          .       2973.49          .          .          .          .          .          .         1    0.99372    2788.40
  7   199.035      .          .             .          .          .          .          .       0.5254        .         1    0.99347    2900.64
  8   201.296      .          .             .          .       2.5525        .          .          .          .         1    0.99332    2967.19
  9   361.235    67.4075      .             .          .          .          .          .          .          .         1    0.97850    9579.95
 10    13.279    -2.4357    11.8990         .          .          .          .          .          .          .         2    0.99997       2.88
 11    15.091      .        12.3368         .          .          .     -0.02522        .          .          .         2    0.99997       6.34
 12    15.242      .        12.3257         .          .          .          .     -0.02597        .          .         2    0.99996       6.65
 13    16.148      .        12.0370   -141.75          .          .          .          .          .          .         2    0.99996       8.57
 14    16.334      .        12.2347         .          .          .          .          .          .     -0.16409     2    0.99996       8.98
 15    16.432      .        11.9887         .          .      -0.1109        .          .          .          .         2    0.99996       9.19
 16    16.552      .        11.9809         .          .          .          .          .      -0.0225        .         2    0.99996       9.46
 17    17.018      .        11.9415         .      -0.1215        .          .          .          .          .         2    0.99996      10.51
 18   118.080      .          .             .          .      -3.8912        .      0.90003        .          .         2    0.99789     930.38
 19   121.905      .          .             .          .          .          .      0.88539    -0.7794        .         2    0.99776     992.23
 20   123.448      .          .             .          .      -3.6843    0.83481        .          .          .         2    0.99770    1017.74
 21   126.167      .          .             .          .      -2.0935        .          .          .      4.60479     2    0.99760    1063.47
 22   127.383      .          .             .          .          .      0.81602        .      -0.7295        .         2    0.99755    1084.25
 23   127.716      .          .             .          .          .          .          .      -0.4228    4.56588     2    0.99754    1089.97
 24   130.823   -23.3931      .             .          .          .      0.45903        .          .          .         2    0.99742    1144.08
 25   131.365   -22.4281      .             .          .          .          .      0.47397        .          .         2    0.99739    1153.66
 26   134.191      .          .             .      -2.1447        .          .          .          .      4.28623     2    0.99728    1204.23
 27   137.408      .          .             .      -3.6307        .          .      0.77552        .          .         2    0.99715    1263.09
 28   141.982    -8.4527      .             .          .          .          .          .          .      2.84489     2    0.99696    1349.19
 29   142.302      .          .             .      -3.2285        .      0.69872        .          .          .         2    0.99694    1355.31
 30   145.650      .          .        381.93          .          .          .          .          .      2.20841     2    0.99680    1420.27
 31   146.997      .          .             .          .          .          .      0.03726        .      2.26834     2    0.99674    1446.83
 32   147.078      .          .             .          .          .      0.02439        .          .      2.35205     2    0.99673    1448.43
 33   147.778      .          .        849.20          .          .          .      0.25541        .          .         2    0.99670    1462.33
 34   149.180      .          .        851.09          .          .      0.24453        .          .          .         2    0.99664    1490.38
 35   154.358      .          .             .          .          .     -2.27530    2.73124        .          .         2    0.99640    1596.29
 36   163.227      .          .       1442.53       1.5981        .          .          .          .          .         2    0.99598    1786.06
 37   168.785      .          .       1534.48          .          .          .          .       0.2554        .         2    0.99570    1910.39
 38   170.199      .          .       1560.95          .       1.2179        .          .          .          .         2    0.99562    1942.67
 39   179.349      .          .             .      18.1083        .          .          .      -2.5534        .         2    0.99514    2158.15
 40   179.349      .          .             .      15.0447    -9.8742        .          .          .          .         2    0.99514    2158.15
 41   179.349      .          .             .          .     -58.3649        .          .      12.5393        .         2    0.99514    2158.15
 42   195.625    -9.2491      .             .       3.5094        .          .          .          .          .         2    0.99422    2569.35
 43   199.668     7.7246      .       2638.72          .          .          .          .          .          .         2    0.99398    2677.02
 44   203.760   -10.1194      .             .          .          .          .          .       0.6033        .         2    0.99373    2788.24
 45   206.115   -10.2512      .             .          .       2.9356        .          .          .          .         2    0.99358    2853.29
 46    12.500    -2.1212    12.2063    -93.65          .          .          .          .          .          .         3    0.99998       2.57
 47    12.598      .        12.7476         .       0.4775        .     -0.09020        .          .          .         3    0.99998       2.72
 48    12.616      .        11.6417         .       2.2040        .          .          .      -0.3817        .         3    0.99998       2.75
 49    12.616      .        11.6417         .       1.7460    -1.4760        .          .          .          .         3    0.99998       2.75
 50    12.616      .        11.6417         .          .      -7.1036        .          .       1.4552        .         3    0.99998       2.75
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balanced based energy gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_INDHP_	_CIN_	_P_	_RSQ_	_CP_
51	12.729	.	12.7958	.	0.5118	.	.	-0.09958	.	.	3	0.99998	2.92
52	13.744	-2.1753	12.0691	.	.	.	.	.	.	-0.04719	3	0.99997	4.57
53	13.751	.	12.8197	.	.	.	-0.08781	.	0.0742	.	3	0.99997	4.58
54	13.891	-2.2064	11.9814	.	.	.	-0.00360	.	.	.	3	0.99997	4.82
55	13.891	-2.5809	11.8497	.	0.0199	.	.	.	.	.	3	0.99997	4.82
56	13.901	-2.2464	11.9690	.	.	.	.	-0.00317	.	.	3	0.99997	4.83
57	13.926	-2.4552	11.8932	.	.	.	.	.	0.0004	.	3	0.99997	4.88
58	13.926	-2.4206	11.9034	.	.	-0.0015	.	.	.	.	3	0.99997	4.88
59	14.069	.	12.8423	.	.	.	.	-0.09347	0.0759	.	3	0.99997	5.12
60	14.075	.	12.8174	.	.	0.3395	-0.08493	.	.	.	3	0.99997	5.13
61	14.426	.	12.8268	.	.	0.3396	.	-0.08894	.	.	3	0.99997	5.75
62	14.487	.	12.2362	.	.	.	-0.44033	0.43631	.	.	3	0.99997	5.86
63	14.719	.	12.5158	-92.03	.	.	-0.02000	.	.	.	3	0.99997	6.27
64	14.794	.	12.5172	-95.17	.	.	.	-0.02054	.	.	3	0.99997	6.40
65	15.579	.	12.3025	-112.73	.	-0.0843	.	.	.	.	3	0.99997	7.86
66	15.656	.	12.3015	-114.42	.	.	.	.	-0.0170	.	3	0.99997	8.01
67	15.699	.	12.2767	.	.	.	-0.03422	.	.	0.07986	3	0.99997	8.10
68	15.905	.	12.2794	.	.	.	.	-0.03361	.	0.06439	3	0.99997	8.49
69	15.954	.	12.2919	-120.94	-0.0906	.	.	.	.	.	3	0.99997	8.59
70	16.260	.	12.3126	-95.20	.	.	.	.	.	-0.10046	3	0.99996	9.19
71	17.065	.	12.2908	.	0.0564	.	.	.	.	-0.22255	3	0.99996	10.84
72	17.070	.	12.1664	.	.	-0.0443	.	.	.	-0.10515	3	0.99996	10.85
73	17.110	.	12.1961	.	.	.	.	.	-0.0054	-0.12958	3	0.99996	10.93
74	82.498	-22.4897	.	.	.	-3.8987	.	1.01845	.	.	3	0.99907	409.85
75	83.218	-24.4112	.	.	.	-3.8159	0.97451	.	.	.	3	0.99905	417.17
76	84.753	-23.3217	.	.	.	.	.	1.02333	-0.8033	.	3	0.99901	432.95
77	85.981	-25.2085	.	.	.	.	0.97554	.	-0.7809	.	3	0.99898	445.80
78	97.042	-26.2798	.	.	-4.3953	.	.	1.00083	.	.	3	0.99871	569.79
79	99.466	-27.8683	.	.	-4.1529	.	0.94025	.	.	.	3	0.99864	598.97
80	103.410	.	.	.	12.6249	.	.	0.80531	-2.8079	.	3	0.99853	647.98
81	103.410	.	.	.	9.2560	-10.8584	.	0.80531	.	.	3	0.99853	647.98
82	103.410	.	.	.	.	-40.6915	.	0.80531	7.7146	.	3	0.99853	647.98
83	103.659	.	.	.	14.0169	.	0.75267	.	-3.0152	.	3	0.99852	651.13
84	103.659	.	.	.	10.3992	-11.6603	0.75267	.	.	.	3	0.99852	651.13
85	103.659	.	.	.	.	-45.1779	0.75267	.	8.6674	.	3	0.99852	651.13
86	104.966	.	.	.	.	-3.9935	.	0.56850	.	2.45389	3	0.99849	667.83
87	108.281	.	.	.	.	-3.8486	0.50297	.	.	2.62005	3	0.99839	711.13
88	108.786	.	.	.	.	.	.	0.55164	-0.8088	2.51011	3	0.99838	717.85
89	112.171	.	.	.	.	.	0.48288	.	-0.7743	2.68245	3	0.99827	763.66
90	114.197	.	.	.	.	-4.0793	-3.09316	4.15406	.	.	3	0.99821	791.74
91	116.529	.	.	.	.	.	-3.41728	4.49316	-0.8410	.	3	0.99814	824.70
92	119.598	.	.	.	10.4112	.	.	.	-2.0856	4.04910	3	0.99804	869.09
93	119.598	.	.	.	7.9088	-8.0654	.	.	.	4.04910	3	0.99804	869.09
94	119.598	.	.	.	.	-33.5563	.	.	6.5917	4.04910	3	0.99804	869.09
95	123.444	.	.	161.13	.	-3.7131	.	0.85592	.	.	3	0.99791	926.34
96	125.422	.	.	.	-4.0056	.	.	0.44298	.	2.66640	3	0.99784	956.50
97	125.482	.	.	-981.95	.	-3.0917	.	.	.	6.42622	3	0.99784	957.41
98	126.931	.	.	-1027.32	.	.	.	.	-0.6482	6.52167	3	0.99779	979.82
99	127.398	.	.	176.47	.	.	.	0.83581	-0.7374	.	3	0.99777	987.09
100	127.684	.	.	.	-4.6877	.	-4.55164	5.64712	.	.	3	0.99776	991.56

balanced based energy gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_INDHP_	_CIN_	_P_	_RSQ_	_CP_
101	128.286	.	.	.	-3.7406	.	0.37138	.	.	2.84291	3	0.99774	1001.00
102	129.144	.	.	153.21	.	-3.5099	0.79393	.	.	.	3	0.99771	1014.53
103	131.693	-20.3405	.	598.82	.	.	.	0.39150	.	.	3	0.99762	1055.24
104	132.075	-21.2097	.	558.45	.	.	0.38414	.	.	.	3	0.99760	1061.42
105	132.324	0.1240	.	.	.	-2.1016	.	.	.	4.60822	3	0.99760	1065.45
106	133.155	.	.	182.32	.	.	0.76638	.	-0.6852	.	3	0.99757	1078.97
107	133.929	-0.5701	.	.	.	.	.	.	-0.4152	4.55051	3	0.99754	1091.62
108	134.828	.	.	-1080.18	-3.7477	.	.	.	.	6.51376	3	0.99750	1106.42
109	136.819	.	.	1556.45	18.4522	.	.	.	-2.8858	.	3	0.99743	1139.55
110	136.819	.	.	1556.45	14.9898	-11.1595	.	.	.	.	3	0.99743	1139.55
111	136.819	.	.	1556.45	.	-59.4733	.	.	12.4935	.	3	0.99743	1139.55
112	136.853	-24.8619	.	.	.	.	1.20651	-0.77235	.	.	3	0.99743	1140.11
113	137.208	-23.3501	.	.	.	.	0.45752	.	.	0.00961	3	0.99742	1146.08
114	137.741	-21.8018	.	.	.	.	.	0.44937	.	0.15138	3	0.99740	1155.05
115	139.988	-3.3623	.	.	-1.9079	.	.	.	.	4.21689	3	0.99731	1193.28
116	141.614	.	.	1230.34	.	.	-4.38020	4.78069	.	.	3	0.99725	1221.32
117	142.649	.	.	342.58	-3.1053	.	.	0.67399	.	.	3	0.99721	1239.35
118	147.406	.	.	396.95	-2.6309	.	0.58722	.	.	.	3	0.99702	1323.85
119	147.683	-8.1619	.	332.39	.	.	.	.	.	2.55205	3	0.99701	1328.87
120	151.590	.	.	.	.	.	-1.81668	1.95159	.	2.13651	3	0.99684	1400.48
121	151.911	.	.	489.49	.	.	.	0.09057	.	1.47481	3	0.99683	1406.45
122	152.249	.	.	453.93	.	.	0.06541	.	.	1.66323	3	0.99682	1412.73
123	164.970	-10.4363	.	1465.98	2.0458	.	.	.	.	.	3	0.99626	1659.91
124	171.406	-10.3594	.	1538.77	.	.	.	.	0.3343	.	3	0.99597	1792.50
125	173.112	-10.2632	.	1561.15	.	1.6013	.	.	.	.	3	0.99589	1828.50
126	188.102	0.0947	.	.	18.1345	.	.	.	-2.5586	.	3	0.99514	2160.14
127	188.102	0.0947	.	.	15.0647	-9.8943	.	.	.	.	3	0.99514	2160.14
128	188.102	0.0947	.	.	.	-58.4495	.	.	12.5559	.	3	0.99514	2160.14
129	11.459	-1.6325	11.6560	.	1.7319	.	.	.	-0.2895	.	4	0.99998	2.24
130	11.459	-1.6325	11.6560	.	1.3845	-1.1196	.	.	.	.	4	0.99998	2.24
131	11.459	-1.6325	11.6560	.	.	-5.5822	.	.	1.1540	.	4	0.99998	2.24
132	11.546	.	12.2804	.	1.7519	.	.	-0.06176	-0.2430	.	4	0.99998	2.35
133	11.546	.	12.2804	.	1.4603	-0.9398	.	-0.06176	.	.	4	0.99998	2.35
134	11.546	.	12.2804	.	.	-5.6464	.	-0.06176	1.2171	.	4	0.99998	2.35
135	11.679	.	12.2536	.	1.6694	.	-0.05545	.	-0.2335	.	4	0.99998	2.52
136	11.679	.	12.2536	.	1.3892	-0.9030	-0.05545	.	.	.	4	0.99998	2.52
137	11.679	.	12.2536	.	.	-5.3806	-0.05545	.	1.1579	.	4	0.99998	2.52
138	12.989	.	11.8054	-45.57	1.9703	.	.	.	-0.3414	.	4	0.99998	4.30
139	12.989	.	11.8054	-45.57	1.5606	-1.3203	.	.	.	.	4	0.99998	4.30
140	12.989	.	11.8054	-45.57	.	-6.3504	.	.	1.3007	.	4	0.99998	4.30
141	13.025	-2.7228	12.2703	.	0.2444	.	.	.	.	-0.27117	4	0.99998	4.35
142	13.064	.	12.8673	.	0.5301	.	-0.08621	.	.	-0.09900	4	0.99998	4.41
143	13.073	-2.3423	12.1358	-95.82	0.0313	.	.	.	.	.	4	0.99998	4.42
144	13.077	.	12.7802	-37.70	0.4302	.	-0.08163	.	.	.	4	0.99998	4.43
145	13.098	-0.7696	12.5530	.	0.3954	.	-0.07148	.	.	.	4	0.99998	4.46
146	13.125	.	12.8342	-44.75	0.4556	.	.	-0.08895	.	.	4	0.99998	4.50
147	13.136	-2.2232	12.1491	-102.36	.	.	.	.	.	0.02380	4	0.99998	4.51
148	13.139	-2.2633	12.1678	-95.57	.	.	.	.	0.0032	.	4	0.99998	4.52
149	13.150	-2.2411	12.1752	-95.37	.	0.0129	.	.	.	.	4	0.99998	4.53
150	13.158	-2.2698	12.1587	-96.44	.	.	0.00248	.	.	.	4	0.99998	4.54

balanced based energy gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_INDHP_	_CIN_	_P_	_RSQ_	_CP_
201	94.535	.	.	-1455.82	.	-5.6519	0.59563	.	.	4.95480	4	0.99890	487.642
202	94.733	.	.	.	10.5804	.	.	0.55702	-2.50242	1.96490	4	0.99889	489.702
203	94.733	.	.	.	7.5780	-9.6772	.	0.55702	.	1.96490	4	0.99889	489.702
204	94.733	.	.	.	.	-34.1018	.	0.55702	6.31598	1.96490	4	0.99889	489.702
205	95.089	.	.	.	11.5466	.	0.51972	.	-2.64522	1.96563	4	0.99888	493.427
206	95.089	.	.	.	8.3729	-10.2294	0.51972	.	.	1.96563	4	0.99888	493.427
207	95.089	.	.	.	.	-37.2160	0.51972	.	6.97849	1.96563	4	0.99888	493.427
208	96.686	.	.	-1429.59	.	.	.	0.63048	-1.17764	4.93792	4	0.99884	510.311
209	97.559	.	.	-1572.66	.	.	0.59219	.	-1.19885	5.25011	4	0.99882	519.656
210	100.852	-27.7058	.	-287.70	-4.8781	.	.	1.09832	.	.	4	0.99874	555.679
211	101.210	-24.2007	.	.	-4.5942	.	-1.11702	2.17854	.	.	4	0.99873	559.666
212	102.137	-25.2234	.	.	-4.4006	.	.	0.95979	.	0.25646	4	0.99871	570.058
213	102.175	.	.	.	.	-4.1451	-2.61889	3.34832	.	2.27089	4	0.99871	570.479
214	102.340	-30.1546	.	-398.49	-4.8287	.	1.07200	.	.	.	4	0.99871	572.347
215	104.377	.	.	.	.	.	-2.94641	3.68871	-0.85959	2.31148	4	0.99865	595.549
216	104.773	-27.0515	.	.	-4.1590	.	0.91198	.	.	0.18406	4	0.99864	600.124
217	104.995	.	.	465.50	13.6631	.	.	0.66794	-2.86387	.	4	0.99864	602.689
218	104.995	.	.	465.50	10.2271	-11.0749	.	0.66794	.	.	4	0.99864	602.689
219	104.995	.	.	465.50	.	-44.0378	.	0.66794	8.52390	.	4	0.99864	602.689
220	105.749	.	.	443.16	14.7897	.	0.62852	.	-3.03369	.	4	0.99862	611.449
221	105.749	.	.	443.16	11.1498	-11.7316	0.62852	.	.	.	4	0.99862	611.449
222	105.749	.	.	443.16	.	-47.6687	0.62852	.	9.29299	.	4	0.99862	611.449
223	108.999	.	.	.	12.7850	.	0.08739	0.71203	-2.83202	.	4	0.99853	649.922
224	108.999	.	.	.	9.3872	-10.9517	0.08739	0.71203	.	.	4	0.99853	649.922
225	108.999	.	.	.	.	-41.2075	0.08739	0.71203	7.8239	.	4	0.99853	649.92
226	115.739	.	.	.	-4.9390	.	-4.14602	4.90639	.	2.45831	4	0.99834	733.42
227	115.810	.	.	-1685.21	-7.0166	.	.	0.56441	.	5.69760	4	0.99834	734.32
228	116.043	.	.	532.18	.	-3.5400	-3.89551	4.85245	.	.	4	0.99834	737.31
229	117.898	.	.	-1779.61	-6.9830	.	0.51132	.	.	5.96892	4	0.99828	761.22
230	118.189	.	.	555.82	.	.	-4.20786	5.17165	-0.7229	.	4	0.99827	765.01
231	124.311	5.1172	.	.	11.6875	.	.	.	-2.3575	4.12372	4	0.99809	846.84
232	124.311	5.1172	.	.	8.8590	-9.1167	.	.	.	4.12372	4	0.99809	846.84
233	124.311	5.1172	.	.	.	-37.6702	.	.	7.3837	4.12372	4	0.99809	846.84
234	125.716	.	.	-265.55	9.2852	.	.	.	-1.9641	4.61053	4	0.99805	866.21
235	125.716	.	.	-265.55	6.9287	-7.5953	.	.	.	4.61053	4	0.99805	866.21
236	125.716	.	.	-265.55	.	-29.9273	.	.	5.7749	4.61053	4	0.99805	866.21
237	127.886	.	.	690.07	-3.8036	.	-5.30294	6.24671	.	.	4	0.99798	896.55
238	130.494	5.5188	.	-1209.19	.	-3.6827	.	.	.	7.00021	4	0.99790	933.70
239	132.410	4.8889	.	-1240.68	.	.	.	.	-0.7600	7.05966	4	0.99783	961.46
240	134.873	-27.1911	.	1001.00	.	.	.	0.66028	.	-1.99469	4	0.99775	997.75
241	135.825	-28.0535	.	900.81	.	.	0.62618	.	.	-1.82919	4	0.99772	1011.96
242	138.386	-17.9650	.	713.31	.	.	-0.97972	1.38778	.	.	4	0.99763	1050.67
243	142.071	0.9172	.	-1126.80	-3.8815	.	.	.	.	6.62881	4	0.99751	1107.64
244	144.220	0.0366	.	1556.44	18.4623	.	.	.	-2.8878	.	4	0.99743	1141.55
245	144.220	0.0366	.	1556.44	14.9975	-11.1673	.	.	.	.	4	0.99743	1141.55
246	144.220	0.0366	.	1556.44	.	-59.5060	.	.	12.4999	.	4	0.99743	1141.55
247	144.238	-25.4231	.	.	.	.	1.26177	-0.81176	.	-0.10869	4	0.99743	1141.84
248	149.263	.	.	1260.83	.	.	-4.45356	4.86752	.	-0.09881	4	0.99725	1223.13
249	11.554	-1.8619	11.9272	.	1.5932	.	.	.	-0.2443	-0.15534	5	0.99999	3.54
250	11.554	-1.8619	11.9272	.	1.3001	-0.9448	.	.	.	-0.15534	5	0.99999	3.54

balanced based energy gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_INDHP_	_CIN_	_P_	_RSQ_	_CP_
151	13.159	-2.2586	12.1604	-96.05	.	.	.	0.00243	.	.	4	0.99998	4.55
152	13.160	.	12.9268	.	0.5695	.	.	-0.09502	.	-0.10841	4	0.99998	4.55
153	13.165	-0.8886	12.5612	.	0.4100	.	.	-0.07592	.	.	4	0.99998	4.55
154	13.189	.	11.7660	.	2.1705	.	.	.	-0.3668	-0.07173	4	0.99998	4.59
155	13.189	.	11.7660	.	1.7305	-1.4184	.	.	.	-0.07173	4	0.99998	4.59
156	13.189	.	11.7660	.	.	-6.9958	.	.	1.4423	-0.07173	4	0.99998	4.59
157	13.251	.	12.7051	.	0.4469	.	-0.15299	0.07036	.	.	4	0.99998	4.68
158	13.674	-2.6955	12.2638	.	.	.	.	.	0.0327	-0.22834	4	0.99998	5.31
159	13.824	-2.6693	12.2547	.	.	0.1447	.	.	.	-0.21310	4	0.99998	5.53
160	14.041	-1.2779	12.4433	.	.	.	-0.05320	.	0.0480	.	4	0.99998	5.87
161	14.058	.	12.8545	-56.34	.	.	-0.07493	.	0.0627	.	4	0.99998	5.89
162	14.133	.	12.4197	-152.97	.	.	-0.04872	.	.	0.28554	4	0.99998	6.01
163	14.150	.	12.6656	.	.	.	-0.29611	0.23260	0.0588	.	4	0.99998	6.04
164	14.169	-1.4826	12.3927	.	.	.	.	-0.05044	0.0444	.	4	0.99998	6.07
165	14.184	.	12.4364	-161.93	.	.	.	-0.05215	.	0.29871	4	0.99998	6.09
166	14.207	-2.9020	11.9832	.	.	.	.	0.02296	.	-0.16424	4	0.99998	6.13
167	14.227	.	12.8891	-65.34	.	.	.	-0.07868	0.0634	.	4	0.99997	6.16
168	14.248	-1.4616	12.3736	.	.	0.1923	-0.04472	.	.	.	4	0.99997	6.19
169	14.255	-2.8991	11.9882	.	.	.	0.02094	.	.	-0.15758	4	0.99997	6.201
170	14.288	-1.7077	12.0067	.	.	.	-0.23559	0.23870	.	.	4	0.99997	6.254
171	14.316	.	12.8545	-61.70	.	0.2809	-0.07114	.	.	.	4	0.99997	6.297
172	14.356	.	12.6395	.	.	0.2579	-0.32815	0.27072	.	.	4	0.99997	6.361
173	14.364	-1.6721	12.3080	.	.	0.1680	.	-0.04014	.	.	4	0.99997	6.374
174	14.382	.	12.9306	.	.	.	-0.08615	.	0.08244	-0.07633	4	0.99997	6.402
175	14.503	.	12.8795	-70.85	.	0.2787	.	-0.07361	.	.	4	0.99997	6.594
176	14.695	.	12.9655	.	.	.	.	-0.09167	0.08507	-0.08418	4	0.99997	6.903
177	14.759	.	12.9146	.	.	0.3740	-0.08377	.	.	-0.06424	4	0.99997	7.007
178	14.920	.	12.3727	-56.08	.	.	-0.32392	0.31729	.	.	4	0.99997	7.270
179	15.114	.	12.9346	.	.	0.3781	.	-0.08769	.	-0.07078	4	0.99997	7.592
180	15.222	.	12.2038	.	.	.	-0.43523	0.42546	.	0.04637	4	0.99997	7.773
181	15.450	.	11.9519	-211.60	.	-0.2955	.	.	.	0.37039	4	0.99997	8.158
182	15.683	.	11.9866	-210.13	.	.	.	.	-0.05867	0.35110	4	0.99997	8.559
183	16.579	.	12.1449	-182.63	-0.2408	.	.	.	.	0.20760	4	0.99997	10.152
184	79.821	-19.8119	.	.	7.6891	.	0.90664	.	-2.02377	.	4	0.99921	346.218
185	79.821	-19.8119	.	.	5.2610	-7.8261	0.90664	.	.	.	4	0.99921	346.218
186	79.821	-19.8119	.	.	.	-24.7829	0.90664	.	4.38486	.	4	0.99921	346.218
187	82.193	-18.8787	.	.	6.3620	.	.	0.95669	-1.82093	.	4	0.99917	367.400
188	82.193	-18.8787	.	.	4.1772	-7.0417	.	0.95669	.	.	4	0.99917	367.400
189	82.193	-18.8787	.	.	.	-20.5053	.	0.95669	3.48156	.	4	0.99917	367.400
190	85.190	-25.8619	.	-343.79	.	-4.2150	1.07453	.	.	.	4	0.99910	395.056
191	86.041	-23.1890	.	-199.61	.	-4.1195	.	1.07678	.	.	4	0.99909	403.089
192	86.415	-20.6467	.	.	.	-3.9166	.	0.94856	.	0.44552	4	0.99908	406.643
193	86.941	-22.7544	.	.	.	-3.8908	0.13130	0.88172	.	.	4	0.99907	411.673
194	87.477	-23.0399	.	.	.	-3.8278	0.92775	.	.	0.30727	4	0.99905	416.826
195	87.808	-26.8899	.	-374.03	.	.	1.08801	.	-0.87511	.	4	0.99905	420.018
196	88.148	-24.1964	.	-232.92	.	.	.	1.09394	-0.85962	.	4	0.99904	423.319
197	88.891	-21.6344	.	.	.	.	.	0.95901	-0.80634	0.40866	4	0.99902	430.567
198	89.316	-23.0354	.	.	.	.	-0.14320	1.17281	-0.80556	.	4	0.99901	434.742
199	90.431	-23.9409	.	.	.	.	0.93218	.	-0.78306	0.28450	4	0.99899	445.793
200	94.022	.	.	-1309.80	.	-5.5323	.	0.63053	.	4.64876	4	0.99891	482.305

