OPTIMUM ANAEROBIC DIGESTER LOADING RATE FOR MAXIMUM METHANE GAS PRODUCTION FROM SWINE MANURE

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FROM SWINE MANURE

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PREFACE

This study was concerned with the anaerobic digestion of swine manure. The primary objectives were to determine the optimum digester loading rate of swine manure for maximum methane gas production and to characterize the farm used to supply the manure.

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To my parents, Edward and O'Delle, and my family I dedicate this thesis.

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LIST OF SYMBOLS

ADGP = Average daily gas production (24°C), ℓ/1000 mg TS of digester

ADLR = Average daily loading rate, mg TS of digester

AGP = Adjusted gas production

ALK = Alkalinity, mg/ℓ as $CaCO_3$

AMMON = Ammonia nitrogen, mg/ℓ as NH_4^+

ANIT = Ammonia nitrogen, mg/ℓ as N

BOD = Biochemical oxygen demand

C = Carbon

$CaCO_3$ = Calcium carbonate

CH_4 = Methane

CH_3 COOH = Acetic acid

CO_2 = Carbon dioxide

COD = Chemical oxygen demand

COD MLSS = Chemical oxygen demand of mixed liquor suspended solids suspension, mg/ℓ

COD SP = Chemical oxygen demand of supernatant, mg/ℓ

DLR = Daily loading rate, mg TS/ℓ of digester

DS = Dissolved solids, mg/ℓ

DT = Detention time

GAS = Total daily gas production (24°C), mℓ/4ℓ of digester

H = Hydrogen

HAc = Acetic acid

HCO_3^- = Carbonate

H_2CO_3 = Bicarbonate

H_2O = Water

H_2S = Hydrogen sulfide

MC = Methane content, %

N = Nitrogen

NH_3 = Ammonia nitrogen

NH_4^+ = Ammonium nitrogen

$NH_4^+ - N$ = Ammonia nitrogen concentration, mg/ℓ as N

NO_3^- = Nitrate

O = Oxygen

OH = Hydroxide

S = Sulfur

SS = Suspended solids, mg/ℓ

SO_4^{2-} = Sulfate

TEMP = Temperature, °C

Θ_C^M = Minimum mean cell residence time, days

TOC = Total organic carbon

TS = Total solids, mg/ℓ

TVS = Total volatile solids, mg/ℓ

UVA = Un-ionized volatile acids

VA = Volatile acids, mg/ℓ as HAc

VDS = Volatile dissolved solids, mg/ℓ

VS = Volatile solids, mg/ℓ

VSS = Volatile suspended solids, mg/ℓ

CHAPTER I

INTRODUCTION

The Problem

The present trend in the United States swine industry is towards more concentrated production using partial or total confinement housing. Confinement housing provides producers the means to closely regulate growing conditions.

Intensive animal production currently has two major problems: (1) manure treatment and/or disposal and (2) odor abatement. Separating animal and feed production operations has reduced access, in some cases, to ample acreage for the land disposal of manure. Land disposal is further hampered because the pollution potential to ground and surface waters exists. The odor problem is mainly due to increased urban expansion in close proximity to farm production units.

Increasing energy needs coupled with the need to treat manure has renewed interest in the anaerobic digestion process. Low cost petroleum energy for fuel and agri-chemicals is no longer available. Swine utilize 4,056 kcal of the available 5,553 kcal in a 1.0 kg corn ration (dry basis) (National Academy of Sciences, 1969). Therefore, the manure excreted has chemically stored energy. The anaerobic process affords a means to partially harvest biologically the chemical energy remaining in the manure. At the same time, manure's environmentally offensive nature is reduced.

Advantages of the anaerobic process are:

1. The partial reduction and stabilization of the manure's organic content.
2. The production of a combustible gas having commercial value.
3. The reduction of odors.
4. The conservation of the raw manure's fertilizer constituents.

Disadvantages of the anaerobic process are:

1. The high initial investment for equipment.
2. The requirement of daily feeding, maintenance, and supervision.
3. The requirement for the additional treatment of digested material prior to final disposal.

The anaerobic process is applied in the United States as a domestic waste sludge treatment. Domestic waste sludge and animal manure are characteristically different. Domestic waste sludge is an aerobic biological treatment product. The aerobic process converts soluble nutrients in relatively dilute domestic wastes to biomass. The biomass is separated from the water flow and concentrated for further treatment. Anaerobic digestion is one process applied to treat the concentrated biomass.

Animal manure, in comparison, is a concentrated material having a high solids content. Manure contains compounds not readily biologically degraded such as cellulose, grain particles, and hair.

Numerous digestion studies conducted with various swine feces loading rates indicated treatability. However, similar studies feeding feces and urine combined experienced digester failure (limited methane production) due to ammonia toxicity. The ammonia toxicity was indicated by the researchers to be due to the inclusion of urine.

Gas production and system stability information is a necessity when determining the economic feasibility of treating manure anaerobically. The existing swine manure anaerobic digestion data are for studies conducted with manure from only grower and finisher buildings. Many swine farms involve all production levels, farrow to finish. The manure (feces and urine) from such a farm better represents the material to be treated in many production situations.

One treatment alternative to overcome ammonia toxicity caused by feces and urine combined is to dilute the manure prior to anaerobic digestion. However, more information is needed on the nature of the combined manure flow from a farrow to finish swine operation and on the recommended practical amount of dilution. The report discusses research to determine the needed information.

Objectives

The research objectives were:

1. To determine the swine manure dilution required to maximize methane production and minimize ammonia toxicity. The swine manure (feces and urine) was obtained from a commercial swine operation, farrowing through finishing.
2. To characterize the commercial swine farm used for the source of digester feed material.

Scope of Study

Digestion Study

The study monitored the response of completely mixed bench scale batch fed anaerobic digesters to different swine manure dilutions. Digester detention time and temperature were held constant. The feed material was obtained from a total confinement farm, including all levels of swine production farrowing through finishing.

Preliminary studies were conducted to evaluate the physical setup of the digesters and to obtain experience operating the digester and performing the required analyses. Details of the preliminary studies are not presented in this report.

The study investigated five dilutions of a manure preparation representing the farm's daily manure production. Manure collected from the farm's finishing barn was also fed to one series of digesters. Two to three replications of each loading rate were performed. The digesters were maintained for extended periods of time to obtain indications of each system's stability. The parameters monitored included pH, alkalinity, temperature, solids, COD (chemical oxygen demand), soluable NH_4^+-N (ammonia nitrogen), VA (volatile acids), and gas volume and composition.

Gas production, gas composition and system stability were evaluated to determine if an optimum loading rate existed.

Commercial Operation Characterization

The commercial operation characterization study focused on factors affecting the volume, characteristics, and treatability of the manure produced. The information compiled included farm layout, yearly production, building description, herd size, feed rations, medications, management practices, and manure collection and treatment systems. Swine manure produced at each production level, farrow to finish, was characterized. Parameters monitored included pH, COD, soluable NH_4^+-N, and solids.

Thesis Organization

The review of literature in Chapter II covers information on the fundamentals of anaerobic digestion and on the applications of anaerobic digestion to treating swine manure. A detailed description of the digestion system used in the study is presented in Chapter III. Chapter IV outlines the experimental materials and procedures used to characterize the farm and to evaluate the digestion study. Results and discussion of the farm characterization and the digestion study are included in Chapter V. Summary and conclusions of the research information compiled are presented in Chapter VI.

CHAPTER II

LITERATURE REVIEW

Fundamentals of Anaerobic Digestion

Anaerobic digestion is a complex process occurring in two stages: liquefaction or "acid" stage and gasification or "methane" stage. Both stages proceed simultaneously in a balanced system. Extracellular enzymes excreted by "acid formers" hydrolyze complex organic solids: proteins, carbohydrates, and fats, to simpler soluable compounds; peptides and amino acids; sugars and alcohols, and glycerol and fatty acids, respectively. The soluabilized compounds, except fatty acids, are fermented by the "acid formers" to violate acids: (1) acetic, (2) butyric and (3) propionic acids, primarily. The "acid formers", except for a few strict anaerobes, are falculatative bacteria. The bacteria grow readily with relatively little sensitivity to environmental changes (McKinney, 1962; McCarty, 1964a).

The "methane formers" metabolize the volatile and fatty acids to methane (CH_4) and carbon dioxide (CO_2). Unlike the "acid formers", the methanogenic bacteria are strict anaerobes. Strict anaerobes have slow growth rates and are highly sensitive to environmental changes. Methane is generated primarily by the direct cleavage of acetic acid to methane and carbon dioxide ($\overset{*}{C}H_3COOH \rightarrow \overset{*}{C}H_4 + CO_2$) and the reduction of carbon dioxide ($8[H] + CO_2 \rightarrow CH_4 + 2H_2O$). Bacteria metabolizing the principle volatile acids, acetic and propionic acids, have the slowest growth rates (minimum mean cell residence time (Θ_C^M) is two to four days) and are considered the rate limiting step in the digestion process (McCarty, 1964a; Jeris and McCarty, 1965).

The energy present in organic substrates is released by successive biological dehydrogenations of carbon chains. The hydrogen atoms thus removed are transferred to a final acceptor. The chemical transfer of the hydrogen atoms to the final acceptor releases energy for other biological activites. The anerobic process is a hydrogen acceptor (energy) limited system and as a result the bacterial populations have slow growth rates and low yields (Sawyer and McCarty, 1967; Salle, 1973; Doelle, 1975).

Anaerobic bacterial fermentations primarily utilize portions of the organic substrate as the final hydrogen acceptor. A few falcultative bacteria, however, are able to use nitrates as their final electron acceptor ($5H_2 + 2NO_3^- \rightarrow N_2 + 4H_2 + 2OH^-$). Also, the strict anaerobes, Desulforibrio and Methanobacterium, are able to use sulfates ($4H_2 + SO_4^{2-} \rightarrow S^{2-} + 4H_2O$) and carbon dioxide ($8[H] + CO_2 \rightarrow CH_4 + 2H_2O$), respectively as their final hydrogen acceptor (Sawyer and McCarty, 1967; Salle, 1973; Doelle, 1975).

The anaerobic process achieves optimum substrate conversion to methane if a constant temperature, detention time, and loading rate are maintained. A few degrees rise in temperature does not affect digestion. However, a 3°C temperature decrease will inhibit methane production without substantially affecting the acid producing bacteria, thus leading to excessive acid accumulation and possibly digestion failure. Methane bacteria are active at two temperature ranges: (1) mesophilic

(18° to 45°C, 36°C optimum) and (2) thermophilic (45° to 85°C, 54°C optimum). Digesters, to date, are usually operated in the mesophilic range, 33° to 37°C, even though thermophilic bacteria convert substrate to methane faster. Operation of digesters in the thermophilic range has not been extensive due to: (1) increased bacterial sensitivity to environmental changes, (2) the additional heat requirements, (3) a strong odorous supernatant, and (4) a problem with solids caking on some types of heat exchangers (Buswell, 1947; McKinney, 1962; McCarty, 1964b).

Detention times range between 30 and 90 days for standard rate digesters and between 10 and 30 days for high rate digesters. Complete mixing of digester contents with either mechanical or gas mixer has been in part responsible for shorter detention times. The average detention time for a high rate complete mix digester operated at 35°C is 15 days (McKinney, 1962; Metcalf and Eddy, 1972).

Digester loading rates depend on the type unit, standard or high rate, and on the composition and degradability of the feed material. Standard rate digesters are normally loaded between 480 and 1600 mg VS/ℓ/day. High rate digesters are loaded at rates between 1600 and 6400 mg VS/ℓ/day (Metcalf and Eddy, 1972).

Additional environmental requirements of the anaerobic process are anaerobic conditions, sufficient biological nutrients, suitable pH, and absences of toxic materials. Free oxygen, when present, is toxic to the methane formers and prevents the production of methane. However, once the oxygen is consumed or excluded, the bacteria are able to resume methane production (McCarty, 1964b; Salle, 1973).

The anaerobic bacteria require inorganic nutrients to maintain growth. The primary nutrients needed by the bacteria are nitrogen (11%

of cell volatile weight) and phosphorous (2% of cell volatile weight) plus essential trace elements (McCarty, 1964b).

The anaerobic process functions between pH 6.6 and 7.6 but is optimum between pH 7.0 and 7.2. Within the neutral pH range, the bicarbonate/carbonic acid system (HCO_3^-/H_2CO_3) is the major chemical system buffering pH. The equilibrium equation ($H_2CO_3 \leftrightharpoons H^+ + HCO_3^-$) indicates the system's relation to pH. The carbonic acid concentration is related to the percentage of carbon dioxide in the digester gas. Alkalinity is a measure of the digester's buffering capacity. Alkalinity levels between 2500 and 5000 mg/ℓ as calcium carbonate ($CaCO_3$) are recommended to buffer digester pH against possible rapid volatile acid production. The methanogenic bacteria are inhibited at pH 6.6 while the acid forming bacteria are not inhibited until pH 5.0. Lack of sufficient alkalinity to buffer rapid increases in volatile acids will result in a drastic pH drop, thus inhibiting the methane formers. However, alkalinities of 10000 mg/ℓ as $CaCO_3$ or greater are indicative of malfunctioning digesters (McCarty, 1964b; Sawyer and McCarty, 1967; American Public Health Association, 1971).

Alkali and alkaline earths, ammonia, sulfides, and heavy metals are toxic to the anaerobic process. The inhibitory effect of alkali and alkaline salts is normally associated with the cation rather than the anion portion of the salt. Table I lists the cations and the effect various concentrations have on the system. When compared on an equal molar concentration basis, monovalent salts are less toxic than divalent salts. The nature of salt inhibition is quite complex. The effect of combinations of the salts is even more complex due to antagonistic (reduced toxicity) and synergistic (increased toxicity) reactions among the cations. Salt toxicity treatments are the addition of chloride salts of sodium and potassium as antagonists, and dilution (McCarty and McKinney, 1961; McCarty, 1964c).

TABLE I

STIMULATORY AND INHIBITORY CONCENTRATIONS OF ALKALI AND ALKALINE-EARTH CATIONS

Cation	Stimulatory mg/ℓ	Moderately Inhibitory mg/ℓ	Strongly Inhibitory mg/ℓ
Sodium	100-200	3500-5500	8000
Potassium	200-400	2500-4500	12000
Calcium	100-200	2500-4500	8000
Magnesium	75-150	1000-1500	3000

Source: McCarty, 1964c.

Ammonia, usually formed from the degradation of proteins and urea, inhibits the anaerobic process at high concentrations. Ammonia can be present either as ammonium ion (NH_4^+) or as dissolved ammonia gas (NH_3). The equilibrium equation, $NH_4^+ \leftrightharpoons NH_3 + H^+$, indicates the relative concentrations of each form is pH dependent. At pH 7.2 or less the process inhibition is related to NH_4^+ concentration. Above pH 7.2, the NH_3 concentration is the cause of inhibition. Ammonia gas inhibits at lower concentrations than does the ammonium ion. Table II presents ranges of ammonia concentration, ion and gas combined, and the effect each range has on the anaerobic system. Recommended treatments to overcome ammonia toxicity are dilution and the removal of the source from the digester feed (Albertson, 1961; McCarty, 1964c).

TABLE II

EFFECT OF AMMONIA NITROGEN ON ANAEROBIC TREATMENT

Ammonia Nitrogen Concentration mg/ℓ	Effect on Anaerobic Treatment
50-200	Beneficial
200-1000	No adverse effect
1500-3000	Inhibitory at higher pH values
Above 3000	Toxic

Source: McCarty, 1964c.

Sulfides resulting either from direct introduction into the system as part of the waste stream or as a product of biological sulfate reduction can be toxic to the anaerobic process. Sulfides are either soluable or insoluable depending on the associated cation. Soluable sulfides are toxic to the anaerobic system. The system can tolerate soluable sulfide concentration varying from 50 to 100 mg/ℓ without acclimation and concentrations up to 200 mg/ℓ in a continuously fed digester with some acclimation. Soluable sulfide concentrations above 200 mg/ℓ are toxic. Gas scrubbing, dilution, precipitation with iron salts, or removal of the sulfate stream from the stream to be treated are recommended treatments to reduce sulfide toxicity (McCarty, 1964c).

Soluable heavy metal salts of copper, zinc, and nickel are toxic to the anaerobic system even at low concentrations. Sodium sulfide or reducable sulfate salt additions to precipitate the heavy metal is the recommended treatment to remove heavy metal toxicity (McCarty, 1964c).

Waste stabilization, COD reduction, in the anaerobic process is related directly to methane production. The CH_4/COD relationship is expressed by the formula: $CH_4 + 2O_2 \rightarrow CO_2 + 2\ H_2O$. The formula shows one mole of methane is equivalent to two moles of oxygen or 1.0 mg of stabilized COD equals 0.37 ml of methane at 20°C and 760 mm Hg pressure. Digester gas (60% CH_4/40% CO_2) has a 22.4 Joule (J)/mℓ calorific value at 20°C and 760 mm Hg pressure (McCarty, 1964a; Smith and Miner, 1975).

Waste stabilization efficiency in a completely mixed digester is equal to effluent COD divided by influent COD. Efficiencies are normally between 0.60 and 0.90 under satisfactory operating conditions. A digester operating at less than normal efficiency is considered unbalanced. Unbalanced conditions can be either temporary or prolonged in character. Temporary digester unbalances are generally due to a sudden change in temperature, loading, or feed composition. Prolonged digester unbalances are caused by the presence of toxic materials, an extreme drop in pH, or slow bacterial growth during startup. The digester will become "stuck" unless factors causing the unbalance are corrected. A stuck digester is defined as a digester whose waste stabilization efficiency is almost zero. A digester, once stuck, is difficult to restart (McCarty, 1964a).

The onset of digester unbalance is indicated by increases in volatile acids concentration and carbon dioxide percentage in gas, and decreases in pH, total gas production, and waste stabilization. Although no single parameter exclusively denotes the onset of unbalance, volatile acids concentration is the best individual parameter. The accumulation of volatile acids means the methane formers are inhibited in their conversion of volatile acids to methane and carbon dioxide. A high volatile acid concentration is the result and not the cause of unbalanced treatment. Digesters have been operated with good gas production at 20000 mg/ℓ volatile acids concentration provided pH was maintained above 6.5 (McKinney, 1962; McCarty, 1964b).

A balanced anaerobic digester produces a gas containing 25 to 35% carbon dioxide, 65 to 75% methane, and possibly small amounts of ammonia, hydrogen, sulfide, nitrogen and oxygen. An increased carbon dioxide percentage results when methanogenic bacteria fail to convert the volatile acids to methane (Eckenfelder and O'Connor, 1961).

Anaerobic Digestion Applied to the Treatment of Swine Manure

Prior to 1940, American agriculture produced livestock on the open range where manure disposal was not a problem. But during the 1940's, the American farmer began to shift from the open range system to partial or total confinement animal production systems. The confinement systems produce large volumes of manure requiring treatment and/or disposal. Anaerobic digestion is one possible treatment (Shindala and Scarbrough, 1971). However, the application of anaerobic digestion to treat concentrated animal manure is relatively new and has received only limited acceptance in the United States (Metcalf and Eddy, 1972; Merrill and Merrill, 1973).

Laboratory scale anaerobic digesters have been operated at different loading rates, temperatures, and detention times to determine process response and limitations to the swine manure substrate. Jeffery et al. (1965), using feces and loading digesters at three rates--2500, 2800, and 3100 mg volatile solids (VS) per ℓ per day (mg/ℓ/day)--researched the effects of loading on the digestion process. Their digesters were operated at a 20-day detention time and 35°C, and depended on rising gas bubbles for mixing. The volatile acids concentration and pH for the digesters loaded at the two lower rates were 126 to 154 mg/ℓ as acetic acid (HAc) and 7.4, respectively. Their results indicated loadings in excess of 2800 mg VS/ℓ/day resulted in digester failure.

Cross and Duran (1970), feeding feces, investigated (using a factorial design) digester response to three temperatures (10°, 21°, and 32°C) and three loading rates (800, 1600, and 3200 mg VS/ℓ/day). Their digesters were operated at a 15-day detention time and depended on rising gas bubbles for mixing. The hogs were fed a corn and milo ration at the time feces were collected. Cross and Duran (1970) could not explicitly evaluate each digester's performance due to the short duration of run. Therefore, evaluation of the results by the researchers was restricted to the tendency of each digester towards success or failure based on solids removal performance. The digesters tending towards success were those operating with a 800 mg VS/ℓ/day loading rate at all three temperatures and a 1600 mg VS/ℓ/day loading rate at the 32°C temperature. All other temperature-loading combinations tended towards digester failure. The authors reported no gas production data.

Gramms et al. (1971), also using feces, studied factorially the effects of loading (1900 and 3800 mg VS/ℓ/day) and detention time (10 and 15 days) on the digestion process. Their digesters were maintained at 32.5°C and mixed once or twice daily. Table III shows a summary of their results. Gramms et al. (1971) concluded digesters operated at a 3800 mg VS/ℓ/day loading, 32.5°C temperature, and 10 and 15 days detention time achieved satisfactory reductions in VS and COD.

Sievers and Brune (1976) studied factorially the effects of loading rate (1120, 2240, and 4000 mg VS/ℓ/day) and feed carbon-nitrogen ratio (C/N) (2/1, 6/1, 16/1, 20/1, and 25/1 mg/mg) on the digestion process. The authors adjusted the C/N ratio of the feces fed by adding either glucose or urea. Their digesters were operated at a 15-day detention time and 35°C, and were mixed prior to and after each feeding. A rise in organic acids and a decline in buffer capacity inhibited the methane producing organisms at the high C/N ratios, 20/1 and 25/1, even though sufficient nitrogen was available for metabolism. Digesters operated at 2/1 C/N ratio failed due to ammonia toxicity. The high ammonium levels developed at the 6/1 C/N ratio tended to stabilize conditions as the digesters became highly buffered. However, gas production was inhibited at the 6/1 C/N ratio. Maximum methane production was obtained between 9/1 and 16/1 C/N ratio for all three loadings (Figure 1) and corresponded to a 55 to 60% reduction in total organic carbon (TOC). Sievers and Brune (1976) indicated the range of optimum C/N ratios narrowed as the loading rate increased. The authors also concluded un-ionized volatile acid (UVA) and ammonia (NH_3) appeared to inhibit gas production in an additive manner.

TABLE III

RESULTS SUMMARY OF THE SWINE MANURE (FECES) DIGESTION STUDY CONDUCTED BY GRAMMS ET AL. (1971)

Parameter				
Loadings:				
VS (mg/ℓ/day)	1900	1900	3800	3800
Detention time (days)	10	15	10	15
Temperature (°C)	32.5	32.5	32.5	32.5
Digester Influent:				
VS (mg/ℓ)	19200	28800	38400	57600
COD (mg/ℓ--average)	23300	35000	46600	70000
$NH_3 + NH_4^+$ - N (mg/ℓ as N)	190	285	380	570
Organic - N (mg/ℓ)	700	1050	1400	2100
Alkalinity (mg/ℓ as $CaCO_3$)	1670	2500	3340	5000
pH	7.0	6.9	7.0	6.9
% VS	83.4	83.4	83.4	83.4
Operating Conditions:				
Gas (mℓ/ℓ of digester/day)	500	780	1560	1630
CO_2/CH_4	0.64	0.67	0.72	0.69
VA (mg/ℓ as HAc)	1090	200	1080	290
Alkalinity (mg/ℓ as $CACO_3$)	2960	4440	6330	7130
pH	6.76	7.14	7.17	7.27
Digester Effluent:				
VS reduction, %	51.6 ± 3.7	60.9 ± 2.9	49.2 ± 2.6	59.2 ± 2.3
COD reduction, %	33.7 ± 9.9	54.6 ± 6.3	35.5 ± 4.1	41.8 ± 10.5
Gas (mℓ/mg VS removed/day)	490	690	830	760
($NH_3 + NH_4^+$) - N (mg/ℓ as N)	450	594	730	1010
Organic - N (mg/ℓ as N)	440	674	1000	1244

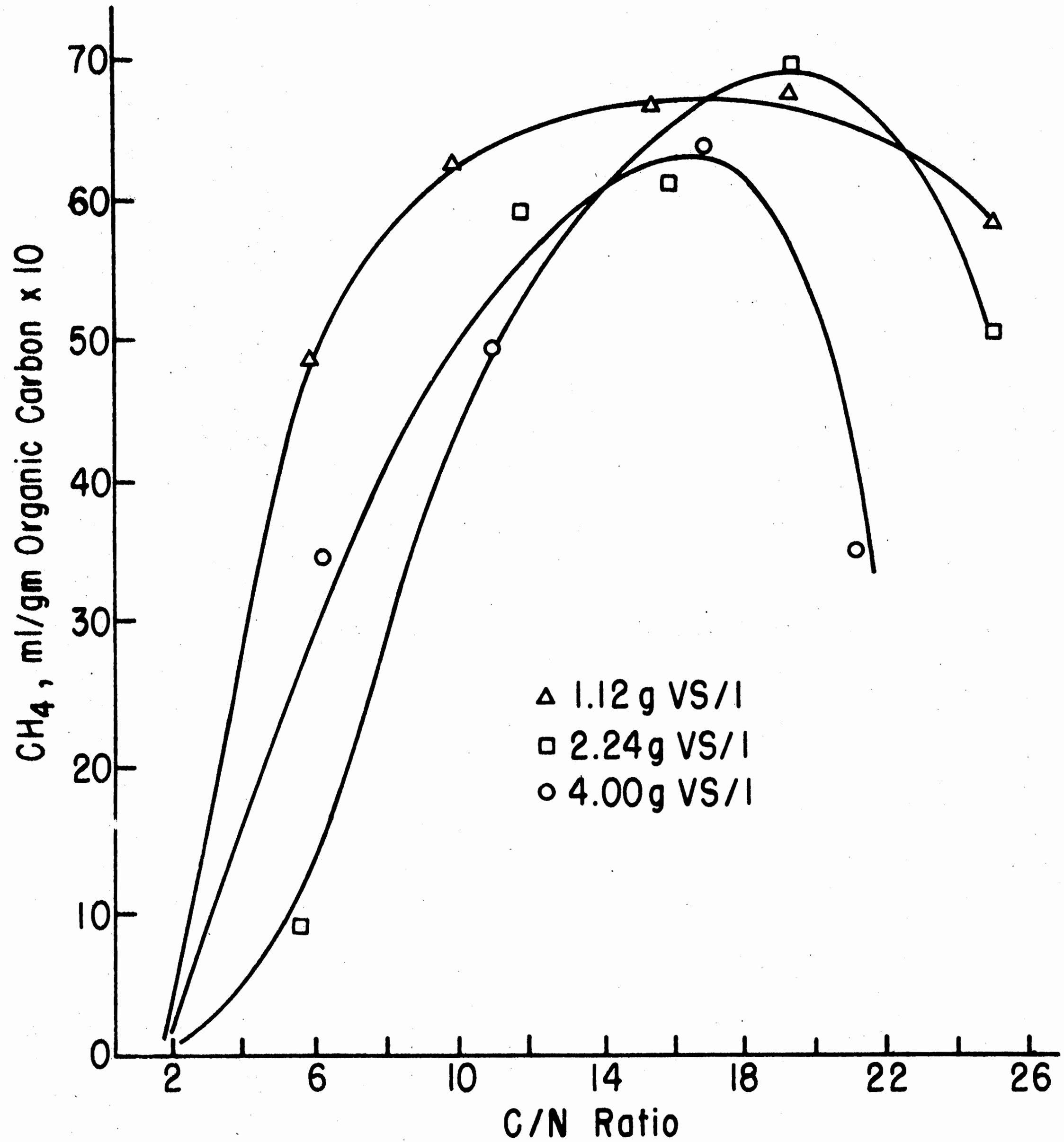

Figure 1. Methane Gas Production (0°C and 1 atm Pressure) for Various C/N Ratios

Taiganides (1963), feeding feces and urine, investigated the effects of loading rate and detention time on the anaerobic digestion process. He operated the digesters at 34°C and mixed contents continuously. Results of the study are summarized in Table IV. Taiganides (1963) indicated digesters operated at loading rates of 400, 960, and 1200 mg VS/ℓ/day and detention times of 48, 25 and 22 days, respectively, exhibited satisfactory performance. However, the other three loading rate-detention time combinations resulted ultimately in digester failure.

Schmid and Lipper (1969) studied the effects of temperature (20 and 35°C), detention time (10 and 20 days), and mixing (continuous and 15 minutes mixing each four-hour period) on the digestion process. They fed digesters with feces and urine collected from hogs fed a 17% protein ration (sorghum and soybean). Results of the study are summarized in Table V. Because the digester with periodic mixing showed no significant difference from the unit with continuous mixing at the same organic loading, the authors included only the data for the continuously mixed digester. Schmid and Lipper (1969) reported digester failure (limited methane production) at all levels due to ammonia toxicity, possibly resulting from inclusion of urine. They concluded manure liquification would occur satisfactorily at ambient temperatures and short detention time.

Hobson and Shaw (1973), also feeding feces and urine, studied the effects of starting procedures (seeded versus unseeded) and loading rate on digester response. Their digesters were operated at a 35°C and a 14-day detention time except for the lowest loading rate when they used a 19-day detention time. The starting procedures tested by the researchers included initiation of digestion with seed from a domestic sludge

TABLE IV

RESULTS SUMMARY OF THE SWINE MANURE (FECES AND URINE) DIGESTION STUDY PERFORMED BY TAIGANIDES (1963)

Parameter						
Loadings:						
VS (mg/ℓ/day)	400	960	1200	1800	1900	1900
Detention time (days)	48	25	22	37	25	40
Duration (days)	40	30	110	35	40	20
Temperature (°C)	34	34	34	34	34	34
Operating Conditions:						
CO_2/CH_4	1.0	---	0.69	0.69	0.69	0.69
VA (mg/ℓ as HAc)	1200	800	1500	800 rising to 3400	800 rising to 3200	800 rising to 2800
Alkalinity (mg/ℓ as $CaCO_3$)	6800	6800	6800	6800	6800	6800
pH	7.4	7.2	7.4	7.4	7.4	7.4
Digester Effluent:						
VS reduction, %	43	41	47	52	54	54
Gas (mℓ/mg VS removed)	1.47	1.41	1.23	1.09	1.01	1.05
$(NH_3 + NH_4^+)$ - N (mg/ℓ as N)	1200	900	1300	1200 rising to 2000	1000 rising to 1800	1400 rising to 1800

TABLE V

RESULTS SUMMARY OF THE SWINE MANURE (FECES AND URINE) DIGESTION STUDY PERFORMED BY SCHMID AND LIPPER (1969)

Parameter				
Loadings:				
VS (mg/ℓ/day)	3200	6400	3200	6400
Detention time (days)	20	10	20	10
Temperature (°C)	35	35	20	20
Operating Conditions:				
Gas (mℓ/ℓ digester/day)	--	--	--	--
CO_2/CH_4	2.33 rising to 5.67	2.33 rising to 5.67	5.67	5.67
VA (mg/ℓ as HAc)	16500	19000	16800	17500
Alkalinity (mg/ℓ as $CaCO_3$)	10700	11800	15000	15000
pH	6.65	6.65	6.80	6.90
Digester Effluent:				
VS reduction, %	--	--	--	20
$(NH_3 + NH_4^+) - N$	1800	1800	2200	2500

digester and initiation of digestion with swine manure alone. Table VI presents a summary of their results. Hobson and Shaw (1973) concluded digestion could be initiated successfully using either procedure tested, but they indicated the loading rate used initially when starting a digester was a critical factor. The authors reported no digester failures due to ammonia toxicity. However, they did report a decline in digester performance above a loading rate of 2600 mg total solids (TS)/ℓ/day.

Booram et al. (1975) monitored the response of an on-farm digester to a swine manure substrate. The digester had a 2.4×10^5 ℓ capacity and was operated at a 32-day hydraulic detention time. The digester was fed the combined manure flow from three production units: a 230 boar test unit, a 48 sow farrowing unit, and a 250 animal confinement unit. Table VII presents characteristics of the combined manure flow. The authors reported the actual gas production, 0.08 ℓ/ℓ of digester (maximum), was only 25% of the calculated gas production. The gas produced contained 55% methane. Booram et al. (1975) cited: (1) fluctuating temperatures between 15 and 27°C, (2) slug loading, and (3) large variations in animal population as reasons for the lower than expected gas production.