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                                         balanced based energy gain predictive equations

OBS     _RMSE_   _ANGAIN_    _CGAIN_       _RQ_      _CO2_       _O2_    _MECON_   _MENCON_    _INDHP_      _CIN_   _P_      _RSQ_     _CP_

251     11.554    -1.8619    11.9272      .          .        -5.1351      .          .         1.0836   -0.15534     5    0.99999     3.54
252     11.709    -1.6569    11.8328     -49.15     1.4729      .          .          .        -0.2447      .         5    0.99998     3.72
253     11.709    -1.6569    11.8328     -49.15     1.1792    -0.9464      .          .          .          .         5    0.99998     3.72
254     11.709    -1.6569    11.8328     -49.15      .        -4.7472      .          .         0.9829      .         5    0.99998     3.72
255     11.844    -1.0069    12.0036      .         1.6629      .          .       -0.03414    -0.2482      .         5    0.99998     3.87
256     11.844    -1.0069    12.0036      .         1.3651    -0.9598      .       -0.03414      .          .         5    0.99998     3.87
257     11.844    -1.0069    12.0036      .          .        -5.3596      .       -0.03414     1.1378      .         5    0.99998     3.87
258     11.953    -1.0906    11.9452      .         1.6319      .       -0.02663      .        -0.2489      .         5    0.99998     4.00
259     11.953    -1.0906    11.9452      .         1.3332    -0.9627   -0.02663      .          .          .         5    0.99998     4.00
260     11.953    -1.0906    11.9452      .          .        -5.2596   -0.02663      .         1.1111      .         5    0.99998     4.00
261     12.052      .         12.2827      .         2.0781      .        0.17918   -0.25316    -0.2921      .         5    0.99998     4.12
262     12.052      .         12.2827      .         1.7277    -1.1294    0.17918   -0.25316      .          .         5    0.99998     4.12
263     12.052      .         12.2827      .          .        -6.6979    0.17918   -0.25316     1.4400      .         5    0.99998     4.12
264     12.174      .         12.3644      .         1.7329      .          .       -0.06096    -0.2338   -0.05320     5    0.99998     4.26
265     12.174      .         12.3644      .         1.4524    -0.9039      .       -0.06096      .       -0.05320     5    0.99998     4.26
266     12.174      .         12.3644      .          .        -5.5853      .       -0.06096     1.2106   -0.05320     5    0.99998     4.26
267     12.185      .         12.3188     -19.21     1.6750      .          .       -0.05880    -0.2327      .         5    0.99998     4.27
268     12.185      .         12.3188     -19.21     1.3958    -0.8998      .       -0.05880      .          .         5    0.99998     4.27
269     12.185      .         12.3188     -19.21      .        -5.3987      .       -0.05880     1.1634      .         5    0.99998     4.27
270     12.319      .         12.3344      .         1.6530      .       -0.05464      .        -0.2249   -0.05175     5    0.99998     4.44
271     12.319      .         12.3344      .         1.3832    -0.8698   -0.05464      .          .       -0.05175     5    0.99998     4.44
272     12.319      .         12.3344      .          .        -5.3279   -0.05464      .         1.1528   -0.05175     5    0.99998     4.44
273     12.338      .         12.2857     -17.45     1.6067      .       -0.05268      .        -0.2255      .         5    0.99998     4.46
274     12.338      .         12.2857     -17.45     1.3361    -0.8720   -0.05268      .          .          .         5    0.99998     4.46
275     12.338      .         12.2857     -17.45      .        -5.1785   -0.05268      .         1.1136      .         5    0.99998     4.46
276     13.249    -1.5754    12.6109      .         0.4330      .          .       -0.04959      .       -0.19111     5    0.99998     5.60
277     13.269    -1.5073    12.5881      .         0.4141      .       -0.04616      .          .       -0.18331     5    0.99998     5.63
278     13.358    -1.3379    12.4985     -65.05     0.2769      .          .       -0.04850      .          .         5    0.99998     5.74
279     13.403    -1.2922    12.4740     -61.37     0.2627      .       -0.04483      .          .          .         5    0.99998     5.80
280     13.712    -2.5481    12.2344     -46.51     0.1567      .          .          .          .       -0.15852     5    0.99998     6.21
281    13.7222      .         11.7528     -72.43    1.87264      .          .          .       -0.33555    0.08602     5    0.99998    6.226
282    13.7222      .         11.7528     -72.43    1.47004    -1.2976      .          .          .        0.08602     5    0.99998    6.226
283    13.7222      .         11.7528     -72.43      .        -6.0357      .          .        1.22523    0.08602     5    0.99998    6.226
284    13.8443      .         12.8383     -16.67    0.49011      .       -0.08387      .          .       -0.06310     5    0.99998    6.391
285    13.8463      .         12.8388      .        0.51074      .       -0.12248    0.04050      .       -0.09566     5    0.99998    6.394
286    13.8704      .         12.7755     -37.20    0.42772      .       -0.08810    0.00712      .          .         5    0.99998    6.427
287    13.8801    -1.9513    12.3133     -87.55      .          .          .       -0.01701    0.01781      .         5    0.99998    6.440
288    13.8844    -0.7379    12.5381      .        0.38229      .       -0.10608    0.03790      .          .         5    0.99998    6.446
289    13.8881    -1.9348    12.3031     -86.14      .          .       -0.01570      .        0.01697      .         5    0.99998    6.451
290    13.9080    -1.9837    12.1850    -111.45      .          .          .       -0.00770      .        0.06938     5    0.99998    6.478
291    13.9115      .         12.8695     -32.27    0.49155      .          .       -0.09031      .       -0.03807     5    0.99998    6.483
292    13.9136    -2.0013    12.1798    -109.37      .          .       -0.00651      .          .        0.06301     5    0.99998    6.486
293    13.9221    -2.1371    12.1230    -112.57      .        -0.0266      .          .          .        0.06142     5    0.99998    6.497
294    13.9327    -2.2285    12.1507    -101.69      .          .          .          .        0.00035    0.02138     5    0.99998    6.512
295    13.9371    -2.1074    12.2415     -92.14      .         0.0441      .       -0.00750      .          .         5    0.99998    6.518
296    13.9376    -2.4043    12.1656    -103.74      .          .        0.06327   -0.06207      .          .         5    0.99998    6.518
297    13.9406    -2.1149    12.2304     -91.91      .         0.0392   -0.00619      .          .          .         5    0.99998    6.523
298    14.3162    -1.9806    12.5031      .          .          .       -0.03017      .        0.05339   -0.18350     5    0.99998    7.043
299    14.3574    -2.1280    12.4808      .          .          .          .       -0.02755    0.05190   -0.19391     5    0.99998    7.100
300    14.5611    -2.1481    12.4389      .          .         0.2205   -0.02256      .          .       -0.18100     5    0.99998    7.389
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balanced based energy gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_INDHP_	_CIN_	_P_	_RSQ_	_CP_
301	14.5978	-2.2994	12.4041	.	.	0.2074	.	-0.01845	.	-0.19090	5	0.99998	7.442
302	14.7040	-1.0483	12.3972	.	.	.	-0.21326	0.17181	0.04132	.	5	0.99998	7.594
303	14.7709	.	12.6743	-100.73	.	.	-0.06788	.	0.03827	0.14280	5	0.99998	7.691
304	14.7745	.	12.7450	-43.25	.	.	-0.21503	0.15312	0.05523	.	5	0.99998	7.696
305	14.8602	-1.1638	12.3345	.	.	0.1629	-0.22995	0.19706	.	.	5	0.99998	7.820
306	14.8681	.	12.6685	-118.73	.	.	.	-0.07038	0.03396	0.17689	5	0.99998	7.832
307	14.8846	-2.3771	12.0073	.	.	.	-0.16963	0.19165	.	-0.12991	5	0.99998	7.856
308	14.8990	.	12.5907	-121.64	.	0.1174	-0.06131	.	.	0.19817	5	0.99998	7.877
309	14.9248	.	12.7652	.	.	.	-0.28446	0.22114	0.06637	-0.06329	5	0.99998	7.915
310	14.9566	.	12.3911	-137.74	.	.	-0.12596	0.08348	.	0.25849	5	0.99998	7.961
311	14.9781	.	12.7218	-44.92	.	0.2406	-0.24240	0.18646	.	.	5	0.99998	7.993
312	14.9828	.	12.5787	-138.40	.	0.0953	.	-0.06308	.	0.23061	5	0.99998	8.000
313	15.1720	.	12.7225	.	.	0.2879	-0.32080	0.26358	.	-0.05180	5	0.99997	8.279
314	83.2184	-17.9610	.	-954.31	.	-5.0144	0.89485	.	.	2.34756	5	0.99924	336.335
315	83.2367	-20.9831	.	.	9.77651	.	2.24507	-1.42274	-2.33125	.	5	0.99924	336.484
316	83.2367	-20.9831	.	.	6.97945	-9.0152	2.24507	-1.42274	.	.	5	0.99924	336.484
317	83.2367	-20.9831	.	.	.	-31.5107	2.24507	-1.42274	5.81714	.	5	0.99924	336.484
318	84.1847	-17.9702	.	.	7.77485	.	0.84494	.	-2.04067	0.39987	5	0.99922	344.261
319	84.1847	-17.9702	.	.	5.32644	-7.8915	0.84494	.	.	0.39987	5	0.99922	344.261
320	84.1847	-17.9702	.	.	.	-25.0592	0.84494	.	4.43941	0.39987	5	0.99922	344.261
321	84.3744	-20.6866	.	-118.65	7.20287	.	0.94668	.	-1.97506	.	5	0.99922	345.828
322	84.3744	-20.6866	.	-118.65	4.83318	-7.6378	0.94668	.	.	.	5	0.99922	345.828
323	84.3744	-20.6866	.	-118.65	.	-23.2156	0.94668	.	4.02829	.	5	0.99922	345.828
324	85.2988	-16.1313	.	-787.10	.	-4.8581	.	0.90272	.	2.20371	5	0.99920	353.513
325	85.3909	-18.6891	.	-1046.36	.	.	0.90635	.	-1.06363	2.51891	5	0.99920	354.284
326	86.1188	-16.2717	.	.	6.61426	.	.	0.86139	-1.86570	0.58873	5	0.99919	360.401
327	86.1188	-16.2717	.	.	4.37578	-7.2149	.	0.86139	.	0.58873	5	0.99919	360.401
328	86.1188	-16.2717	.	.	.	-21.3185	.	0.86139	3.64706	0.58873	5	0.99919	360.401
329	86.9928	-16.8673	.	-876.68	.	.	.	0.91759	-1.03306	2.36054	5	0.99917	367.814
330	87.1763	-18.9522	.	-10.63	6.31388	.	.	0.96042	-1.81580	.	5	0.99917	369.380
331	87.1763	-18.9522	.	-10.63	.	-20.3503	.	0.96042	3.44660	.	5	0.99917	369.380
332	87.1763	-18.9522	.	-10.63	4.13526	-7.0219	.	0.96042	.	.	5	0.99917	369.380
333	90.3570	-25.9418	.	-347.92	.	-4.2169	1.10752	-0.03325	.	.	5	0.99910	397.049
334	91.6427	-20.3081	.	.	.	-3.9247	-0.11715	1.06667	.	0.47027	5	0.99908	408.515
335	93.0615	-26.1263	.	-335.26	.	.	0.77298	0.31804	-0.87203	.	5	0.99905	421.356
336	94.1165	-20.4613	.	.	.	.	-0.40821	1.37154	-0.81351	0.49508	5	0.99903	431.032
337	95.201	.	.	-915.27	7.7786	.	0.57131	.	-2.28178	3.69390	5	0.99900	441.094
338	95.201	.	.	-915.27	5.0409	-8.8239	0.57131	.	.	3.69390	5	0.99900	441.094
339	95.201	.	.	-915.27	.	-25.0713	0.57131	.	4.20143	3.69390	5	0.99900	441.094
340	95.755	.	.	-830.60	7.0720	.	.	0.60104	-2.15513	3.55626	5	0.99899	446.274
341	95.755	.	.	-830.60	4.4863	-8.3341	.	0.60104	.	3.55626	5	0.99899	446.274
342	95.755	.	.	-830.60	.	-22.7939	.	0.60104	3.73917	3.55626	5	0.99899	446.274
343	99.663	.	.	-1239.10	.	-5.4656	-0.28301	0.92758	.	4.51051	5	0.99891	483.691
344	100.439	.	.	.	10.1420	.	-0.23548	0.80751	-2.43631	1.97161	5	0.99889	491.303
345	100.439	.	.	.	7.2189	-9.4215	-0.23548	0.80751	.	1.97161	5	0.99889	491.303
346	100.439	.	.	.	.	-32.6889	-0.23548	0.80751	6.01674	1.97161	5	0.99889	491.303
347	101.265	-21.0741	.	-1026.03	-6.1689	.	.	0.94870	.	2.49842	5	0.99887	499.470
348	101.908	-22.7407	.	-1181.01	-6.2441	.	0.91870	.	.	2.68230	5	0.99886	505.874
349	102.170	.	.	-1255.45	.	.	-0.69548	1.36136	-1.14470	4.59530	5	0.99885	508.494
350	106.661	-21.3069	.	.	-4.6625	.	-1.43555	2.42499	.	0.55860	5	0.99875	554.439

balanced based energy gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_INDHP_	_CIN_	_P_	_RSQ_	_CP_
351	106.742	-26.2486	.	-215.80	-4.8627	.	-0.59144	1.69753	.	.	5	0.99875	555.287
352	111.037	.	.	505.18	.	-39.9802	-0.73554	1.44131	7.67311	.	5	0.99865	601.122
353	111.037	.	.	505.18	12.4042	.	-0.73554	1.44131	-2.66540	.	5	0.99865	601.122
354	111.037	.	.	505.18	9.2063	-10.3074	-0.73554	1.44131	.	.	5	0.99865	601.122
355	117.558	.	.	-1071.20	-6.5161	.	-2.64946	3.37245	.	4.46020	5	0.99848	674.170
356	130.660	6.4314	.	-494.12	9.9203	.	.	.	-2.20112	5.18756	5	0.99812	833.523
357	130.660	6.4314	.	-494.12	7.2794	-8.5120	.	.	.	5.18756	5	0.99812	833.523
358	130.660	6.4314	.	-494.12	.	-31.9741	.	.	6.06710	5.18756	5	0.99812	833.523
359	142.189	-24.3062	.	1178.49	.	.	-1.33815	2.03515	.	-2.09941	5	0.99778	987.647
360	12.024	-1.5245	11.8656	.	2.2231	.	0.33282	-0.37548	-0.34193	.	6	0.99999	5.199
361	12.024	-1.5245	11.8656	.	1.8129	-1.3223	0.33282	-0.37548	.	.	6	0.99999	5.199
362	12.024	-1.5245	11.8656	.	.	-7.1654	0.33282	-0.37548	1.51097	.	6	0.99999	5.199
363	12.255	-1.4711	12.0841	.	1.5749	.	.	-0.01944	-0.22761	-0.13188	6	0.99999	5.439
364	12.255	-1.4711	12.0841	.	1.3018	-0.8802	.	-0.01944	.	-0.13188	6	0.99999	5.439
365	12.255	-1.4711	12.0841	.	.	-5.0759	.	-0.01944	1.08498	-0.13188	6	0.99999	5.439
366	12.326	-1.6409	12.0108	.	1.5682	.	-0.00988	.	-0.23321	-0.14180	6	0.99999	5.514
367	12.326	-1.6409	12.0108	.	1.2884	-0.9018	-0.00988	.	.	-0.14180	6	0.99999	5.514
368	12.326	-1.6409	12.0108	.	.	-5.0544	-0.00988	.	1.07382	-0.14180	6	0.99999	5.514
369	12.351	-1.8508	11.9255	-3.82	1.5810	.	.	.	-0.24340	-0.14652	6	0.99999	5.540
370	12.351	-1.8508	11.9255	-3.82	1.2889	-0.9413	.	.	.	-0.14652	6	0.99999	5.540
371	12.351	-1.8508	11.9255	-3.82	.	-5.0956	.	.	1.07427	-0.14652	6	0.99999	5.540
372	12.409	-1.2660	12.0101	-38.87	1.4845	.	.	-0.02105	-0.22860	.	6	0.99999	5.602
373	12.409	-1.2660	12.0101	-38.87	1.2102	-0.8840	.	-0.02105	.	.	6	0.99999	5.602
374	12.409	-1.2660	12.0101	-38.87	.	-4.7847	.	-0.02105	1.00866	.	6	0.99999	5.602
375	12.490	-1.4377	11.9260	-43.01	1.4653	.	-0.01062	.	-0.23414	.	6	0.99999	5.688
376	12.490	-1.4377	11.9260	-43.01	1.1844	-0.9055	-0.01062	.	.	.	6	0.99999	5.688
377	12.490	-1.4377	11.9260	-43.01	.	-4.7229	-0.01062	.	0.98717	.	6	0.99999	5.688
378	12.704	.	12.3494	-33.00	2.0448	.	0.23343	-0.30605	-0.28915	.	6	0.99998	5.919
379	12.704	.	12.3494	-33.00	1.6979	-1.1182	0.23343	-0.30605	.	.	6	0.99998	5.919
380	12.704	.	12.3494	-33.00	.	-6.5908	0.23343	-0.30605	1.41516	.	6	0.99998	5.919
381	12.780	.	12.3791	.	2.0758	.	0.18989	-0.26370	-0.28436	-0.06102	6	0.99998	6.003
382	12.780	.	12.3791	.	1.7347	-1.0997	0.18989	-0.26370	.	-0.06102	6	0.99998	6.003
383	12.780	.	12.3791	.	.	-6.6907	0.18989	-0.26370	1.44579	-0.06102	6	0.99998	6.003
384	13.012	.	12.3563	-5.88	1.7139	.	.	-0.06025	-0.23278	-0.04063	6	0.99998	6.260
385	13.012	.	12.3563	-5.88	1.4346	-0.9002	.	-0.06025	.	-0.04063	6	0.99998	6.260
386	13.012	.	12.3563	-5.88	.	-5.5240	.	-0.06025	1.19567	-0.04063	6	0.99998	6.260
387	13.170	.	12.3331	-0.88	1.6505	.	-0.05453	.	-0.22482	-0.04988	6	0.99998	6.436
388	13.170	.	12.3331	-0.88	1.3807	-0.8694	-0.05453	.	.	-0.04988	6	0.99998	6.436
389	13.170	.	12.3331	-0.88	.	-5.3196	-0.05453	.	1.15079	-0.04988	6	0.99998	6.436
390	14.141	-1.5512	12.5781	-21.17	0.3839	.	.	-0.04720	.	-0.14369	6	0.99998	7.574
391	14.163	-1.5982	12.6137	.	0.4359	.	0.01029	-0.06032	.	-0.19338	6	0.99998	7.600
392	14.174	-1.5043	12.5627	-14.91	0.3786	.	-0.04414	.	.	-0.15103	6	0.99998	7.614
393	14.253	-1.4957	12.5057	-73.46	0.27800	.	0.07023	-0.12031	.	.	6	0.99998	7.710
394	14.796	.	12.8262	-12.61	0.48684	.	-0.10880	0.02720	.	-0.06958	6	0.99998	8.386
395	14.829	-2.0665	12.3074	-93.16	.	.	0.04183	-0.05846	0.01672	.	6	0.99998	8.429
396	14.833	-1.9024	12.2943	-95.09	.	.	.	-0.01730	0.01449	0.02681	6	0.99998	8.434
397	14.836	-2.1346	12.1943	-122.76	.	.	0.07890	-0.08928	.	0.07712	6	0.99998	8.437
398	14.844	-1.8985	12.2857	-92.40	.	.	-0.01573	.	0.01407	0.02195	6	0.99998	8.447
399	14.868	-1.9765	12.1957	-110.02	.	0.0065	.	-0.00861	.	0.06556	6	0.99998	8.478
400	14.874	-2.0004	12.1808	-109.22	.	0.0006	-0.00660	.	.	0.06264	6	0.99998	8.486

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                                          best balance based energy gain predictive equations

OBS   _RMSE_    _ANGAIN_   _CGAIN_      _RQ_       _CO2_        _O2_     _MECON_    _MENCON_     _INDHP_       _CIN_   _P_    _RSQ_      _CP_

  1   13.2787    -2.43570   11.8990       .         .           .           .           .           .           .        2   0.99997   2.87965
  2   12.5003    -2.12116   12.2063    -93.645      .           .           .           .           .           .        3   0.99998   2.57059
  3   12.5976      .        12.7476       .        0.47746      .        -0.09020      .           .           .        3   0.99998   2.72021
  4   12.6158      .        11.6417       .        2.20395      .           .           .        -0.38168      .        3   0.99998   2.74831
  5   12.6158      .        11.6417       .        1.74601    -1.47602      .           .           .           .        3   0.99998   2.74831
  6   12.6158      .        11.6417       .         .        -7.10358      .           .         1.45524      .        3   0.99998   2.74831
  7   12.7290      .        12.7958       .        0.51182      .           .        -0.09958      .           .        3   0.99998   2.92407
  8   13.7442    -2.17531   12.0691       .         .           .           .           .           .        -0.04719   3   0.99997   4.57009
  9   13.7512      .        12.8197       .         .           .        -0.08781      .         0.07421      .        3   0.99997   4.58193
 10   13.8910    -2.20639   11.9814       .         .           .        -0.00360      .           .           .        3   0.99997   4.81859
 11   13.8911    -2.58090   11.8497       .        0.01990      .           .           .           .           .        3   0.99997   4.81872
 12   13.9006    -2.24638   11.9690       .         .           .           .        -0.00317      .           .        3   0.99997   4.83497
 13   13.9263    -2.45522   11.8932       .         .           .           .           .         0.00042      .        3   0.99997   4.87869
 14   13.9265    -2.42064   11.9034       .         .        -0.00155      .           .           .           .        3   0.99997   4.87909
 15   14.0687      .        12.8423       .         .           .           .        -0.09347    0.07588      .        3   0.99997   5.12285
 16   14.0752      .        12.8174       .         .         0.33949   -0.08493      .           .           .        3   0.99997   5.13410
 17   14.4260      .        12.8268       .         .         0.33964      .        -0.08894      .           .        3   0.99997   5.74652
 18   14.4873      .        12.2362       .         .           .        -0.44033     0.43631      .           .        3   0.99997   5.85512
 19   11.4595    -1.63254   11.6560       .        1.73192      .           .           .        -0.28953      .        4   0.99998   2.23888
 20   11.4595    -1.63254   11.6560       .        1.38455    -1.11964      .           .           .           .        4   0.99998   2.23888
 21   11.4595    -1.63254   11.6560       .         .        -5.58218      .           .         1.15397      .        4   0.99998   2.23888
 22   11.5463      .        12.2804       .        1.75186      .           .        -0.06176   -0.24301      .        4   0.99998   2.34899
 23   11.5463      .        12.2804       .        1.46029    -0.93976      .        -0.06176      .           .        4   0.99998   2.34899
 24   11.5463      .        12.2804       .         .        -5.64644      .        -0.06176    1.21710      .        4   0.99998   2.34899
 25   11.6789      .        12.2536       .        1.66937      .        -0.05545      .        -0.23350      .        4   0.99998   2.51882
 26   11.6789      .        12.2536       .        1.38921    -0.90298   -0.05545      .           .           .        4   0.99998   2.51882
 27   11.6789      .        12.2536       .         .        -5.38056   -0.05545      .         1.15786      .        4   0.99998   2.51882
 28   12.9887      .        11.8054    -45.572    1.97028      .           .           .        -0.34142      .        4   0.99998   4.29978
 29   12.9887      .        11.8054    -45.572    1.56064    -1.32031      .           .           .           .        4   0.99998   4.29978
 30   12.9887      .        11.8054    -45.572      .        -6.35044      .           .         1.30074      .        4   0.99998   4.29978
 31   13.0255    -2.72281   12.2703       .        0.24443      .           .           .           .        -0.27117   4   0.99998   4.35253
 32   13.0638      .        12.8673       .        0.53009      .        -0.08621      .           .        -0.09900   4   0.99998   4.40760
 33   13.0731    -2.34229   12.1358    -95.823    0.03131      .           .           .           .           .        4   0.99998   4.42102
 34   13.0774      .        12.7802    -37.700    0.43019      .        -0.08163      .           .           .        4   0.99998   4.42727
 35   13.0984    -0.76960   12.5530       .        0.39535      .        -0.07148      .           .           .        4   0.99998   4.45758
 36   13.1251      .        12.8342    -44.750    0.45562      .           .        -0.08895      .           .        4   0.99998   4.49617
 37   13.1359    -2.22322   12.1491   -102.360      .           .           .           .           .         0.02380   4   0.99998   4.51183
 38   13.1387    -2.26331   12.1678    -95.568      .           .           .           .         0.00320      .        4   0.99998   4.51587
 39   13.1503    -2.24113   12.1752    -95.372      .         0.01291      .           .           .           .        4   0.99998   4.53265
 40   13.1579    -2.26980   12.1587    -96.445      .           .         0.00248      .           .           .        4   0.99998   4.54365
 41   13.1593    -2.25863   12.1604    -96.047      .           .           .         0.00243      .           .        4   0.99998   4.54570
 42   13.1597      .        12.9268       .        0.56948      .           .        -0.09502      .        -0.10841   4   0.99998   4.54631
 43   13.1645    -0.88861   12.5612       .        0.41002      .           .        -0.07592      .           .        4   0.99998   4.55332
 44   13.1891      .        11.7660       .        2.17053      .           .           .        -0.36679   -0.07173   4   0.99998   4.58898
 45   13.1891      .        11.7660       .        1.73045    -1.41841      .           .           .        -0.07173   4   0.99998   4.58898
 46   13.1891      .        11.7660       .         .        -6.99584      .           .         1.44227   -0.07173   4   0.99998   4.58898
 47   13.2505      .        12.7051       .        0.44692      .        -0.15299     0.07036      .           .        4   0.99998   4.67848
 48   13.6740    -2.69554   12.2638       .         .           .           .           .         0.03274   -0.22834   4   0.99998   5.30701
 49   13.8236    -2.66934   12.2547       .         .         0.14471      .           .           .        -0.21310   4   0.99998   5.53377
 50   14.0413    -1.27786   12.4433       .         .           .        -0.05320      .         0.04801      .        4   0.99998   5.86826
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balanced based energy gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_INDHP_	_CIN_	_P_	_RSQ_	_CP_
401	14.886	-2.2531	12.2307	-99.08	.	0.0359	0.05109	-0.05774	.	.	6	0.99998	8.501
402	15.241	-1.7860	12.4712	.	.	.	-0.12421	0.09873	0.04906	-0.16715	6	0.99998	8.959
403	15.453	-1.8708	12.4054	.	.	0.1977	-0.14762	0.13028	.	-0.15978	6	0.99998	9.238
404	15.733	.	12.6509	-78.68	.	.	-0.16723	0.10633	0.04021	0.10109	6	0.99998	9.612
405	15.870	.	12.5747	-98.20	.	0.1317	-0.16237	0.10756	.	0.15268	6	0.99998	9.798
406	86.492	-16.5283	.	-651.10	5.39702	.	0.85554	.	-1.83063	1.75494	6	0.99928	319.739
407	86.492	-16.5283	.	-651.10	3.20062	-7.0793	0.85554	.	.	1.75494	6	0.99928	319.739
408	86.492	-16.5283	.	-651.10	.	-17.3952	0.85554	.	2.66761	1.75494	6	0.99928	319.739
409	87.443	-23.7124	.	-292.15	6.77088	-9.1359	3.00163	-2.12216	.	.	6	0.99927	326.832
410	87.443	-23.7124	.	-292.15	9.60539	.	3.00163	-2.12216	-2.36247	.	6	0.99927	326.832
411	87.443	-23.7124	.	-292.15	.	-30.9592	3.00163	-2.12216	5.64330	.	6	0.99927	326.832
412	87.911	-19.7808	.	-1178.24	.	-5.1860	2.03905	-1.17593	.	2.64663	6	0.99926	330.345
413	88.826	-19.8226	.	.	9.63609	.	2.08825	-1.29359	-2.31301	0.22887	6	0.99924	337.284
414	88.826	-19.8226	.	.	6.86092	-8.9447	2.08825	-1.29359	.	0.22887	6	0.99924	337.284
415	88.826	-19.8226	.	.	.	-31.0582	2.08825	-1.29359	5.71834	0.22887	6	0.99924	337.284
416	89.636	-14.8938	.	-549.19	4.63041	.	.	0.86473	-1.68999	1.75745	6	0.99923	343.482
417	89.636	-14.8938	.	-549.19	2.60275	-6.5354	.	0.86473	.	1.75745	6	0.99923	343.482
418	89.636	-14.8938	.	-549.19	.	-14.9243	.	0.86473	2.16930	1.75745	6	0.99923	343.482
419	90.827	-19.9321	.	-1193.23	.	.	1.66552	-0.78052	-1.08568	2.71269	6	0.99921	352.698
420	101.611	.	.	-984.38	8.40555	.	1.06529	-0.52402	-2.38990	3.82052	6	0.99901	441.668
421	101.611	.	.	-984.38	5.53813	-9.2420	1.06529	-0.52402	.	3.82052	6	0.99901	441.668
422	101.611	.	.	-984.38	.	-27.0920	1.06529	-0.52402	4.61584	3.82052	6	0.99901	441.668
423	108.254	-20.9453	.	-1015.51	-6.16217	.	-0.06280	1.01291	.	2.48864	6	0.99887	501.444
424	11.689	-2.5487	11.7745	-93.65	2.22623	.	0.59002	-0.60773	-0.36720	.	7	0.99999	6.021
425	11.689	-2.5487	11.7745	-93.65	1.78566	-1.4200	0.59002	-0.60773	.	.	7	0.99999	6.021
426	11.689	-2.5487	11.7745	-93.65	.	-7.1754	0.59002	-0.60773	1.48829	.	7	0.99999	6.021
427	11.979	-2.4345	11.9363	.	2.30225	.	0.46006	-0.48342	-0.34620	-0.20234	7	0.99999	6.273
428	11.979	-2.4345	11.9363	.	1.88688	-1.3388	0.46006	-0.48342	.	-0.20234	7	0.99999	6.273
429	11.979	-2.4345	11.9363	.	.	-7.4204	0.46006	-0.48342	1.57265	-0.20234	7	0.99999	6.273
430	13.236	-1.4755	12.0890	4.17	1.58787	.	.	-0.01982	-0.22828	-0.14104	7	0.99999	7.438
431	13.236	-1.4755	12.0890	4.17	1.31398	-0.8828	.	-0.01982	.	-0.14104	7	0.99999	7.438
432	13.236	-1.4755	12.0890	4.17	.	-5.1179	.	-0.01982	1.09516	-0.14104	7	0.99999	7.438
433	13.313	-1.6413	12.0131	1.63	1.57293	.	-0.01007	.	-0.23338	-0.14531	7	0.99999	7.514
434	13.313	-1.6413	12.0131	1.63	1.29292	-0.9025	-0.01007	.	.	-0.14531	7	0.99999	7.514
435	13.313	-1.6413	12.0131	1.63	.	-5.0697	-0.01007	.	1.07761	-0.14531	7	0.99999	7.514
436	13.714	.	12.3234	-43.50	2.03537	.	0.24546	-0.31772	-0.29198	0.02982	7	0.99998	7.912
437	13.714	.	12.3234	-43.50	1.68505	-1.1291	0.24546	-0.31772	.	0.02982	7	0.99998	7.912
438	13.714	.	12.3234	-43.50	.	-6.5602	0.24546	-0.31772	1.40443	0.02982	7	0.99998	7.912
439	15.262	-1.6423	12.5789	-28.65	0.37958	.	0.04504	-0.09332	.	-0.13684	7	0.99998	9.560
440	16.005	-2.0326	12.2748	-107.32	.	.	0.05783	-0.07478	0.01100	0.04274	7	0.99998	10.414
441	16.021	-2.1800	12.1584	-129.27	.	-0.0228	0.08955	-0.09711	.	0.09154	7	0.99998	10.432
442	89.071	-19.5161	.	-936.81	7.99133	.	3.29024	-2.52829	-2.27075	2.01538	7	0.99935	292.556
443	89.071	-19.5161	.	-936.81	5.26687	-8.7812	3.29024	-2.52829	.	2.01538	7	0.99935	292.556
444	89.071	-19.5161	.	-936.81	.	-25.7569	3.29024	-2.52829	4.38976	2.01538	7	0.99935	292.556
445	12.778	-2.5942	11.8094	-76.42	2.24600	.	0.57541	-0.59275	-0.36365	-0.05203	8	0.99999	8.000
446	12.778	-2.5942	11.8094	-76.42	1.80970	-1.4063	0.57541	-0.59275	.	-0.05203	8	0.99999	8.000
447	12.778	-2.5942	11.8094	-76.42	.	-7.2391	0.57541	-0.59275	1.50832	-0.05203	8	0.99999	8.000

best balance based energy gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_INDHP_	_CIN_	_P_	_RSQ_	_CP_
51	14.0585	.	12.8545	-56.341	.	.	-0.07493	.	0.06272	.	4	0.99998	5.89481
52	14.1327	.	12.4197	-152.972	.	.	-0.04872	.	.	0.28554	4	0.99998	6.01006
53	14.1500	.	12.6656	.	.	.	-0.29611	0.23260	0.05878	.	4	0.99998	6.03712
54	14.1689	-1.48261	12.3927	.	.	.	.	-0.05044	0.04442	.	4	0.99998	6.06663
55	14.1843	.	12.4364	-161.930	.	.	.	-0.05215	.	0.29871	4	0.99998	6.09076
56	14.2070	-2.90199	11.9832	.	.	.	.	0.02296	.	-0.16424	4	0.99998	6.12619
57	14.2274	.	12.8891	-65.340	.	.	.	-0.07868	0.06344	.	4	0.99997	6.15816
58	14.2481	-1.46158	12.3736	.	.	0.19228	-0.04472	.	.	.	4	0.99997	6.19066
59	14.2546	-2.89910	11.9882	.	.	.	0.02094	.	.	-0.15758	4	0.99997	6.20091
60	14.2882	-1.70771	12.0067	.	.	.	-0.23559	0.23870	.	.	4	0.99997	6.25371
61	14.3159	.	12.8545	-61.700	.	0.28092	-0.07114	.	.	.	4	0.99997	6.29740
62	14.3563	.	12.6395	.	.	0.25789	-0.32815	0.27072	.	.	4	0.99997	6.36131
63	14.3641	-1.67215	12.3080	.	.	0.16797	.	-0.04014	.	.	4	0.99997	6.37370
64	14.3818	.	12.9306	.	.	.	-0.08615	.	0.08244	-0.07633	4	0.99997	6.40171
65	14.5027	.	12.8795	-70.849	.	0.27875	.	-0.07361	.	.	4	0.99997	6.59422
66	14.6946	.	12.9655	.	.	.	.	-0.09167	0.08507	-0.08418	4	0.99997	6.90303
67	14.7586	.	12.9146	.	.	0.37404	-0.08377	.	.	-0.06424	4	0.99997	7.00692
68	14.9195	.	12.3727	-56.078	.	.	-0.32392	0.31729	.	.	4	0.99997	7.27021
69	15.1138	.	12.9346	.	.	0.37814	.	-0.08769	.	-0.07078	4	0.99997	7.59184
70	15.2222	.	12.2038	.	.	.	-0.43523	0.42546	.	0.04637	4	0.99997	7.77308
71	11.5541	-1.86191	11.9272	.	1.59322	.	.	.	-0.24432	-0.15534	5	0.99999	3.54128
72	11.5541	-1.86191	11.9272	.	1.30008	-0.94481	.	.	.	-0.15534	5	0.99999	3.54128
73	11.5541	-1.86191	11.9272	.	.	-5.13511	.	.	1.08357	-0.15534	5	0.99999	3.54128
74	11.7089	-1.65690	11.8328	-49.152	1.47286	.	.	.	-0.24473	.	5	0.99998	3.71769
75	11.7089	-1.65690	11.8328	-49.152	1.17923	-0.94639	.	.	.	.	5	0.99998	3.71769
76	11.7089	-1.65690	11.8328	-49.152	.	-4.74718	.	.	0.98285	.	5	0.99998	3.71769
77	11.8444	-1.00693	12.0036	.	1.66288	.	.	-0.03414	-0.24818	.	5	0.99998	3.87412
78	11.8444	-1.00693	12.0036	.	1.36511	-0.95975	.	-0.03414	.	.	5	0.99998	3.87412
79	11.8444	-1.00693	12.0036	.	.	-5.35965	.	-0.03414	1.13777	.	5	0.99998	3.87412
80	11.9533	-1.09058	11.9452	.	1.63185	.	-0.02663	.	-0.24895	.	5	0.99998	4.00106
81	11.9533	-1.09058	11.9452	.	1.33316	-0.96270	-0.02663	.	.	.	5	0.99998	4.00106
82	11.9533	-1.09058	11.9452	.	.	-5.25963	-0.02663	.	1.11115	.	5	0.99998	4.00106
83	12.0518	.	12.2827	.	2.07809	.	0.17918	-0.25316	-0.29205	.	5	0.99998	4.11700
84	12.0518	.	12.2827	.	1.72769	-1.12940	0.17918	-0.25316	.	.	5	0.99998	4.11700
85	12.0518	.	12.2827	.	.	-6.69791	0.17918	-0.25316	1.43997	.	5	0.99998	4.11700
86	12.1738	.	12.3644	.	1.73290	.	.	-0.06096	-0.23375	-0.05320	5	0.99998	4.26174
87	12.1738	.	12.3644	.	1.45244	-0.90394	.	-0.06096	.	-0.05320	5	0.99998	4.26174
88	12.1738	.	12.3644	.	.	-5.58531	.	-0.06096	1.21056	-0.05320	5	0.99998	4.26174
89	12.1847	.	12.3188	-19.209	1.67501	.	.	-0.05880	-0.23268	.	5	0.99998	4.27481
90	12.1847	.	12.3188	-19.209	1.39584	-0.89981	.	-0.05880	.	.	5	0.99998	4.27481
91	12.1847	.	12.3188	-19.209	.	-5.39875	.	-0.05880	1.16338	.	5	0.99998	4.27481
92	12.3193	.	12.3344	.	1.65304	.	-0.05464	.	-0.22491	-0.05175	5	0.99998	4.43636
93	12.3193	.	12.3344	.	1.38319	-0.86977	-0.05464	.	.	-0.05175	5	0.99998	4.43636
94	12.3193	.	12.3344	.	.	-5.32794	-0.05464	.	1.15284	-0.05175	5	0.99998	4.43636
95	12.3377	.	12.2857	-17.445	1.60667	.	-0.05268	.	-0.22550	.	5	0.99998	4.45867
96	12.3377	.	12.2857	-17.445	1.33610	-0.87205	-0.05268	.	.	.	5	0.99998	4.45867
97	12.3377	.	12.2857	-17.445	.	-5.17846	-0.05268	.	1.11360	.	5	0.99998	4.45867
98	13.2488	-1.57545	12.6109	.	0.43298	.	.	-0.04959	.	-0.19111	5	0.99998	5.60082
99	13.2689	-1.50726	12.5881	.	0.41412	.	-0.04616	.	.	-0.18331	5	0.99998	5.62698
100	13.3585	-1.33788	12.4985	-65.052	0.27685	.	.	-0.04850	.	.	5	0.99998	5.74384

best balance based energy gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_INDHP_	_CIN_	_P_	_RSQ_	_CP_
101	13.4031	-1.29217	12.4740	-61.370	0.26267	.	-0.04483	.	.	.	5	0.99998	5.80238
102	13.7124	-2.54805	12.2344	-46.506	0.15669	.	.	.	.	-0.15852	5	0.99998	6.21340
103	13.7222	.	11.7528	-72.432	1.87264	.	.	.	-0.33555	0.08602	5	0.99998	6.22648
104	13.7222	.	11.7528	-72.432	1.47004	-1.29762	.	.	.	0.08602	5	0.99998	6.22648
105	13.7222	.	11.7528	-72.432	.	-6.03573	.	.	1.22523	0.08602	5	0.99998	6.22648
106	13.8443	.	12.8383	-16.666	0.49011	.	-0.08387	.	.	-0.06310	5	0.99998	6.39145
107	13.8463	.	12.8388	.	0.51074	.	-0.12248	0.04050	.	-0.09566	5	0.99998	6.39413
108	13.8704	.	12.7755	-37.205	0.42772	.	-0.08810	0.00712	.	.	5	0.99998	6.42689
109	13.8801	-1.95130	12.3133	-87.553	.	.	.	-0.01701	0.01781	.	5	0.99998	6.44008
110	13.8844	-0.73790	12.5381	.	0.38229	.	-0.10608	0.03790	.	.	5	0.99998	6.44592
111	13.8881	-1.93479	12.3031	-86.135	.	.	-0.01570	.	0.01697	.	5	0.99998	6.45089
112	13.9080	-1.98366	12.1850	-111.446	.	.	.	-0.00770	.	0.06938	5	0.99998	6.47808
113	13.9115	.	12.8695	-32.265	0.49155	.	.	-0.09031	.	-0.03807	5	0.99998	6.48288
114	13.9136	-2.00132	12.1798	-109.369	.	.	-0.00651	.	.	0.06301	5	0.99998	6.48575
115	13.9221	-2.13708	12.1230	-112.573	.	-0.02663	.	.	.	0.06142	5	0.99998	6.49722
116	13.9327	-2.22852	12.1507	-101.685	.	.	.	.	0.00035	0.02138	5	0.99998	6.51178
117	13.9371	-2.10743	12.2415	-92.143	.	0.04408	.	-0.00750	.	.	5	0.99998	6.51772
118	13.9376	-2.40428	12.1656	-103.740	.	.	0.06327	-0.06207	.	.	5	0.99998	6.51846
119	13.9406	-2.11493	12.2304	-91.910	.	0.03921	-0.00619	.	.	.	5	0.99998	6.52256
120	14.3162	-1.98055	12.5031	.	.	.	-0.03017	.	0.05339	-0.18350	5	0.99998	7.04256
121	14.3574	-2.12804	12.4808	.	.	.	.	-0.02755	0.05190	-0.19391	5	0.99998	7.10047
122	14.5611	-2.14815	12.4389	.	.	0.22045	-0.02256	.	.	-0.18100	5	0.99998	7.38913
123	14.5978	-2.29935	12.4041	.	.	0.20741	.	-0.01845	.	-0.19090	5	0.99998	7.44156
124	14.7040	-1.04828	12.3972	.	.	.	-0.21326	0.17181	0.04132	.	5	0.99998	7.59407
125	14.7709	.	12.6743	-100.732	.	.	-0.06788	.	0.03827	0.14280	5	0.99998	7.69060
126	14.7745	.	12.7450	-43.251	.	.	-0.21503	0.15312	0.05523	.	5	0.99998	7.69582
127	14.8602	-1.16380	12.3345	.	.	0.16287	-0.22995	0.19706	.	.	5	0.99998	7.82035
128	14.8681	.	12.6685	-118.734	.	.	.	-0.07038	0.03396	0.17689	5	0.99998	7.83175
129	14.8846	-2.37711	12.0073	.	.	.	-0.16963	0.19165	.	-0.12991	5	0.99998	7.85582
130	14.8990	.	12.5907	-121.644	.	0.11745	-0.06131	.	.	0.19817	5	0.99998	7.87685
131	14.9248	.	12.7652	.	.	.	-0.28446	0.22114	0.06637	-0.06329	5	0.99998	7.91455
132	14.9566	.	12.3911	-137.739	.	.	-0.12596	0.08348	.	0.25849	5	0.99998	7.96114
133	14.9781	.	12.7218	-44.920	.	0.24064	-0.24240	0.18646	.	.	5	0.99998	7.99269
134	14.9828	.	12.5787	-138.398	.	0.09526	.	-0.06308	.	0.23061	5	0.99998	7.99959
135	15.1720	.	12.7225	.	.	0.28790	-0.32080	0.26358	.	-0.05180	5	0.99997	8.27914
136	12.0245	-1.52447	11.8656	.	2.22312	.	0.33282	-0.37548	-0.34193	.	6	0.99999	5.19910
137	12.0245	-1.52447	11.8656	.	1.81288	-1.32227	0.33282	-0.37548	.	.	6	0.99999	5.19910
138	12.0245	-1.52447	11.8656	.	.	-7.16536	0.33282	-0.37548	1.51097	.	6	0.99999	5.19910
139	12.2549	-1.47108	12.0841	.	1.57485	.	.	-0.01944	-0.22761	-0.13188	6	0.99999	5.43894
140	12.2549	-1.47108	12.0841	.	1.30177	-0.88018	.	-0.01944	.	-0.13188	6	0.99999	5.43894
141	12.2549	-1.47108	12.0841	.	.	-5.07593	.	-0.01944	1.08498	-0.13188	6	0.99999	5.43894
142	12.3259	-1.64091	12.0108	.	1.56819	.	-0.00988	.	-0.23321	-0.14180	6	0.99999	5.51386
143	12.3259	-1.64091	12.0108	.	1.28838	-0.90184	-0.00988	.	.	-0.14180	6	0.99999	5.51386
144	12.3259	-1.64091	12.0108	.	.	-5.05443	-0.00988	.	1.07382	-0.14180	6	0.99999	5.51386
145	12.3510	-1.85079	11.9255	-3.819	1.58096	.	.	.	-0.24340	-0.14652	6	0.99999	5.54038
146	12.3510	-1.85079	11.9255	-3.819	1.28892	-0.94127	.	.	.	-0.14652	6	0.99999	5.54038
147	12.3510	-1.85079	11.9255	-3.819	.	-5.09561	.	.	1.07427	-0.14652	6	0.99999	5.54038
148	12.4089	-1.26603	12.0101	-38.868	1.48449	.	.	-0.02105	-0.22860	.	6	0.99999	5.60181
149	12.4089	-1.26603	12.0101	-38.868	1.21020	-0.88404	.	-0.02105	.	.	6	0.99999	5.60181
150	12.4089	-1.26603	12.0101	-38.868	.	-4.78466	.	-0.02105	1.00866	.	6	0.99999	5.60181

composition based energy gain predictive equations

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OBS     _RMSE_    _COMPP_    _COMPF_      _CO2_       _O2_    _MECON_   _MENCON_      _CIN_  _P_      _RSQ_       _CP_