The research by Jeffery et al. (1965), Cross and Duran (1970), Gramms et al. (1971), and Sievers and Brune (1976) determined swine feces can be anaerobically digested for methane production. Gramms et al. (1971), operating digesters at a 3800 mg VS/ℓ/day loading rate, 10 and 15 days detention times, and 35°C, reported gas production between 1.5 and 1.6 ℓ/ℓ of digester. The gas produced contained 59 to 61% methane. Schmid and Lipper (1969), however, reported digesters operated under

TABLE VI

RESULTS SUMMARY OF THE SWINE MANURE (FECES AND URINE) DIGESTION STUDY CONDUCTED BY HOBSON AND SHAW (1973)

Parameter	Seeded					Unseeded				
Loading:										
TS (mg/ℓ/day)	1100	1900	2600	3300	3700	1100	1900	2600	3300	3700
Detention time (days)	19	14	14	14	14	19	14	14	14	14
Temperature (°C)	35	35	35	35	35	35	35	35	35	35
Duration (days)	140	32	35	28	35	70	28	28	28	28
Digester Influent:										
TS (mg/ℓ)	20800	26000	36400	46000	51800	20800	26000	36400	46000	51800
COD (mg/ℓ)	24300	30400	42500	54400	60500	24300	30400	42500	54400	60500
BOD (mg/ℓ)	5400	6700	9500	12100	13400	5400	6700	9500	12100	13400
Operating Conditions:										
Gas (mℓ/ℓ of digester/day)	233	453	660	680	787	287	447	733	880	933
CO_2/CH_4	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
VA (mg/ℓ as HAc)	163	216	1530	222	685	581	313	417	220	644
Alkalinity (mg/ℓ as $CaCO_3$)	5880	3320	4300	5480	6800	5490	6590	2430	5300	5950
Digester Effluent:										
TS reduction, %	13.0	--	21.0	24.9	14.1	34.0	33.0	26.0	31.3	8.3
COD reduction, %	30.0	23.0	54.0	9.1	18.0	22.0	30.0	31.0	46.0	56.7
BOD reduction, %	74.0	71.0	79.0	24.6	53.4	80.0	82.0	56.0	67.0	59.9
$(NH_3 + NH_4^+) - N$	581	731	1148	1008	1288	580	700	840	1176	1400

TABLE VII

CHARACTERISTICS OF SWINE MANURE FED TO AN ON-FARM ANAEROBIC DIGESTER REPORTED BY BOORAM ET AL. (1975)

Parameter	Range of Values
Daily flow (ℓ/day)	7560 (approximate)
pH	5.8 to 6.6
(Organic + NH_3) - N (mg/ℓ)	284 to 1374
TS (mg/ℓ)	3252 to 19184
VS (mg/ℓ)	1740 to 5608
COD (mg/ℓ)	2368 to 8581

similar conditions failed due to ammonia toxicity when fed feces and urine combined. Therefore, if swine manure (feces and urine) is to be digested for methane production, the ammonia toxicity problem must be eliminated. McCarty (1964c) recommended either the removal of the ammonia nitrogen source from the digester feed or dilution as treatment alternatives for ammonia toxicity.

Schmid et al. (1975) investigated desorption as a method to remove toxic ammonia from the anaerobic environment, thereby enhancing the treatability of swine manure (feces and urine) at the higher solids loading rates. The researchers calculated their desorption system could collect 6510 kg of nitrogen from a 2000 head growing and finishing operation when operated at pH 8.0 and 35°C. Their calculations assumed 50% ammonia removal and were based on equations presented by Srinath and Loehr (1974) describing desorption of ammonia from an aqueous solution. Schmid et al. (1975) reported the ammonia gas stripped would be adsorbed into a phosphoric acid solution forming ammonium phosphate, a valuable fertilizer. Due to mechanical problems and short duration of test runs, however, the researchers were unable to evaluate economic feasibility of the system.

The research by Taiganides (1963) and Hobson and Shaw (1973) demonstrated dilution was an effective treatment alternative for eliminating the ammonia toxicity problems reported by Schmid and Lipper (1969). Taiganides (1963) and Hobson and Shaw (1973) indicated manure (feces and urine) can be digested for methane production if digesters are fed at loading rates lower than recommended for feces alone. Hobson and Shaw (1973), operating digesters at 3700 mg TS/ℓ/day (approximately 3100 mg VS/ℓ/day) loading rate, a 14-day detention time, and 35°C, reported gas production between 0.8 and 0.9 ℓ/ℓ of digester. The gas produced contained 60% methane. The researchers, however, stated digester performance was maximum when digesters were operated at a 2600 mg TS/ℓ/day (approximately 2200 mg VS/ℓ/day) loading rate.

Laboratory swine manure digestion research has been conducted with manure collected solely from growing and finishing operations. Many swine operations, however, encompass the entire production spectrum from farrowing to finishing. In addition, the laboratory digesters were fed at constant loading rates. A constant loading rate is inconsistent with what is to be expected under actual on-farm operating conditions. Manure characteristics vary with manure collection methods, production facilities, and farm management practices. Knowledge of the variations occurring in the daily manure production is essential to the engineer when designing a waste treatment system, particularly a biological treatment system such as anaerobic digestion. Average daily manure production values for the various stages of swine growth are readily available in the literature, Table VIII (Muehling, 1969). Taiganides and Hazen (1966) stated the daily quantity of manure varied with the seasons of the year and the status of the animal. They reported the average weight of manure from a 45.4 kg hog will vary from 1.3 to 4.3 kg/day. Booram et al. (1975) demonstrated the adverse effects fluctuations in loading had on methane gas production. Therefore, a waste treatment system when designed must include enough flexibility to withstand variations in manure characteristics without the system failing. However, no data was found for laboratory studies where anaerobic digesters were fed manure (feces and urine) representing the daily flow from a farrow to finish swine production operation.

TABLE VIII

APPROXIMATE DAILY MANURE PRODUCTION (MEDIAN VALUE FOR UNDILUTED MANURE WITHOUT BEDDING)

	Size of Hog		Waste Production	
	Age (wk)	Weight (kg)	Liquid and Solid (ℓ)	Wet Solid Only (kg)
Pigs	6-9	18.2	1.9	1.1
	9-13	45.4	3.8	2.7
	13-18	68.2	6.4	4.0
	18-23	95.4	8.3	5.4
Sows, boars	20-52	136.4	11.3	5.4
	52+	227.3	18.9	13.6
Sow and litter			15.1	13.6

Source: Muehling, 1969.

CHAPTER III

FACILITIES

Swine Production Facilities

The commercial operation characterized includes eight buildings: office and shop, storage, sow and boar barn, farrower, nursery I, nursery II, grower, and finisher on 4.05 ha (see Figure 2 for layout). Information presented on the commercial operation is based on personal communication with herdsman Edwards (1975-1976) and personal observations.

The farm's yearly production ranges between 5500 and 6400 head, 60% for slaughter and 40% for breeding. The farm maintains an average population of 3860 head (198000 kg, live weight). All feed preparations are purchased in bulk form from local mills.

The animals are grown on aluminum slotted floors with manure collection pits located below. Animal activity and urine force manure through slotted floor to the pit. The pits were designed by the owner to be drained on a six to eight week staggered schedule to lagoons for treatment. Manure levels in the pits are controlled by standpipes (Figure 3).

Building Descriptions

Office and Shop. The office building includes an office for business transactions and production records, restroom facilities, a shop area for farm maintenance, and a small nursery. The nursery has a 54

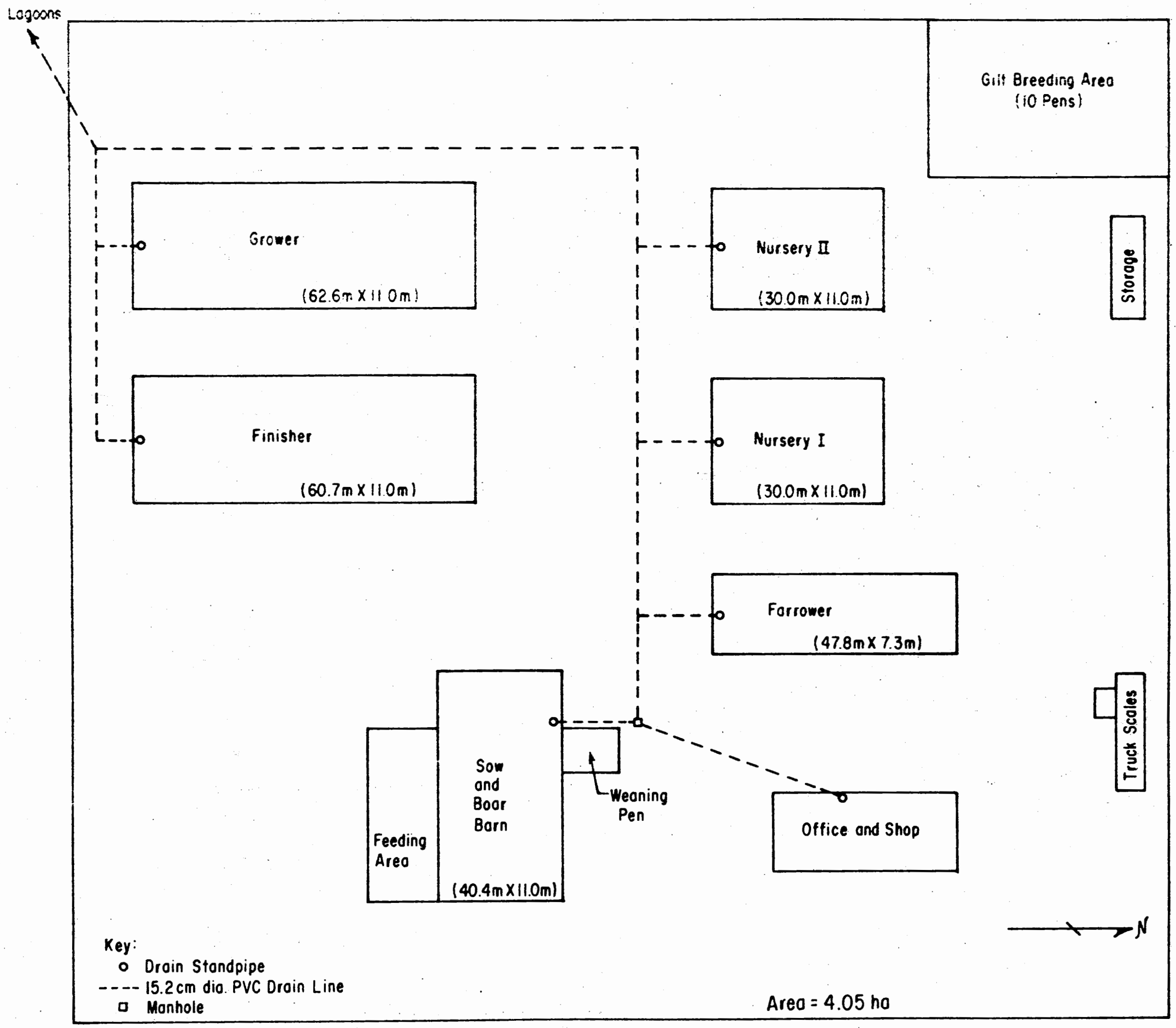

Figure 2. Farm Layout

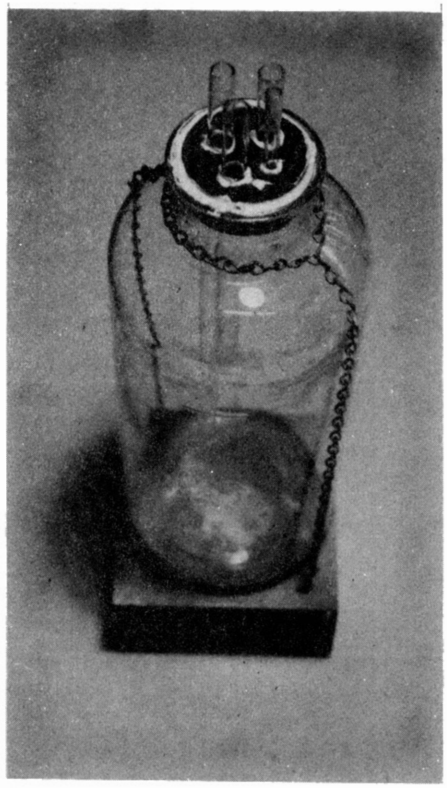

Figure 3. Standpipe to Control Measure Level Shown in Position (Typical)

head capacity and is for pigs weighing between 0.9 and 8.2 kg requiring special care.

Storage. The storage structure, an old box car, provides storage area for feed and bedding used for gestating gilts maintained on nearby dirt lots.

Sow and Boar Barn. The sow and boar barn is divided into 11 holding pens and six breeding stalls. The stalls are at the building's west end. The floor under the stalls is half slotted floor and half dirt.

The building houses 18 to 24 boars and 250 to 300 sows and gilts. The animals weigh between 159.1 and 204.5 kg. The water supply, typical of all buildings, is a gravity flow system to MonValv® watering nozzles. The animals consume, on the average, 5.4 kg per head per feeding period of a 14% protein ration (corn and soybean) containing alfalfa meal for bulk. A feeding period is two hours every other day.

The feeding area is a concrete slab adjacent to the barn on the south side. The fenced area is divided into four sections. Only animals from one holding pen occupy a feed section at a time. The slab is sloped so manure washed away by rain is collected in the pit.

A weaning pen on dirt is adjacent to the northwest corner of the barn. The pen holds an average of 16 sows for five days before the sows re-enter the barn.

Ten dirt lot pens on the farm's northwest corner confine gilts during gestation. The herdsman moves the gilts back to the sow barn one month prior to farrowing.

Farrower. The farrowing building is divided into three rooms containing 16 pens each. The building houses 48 sows and 360 nursing pigs. The average weight of the sows and pigs is 159.0 kg and 1.8 kg, respectively. The herdsman moves the sows to the farrower two to three days prior to farrowing. The sows consume 1.4 to 1.8 kg per head of a 14% protein ration (corn and soybean) twice daily. The ration includes alfalfa for bulk and the medication Furox for uterine infection control.

The herdsman, two days after farrowing, castrates, removes tails, clips needle teeth, and gives iron and combiotic (penicillin and streptimicin) shots to the pigs. The pigs remain in the farrower for two to three weeks.

The herdsman washes the farrowing rooms in rotation, one per week, in preparation for the next group of sows. The room is initially wet down using an ordinary lawn sprinkler (0.52 ℓ/s) for 8 to 12 hours. The wet down is followed by hand scrubbing of pens with an iodine solution and a high pressure spray rinse (0.11 ℓ/s). The scrub and rinse take approximately three hours to complete.

Nursery I and II. The two nurseries are identical to each other in layout and construction. Each is divided into three rooms containing 16 pens per room. The nurseries house 48 sows, 360 nursing pigs, and 500 to 600 weaned pigs. The average weight of the sows, nursing pigs, and weaned pigs is 159.0 kg, 5.0 kg, and 15.9 kg, respectively. The herdsman moves the sow and nursing pigs to the nursery during the second or third week after farrowing. The sows get the same ration that is fed in the farrower.

The pigs are weaned during the fourth to fifth week after farrowing. The weaned pigs consume 0.9 to 1.4 kg per head per day of a 22% high protein creep ration (corn and soybean). The ration includes the medication Mecadox for worm control. The pigs remain in the nursery until the tenth week.

The herdsman washes the six nursery rooms in rotation, one room per week, following the same procedures outlined for the farrower.

Grower. The grower is divided into four rooms containing 12 pens each. The building houses 1400 to 1500 animals having an average weight of 36.4 kg. The herdsman moves the pigs to the grower the tenth week after farrowing. The pigs remain in the grower until 16 weeks old. The animals consume 1.4 to 2.7 kg per head per day of 16% protein ration (corn and soybean).

Finisher. The finisher is divided into two rooms containing 12 pens each. The building houses 650 to 750 head having an average weight of 91.0 kg. The animals consume 2.7 to 3.6 kg per head per day of a 15% protein ration (corn and soybean). The herdsman moves the animals to the finisher during the sixteenth week after farrowing. The duration of the animal's confinement in the finisher varies from 26 to 36 weeks. The period of confinement is affected by market demand and market price.

Manure Treatment System

A two lagoon system retains the manure from the production facilities. The lagoons are on 2.02 ha adjacent to the southwest corner of the farm. Each lagoon has a surface area of 0.405 ha, a liquid depth of about 2.2 m, and side slopes of three horizontal to one vertical. The influent enters the system on the north side of the lagoon closest to the farm (Figure 4) through a single 15.9 cm diameter PVC pipe.

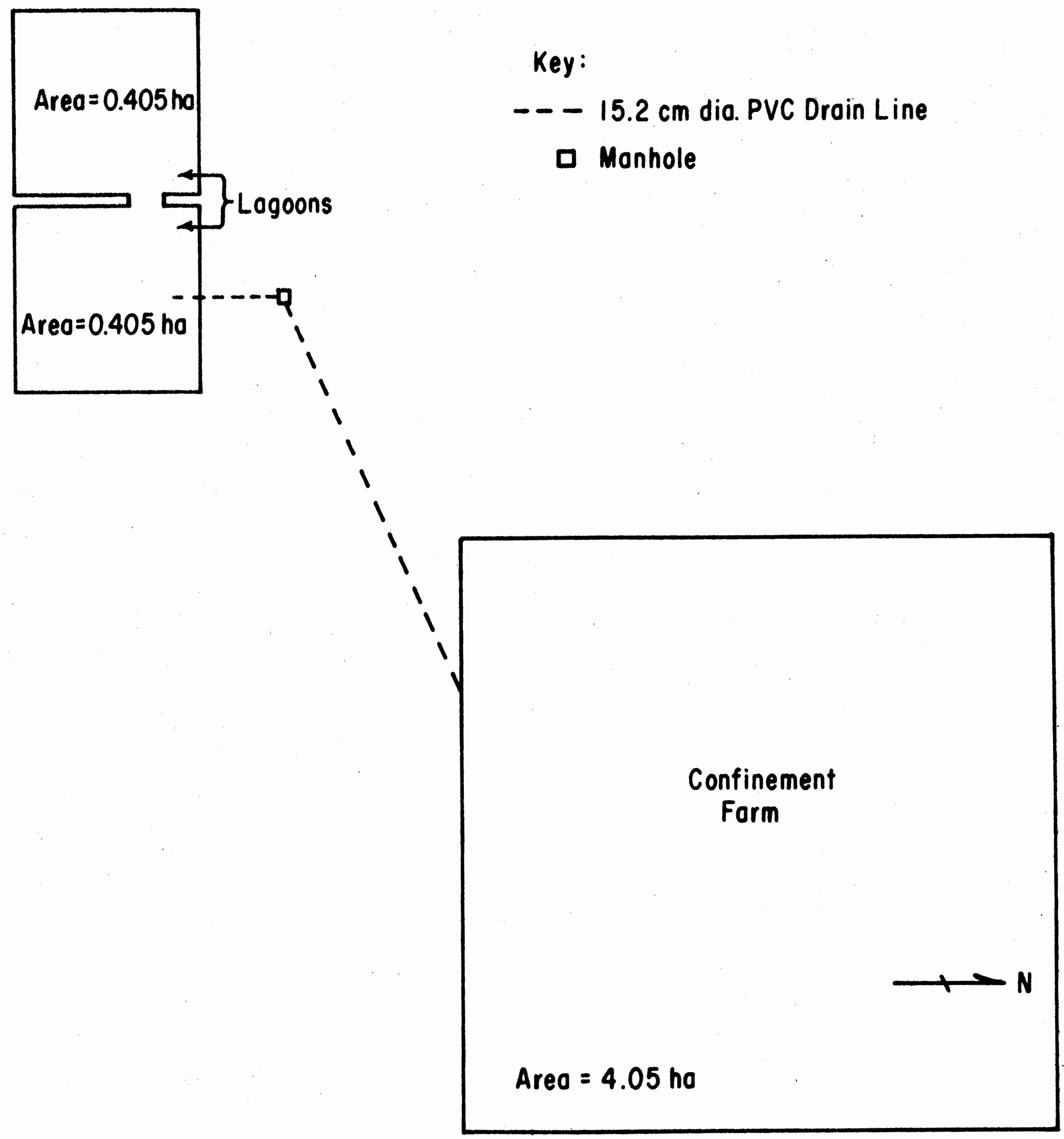

Figure 4. Lagoon System Layout

Initially, one lagoon was used for primary treatment and the second lagoon for secondary treatment. The system did not perform as intended and there was an odor problem. Therefore, the owners made a cut in the dike between the lagoons to in effect make them a single lagoon. The cut was made by a backhoe with the cut size limited to the backhoe's reach. The resulting cut was about 1.2 m deep by about 1.8 m wide. The dike separating the lagoons had a top width of approximately three meters.

Anaerobic Digestion Facilities

Six identical completely mixed bench scale, batch fed anaerobic digesters were operated simultaneously. Figure 5 presents a schematic diagram of the anaerobic digestion system used in the study. Figure 6 shows the actual anaerobic digestion system used in the study.

Digestion Chambers

The chambers were wide mouth solution bottles, 34.6 x 16.4 cm having approximately 4.3 ℓ capacity (Figure 7). The solution bottles were sealed with number 12 rubber stoppers. Four holes were made in each stopper. The holes were ports for feed inlet, gas outlet, mixing pump intake, and mixing pump return. A silicon rubber compound applied to all glass-rubber interfaces insured an air tight seal.

The feed inlet was a 14.0 cm length of 1.0 cm (ID) glass rod. The inlet dispensed the feed material above the digester's liquid level. A 10.0 cm length of 1.0 cm (ID) latex tubing was attached to the exterior end of the feed inlet. The latex tubing was a flexible coupling between the glass inlet and the funnel used when feeding. A modified 3201 Pony®

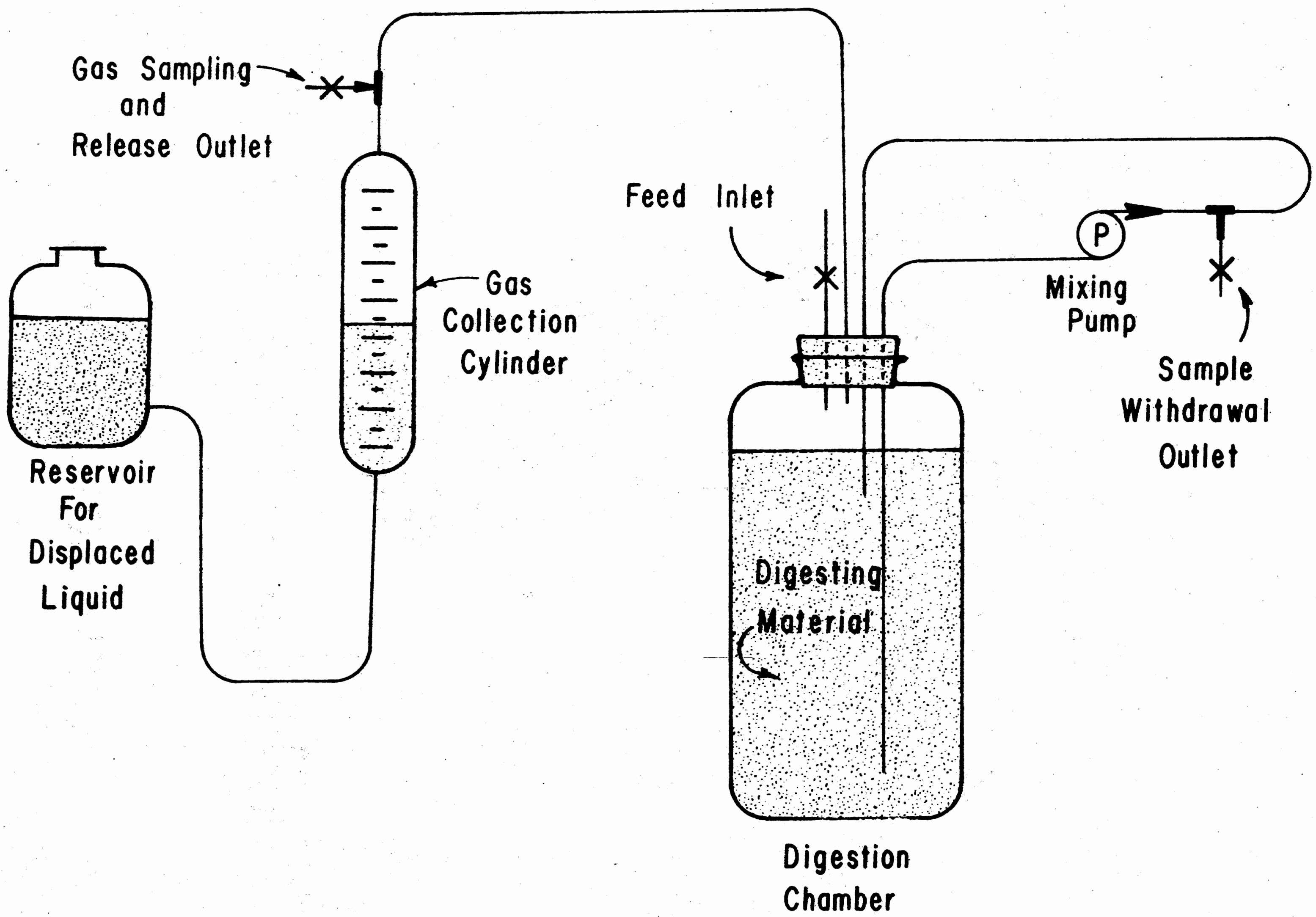

Figure 5. Schematic Drawing of Anaerobic Digestion System

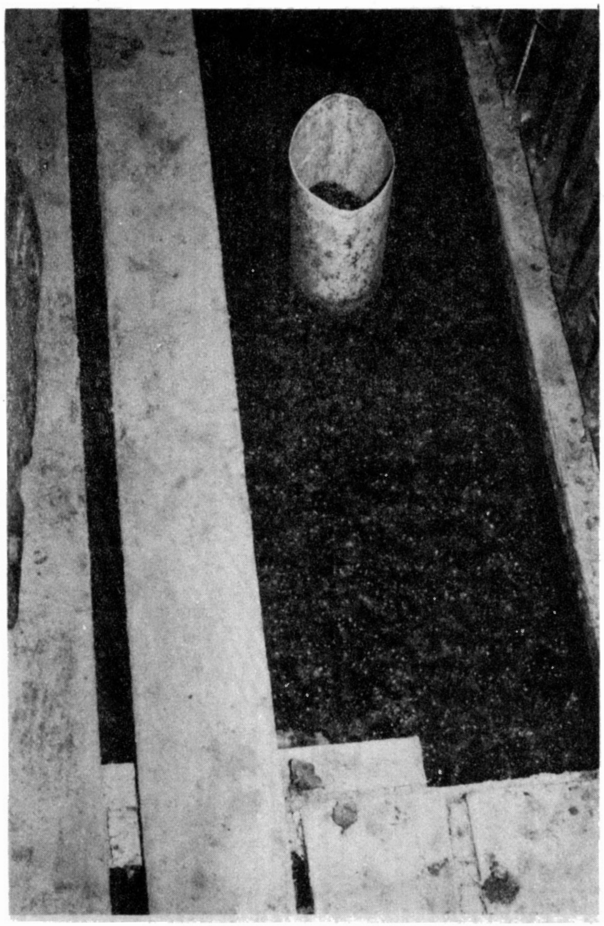

Figure 6. Anaerobic Digestion System (Digestion Chamber is Concealed by Temperature Control Bath)

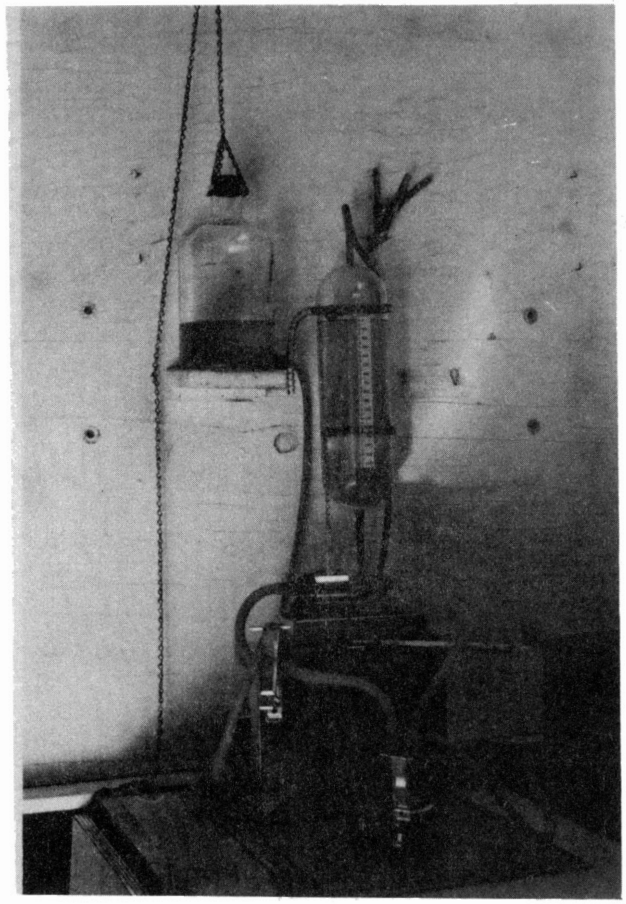

Figure 7. Digestion Chamber with Rubber Stopper in Place

clamp (Figure 8) was applied to the tubing to seal the feed inlet between feedings (Figure 8, Inset A).

The gas outlet was a 10.0 cm length of 0.55 cm (ID) glass rod. The outlet projected 1.0 cm into the digester.

The mixing pump intake was a 32.0 cm length of 1.0 cm (ID) glass rod. The pump intake extended to within 8.0 $\pm$ 1.0 cm of the digester's bottom. The pump return was a 19.0 cm length of 1.0 cm (ID) glass rod. The return extended 5.0 $\pm$ 0.5 cm below the digester's liquid level.

Gas Collection and Measurement System

Two sizes of graduated glass gas collection cylinders were used in the study. The graduated cylinders had both ends tapered and fitted with tubing outlets (Figure 9). The smaller cylinder had 0.25 ℓ capacity graduated in 10 mℓ increments. The larger cylinder had 1.6 ℓ capacity graduated in 50 mℓ increments.

The cylinders were calibrated with tap water at 24 $\pm$ 2°C. Each cylinder was filled with water. The water was released at 10 or 50 mℓ increments, depending on cylinder size, through the linear range of the cylinder. The increments were marked at the meniscus.

The volume of gas generated was measured by liquid displacement (Figure 10). Latex tubing, 0.6 cm (ID), connected the top of the gas collection cylinder to the digester's gas outlet. The expected gas volume determined collection cylinder size, 0.25 or 1.6 ℓ. The displacement liquid was a saturated sodium chloride solution containing 5% sulfuric acid and methyl orange for color.