  1    140.888          .          .          .          .          .          .    2.53255    1    0.99673    114.031
  2    151.292          .          .          .          .          .    0.35692          .    1    0.99623    133.179
  3    152.407          .          .          .          .    0.34202          .          .    1    0.99617    135.313
  4    190.924          .          .     3.0912          .          .          .          .    1    0.99399    218.611
  5    201.296          .          .          .     2.5525          .          .          .    1    0.99332    244.236
  6    222.034    10.2383          .          .          .          .          .          .    1    0.99188    299.534
  7    314.532          .    20.1500          .          .          .          .          .    1    0.98370    612.163
  8     57.063     6.0979     8.3728          .          .          .          .          .    2    0.99951      9.802
  9     61.910          .     6.3699          .          .    0.23637          .          .    2    0.99942     13.131
 10     63.629          .     6.3137          .          .          .    0.24762          .    2    0.99939     14.377
 11     65.941          .     5.9119          .          .          .          .    1.80587    2    0.99934     16.107
 12     81.161          .     7.7240          .     1.5981          .          .          .    2    0.99901     29.034
 13     88.505          .     7.3604     1.9887          .          .          .          .    2    0.99882     36.230
 14    118.080          .          .          .    -3.8912          .    0.90003          .    2    0.99789     71.507
 15    123.448          .          .          .    -3.6843    0.83481          .          .    2    0.99770     78.993
 16    126.167          .          .          .    -2.0935          .          .    4.60479    2    0.99760     82.912
 17    134.191          .          .    -2.1447          .          .          .    4.28623    2    0.99728     94.976
 18    137.408          .          .    -3.6307          .          .    0.77552          .    2    0.99715    100.021
 19    142.044    -2.7218          .          .          .          .          .    3.20311    2    0.99695    107.500
 20    142.302          .          .    -3.2285          .    0.69872          .          .    2    0.99694    107.924
 21    145.566    -5.6897          .          .          .    0.53148          .          .    2    0.99680    113.350
 22    146.719    -4.9772          .          .          .          .    0.52985          .    2    0.99675    115.295
 23    146.997          .          .          .          .          .    0.03726    2.26834    2    0.99674    115.767
 24    147.078          .          .          .          .    0.02439          .    2.35205    2    0.99673    115.905
 25    154.358          .          .          .          .   -2.27530    2.73124          .    2    0.99640    128.576
 26    179.349          .          .    15.0447    -9.8742          .          .          .    2    0.99514    176.729
 27    198.177     1.5939          .     2.6112          .          .          .          .    2    0.99407    217.772
 28    208.281     2.2499          .          .     1.9927          .          .          .    2    0.99345    241.485
 29     51.992     3.7317     7.2498          .          .          .          .    0.72207    3    0.99963      7.189
 30     54.129          .    10.7466   -13.4939    12.3704          .          .          .    3    0.99960      8.380
 31     54.961          .     7.1206          .          .    2.72848   -2.61358          .    3    0.99959      8.856
 32     55.169     3.6562     7.4754          .          .    0.09628          .          .    3    0.99958      8.977
 33     55.225     3.7972     7.4916          .          .          .    0.09529          .    3    0.99958      9.009
 34     57.110     4.7810     8.1087          .     0.3611          .          .          .    3    0.99955     10.120
 35     58.128     5.1226     8.0937     0.3363          .          .          .          .    3    0.99954     10.736
 36     58.841          .     5.9895    -1.2492          .    0.38069          .          .    3    0.99952     11.174
 37     60.517          .     5.8518    -1.3415          .          .    0.41028          .    3    0.99950     12.224
 38     61.408          .     5.7591          .    -0.8998    0.36685          .          .    3    0.99948     12.794
 39     62.548          .     6.1367          .          .    0.14912          .    0.67471    3    0.99946     13.536
 40     63.367          .     5.6298          .    -0.9402          .    0.39069          .    3    0.99945     14.077
 41     63.704          .     6.0771          .          .          .    0.14301    0.77136    3    0.99944     14.302
 42     68.702          .     5.7605    -0.2944          .          .          .    2.06517    3    0.99935     17.776
 43     69.159          .     5.9240          .     0.0129          .          .    1.79163    3    0.99934     18.106
 44    103.410          .          .     9.2560   -10.8584          .    0.80531          .    3    0.99853     49.133
 45    103.659          .          .    10.3992   -11.6603    0.75267          .          .    3    0.99852     49.403
 46    104.966          .          .          .    -3.9935          .    0.56850    2.45389    3    0.99849     50.834
 47    108.281          .          .          .    -3.8486    0.50297          .    2.62005    3    0.99839     54.545
 48    114.197          .          .          .    -4.0793   -3.09316    4.15406          .    3    0.99821     61.454
 49    114.586    -3.8350          .          .    -3.6629          .    1.00142          .    3    0.99820     61.921
 50    114.895    -5.0409          .          .    -3.5244    0.98128          .          .    3    0.99819     62.293
```

best balance based energy gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_INDHP_	_CIN_	_P_	_RSQ_	_CP_
151	12.4896	-1.43768	11.9260	-43.006	1.46534	.	-0.01062	.	-0.23414	.	6	0.99999	5.68800
152	12.4896	-1.43768	11.9260	-43.006	1.18441	-0.90545	-0.01062	.	.	.	6	0.99999	5.68800
153	12.4896	-1.43768	11.9260	-43.006	.	-4.72294	-0.01062	.	0.98717	.	6	0.99999	5.68800
154	12.7037	.	12.3494	-33.003	2.04485	.	0.23343	-0.30605	-0.28915	.	6	0.99998	5.91928
155	12.7037	.	12.3494	-33.003	1.69793	-1.11817	0.23343	-0.30605	.	.	6	0.99998	5.91928
156	12.7037	.	12.3494	-33.003	.	-6.59077	0.23343	-0.30605	1.41516	.	6	0.99998	5.91928
157	12.7804	.	12.3791	.	2.07585	.	0.18989	-0.26370	-0.28436	-0.06102	6	0.99998	6.00305
158	12.7804	.	12.3791	.	1.73467	-1.09965	0.18989	-0.26370	.	-0.06102	6	0.99998	6.00305
159	12.7804	.	12.3791	.	.	-6.69067	0.18989	-0.26370	1.44579	-0.06102	6	0.99998	6.00305
160	13.0125	.	12.3563	-5.876	1.71387	.	.	-0.06025	-0.23278	-0.04063	6	0.99998	6.25968
161	13.0125	.	12.3563	-5.876	1.43458	-0.90019	.	-0.06025	.	-0.04063	6	0.99998	6.25968
162	13.0125	.	12.3563	-5.876	.	-5.52399	.	-0.06025	1.19567	-0.04063	6	0.99998	6.25968
163	13.1698	.	12.3331	-0.881	1.65047	.	-0.05453	.	-0.22482	-0.04988	6	0.99998	6.43632
164	13.1698	.	12.3331	-0.881	1.38073	-0.86941	-0.05453	.	.	-0.04988	6	0.99998	6.43632
165	13.1698	.	12.3331	-0.881	.	-5.31964	-0.05453	.	1.15079	-0.04988	6	0.99998	6.43632
166	14.1412	-1.55123	12.5781	-21.171	0.38395	.	.	-0.04720	.	-0.14369	6	0.99998	7.57373
167	14.1628	-1.59820	12.6137	.	0.43594	.	0.01029	-0.06032	.	-0.19338	6	0.99998	7.59994
168	14.1744	-1.50432	12.5627	-14.912	0.37857	.	-0.04414	.	.	-0.15103	6	0.99998	7.61406
169	14.2534	-1.49574	12.5057	-73.463	0.27800	.	0.07023	-0.12031	.	.	6	0.99998	7.7103
170	14.7962	.	12.8262	-12.613	0.48684	.	-0.10880	0.02720	.	-0.06958	6	0.99998	8.3863
171	14.8294	-2.06651	12.3074	-93.162	.	.	0.04183	-0.05846	0.01672	.	6	0.99998	8.4286
172	14.8334	-1.90241	12.2943	-95.088	.	.	.	-0.01730	0.01449	0.02681	6	0.99998	8.4337
173	14.8357	-2.13460	12.1943	-122.757	.	.	0.07890	-0.08928	.	0.07712	6	0.99998	8.4366
174	14.8436	-1.89852	12.2857	-92.399	.	.	-0.01573	.	0.01407	0.02195	6	0.99998	8.4466
175	14.8680	-1.97651	12.1957	-110.022	.	0.00650	.	-0.00861	.	0.06556	6	0.99998	8.4777
176	14.8743	-2.00039	12.1808	-109.221	.	0.00063	-0.00660	.	.	0.06264	6	0.99998	8.4857
177	14.8862	-2.25314	12.2307	-99.080	.	0.03589	0.05109	-0.05774	.	.	6	0.99998	8.5009
178	15.2405	-1.78600	12.4712	.	.	.	-0.12421	0.09873	0.04906	-0.16715	6	0.99998	8.9586
179	15.4531	-1.87077	12.4054	.	.	0.19771	-0.14762	0.13028	.	-0.15978	6	0.99998	9.2383
180	15.7326	.	12.6509	-78.676	.	.	-0.16723	0.10633	0.04021	0.10109	6	0.99998	9.6121
181	15.8696	.	12.5747	-98.204	.	0.13174	-0.16237	0.10756	.	0.15268	6	0.99998	9.7976
182	11.6892	-2.54871	11.7745	-93.651	2.22623	.	0.59002	-0.60773	-0.36720	.	7	0.99999	6.0213
183	11.6892	-2.54871	11.7745	-93.651	1.78566	-1.42000	0.59002	-0.60773	.	.	7	0.99999	6.0213
184	11.6892	-2.54871	11.7745	-93.651	.	-7.17539	0.59002	-0.60773	1.48829	.	7	0.99999	6.0213
185	11.9789	-2.43448	11.9363	.	2.30225	.	0.46006	-0.48342	-0.34620	-0.20234	7	0.99999	6.2734
186	11.9789	-2.43448	11.9363	.	1.88688	-1.33878	0.46006	-0.48342	.	-0.20234	7	0.99999	6.2734
187	11.9789	-2.43448	11.9363	.	.	-7.42039	0.46006	-0.48342	1.57265	-0.20234	7	0.99999	6.2734
188	13.2357	-1.47554	12.0890	4.167	1.58787	.	.	-0.01982	-0.22828	-0.14104	7	0.99999	7.4379
189	13.2357	-1.47554	12.0890	4.167	1.31398	-0.88277	.	-0.01982	.	-0.14104	7	0.99999	7.4379
190	13.2357	-1.47554	12.0890	4.167	.	-5.11786	.	-0.01982	1.09516	-0.14104	7	0.99999	7.4379
191	13.3134	-1.64133	12.0131	1.633	1.57293	.	-0.01007	.	-0.23338	-0.14531	7	0.99999	7.5137
192	13.3134	-1.64133	12.0131	1.633	1.29292	-0.90251	-0.01007	.	.	-0.14531	7	0.99999	7.5137
193	13.3134	-1.64133	12.0131	1.633	.	-5.06974	-0.01007	.	1.07761	-0.14531	7	0.99999	7.5137
194	13.7145	.	12.3234	-43.501	2.03537	.	0.24546	-0.31772	-0.29198	0.02982	7	0.99998	7.9121
195	13.7145	.	12.3234	-43.501	1.68505	-1.12914	0.24546	-0.31772	.	0.02982	7	0.99998	7.9121
196	13.7145	.	12.3234	-43.501	.	-6.56022	0.24546	-0.31772	1.40443	0.02982	7	0.99998	7.9121
197	15.2623	-1.64230	12.5789	-28.654	0.37958	.	0.04504	-0.09332	.	-0.13684	7	0.99998	9.5603
198	16.0052	-2.03262	12.2748	-107.322	.	.	0.05783	-0.07478	0.01100	0.04274	7	0.99998	10.4139
199	16.0208	-2.18003	12.1584	-129.269	.	-0.02276	0.08955	-0.09711	.	0.09154	7	0.99998	10.4324
200	12.7776	-2.59425	11.8094	-76.421	2.24600	.	0.57541	-0.59275	-0.36365	-0.05203	8	0.99999	8.0000

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                               composition based energy gain predictive equations

OBS    _RMSE_    _COMPP_    _COMPF_      _CO2_       _O2_     _MECON_    _MENCON_      _CIN_     _P_     _RSQ_       _CP_

101    48.276     2.6126     9.6715    -8.7663     7.6326     0.0423         .           .        5    0.99974      6.787
102    49.560       .        8.1655    -8.9150     7.0512     0.1405         .        0.79905     5    0.99973      7.314
103    50.081       .        8.2055    -9.2071     7.3059       .          0.1407     0.82259     5    0.99972      7.532
104    51.042       .        9.2868    -8.3215     7.3427     1.6819      -1.6244        .        5    0.99971      7.941
105    53.591     2.7578     6.4986    -1.0977       .          .          0.1407     0.95413     5    0.99968      9.061
106    53.678     2.6193     6.5085    -1.0626       .        0.1354         .        0.95444     5    0.99968      9.100
107    55.351       .        6.3182    -0.8357       .        1.9600      -1.8335     0.93725     5    0.99966      9.866
108    55.962     3.1066     6.4763       .       -0.7192       .          0.1095     0.90640     5    0.99966     10.151
109    55.969     2.9810     6.4829       .       -0.7011     0.1069         .        0.90425     5    0.99966     10.154
110    56.776       .        6.4600       .       -0.3970     2.3709      -2.2958     0.86754     5    0.99965     10.537
111    57.199     0.9437     6.9925       .          .        2.0919      -2.0868     0.75842     5    0.99964     10.739
112    59.476     5.0970     7.0580    -1.0202       .       -1.6421       1.8888        .        5    0.99961     11.855
113    61.085     2.3117     7.1652       .       -0.2134     0.97953    -0.83982        .        5    0.99959    12.6693
114   100.331    -1.0352       .        7.3044    -9.3761     0.56012        .        1.95081     5    0.99889    39.2714
115   100.393    -0.4004       .        7.1419    -9.3251       .         0.57190     1.96610     5    0.99889    39.3244
116   100.439       .          .        7.2189    -9.4215    -0.23548     0.80751     1.97161     5    0.99889    39.3627
117   108.023     3.0428       .          .       -4.4704    -4.96243     5.72777     2.31181     5    0.99872    46.0018
118   114.253    -6.4115       .       10.3421   -10.9679     5.36706    -4.68250        .        5    0.99857    51.8172
119   122.747    -0.6519       .       -4.8428       .       -3.61200     4.36248     2.44553     5    0.99835    60.2710
120    46.614    10.5277    10.3367   -11.8917     9.4376    -6.80707     6.96930        .        6    0.99979     6.9840
121    47.224     2.3889     8.9189    -8.0645     6.6820       .         0.01574     0.71608     6    0.99979     7.1944
122    47.245     2.4143     8.9593    -8.1036     6.7410     0.00945        .        0.72020     6    0.99979     7.2016
123    50.359       .        8.5719    -7.7618     6.5015     1.43953    -1.40916     0.73054     6    0.99976     8.3184
124    56.216     6.5110     6.4915    -1.6848       .       -3.20605     3.41396     1.02317     6    0.99970    10.6120
125    59.821     3.3609     6.4666       .       -0.7525    -0.21256     0.32662     0.91129     6    0.99966    12.1490
126   107.219    -2.0041       .        7.5627    -9.4585     1.42158    -0.88070     1.93041     6    0.99890    41.2406
127    43.647    11.1859     9.6095   -11.4941     8.6355    -7.60666     7.74533     0.81029     7    0.99984     7.0000
                            best composition based energy gain predictive equations

 OBS    _RMSE_     _COMPP_    _COMPF_      _CO2_       _O2_      _MECON_    _MENCON_      _CIN_     _P_    _RSQ_       _CP_

   1    45.7195     2.9340    10.0048    -9.1280    8.12587       .           .            .        4    0.99974     4.8749
   2    50.1028       .        9.2160   -11.2210    9.65631       .           .         1.01674     4    0.99969     6.8592
   3    50.9906       .        8.8899    -9.7316    8.07781    0.18932        .            .        4    0.99968     7.2832
   4    51.7128       .        8.9569   -10.1310    8.42949       .         0.19336        .        4    0.99967     7.6336
   5    44.2052     2.4820     9.0247    -8.1756    6.83936       .           .         0.72693     5    0.99979     5.2059
   6    48.2175     2.6274     9.6344    -8.7428    7.58336       .         0.04838        .        5    0.99974     6.7631
   7    48.2756     2.6126     9.6715    -8.7663    7.63256    0.04226        .            .        5    0.99974     6.7867
   8    49.5601       .        8.1655    -8.9150    7.05116    0.14052        .         0.79905     5    0.99973     7.3144
   9    50.0811       .        8.2055    -9.2071    7.30591       .         0.14075     0.82259     5    0.99972     7.5324
  10    51.0422       .        9.2868    -8.3215    7.34270    1.68190    -1.62438        .        5    0.99971     7.9405
  11    53.5912     2.7578     6.4986    -1.0977       .          .         0.14070     0.95413     5    0.99968     9.0605
  12    53.6779     2.6193     6.5085    -1.0626       .       0.13535        .         0.95444     5    0.99968     9.0996
  13    55.3514       .        6.3182    -0.8357       .       1.96001    -1.83350     0.93725     5    0.99966     9.8658
  14    46.6141    10.5277    10.3367   -11.8917    9.43761   -6.80707     6.96930        .        6    0.99979     6.9840
  15    47.2243     2.3889     8.9189    -8.0645    6.68205       .         0.01574     0.71608     6    0.99979     7.1944
  16    47.2450     2.4143     8.9593    -8.1036    6.74101    0.00945        .         0.72020     6    0.99979     7.2016
  17    50.3590       .        8.5719    -7.7618    6.50147    1.43953    -1.40916     0.73054     6    0.99976     8.3184
  18    56.2160     6.5110     6.4915    -1.6848       .      -3.20605     3.41396     1.02317     6    0.99970    10.6120
  19    43.6471    11.1859     9.6095   -11.4941    8.63553   -7.60666     7.74533     0.81029     7    0.99984     7.0000
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                                        best balance based energy gain predictive equations

OBS    _RMSE_    _ANGAIN_    _CGAIN_     _RQ_      _CO2_       _O2_      _MECON_    _MENCON_     _INDHP_      _CIN_     _P_     _RSQ_       _CP_

201   12.7776   -2.59425    11.8094    -76.421    1.80970    -1.40627    0.57541    -0.59275        .       -0.05203    8     0.99999    8.0000
202   12.7776   -2.59425    11.8094    -76.421     .         -7.23912    0.57541    -0.59275     1.50832    -0.05203    8     0.99999    8.0000
```