Latex tubing, 0.6 cm (ID), connected the bottom of the collection cylinder to an aspirator bottle. The aspirator bottle was the reservoir

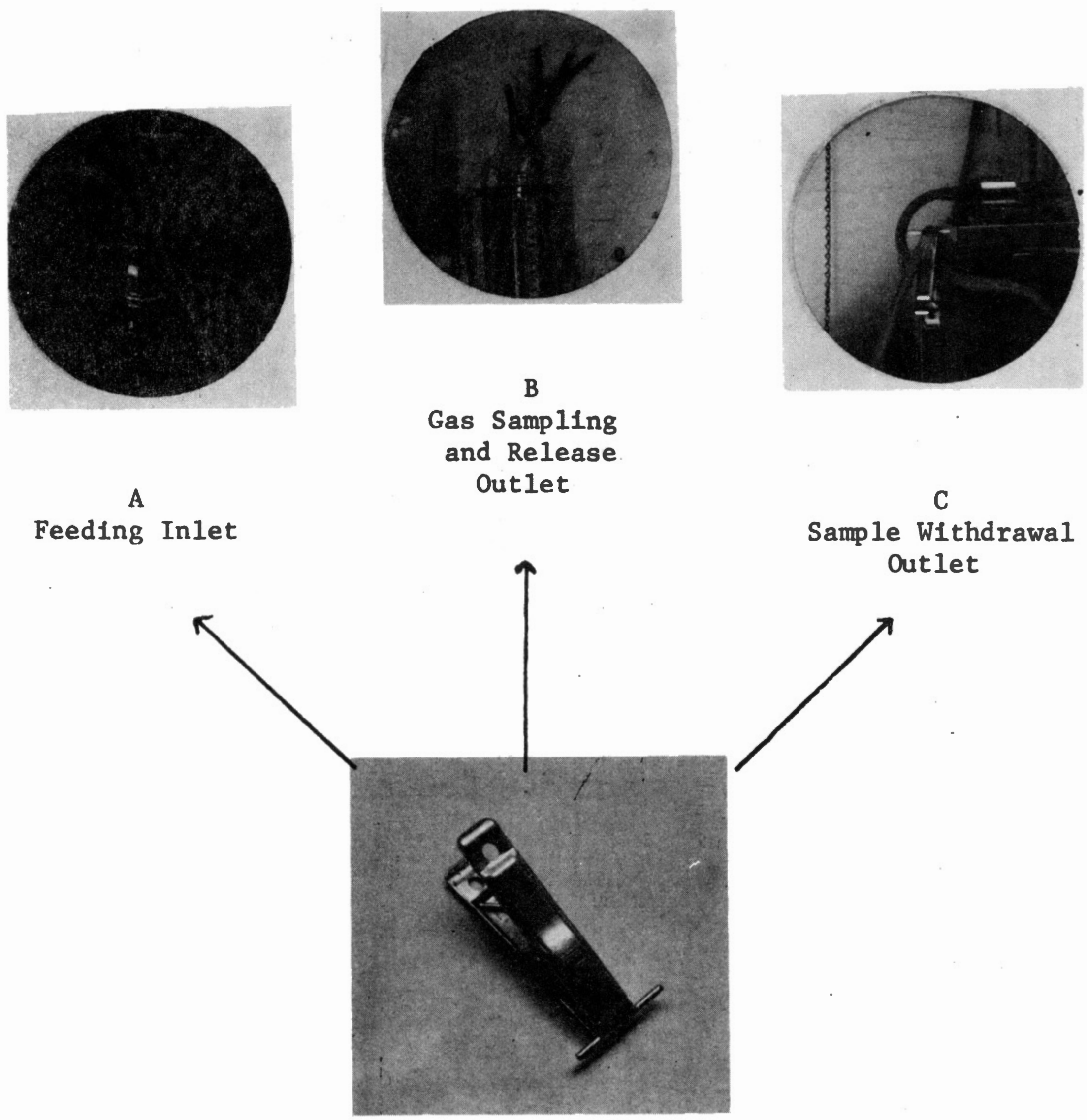

Figure 8. Modified 3201 Pony® Clamp Used to Seal Access Ports (Pictured in Insets) to Digestion System

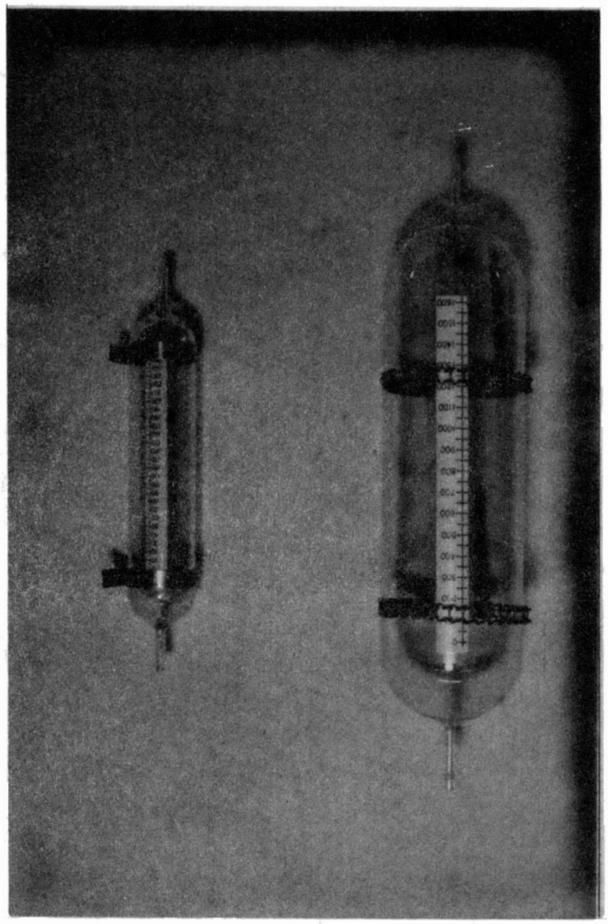

Figure 9. Graduated Glass Collection Cylinders

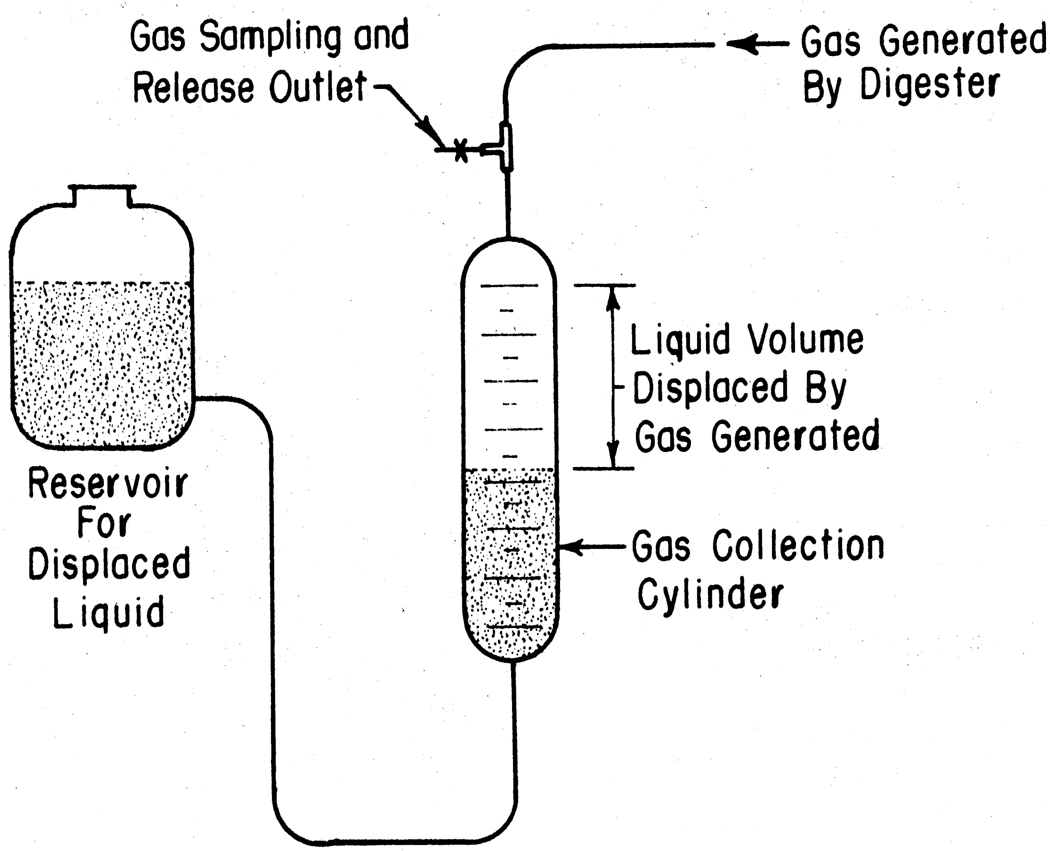

Figure 10. Gas Volume Measurement Scheme

for the liquid displaced by the gas generated. The collection cylinder's size determined the aspirator bottle capacity, 0.5 or 2.0 ℓ.

A plastic tee, 0.4 cm (ID), was inserted in the gas line near the top of the gas collection cylinder. The tee arrangement had two functions: (1) to provide an orifice for the release of gas generated daily, and (2) to provide an orifice for the collection of gas samples used for chromatographic analysis. A modified 3201 Pony® clamp was applied to latex tubing on the tee to seal the orifice (Figure 8, Inset B).

Mixing Scheme

A Cole-Parmer (115 V, 60 Hz, 17 W, 0.25 A) oscillating pump (Figure 11) mixed the contents of each digester. Latex tubing, 1.0 cm (ID), connected the pump to the digester's pump intake and return. The pump continually circulated the digester contents at the rate of 17 to 23 mℓ/s. The pump circulated bottom material to the top of the digester. The return outlet was positioned below the liquid surface to prevent foaming in the digesters. The digesting material was assumed completely mixed.

A plastic tee, 1.0 cm (ID), was inserted in the pump return line. The tee provided an orifice for the digesting material wasted daily. Positioning the tee upright prevented the solids settling in the extraction line. A modified 3201 Pony® clamp was applied to the latex tubing on the tee to seal the orifice (Figure 8, Inset C).

Temperature Control

A Tenny environmental stand, model 6PLB-6050C, (Figure 12) was used to maintain digesters within desired temperature range. The unit has six liquid baths with independent temperature controls. The liquid

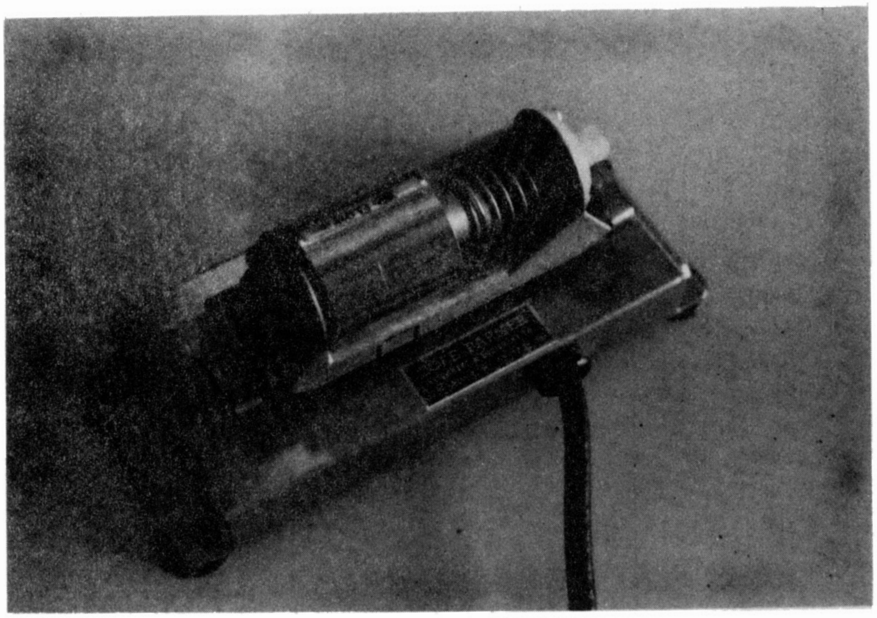

Figure 11. Cole Parmer (115 V, 60 Hz, 17 W, 0.25 A) Oscillating Pump

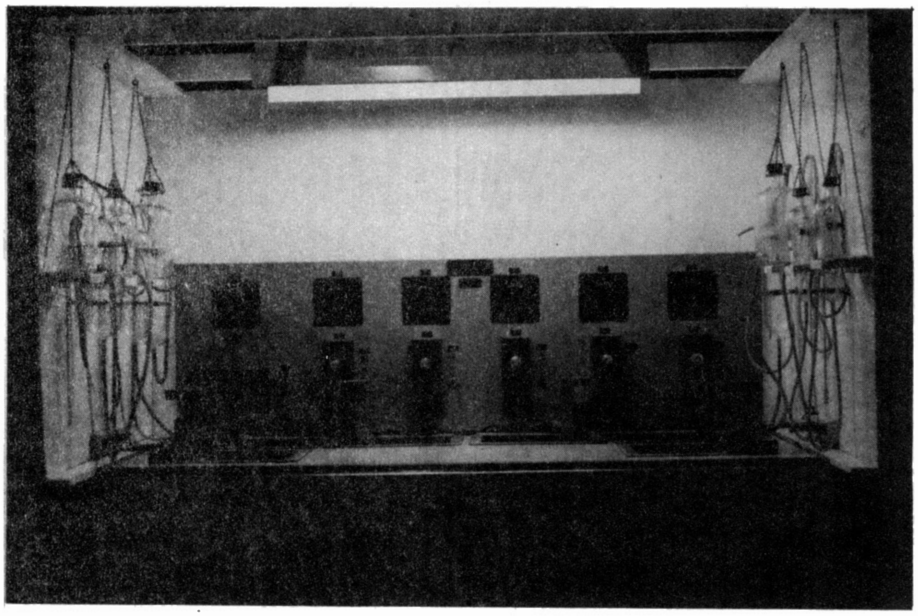

Figure 12. Tenny Environmental Stand
(Model 6PLB-6050C)

used in the baths was a 50-50 mixture of ethylene glycol and distilled water. Sheet metal plates (Figure 13) were placed over the baths to reduce evaporation losses.

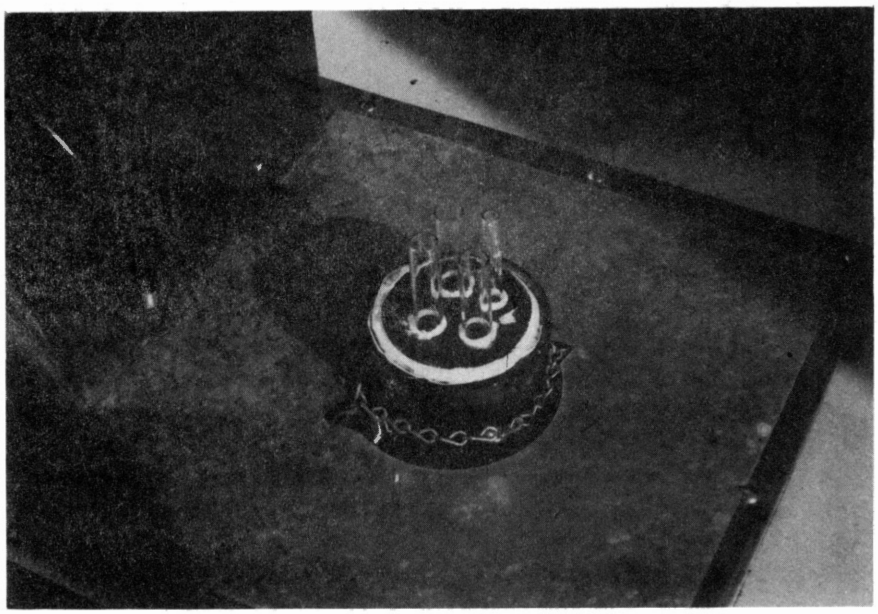

Figure 13. Sheet Metal Plate Positioned Over Temperature Control Bath

CHAPTER IV

EXPERIMENTAL PROCEDURE AND MATERIAL

Commercial Operation Characterization

A characterization study was performed on the commercial total confinement swine operation described in Chapter III. The facility was selected because: (1) the operation includes all levels of swine production from farrowing to finishing, (2) the animals are grown on slotted floors and the manure is in a concentrated form, and (3) the owner permitted access to the facility.

Manure generated in each of the farm's confinement buildings was characterized. The manure pits were sampled over a nine-month period, March 1976 to November 1976. Samples were taken every 7 to 14 days. The sampling area for each pit was limited to the area below the opening providing access to the pit's drain standpipe (Figure 3). The manure sampled was assumed representative of the manure throughout the pit.

The herdsman provided information on the pits drained since the last samples were collected. The information included the date a pit was drained and the manure level in the pit after being drained. The manure level and visual characteristics (thick, thin) were observed prior to each sampling. The manure was vigorously mixed before sampled. The minimum sample taken was 1.0 ℓ.

Screening manure through 0.635 cm hardware cloth prior to analysis removed large particles and most hair. Table IX lists the analyses performed on manure samples.

TABLE IX

ANALYSIS SCHEME FOR MANURE CHARACTERIZATION

Analysis	Raw Waste	Liquid Fraction	Solid Fraction
pH	X		
Solids	X	X	X
COD	X	X	
NH_4^+ - N		X	

All analyses, except ammonia nitrogen, were conducted in accordance to procedures outlined in Standard Methods for the Examination of Water and Wastewater (American Public Health Association, 1971). Appendix A presents a partial listing of the equipment used in the analyses. Total solids, suspended solids, and dissolved solids were determined by drying samples overnight at 103°C. Liquid and solid phase separation of samples for COD, NH_4^+ - N, and solids analysis was obtained by centrifuging. Manure samples were spun at 83 rps for 40 minutes to achieve separation. The decanted liquid fraction for COD and NH_4^+ - N analyses was filtered through a reeve angel glass fiber filter prior to analysis.

Ammonia nitrogen was determined by a procedure outlined by Ecker and Lockhart (1961). Details of the procedure are presented in Appendix B.

Digestion Study

Study Format

The digestion study investigated six swine manure loading rates. The manure fed to digesters was obtained from the total confinement farm described previously. Five loading rates were dilutions (straight, 1/2, 1/3, 1/5, 1/7) of the farm's calculated daily manure production. The sixth loading rate was material collected directly from the finishing barn. Two to three replications of each loading rate were performed.

The study was performed in three segments. Each segment included six simultaneously operated digesters. Three loading rates were fed in duplicate during the first segment. Each of the six loading rates were fed during both the second and third segment. However, three digesters in the third segment were holdovers from the second segment. The three digesters were maintained until the gas generated was analyzed for composition. Table X presents the format followed when investigating the six loading rates.

Digester Operation

The digesters were 4.0 ℓ completely mixed bench scale batch fed systems. Digester detention time and temperature were held constant throughout the study at 20 days and 35 $\pm$ 2°C, respectively. Each digester was operated a minimum of 60 days (three detention periods) to obtain indications of the system's stability.

Seed Material

Seed material in preliminary studies was anaerobic sludge from the

Stillwater Municipal Waste Treatment Plant, Stillwater, Oklahoma. Screening sludge through 0.635 cm hardware cloth prior to seeding digesters removed large particles and hair. The digesters were started with 4.0 ℓ of straight sludge.

TABLE X

FORMAT FOR INVESTIGATING DIGESTER LOADING RATES*

Segment	Digester Loading Rates					
	Finisher	Straight	1/2	1/3	1/5	1/7
1		2		2		2
2	1	1	1	1	1	1
3	1	**	1	**	1	**
Total Number of Trials	2	3	2	3	2	3

*Numbers indicate the number of digesters fed at the indicated loading rate during each segment.

**Indicates the digesters held over from previous segment and maintained until the gas generated was analyzed for composition.

Problems were encountered maintaining an active biomass beyond 14 days on swine manure feed. A new seed source was sought after repeated attempts to acclimate seed to swine manure failed.

The new seed source was a lagoon at the commercial farm characterized as part of the study. The lagoon material had the advantage of being acclimated to swine manure. Samples of the lagoon's anaerobic bottom material were taken with a Kemmerer water sampler. Prior to seeding digesters the lagoon material was screened. Each digester was started with 4.0 ℓ of straight lagoon material.

Three digesters, seeded with lagoon material, were fed a synthetic glucose feed. These preliminary trials were conducted to determine if the previous problem with the biomass was because of the seed material or the physical setup of the digester. No problems maintaining an active biomass (gas production) were experienced during a month of operation. Therefore, all digesters, except two, in the study were seeded with 4.0 ℓ of anaerobic lagoon material. The two exceptions were digesters in the first segment switched from glucose to swine manure feeds.

Feed Material

Expected Daily Manure Production. The expected daily manure production of each of the farm's confinement buildings was calculated. The mean manure production values (liquid and solids) based on livestock weight and age reported by Muehling (1969) were used for the calculations. The herdsman provided the information on each building's livestock population. The calculations did not include the additional water resulting from wastage and washing operations. Table XI presents the calculated values. Detailed calculations are shown in Appendix C.

Preparation and Storage. Manure samples used to prepare digester feeds were collected simultaneously with the samples used to characterize manure. Therefore, the same sampling limitations and assumptions discussed previously applied to samples collected. All manure was screened prior to preparing feed solutions to remove large particles and most hair.

TABLE XI

EXPECTED DAILY MANURE PRODUCTION (LIQUID AND SOLIDS)
FOR COMMERCIAL FARM CHARACTERIZED

Building	Expected Manure Production (ℓ/day)	Percent of Total (%)
Sow and Boar Barn	3780	21.5
Farrower	726	4.1
Nursery I and II	1584	10.1
Grower	5481	31.3
Finisher	5821	33.0
Total	17392	100.0

The straight feed solution was prepared by mixing manure from each building in the proportions calculated for the daily manure production. Table XII presents the composition of a 1.0 ℓ straight feed preparation. The straight feed solution was prepared in 3.0 ℓ batches.

The straight feed solution was the stock solution used in preparing the 1/2, 1/3, 1/5, and 1/7 dilutions of the calculated daily manure production. The diluted feed solutions were prepared in 1.0 ℓ batches. The required volume of straight feed solution for each dilution was transferred to a 1.0 ℓ volumetric flask (i.e., 500 mℓ of straight feed for the 1/2 dilution) and the manure was diluted to 1.0 ℓ with distilled water.

The finisher feed solution was the undiluted manure collected directly from the farm's finishing barn.

TABLE XII

COMPOSITION OF A 1.0 ℓ STRAIGHT FEED PREPARATION

Source	mℓ of Manure
Sow and Boar Barn	215
Farrower	41
Nursery I	50
Nursery II	51
Grower	313
Finisher	330
Total	1000

The feed solutions were kept refrigerated at about 5°C between feedings. The solutions were brought to room temperature prior to each feeding. The straight feed and finisher stock feed solutions were stored in a freezer maintained at -6.6°C until needed.

Characterization. Feed solutions were analyzed following the same scheme outlined for characterizing manure samples (Table IX). All analyses, except phase separation for solids, were conducted according to procedures and specifications presented for the manure samples. Liquid and solid phase separation for solids analysis was obtained by filtering samples through 0.45 μm filters.

Daily Operating Procedures

The digesters were fed once daily, normally between 8:30 a.m. and

10:30 a.m. The procedures followed for the daily operating and feed of each digester were:

1. Gas production with the liquid in the aspirator bottle and gas collection cylinder at equal levels (Figure 14) was recorded. Room temperature was recorded at the time of gas reading.
2. Positive pressure was applied to the system by raising aspirator bottle (Figure 15).
   a. A gas sample to be used for determining gas composition was taken when required.
   b. A modified 3201 Pony® clamp was applied to the pump line below tee. The clamp sealing extraction line was released and 200 mℓ of digesting material was removed (Figure 16). The extraction line was resealed and the clamp was removed from the pump line. Temperature of the digesting material wasted was taken immediately with a chemical thermometer (-20 to 110°C, 1°C divisions) and recorded.
3. Negative pressure was applied to system by lowering aspirator bottle. The clamp sealing the feed port was opened and 200 mℓ of feed material was added to the digester (Figure 17). Resealing the feed port as the last of the feed entered the digester kept oxygen from entering the system.
4. Gas was expelled from the system by removing the clamp on gas release outlet. Gas was expelled until the liquid surface in the collection cylinder read zero and was level with the liquid surface in the aspirator bottle (Figure 18). The gas release outlet was resealed.

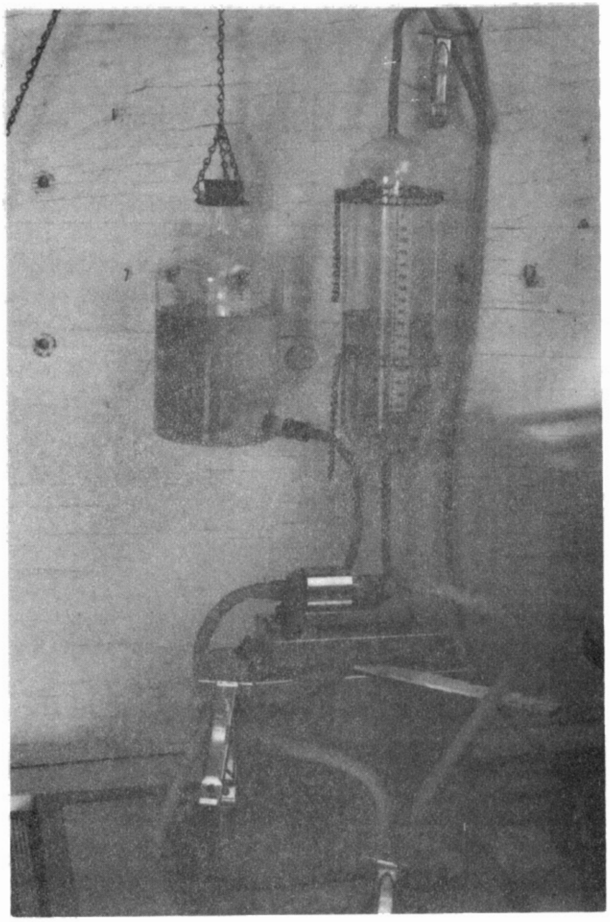

Figure 14. Liquid in the Aspirator Bottle and Gas Collection Cylinder at Equal Levels for Reading Gas Production

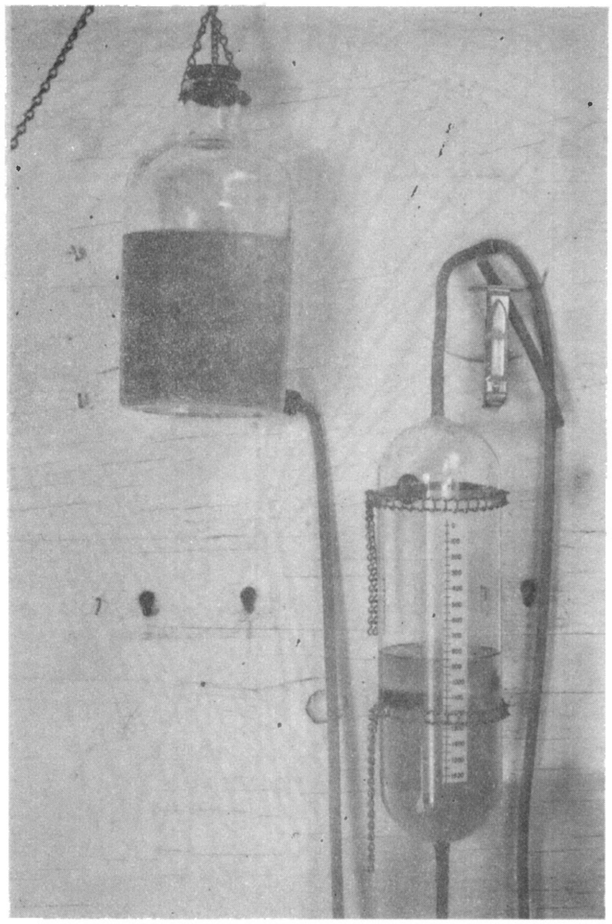

Figure 15. Positive Pressure Applied to System by Raised Aspirator Bottle

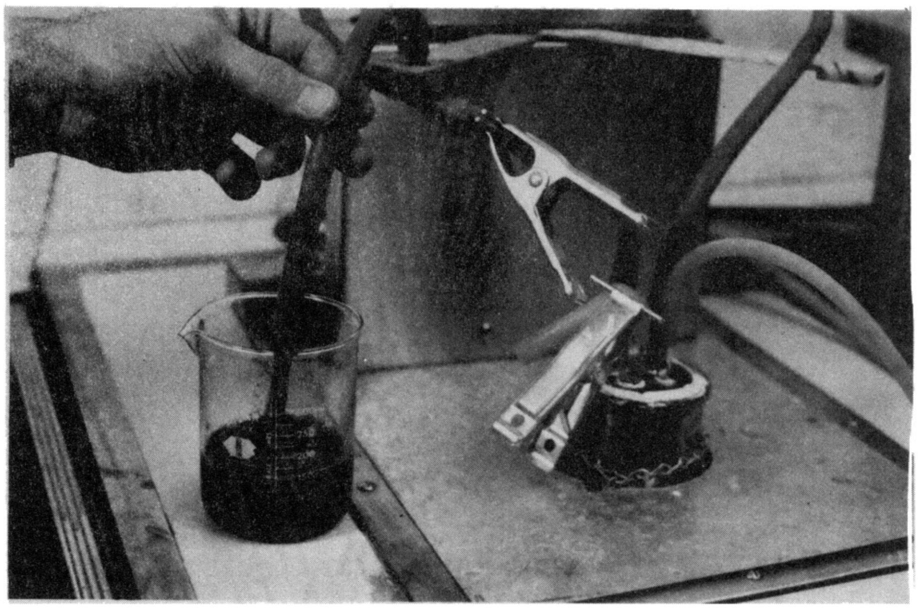

Figure 16. A Modified 3201 Pony® Clamp Applied to the Pump Line Below Tee and 200 mℓ of Digesting Material Being Removed

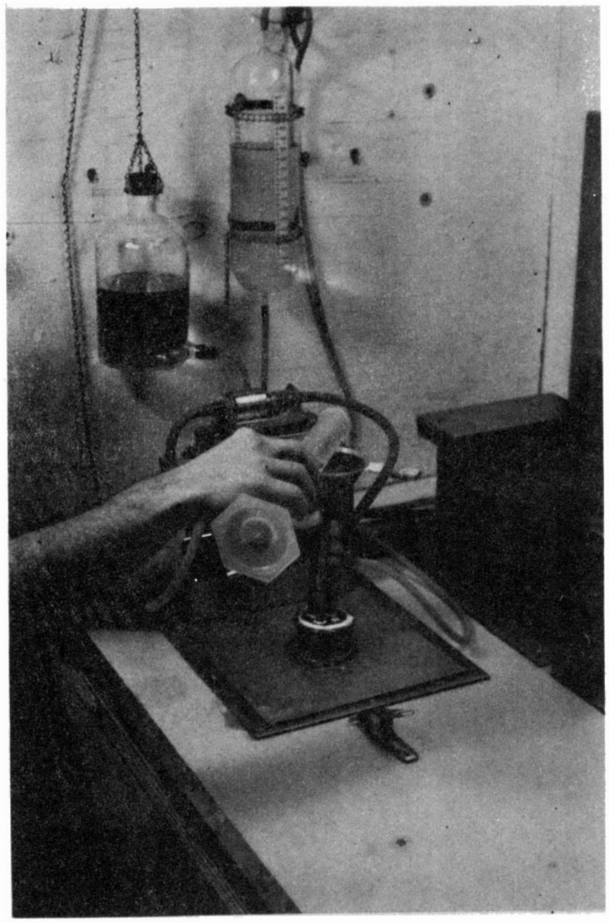

Figure 17. Negative Pressure Applied to System by Lowered Aspirator Bottle and 200 mℓ of Feed Material Being Added to Digesters

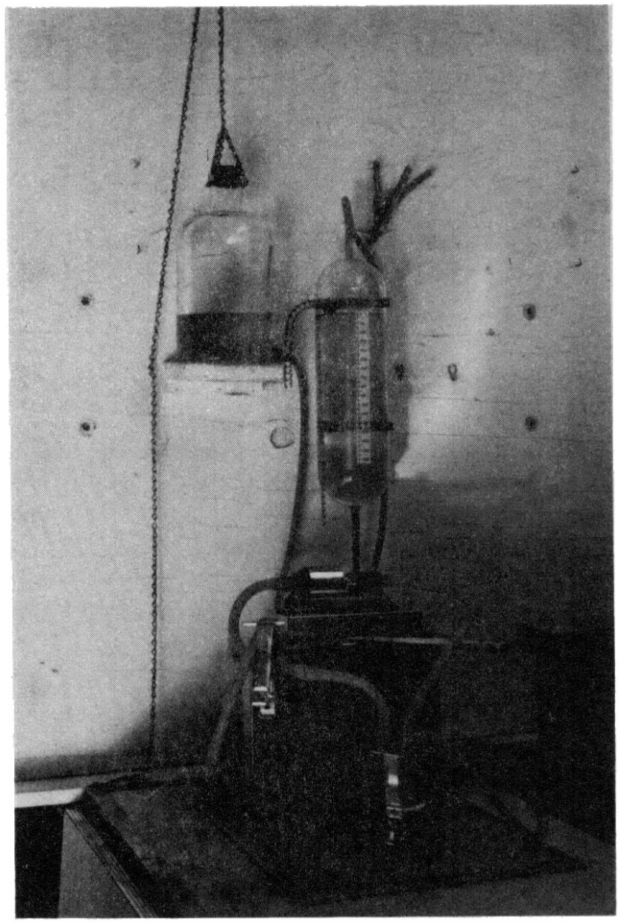

Figure 18. Gas Collection System
Zeroed After Feeding

5. Gas production with the liquid in the aspirator bottle and gas collection cylinder at equal levels was measured and recorded periodically during the day. The data were used to determine and compare rates of gas production. Room temperature was recorded at time of gas reading. Gas was expelled from the system to a reference level if the production appeared to be going to exceed the collection cylinder's capacity before the next feeding.

Gas Sampling Procedure

Samples of gas generated were taken to determine gas composition. A reusable sampling cylinder was used to collect a sample from each digestion system. The reusable sampling cylinder was a glass chamber, 20 to 30 mℓ capacity, fitted with a vacuum stopcock at either end (Figure 19). The sampling cylinder had a port sealed with a rubber septum to permit needle withdrawal of samples for analysis. The septum was replaced prior to each sampling.

A positive pressure was applied to the system and a sampling cylinder was attached to the latex tubing on the gas collection cylinder's sampling outlet (Figure 20). Both stopcocks on the collection cylinder were opened and the clamp on the gas sampling outlet released. A minimum of 100 mℓ of gas from a 0.25 ℓ collection cylinder was flushed through the sampling cylinder prior to sampling. A minimum of 300 mℓ of gas from a 1.6 ℓ collection cylinder was flushed through the sampling cylinder prior to sampling. A sample was collected by sequentially closing the two stopcocks. The outer stopcock was the first closed. The clamp was

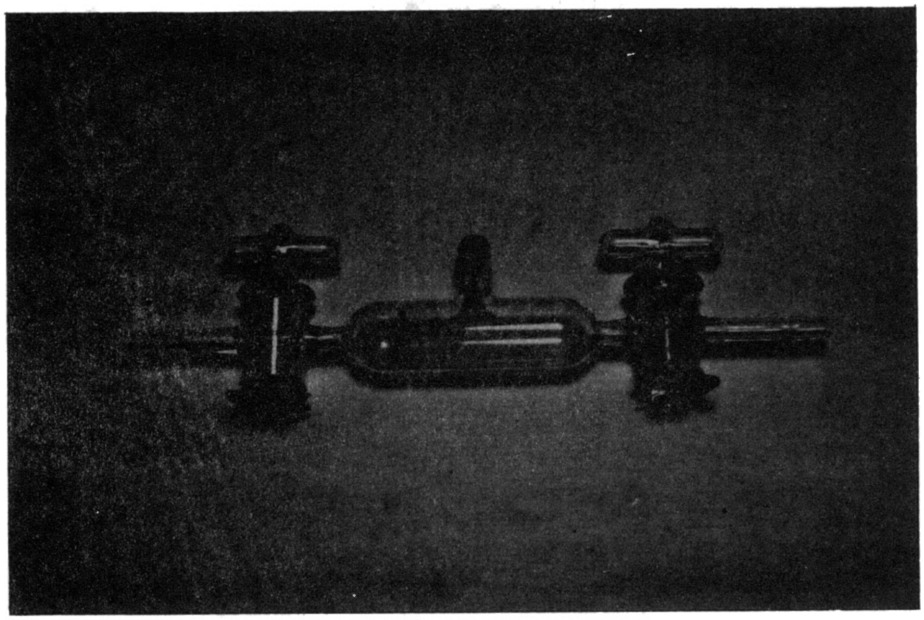

Figure 19. Gas Sampling Cylinder
(Typical)

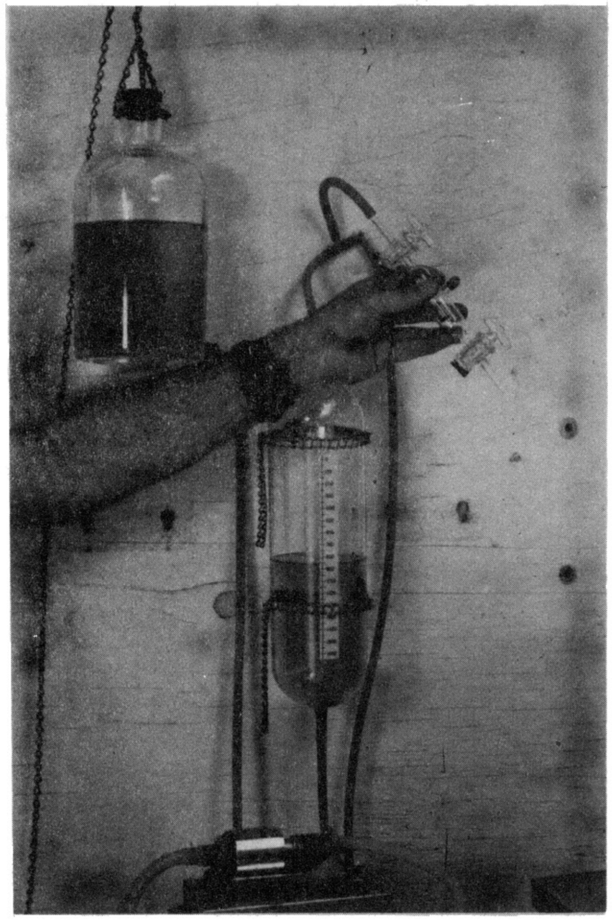

Figure 20. Positive Pressure Applied to System by Raised Aspirator Bottle and Gas Sample Being Taken

reapplied to the gas sampling outlet prior to removing the sampling cylinder.

Parameters Monitored

The 200 mℓ of digesting material wasted from each digester daily was analyzed to determine the digester's operating characteristics. Table XIII presents the analysis schedule for parameters monitored for each digestion system.

TABLE XIII

ANALYSIS SCHEDULE FOR PARAMETERS MONITORED FOR EACH DIGESTION SYSTEM

Analysis	Frequency	Combined Waste	Liquid Fraction	Solid Fraction
pH	Daily	X		
Alkalinity	Daily	X		
Solids	3/Week	X	X	X
COD ML	Daily		X	
COD MLSS	3/Week	X		
NH_4^+ - N	2-3/Week		X	
Volatile Acids	1-2/Week		X	
Gas	Limited			

All analyses, except NH_4^+ - N and gas, were conducted in accordance to procedures outlined in Standard Methods for the Examination of Water and Wastewater (American Public Health Association, 1971). Alkalinity was determined by potentiometrically titrating to a pH 3.7 endpoint. Total solids, suspended solids, and dissolved solids were determined by drying samples overnight at 103°C. Liquid and solid phase separation for solids analysis was obtained by filtering samples through 0.45 μm filters. Liquid and solid phase separation of samples for COD, NH_4^+ - N and VA analyses was obtained by centrifuging. Manure samples were spun at 83 rps for 40 minutes to achieve separation. The decanted liquid fraction was filtered through a reeve angel glass fiber filter prior to analysis. The liquid fractions for VA analysis were further filtered through a 0.45 μm filter before being analyzed.

Ammonia nitrogen was determined by a procedure outlined by Ecker and Lockhart (1961). Details of the procedure are presented in Appendix B.

Gas samples were analyzed with a model LKB-9000 gas chromatograph-mass spectrometer located in the Oklahoma State University Biochemistry Department. Appendix A presents details on the LKB-9000. A 1.8 m x 0.32 cm (OD) stainless steel column packed with 80 to 100 mesh Porapak Q was used in the LKB-9000 to separate component gases. Helium carrier gas was supplied at the rate of 0.75 mℓ/s at 2.76×10^5 Pascals (Pa). The column and injection port were maintained at ambient temperature. A Hamilton gas tight microliter syringe was used to inject gas samples, 25 to 30 μℓ. Samples of research grade CO_2 (carbon dioxide), CH_4 (methane), and H_2S (hydrogen sulfide) were run to determine the retention time of each expected gas component.

Two runs were made with each anaerobic digester gas sample. The first run was made to get a chromatogram for the sample. Mass spectrometry information for each peak on the chromatogram was taken during the second run. The component gases were identified by retention times and mass spectrometry information. The areas under the peaks on chromatograms were calculated by the triangulation method. These values were used to calculate the percentage of each component gas present.

CHAPTER V

RESULTS AND DISCUSSION

Commercial Operation Characterization

Livestock Inventories

The monthly inventories during the period of January 1976 to November 1976 (Table XIV) shows the total number of animals on the farm remained relatively constant at 4232. The number of animals within the different weight-age classifications, however, varied considerably from month to month.

The birth-sales records for the same period (Table XV) show the number of pigs born on a monthly basis varied drastically with values ranging between 376 and 921. In addition, the herdsman periodically withheld animals from market because of poor prices, accounting in part for the wide range, 26 to 36 weeks, of animals in the finisher.

Lagoon System

At the start of the study, fall 1975, the herdsman was experiencing a problem with the lagoon system. Above average rainfall earlier in the year and the lack of irrigation required to remove an adequate volume of water had the lagoons filled to capacity. The lack of additional lagoon capacity meant the herdsman could not drain the pits as required. Thus, manure was accumulated in the pits. The problem was critical by

TABLE XIV

FARM'S MONTHLY LIVESTOCK INVENTORIES (JANUARY 1976 TO NOVEMBER 1976)

	Jan 1	Feb 1	Mar 1	Apr 1	May 1	June 1	July 1	Aug 1	Sept 1	Oct 1	Nov 1
Breeding Stock:											
Boars (204)*	32	32	24	22	20	17	12	15	20	19	21
Sows (182)	310	360	360	354	367	398	398	395	390	379	375
Gilts (159)	105	85	81	81	64	30	33	37	37	36	9
Breeding Hogs for Sale:											
Gilts (84)	480	505	530	536	542	575	556	585	620	730	718
Pig Inventory:											
Suckling (4)	888	499	360	515	815	746	674	449	496	452	494
Wean-23 kg (14)	736	1273	805	703	612	919	1024	656	505	546	641
23-46 kg (34)	578	514	832	715	625	527	605	854	670	666	589
46-69 kg (59)	519	578	484	689	725	700	536	660	829	681	624
69+ kg (84)	487	435	620	476	530	620	503	615	597	697	672
Total	4135	4281	4096	4091	4300	4532	4342	4266	4164	4206	4143

*Average wt, kg.

TABLE XV

FARM'S MONTHLY LIVESTOCK SALES AND BIRTH RECORDS (JANUARY 1976 TO NOVEMBER 1976)

	Jan 1	Feb 1	Mar 1	Apr 1	May 1	June 1	July 1	Aug 1	Sept 1	Oct 1	Nov 1
Sales:											
Butcher	?	363	333	339	296	487	267	394	251	338	509
Gilts	?	70	190	40	260	225	105	111	155	83	95
Others	?	52	6	21	21	18	21	17	23	39	1
Total*	235	485	529	400	577	730	393	522	429	460	605
Births:											
Litters	47	42	79	87	105	82	50	59	76	60	50
Pigs	430	376	634	707	921	661	417	512	617	495	423

*Average wt of animals 84 kg.

February 1976 because pit storage capacity was also nearly expended. A neighboring farmer pre-irrigating from the lagoons during late February and March 1976 lowered the liquid level in the lagoons by 0.8 m. The water removed was sufficient to permit the herdsman to resume draining the pits.

The lowering of the lagoon's liquid level revealed the sediment deposition patterns in the lagoons. The lagoon receiving manure directly from the production facilities had solid deposits around its edges. Because of the sediment deposits, the lagoon's capacity appeared to be reduced by one-fourth to one-third. Similar deposits were not observed in the other lagoon.

Manure Characterization

Manure samples collected prior to June were not included in the characterization study since the samples did not represent the farm's normal operating conditions. By June, the herdsman was able to reestablish a near normal draining schedule, but he was unable to drain the pits completely each time due to the limited lagoon capacity. The manure sampling period spanned the five month period between June 1, 1976 and November 1, 1976. Appendix D contains the raw manure characterization data for the individual production buildings.

Sow and Boar Barn

The sow and boar barn's pit was normally covered with a scum layer 10 to 12 cm thick. Solid particles brought to the surface by rising gas bubbles appeared to create the layer. Hair present in the manure also seemed to contribute to formation of the layer. During the warmer months the upper surface of the layer dried forming a hard crust, occasionally creating a clogging problem when draining the pit.

Table XVI summarizes the manure characterization results for the barn. Figure 21 is a plot of TS, MLSS COD, NH_4^+ - N versus sampling date for the analyzed manure samples from the barn. The letter "D" on the plot, a notation used throughout the manure characterization presentation, indicates dates the pit was drained. The dotted line within the COD plot denotes the data point was not measured analytically but estimated. The estimated point was not used when developing Table XVI.

TABLE XVI

SOW AND BOAR BARN MANURE CHARACTERIZATION RESULTS SUMMARY
(JUNE 1, 1976 TO NOVEMBER 1, 1976)

Parameter	Range	Mean Value	Standard Error
pH	7.2-7.5	7.4	0.025
MLSS COD (mg/ℓ)	38,000-132,000	76,000	7,500
TS (mg/ℓ)	53,000-165,000	93,000	8,300
VS (mg/ℓ)	33,000-104,000	59,000	5,200
NH_4^+ - N (mg/ℓ)	720-1,730	1,120	65
% VS	61-70	64	0.51
% SS	90-97	94	0.80
% VSS	61-72	64	0.77
% CODSP	5-13	8	0.80

The TS content of the manure reflected the high bulk content in the animal feed. Manure characteristics fluctuated throughout the study as illustrated by the TS and MLSS COD plots (Figure 21). The general decline in TS and MLSS COD concentration following each pit draining was due to the herdsman adding water when draining the pit. The water added by the herdsman was used to dilute the thick scum layer and manure suspension near the standpipe and thereby maintain drainage. Although the pit was partially drained periodically, it was never completely drained during the study. Consequently, the manure level was rarely below 45 cm in the pit. Many weeks during the sampling period the manure level equaled or exceeded the standpipe height permitting overflow of the liquid fraction while retaining the solids. Therefore, a portion of the increase in TS and MLSS COD concentrations was thought to be due to overflow.

Figure 21 shows NH_4^+ - N also fluctuated initially but stabilized by mid-July and remained relatively stable for the duration of the study. The NH_4^+ - N concentration, unlike TS and MLSS COD concentrations, was only slightly affected by water additions during pit draining. The contrasting effects caused by water additions suggested the liquid fraction equilibrated more rapidly than the solid fraction immediately surrounding the standpipe.

Farrower

The pit of the farrowing building was periodically covered with a thin gaseous scum layer. The manure samples had a watery consistency, screened readily, and contained little or no hair. Table XVII summarizes

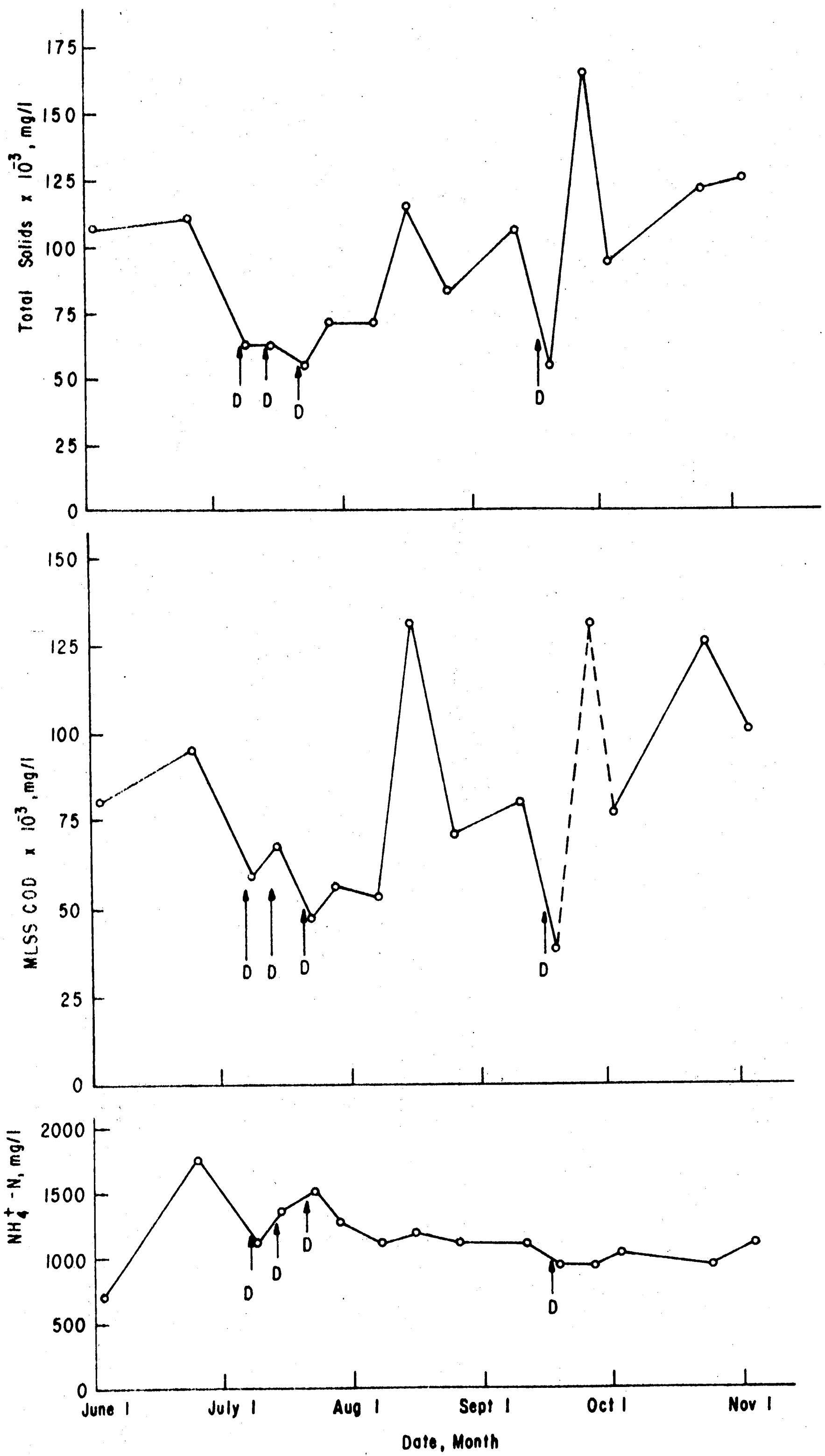

Figure 21. TS, MLSS COD, and NH_4^+ - N Versus Sampling Date for Manure Samples Collected from the Sow and Boar Barn (June 1, 1976 to November 1, 1976)

the manure characterization results for the farrowing building. Figure 22 presents a plot of TS, MLSS COD, and NH_4^+ - N versus sampling date for the manure samples.

TABLE XVII

FARROWER MANURE CHARACTERIZATION RESULTS SUMMARY
(JUNE 1, 1976 TO NOVEMBER 1, 1976)

Parameter	Range	Mean Value	Standard Error
pH	7.1-7.7	7.4	0.052
MLSS COD (mg/ℓ)	6,000-39,000	26,000	2,400
TS (mg/ℓ)	8,000-34,000	26,000	1,900
VS (mg/ℓ)	5,000-26,000	18,000	1,300
NH_4^+ - N (mg/ℓ)	200-700	380	32
% VS	60-76	72	1.3
% SS	77-95	90	1.4
% VSS	62-80	75	1.3
% CODSP	3-14	5	0.8

Figure 22 indicates TS and MLSS COD concentrations fluctuated considerably during the sampling period. The fluctuations were related to: (1) manure level, (2) pit draining, and (3) wash water additions. Prior to late August, except in mid-July when the pit was partially drained once, the manure level equaled or exceeded the standpipe height during

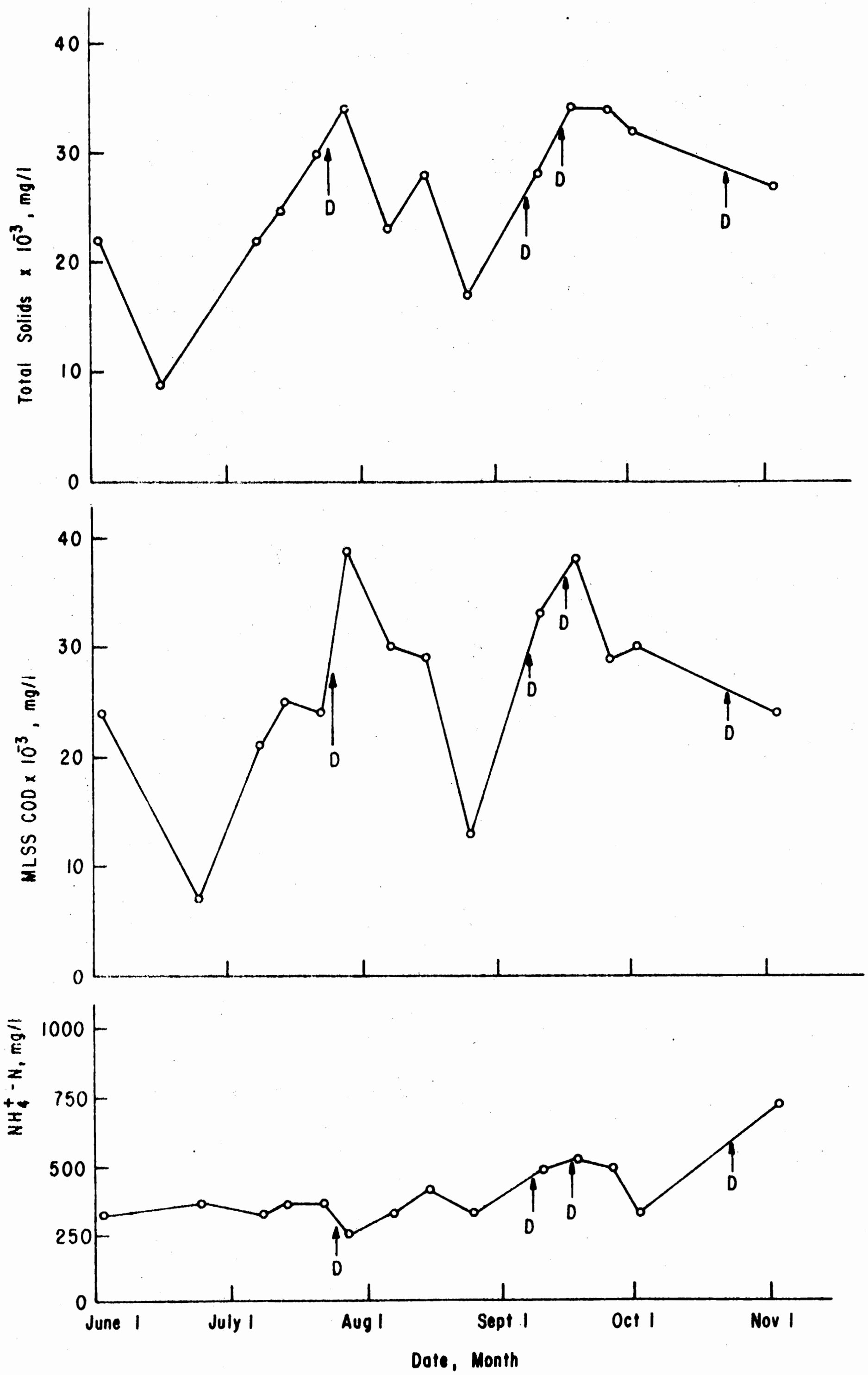

Figure 22. TS, MLSS COD, and NH_4^+ - N Versus Sampling Date for Manure Samples Collected from the Farrower (June 1, 1976 to November 1, 1976)

the sampling period. The elevated manure level enabled liquid to overflow the standpipe while most solids settled and were retained in the pit. Solids retention partially accounted for the increase in TS and MLSS COD concentrations noted particularly between mid-June and mid-July. The increased TS and MLSS COD concentrations observed in samples collected shortly after the pit was drained indicated settled solids were also not effectively removed when the pit was drained.

Wash water entering the pit also affected TS and MLSS COD concentrations. The herdsman washed the three farrowing rooms in rotation, one per week, utilizing approximately 19,000 ℓ of water per washing. The extent wash water influenced TS and MLSS COD concentrations was thought to be dependent on the location of the room washed in relation to the standpipe, and on the date the room was washed in relation to the sampling date. However, correlating wash water additions to manure characteristics was not possible because detailed records on the washing schedule were not kept during the study. Wash water additions probably influenced the low TS and MLSS COD values determined for samples collected in mid-June, early and late August, and early November. The NH_4^+ - N concentration also fluctuated during the pit sampling period but not as drastically as the TS and MLSS COD concentrations. The decreased fluctuation of NH_4^+ - N was attributed to the faster equilibriation of the liquid fraction with the solid fraction immediately surrounding the standpipe. The NH_4^+ - N plot (Figure 22) indicates a rapid increase in the NH_4^+ - N concentration during the final month of the study. The data collected provided no explanation for the rapid NH_4^+ - N increase.

Nursery I and II

The pit areas of the two nurseries were commonly covered with a thin gaseous scum layer. The manure samples from both buildings commonly had a watery consistency, screened readily, and contained only small quantities of hair. Tables XVIII and XIX present summaries of Nursery I and Nursery II manure characteristics, respectively. Figures 23 and 24 are plots of TS, MLSS COD, and NH_4^+ - N versus sampling date for Nursery I and Nursery II manure samples, respectively. A comparison of the manure characteristics for the two nurseries revealed a wide variation in the average MLSS COD, TS, VS, and NH_4^+ - N concentrations. The average MLSS COD, TS, VS, and NH_4^+ - N concentrations for Nursery II were 1.4 to 2.0 times the values for Nursery I. Although variation in manure characteristics was expected over the sampling period due to washing schedule rotation, the average values were expected to be similar, since both buildings were constructed and operated identically. The variation in manure characteristics was attributed to conditions existing in the pits prior to when the study was initiated. The pit of Nursery II operated at overflow conditions from the start of the study in June through the first of September. The pit of Nursery I on the other hand was drained substantially in late June.

Nursery I. The pit of Nursery I was partially drained only once during the five month sampling period. Figure 23 shows TS and MLSS COD concentrations declined sharply prior to pit draining in late June. A rapid increase in pit manure level, 10 cm in 14 days, suggested the decline in TS and MLSS COD concentrations was primarily the result of wash water entering the pit between sample dates. The sudden rise in TS

TABLE XVIII

NURSERY I MANURE CHARACTERIZATION RESULTS SUMMARY
(JUNE 1, 1976 TO NOVEMBER 1, 1976)

Parameter	Range	Mean Value	Standard Error
pH	7.0-7.4	7.3	0.025
MLSS COD (mg/ℓ)	11000-36000	19000	1500
TS (mg/ℓ)	12000-36000	20000	1800
VS (mg/ℓ)	8000-26000	13000	1300
NH_4^+ - N (mg/ℓ)	470-1490	660	64
% VS	61-72	66	0.8
% SS	76-92	86	1.3
% VSS	64-75	71	0.8
% CODSP	3-26	9	1.6

TABLE XIX

NURSERY II MANURE CHARACTERIZATION RESULTS SUMMARY
(JUNE 1, 1976 TO NOVEMBER 1, 1976)

Parameter	Range	Mean Value	Standard Error
pH	7.1-7.5	7.3	0.025
MLSS COD (mg/ℓ)	16000-56000	37000	2600
TS (mg/ℓ)	19000-52000	38000	2800
VS (mg/ℓ)	12000-34000	26000	2100
NH_4^+ - N (mg/ℓ)	550-1140	910	46
% VS	64-70	67	0.52
% SS	87-94	91	0.52
% VSS	67-72	69	0.52
% CODSP	4-14	7	0.52

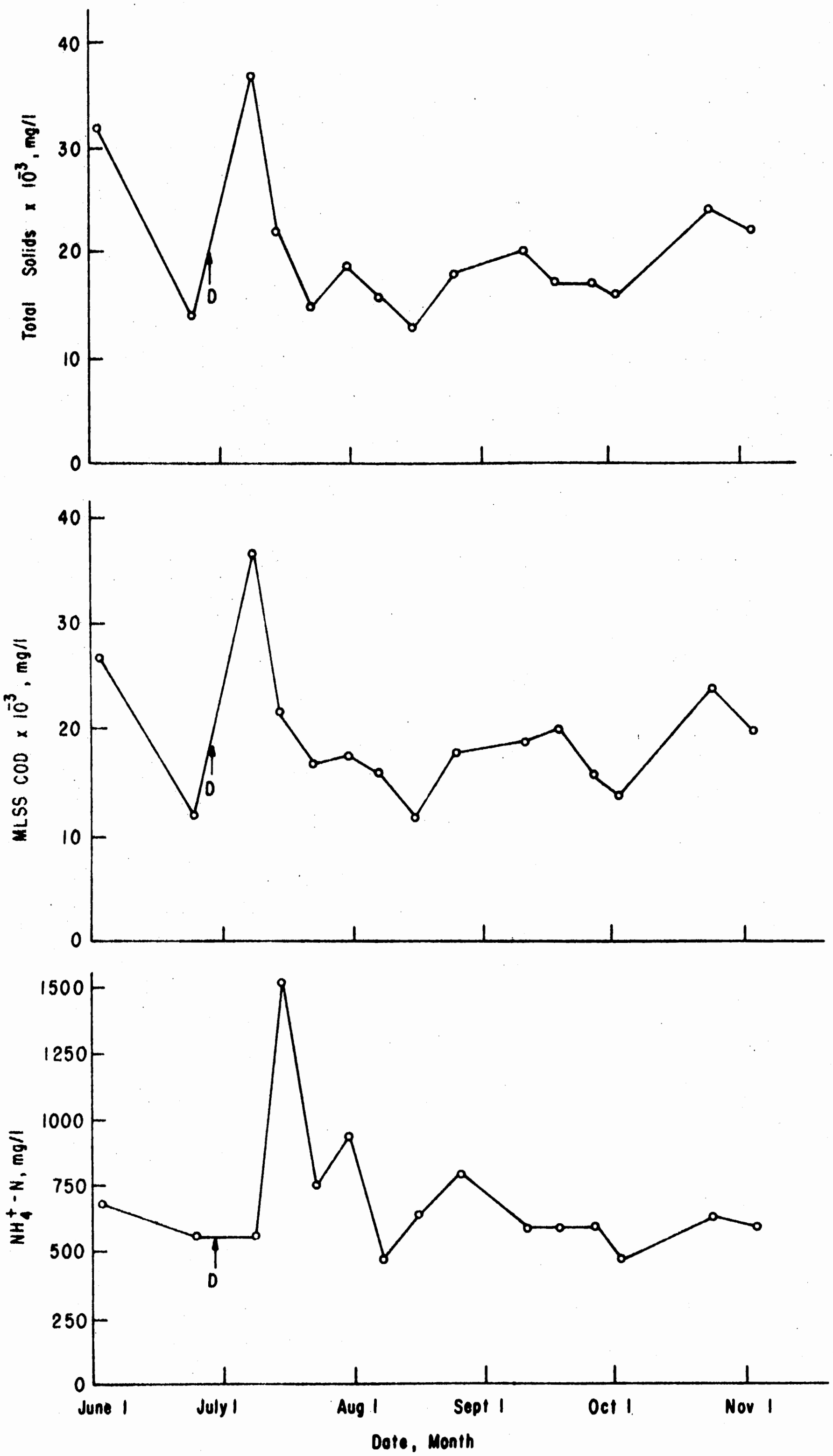

Figure 23. TS, MLSS COD, and N_4^+ - N Versus Sampling Date for Manure Samples Collected from Nursery I (June 1, 1976 to November 1, 1976)

and MLSS COD concentrations for the sample taken shortly after the pit was drained indicated settled solids were not effectively removed during draining. The rise in TS and MLSS COD concentrations in mid-July was followed by a sharp decline in these parameters at the two subsequent samplings. Again, a rapid increase in pit manure level, 20 cm in 14 days, suggested the decline in TS and MLSS COD concentrations was primarily due to dilution caused by wash water entering the pit between samplings. Manure was overflowing the standpipe by late July and remained overflowing the remainder of the sampling period. The elevated manure level permitted liquid to overflow the standpipe while solids generally settled and were retained in the pit. As a result, the TS and MLSS COD concentrations followed a gradual increasing trend during the last three months of sampling. Although there was an increasing trend, the concentrations did fluctuate. The fluctuations in TS and MLSS COD concentrations were believed to be due to wash water periodically entering the pit similar to the farrower.