composition based energy gain predictive equations

OBS	_RMSE_	_COMPP_	_COMPF_	_CO2_	_O2_	_MECON_	_MENCON_	_CIN_	_P_	_RSQ_	_CP_
51	119.598	.	.	7.9088	-8.0654	.	.	4.04910	3	0.99804	68.083
52	125.422	.	.	-4.0056	.	.	0.44298	2.66640	3	0.99784	75.573
53	126.773	-6.6978	.	-3.7068	.	0.97459	.	.	3	0.99779	77.361
54	126.777	-5.5611	.	-3.8825	.	.	0.99777	.	3	0.99779	77.366
55	127.684	.	.	-4.6877	.	-4.55164	5.64712	.	3	0.99776	78.578
56	128.286	.	.	-3.7406	.	0.37138	.	2.84291	3	0.99774	79.387
57	132.267	-0.2987	.	.	-2.0394	.	.	4.62485	3	0.99760	84.832
58	136.297	-22.0871	.	.	.	14.3264	-13.8256	.	3	0.99745	90.514
59	139.186	-1.4897	.	-1.9019	.	.	.	4.45473	3	0.99734	94.690
60	143.994	-4.7665	.	.	.	0.2426	.	1.91178	3	0.99715	101.837
61	144.560	-4.3761	.	.	.	.	0.2290	1.98666	3	0.99713	102.695
62	151.590	.	.	.	.	-1.8167	1.9516	2.13651	3	0.99684	113.624
63	162.460	8.0191	.	21.5929	-17.2780	.	.	.	3	0.99638	131.543
64	45.719	2.9340	10.0048	-9.1280	8.1259	.	.	.	4	0.99974	4.875
65	50.103	.	9.2160	-11.2210	9.6563	.	.	1.01674	4	0.99969	6.859
66	50.991	.	8.8899	-9.7316	8.0778	0.1893	.	.	4	0.99968	7.283
67	51.713	.	8.9569	-10.1310	8.4295	.	0.1934	.	4	0.99967	7.634
68	52.833	3.8758	7.0359	-0.5163	.	.	.	1.13502	4	0.99966	8.187
69	53.961	3.8865	7.0235	.	-0.2998	.	.	1.00851	4	0.99964	8.756
70	54.019	.	6.8840	.	.	2.7277	-2.7172	0.77052	4	0.99964	8.785
71	54.804	3.7146	7.2461	.	.	0.0016	.	0.71457	4	0.99963	9.189
72	54.804	3.7330	7.2501	.	.	.	-0.0001	0.72271	4	0.99963	9.189
73	55.584	.	5.5211	-1.5935	.	0.2844	.	1.05206	4	0.99962	9.596
74	56.304	3.1598	7.0415	-0.7331	.	.	0.2097	.	4	0.99961	9.976
75	56.364	2.9314	7.0460	-0.6908	.	0.2039	.	.	4	0.99961	10.009
76	56.763	.	5.3984	-1.6742	.	.	0.3008	1.10491	4	0.99960	10.222
77	57.533	.	6.8818	-0.3876	.	2.3725	-2.1932	.	4	0.99959	10.637
78	57.660	3.2948	7.1365	.	-0.3383	0.1592	.	.	4	0.99959	10.706
79	57.689	3.4934	7.1369	.	-0.3582	.	0.1620	.	4	0.99959	10.722
80	57.691	1.5893	7.2970	.	.	1.6578	-1.5546	.	4	0.99959	10.723
81	57.933	.	7.1372	.	0.0168	2.7435	-2.6319	.	4	0.99959	10.856
82	59.014	.	5.1656	.	-1.2512	0.2850	.	1.02725	4	0.99957	11.453
83	60.480	.	5.0374	.	-1.2961	.	0.2973	1.08768	4	0.99955	12.281
84	94.733	.	.	7.5780	-9.6772	.	0.5570	1.96490	4	0.99889	37.397
85	95.089	.	.	8.3729	-10.2294	0.5197	.	1.96563	4	0.99888	37.716
86	102.175	.	.	.	-4.1451	-2.6189	3.3483	2.27089	4	0.99871	44.320
87	103.250	-3.1134	.	.	-3.7994	.	0.6791	2.24447	4	0.99868	45.363
88	103.649	-3.9232	.	.	-3.7008	0.6642	.	2.24738	4	0.99867	45.753
89	108.611	-1.2731	.	9.0663	-10.5976	0.8002	.	.	4	0.99854	50.729
90	108.949	-0.3538	.	8.8716	-10.5480	.	0.8186	.	4	0.99853	51.076
91	108.999	.	.	9.3872	-10.9517	0.0874	0.7120	.	4	0.99853	51.128
92	115.739	.	.	-4.9390	.	-4.1460	4.9064	2.45831	4	0.99834	58.284
93	116.247	-4.8898	.	-4.1852	.	.	0.6754	2.36950	4	0.99833	58.840
94	116.454	-5.6525	.	-4.0577	.	0.6595	.	2.36242	4	0.99832	59.068
95	120.312	3.3485	.	11.4818	-11.3696	.	.	3.57321	4	0.99821	63.384
96	120.372	-0.2535	.	.	-4.0523	-2.8972	3.9546	.	4	0.99821	63.451
97	133.199	-21.2183	.	.	.	14.0866	-13.8768	1.92474	4	0.99781	78.817
98	133.624	-6.1982	.	-3.7846	.	0.5458	0.4391	.	4	0.99779	79.353
99	44.205	2.4820	9.0247	-8.1756	6.8394	.	.	0.72693	5	0.99979	5.206
100	48.217	2.6274	9.6344	-8.7428	7.5834	.	0.0484	.	5	0.99974	6.763

```
                                        heat production predictive equations

 OBS     _RMSE_   _ANGAIN_    _TCARB_       _RQ_      _CO2_      _O2_    _MECON_   _MENCON_    _COMPP_    _COMPF_  _P_     _RSQ_      _CP_

   1    122.512       .         .            .       .         4.9185     .          .           .          .        1   0.99933     44.69
   2    147.948       .         .            .      5.95354     .         .          .           .          .        1   0.99902     70.22
   3    152.407       .         .            .       .          .        0.65798     .           .          .        1   0.99896     75.19
   4    154.961       .         .            .       .          .         .         0.68661      .          .        1   0.99893     78.10
   5    206.493       .         .            .       .          .         .          .         19.7307      .        1   0.99810    147.22
   6    313.571       .       21.2662        .       .          .         .          .           .          .        1   0.99561    353.85
   7    418.485    130.400      .            .       .          .         .          .           .          .        1   0.99218    638.83
   8    435.011       .         .        5706.19     .          .         .          .           .          .        1   0.99155    691.17
   9    999.706       .         .            .       .          .         .          .           .        38.1493    1   0.95538   3697.37
  10     57.174       .         .            .       .          .         .         0.80102      .        -6.6094    2   0.99987      2.12
  11     61.910       .         .            .       .          .        0.76363     .           .        -6.3699    2   0.99984      4.04
  12     79.502     24.782      .            .       .         3.9925     .          .           .          .        2   0.99974     12.50
  13     95.458     29.052      .            .      4.63985     .         .          .           .          .        2   0.99963     21.99
  14    109.600       .         .            .       .         3.6297     .          .          5.1800      .        2   0.99951     31.86
  15    110.393       .         .            .     -8.87268   12.2472     .          .           .          .        2   0.99950     32.45
  16    113.306       .         .            .       .         5.2110     .          .           .        -2.3679    2   0.99947     34.67
  17    113.667       .        3.4232        .       .         4.1304     .          .           .          .        2   0.99947     34.95
  18    120.943       .         .            .      3.87151     .         .          .          6.9140      .        2   0.99940     40.75
  19    123.448       .         .            .       .         3.6843    0.16519     .           .          .        2   0.99938     42.83
  20    124.542       .         .            .       .         3.8304     .         0.15198      .          .        2   0.99937     43.76
  21    124.691       .         .            .      6.51664     .         .          .           .        -3.7594    2   0.99936     43.88
  22    126.855       .         .         212.17     .         4.7371     .          .           .          .        2   0.99934     45.73
  23    130.510     24.445      .            .       .          .         .         0.55902      .          .        2   0.99930     48.93
  24    130.823     23.393      .            .       .          .        0.54097     .           .          .        2   0.99930     49.21
  25    138.076       .        4.0362        .      4.82864     .         .          .           .          .        2   0.99922     55.85
  26    142.302       .         .            .      3.22854     .        0.30128     .           .          .        2   0.99917     59.88
  27    144.433       .         .            .      3.39854     .         .         0.29477      .          .        2   0.99915     61.96
  28    144.573       .         .            .       .          .         .         0.47217     6.1715      .        2   0.99914     62.09
  29    145.566       .         .            .       .          .        0.46852     .          5.6897      .        2   0.99913     63.07
  30    149.180       .         .        -851.09     .          .        0.75547     .           .          .        2   0.99909     66.70
  31    150.478       .       -4.6273        .       .          .        0.80074     .           .          .        2   0.99907     68.02
  32    152.177       .         .         338.04    5.60367     .         .          .           .          .        2   0.99905     69.77
  33    153.861       .         .        -762.19     .          .         .         0.77771      .          .        2   0.99903     71.52
  34    154.358       .         .            .       .          .        3.27530   -2.73124      .          .        2   0.99902     72.04
  35    155.269       .       -4.0094        .       .          .         .         0.81568      .          .        2   0.99901     73.00
  36    208.967       .        3.7206        .       .          .         .          .         16.2896      .        2   0.99821    139.53
  37    211.012     13.656      .            .       .          .         .          .         17.6783      .        2   0.99818    142.45
  38    214.171       .         .            .       .          .         .          .         19.2623     0.9472    2   0.99812    147.02
  39    215.475       .         .        -136.28     .          .         .          .         20.1989      .        2   0.99810    148.92
  40    278.511     67.597      .        2776.67     .          .         .          .           .          .        2   0.99683    254.84
  41    294.046     40.345    14.7275        .       .          .         .          .           .          .        2   0.99646    285.09
  42    297.303       .       24.5890        .       .          .         .          .           .        -6.1809    2   0.99638    291.64
  43    323.667       .       18.3879     776.06     .          .         .          .           .          .        2   0.99571    347.33
  44    344.284    103.141      .            .       .          .         .          .           .         8.4004    2   0.99515    394.17
  45    452.368       .         .        5970.91     .          .         .          .           .        -1.8339    2   0.99163    687.04
  46     48.091       .        7.3699        .      4.77736     .         .          .           .        -5.8608    3   0.99991      0.15
  47     54.808       .         .            .       .          .         .         0.89992    -2.4654    -7.3742    3   0.99989      2.29
  48     54.961       .         .            .       .          .       -1.72848    2.61358      .        -7.1206    3   0.99989      2.34
  49     54.980       .         .        -352.30     .          .         .         0.83991      .        -6.4234    3   0.99989      2.35
  50     55.169       .         .            .       .          .        0.90372     .         -3.6562    -7.4754    3   0.99989      2.41
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heat production predictive equations

OBS	_RMSE_	_ANGAIN_	_TCARB_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_COMPP_	_COMPF_	_P_	_RSQ_	_CP_
51	56.636	.	.	.	0.93945	.	.	0.68711	.	-6.2860	3	0.99988	2.92
52	57.268	.	6.5847	.	.	3.9611	.	.	.	-4.5205	3	0.99988	3.14
53	57.990	.	.	-434.89	.	.	0.80952	.	.	-6.1327	3	0.99987	3.40
54	58.501	.	.	.	.	0.5914	.	0.71103	.	-6.1792	3	0.99987	3.58
55	58.841	.	.	.	1.24921	.	0.61931	.	.	-5.9895	3	0.99987	3.71
56	58.887	3.364	.	.	.	.	.	0.77775	.	-6.2795	3	0.99987	3.72
57	59.193	.	-0.8272	.	.	.	.	0.8259	.	-6.50935	3	0.99987	3.8341
58	61.408	.	.	.	.	0.8998	0.6332	.	.	-5.75915	3	0.99986	4.6603
59	63.193	.	-1.3134	.	.	.	0.8014	.	.	-6.20317	3	0.99985	5.3481
60	64.384	2.5262	.	.	.	.	0.7469	.	.	-6.12585	3	0.99985	5.8180
61	75.232	.	19.6256	.	.	11.2089	.	-1.5097	.	.	3	0.99979	10.5011
62	75.347	.	22.3547	.	.	12.1118	-1.6517	.	.	.	3	0.99979	10.5547
63	77.773	21.8619	.	.	-4.2514	7.6132	.	.	.	.	3	0.99977	11.7032
64	78.170	22.3683	.	.	.	4.2270	.	.	.	-1.16845	3	0.99977	11.8945
65	81.513	24.7800	.	211.67	.	3.8116	.	.	.	.	3	0.99975	13.5452
66	82.772	23.3995	0.6471	.	.	3.8951	.	.	.	.	3	0.99975	14.1848
67	83.074	23.5016	.	.	.	3.8731	.	.	0.6720	.	3	0.99974	14.3397
68	83.218	24.4112	.	.	.	3.8159	0.0255	.	.	.	3	0.99974	14.4139
69	83.260	24.5060	.	.	.	3.8385	.	0.0229	.	.	3	0.99974	14.4355
70	85.782	24.2806	.	.	5.1833	.	.	.	.	-2.18766	3	0.99973	15.7537
71	93.904	33.9432	-9.2489	.	.	.	0.7735	.	.	.	3	0.99967	20.2662
72	95.518	35.2510	-9.0047	.	.	.	.	0.7925	.	.	3	0.99966	21.2118
73	95.817	.	3.6141	.	-9.2845	11.7553	.	.	.	.	3	0.99966	21.3884
74	96.919	24.2825	.	.	4.1810	.	.	.	2.2397	.	3	0.99965	22.0453
75	97.501	28.8303	.	273.27	4.3670	.	.	.	.	.	3	0.99965	22.3951
76	99.466	27.8683	.	.	4.1529	.	0.0598	.	.	.	3	0.99963	23.5919
77	99.650	28.1410	.	.	4.2172	.	.	0.0535	.	.	3	0.99963	23.7051
78	99.974	28.2767	0.3522	.	4.5767	.	.	.	.	.	3	0.99963	23.9051
79	102.495	.	.	.	.	4.0324	.	.	4.5553	-2.00133	3	0.99961	25.4834
80	103.659	.	.	.	-10.3992	11.6603	0.2473	.	.	.	3	0.99960	26.2253
81	103.851	.	.	.	4.7018	.	.	.	5.6261	-2.95404	3	0.99960	26.3488
82	103.880	.	.	.	-10.7564	11.9269	.	0.2621	.	.	3	0.99960	26.3673
83	107.705	.	.	.	-5.9385	8.9295	.	.	3.5934	.	3	0.99957	28.8699
84	109.658	.	.	600.53	.	4.7895	.	.	.	-3.11130	3	0.99955	30.1825
85	111.639	.	1.8407	.	.	3.5531	.	.	3.7844	.	3	0.99954	31.5381
86	113.135	.	.	-284.63	.	3.6502	.	.	6.0754	.	3	0.99952	32.5776
87	114.197	.	.	.	.	4.0793	4.0932	-4.1541	.	.	3	0.99951	33.3240
88	114.224	.	.	810.94	5.8096	.	.	.	.	-4.64310	3	0.99951	33.3435
89	114.403	.	.	214.83	-8.8803	12.0697	.	.	.	.	3	0.99951	33.4696
90	114.707	.	.	.	-6.3792	10.3036	.	.	.	-0.93897	3	0.99951	33.6851
91	114.895	.	.	.	.	3.5244	0.0187	.	5.0409	.	3	0.99951	33.8187
92	114.901	.	.	.	.	3.5286	.	0.0179	5.0712	.	3	0.99951	33.8233
93	116.498	.	4.5067	-385.23	.	4.2103	.	.	.	.	3	0.99950	34.9661
94	123.676	.	.	-395.58	3.9287	.	.	.	8.0838	.	3	0.99943	40.2961
95	125.588	.	1.2103	.	3.7940	.	.	.	6.0510	.	3	0.99941	41.7698
96	126.773	.	.	.	3.7068	.	0.0254	.	6.6978	.	3	0.99940	42.6948
97	126.774	.	.	.	3.7031	.	.	0.0259	6.7284	.	3	0.99940	42.6954
98	127.684	.	.	.	4.6877	.	5.5516	-5.6471	.	.	3	0.99939	43.4115
99	129.144	.	.	-153.21	.	3.5099	0.2061	.	.	.	3	0.99938	44.5713
100	129.520	.	20.8408	.	13.8845	.	.	-1.5851	.	.	3	0.99938	44.8718

heat production predictive equations

OBS	_RMSE_	_ANGAIN_	_TCARB_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_COMPP_	_COMPF_	_P_	_RSQ_	_CP_
151	57.082	.	.	-277.17	0.51429	.	.	0.76926	.	-6.28599	4	0.99989	4.068
152	57.281	2.5037	.	-336.63	.	.	.	0.82086	.	-6.18608	4	0.99989	4.131
153	57.533	.	.	.	0.38764	.	-1.37246	2.19324	.	-6.88182	4	0.99989	4.211
154	57.592	.	.	.	.	0.21037	.	0.86075	-2.2870	-7.16584	4	0.99989	4.230
155	57.635	.	0.5938	.	.	.	-2.02011	2.90152	.	-7.27864	4	0.99989	4.244
156	57.660	.	.	.	.	0.33833	0.84081	.	-3.2948	-7.13650	4	0.99989	4.252
157	57.691	.	.	.	.	.	-0.65784	1.55461	-1.5893	-7.29698	4	0.99989	4.262
158	57.770	.	0.0492	.	.	.	.	0.89940	-2.4893	-7.38759	4	0.99989	4.288
159	57.869	.	.	-330.98	.	0.14838	.	0.81498	.	-6.32672	4	0.99989	4.320
160	57.918	.	-0.1766	-342.54	.	.	.	0.84415	.	-6.40719	4	0.99989	4.335
161	57.933	.	.	.	.	-0.01675	-1.74353	2.63191	.	-7.13721	4	0.99989	4.340
162	58.109	.	-0.2048	.	.	.	0.90601	.	-3.5624	-7.42107	4	0.99989	4.397
163	58.972	.	.	-309.81	0.79267	.	0.70474	.	.	-5.95959	4	0.99988	4.678
164	59.372	4.3110	5.7121	.	.	3.93709	.	.	.	-4.00403	4	0.99988	4.810
165	59.399	.	6.9812	-157.09	.	3.99612	.	.	.	-4.45562	4	0.99988	4.819
166	59.675	8.5247	.	.	.	1.56075	0.48101	.	.	-4.48711	4	0.99988	4.910
167	60.091	.	4.6725	.	.	2.95174	.	0.21122	.	-5.02758	4	0.99988	5.049
168	60.194	.	8.1117	.	.	4.71070	-0.15266	.	.	-4.20201	4	0.99988	5.083
169	60.422	.	.	-368.163	.	0.4206	0.74148	.	.	-5.88361	4	0.99988	5.1598
170	60.757	.	-0.5882	-404.722	.	.	0.82324	.	.	-6.07450	4	0.99988	5.2731
171	60.856	10.6196	-3.4523	.	.	.	0.79274	.	.	-4.90597	4	0.99988	5.3063
172	60.980	1.2242	.	-425.679	.	.	0.80046	.	.	-6.01948	4	0.99988	5.3483
173	74.878	21.1201	.	432.825	.	3.9781	.	.	.	-1.77119	4	0.99981	10.6028
174	76.237	.	23.6640	365.536	.	13.0214	-1.85563	.	.	.	4	0.99981	11.1747
175	76.607	22.0868	.	591.330	4.7882	.	.	.	.	-2.97405	4	0.99980	11.3318
176	78.307	.	20.0961	.	-2.2092	12.9548	-1.45068	.	.	.	4	0.99979	12.0648
177	78.575	5.7124	15.7391	.	.	9.7496	.	-1.21071	.	.	4	0.99979	12.1818
178	78.575	.	21.2392	.	.	11.8807	.	-1.61733	-1.09608	.	4	0.99979	12.1819
179	78.658	5.8495	17.8205	.	.	10.4340	-1.31665	.	.	.	4	0.99979	12.2183
180	78.695	.	21.1221	.	.	11.7230	-0.79722	-0.79772	.	.	4	0.99979	12.2344
181	78.738	.	19.8267	146.372	.	11.4462	.	-1.56679	.	.	4	0.99979	12.2532
182	78.887	.	21.2987	.	.	11.6868	-1.59054	.	0.84898	.	4	0.99979	12.3187
183	79.213	18.3645	1.3502	.	-5.1446	8.1708	.	.	.	.	4	0.99979	12.4621
184	79.240	.	19.0577	.	-0.5810	11.4327	.	-1.45566	.	.	4	0.99979	12.4741
185	79.638	19.8160	.	.	-5.4254	7.9208	.	0.10316	.	.	4	0.99979	12.6498
186	79.821	19.8119	.	.	-5.2610	7.8261	0.09336	.	.	.	4	0.99979	12.7310
187	79.837	21.8539	.	213.006	-4.2606	7.4390	.	.	.	.	4	0.99979	12.7382
188	81.287	21.6914	.	.	-2.6858	6.4009	.	.	.	-0.60312	4	0.99978	13.3885
189	81.872	20.7469	.	.	.	4.0837	.	.	0.82940	-1.18865	4	0.99978	13.6539
190	81.932	22.2744	.	.	-4.3785	7.7680	.	.	-0.26242	.	4	0.99978	13.6815
191	85.190	25.8619	.	343.791	.	4.2150	-0.07453	.	.	.	4	0.99976	15.1966
192	85.197	25.6745	.	333.524	.	4.2075	.	-0.07452	.	.	4	0.99976	15.2001
193	85.747	25.9852	.	263.404	.	3.8798	.	.	-0.63297	.	4	0.99975	15.4616
194	85.852	25.4196	-0.2996	251.373	.	3.8227	.	.	.	.	4	0.99975	15.5116
195	86.677	19.6680	.	.	4.7333	.	.	.	2.18010	-2.17417	4	0.99975	15.9078
196	86.941	22.7544	.	.	.	3.8908	0.86870	-0.88172	.	.	4	0.99975	16.0355
197	87.165	22.8998	0.5521	.	.	3.8439	.	.	0.36888	.	4	0.99975	16.1438
198	87.522	23.4931	.	.	.	3.7929	0.01424	.	0.56783	.	4	0.99974	16.3172
199	87.534	23.4929	.	.	.	3.8026	.	0.01246	0.59797	.	4	0.99974	16.3231
200	96.695	.	4.8024	-421.613	-9.4051	11.9418	.	.	.	.	4	0.99969	21.01[illegible]

heat production predictive equations

OBS	_RMSE_	_ANGAIN_	_TCARB_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_COMPP_	_COMPF_	_P_	_RSQ_	_CP_
251	226.737	5.1063	4.4653	-457.24	.	.	.	.	16.4043	.	4	0.99828	138.069
252	227.137	.	5.2802	-607.33	.	.	.	.	17.0232	-0.18094	4	0.99827	138.573
253	227.694	13.6977	2.0884	.	.	.	.	.	15.3764	0.73629	4	0.99826	139.279
254	228.202	17.3683	.	-156.81	.	.	.	.	16.7335	1.87177	4	0.99826	139.924
255	300.108	49.1509	6.9259	1829.18	.	.	.	.	.	-0.76236	4	0.99698	245.642
256	47.063	.	9.1545	.	7.7542	-2.21144	.	.	-1.9536	-7.25467	5	0.99993	2.479
257	48.077	.	8.8250	85.05	5.1877	.	.	.	-2.5664	-6.73578	5	0.99993	2.718
258	48.276	.	.	.	8.7663	-7.63256	0.9577	.	-2.6126	-9.67153	5	0.99993	2.765
259	48.392	.	9.0925	.	5.2893	.	.	-0.0224	-2.2847	-6.59685	5	0.99993	2.793
260	48.400	.	8.8127	.	5.1288	.	0.0063	.	-2.3122	-6.62606	5	0.99993	2.795
261	48.400	-0.0511	8.8860	.	5.1645	.	.	.	-2.3005	-6.62574	5	0.99993	2.795
262	49.533	.	4.6993	.	9.0621	-5.41593	.	0.3849	.	-7.99706	5	0.99993	3.069
263	49.584	.	.	.	8.2802	-7.31096	.	0.9683	-1.4668	-9.53128	5	0.99993	3.082
264	49.804	-4.2220	9.2127	.	10.0507	-4.37554	.	.	.	-7.85729	5	0.99993	3.136
265	50.044	.	.	-195.71	8.2961	-7.34329	.	0.9341	.	-8.99096	5	0.99993	3.195
266	50.371	.	8.7600	.	4.9612	.	-1.4745	1.4820	.	-6.39689	5	0.99992	3.276
267	50.433	.	6.3381	.	9.0978	-4.51548	0.1851	.	.	-7.46931	5	0.99992	3.292
268	50.490	3.7962	.	.	8.0712	-6.55585	.	0.7937	.	-8.22662	5	0.99992	3.306
269	50.746	.	8.1172	7.11	8.7875	-3.34995	.	.	.	-6.99865	5	0.99992	3.370
270	51.042	.	.	.	8.3215	-7.34270	-0.6819	1.6244	.	-9.28677	5	0.99992	3.445
271	51.231	9.4827	.	.	1.3033	.	0.6776	.	-3.3184	-6.06056	5	0.99992	3.493
272	51.777	.	.	-239.56	8.9125	-7.63402	0.8662	.	.	-8.70736	5	0.99992	3.632
273	51.818	9.3964	.	.	1.1927	.	.	0.6913	-2.4892	-6.04930	5	0.99992	3.642
274	51.954	-5.6211	13.5127	.	7.4664	.	-0.4503	.	.	-6.35464	5	0.99992	3.677
275	52.884	.	9.9387	27.82	6.1622	.	-0.2370	.	.	-5.77034	5	0.99992	3.918
276	53.067	3.6561	.	.	8.6739	-6.81859	0.7261	.	.	-8.00405	5	0.99992	3.966
277	53.179	11.5438	-2.4615	.	.	.	0.9031	.	-3.7820	-6.08606	5	0.99992	3.996
278	53.234	-3.5822	11.2041	.	6.5623	.	.	-0.3071	.	-6.05657	5	0.99992	4.010
279	53.451	-1.1686	7.8506	-93.67	4.8098	.	.	.	.	-5.97145	5	0.99991	4.067
280	53.454	9.5676	.	.	.	1.02883	0.6890	.	-3.5960	-5.83476	5	0.99991	4.068
281	53.4672	.	8.2031	-48.111	5.18690	.	.	-0.06951	.	-5.79037	5	0.99991	4.0717
282	53.6044	10.9999	-2.0983	.	.	.	.	0.89591	-2.68773	-6.11045	5	0.99991	4.1080
283	53.7208	9.4052	.	.	.	0.9204	.	0.70610	-2.74667	-5.86951	5	0.99991	4.1389
284	53.8437	8.7891	.	.	0.97108	.	-1.62569	2.32724	.	-5.89374	5	0.99991	4.1716
285	55.1652	9.7602	-1.4704	.	.	.	-1.88250	2.75184	.	-6.03093	5	0.99991	4.5280
286	55.1772	8.6678	.	.	.	0.6437	-1.92844	2.66536	.	-5.86134	5	0.99991	4.5312
287	56.0998	5.5784	.	-141.153	.	.	.	0.88434	-2.65030	-6.80987	5	0.99991	4.7852
288	56.2118	6.3007	.	-86.327	.	.	-2.06726	2.93479	.	-6.55717	5	0.99991	4.8163
289	56.2921	6.8820	.	.	.	.	-1.57552	2.45147	-1.14421	-6.75526	5	0.99991	4.8387
290	56.5095	5.1557	.	-172.275	.	.	0.88863	.	-3.67655	-6.88964	5	0.99990	4.8993
291	56.6567	4.3917	7.3897	.	.	4.3277	.	.	-2.75411	-4.76976	5	0.99990	4.9405
292	56.9834	7.0244	.	-117.352	1.30708	.	.	0.60690	.	-5.40842	5	0.99990	5.0324
293	57.6277	.	6.6048	.	.	3.4732	.	0.18319	-2.72902	-5.72861	5	0.99990	5.2150
294	57.6416	.	6.6552	.	.	3.5257	0.17364	.	-2.93839	-5.70998	5	0.99990	5.2190
295	57.8703	.	8.2721	1.333	.	4.3511	.	.	-2.74888	-5.29495	5	0.99990	5.2844
296	58.0396	.	6.5854	.	.	3.1849	-2.10186	2.32226	.	-5.71093	5	0.99990	5.3329
297	58.3142	.	.	-208.684	0.46203	.	0.82874	.	-2.51791	-6.87676	5	0.99990	5.4119
298	58.7459	.	.	-200.984	0.33442	.	.	0.84448	-1.54098	-6.86618	5	0.99990	5.5370
299	58.8016	7.6791	-2.0082	-193.170	.	.	.	0.82967	.	-5.51130	5	0.99990	5.5531
300	59.0336	.	0.2841	-246.598	.	.	.	0.89295	-1.82605	-7.08003	5	0.99990	5.6208

heat production predictive equations

OBS	_RMSE_	_ANGAIN_	_TCARB_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_COMPP_	_COMPF_	_P_	_RSQ_	_CP_
301	59.0357	.	.	-250.352	.	0.1033	0.88089	.	-2.76184	-6.99835	5	0.99990	5.6214
302	59.0632	.	.	-253.963	.	.	0.58747	0.31118	-2.44717	-7.06073	5	0.99990	5.6294
303	59.0785	.	0.0465	-263.641	.	.	0.89938	.	-2.85188	-7.09434	5	0.99990	5.6339
304	59.1249	.	.	-240.233	.	-0.0172	.	0.89926	-1.72261	-7.02942	5	0.99990	5.6474
305	59.2855	5.8358	.	-198.866	.	0.8133	.	0.65885	.	-5.34044	5	0.99990	5.6945
306	59.2986	7.0069	.	-136.884	1.55458	.	0.55219	.	.	-5.14513	5	0.99990	5.6983
307	59.3268	.	0.6117	-230.058	.	.	-1.42430	2.30159	.	-6.98313	5	0.99990	5.7066
308	59.4759	.	.	.	1.02023	.	2.64211	-1.88884	-5.09701	-7.05795	5	0.99989	5.7504
309	59.5318	.	.	-214.394	0.22539	.	-0.95805	1.80201	.	-6.70193	5	0.99989	5.7669
310	59.5805	.	.	-239.202	.	-0.1637	-1.24692	2.15991	.	-6.97094	5	0.99989	5.7812
311	59.9554	11.0552	-3.9305	.	.	-0.4695	.	0.91431	.	-5.39116	5	0.99989	5.8921
312	61.0754	.	0.4284	.	.	.	-1.34007	2.22904	-0.88890	-7.33327	5	0.99989	6.2274
313	61.0851	.	.	.	.	0.2134	0.02047	0.83982	-2.31167	-7.16525	5	0.99989	6.2304
314	61.1988	.	1.6924	-294.705	.	1.0518	.	0.62256	.	-5.89343	5	0.99989	6.2647
315	62.0893	6.0254	.	-217.663	.	1.0837	0.58966	.	.	-4.93364	5	0.99989	6.5363
316	62.4240	6.9255	-2.2270	-268.600	.	.	0.81025	.	.	-5.27181	5	0.99988	6.6394
317	62.6583	2.8740	6.2593	-101.573	.	3.9677	.	.	.	-4.13425	5	0.99988	6.7119
318	62.8487	.	5.1849	-216.265	.	3.0542	0.19451	.	.	-4.83697	5	0.99988	6.7710
319	62.8501	5.6335	3.7677	.	.	3.1067	0.16762	.	.	-4.19527	5	0.99988	6.7715
320	76.8555	24.9546	.	650.211	.	4.2473	.	.	-2.28213	-2.01832	5	0.99982	11.6116
321	79.2958	21.2750	.	462.991	0.95968	3.1840	.	.	.	-2.01519	5	0.99981	12.5542
322	79.7181	6.8185	18.4376	382.002	.	11.1066	-1.47426	.	.	.	5	0.99981	12.7203
323	80.4611	24.2761	.	718.599	4.96280	.	.	.	-1.25789	-3.15108	5	0.99981	13.0147
324	80.8124	.	24.1156	391.914	.	13.2308	-1.89102	.	-0.28708	.	5	0.99981	13.1549
325	80.8385	.	23.9875	385.385	.	13.1505	-2.04168	0.16335	.	.	5	0.99981	13.1653
326	80.8428	.	23.2698	348.427	-0.32563	13.1031	-1.81645	.	.	.	5	0.99981	13.1670
327	80.8675	.	23.7345	359.541	.	13.2971	.	-1.89109	-2.45565	.	5	0.99981	13.1769
328	81.3298	8.8893	12.3245	.	-3.07104	10.7339	-0.86311	.	.	.	5	0.99980	13.3624
329	81.7756	25.9911	.	428.929	-5.54689	8.8182	.	.	-2.63683	.	5	0.99980	13.5422
330	82.1768	7.8182	14.5977	212.016	.	9.5554	.	-1.18319	.	.	5	0.99980	13.7050
331	82.2328	19.5307	1.9881	.	-6.43485	9.4921	.	.	-1.79295	.	5	0.99980	13.7278
332	82.5067	9.7543	10.5414	.	-2.50391	9.6815	.	-0.76629	.	.	5	0.99980	13.8394
333	82.6592	5.3632	17.4915	.	.	10.4696	.	-1.33004	-1.02907	.	5	0.99980	13.9017
334	82.8650	21.5113	.	.	-6.78116	9.0606	0.15007	.	-1.87296	.	5	0.99980	13.9859
335	82.8901	21.4832	.	.	-6.81851	9.0708	.	0.15345	-1.69495	.	5	0.99980	13.9963
336	82.9126	4.9211	17.5155	.	.	10.3771	-0.65954	-0.66310	.	.	5	0.99980	14.0055
337	82.980	.	20.0463	.	-1.7808	12.6375	-1.1515	-0.3157	.	.	5	0.99980	14.033
338	82.985	.	20.2320	.	-1.4420	12.6037	.	-1.5101	-1.3695	.	5	0.99980	14.035
339	83.004	.	20.0066	.	-1.9306	12.6978	-1.4544	.	0.3010	.	5	0.99979	14.043
340	83.162	4.8375	17.8504	.	.	10.4206	-1.3309	.	0.6066	.	5	0.99979	14.108
341	83.237	20.9831	.	.	-6.9795	9.0152	-1.2451	1.4227	.	.	5	0.99979	14.139
342	83.320	.	21.1866	.	.	11.9306	0.5251	-2.1485	-1.7299	.	5	0.99979	14.173
343	83.494	.	20.2110	161.551	0.3718	11.3276	.	-1.6073	.	.	5	0.99979	14.245
344	83.885	19.1737	1.0367	75.840	-4.9405	7.9793	.	.	.	.	5	0.99979	14.407
345	84.231	20.5381	.	104.418	-5.0133	7.7262	.	0.0666	.	.	5	0.99979	14.550
346	84.374	20.6866	.	118.651	-4.8332	7.6378	0.0533	.	.	.	5	0.99979	14.610
347	86.181	21.2733	.	.	-2.3802	6.1098	.	.	0.2532	-0.6736	5	0.99978	15.373
348	89.419	24.2862	.	.	.	4.7381	6.8929	-7.0139	-8.0741	.	5	0.99976	16.779
349	89.966	27.6124	.	429.618	.	4.3705	.	-0.0860	-0.9452	.	5	0.99976	17.022
350	90.039	27.5485	.	424.060	.	4.3418	-0.0814	.	-0.8337	.	5	0.99976	17.054

heat production predictive equations

OBS	_RMSE_	_ANGAIN_	_TCARB_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_COMPP_	_COMPF_	_P_	_RSQ_	_CP_
451	86.831	24.6192	.	313.797	-6.3875	9.1526	.	0.07258	-2.6771	.	6	0.99980	15.3193
452	87.443	23.7124	.	292.149	-6.7709	9.1359	-2.00163	2.12216	.	.	6	0.99980	15.5504
453	87.567	9.8546	11.6394	166.069	-1.5442	9.5555	.	-0.91507	.	.	6	0.99980	15.5971
454	88.026	7.1285	16.0354	.	.	10.2164	2.22427	-3.48559	-3.6920	.	6	0.99980	15.7716
455	88.473	21.7841	.	.	-6.3784	8.9326	1.48740	-1.37184	-3.4183	.	6	0.99980	15.9424
456	88.689	.	20.1545	.	-1.6421	12.6449	-0.62283	-0.86511	-0.6556	.	6	0.99980	16.0254
457	93.258	27.7616	.	371.607	.	5.1258	6.12986	-6.32123	-8.4488	.	6	0.99977	17.8246
458	109.770	37.5579	-11.6265	172.419	.	.	5.90056	-5.09839	-6.1793	.	6	0.99969	25.0810
459	110.174	36.6291	-12.5037	.	-0.6959	.	6.01370	-5.09366	-5.8590	.	6	0.99968	25.2730
460	111.032	37.9438	-12.9547	176.281	-1.5352	.	1.03259	.	-0.4599	.	6	0.99968	25.6839
461	111.084	35.7939	-11.5084	144.504	-0.8759	.	1.08943	-0.18284	.	.	6	0.99968	25.7091
462	111.594	37.0855	-12.0429	190.174	-1.2534	.	.	0.97430	0.8126	.	6	0.99968	25.9551
463	113.026	27.7624	.	241.004	5.7119	.	5.99321	-6.20349	-5.6470	.	6	0.99967	26.6510
464	117.746	.	.	-479.746	-9.9812	10.3528	-2.54012	2.92174	5.1419	.	6	0.99964	29.0087
465	134.791	.	14.6434	-177.453	11.5154	.	4.28595	-5.58372	0.5748	.	6	0.99953	38.3260
466	46.665	.	5.3677	.	11.4666	-6.4743	7.30278	-7.00972	-10.3207	-9.0619	7	0.99995	5.0400