The NH_4^+ - N concentration, except for the peak occurring in mid-July, remained relatively stable throughout the sampling period. The relative stability of the NH_4^+ - N concentration was attributed to the faster equilibriation of the liquid fraction than the solid fraction immediately surrounding the standpipe. The data collected provided no insight as to the cause for the rapid increase in NH_4^+ - N concentration occurring in mid-July.

Nursery II. Manure was overflowing the standpipe when sampling was initiated in June. Figure 24 indicates TS and MLSS COD concentrations increased during the first weeks of sampling. The increase in TS and

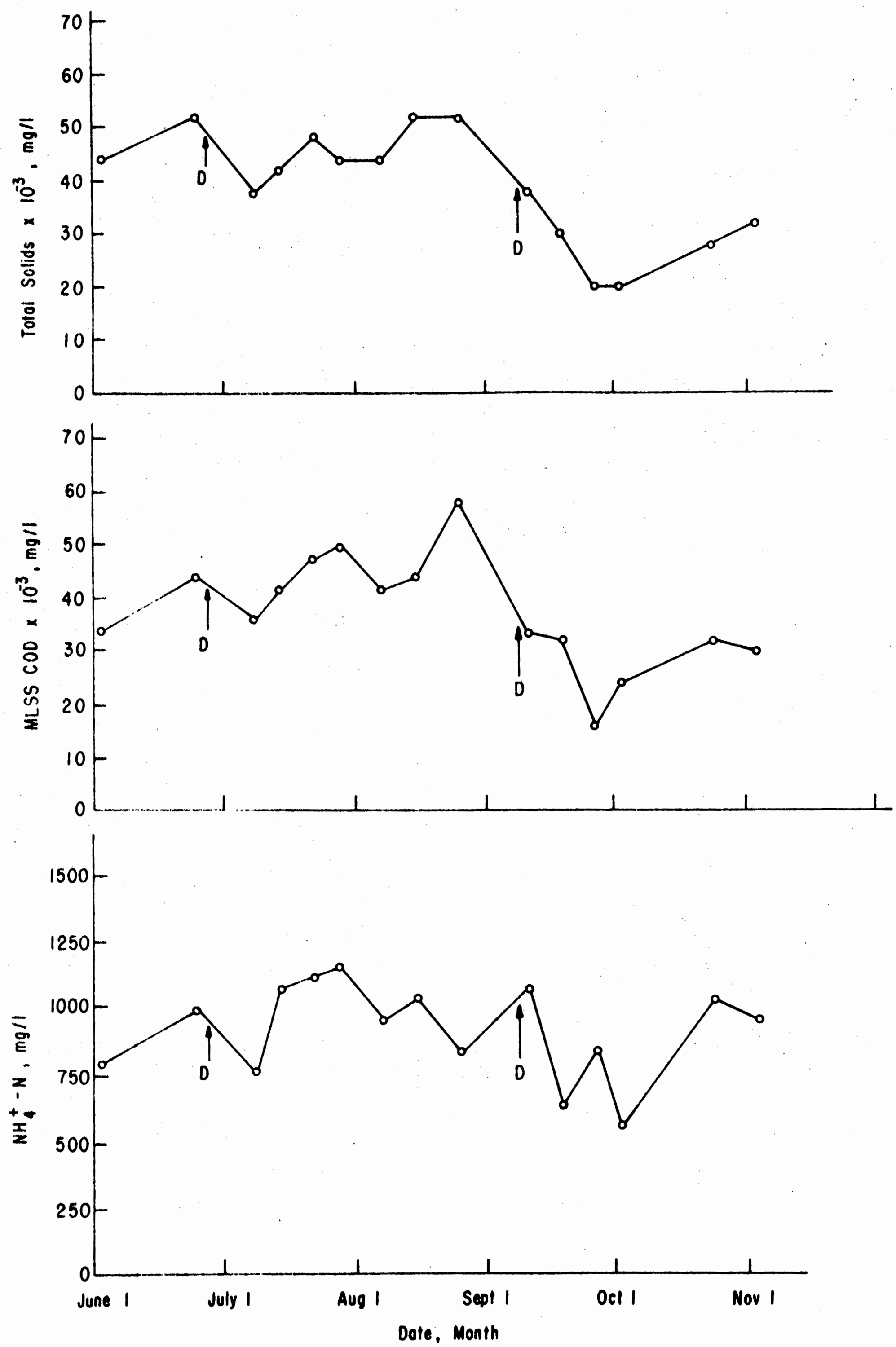

Figure 24. TS, MLSS COD, and NH_4^+ - N Versus Sampling Date for Manure Samples Collected from Nursery II (June 1, 1976 to November 1, 1976)

MLSS COD concentrations was presumably due to solids being retained in the pit while the liquid fraction overflowed the standpipe. The pit was partially drained between samplings in late June. However, the manure was overflowing the standpipe again at the next sampling. The rapid return of the manure level to overflowing the standpipe and the decline in TS and MLSS COD concentrations were attributed to wash water entering the pit between samplings. The manure level equaled or exceeded the standpipe height until the pit was drained again in early September. Thus, the TS and MLSS COD concentrations followed a gradually increasing trend between late June and early September. Although there was an increasing trend, the TS and MLSS COD concentrations did fluctuate due to wash water periodically entering the pit. As indicated previously, the pit was partially drained in early September. The TS and MLSS COD concentrations declined following the pit draining. The decline in TS and MLSS COD concentrations was contrary to previous trends where the TS and MLSS COD concentrations increased rapidly when the nurseries' pits were drained. The decline in TS and MLSS COD concentrations was thought to be due to wash water entering the pit in the vicinity of the standpipe rather than the result of solids being removed efficiently during draining. The TS and MLSS COD concentrations continued to decline during the two subsequent samplings. A rapid increase in pit manure level, 28 cm in 17 days, indicated the decline in TS and MLSS COD concentrations was primarily due to dilution caused by wash water entering the pit between samplings. Manure was again overflowing the standpipe by late September and remained overflowing the remainder of the sampling period. Thus, the TS and MLSS COD concentrations exhibited a gradual increasing trend during the remainder of the study.

Figure 24 shows NH_4^+ - N remained relatively stable except when the pit was drained. Although the periods of greatest fluctuations of the NH_4^+ - N concentration coincided with pit draining, the fluctuations were attributed to wash water entering the pit during the same period.

Grower

The pit of the grower was normally covered with a scum layer approximately 8 to 10 cm thick. The scum layer was similar to the layer described for the sow and boar barn.

Table XX summarizes the manure characterization results for the grower. Figure 25 presents a plot of TS, MLSS COD, and NH_4^+ - N versus sampling date for the manure samples taken from the grower. The letter "L" on the plot denotes significant water leaks occurred due to broken water pipes in the grower.

The TS and MLSS COD concentrations reflect the high bulk content in the feed ration. Manure characteristics fluctuated throughout the study as exemplified by the TS, MLSS COD, and NH_4^+ - N plots (Figure 25). Fluctuations in TS, MLSS COD, and NH_4^+ - N concentrations were particularly pronounced when samples were collected shortly after the pit was drained in early August and late October. The general decline in TS, MLSS COD, and NH_4^+ - N concentrations noted following each pit draining was attributed to water added to the pit when the herdsman drained the pit. The herdsman added water to dilute the thick scum layer and manure suspension near the standpipe and thereby maintain drainage. The quantity of water added by the herdsman varied, thus contributing to the TS and MLSS COD fluctuations. The particularly rapid decline of TS, MLSS COD, and NH_4^+ - N concentrations in early August was due to

TABLE XX

GROWER MANURE CHARACTERIZATION RESULTS SUMMARY
(JUNE 1, 1976 TO NOVEMBER 1, 1976)

Parameter	Range	Mean Value	Standard Error
pH	7.2-7.6	7.3	0.025
MLSS COD (mg/ℓ)	15000-62000	39000	3400
TS (mg/ℓ)	24000-57000	43000	3100
VS (mg/ℓ)	16000-39000	29000	2100
NH_4^+ - N (mg/ℓ)	840-2060	1430	96
% VS	55-74	68	1.0
% SS	79-90	86	1.0
% VSS	56-77	70	1.3
% CODSP	4-21	14	1.0

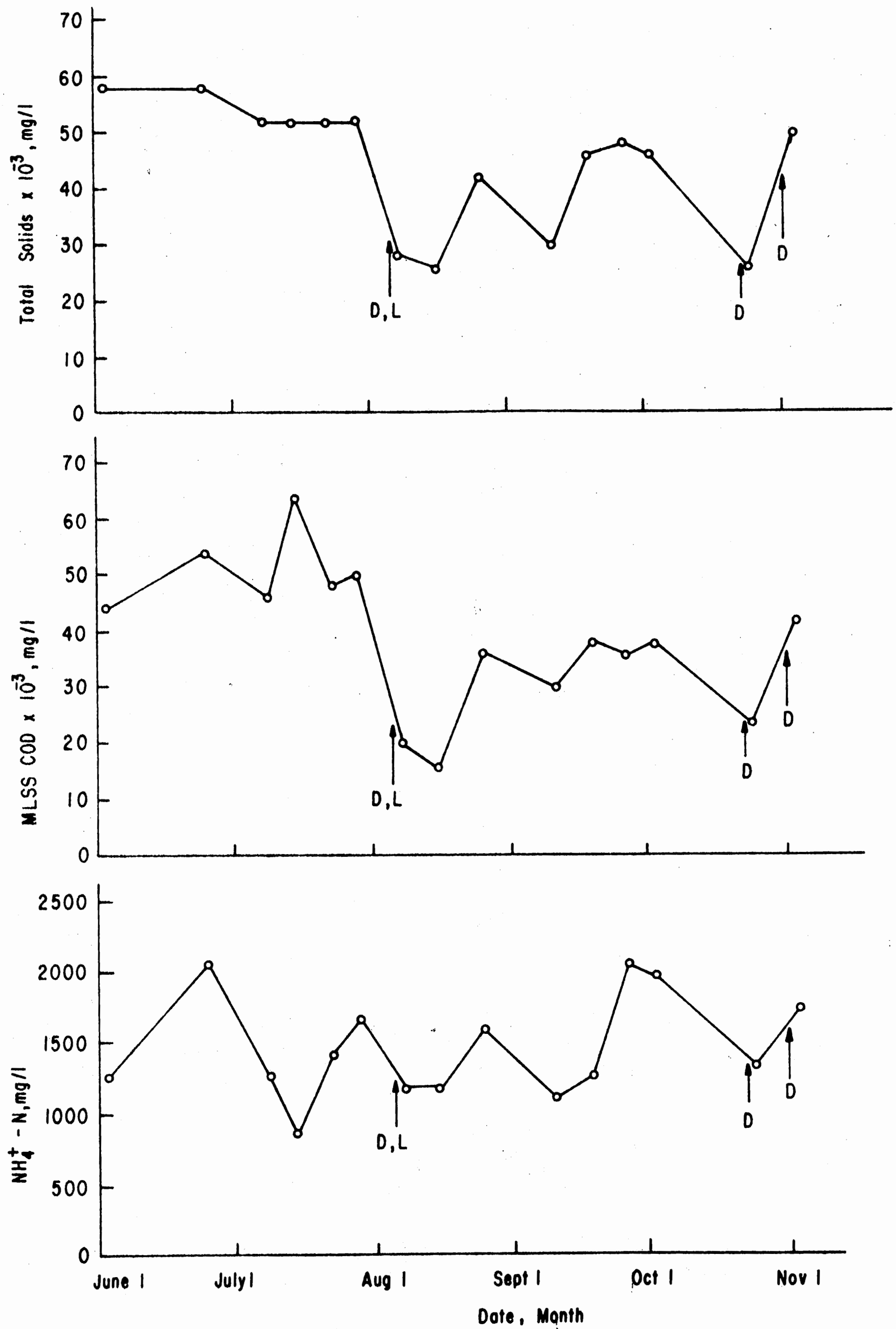

Figure 25. TS, MLSS COD, and NH_4^+ - N Versus Sampling Date for Manure Samples Collected from the Grower (June 1, 1976 to November 1, 1976)

concurrence of water leaks with the pit draining. A rapid increase in pit manure level, 25 cm in seven days, indicated problems with the leaking water pipes persisted off and on during the week after the pit was drained in early August. The increase in TS and MLSS COD concentrations after the pit was drained in late October was contrary to previous trends. Normally, TS and MLSS COD concentrations decreased due to water additions by the herdsman when the pit was drained. The increase in TS and MLSS COD concentrations was attributed to the four day lag between draining and sampling. The four day lag allowed concentrated manure from the area surrounding the standpipe to equilibrate with the diluted manure suspension in the immediate vicinity of the standpipe. The data collected provided no explanation for the rapid NH_4^+ - N increases occurring in late June and late September.

Finisher

A scum layer 12 to 16 cm thick typically covered the pit of the finisher. The scum layer was similar to those in the sow and boar barn and the grower pits. Table XXI summarizes the manure characterization results for the finisher. Figure 26 presents a plot of TS, MLSS COD, and NH_4^+ - N versus sampling date for the manure samples taken from the finisher. The letter "L" on the plots again denotes dates significant water leaks occurred due to broken water pipes in the finisher. The fluctuations of TS, MLSS COD, and NH_4^+ - N were caused by the same factors described in the grower discussion.

Although the pit was partially drained periodically, the manure level never dropped below 45 cm in the pit. Many weeks during the sampling period the manure level equaled or exceeded the standpipe

TABLE XXI

FINISHER MANURE CHARACTERIZATION RESULTS SUMMARY
(JUNE 1, 1976 TO NOVEMBER 1, 1976)

Parameter	Range	Mean Value	Standard Error
pH	6.9-7.6	7.2	0.075
MLSS COD (mg/ℓ)	53000-114000	90000	5000
TS (mg/ℓ)	69000-129000	98000	8000
VS (mg/ℓ)	46000-98000	65000	3500
NH_4^+ - N (mg/ℓ)	1410-3460	2330	150
% VS	59-77	64	1.5
% SS	88-98	93	0.8
% VSS	59-78	65	1.6
% CODSP	10-43	24	2.6

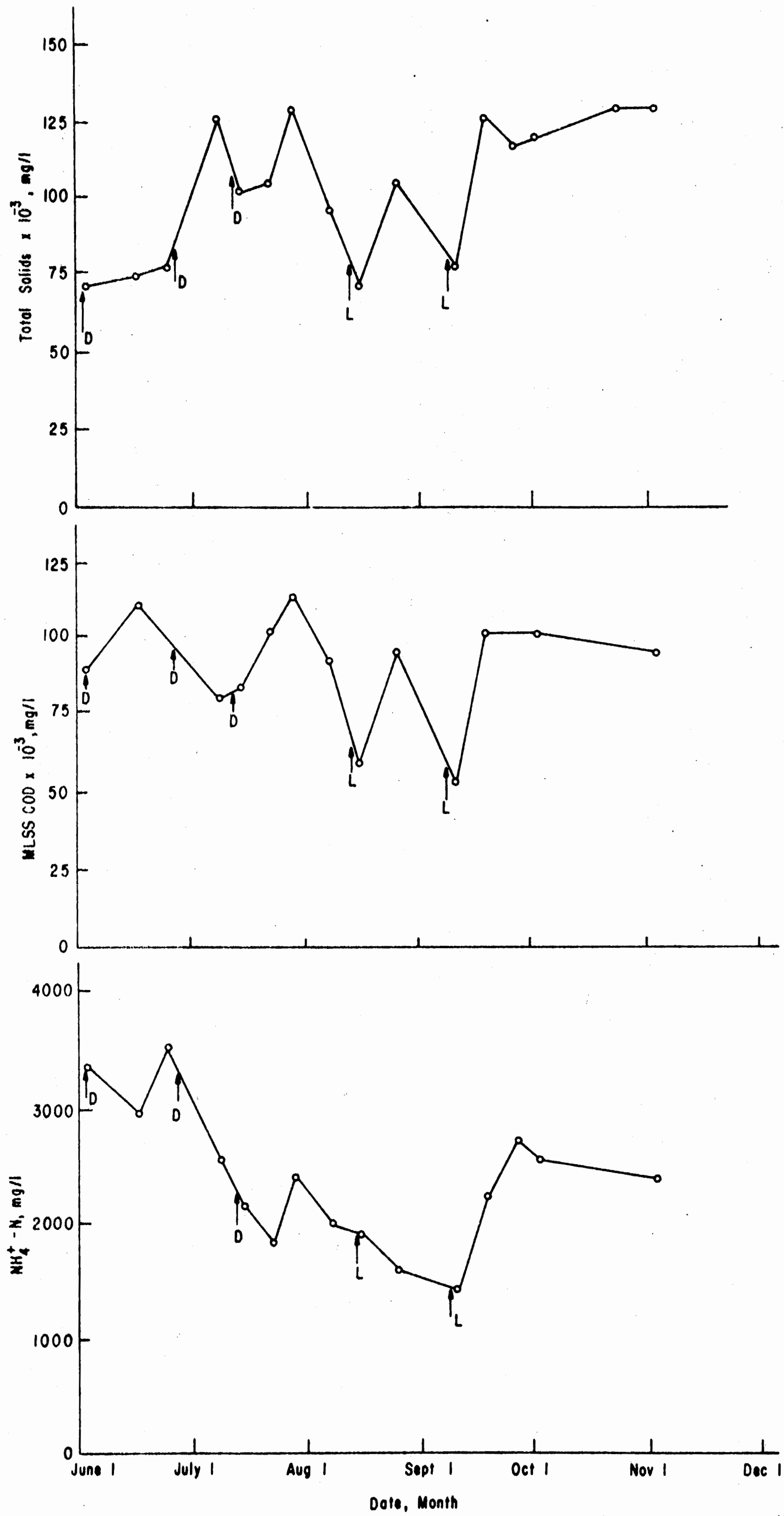

Figure 26. TS, MLSS COD, and NH_4^+ - N Versus Sampling Date for Manure Samples Collected from the Finisher (June 1, 1976 to November 1, 1976)

height. Overflow of the liquid fraction was, therefore, considered to be the principle cause of the increase in TS and MLSS COD concentrations. The increased TS concentration noted following the late June pit draining was attributed to the 12 day lag between draining and sampling and to the overflowing of the liquid fraction. The 12 day lag permitted concentrated manure from the area surrounding the standpipe to equilibrate with the diluted manure suspension in the immediate vicinity of the standpipe. Also, the manure level exceeded the standpipe height at the time of sampling.

Discussion of the Commercial Operation Characterization

The lagoon problem hampered draining manure pits for several months preceding the study. Limited lagoon capacity during the study also prevented the herdsman from draining the pits completely each time. As a result, the level of the pit in many instances exceeded the standpipe permitting the liquid fraction to overflow the standpipe while retaining the solids. Therefore, the volume of manure produced per unit of time between samplings could not be measured and compared to data available in the literature.

Numerous interesting factors caused the wide variation in daily wet manure production. Several factors noted during the study were: (1) season of the year, (2) wash water, (3) water leaks, and (4) variations in the herd size and number. Herdsman Edwards (1975-1976) indicated feed consumption was approximately one-half normal during the months of July and August when temperatures ranged between 35°C and 40°C. The reduction in the quantity of feed consumed will affect the quantity of manure generated per day requiring treatment.

Wash water diluted the manure and increased the total volume of manure requiring treatment. Weekly additions of wash water are common with confinement operations including farrower and nursery facilities. Approximately 19000 ℓ of water was utilized per washing at the visited production facility. However, the volume of water used per washing will vary with farm management practices. A potential problem with biological treatment systems may also exist due to disinfectants commonly used when washing.

Water leaks, like wash water, diluted the manure suspension and increased the volume of manure needing treatment. However, the occurrence of major water leaks (i.e., broken water pipes) is not predictable and the volume of water added to the manure depends on the size of the leak and the time required to correct the problem. Water leaks were periodically a problem in the grower and finisher buildings.

Plots for the six buildings revealed the manure characteristics fluctuated considerably during the sampling period. The fluctuations in values obtained for the manure characterization study did not always reflect real fluctuations in manure production. Manure characteristics were thought to be influenced by factors not common to all manure collection systems. Factors were: (1) addition of water at the standpipe by the herdsman to promote drainage, (2) retention of solids in the pit while the liquid fraction passed freely over the standpipe, and (3) retention of settled solids in the pit when the pit was partially drained. The above factors caused artificial fluctuation of the manure characteristics. Decreases in TS and MLSS COD were generally noted when the pits were drained or water leaks occurred. The decline in TS and MLSS COD concentrations after the pits were drained was thought to be principally due to the water additions by the herdsman. The characteristics of the liquid fraction were generally not as variable due to faster equilibration. The volume of manure retained in the pits was generally of sufficient mass so as to buffer the weekly fluctuations in the manure characteristics hoped to be monitored during the study. An average value for the daily flow could not be attained due to the problem with the lagoon. The farrower, nursery I and nursery II tended to dilute the daily manure stream.

Anaerobic Digestion

Digester Response to Five Dilutions of Swine Manure

The first 20 days of operation for each digester were considered to be a stabilization period and, therefore, not included when discussing the response of the individual digesters. The discussion of digester response to the various loading rates or dilutions was limited to the twenty-first through sixtieth day of operation unless stated otherwise. Discussion of each dilution or loading rate is presented separately. Appendixes E and F contain the feed characterization and digester response data for each digester respectively.

One-Seventh Dilution

Three digesters were fed the one-seventh (1/7) dilution--two during the first segment and one during the second segment of the study.

Figures 27, 28, and 29 are plots of feed TS, digester TS, and digester gas production versus days of operation for each of the three respective digesters. Table XXII summarizes the operating characteristics of the three digesters. The variation in effluent characteristics and initial conditions of Unit 1 compared to the other two digesters was due to the initial period when Unit 1 was fed a synthetic feed. A pumping problem also occurred in Unit 1 during the fifty-first day of operation. The digester effluent characteristics beyond the fiftieth day of operation were not representative of actual operating conditions because contents of the digester were no longer completely mixed. Therefore, the analysis of results for Unit 1 was limited to the twenty-first through fiftieth day of operation.

The overall response of the digesters to the 1/7 dilution was relatively stable. The average daily gas production per individual digester was between 290 and 360 mℓ/day. Average alkalinity per digester was between 2500 and 3000 mg/ℓ as $CaCO_3$. The average pH per digester was between 7.4 and 7.5. Average NH_4^+ - N concentration per digester was between 280 and 380 mg/ℓ, well within good operating conditions. No problems were encountered with VA in either of the three digesters during the study. The VA concentrations in the digesters never exceeded 260 mg/ℓ as HAc and the average VA concentration per digester was between 170 and 180 mg/ℓ as HAc. The digesters typically had a thin surface scum and a thin layer of solids on the bottom when dismantled at the conclusion of the run.

Unit 3 was operated for an extended period of time until gas composition data could be obtained. Operating conditions remained stable throughout the extended period of operation. Daily gas production,

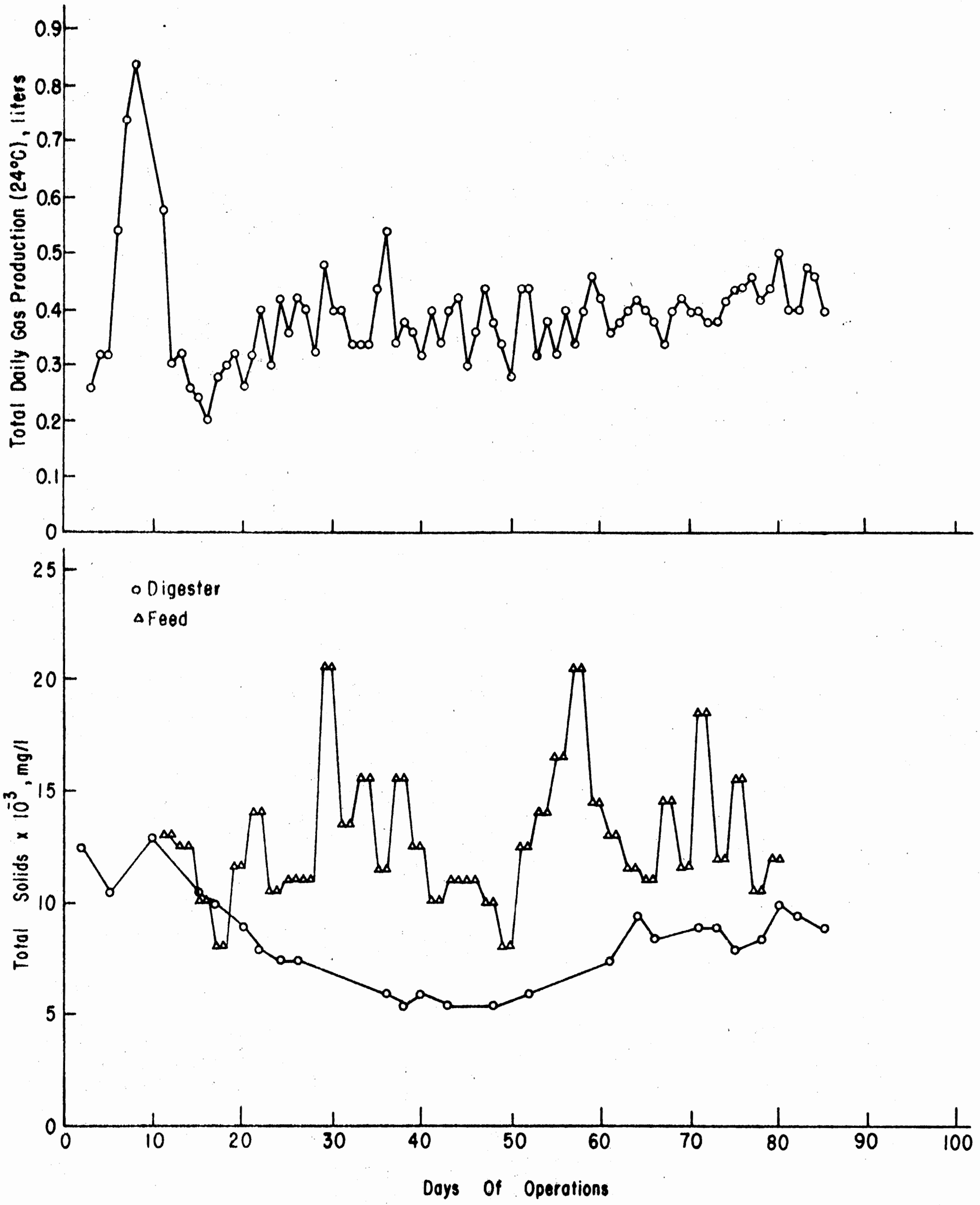

Figure 27. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the First Unit Operated on One-Seventh Dilution (March 9, 1976 to May 31, 1976)

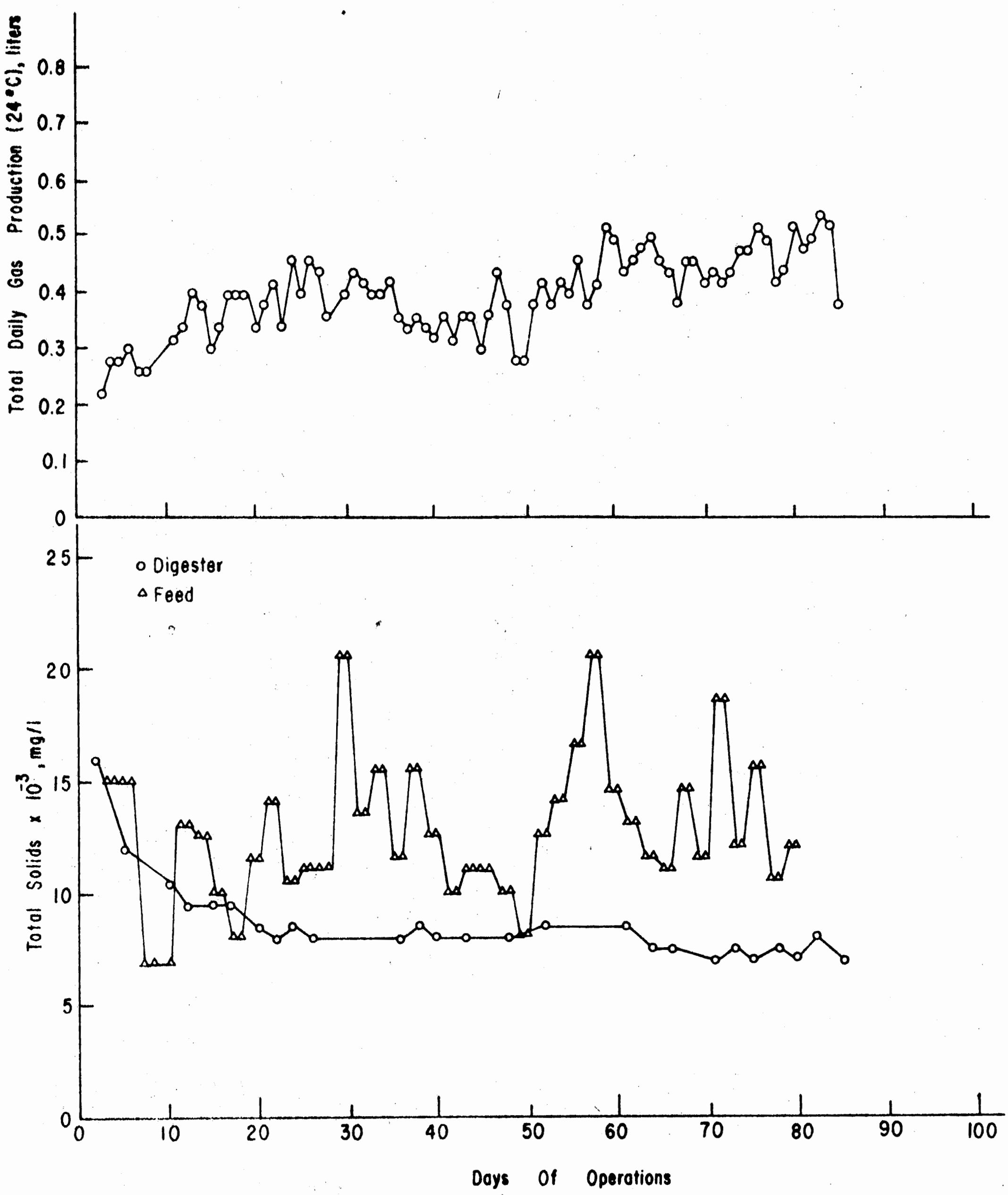

Figure 28. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the Second Unit Operated on the One-Seventh Dilution (March 9, 1976 to May 31, 1976)

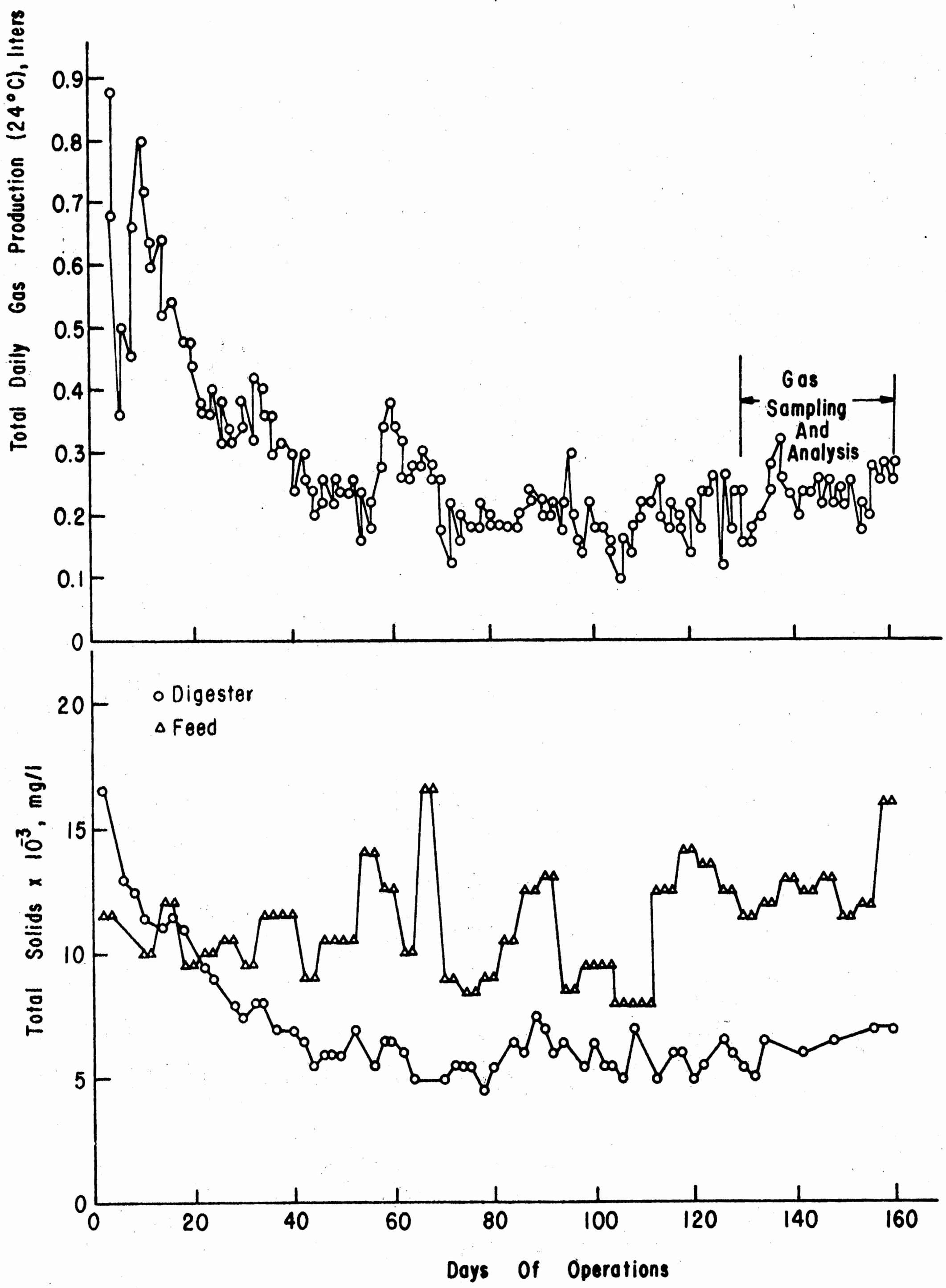

Figure 29. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the Third Unit Operated on the One-Seventh Dilution (June 10, 1976 to November 15, 1976)

TABLE XXII

DATA SUMMARY FOR DIGESTERS FED THE ONE-SEVENTH DILUTION OF SWINE MANURE

Parameter	Unit #1	Unit #2	Unit #3
Loading:			
mg TS/ℓ of digester/day*	550	600	550
Detention time, days	20	20	20
Digester Influent:			
TS, mg/ℓ*	11000 (2000)**	12000 (3000)	11000 (1500)
VSS, mg/ℓ*	7600 (1500)	8500 (2100)	7300 (1200)
COD MLSS, mg/ℓ*	11000 (2000)	11400 (2000)	9500 (2200)
NH_4^+ - N, mg/ℓ*	290 (40)	290 (40)	210 (70)
TVS, %*	72 (3)	72 (3)	74 (3)
SS, %*	85 (9)	86 (9)	88 (3)
VSS, %*	77 (6)	75 (7)	77 (3)
COD SP, %*	17 (5)	15 (5)	13 (5)
Operating Conditions:			
Duration, days	50	60	60
Temperature, °C*	34.6 (1.3)	34.7 (1.3)	34.5 (1.2)
Gas, mℓ/day*	360 (85)	360 (80)	290 (65)
pH*	7.4 (0.09)	7.5 (0.08)	7.5 (0.1)
Alkalinity, mg/ℓ as $CaCO_3$*	2500 (180)	3000 (100)	2800 (400)
VA, mg/ℓ as HAc*	170 (20)	180 (30)	170 (40)
Digester Effluent:			
TS, mg/ℓ*	6000 (1000)	8000 (200)	7000 (1000)
VSS, mg/ℓ*	2000 (300)	4500 (300)	4000 (600)
COD MLSS, mg/ℓ*	3700 (600)	7600 (500)	6700 (900)
NH_4^+ - N, mg/ℓ*	280 (40)	360 (50)	380 (80)
TVS, %*	44 (10)	63 (3)	64 (3)
SS, %*	46 (12)	79 (7)	76 (6)
VSS, %*	71 (10)	72 (7)	75 (5)
COD SP, %*	26 (2)	16 (1)	23 (3)
Initial Conditions:			
TS, mg/ℓ	13000	16000	16000
VSS, mg/ℓ	1900	5300	9500
COD MLSS, mg/ℓ	3300	16000	15400
NH_4^+ - N, mg/ℓ	150	340	240

*Average values.

**Value in parentheses is the standard deviation.

however, was below the expected volume. After 120 days of operation the digester was noted to be 300 to 500 mℓ below the 4.0 ℓ operating level. The decline in digester volume was attributed to volume reduction due to solids degradation and spillage when servicing the stirring pump. The volume was returned to the design operating level and a slight improvement in daily gas production was noted.

One-Fifth Dilution

A digester was operated on the one-fifth (1/5) dilution during both the second and third segments of the study. Figures 30 and 31 are profiles of feed TS, digester TS, and digester gas production versus days of operation for the two respective digesters. Table XXIII summarizes the feed characteristics, operating conditions, digester effluent characteristics, and initial conditions for each digester.

The average volume of gas generated daily varied drastically between the two digesters. Unit 1 averaged 500 mℓ of gas per day. Unit 2, however, averaged only 220 mℓ of gas per day. The different initial conditions for the two digesters, particularly the NH_4^+ - N concentration, was partially responsible for the variation in gas production. The initial NH_4^+ - N concentration in Unit 2 was 780 mg/ℓ, 3.25 times greater than the initial NH_4^+ - N concentration in Unit 1. The higher initial NH_4^+ - N concentration initially inhibited Unit 2. Also, the feed TS profile for Unit 2 (Figure 31) indicates the feed suspension was relatively weak during the first half of the run. The daily gas production for Unit 2 tended to increase with increased TS concentration in the feed suspension. Daily gas production for Unit 1, however, followed a decreasing trend, but appeared to be stabilizing after 60 days of operation.

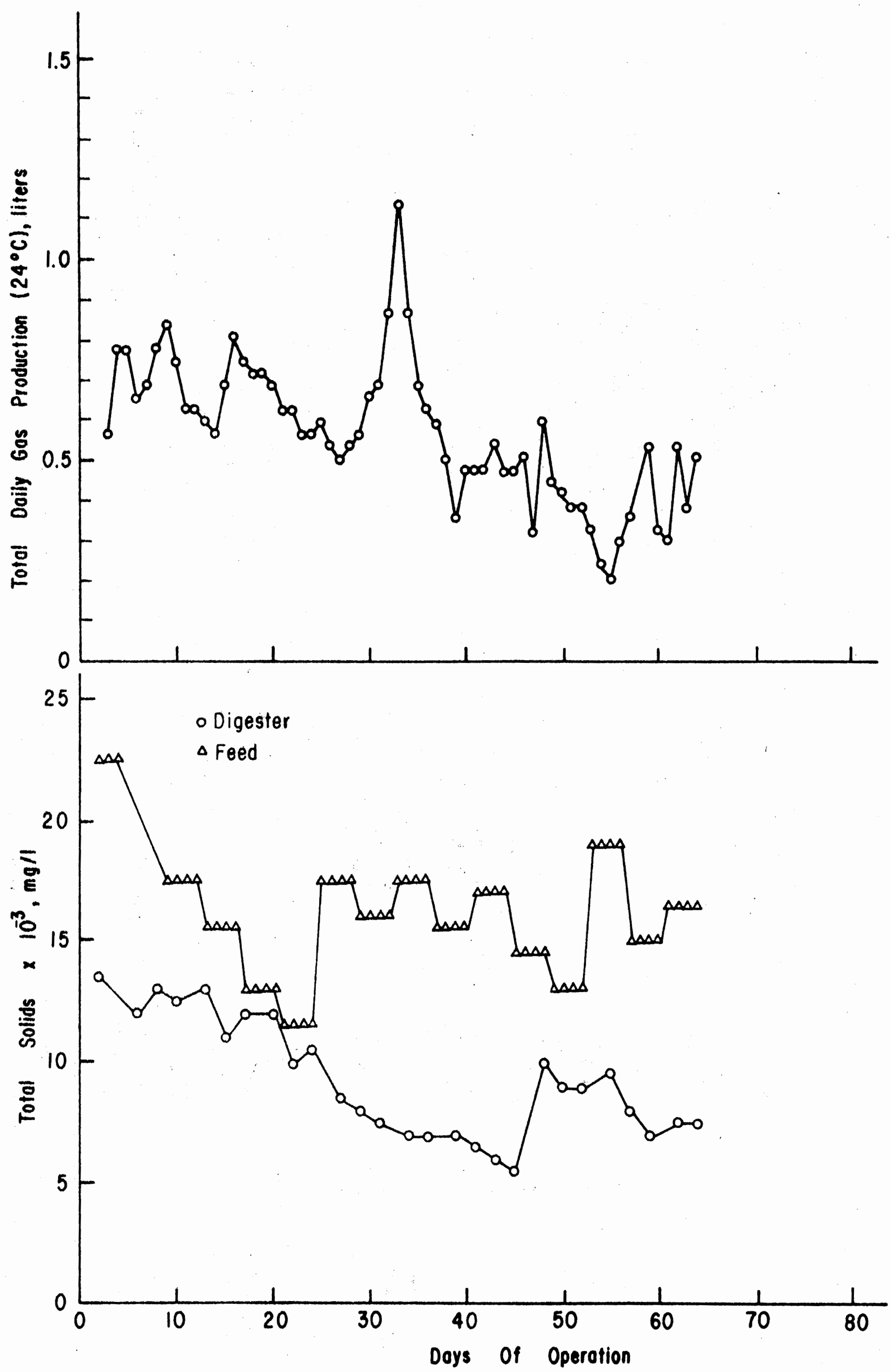

Figure 30. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the First Unit Operated on the One-Fifth Dilution (June 10, 1976 to August 11, 1976)

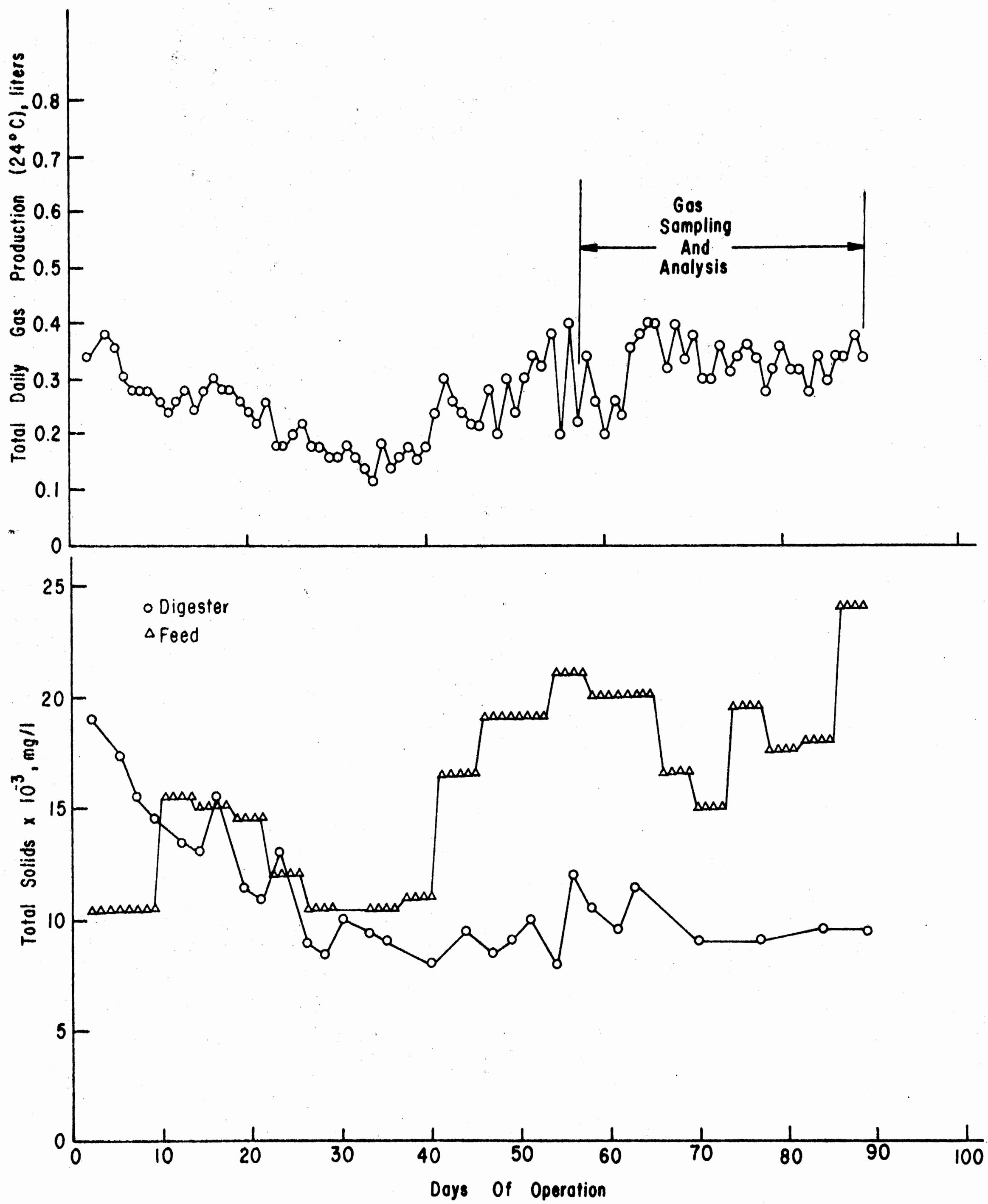

Figure 31. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the Second Unit Operated on the One-Fifth Dilution (August 20, 1976 to November 15, 1976)

TABLE XXIII

DATA SUMMARY FOR DIGESTERS FED THE ONE-FIFTH DILUTION OF SWINE MANURE

Parameter	Unit #1	Unit #2
Loading:		
mg TS/ℓ of digester/day*	800	750
Detention time, days	20	20
Digester Influent:		
TS, mg/ℓ*	16000 (1900)**	15000 (4000)
VSS, mg/ℓ*	10000 (1600)	9700 (2900)
COD MLSS, mg/ℓ*	13000 (2200)	13000 (4000)
NH_4^+ - N, mg/ℓ*	300 (60)	370 (60)
TVS, %*	73 (2)	67 (2)
SS, %*	88 (7)	92 (6)
VSS, %*	79 (6)	70 (5)
COD SP, %*	14 (5)	6 (1)
Operating Conditions:		
Duration, days	60	60
Temperature, °C*	35.0 (1.3)	34.0 (1.1)
Gas, mℓ/day*	500 (170)	220 (70)
pH*	7.5 (0.2)	7.4 (0.1)
Alkalinity, mg/ℓ as $CaCO_3$*	3200 (520)	3300 (400)
VA, mg/ℓ as HAc*	190 (40)	190 (20)
Digester Effluent:		
TS, mg/ℓ*	7700 (1400)	9400 (1400)
VSS, mg/ℓ*	3600 (600)	6000 (1100)
COD MLSS, mg/ℓ*	6600 (1200)	10000 (1200)
NH_4^+ - N, mg/ℓ*	490 (80)	500 (80)
TVS, %*	57 (5)	70 (2)
SS, %*	62 (7)	84 (4)
VSS, %*	75 (7)	76 (6)
COD SP, %*	27 (4)	22 (3)
Initial Conditions:		
TS, mg/ℓ	14000	19000
VSS, mg/ℓ	6600	12000
COD MLSS, mg/ℓ	12000	21000
NH_4^+ - N, mg/ℓ	240	780

*Average values.

**Value in parentheses is the standard deviation.

Digester TS concentration also followed a decreasing trend during much of the run. A rapid increase in TS followed when the pump digester was cleaned after 44 days of operation. Therefore, poor mixing was thought to have influenced both the decline in digester TS concentration and gas production profiles for Unit 1.

The general operating characteristics of the two digesters were well within the range of good operating conditions. The two digesters had average alkalinities of 3200 and 3300 mg/ℓ as $CaCO_3$, respectively. The pH of the individual digesters averaged 7.4 and 7.5, respectively. Volatile acids were not a problem in either unit since the levels never exceeded 320 mg/ℓ as HAc and averaged 190 mg/ℓ as HAc. The NH_4^+ - N level in both digesters stabilized between 400 and 500 mg/ℓ. A thin surface scum and a thin layer of solids on the bottom was noted with both digesters when each was dismantled at the conclusion of the run.

<u>One-Third Dilution</u>

Three digesters were fed the one-third (1/3) dilution of swine manure. Two digesters were operated at the 1/3 dilution during the first segment of the study and one during the second segment of the study. Plots of feed TS, digester TS, and digester gas production versus days of operation for each of the three digesters are presented in Figures 32, 33 and 34, respectively. Table XXIV summarizes the operating characteristics for the three digesters.

The three digesters functioned satisfactorily throughout the 60 day study period. Gas production by the three units was generally stable by the twenty-first day of operation. Gas production for Units 1 and 2 followed a slight increasing trend while Unit 3 maintained relatively

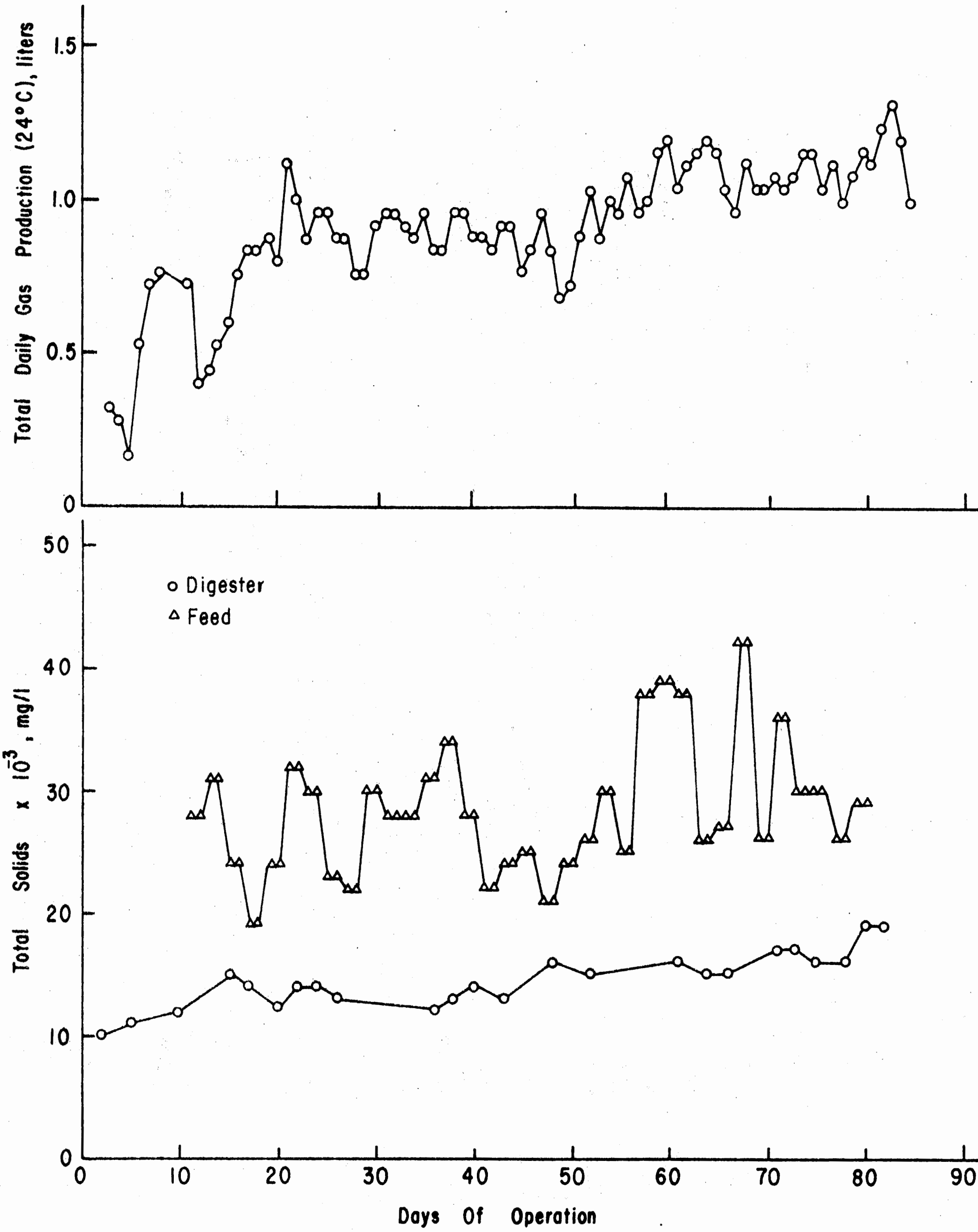

Figure 32. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the First Unit Operated on the One-Third Dilution (March 9, 1976 to May 31, 1976)

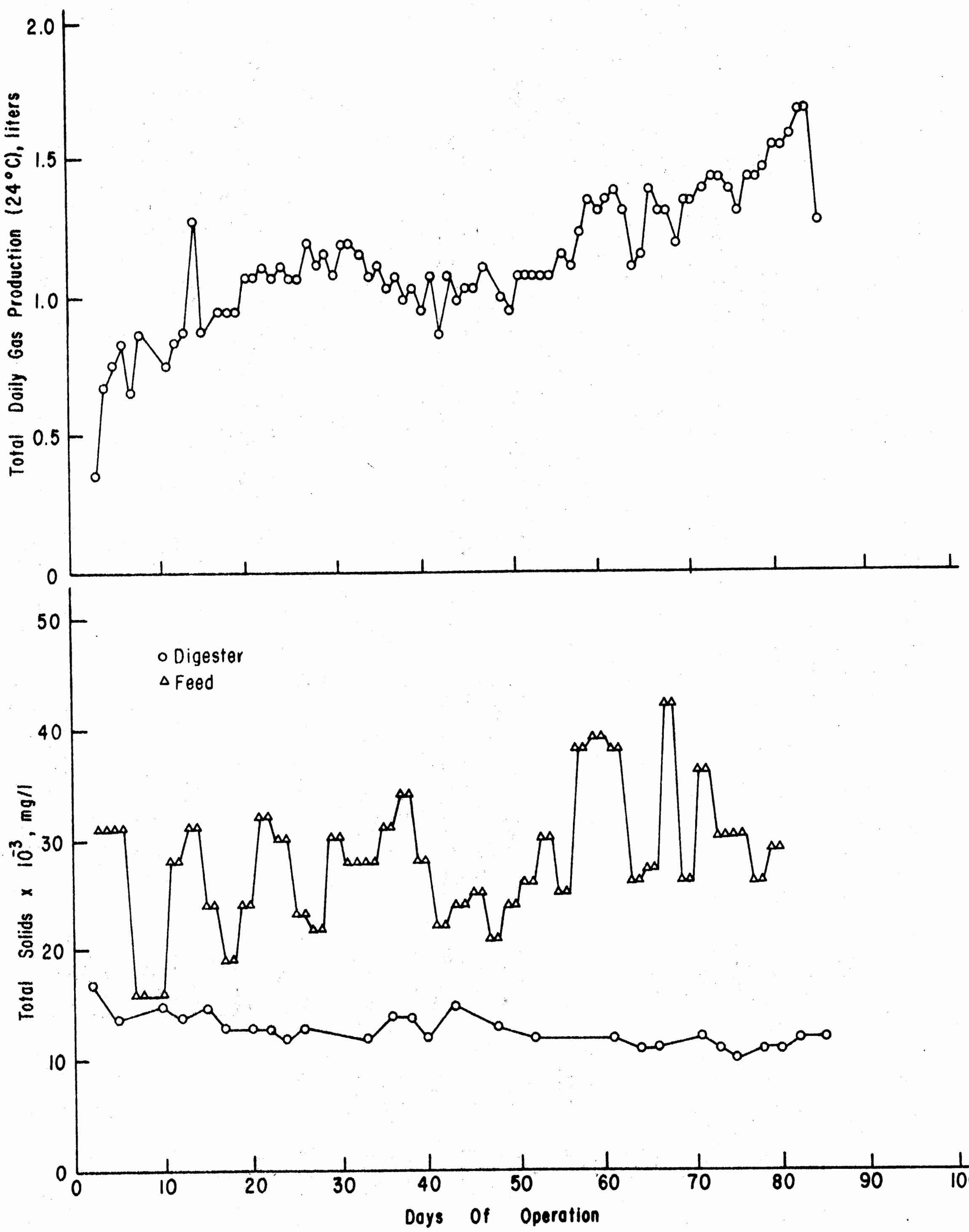

Figure 33. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the Second Unit Operated on the One-Third Dilution (March 9, 1976 to May 31, 1976)

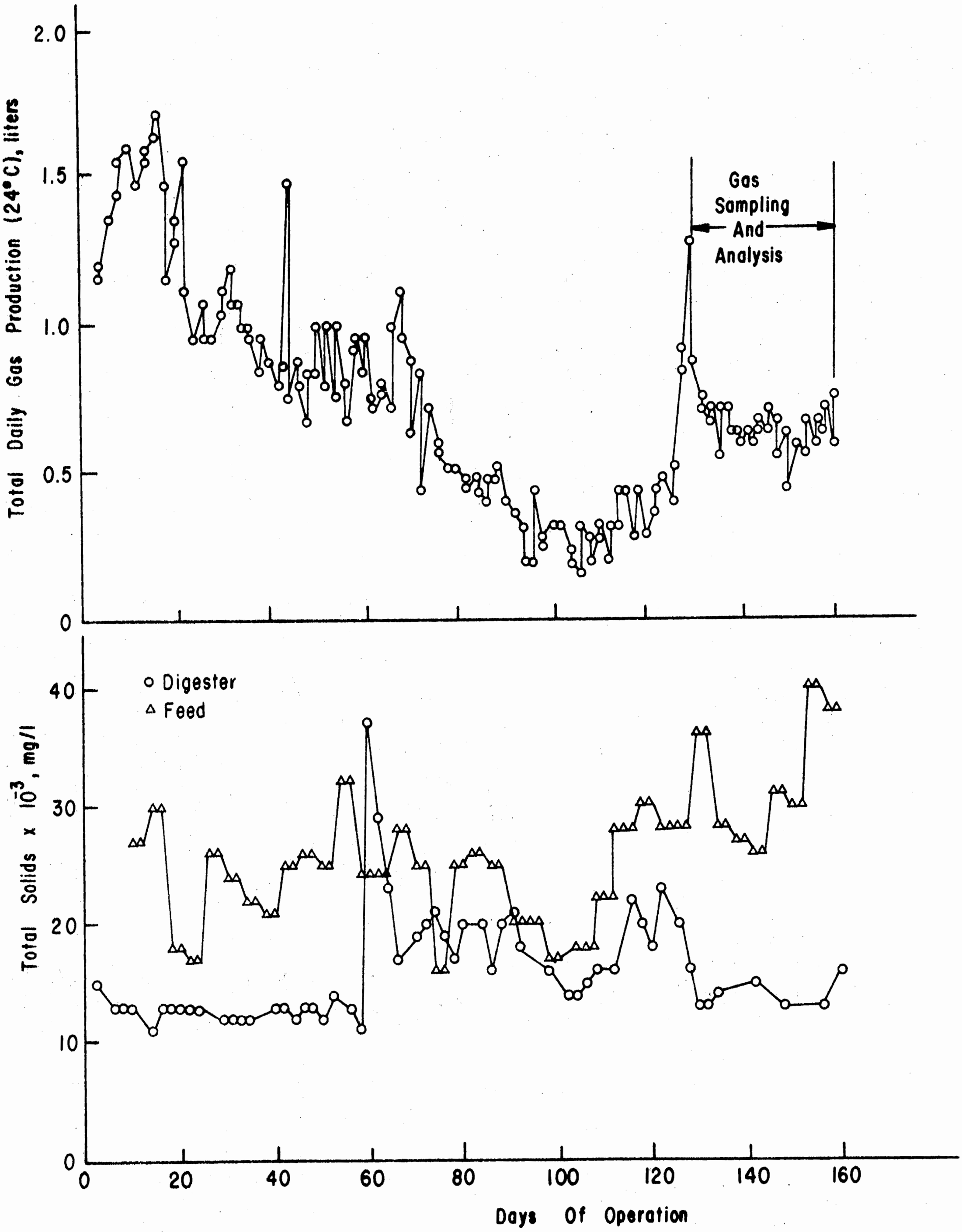

Figure 34. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the Third Unit Operated on the One-Third Dilution (June 10, 1976 to November 15, 1976)

TABLE XXIV

DATA SUMMARY FOR DIGESTERS FED THE ONE-THIRD DILUTION OF SWINE MANURE

Parameter	Unit #1	Unit #2	Unit #3
Loading:			
mg TS/ℓ of digester/day*	1400	1400	1200
Detention time, days	20	20	20
Digester Influent:			
TS, mg/ℓ*	28000 (5000)**	28000 (5000)	24000 (3400)
VSS, mg/ℓ*	18000 (4000)	18000 (4000)	17000 (2600)
COD MLSS, mg/ℓ*	29000 (5000)	29000 (5000)	21000 (5500)
NH_4^+ - N, mg/ℓ*	660 (80)	660 (80)	520 (130)
TVS, %*	70 (2)	70 (2)	72 (2)
SS, %*	89 (5)	89 (5)	92 (3)
VSS, %*	73 (7)	73 (7)	77 (6)
COD SP, %*	17 (6)	17 (6)	17 (7)
Operating Conditions:			
Duration, days	60	60	60
Temperature, °C*	34.8 (1.2)	34.5 (1.1)	35.5 (1.4)
Gas, mℓ/ day*	880 (130)	1080 (100)	920 (150)
pH*	7.6 (0.2)	7.7 (0.1)	7.5 (0.09)
Alkalinity, mg/ℓ as $CaCO_3$*	4710 (750)	5490 (250)	5030 (400)
VA, mg/ℓ as HAc*	170 (40)	200 (20)	210 (60)
Digester Effluent:			
TS, mg/ℓ*	13000 (1400)	12000 (1000)	12000 (700)
VSS, mg/ℓ*	6700 (2100)	7300 (1000)	7400 (700)
COD MLSS, mg/ℓ*	11000 (2500)	11000 (600)	13000 (1400)
NH_4^+ - N, mg/ℓ*	600 (140)	700 (90)	710 (100)
TVS, %*	57 (11)	65 (4)	69 (3)
SS, %*	65 (13)	75 (4)	80 (5)
VSS, %*	75 (8)	78 (7)	78 (4)
COD SP, %*	18 (2)	20 (4)	24 (6)
Initial Conditions:			
TS, mg/ℓ	9500	16000	14000
VSS, mg/ℓ	1400	5000	7400
COD MLSS, mg/ℓ	3500	14000	14000
NH_4^+ - N, mg/ℓ	160	360	230

*Average values.

**Value in parentheses is the standard deviation.

stable gas production during the 21 to 60 day period. Several of the other pertinent operational characteristics, however, took longer to fully stabilize. The average pH per digester was between 7.5 and 7.7. Alkalinity concentrations in the digesters stabilized between 5000 and 6000 mg/ℓ as $CaCO_3$. Similarly, NH_4^+ - N concentrations in the digesters stabilized between 800 and 900 mg/ℓ. The VA concentration was typically between 170 and 210 mg/ℓ as HAc. The average VA level per individual digester never exceeded 360 mg/ℓ as HAc. A surface scum layer and a layer of settled solids were noted in each digester at the conclusion of run.

Unit 3 was operated beyond the 60 day test period until gas composition could be determined. Although operating conditions remained stable throughout the extended period of operation, the daily gas production profile for Unit 3 (Figure 34) indicates gas production declined substantially between 70 and 124 days of operation. The decline in gas production was due to a combination of effects. A problem was encountered with the mixing pump at the end of the 60 day test period. Failure to adequately mix digester permitted solids to settle and accounted for the high TS content in the digester effluent during the same period. Also, the feed TS profile for Unit 3 (Figure 34) shows the solid content of the feed was below average during the corresponding 54 day period. Inspection of the digester after 120 days of operation revealed the level was 500 to 600 mℓ below the 4.0 ℓ mark. The decline in the digester volume was attributed to volume reduction due to solids degradation and spillage occurring when servicing the mixing pump. The volume was returned to the 4.0 ℓ mark. The daily gas production for the digester approached normal once the level of the digester was corrected and the concentration of solids in the feed increased.