467	46.969	5.5959	.	.	10.2241	-7.4955	7.84037	-7.11704	-11.0066	-9.0881	7	0.99995	5.0929
468	48.486	.	.	-188.606	11.5857	-9.2683	8.28006	-7.42679	-10.6856	-10.1285	7	0.99995	5.3616
469	52.399	1.8557	3.8913	.	7.8700	-4.8200	0.52625	.	-2.5324	-8.3258	7	0.99994	6.0939
470	52.496	.	5.5117	15.475	8.3531	-4.6026	0.39721	.	-2.3826	-8.3792	7	0.99994	6.1127
471	52.573	.	10.7871	120.192	7.0966	.	4.52733	-4.82625	-7.9451	-6.6601	7	0.99994	6.1278
472	52.934	5.2287	.	-12.059	7.1136	-5.7638	0.85468	.	-2.8802	-8.4755	7	0.99994	6.1985
473	53.030	.	6.6965	54.151	8.1915	-3.8710	.	0.27154	-2.0509	-8.0795	7	0.99994	6.2174
474	53.090	-0.0086	9.7794	.	6.4639	.	4.67630	-4.86695	-7.8240	-6.6118	7	0.99994	6.2292
475	53.122	0.2196	5.8689	.	8.0044	-4.1446	.	0.35908	-1.8976	-8.1451	7	0.99994	6.2356
476	53.392	-1.5348	9.4964	98.896	8.6083	-2.9054	.	.	-2.1652	-7.7795	7	0.99994	6.2889
477	54.363	5.6002	.	4.518	6.6085	-5.3654	.	0.85381	-1.9167	-8.2844	7	0.99993	6.4830
478	55.200	0.1057	10.2347	141.418	6.0482	.	.	-0.15094	-2.6376	-6.6475	7	0.99993	6.6531
479	55.320	1.0292	9.2001	132.100	5.5351	.	-0.06188	.	-2.5888	-6.6078	7	0.99993	6.6776
480	55.471	-0.7443	6.2088	.	8.1544	-4.2337	-1.02519	1.34981	.	-8.0084	7	0.99993	6.7087
481	55.485	.	5.5377	-8.118	7.9399	-4.3194	-1.01506	1.39419	.	-7.9832	7	0.99993	6.7117
482	56.569	-1.9462	5.0080	-119.250	9.1045	-5.6216	.	0.42835	.	-8.2973	7	0.99993	6.9369
483	56.649	3.9303	.	-70.563	6.9017	-5.8367	-0.80038	1.67222	.	-8.2924	7	0.99993	6.9537
484	57.064	11.1963	.	81.161	2.2077	.	4.59191	-4.04014	-8.1813	-5.9739	7	0.99993	7.0413
485	57.247	-4.5947	8.4874	-91.433	9.8996	-4.7206	0.10045	.	.	-8.0312	7	0.99993	7.0801
486	57.790	-1.2225	10.4259	93.566	5.8206	.	-1.63957	1.49888	.	-6.5206	7	0.99993	7.1960
487	60.986	13.0711	-3.7628	.	.	-0.2468	2.80715	-1.83914	-6.0606	-6.1017	7	0.99992	7.9003
488	60.998	12.7045	-3.2111	3.343	.	.	2.74562	-1.82879	-6.0066	-6.0280	7	0.99992	7.9030
489	61.392	11.9825	-2.8928	10.587	.	-0.1724	0.93903	.	-3.8494	-6.1321	7	0.99992	7.9926
490	61.446	10.3970	.	36.198	.	1.3224	1.98184	-1.34291	-5.2711	-5.6959	7	0.99992	8.0049
491	61.869	11.0357	-1.6264	30.978	.	0.2693	.	0.84117	-2.7903	-6.0163	7	0.99991	8.1015
492	63.685	9.3480	-0.8451	2.538	.	0.2862	-1.90223	2.71273	.	-5.9460	7	0.99991	8.5245
493	66.370	.	5.5866	-82.001	.	2.9041	0.07811	0.22091	-2.5625	-5.9014	7	0.99990	9.1725
494	90.236	12.9355	13.2034	406.064	-2.5988	11.3798	.	-1.04029	-2.9627	.	7	0.99982	16.1065
495	90.313	12.7621	13.2032	409.413	-2.9000	11.4779	-1.01494	.	-1.8004	.	7	0.99982	16.1323
496	90.671	11.6543	13.7341	397.303	-2.9809	11.5378	-2.34717	1.31875	.	.	7	0.99982	16.2528
497	91.048	10.0295	17.2713	451.578	.	11.1098	0.93717	-2.37198	-3.8097	.	7	0.99981	16.3796
498	93.241	.	23.6614	370.023	-0.4067	13.4111	-1.38044	-0.47234	-0.9060	.	7	0.99981	17.1297
499	93.374	11.7455	10.3503	.	-3.7371	10.7317	0.71237	-1.43083	-2.5178	.	7	0.99981	17.1758
500	93.700	24.7988	.	309.087	-6.0624	9.0473	1.12055	-1.07529	-3.9607	.	7	0.99980	17.2889

heat production predictive equations

OBS	_RMSE_	_ANGAIN_	_TCARB_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_COMPP_	_COMPF_	_P_	_RSQ_	_CP_
351	90.357	25.9418	.	347.924	.	4.2169	-0.1075	0.0332	.	.	5	0.99976	17.196
352	90.836	26.9022	-0.3700	317.893	.	3.9007	.	.	-0.6998	.	5	0.99975	17.411
353	102.223	.	4.5159	-455.527	-8.6555	11.1995	.	.	0.8765	.	5	0.99969	22.849
354	103.100	35.5029	-11.1894	.	.	.	6.2573	-5.4577	-6.0554	.	5	0.99968	23.295
355	103.924	36.4646	-11.9831	154.516	-1.1151	.	0.9508	.	.	.	5	0.99968	23.716
356	103.974	34.4563	-9.8229	161.722	.	.	1.1601	-0.4069	.	.	5	0.99968	23.742
357	104.080	35.5353	-9.8807	213.147	.	.	0.7614	.	-0.0237	.	5	0.99968	23.797
358	104.184	34.9046	-12.0511	.	-1.3222	.	1.4095	-0.4260	.	.	5	0.99968	23.850
359	104.266	36.7758	-13.6088	.	-2.1292	.	1.1323	.	-0.0957	.	5	0.99968	23.893
360	104.521	35.2040	-9.6073	218.474	.	.	.	0.7546	0.9046	.	5	0.99967	24.024
361	104.660	39.4820	-12.8989	260.968	-1.5426	.	.	1.0425	.	.	5	0.99967	24.096
362	104.857	35.7991	-12.7400	.	-1.9096	.	.	1.0837	1.3352	.	5	0.99967	24.199
363	106.485	25.3759	.	.	5.3482	.	6.2318	-6.3846	-5.2061	.	5	0.99966	25.049
364	106.742	26.2486	.	215.797	4.8627	.	1.5914	-1.6975	.	.	5	0.99966	25.185
365	106.972	28.5279	-1.1897	308.708	4.2667	.	.	.	1.3578	.	5	0.99966	25.307
366	107.464	26.9450	.	263.072	4.6526	.	.	-0.0731	1.4734	.	5	0.99966	25.567
367	107.504	26.8723	.	257.564	4.6191	.	-0.0682	.	1.5599	.	5	0.99966	25.589
368	110.435	.	.	-503.946	-9.2923	10.1303	.	0.3238	2.3149	.	5	0.99964	27.169
369	110.512	.	.	-505.382	-9.1915	10.0963	0.3153	.	1.9711	.	5	0.99964	27.211
370	111.037	.	.	-505.180	-9.2063	10.3074	1.7355	-1.4413	.	.	5	0.99963	27.499
371	113.858	.	.	197.821	1.3172	2.9585	.	.	4.1050	-2.5775	5	0.99961	29.068
372	114.253	.	.	.	-10.3421	10.9679	-4.3671	4.6825	6.4115	.	5	0.99961	29.291
373	123.054	.	.	-536.350	.	3.6344	5.6173	-5.5862	-0.9256	.	5	0.99955	34.457
374	126.095	.	14.7424	-176.755	11.6483	.	4.7512	-6.0679	.	.	5	0.99953	36.332
375	126.446	.	16.2105	.	12.5194	.	4.0587	-5.5309	0.4879	.	5	0.99952	36.551
376	126.838	.	14.1842	-157.763	10.5467	.	.	-1.1616	5.5974	.	5	0.99952	36.797
377	127.274	.	13.6070	-171.904	10.0335	.	-1.0810	.	6.9180	.	5	0.99952	37.070
378	130.119	17.7658	.	-307.186	.	.	-11.2651	11.8045	16.7337	.	5	0.99950	38.882
379	135.096	.	.	-668.789	3.1832	.	2.6242	-2.4933	4.4451	.	5	0.99946	42.148
380	140.597	.	-2.7790	-835.636	.	.	-3.0448	3.6559	11.4345	.	5	0.99941	45.899
381	240.367	7.4219	3.6759	-431.918	.	.	.	.	16.4628	0.4783	5	0.99828	139.921
382	46.614	.	.	.	11.8917	-9.4376	7.8071	-6.9693	-10.5277	-10.3367	6	0.99994	3.703
383	48.608	.	5.3175	.	8.3272	-4.6866	0.4188	.	-2.3621	-8.4048	6	0.99994	4.114
384	49.012	5.3853	.	.	7.0978	-5.7267	0.8501	.	-2.9120	-8.4563	6	0.99994	4.199
385	49.152	.	9.7732	.	6.4613	.	4.6767	-4.8669	-7.8248	-6.6112	6	0.99994	4.229
386	49.183	.	6.0361	.	8.0644	-4.1331	.	0.3463	-1.8921	-8.1562	6	0.99994	4.236
387	49.530	.	9.1237	129.018	8.2166	-2.5756	.	.	-2.3004	-7.5358	6	0.99994	4.310
388	49.754	-3.0656	9.8845	.	8.7523	-3.0400	.	.	-1.8453	-7.8726	6	0.99994	4.358
389	50.331	5.5417	.	.	6.6135	-5.3787	.	0.8556	-1.9027	-8.2913	6	0.99993	4.483
390	50.644	.	.	-148.135	8.3648	-7.4066	0.9761	.	-2.3285	-9.4737	6	0.99993	4.552
391	51.106	.	10.3053	140.746	6.0770	.	.	-0.1559	-2.6328	-6.6546	6	0.99993	4.653
392	51.240	1.7150	8.4513	124.998	5.1833	.	.	.	-2.6794	-6.5779	6	0.99993	4.683
393	51.2437	.	9.8818	125.746	5.8050	.	-0.10912	.	-2.48628	-6.67707	6	0.99993	4.6838
394	51.3712	.	5.6391	.	7.9487	-4.2728	-1.03632	1.40438	.	-7.96912	6	0.99993	4.7121
395	51.7097	-0.9307	9.7652	.	5.5764	.	.	-0.07211	-2.25680	-6.66198	6	0.99993	4.7876
396	51.7414	0.0857	8.7515	.	5.1035	.	0.01076	.	-2.32003	-6.62008	6	0.99993	4.7947
397	52.1632	.	.	-140.413	7.8894	-7.0890	.	0.98577	-1.17560	-9.33992	6	0.99993	4.8896
398	52.4746	.	3.5385	-114.659	8.6157	-5.7429	.	0.53636	.	-8.18765	6	0.99993	4.9601
399	52.5857	4.8409	.	.	6.7385	-5.5802	-0.98713	1.83474	.	-8.16528	6	0.99993	4.9854
400	52.8861	-1.5687	5.9212	.	9.4705	-5.3076	.	0.29294	.	-8.07930	6	0.99993	5.0539

heat production predictive equations

OBS	_RMSE_	_ANGAIN_	_TCARB_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_COMPP_	_COMPF_	_P_	_RSQ_	_CP_
101	130.558	.	.	-65.88	.	3.7576	.	0.1700	.	.	3	0.99937	45.7063
102	132.075	21.2097	.	-558.45	.	.	0.6159	.	.	.	3	0.99935	46.9386
103	132.368	.	.	-1104.75	.	.	.	0.5509	7.7057	.	3	0.99935	47.1784
104	132.944	22.7651	.	-481.96	.	.	.	0.6254	.	.	3	0.99934	47.6506
105	133.022	.	.	-1122.04	.	.	0.5497	.	7.1102	.	3	0.99934	47.7146
106	134.757	20.4689	.	.	.	.	.	0.4982	2.3485	.	3	0.99932	49.1513
107	135.987	20.4349	.	.	.	.	0.4944	.	1.8419	.	3	0.99931	50.1807
108	136.297	.	.	.	.	.	-13.3264	13.8256	22.0871	.	3	0.99931	50.4425
109	136.853	24.8619	.	.	.	.	-0.2065	0.7723	.	.	3	0.99930	50.9114
110	138.327	.	-5.2767	.	.	.	.	0.6113	7.0566	.	3	0.99929	52.1660
111	138.800	.	-5.4472	.	.	.	0.6137	.	6.3775	.	3	0.99928	52.5709
112	139.190	.	14.7725	.	10.3611	.	-0.9425	.	.	.	3	0.99928	52.9066
113	141.614	.	.	-1230.34	.	.	5.38020	-4.78069	.	.	3	0.99925	55.011
114	143.303	.	4.9359	-317.44	4.90644	.	.	.	.	.	3	0.99924	56.499
115	143.859	.	-6.7680	.	.	.	5.33333	-4.66096	.	.	3	0.99923	56.993
116	147.406	.	.	-396.95	2.63090	.	0.41278	.	.	.	3	0.99919	60.187
117	150.573	.	.	-277.05	2.97358	.	.	0.37689	.	.	3	0.99916	63.105
118	152.029	.	-3.3374	-657.53	.	.	0.83627	.	.	.	3	0.99914	64.468
119	158.304	.	-2.8009	-590.90	.	.	.	0.84741	.	.	3	0.99907	70.489
120	215.508	.	5.0884	-626.84	.	.	.	.	17.1781	.	3	0.99827	136.611
121	216.280	10.6018	3.1952	.	.	.	.	.	15.1821	.	3	0.99826	137.640
122	216.676	18.3601	.	.	.	.	.	.	16.1308	1.69957	3	0.99825	138.171
123	218.528	.	4.7854	.	.	.	.	.	15.7114	-0.82234	3	0.99822	140.663
124	220.956	15.4908	.	195.99	.	.	.	.	16.7292	.	3	0.99818	143.962
125	222.825	.	.	-468.81	.	.	.	.	20.5583	1.58347	3	0.99815	146.527
126	284.922	53.1146	5.6747	1882.84	.	.	.	.	.	.	3	0.99698	244.021
127	288.776	69.4792	.	2426.21	.	.	.	.	.	1.86281	3	0.99690	250.857
128	304.134	.	20.9706	1022.97	.	.	.	.	.	-6.50761	3	0.99656	279.015
129	305.110	26.3626	18.5855	.	.	.	.	.	.	-2.96121	3	0.99654	280.852
130	45.633	.	8.8756	.	5.16400	.	.	.	-2.3002	-6.61941	4	0.99993	0.795
131	47.846	.	8.1289	.	8.75230	-3.31905	.	.	.	-6.98579	4	0.99992	1.371
132	48.731	.	.	.	9.05514	-7.78332	.	0.88741	.	-9.15302	4	0.99992	1.609
133	49.881	.	9.6876	.	5.99810	.	-0.20784	.	.	-5.77325	4	0.99992	1.924
134	50.456	.	7.5579	-71.14	4.79500	.	.	.	.	-5.83691	4	0.99991	2.085
135	50.480	.	8.5916	.	5.46534	.	.	-0.12028	.	-5.76689	4	0.99991	2.092
136	50.691	0.1839	7.3332	.	4.77592	.	.	.	.	-5.83846	4	0.99991	2.151
137	50.991	.	.	.	9.73157	-8.07781	0.81068	.	.	-8.88986	4	0.99991	2.236
138	53.209	6.9579	.	.	.	.	-2.35313	3.22048	.	-6.62283	4	0.99991	2.879
139	53.567	6.4692	.	.	.	.	.	0.88448	-3.1959	-6.96628	4	0.99990	2.985
140	54.124	8.1310	.	.	1.57338	.	.	0.55400	.	-5.27015	4	0.99990	3.152
141	54.273	6.2476	.	.	.	.	0.88845	.	-4.3346	-7.07710	4	0.99990	3.197
142	54.561	.	8.2730	.	.	4.35083	.	.	-2.7448	-5.29325	4	0.99990	3.284
143	55.702	.	.	-262.30	.	.	0.89992	.	-2.8348	-7.08401	4	0.99990	3.635
144	55.745	.	.	-238.34	.	.	.	0.89609	-1.7140	-7.01528	4	0.99990	3.648
145	56.260	.	.	-228.79	.	.	-1.12723	2.00834	.	-6.82196	4	0.99989	3.808
146	56.364	.	.	.	0.69078	.	0.79614	.	-2.9314	-7.04596	4	0.99989	3.841
147	56.391	8.3728	.	.	1.85515	.	0.49400	.	.	-4.99634	4	0.99989	3.850
148	56.560	10.3315	-2.9098	.	.	.	.	0.81714	.	-5.24407	4	0.99989	3.902
149	56.666	.	.	.	0.55817	.	.	0.81277	-1.9800	-7.03146	4	0.99989	3.936
150	56.993	7.9749	.	.	.	1.25836	.	0.55438	.	-4.91190	4	0.99989	4.039

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                                   heat production predictive equations

OBS    _RMSE_   _ANGAIN_    _TCARB_       _RQ_      _CO2_      _O2_    _MECON_   _MENCON_    _COMPP_    _COMPF_  _P_      _RSQ_       _CP_

201    98.128    35.4783    -9.8717    210.934       .         .       0.76091       .          .          .       4    0.99968    21.7968
202    98.306    36.4678   -13.3660       .       -2.0153      .       1.11059       .          .          .       4    0.99968    21.8941
203    98.372    32.5848    -9.4464       .          .         .       1.58441   -0.83271       .          .       4    0.99968    21.9301
204    98.733    32.7727    -9.1766       .          .         .       0.75461       .       0.67746       .       4    0.99967    22.1285
205    98.870    37.4474    -9.9435    306.866       .         .          .       0.77460       .          .       4    0.99967    22.2036
206    99.177    32.3741    -8.8872       .          .         .          .       0.74761    1.61580       .       4    0.99967    22.3728
207    99.766    39.9418   -15.1498       .       -3.0621      .          .       1.31891       .          .       4    0.99967    22.6988
208   100.996       .        3.6548       .       -9.3654   11.8359       .          .      -0.09329       .       4    0.99966    23.3863
209   101.210    24.2007       .          .        4.5942      .       2.11702   -2.17854       .          .       4    0.99966    23.5069
210   101.587    31.6800    -1.3592    447.370     4.4368      .         .          .          .          .       4    0.99965    23.7196
211   101.749    25.5466       .       135.954     4.1775      .         .          .       1.59437       .       4    0.99965    23.8114
212   102.076    24.6056    -0.2796       .        4.2031      .         .          .       2.37686       .       4    0.99965    23.9966
213   102.159    24.2947       .          .        4.2079      .         .      -0.00411    2.26685       .       4    0.99965    24.0439
214   102.161    24.2888       .          .        4.1954      .      -0.00220       .       2.25723       .       4    0.99965    24.0449
215   102.186    30.1697       .       409.282     4.9040      .         .      -0.08518       .          .       4    0.99965    24.0592
216   102.340    30.1546       .       398.486     4.8287      .      -0.07200       .          .          .       4    0.99965    24.1470
217   105.749       .          .      -443.157   -11.1498   11.7316    0.37148       .          .          .       4    0.99963    26.1211
218   106.393       .          .      -411.552   -11.6149   12.1183       .       0.38351       .          .       4    0.99962    26.5012
219   107.485       .          .       174.495       .       4.0735       .          .       3.92304   -2.26822    4    0.99961    27.1513
220   108.011       .          .          .        0.5712    3.5465       .          .       4.67086   -2.11998    4    0.99961    27.4667
221   108.311       .          .       254.934     4.7806      .         .          .       4.69280   -3.36544    4    0.99961    27.6471
222   108.535       .          .          .       -9.1456   10.6262       .       0.20638    1.48245       .       4    0.99961    27.7822
223   108.611       .          .          .       -9.0663   10.5976    0.19981       .       1.27312       .       4    0.99961    27.8284
224   108.999       .          .          .       -9.3872   10.9517    0.91261   -0.71203       .          .       4    0.99960    28.0634
225   111.060       .        3.1128    -580.34       .      3.54221       .          .        4.6455       .       4    0.99959     29.325
226   113.210       .          .       -119.42    -5.5407   8.58316       .          .        4.0753       .       4    0.99957     30.667
227   115.214       .          .        531.37    -2.1139   6.52552       .          .          .      -2.55219    4    0.99956     31.941
228   116.043       .          .       -532.18       .      3.54002     4.8955    -4.8525       .          .       4    0.99955     32.475
229   117.496       .          .       -483.79       .      2.95108     0.1269       .        5.7589       .       4    0.99954     33.419
230   117.564       .          .       -478.69       .      2.94930       .        0.1266     5.9166       .       4    0.99954     33.463
231   119.221       .       16.2894       .       12.6289      .        4.4546    -5.9423       .          .       4    0.99952     34.555
232   119.853       .       15.6075       .       11.4905      .         .       -1.3242     5.2815       .       4    0.99952     34.976
233   120.311       .       15.1351       .       11.0200      .       -1.2521       .        6.7757       .       4    0.99952     35.282
234   120.372       .          .          .          .      4.05227     3.8972    -3.9546     0.2535       .       4    0.99951     35.323
235   123.781    20.3742       .          .          .         .      -13.2589    13.7838    18.2011       .       4    0.99949     37.639
236   125.290       .        2.5993    -637.50     3.7973      .         .          .        6.9459       .       4    0.99947     38.685
237   127.588       .          .       -650.05     2.7686      .        0.1846       .        7.2656       .       4    0.99945     40.302
238   127.622       .          .       -647.04     2.7448      .         .        0.1875     7.4829       .       4    0.99945     40.326
239   127.886       .          .       -690.07     3.8036      .        6.3029    -6.2467       .          .       4    0.99945     40.514
240   132.464    13.5851       .       -806.30       .         .          .        0.5469     4.7540       .       4    0.99941     43.831
241   132.931       .       -3.6141    -897.92       .         .          .        0.6315     8.0248       .       4    0.99941     44.176
242   133.104       .       -3.7819    -910.71       .         .        0.6352       .        7.3202       .       4    0.99941     44.304
243   133.397    13.3893       .       -826.99       .         .        0.5454       .        4.2155       .       4    0.99940     44.522
244   133.624       .          .          .        3.7846      .        0.4542    -0.4391     6.1982       .       4    0.99940     44.690
245   134.583       .          .       -815.04       .         .       -8.0135     8.5600    16.8738       .       4    0.99939     45.406
246   134.830       .       23.5110     379.42    15.8101      .         .       -1.9385       .          .       4    0.99939     45.591
247   136.509       .       -5.3757   -1011.21       .         .        6.6400    -5.9484       .          .       4    0.99938     46.859
248   138.386    17.9650       .       -713.31       .         .        1.9797    -1.3878       .          .       4    0.99936     48.295
249   142.201       .       -2.4438       .          .         .       -9.0750     9.6300    17.4196       .       4    0.99932     51.274
250   146.494       .       16.1757     157.06    11.2751      .       -1.1048       .          .          .       4    0.99928     54.723
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                                                   heat production predictive equations

OBS    _RMSE_   _ANGAIN_    _TCARB_       _RQ_      _CO2_      _O2_    _MECON_   _MENCON_    _COMPP_    _COMPF_  _P_     _RSQ_      _CP_

401   53.0263    10.3314      .           .        2.0718     .        4.66588   -4.09179   -8.04436   -5.99835    6   0.99993    5.0861
402   53.0404    -5.1657     9.5706    -70.157     9.9931   -4.3068     .          .          .        -7.92517    6   0.99993    5.0893
403   53.1234     2.2694      .       -151.107     7.8809   -6.7098     .         0.86742     .        -8.47408    6   0.99993    5.1084
404   53.2354    -4.5288     9.6392       .       10.0779   -4.2199   -0.03596     .          .        -7.82671    6   0.99993    5.1342
405   53.3202      .          .       -173.988     7.9898   -7.1576   -0.36300    1.32123     .        -9.08015    6   0.99993    5.1537
406   53.5414      .         9.5976    100.851     5.4749     .       -1.67922    1.59805     .        -6.43515    6   0.99993    5.2049
407   53.7022      .         5.1899    -87.502     8.9135   -4.9988    0.31875     .          .        -7.66001    6   0.99992    5.2422
408   53.7576    -1.8559    10.1091       .        5.5424     .       -1.43677    1.34419     .        -6.53084    6   0.99992    5.2551
409   54.5337    10.4572      .         90.323     1.4653     .        0.65128     .        -3.53715   -6.03252    6   0.99992    5.4370
410   55.1278    10.4458      .         96.819     1.3714     .          .         0.66242   -2.75759   -6.01923    6   0.99992    5.5780
411   55.2572     1.2275      .       -212.698     8.6492   -7.2610    0.83161     .          .        -8.43041    6   0.99992    5.6090
412   55.5340    -5.5885    13.6281     15.240     7.5478     .       -0.46485     .          .        -6.34967    6   0.99992    5.6753
413   56.4733    12.6598    -3.2009       .         .         .        2.75180   -1.83499   -6.00415   -6.02927    6   0.99992    5.9031
414   56.7859    -3.8317    10.9023    -59.920     6.2919     .          .        -0.25694     .        -6.10599    6   0.99992    5.9797
415   56.8409    11.9215    -2.9792       .         .       -0.2281    0.95035     .        -3.82960   -6.15309    6   0.99992    5.9932
416   56.8428    11.7798    -2.5232     16.302       .         .        0.90341     .        -3.83046   -6.07897    6   0.99992    5.9937
417   56.9228     9.9637      .           .         .        1.2617    2.02395   -1.37304   -5.21571   -5.73387    6   0.99992    6.0134
418   57.0997    10.0705      .         41.181       .        1.1038    0.67446     .        -3.69946   -5.78907    6   0.99992    6.0570
419   57.2909    11.3245    -2.1830     22.435       .         .          .         0.89640   -2.75393   -6.10075    6   0.99991    6.1044
420   57.3029    10.8195    -1.8405       .         .        0.1179     .         0.87166   -2.69261   -6.07509    6   0.99991    6.1074
421   57.3719     9.9832      .         47.019       .        1.0085     .         0.68906   -2.88538   -5.81655    6   0.99991    6.1245
422   57.4996     9.2787      .         47.377     1.0394     .       -1.73137    2.42116     .        -5.87846    6   0.99991    6.1563
423   58.9605     9.3357    -0.8673       .         .        0.2729   -1.89549    2.70872     .        -5.95087    6   0.99991    6.5245
424   58.9726     9.6664    -1.4501     -7.213       .         .       -1.86514    2.73447     .        -6.03365    6   0.99991    6.5276
425   58.9828     8.8147      .         12.675       .        0.6626   -1.95788    2.69094     .        -5.84852    6   0.99991    6.5302
426   59.8177     6.0270      .       -108.631       .         .       -0.92883    1.80818   -1.56645   -6.72150    6   0.99991    6.7449
427   59.8842     6.6418     6.8352    158.027       .        4.3491     .          .        -3.24141   -4.70265    6   0.99991    6.7621
428   61.4477      .         5.6107    -80.417       .        2.9059     .         0.29806   -2.47357   -5.89926    6   0.99990    7.1727
429   61.4525      .         5.5656    -84.997       .        2.9241    0.29647     .        -2.81580   -5.89662    6   0.99990    7.1740
430   61.5985      .         6.6199       .         .        3.4425   -0.25815    0.44566   -2.41859   -5.73280    6   0.99990    7.2129
431   61.7381      .          .       -227.816     0.8861     .        3.32532   -2.55150   -5.40534   -6.87745    6   0.99990    7.2502
432   61.9462      .         5.7421    -66.787       .        2.7339   -1.91732    2.23013     .        -5.84715    6   0.99990    7.3059
433   62.5488     9.4375    -4.9257   -222.906       .       -1.4059     .         1.12255     .        -5.99286    6   0.99990    7.4682
434   63.1050      .         0.2301   -250.449       .         .        0.20380    0.69063   -2.05909   -7.08349    6   0.99990    7.6195
435   63.1117      .          .       -250.734       .        0.1082    0.91566   -0.03554   -2.80263   -6.99692    6   0.99990    7.6214
436   66.3103     5.1065     1.5206   -196.066       .        1.7549    0.45240     .          .        -4.77155    6   0.99989    8.5174
437   82.1320    25.0123      .        642.906    -0.4746    4.6494     .          .        -2.36206   -1.90630    6   0.99982   13.6009
438   84.3550     9.3724    17.8935    461.558       .       11.2329     .        -1.46672   -2.72433     .          6   0.99981   14.4020
439   84.7092     8.6567    18.5400    474.728       .       11.2911   -1.48992     .        -0.96086     .          6   0.99981   14.5316
440   84.9478     7.8966    16.0969    318.879    -1.2510   11.1176   -1.26347     .          .          .          6   0.99981   14.6192
441   84.9733     7.7361    18.7915    449.083       .       11.2705   -2.03093    0.53382     .          .          6   0.99981   14.6286
442   86.3387      .        23.5979    371.805    -0.5576   13.4436   -1.83627     .        -0.38707     .          6   0.99981   15.1349
443   86.3470      .        23.9937    380.411       .       13.2708   -1.14168   -0.75203   -1.15642     .          6   0.99981   15.1380
444   86.3584    23.1655     1.1403    284.446    -6.3327    9.4533     .          .        -2.71485     .          6   0.99981   15.1423
445   86.3637      .        23.4963    368.366    -0.6037   13.3974   -2.10682    0.28431     .          .          6   0.99981   15.1442
446   86.4510      .        23.7290    359.329    -0.0058   13.2992     .        -1.89050   -2.45596     .          6   0.99981   15.1769
447   86.4804    11.4314    10.5284       .       -3.8985   10.8276     .        -0.71500   -1.69235     .          6   0.99981   15.1879
448   86.5745    11.4866    10.3239       .       -4.1639   10.8607   -0.68034     .        -0.90848     .          6   0.99980   15.2232
449    86.727    10.6758    10.8555       .       -4.0432   10.8793   -1.30295    0.58873     .          .          6   0.99980   15.2804
450    86.821    24.6196      .        312.567    -6.3735    9.1486    0.07143     .         -2.7593     .          6   0.99980   15.3156
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                                                            heat production predictive equations

 OBS    _RMSE_    _ANGAIN_     _TCARB_       _RQ_       _CO2_       _O2_      _MECON_    _MENCON_     _COMPP_     _COMPF_    _P_     _RSQ_        _CP_

 501   118.563    37.7543    -11.8884    169.544     -0.1425         .       5.85660    -5.02980     -6.1370          .         7    0.99969    27.0802
 502    50.904     2.3943      3.5278          .     10.8988    -6.6591     7.48988    -7.05908    -10.5965     -8.9646       8    0.99995     7.0062
 503    51.046          .      4.8176    -43.884     11.4389    -6.7386     7.46450    -7.11202    -10.3786     -9.1440       8    0.99995     7.0285
 504    51.292     4.7779          .     -63.291     10.3652    -7.7226     7.99422    -7.24897    -10.9895     -9.2007       8    0.99995     7.0675
 505   57.3777     1.9915      4.1090     25.665      7.8795    -4.6905     0.49829          .      -2.5789    -8.27755       8    0.99994     8.0899
 506   57.5651     0.8900     10.1963    125.694      6.8615         .      4.56218    -4.82001     -8.0266    -6.60016       8    0.99994     8.1233
 507   58.0811     0.5685      6.3040     57.462      8.0438    -3.8846          .       0.30000     -2.0749    -8.04623       8    0.99994     8.2155
 508   60.7604    -0.8111      6.1036    -12.512      8.1593    -4.3020    -0.99143     1.32922          .     -8.03365       8    0.99993     8.7078
 509   66.8057    13.0436     -3.8172     -6.057           .    -0.2788     2.82553    -1.85093     -6.0636    -6.11334       8    0.99992     9.9001
 510   98.8481    12.9427     13.1984    405.956     -2.5952    11.3774     0.01728    -1.05757     -2.9823          .         8    0.99982    18.1065
 511   56.8684     2.2271      3.2470    -32.653     10.9179    -6.8428     7.59715    -7.13175    -10.6204    -9.03252       9    0.99995     9.0000
```