One-Half Dilution

A digester was fed the one-half (1/2) dilution during both the second and third segments of the study. Figures 35 and 36 are plots of feed TS, digester TS, and digester daily gas production versus days of operation for each unit, respectively. Table XXV summarizes the feed characteristics, operating conditions, digester effluent characteristics, and initial conditions for both digesters. The analyses of digester response data were limited to 54 days of operation for both units because of pump problems. The pump on Unit 2 was repaired and the unit was maintained until composition of the gas was determined.

The daily gas production by the two digesters was noticeably different. Unit 1 averaged 1350 mℓ of gas per day. A comparison of the gas production profiles for both digesters over the initial 20 days of operation indicated the seed material used to start Unit 1 was more biologically active than the seed used to start Unit 2. Daily gas production by Unit 1 was declining during the initial 20 day period but stabilized around 1300 mℓ/day after 20 days of operation. Daily gas production by Unit 2 increased throughout the study and did not stabilize during the 60 day test period. Gas production by Unit 2 continued to increase and was approaching the gas production rate of Unit 1 by the seventieth day of operation. The initial NH_4^+ - N concentration in Unit 2 was 990 mg/ℓ, 3.2 times greater than the initial NH_4^+ - N concentration in Unit 1. The higher initial NH_4^+ - N inhibited Unit 2 and retarded stabilization of the system. The digester TS profile for Unit 2 (Figure 36) shows a rapid increase in TS after the pump was replaced on the fifty-fourth day of operation. The rapid rise in TS was due to solids being

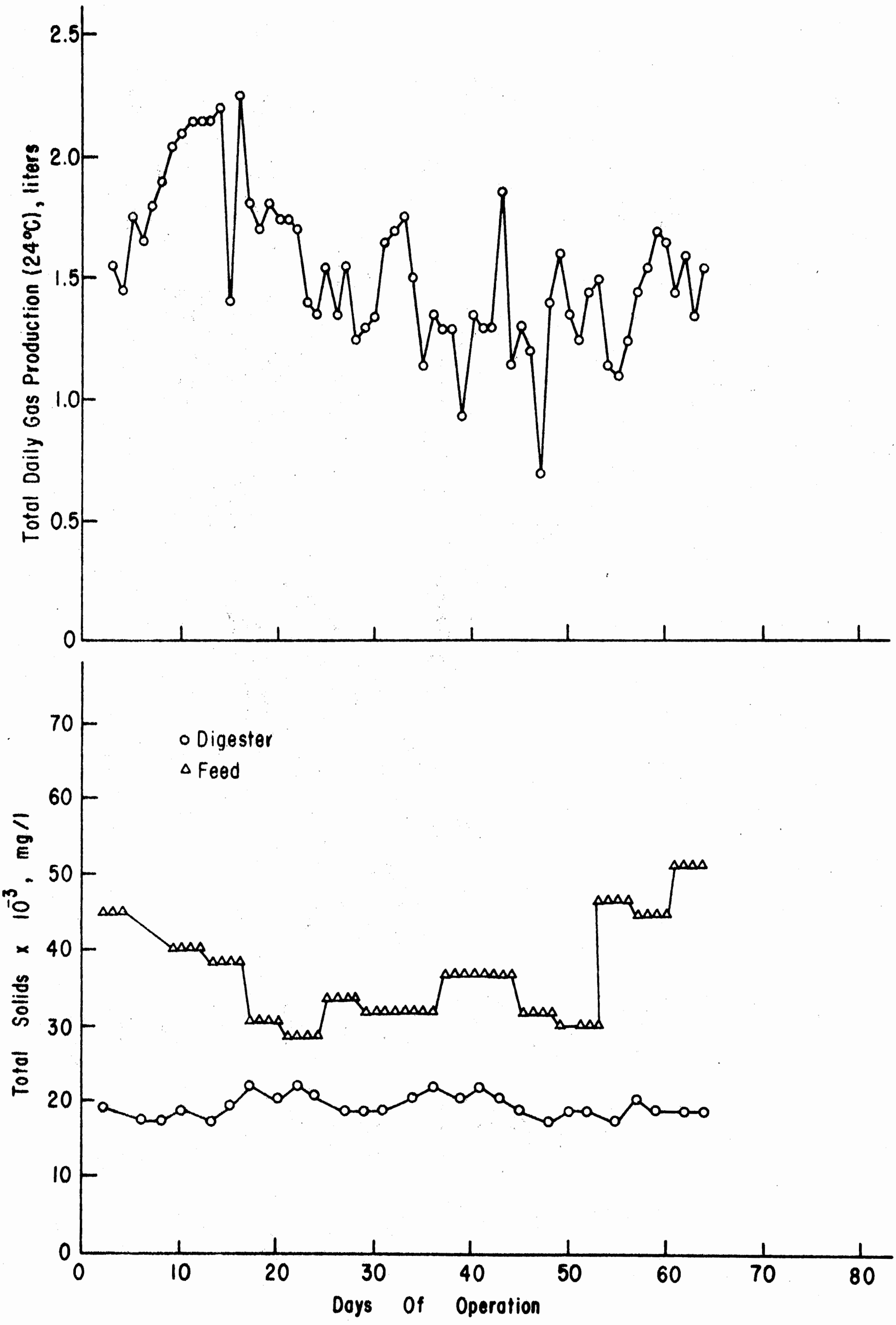

Figure 35. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the First Unit Operated on the One-Half Dilution (June 10, 1976 to August 11, 1976)

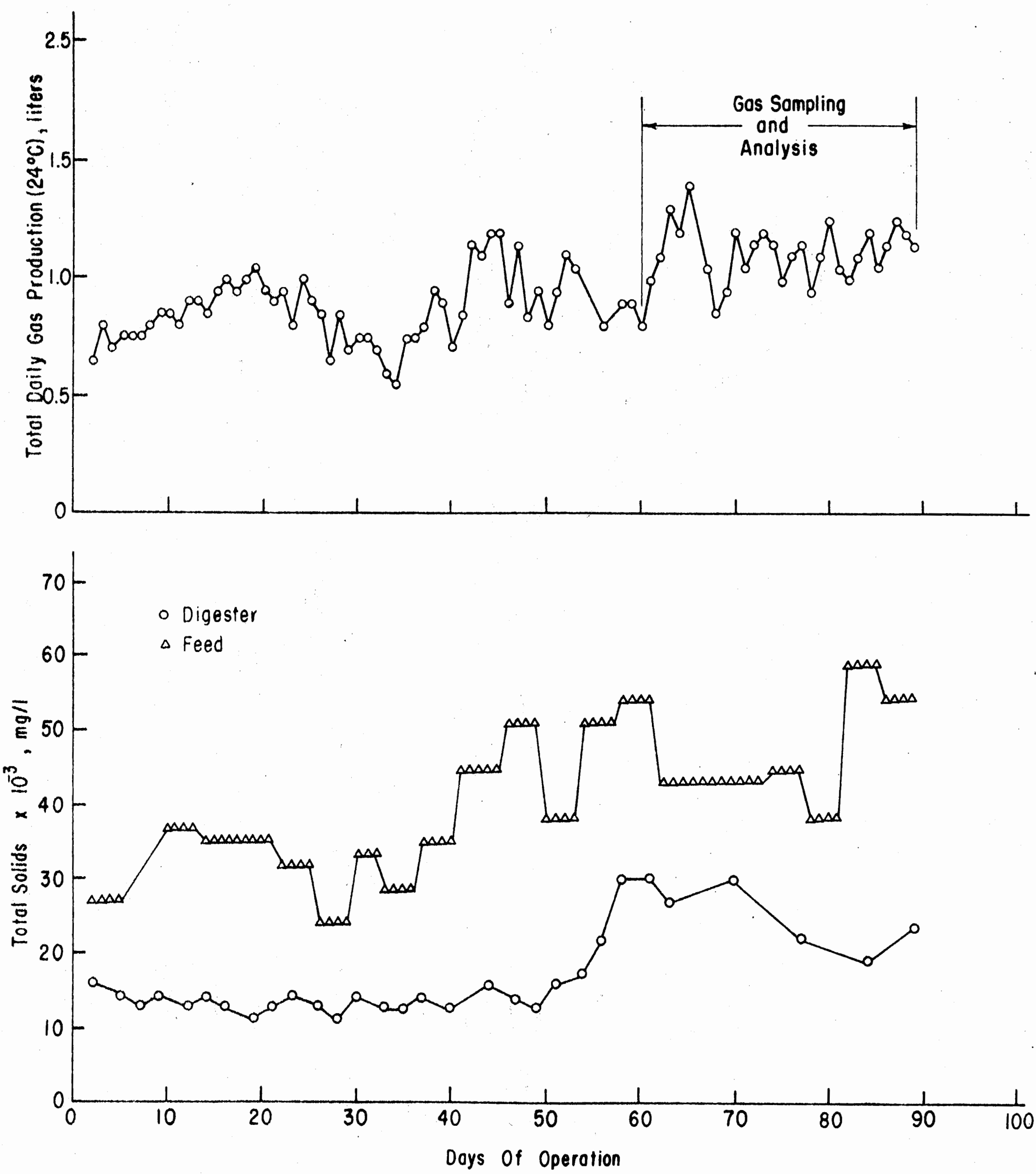

Figure 36. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the Second Unit Operated on the One-Half Dilution (August 20, 1976 to November 15, 1976)

TABLE XXV

DATA SUMMARY FOR DIGESTERS FED THE ONE-HALF DILUTION OF SWINE MANURE

Parameter	Unit #1	Unit #2
Loading:		
mg TS/ℓ of digester/day*	1650	1800
Detention time, days	20	20
Digester Influent:		
TS, mg/ℓ*	33000 (4700)**	36000 (8700)
VSS, mg/ℓ*	22000 (3400)	23000 (5500)
COD MLSS, mg/ℓ*	31000 (5400)	30000 (5900)
NH_4^+ - N, mg/ℓ*	810 (170)	690 (140)
TVS, %*	70 (3)	65 (3)
SS, %*	90 (2)	95 (2)
VSS, %*	74 (3)	67 (3)
COD SP, %*	19 (6)	7 (1)
Operating Conditions:		
Duration, days	54	54
Temperature, °C*	35.3 (1.2)	34.4 (1.4)
Gas, mℓ/day*	1350 (230)	860 (180)
pH*	7.7 (0.08)	7.4 (0.08)
Alkalinity, mg/ℓ as $CaCO_3$*	7400 (560)	4900 (280)
VA, mg/ℓ as HAc*	270 (50)	210 (30)
Digester Effluent:		
TS, mg/ℓ*	19000 (1300)	13000 (1500)
VSS, mg/ℓ*	12000 (1000)	8500 (1500)
COD MLSS, mg/ℓ*	20000 (1400)	14000 (2200)
NH_4^+ - N, mg/ℓ*	930 (100)	860 (80)
TVS, %*	70 (2)	71 (3)
SS, %*	82 (4)	82 (3)
VSS, %*	77 (5)	78 (5)
COD SP, %*	24 (3)	26 (3)
Initial Conditions:		
TS, mg/ℓ	18000	16000
VSS, mg/ℓ	9300	9200
COD MLSS, mg/ℓ	16000	17000
NH_4^+ - N, mg/ℓ	310	990

*Average values.

**Value in parentheses is the standard deviation.

picked up from the layer typically noted on the bottom of digesters by the improved circulation of the new pump. The TS level in Unit 2 stabilized again after two weeks and was comparable to the TS level in Unit 1.

General operating characteristics of the two digesters were within acceptable limits. The alkalinity and pH of the two digesters stabilized between 6500 and 7000 mg/ℓ as $CaCO_3$, and 7.5 and 7.7 respectively. The NH_4^+ - N concentrations characteristically leveled off between 850 and 950 mg/ℓ. Volatile acids (VA) buildup posed no problem in either digester. The two digesters had average VA concentrations of 210 and 270 mg/ℓ as HAc, respectively. The VA concentration never exceeded 440 mg/ℓ in either unit. A gaseous scum layer of solids and a layer of settled solids were noted in each digester when dismantled at the conclusion of the run. The scum layers were also noted to contain hair.

Straight Dilution

Three digesters were fed the straight manure solution prepared to represent the daily manure flow from the farrow to finish production facilities. Two digesters were maintained on straight feed during the first segment of the study. A single digester was fed the straight feed solution during the second segment of the study. Figures 37, 38 and 39 are plots of feed TS, digester TS, and digester gas production versus days of operation for each of the three respective digesters. Table XXVI summarizes the operating characteristics for the three digesters.

The daily gas production by each of the three digesters stabilized within the first 20 days of operation. Although the daily gas production for Unit 1 appeared to be declining by the fiftieth day of

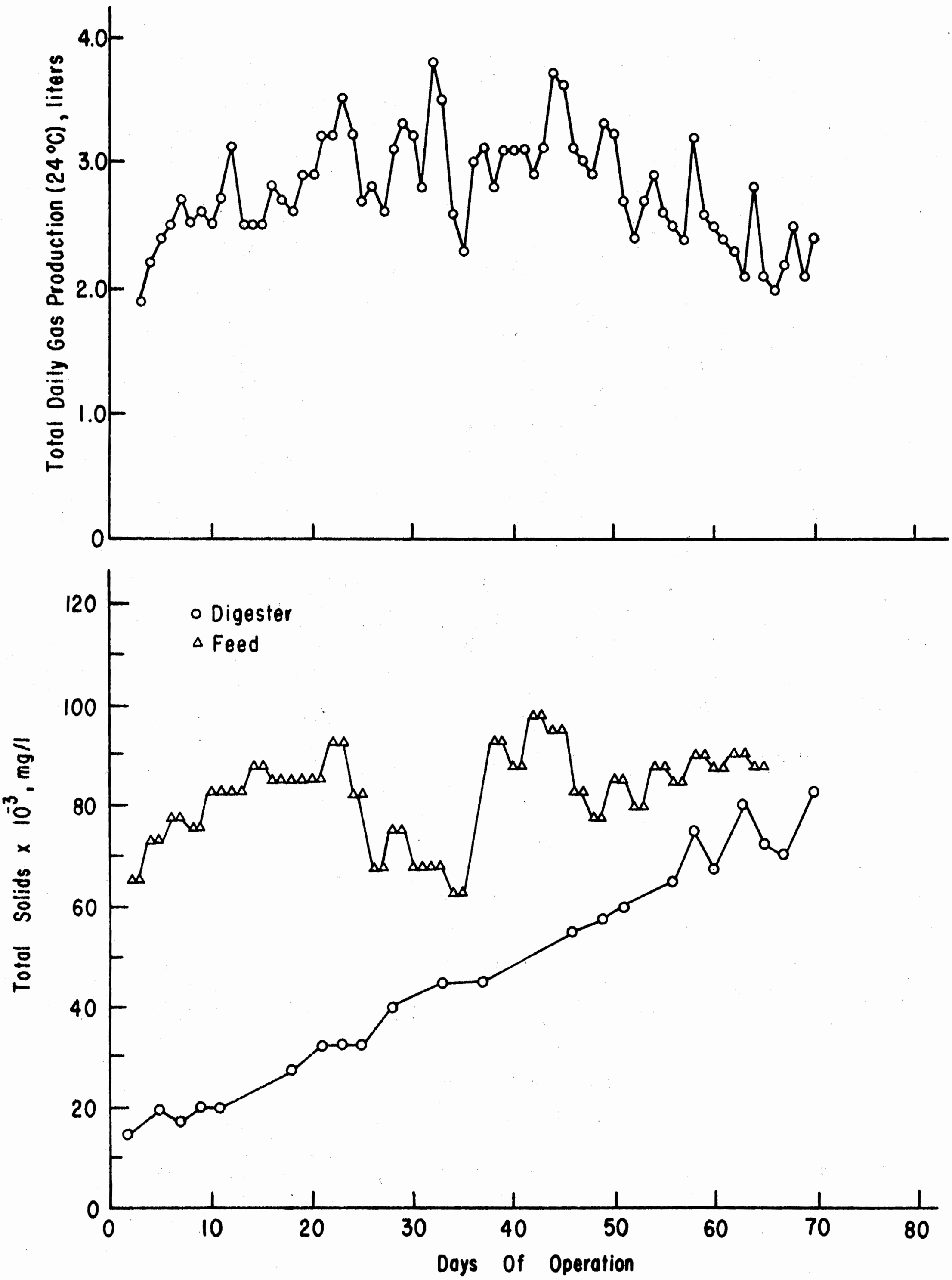

Figure 37. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the First Unit Operated on the Straight Dilution (March 24, 1976 to May 31, 1976)

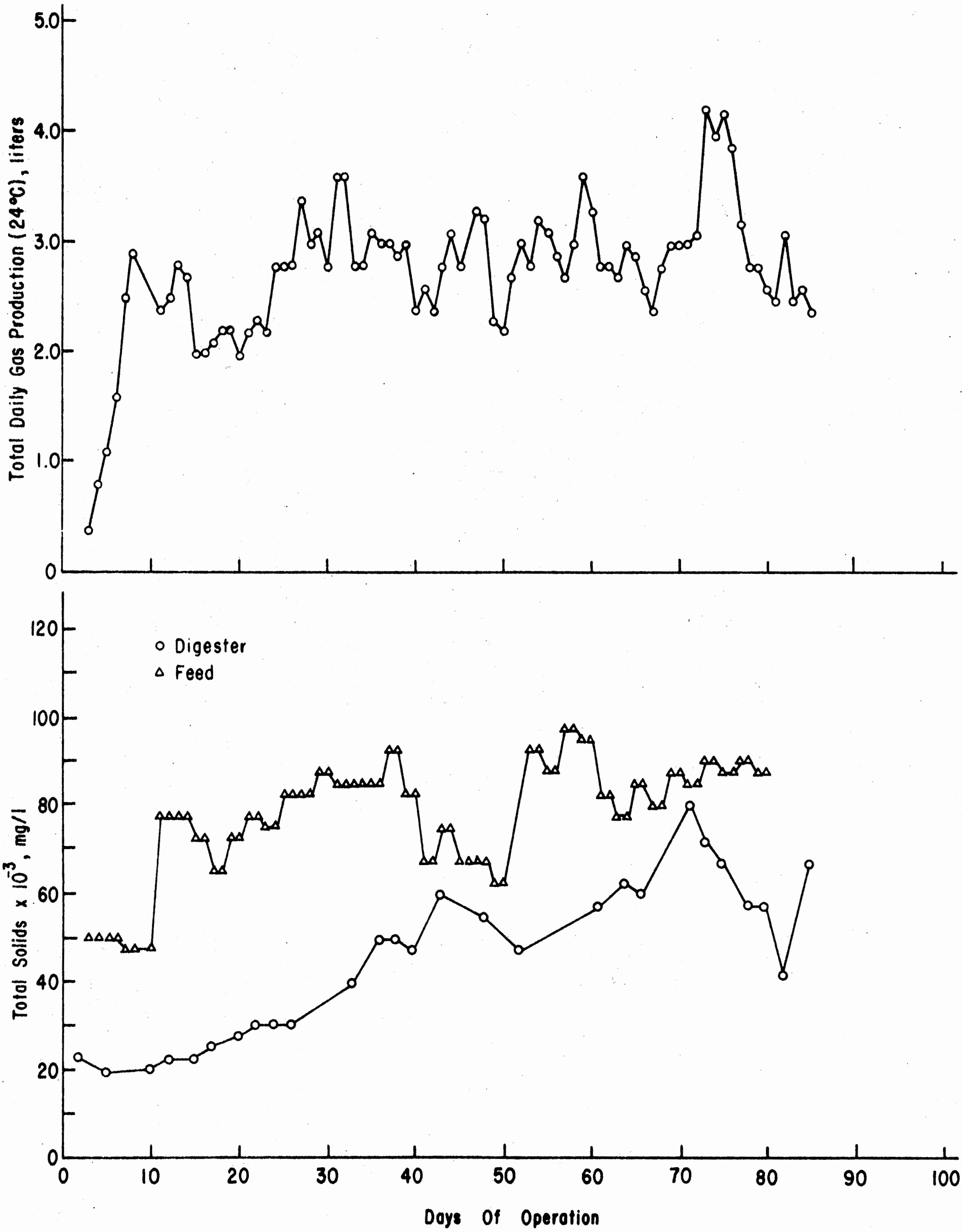

Figure 38. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the Second Unit Operated on the Straight Dilution (March 9, 1976 to May 31, 1976)

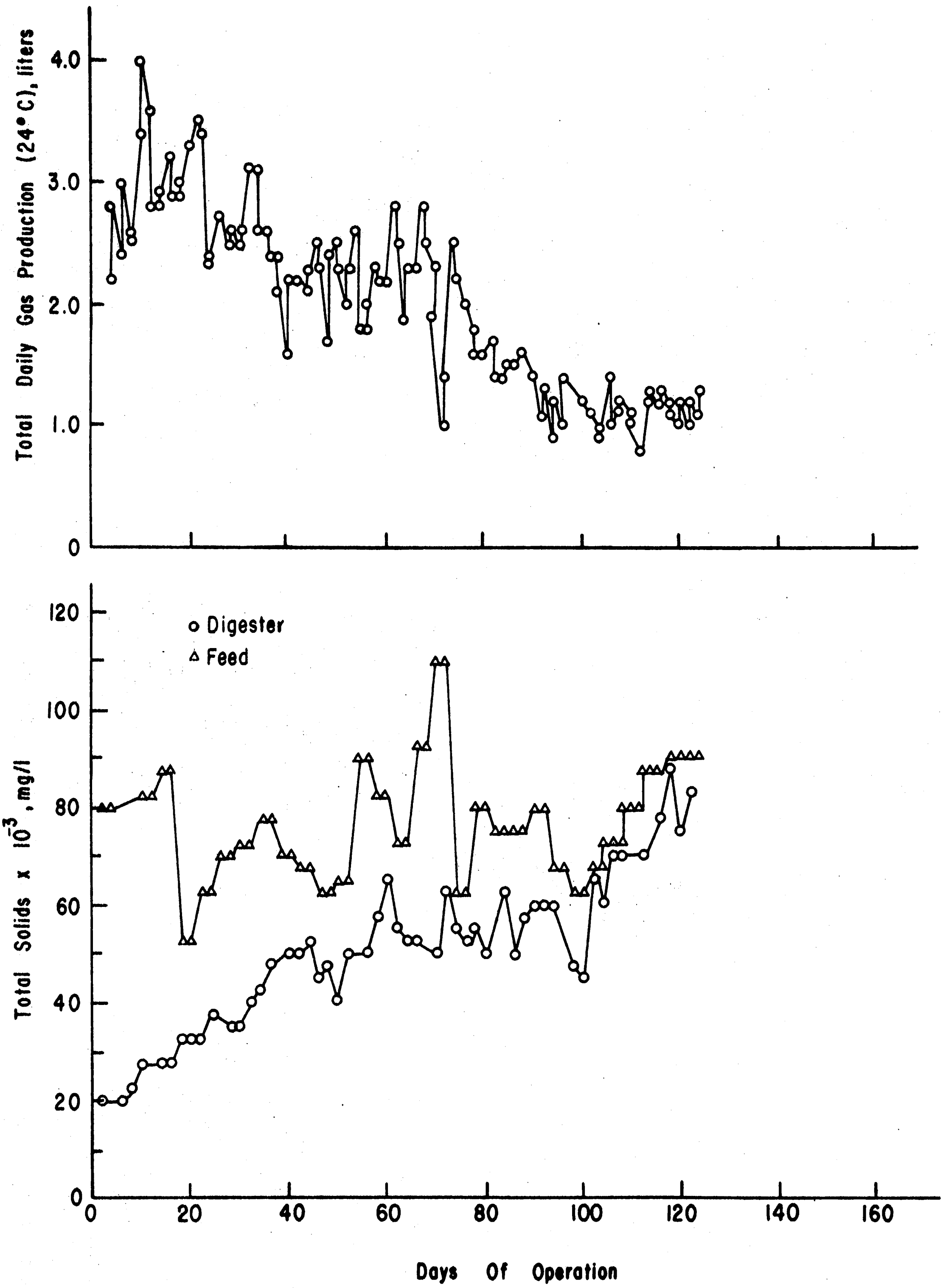

Figure 39. Feed TS, Digester TS, and Digester Gas Production Versus Days of Operation for the Third Unit Operated on the Straight Dilution (June 10, 1976 to October 7, 1976)

TABLE XXVI

DATA SUMMARY FOR DIGESTERS FED THE STRAIGHT SWINE MANURE SUSPENSION

Parameter	Unit #1		Unit #2		Unit #3	
Loading:						
mg TS/ℓ of digester/day*	4100		3950		3550	
Detention time, days	20		20		20	
Digester Influent:						
TS, mg/ℓ*	82000	(10000)**	79000	(12000)	71000	(8400)
VSS, mg/ℓ*	53000	(6200)	52000	(6300)	45000	(5800)
COD MLSS, mg/ℓ*	74000	(13000)	72000	(8400)	59000	(16000)
NH_4^+ - N, mg/ℓ*	2120	(330)	2080	(360)	1630	(340)
TVS, %*	69	(1)	68	(2)	68	(2)
SS, %*	91	(2)	92	(3)	91	(3)
VSS, %*	71	(2)	70	(3)	70	(3)
COD SP, %*	24	(6)	24	(6)	20	(5)
Operating Conditions:						
Duration, days	60		60		60	
Temperature, °C*	35.1	(1.1)	34.9	(1.4)	35.7	(1.2)
Gas, mℓ/day*	2800	(440)	2860	(350)	2340	(380)
pH*	8.0	(0.08)	8.0	(0.1)	7.9	(0.07)
Alkalinity, mg/ℓ as $CaCO_3$*	17200	(2800)	16300	(2800)	14400	(900)
VA, mg/ℓ as HAc*	2680	(1450)	1360	(900)	570	(220)
Digester Effluent:						
TS, mg/ℓ*	57000	(17000)	44000	(11000)	44000	(8900)
VSS, mg/ℓ*	38000	(12000)	27000	(8400)	29000	(6400)
COD MLSS, mg/ℓ*	68000	(31000)	54000	(17000)	45000	(12000)
NH_4^+ - N, mg/ℓ*	2540	(410)	2240	(510)	1790	(190)
TVS, %*	71	(3)	67	(3)	71	(1)
SS, %*	87	(5)	85	(6)	86	(5)
VSS, %*	76	(3)	71	(3)	76	(3)
COD SP, %*	25	(7)	22	(5)	21	(5)
Initial Conditions:						
TS, mg/ℓ	15000		19000		19000	
VSS, mg/ℓ	6200		8900		11000	
COD MLSS, mg/ℓ	11000		18000		19000	
NH_4^+ - N, mg/ℓ	650		550		1030	

*Average values.

**Value in parentheses is the standard deviation.

operation, daily gas production by Units 2 and 3 remained relatively stable throughout the 60 day test period. The TS concentrations in each of the digesters continually increased throughout the 40 day response period. The continued increase in the TS levels in the three digesters was the result of the seed material TS content being less than the normal operating TS levels. The TS concentration in the three units, as a result, were exhibiting a dilute-in phenomenon. The fluctuations in TS concentration at the end of the run in Unit 2 was due to pumping problems.

The general operating characteristics for the three units took longer than the initial 20 days to stabilize. The pH for the digesters stabilized between 7.9 and 8.0. The average alkalinity per digester was between 14400 and 17200 mg/ℓ as $CaCO_3$, but the alkalinities appeared to finally level off between 18000 and 20000 mg/ℓ as $CaCO_3$. The NH_4^+ - N concentrations stabilized in the 1800 to 2700 mg/ℓ range. Alkalinity, pH, and NH_4^+ - N levels exceeded values accepted for correctly functioning digesters. The VA concentrations in the three units varied considerably. Unit 1 had VA concentrations ranging between 2000 and 4000 mg/ℓ as HAc near the end of the 60 day trial. The VA concentrations in Units 2 and 3 were lower than Unit 1 and ranged between 600 and 1300 mg/ℓ as HAc.

Each digester had a scum layer on the surface and a solids layer on the bottom when they were dismantled at the conclusion of the run. Both layers were thicker than any noted with the other digesters. The scum layer again contained hair.

Digester 3 was operated for an extended period until gas samples could be taken and analyzed for composition. However, before the gas could be sampled, the mixing pump line broke and a large portion of the contents of the unit was lost. The volume of material lost made it impossible to restart and stabilize the unit in time for gas analyses. Inspection of the digester after the line breakage revealed the level was 500 to 700 mℓ below the 4.0 ℓ operating volume. The reduced volume was attributed to solids degradation and spillage occurring when servicing the mixing pump. The pump had to be serviced frequently during the extended period because of hair clogging the pump. The reduced volume was thought to be a primary cause for the decline in gas production noted after 80 days of operation.

Finisher

A digester was fed during the second and third segment of the study manure taken directly from the finishing building. The 60 day study period, however, was too short for the digesters to achieve stability. Pumping problems were frequently experienced during both trials due to the extremely thick manure suspension and hair. Foaming was also a problem in both trials, particularly Trial 2. Pumping problems and foaming made it difficult to maintain the 4.0 ℓ digester volume. A formal data summary for the two trials has been omitted because of aforementioned conditions and problems.

The general operating characteristics at the conclusion of the study for the two digesters were indicative of eventual digester failure. The daily gas production by the two units exhibited declining trends, particularly Unit 1. The digesters were producing 800 to 1000 mℓ of gas/day at the conclusion of the study. The VA concentrations in the two digesters were noticeably different. Unit 1 had a maximum VA concentration of 10000 mg/ℓ as HAc but the VA concentration typically ranged between 5500 and 6500 mg/ℓ as HAc. Unit 2, however, generally had VA concentrations in the 1000 mg/ℓ as HAc range. The variation in VA concentrations between the two units was due to a difference in biological activity. Based on the daily gas production records for the two units, Unit 2 was not as biologically active as Unit 1. The pH in the units ranged between 7.6 and 7.8. The TS and NH_4^+ - N concentrations in the digesters continually increased throughout the study and ranged between 95000 to 110000 mg/ℓ and 3000 to 3400 mg/ℓ, respectively, when the trials were terminated. The alkalinity in each unit also continually increased initially but appeared to stabilize between 20000 and 25000 mg/ℓ as $CaCO_3$.

The surface of each digester was covered with a two to three cm thick scum layer when the digesters were dismantled. A layer of solids was also noted at the bottom of each digester.

Gas Composition

Gas samples were analyzed for composition during the 24 days (October 8, 1976 to November 10, 1976) at the end of the third segment of the study. Procedures used to determine gas composition and raw data for the gas composition work are presented in Appendix G. Gas was sampled and analyzed eight times during the 24 day period. Samples were taken from digesters operating on 1/7, 1/5, 1/3, and 1/2 dilutions. The digester operating on the straight feed solution was lost prior to the initiation of gas analyses due to a system malfunction previously discussed. Therefore, no gas composition data is available for the straight loading rate. Gas samples, however, were taken and analyzed for composition from a digester being fed manure taken directly from the finisher.

Table XVII is a summary of the gas composition results. The gas sample taken on October 18, 1976, from the 1/7 digester did not truly represent the gas generated due to a sampling error and the sample was therefore not included in the analyses. The data presented in Table XVII indicates gas samples taken from the 1/7 and 1/5 digesters contained a higher percentage of O_2. The reason for the unusually high O_2 content was attributed to a sampling problem. Both digesters had the smaller 0.25 ℓ gas collection cylinder because they typically generated less gas than the other digesters. The daily volume of gas generated by the two digesters was apparently insufficient to completely purge the sampling vessel prior to collecting the sample.

Analysis of variance (shown in Appendix H) indicated a significant difference ($\alpha = 0.01$) in percent of CH_4 content due to the different dilutions or loading rates. Duncan's new multiple range test was used to compare treatment means ($\alpha = 0.01$) (Steel and Torrie, 1960). Range test is located in Appendix H. Table XVIII summarizes the results of the multiple range test.