total protein gain predictive equations

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OBS    _RMSE_   _ANGAIN_    _TCARB_      _RQ_      _CO2_      _O2_   _MECON_   _MENCON_   _P_     _RSQ_      _CP_

  1   10.8405          .          .         .          .         .   0.03330          .     1   0.99795   148.053
  2   11.2884          .          .         .          .         .         .    0.03475     1   0.99778   161.466
  3   12.2065          .          .         .          .   0.24880         .          .     1   0.99741   190.662
  4   13.3192          .          .         .    0.30113         .         .          .     1   0.99691   229.103
  5   14.8224          .    1.07710         .          .         .         .          .     1   0.99617   286.359
  6   18.9605          .          .   289.247          .         .         .          .     1   0.99374   475.567
  7   20.7310    6.60384          .         .          .         .         .          .     1   0.99252   570.678
  8    3.7713          .          .         .          .         .   0.75165   -0.74962     2   0.99977     8.646
  9    9.4567    1.60608          .         .          .         .   0.02527          .     2   0.99857   101.952
 10    9.7494    1.69318          .         .          .         .         .    0.02591     2   0.99848   108.927
 11   10.1568    1.90463          .         .          .   0.17763         .          .     2   0.99835   118.988
 12   10.5361          .    0.41817         .          .   0.15253         .          .     2   0.99823   128.725
 13   10.6867    2.12929          .         .    0.20485         .         .          .     2   0.99818   132.690
 14   10.8893    3.11471          .   154.262          .         .         .          .     2   0.99811   138.114
 15   10.9878          .          .    81.773          .   0.17889         .          .     2   0.99807   140.786
 16   11.0460          .          .    38.108          .         .   0.02893          .     2   0.99805   142.380
 17   11.2121          .          .         .   -0.07141         .   0.04119          .     2   0.99799   146.964
 18   11.2303          .    0.12856         .          .         .   0.02933          .     2   0.99799   147.471
 19   11.2730          .          .         .   -0.81657   0.92328         .          .     2   0.99797   148.666
 20   11.2894          .          .         .          .   0.03171   0.02906          .     2   0.99797   149.125
 21   11.3618          .    0.46700         .    0.17098         .         .          .     2   0.99794   151.157
 22   11.4205          .          .    44.456          .         .         .    0.02943     2   0.99792   152.818
 23   11.6114          .    0.17959         .          .         .         .    0.02896     2   0.99785   158.271
 24   11.6804          .          .         .          .   0.05952         .    0.02644     2   0.99782   160.266
 25   11.7501          .          .         .   -0.04527         .         .    0.03996     2   0.99780   162.292
 26   11.8992          .          .    90.752    0.20720         .         .          .     2   0.99774   166.666
 27   13.8067    1.95907    0.75959         .          .         .         .          .     2   0.99696   227.503
 28   14.5579          .    0.77421    81.668          .         .         .          .     2   0.99662   253.937
 29    2.4647          .          .         .    0.14570         .   0.82240   -0.84025     3   0.99991    -0.148
 30    2.5818          .          .         .          .   0.10652   0.77300   -0.78677     3   0.99990     0.518
 31    2.8683          .   -0.24824         .          .         .   0.82713   -0.82039     3   0.99988     2.279
 32    3.6307          .          .   -24.612          .         .   0.79376   -0.79061     3   0.99981     7.868
 33    3.8612    0.24656          .         .          .         .   0.71712   -0.71487     3   0.99978     9.816
 34    8.2174    1.90400          .    81.734          .   0.10778         .          .     3   0.99902    69.160
 35    8.6178    2.05955          .    86.125    0.11886         .         .          .     3   0.99892    76.762
 36    8.8494          .    0.43598         .   -0.86626   0.86395         .          .     3   0.99886    81.327
 37    8.8993          .          .         .   -1.04695   0.83470   0.03733          .     3   0.99885    82.325
 38    8.9658    1.85515          .    63.704          .         .   0.01672          .     3   0.99883    83.666
 39    9.1255    1.93103          .    68.226          .         .         .    0.01651     3   0.99879    86.923
 40    9.2696          .    1.47209         .          .   0.61296         .   -0.09820     3   0.99875    89.913
 41    9.2784          .          .         .   -1.08654   0.87738         .    0.03756     3   0.99875    90.098
 42    9.6705          .          .    82.018   -0.81947   0.85554         .          .     3   0.99864    98.478
 43    9.8507    1.61687          .         .          .   0.04043   0.01980          .     3   0.99859   102.446
 44    9.8509    1.72778   -0.10669         .          .         .   0.02795          .     3   0.99859   102.450
 45    9.8710    1.35475    0.25744         .          .   0.13891         .          .     3   0.99859   102.896
 46    9.9091    1.58582          .         .   -0.01880         .   0.02744          .     3   0.99858   103.746
 47   10.0829    1.69413          .         .          .   0.06008         .    0.01752     3   0.99852   107.665
 48   10.0871    1.57206          .         .   -0.48426   0.59006         .          .     3   0.99852   107.760
 49   10.1946    1.78043   -0.07271         .          .         .         .    0.02779     3   0.99849   110.220
 50   10.2249    1.69677          .         .    0.00410         .         .    0.02542     3   0.99848   110.917
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                                          total protein gain predictive equations

OBS    _RMSE_   _ANGAIN_    _TCARB_      _RQ_      _CO2_       _O2_    _MECON_   _MENCON_  _P_     _RSQ_      _CP_

 51   10.2896     .         1.24382      .        .         0.50062   -0.07203     .         3   0.99846   112.415
 52   10.4522    1.54452    0.26578      .       0.15722     .          .          .         3   0.99841   116.220
 53   10.7005     .         0.30004    41.999     .         0.14382     .          .         3   0.99834   122.142
 54   11.3249     .          .         57.402     .         0.09704    0.01374     .         3   0.99814   137.653
 55   11.3901    2.92657    0.07372   142.651     .          .          .          .         3   0.99812   139.325
 56   11.4709     .          .         69.771     .         0.13661     .         0.00734    3   0.99809   141.408
 57   11.5245     .         0.33640    46.079    0.15969     .          .          .         3   0.99807   142.797
 58   11.5656     .         0.06072    34.586     .          .         0.02746     .         3   0.99806   143.869
 59   11.5790     .          .         34.835   -0.01896     .         0.03140     .         3   0.99805   144.219
 60   11.7440     .         0.99086      .       0.45328     .          .        -0.04941    3   0.99800   148.557
 61   11.7577     .        -0.05351      .      -0.09724     .         0.04569     .         3   0.99799   148.921
 62   11.9243     .         0.10134    38.259     .          .          .         0.02691    3   0.99794   153.371
 63   11.9631     .          .         49.445    0.03058     .          .         0.02531    3   0.99792   154.417
 64    2.4628    0.22572     .            .       0.14483     .         0.79037   -0.80790    4   0.99992     1.157
 65    2.4957    0.48189   -0.28785      .        .          .         0.77169   -0.76378    4   0.99992     1.323
 66    2.5230     .         0.16173      .       0.22455     .         0.81151   -0.84318    4   0.99992     1.461
 67    2.5817     .          .         -4.788    0.13957     .         0.82761   -0.84441    4   0.99991     1.766
 68    2.5980     .          .            .       0.14895   -0.00253    0.82347   -0.84138    4   0.99991     1.851
 69    2.6315    0.18972     .            .        .         0.10495    0.74612   -0.75949    4   0.99991     2.029
 70    2.7080     .          .         -4.504     .         0.10196    0.77980   -0.79268    4   0.99990     2.444
 71    2.7167     .         0.03728      .        .         0.12001    0.76437   -0.78085    4   0.99990     2.492
 72    2.8524     .        -0.22710   -15.355     .          .         0.84697   -0.83994    4   0.99989     3.259
 73    3.8269    0.01190     .        -24.270     .          .         0.79150   -0.78837    4   0.99981     9.866
 74    7.8268    3.21756   -2.53617      .      -1.18921     .         0.22684     .         4   0.99920    57.183
 75    7.8617    1.56900     .         81.887   -0.48780    0.52308     .          .         4   0.99919    57.739
 76    8.0083     .         1.59134    86.807     .         0.75372     .        -0.13206    4   0.99916    60.100
 77    8.4682    2.05033     .        101.667     .         0.17254     .        -0.01219    4   0.99906    67.792
 78    8.5738    2.02313     .         96.282     .         0.15219   -0.00821     .         4   0.99904    69.619
 79    8.5829    2.11868   -0.10055    95.059     .         0.11151     .          .         4   0.99904    69.778
 80    8.6398    2.40858   -0.38289    93.546     .          .         0.02235     .         4   0.99903    70.772
 81    8.7362    0.90731     .            .      -0.81164    0.65912    0.03028     .         4   0.99900    72.472
 82    8.8741    2.47980   -0.37165    97.710     .          .          .         0.02209    4   0.99897    74.937
 83    8.9357     .         0.32693    38.691   -0.85519    0.84683     .          .         4   0.99896    76.051
 84    8.9704    2.32136   -0.12488   102.120    0.12527     .          .          .         4   0.99895    76.683
 85    9.0220    2.18864     .         99.234    0.17062     .          .        -0.00821    4   0.99894    77.624
 86    9.0409    0.98362     .            .      -0.82193    0.67852     .         0.02967    4   0.99893    77.972
 87    9.0603    0.65045    0.35580      .      -0.71962    0.73698     .          .         4   0.99893    78.327
 88    9.0783    2.10412     .         90.339    0.13440     .        -0.00242     .         4   0.99892    78.660
 89    9.1702     .         0.85749      .      -0.62871    0.85514     .        -0.03973    4   0.99890    80.361
 90    9.1739     .          .         31.568   -0.99348    0.82962    0.02848     .         4   0.99890    80.431
 91    9.2902     .         1.57293    91.884     .         0.72927   -0.12330     .         4   0.99887    82.609
 92    9.3127     .         0.29737      .      -0.92576    0.85386    0.01220     .         4   0.99887    83.035
 93    9.4524     .          .         39.912   -1.00329    0.85881     .         0.02578    4   0.99883    85.696
 94    9.7502   -0.33927    1.70291      .        .         0.69963     .        -0.11596    4   0.99876    91.502
 95   10.0415    3.10263   -1.80484      .      -0.86311     .          .         0.17617    4   0.99868    97.354
 96   10.3830    1.66826   -0.04934      .        .         0.02211    0.02352     .         4   0.99859   104.434
 97   11.1264     .         1.66628    95.970    0.94032     .          .        -0.13878    4   0.99838   120.664
 98   12.1473     .         0.37131    47.553    0.17947     .        -0.00343     .         4   0.99807   144.784
 99    2.6015    0.26808     .          4.464    0.15038     .         0.77949   -0.79795    5   0.99992     3.106
100    2.6058    0.23434     .            .       0.17584   -0.02415    0.79937   -0.81754    5   0.99992     3.127
```

total protein gain predictive equations

OBS	_RMSE_	_ANGAIN_	_TCARB_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_P_	_RSQ_	_CP_
101	2.6069	0.29434	-0.07725	.	0.10690	.	0.78583	-0.79666	5	0.99992	3.132
102	2.6338	0.59788	-0.40090	.	.	-0.04351	0.78110	-0.76449	5	0.99992	3.259
103	2.6455	0.50193	-0.29188	1.731	.	.	0.76715	-0.75922	5	0.99992	3.315
104	2.6746	.	0.16511	.	0.21159	0.01136	0.80647	-0.83812	5	0.99992	3.455
105	2.6752	.	0.17235	1.213	0.23128	.	0.80947	-0.84232	5	0.99992	3.458
106	2.7375	.	.	-4.946	0.15072	-0.00883	0.83153	-0.84853	5	0.99991	3.762
107	2.7871	0.21539	.	2.803	.	0.10758	0.73826	-0.75211	5	0.99991	4.009
108	2.8722	.	0.00530	-4.302	.	0.10408	0.77826	-0.79157	5	0.99990	4.443
109	7.8854	3.21657	-2.11260	47.328	-0.91348	.	0.17789	.	5	0.99928	53.104
110	8.2581	2.85896	-2.20213	.	-1.20294	0.13957	0.20118	.	5	0.99921	58.534
111	8.2916	1.42538	.	70.278	-0.55824	0.54754	0.00656	.	5	0.99920	59.034
112	8.3277	1.47035	0.03816	76.839	-0.51282	0.54296	.	.	5	0.99919	59.576
113	8.33340	1.52444	.	78.2105	-0.51329	0.53280	.	0.00225	5	0.99919	59.6608
114	8.42433	0.57050	1.20977	91.5975	.	0.61575	.	-0.10407	5	0.99918	61.0358
115	8.45979	.	1.43241	80.5299	-0.15376	0.80277	.	-0.11531	5	0.99917	61.5759
116	9.09054	1.91306	0.10657	96.5032	.	0.19203	-0.01630	.	5	0.99904	71.5642
117	9.28858	2.94913	-1.05338	87.1221	-0.35584	.	.	0.08388	5	0.99900	74.8484
118	9.30925	.	0.84752	60.3981	-0.59925	0.87957	-0.05120	.	5	0.99899	75.1953
119	9.58936	0.99098	-0.00771	.	-0.82406	0.67723	.	0.03031	5	0.99893	79.9718
120	2.76133	0.42486	-0.20066	.	0.12156	-0.05861	0.80044	-0.80213	6	0.99992	5.0200
121	2.77528	0.27429	.	4.2767	0.17889	-0.02239	0.78830	-0.80730	6	0.99992	5.0810
122	2.77754	0.31945	-0.06193	4.0801	0.11950	.	0.77679	-0.78979	6	0.99992	5.0909
123	2.81538	0.60199	-0.39903	0.6550	.	-0.04221	0.77910	-0.76274	6	0.99992	5.2580
124	2.85754	.	0.18224	1.8287	0.21744	0.01513	0.80173	-0.83514	6	0.99992	5.4468
125	8.33072	2.70242	-1.60724	50.2859	-0.91592	0.20009	0.13804	.	6	0.99930	53.7929
126	8.85778	1.03990	0.52790	81.0066	-0.35595	0.61577	.	-0.04227	6	0.99920	60.9455
127	2.97762	0.43201	-0.17963	2.9013	0.12932	-0.05380	0.79282	-0.79680	7	0.99992	7.0000

best protein predictive equations

OBS	_RMSE_	_ANGAIN_	_TCARB_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_P_	_RSQ_	_CP_
1	2.46474	.	.	.	0.14570	.	0.82240	-0.84025	3	0.99991	-0.14823
2	2.58182	.	.	.	.	0.10652	0.77300	-0.78677	3	0.99990	0.51820
3	2.86834	.	-0.24824	.	.	.	0.82713	-0.82039	3	0.99988	2.27947
4	2.46276	0.22572	.	.	0.14483	.	0.79037	-0.80790	4	0.99992	1.15671
5	2.49574	0.48189	-0.28785	.	.	.	0.77169	-0.76378	4	0.99992	1.32270
6	2.52297	.	0.16173	.	0.22455	.	0.81151	-0.84318	4	0.99992	1.46142
7	2.58171	.	.	-4.7880	0.13957	.	0.82761	-0.84441	4	0.99991	1.76578
8	2.59800	.	.	.	0.14895	-0.00253	0.82347	-0.84138	4	0.99991	1.85144
9	2.63147	0.18972	.	.	.	0.10495	0.74612	-0.75949	4	0.99991	2.02913
10	2.70797	.	.	-4.5044	.	0.10196	0.77980	-0.79268	4	0.99990	2.44375
11	2.71673	.	0.03728	.	.	0.12001	0.76437	-0.78085	4	0.99990	2.49196
12	2.85240	.	-0.22710	-15.3551	.	.	0.84697	-0.83994	4	0.99989	3.25892
13	2.60147	0.26808	.	4.4638	0.15038	.	0.77949	-0.79795	5	0.99992	3.10645
14	2.60583	0.23434	.	.	0.17584	-0.02415	0.79937	-0.81754	5	0.99992	3.12695
15	2.60688	0.29434	-0.07725	.	0.10690	.	0.78583	-0.79666	5	0.99992	3.13188
16	2.63378	0.59788	-0.40090	.	.	-0.04351	0.78110	-0.76449	5	0.99992	3.25906
17	2.64548	0.50193	-0.29188	1.7311	.	.	0.76715	-0.75922	5	0.99992	3.31484
18	2.67464	.	0.16511	.	0.21159	0.01136	0.80647	-0.83812	5	0.99992	3.45478
19	2.67522	.	0.17235	1.2130	0.23128	.	0.80947	-0.84232	5	0.99992	3.45758

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                                                      best protein predictive equations

OBS    _RMSE_    _ANGAIN_     _TCARB_        _RQ_     _CO2_        _O2_     _MECON_    _MENCON_    _P_     _RSQ_        _CP_

 20    2.73750        .            .        -4.9464    0.15072    -0.00883    0.83153    -0.84853     5     0.99991     3.76175
 21    2.78715    0.21539          .         2.8031     .          0.10758    0.73826    -0.75211     5     0.99991     4.00926
 22    2.87216        .        0.00530      -4.3016     .          0.10408    0.77826    -0.79157     5     0.99990     4.44337
 23    2.76133    0.42486     -0.20066        .        0.12156    -0.05861    0.80044    -0.80213     6     0.99992     5.01999
 24    2.77528    0.27429          .         4.2767    0.17889    -0.02239    0.78830    -0.80730     6     0.99992     5.08097
 25    2.77754    0.31945     -0.06193       4.0801    0.11950      .         0.77679    -0.78979     6     0.99992     5.09086
 26    2.81538    0.60199     -0.39903       0.6550     .         -0.04221    0.77910    -0.76274     6     0.99992     5.25799
 27    2.85754        .        0.18224       1.8287    0.21744     0.01513    0.80173    -0.83514     6     0.99992     5.44679
 28    2.97762    0.43201     -0.17963       2.9013    0.12932    -0.05380    0.79282    -0.79680     7     0.99992     7.00000
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                                                 total fat gain predictive equations

OBS    _RMSE_   _ANGAIN_    _CGAIN_       _RQ_      _CO2_       _O2_    _MECON_   _MENCON_    _EGAIN_    _COMPP_  _P_     _RSQ_      _CP_

  1   15.4818     .          .            .        .          .          .          .         0.04882     .         1   0.98370    320.24
  2   16.1870     .         0.56063       .        .          .          .          .          .          .         1   0.98218    351.10
  3   21.9341     .          .            .        .          .          .         0.01731     .          .         1   0.96728    653.87
  4   22.0427     .          .            .        .          .         0.01659     .          .          .         1   0.96696    660.47
  5   22.1555     .          .         144.350     .          .          .          .          .          .         1   0.96662    667.36
  6   23.2445     .          .            .       0.14978     .          .          .          .          .         1   0.96326    735.68
  7   24.0410     .          .            .        .         0.12356     .          .          .          .         1   0.96069    787.74
  8   25.7033     .          .            .        .          .          .          .          .         0.49451    1   0.95507    902.01
  9   30.6924    3.24495     .            .        .          .          .          .          .          .         1   0.93594   1290.85
 10    6.6058     .          .            .        .          .          .          .         0.11220   -0.65427    2   0.99728     46.28
 11    7.7074     .         1.34447       .        .          .          .          .          .        -0.70372    2   0.99630     66.25
 12    8.9541     .          .            .        .          .        -0.02899     .         0.13324     .         2   0.99500     92.57
 13    9.2249     .          .            .        .          .          .        -0.03005    0.13271     .         2   0.99470     98.80
 14    9.6574     .        -8.01591       .        .          .          .          .         0.74628     .         2   0.99419    109.15
 15    9.6932     .          .            .        .        -0.15766     .          .         0.11017     .         2   0.99414    110.03
 16   10.2850     .         1.60355       .        .          .        -0.03115     .          .          .         2   0.99341    125.00
 17   10.5786     .         1.59248       .        .          .          .        -0.03216     .          .         2   0.99302    132.76
 18   10.7753     .          .            .      -0.18746     .          .          .         0.10910     .         2   0.99276    138.08
 19   11.0586   -2.13078     .            .        .          .          .          .         0.07975     .         2   0.99238    145.92
 20   11.0784     .         1.28888       .        .        -0.16278     .          .          .          .         2   0.99235    146.48
 21   11.7023   -2.28320    0.94182       .        .          .          .          .          .          .         2   0.99146    164.48
 22   12.2219     .         1.26079       .      -0.18941     .          .          .          .          .         2   0.99069    180.23
 23   13.5368     .          .        -129.430     .          .          .          .         0.09207     .         2   0.98858    223.14
 24   14.6127     .         1.06292   -130.739     .          .          .          .          .          .         2   0.98669    261.50
 25   15.9829     .          .            .       2.65559   -2.06991     .          .          .          .         2   0.98408    314.61
 26   18.0205     .          .            .        .        -0.52417     .         0.09047     .          .         2   0.97976    402.38
 27   18.1568     .          .            .        .          .         0.05822     .          .        -1.25021    2   0.97945    408.62
 28   18.2797     .          .            .        .          .          .         0.05801     .        -1.17123    2   0.97917    414.30
 29   18.7620   -3.35722     .            .        .          .          .         0.03483     .          .         2   0.97806    436.93
 30   18.8587   -3.40637     .            .        .          .         0.03363     .          .          .         2   0.97783    441.54
 31   18.8708     .          .            .        .        -0.48350    0.08126     .          .          .         2   0.97780    442.12
 32   20.3904     .          .            .        .          .        -0.70272    0.75062     .          .         2   0.97408    517.70
 33   21.3108     .          .            .      -0.39120     .          .         0.06241     .          .         2   0.97169    566.32
 34   21.8340     .          .            .      -0.33047     .         0.05310     .          .          .         2   0.97028    594.91
 35   22.4992   -2.18084     .            .       0.24840     .          .          .          .          .         2   0.96844    632.27
 36   22.5102   -1.01022     .         188.131     .          .          .          .          .          .         2   0.96841    632.90
 37   22.5201     .          .          63.811     .          .          .         0.00968     .          .         2   0.96838    633.47
 38   22.5928     .          .          67.866     .          .         0.00881     .          .          .         2   0.96818    637.62
 39   22.7000     .          .         210.000     .          .          .          .          .        -0.22697    2   0.96788    643.77
 40   22.8911     .          .         101.852    0.04436     .          .          .          .          .         2   0.96733    654.81
 41   23.0887     .          .         124.822     .         0.01684     .          .          .          .         2   0.96677    666.32
 42   23.5082     .          .            .       0.28107     .          .          .          .        -0.43599    2   0.96555    691.08
 43   23.6788   -2.06539     .            .        .         0.20073     .          .          .          .         2   0.96505    701.27
 44   24.7927     .          .            .        .         0.20122     .          .          .        -0.31214    2   0.96168    769.67
 45   25.2777   -2.76807     .            .        .          .          .          .          .         0.91053    2   0.96017    800.44
 46    4.8238     .          .            .       1.37157   -1.22718     .          .         0.08535     .         3   0.99868     19.80
 47    5.3886     .         0.98462       .       1.53082   -1.35962     .          .          .          .         3   0.99835     26.44
 48    5.4555     .        -3.41194       .        .          .          .          .         0.39307   -0.48902    3   0.99831     27.28
 49    6.7980     .          .            .        .        -0.02773     .          .         0.11489   -0.57065    3   0.99738     46.22
 50    6.8365    0.35542     .            .        .          .          .          .         0.11413   -0.72744    3   0.99735     46.83
```

total fat gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_EGAIN_	_COMPP_	_P_	_RSQ_	_CP_
51	6.8641	.	-5.23273	.	.	-0.10243	.	.	0.54398	.	3	0.99733	47.26
52	6.8805	.	.	.	.	.	.	-0.00361	0.11629	-0.59243	3	0.99732	47.52
53	6.8814	.	.	.	.	.	-0.00360	.	0.11630	-0.58849	3	0.99732	47.53
54	6.8953	.	.	.	-0.01632	.	.	.	0.11389	-0.61751	3	0.99731	47.75
55	6.9052	.	.	-9.571	.	.	.	.	0.11380	-0.63776	3	0.99730	47.91
56	7.2602	.	.	.	.	.	-0.42001	0.41125	0.12425	.	3	0.99701	53.70
57	7.3410	.	-5.76949	.	-0.11788	.	.	.	0.58873	.	3	0.99695	55.063
58	7.4489	.	-4.47768	.	.	.	-0.01872	.	0.49294	.	3	0.99686	56.901
59	7.5927	.	-4.64518	.	.	.	.	-0.01901	0.50607	.	3	0.99673	59.391
60	8.0145	.	1.36991	.	.	-0.02183	.	.	.	-0.63889	3	0.99636	66.972
61	8.0427	.	1.37343	-13.949	.	.	.	.	.	-0.68160	3	0.99633	67.493
62	8.0582	.	1.38472	.	.	.	-0.00289	.	.	-0.65291	3	0.99632	67.781
63	8.0583	.	1.38406	.	.	.	.	-0.00287	.	-0.65669	3	0.99632	67.783
64	8.0779	0.09474	1.35033	.	.	.	.	.	.	-0.72318	3	0.99630	68.147
65	8.0798	.	1.35176	.	-0.00590	.	.	.	.	-0.69067	3	0.99630	68.183
66	8.3165	.	1.49514	.	.	.	-0.47851	0.47020	.	.	3	0.99608	72.652
67	8.7825	.	.	-51.848	.	.	-0.02558	.	0.14066	.	3	0.99563	81.828
68	8.9451	.	.	-71.954	.	-0.13670	.	.	0.12606	.	3	0.99547	85.149
69	8.9753	.	.	-55.893	.	.	.	-0.02632	0.14096	.	3	0.99543	85.772
70	9.0282	.	.	.	0.12478	.	-0.04543	.	0.14101	.	3	0.99538	86.869
71	9.2813	-0.42848	.	.	.	.	-0.02481	.	0.12730	.	3	0.99512	92.205
72	9.3241	-0.97387	.	.	.	-0.11183	.	.	0.10648	.	3	0.99507	93.123
73	9.3857	.	.	.	0.11984	.	.	-0.04674	0.14075	.	3	0.99501	94.448
74	9.3871	.	.	.	.	0.01233	-0.03109	.	0.13458	.	3	0.99501	94.480
75	9.4468	-0.91283	-5.75282	.	.	.	.	.	0.56262	.	3	0.99494	95.774
76	9.4904	-0.55114	.	.	.	.	.	-0.02447	0.12511	.	3	0.99490	96.725
77	9.6706	.	.	.	.	-0.01395	.	-0.02754	0.13112	.	3	0.99470	100.702
78	9.7875	.	.	-82.876	-0.16029	.	.	.	0.12806	.	3	0.99457	103.321
79	9.9373	.	-7.22931	-33.089	.	.	.	.	0.68890	.	3	0.99440	106.724
80	10.0130	-1.21760	.	.	-0.11709	.	.	.	0.10414	.	3	0.99432	108.463
81	10.0478	.	1.72427	-62.066	.	.	-0.02763	.	.	.	3	0.99428	109.267
82	10.1570	.	1.75927	.	0.18100	.	-0.05578	.	.	.	3	0.99415	111.808
83	10.1634	.	.	.	2.16448	-2.15341	.	0.06832	.	.	3	0.99415	111.958
84	10.2579	.	1.72612	-66.417	.	.	.	-0.02837	.	.	3	0.99404	114.181
85	10.2838	-1.79412	.	-79.648	.	.	.	.	0.10148	.	3	0.99401	114.793
86	10.3128	.	.	.	2.26446	-2.22029	0.06337	.	.	.	3	0.99397	115.481
87	10.3320	.	1.51516	-81.307	.	-0.14354	.	.	.	.	3	0.99395	115.937
88	10.3769	-1.24639	1.24497	.	.	-0.10645	.	.	.	.	3	0.99390	117.009
89	10.4320	-0.79816	1.47498	.	.	.	-0.02333	.	.	.	3	0.99383	118.329
90	10.5791	.	1.75500	.	0.17697	.	.	-0.05761	.	.	3	0.99366	121.888
91	10.6157	-0.91779	1.44674	.	.	.	.	-0.02284	.	.	3	0.99361	122.783
92	10.7599	.	1.65428	.	.	0.03584	-0.03745	.	.	.	3	0.99344	126.331
93	10.9193	-1.99611	1.22226	-85.471	.	.	.	.	.	.	3	0.99324	130.312
94	11.0363	-1.50140	1.20739	.	-0.10716	.	.	.	.	.	3	0.99310	133.268
95	11.0949	.	1.59562	.	.	0.00213	.	-0.03255	.	.	3	0.99302	134.762
96	11.2561	.	1.52928	-92.665	-0.16574	.	.	.	.	.	3	0.99282	138.913
97	12.8904	-3.36552	.	.	.	-0.52529	.	0.10819	.	.	3	0.99058	184.359
98	13.2360	.	.	124.026	2.65121	-2.17234	.	.	.	.	3	0.99007	194.758
99	13.5932	-3.54047	.	.	.	-0.50258	0.10152	.	.	.	3	0.98953	205.793
100	14.0253	.	.	.	.	-0.57390	-0.81778	0.95079	.	.	3	0.98885	219.537

total fat gain predictive equations

OBS	_RMSE_	_ANGAIN_	_CGAIN_	_RQ_	_CO2_	_O2_	_MECON_	_MENCON_	_EGAIN_	_COMPP_	_P_	_RSQ_	_CP_
101	14.1058	.	.	.	.	-0.46306	.	0.11762	.	-1.02684	3	0.98872	222.147
102	14.1579	.	.	.	.	-0.44645	0.11520	.	.	-1.16803	3	0.98864	223.842
103	15.6489	.	.	.	3.07062	-2.53918	.	.	.	0.50826	3	0.98612	275.022
104	16.2050	-3.79684	.	.	-0.50166	.	.	0.09497	.	.	3	0.98512	295.424
105	16.3135	.	.	.	-0.42805	.	0.10939	.	.	-1.36663	3	0.98492	299.485
106	16.3282	.	.	.	-0.44727	.	.	0.11191	.	-1.23850	3	0.98489	300.040
107	16.7263	-0.28265	.	.	2.59584	-2.01000	.	.	.	.	3	0.98414	315.193
108	16.7732	.	.	.	-0.62484	.	-1.00614	1.13929	.	.	3	0.98406	317.004
109	16.7831	-3.90196	.	.	-0.45989	.	0.08691	.	.	.	3	0.98404	317.385
110	17.1066	.	.	.	.	.	1.73614	-1.68165	.	-3.24468	3	0.98342	330.010
111	17.2325	.	.	121.364	.	.	0.04943	.	.	-1.40386	3	0.98317	334.989
112	17.2973	.	.	123.504	.	.	.	0.04920	.	-1.34275	3	0.98304	337.566
113	17.7844	-2.00468	.	.	.	.	0.05568	.	.	-0.87274	3	0.98208	357.248
114	17.9160	-2.00965	.	.	.	.	.	0.05545	.	-0.79589	3	0.98181	362.656
115	18.7228	.	.	-41.901	.	-0.57047	.	0.10194	.	.	3	0.98013	396.700
116	19.2067	-2.70338	.	.	.	.	-0.32412	0.36965	.	.	3	0.97909	417.838
117	19.2278	.	.	146.813	.	.	-0.95389	0.99517	.	.	3	0.97905	418.770
118	19.6135	-3.27532	.	23.493	.	.	.	0.03160	.	.	3	0.97820	436.022
119	19.6692	.	.	-36.534	.	-0.52507	0.09100	.	.	.	3	0.97807	438.545
120	19.7246	-3.32014	.	22.056	.	.	0.03067	.	.	.	3	0.97795	441.055
121	20.4519	.	.	193.292	0.25314	.	.	.	.	-1.00759	3	0.97630	474.709
122	21.6059	.	.	202.417	.	0.18659	.	.	.	-0.94891	3	0.97354	530.601
123	21.8550	-2.26745	.	106.946	0.14162	.	.	.	.	.	3	0.97293	543.069
124	22.3509	.	.	-0.019	-0.39123	.	.	0.06242	.	.	3	0.97169	568.317
125	22.5723	-2.06635	.	124.864	.	0.09401	.	.	.	.	3	0.97113	579.772
126	22.8835	.	.	14.622	-0.30845	.	0.04899	.	.	.	3	0.97032	596.061
127	23.5954	-2.12243	.	.	0.25402	.	.	.	.	-0.02743	3	0.96845	634.164
128	23.6089	-1.00310	.	188.484	.	.	.	.	.	-0.00229	3	0.96841	634.899
129	24.7944	-2.31755	.	.	.	0.17722	.	.	.	0.13240	3	0.96516	700.984
130	4.4039	.	.	.	1.06620	-0.93529	.	.	0.09283	-0.23613	4	0.99901	15.102
131	4.5494	.	-1.99269	.	1.08429	-0.98214	.	.	0.25575	.	4	0.99894	16.452
132	4.7672	1.04992	-4.45579	.	.	.	.	.	0.48469	-0.65463	4	0.99884	18.555
133	4.9405	-0.29074	.	.	1.30993	-1.16544	.	.	0.08536	.	4	0.99876	20.299
134	4.9732	.	.	-16.655	1.29634	-1.16367	.	.	0.09039	.	4	0.99874	20.635
135	5.0719	.	1.07385	.	1.23410	-1.07501	.	.	.	-0.23855	4	0.99869	21.662
136	5.0730	.	.	.	1.34943	-1.19430	-0.00286	.	0.08799	.	4	0.99869	21.673
137	5.0825	.	.	.	1.36366	-1.21397	.	-0.00135	0.08652	.	4	0.99868	21.773
138	5.3961	-0.42912	0.98838	.	1.43581	-1.26595	.	.	.	.	4	0.99851	25.180
139	5.5017	.	-3.48571	.	.	-0.03299	.	.	0.40234	-0.38598	4	0.99846	26.373
140	5.5581	.	1.05180	-18.706	1.45474	-1.29571	.	.	.	.	4	0.99842	27.019
141	5.6109	.	-3.52723	.	-0.02912	.	.	.	0.40556	-0.41784	4	0.99839	27.631
142	5.6417	.	1.04806	.	1.49383	-1.30021	-0.00575	.	.	.	4	0.99838	27.989
143	5.6602	.	1.03053	.	1.51029	-1.32108	.	-0.00444	.	.	4	0.99837	28.207
144	5.6996	.	-3.59020	12.869	.	.	.	.	0.40559	-0.50259	4	0.99834	28.670
145	5.7493	.	-3.39686	.	.	.	.	-0.00051	0.39241	-0.48098	4	0.99831	29.260
146	5.7501	.	-3.40255	.	.	.	-0.00030	.	0.39264	-0.48391	4	0.99831	29.270
147	6.5745	.	-3.15117	.	.	.	-0.31130	0.30452	0.37972	.	4	0.99780	39.801
148	6.9199	.	-6.35710	.	.	-0.20845	.	0.02259	0.62001	.	4	0.99756	44.632
149	7.0651	0.35915	.	.	.	-0.02794	.	.	0.11686	-0.64397	4	0.99745	46.736
150	7.0732	.	-4.68903	-24.456	.	-0.10105	.	.	0.50430	.	4	0.99745	46.855

VITA

Kevin Ray McDonald

Candidate for the degree of

Master of Science

Thesis: BROILER PERFORMANCE: AN EVALUATION OF METABOLIC CONSIDERATIONS RELATED TO STRESS TOLERANCE AND TISSUE ACCRETION METHODOLOGY

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