Figure 40 is a plot of the average CH_4 content of the digester gas versus the average daily loading rate. Linear regression was undertaken to determine the best fit equation describing the effect of average daily loading rate on methane content of digester gas. A second order polynominal was found to provide the best fit line. The equation was:

$$MC = 85.8 - 0.016\ DLR + 0.0000026\ DLR^2 \qquad (1)$$

where MC = methane content, %; DLR = daily loading rate, mg TS/ℓ of digester. Equation 1 had a correlation coefficient (R^2) of 0.84 and

TABLE XXVII

SUMMARY OF THE GAS COMPOSITION RESULTS

Feed Dilution	CH_4 Mean (%)	CH_4 Standard Deviation	CO_2 Mean (%)	CO_2 Standard Deviation	O_2 Mean (%)	O_2 Standard Deviation
1/7	76.4	2.8	16.0	2.2	7.6	1.7
1/5	74.6	1.2	19.2	1.2	6.2	0.7
1/3	66.8	1.5	30.4	1.6	2.8	0.4
1/2	62.0	1.4	35.3	2.7	2.7	1.5
Finisher	62.9	4.4	34.6	3.8	2.5	1.2

TABLE XVIII

SUMMARY OF DUNCAN'S NEW MULTIPLE RANGE TEST OF TREATMENT MEANS FOR PERCENT METHANE IN THE DIGESTER GAS (α = 0.01)*

Treatment 1/7	Treatment 1/5	Treatment 1/3	Treatment 1/2
76.2	74.6	66.8	62.0
		———	———
——————	——————		

*Any two means not underlined by the same line are significantly different. Any two means underlined by the same line are not significantly different.

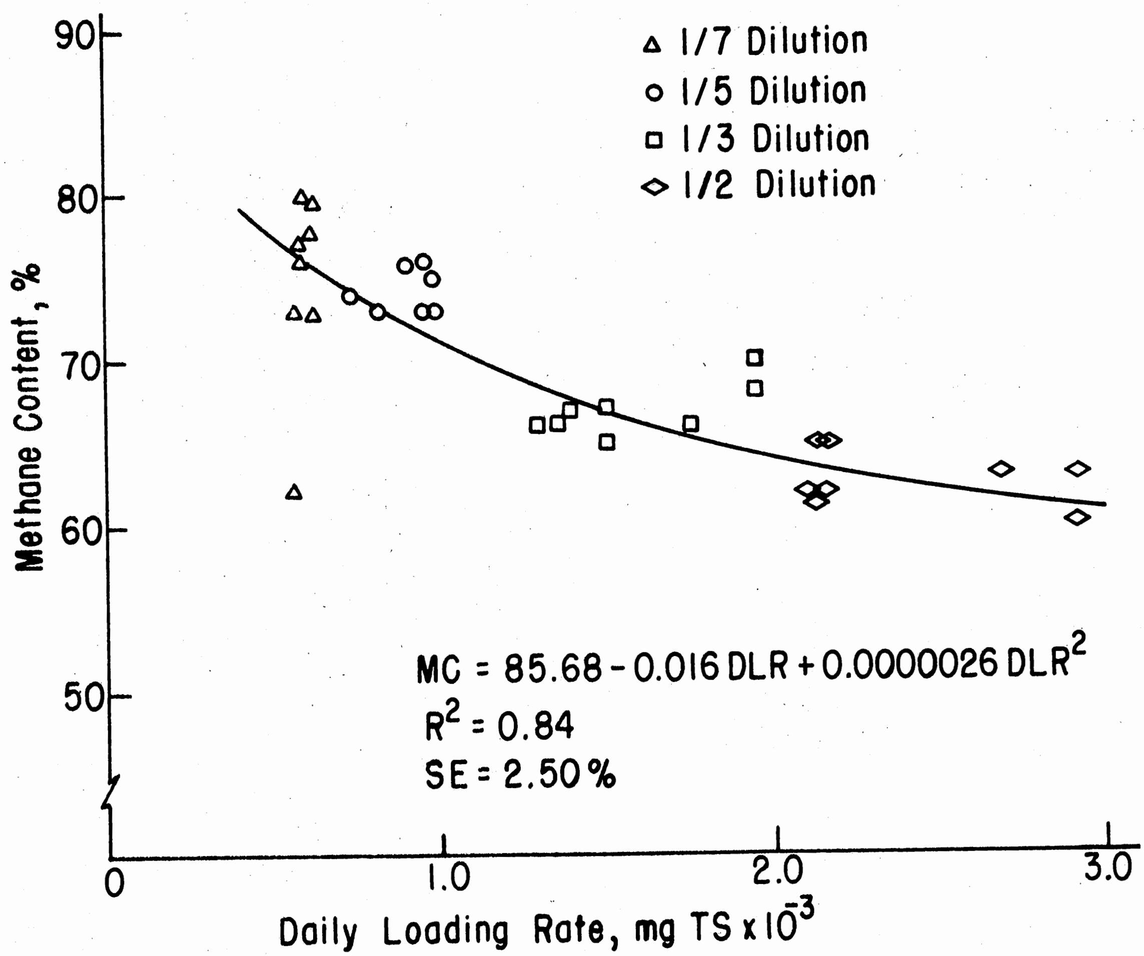

Figure 40. Methane Content Versus Daily Loading Rate

standard error of 2.50%. Analysis of variance of regression is shown in Appendix H.

Discussion of the Anaerobic Digestion Study

Figure 41 is a plot of average daily gas production (ADGP) versus average daily loading rate (ADLR) for the digesters operated during the study. The ADGP for each digester was adjusted to a common base of 1000 mg TS feed/ℓ of digester for the purpose of comparing the digesters. Appendix I represents a sample calculation of adjusting ADGP values.

Analysis of variance (presented in Appendix J) indicated no significant difference ($\alpha = 0.10$) in ADGP values due to the different dilutions or loading rates. The analysis included only the straight, 1/3, and 1/7 dilutions. The 1/5 and 1/2 dilutions were not included in the analysis due to the lack of adequate replications. Although the 1/2 and 1/3 dilutions appeared to give higher gas production, there were not enough trials to determine a significant relationship. Previous discussion, however, indicated digester fed the straight manure suspension had performance characteristics indicative of eventual failure.

Table XXIX summarizes data on the performance of anaerobic digesters fed swine manure under similar operating conditions. The summary indicates the loading rates of the current study were conservative when compared to loading rates attained by researchers feeding digesters swine feces without the urine included. Gramms et al. (1971) also reported a significantly higher gas production rate of 0.35 ℓ/1000 mg TS/ℓ of digester at a similar loading rate. The difference in loading rate and gas production was attributed primarily to the inhibition of the

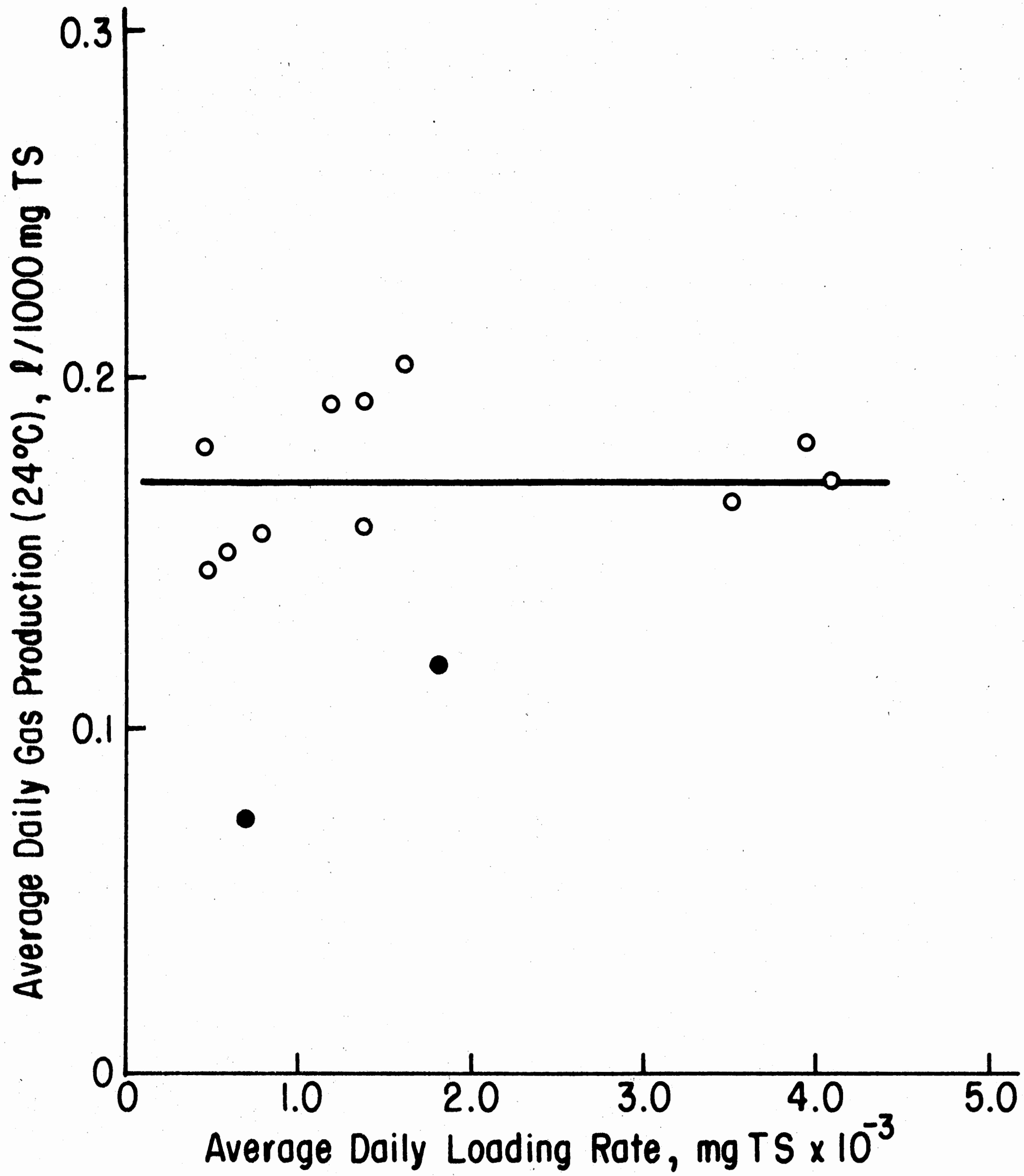

Figure 41. Average Daily Gas Production (24°C) Versus Average Daily Loading Rate

TABLE XXIX

COMPARATIVE SUMMARY OF SELECTED RESEARCH DATA ON THE PERFORMANCE OF ANAEROBIC DIGESTERS FED SWINE MANURE

Researcher	Manure Feed: Feces	Manure Feed: Feces & Urine	Loading Rate (mg TS/ℓ)	Detention Time (Days)	Temp. (°C)	Gas Production (ℓ/1000 mg TS/ℓ)	Digester Tendency: Success	Digester Tendency: Failure
Jeffery et al. (1965)	X		3100[1]	20	35	--	X	
	X		3500[1]	20	35	--	X	
	X		3900[1]	20	35	--		X
Cross and Duran (1970)	X		1000[1]	15	32	--	X	
	X		2000[1]	15	32	--	X	
	X		4000[1]	15	32	--		X
Gramms et al. (1971)	X		2300	15	32.5	0.34	X	
	X		4600	15	32.5	0.35	X	
Taiganides (1963)		X	1500[1]	22	34	0.46	X	
		X	2400[1]	25	34	0.44		X
Schmid and Lipper (1969)		X	3800[1]	20	35	--		X
Hobson and Shaw (1973)		X	1100	19	35	0.26	X	
		X	1900	14	35	0.23	X	
		X	2600	14	35	0.28	X	
		X	3300	14	35	0.27	X	
		X	3700	14	35	0.25	X	
Frey (1979)		X	500[2]	20	35	0.15	X	
		X	800[3]	20	35	0.16	X	
		X	1300[2]	20	35	0.23	X	
		X	1600[3]	20	35	0.20	X	
		X	3900[2]	20	35	0.17		X

[1]Calculated assuming VS equaled 80% TS (Smith and Miner, 1975).
[2]Average based on the performance of three digesters.
[3]Based on the performance of a single digester.

digestion process due to the higher NH_4^+ - N concentrations resulting with the inclusion of urine in the manure.

The loading rates, however, were comparable to the research reported by Taiganides (1963), Schmid and Lipper (1969), and Hobson and Shaw (1973) for digesters fed swine feces and urine combined. Previous discussion also indicated digesters fed the straight manure suspension had operating characteristics indicative of eventual digester failure. The straight manure suspension corresponded to an average daily loading rate of 3900 mg TS/ℓ of digester. The daily gas production rates were 33% to 82% below the values reported by other researchers for digesters operated at similar conditions. The noted reduction in gas production was attributed to fluctuations in the daily loading rate corresponding to variations in characteristics of the daily manure flow from the production buildings.

The gas composition analysis, however, indicated the gas generated by the digesters operated at the lower loading rates, 500 to 1300 mg TS/ℓ of digester/day, contained a significantly higher percentage of methane. Assuming the limited gas composition data were representative of digesters operated at similar loading rates, the inclusion of the methane content data would tend to reduce the decline in gas production noted at the lower loading rates in Figure 41. The digester volume required to treat the manure production of the farm at the lower dilutions would be 1.5 to 3.5 times greater than the volume required to treat the manure at the 1/2 dilution. The higher initial cost of the larger digester and the volume of dilution water required would tend to offset any benefits associated with the increased methane content of gas generated at the lower loading rates.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary

A commercial farrow to finish swine production facility was studied to gain a better understanding of factors affecting the volume, characteristics, and treatability of the manure produced. Manure samples from each production building were used to create manure suspensions representing the daily manure flow of the farm. Dilutions (straight, 1/2, 1/3, 1/5, and 1/7) of the manure suspension were fed to a series of digesters to determine the dilution or loading rate required to maximize methane production and minimize ammonia toxicity problems. Digester detention time and temperature were held constant at 20 days and $35 \pm 2°C$, respectively. There was no significant difference in gas production due to different dilutions; however, a 1/2 dilution appeared to provide the maximum daily gas production. The gas produced at the 1/2 dilution contained between 60% and 64% methane. The daily gas production rates were 33% to 82% below the values reported by other researchers for digesters operated at similar conditions.

Conclusions

A farm with a pit manure collection system was selected to determine the variation in manure characteristics. Several factors were noted to cause variations in the daily manure production. The factors noted included: (1) season of the year, (2) wash water, (3) water leaks, and (4) variations in herd size and number. However, quantitatively measuring the effects individually was not possible.

The lagoon problems meant the pits could not be totally drained according to the design schedule and the level of the pits in many instances exceeded the standpipes. Therefore, some fluctuations noted in the manure characterization data did not always reflect real fluctuations in manure production. Also, a value for the average daily flow from each production building was not obtained because of the problem with the lagoon. The data indicated the manure flows from the farrower and nurseries tended to dilute the daily manure flow of the farm.

There were no significant differences in gas production due to different dilutions. A 1/2 dilution, however, appeared to provide the maximum daily gas production. The daily gas production rates were 33% to 82% below the values reported by other researchers for digesters operated at similar conditions.

Methane content of the gas generated increased with a decrease in the average loading rate. The relationship is described by the following equation:

$$MC = 85.68 - 0.016\ DLR + 0.0000026\ DLR^2 \qquad (2)$$

where,

MC = methane content, %

DLR = daily loading rate, mg TS/ℓ of digester.

The higher initial cost of the digester and the volume of dilution water required would tend to offset any benefits associated with the increased methane content of gas generated at the lower loading rates.

The operation of the production facility studied was oriented to the production of meat and not the treatment of manure. The observed fluctuations and the resultant depressed gas production indicates anaerobic digestion would not be a viable alternative unless the herdsman is willing to make a commitment to the daily operation of a digester.

Recommendations for Future Research

The characterization of the commercial farm was limited primarily to observations made on weekly or bi-monthly trips to the farm. Also, problems with the lagoon system affected the manure characterization study and tended to buffer variations in the manure characteristics. Information in more detail is needed on the causes and types of variations occurring in the daily manure production of a farrow to finish operation to: (1) aid the engineer who will design the anaerobic digestion system, and (2) guide the operator who will maintain the digestion system once operating.

The research presented was conducted with small bench scale digesters. Additional research data are needed on the response of larger anaerobic digesters (1000 ℓ) operated under similar conditions prior to the installation of full scale on-farm digesters.

Anaerobic digestion is but a component in a manure treatment system. The effluent from the digester is still environmentally offensive and requires careful disposal. Land disposal is a common disposal technique. However, alternatives need to be explored for the extraction of additional energy prior to disposal of the digester effluent. One alternative would be to separate the solids from the raw manure and combust under controlled conditions to generate producer gas and ultimately methanol. Alternatives need to be explored for the extraction of additional energy by combining the anaerobic digester with other energy conversion devices.

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APPENDIXES

APPENDIX A

PARTIAL LISTING OF EQUIPMENT USED IN THE ANALYSIS OF MANURE AND DIGESTER CHARACTERISTICS

1. The following equipment was used in the analyses for determining manure and digester characteristics:

Centrifuge---------Precision Scientific Co., Model 11-AD-10 vari hi-speed centrifuge, maximum rps 83.

600°C Furnace-----Thermolyne, type 1500 furnace, 0 to 1200°C.

103°C Oven--------Precision Scientific Co., Type A oven, 0 to 260°C.

Spectrophotometer--Coleman Co., Model 6C Coleman Jr. Spectrophotometer with Coleman solid state regulated DC power supply.

pH Meter-----------Sargent Welch, Model NX digital pH meter, relative accuracy ± 0.01 pH.

Vacuum Pump--------Welch Scientific, Model 1376 Duo-Seal vacuum pump, ultimate pressure 0.1 micron.

Gas Chromatograph--LKB Instruments, LKB-9000 Gas Chromatograph-Mass Spectrometer.

2. Detailed description of LKB-9000 Gas Chromatograph-Mass Spectrometer (Waller, 1968).

The LKB-9000 gas chromatograph-mass spectrometer was designed in 1963-64 by Dr. Waller, Oklahoma State University Biochemistry Department, Stillwater, Oklahoma, and Dr. Ryhage, Director of Mass Spectrometry Laboratory at the Karolinska Institutet, Stockholm, Sweden. A block diagram of the instrument is shown in Figure 42. The instrument was built by Dr. Ryhage for research use at Oklahoma State University. The instrument is capable of detecting 0.1 to 10 μg of compound in gas chromatography column effluent, of providing useful mass spectrum (m/e = 12 to 600) on a few μg of sample within 2 to 10 s, of making

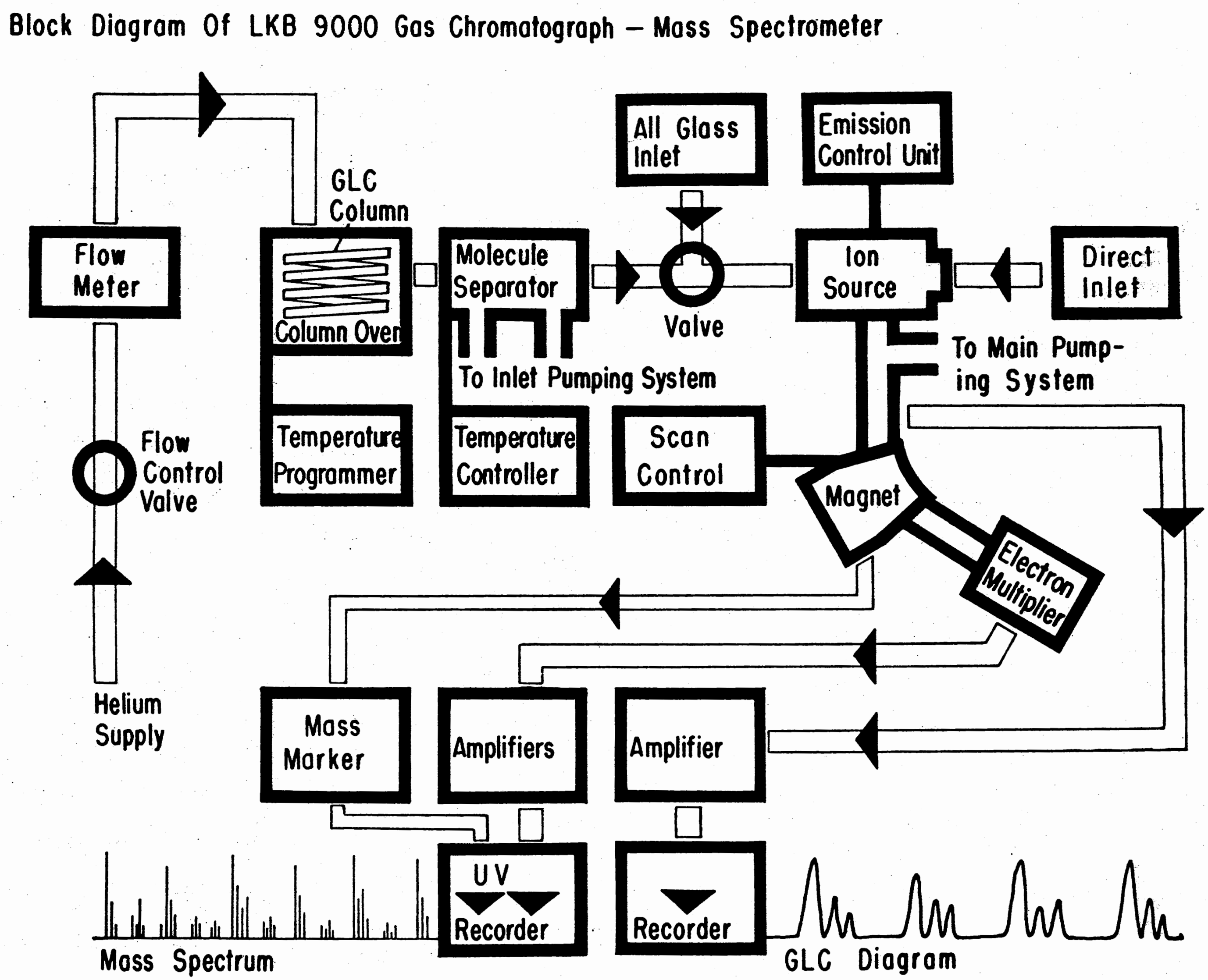

Figure 42. Block Diagram of LKB-9000(P) Gas Chromatograph-Mass Spectrometer

accurate isotope ratio measurement on compounds with m/e ratios of up to 300, and of obtaining useful spectra on submicrogram quantities of sample when the direct probe is used. Additions to the original instrument include a mass marker and double collectors for determining quantities of stable isotopes present in compounds with m/e ratios up to 300. The instrument's single-focus mass spectrometer features three different sample inlet systems: (1) a gas chromatography system (system used for gas analysis), (2) a heated glass inlet system, and (3) a direct probe.

The gas chromatography inlet system utilizes gas-liquid chromatography (GLC) to separate sample components and the mass spectrometer as the specific detector. The GLC effluent, after passing through a series of separators to remove the helium (He) carrier gas, is fed directly to an ionization chamber. Electron impact ionizes sample entering the chamber. The ions formed are accelerated and the beam collimated to its final shape using potential differences. The resulting ion beam passes through a plate (electrode) pierced centrally by a rectangular hole. The electrode collects about 10% of the positively charged ions producing an electric current. The current is amplified and finally recorded as a chromatogram using a strip chart recorder.

The remaining ions, 90%, pass through the electrode to the analyzer tube. Prior to reaching the analyzer tube, the ions go through a fixed focus and an adjustable focus control. The ions then transverse a 60° magnetic sector of the analyzer tube. The magnetic sector deflects ion groups according to m/e ratios. An ion group having equal m/e ratio is focused to impinge on the electron multiplier's collector plate. The signal produced is amplified and its intensity recorded with a high speed recording oscillograph on light sensitive photographic paper.

Each ion of a particular m/e ratio is recorded simultaneously by three galvanometers of different gains (1, 10, 100). A recording of the m/e ratios of all fragment ions of a particular sample is obtained by sweeping a range of magnetic field strengths.

APPENDIX B

SUPERNATANT AMMONIA NITROGEN DETERMINATION PROCEDURE

A colorimetric procedure adapted by Ecker and Lockhart (1961) from Niss (1957) was used to determine supernatant NH_4^+ - N concentrations. The procedure employed two reagents. Reagent A contained: sodium citrate, 4.7 g; citric acid, 1.7 g; phenol, 9.6 g; distilled water to 480 mℓ. Reagent B contained: boric acid, 6.0 g; sodium hydroxide, 8.0 g; chlorox bleach, 30.0 mℓ; distilled water to 200 mℓ. Supernatant samples were diluted to give between 2 and 20 mg of NH_4^+ - N per ℓ. To 1.0 mℓ samples of diluted supernatant samples were added 5.0 mℓ of reagent A and 2.0 m of reagent B. Samples were mixed, capped with aluminum foil, heated in a boiling water bath for five minutes, and cooled rapidly. Optical densities of samples were determined in a spectrophotometer at 615 ηm against a distilled water-reagent blank.

Optical density readings were compared to a standard curve plotted using known concentrations (2, 5, 10, 15, and 20 mg/ℓ) of ammonium chloride. A typical standard curve is plotted in Figure 43. A new standard curve was prepared for each batch of reagents. The NH_4^+ - N concentrations read from the curve was multiplied by the dilution factor to obtain the actual supernatant NH_4^+ - N concentrations.

Sample calculation:

Given: A 1.0 mℓ sample of diluted (1/100) supernatant sample having an optical density reading of 0.250.

Required: NH_4^+ - N concentration.

Solution: NH_4^+ - N concentration = NH_4^+ - N concentration of diluted sample x dilution factor

NH_4^+ - N concentration of diluted sample = 11.3 mg/ℓ from standard curve

dilution factor = 100

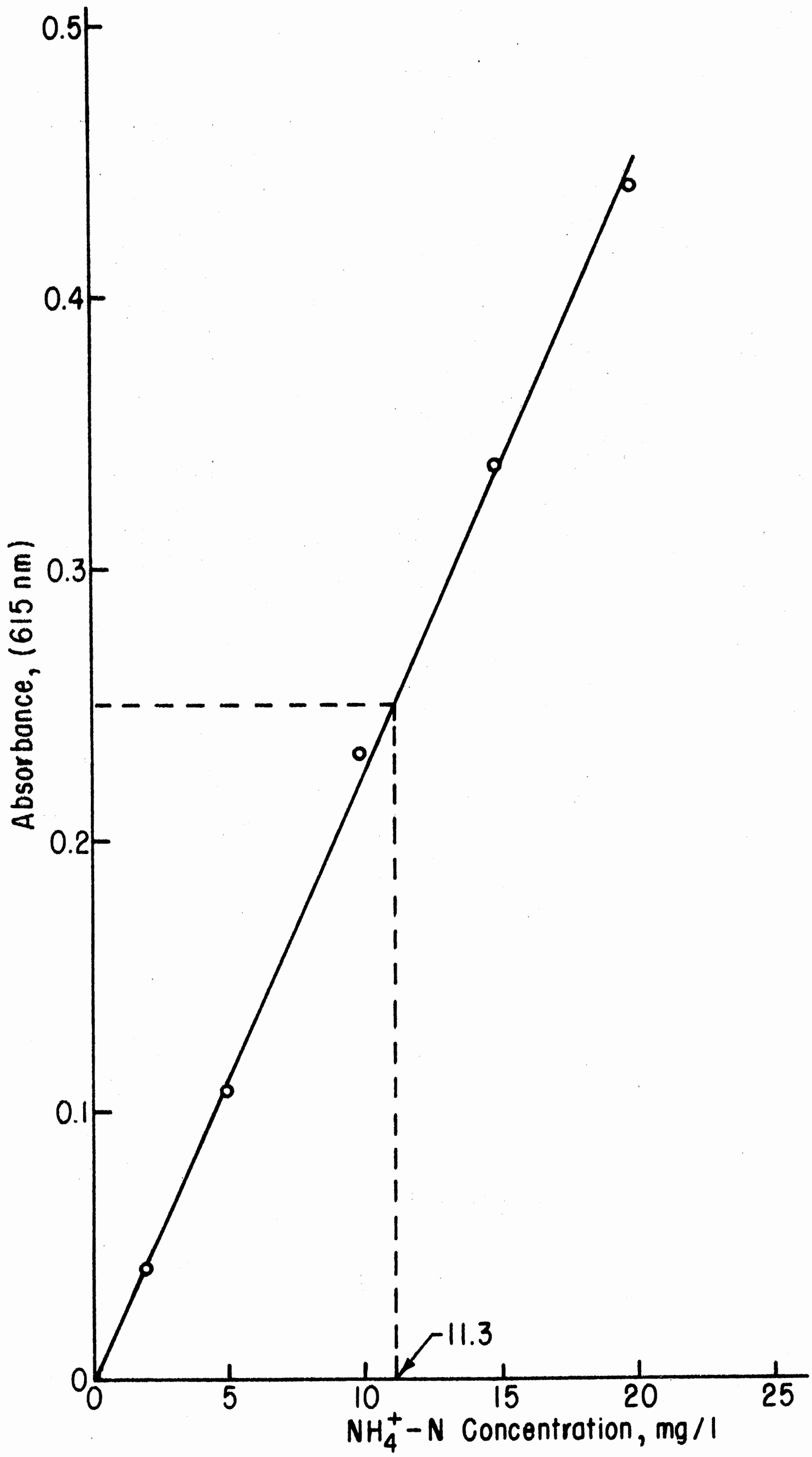

Figure 43. Standard Curve--Absorbance (615 nm) Versus NH_4^+ - N Concentration

substituting

NH_4^+ - N concentration = 11.3 x 100 = 1130 mg/ℓ.

APPENDIX C

EXPECTED DAILY MANURE PRODUCTION CALCULATIONS FOR EACH OF THE FARM'S CONFINEMENT BUILDINGS

Table XXX presents calculations for the daily manure production from each of the farm's confinement buildings. The calculations were based on livestock information obtained from herdsman Edward on October 23, 1975, and the mean manure production values (liquid and solids) reported by Muehling (1969). The mean manure production values reported by Muehling (1969) were specified according to livestock weight, age and classification (sow, boar, etc.).

TABLE XXX

EXPECTED DAILY MANURE PRODUCTION (SOLIDS AND LIQUID) CALCULATIONS FOR EACH OF THE FARM'S CONFINEMENT BUILDINGS

Building	Livestock Classification	Average No. of Animals	Average Age (wks)	Average Weight (kg/animal)	Average Weight (kg)	Daily Manure Product (ℓ/animal)	Daily Manure Product (ℓ)	% of Total Production (%)
Sow and Boar Barn	Sows, Boars, Gilts	250	104	181.8	45450	15.4	3785	21.5
Farrowing	Sows	48		181.8	8726			
	+					15.4	727	4.1
	Litters	360		1.8	648			
Nursery I and II	Sows	48		181.8	8726			
	+					15.4	727	
	Litters	360		5.0	1800			10.1
	Weaned Pigs	550	8	15.9	8745	1.9	1045	
Grower	Pigs	1450	14	36.4	52780	3.8	5510	31.3
Finisher	Pigs	700	26	90.9	63630	8.3	5810	33.0
Weaning Pens	Sows	16		181.8	2909			
Dirt Breeding Pens	Gilts	30		159.1	4773			
Special Nursery	Pigs	48		4.5	216			
TOTALS		3860			198403		17604	100.0

APPENDIX D

MANURE CHARACTERIZATION DATA

SOW BARN

DATE	PH	ML COD	MLSS COD	TS	TVS	DS	VDS	DEPTH	AMMON	ANIT
6/ 1/76	7.45	9091	80620	106190	65675	6153	3620	58.50	924	718
6/15/76	7.37							57.00		
6/22/76	7.38	3594	93023	108860	70440	5480	3087	56.30	2223	1732
7/ 6/76	7.53	4506	57364	63745	42580	5573	2960	58.50	1352	1051
7/13/76	7.42	4331	68482	60860	38290	6047	3040	45.00	1736	1350
7/20/76	7.32	5938	45560	54840	38200	5753	2807	52.50	1887	1467
7/27/76	7.44	7226	55859	69730	45905	5853	3033	55.00	1631	1268
8/ 5/76	7.32	4651	51533	71810	45635	4413	2180	55.00	1436	1116
8/13/76	7.29	8794	131533	114595	74180	3413	1940	54.00	1441	1120
8/24/76	7.38	3861	70312	82790	53680	3727	2147	57.00	1395	1085
9/ 8/76	7.17	6187	79688	107820	65945	3173	1967	55.50	1352	1051
9/17/76	7.51	2840	37500	52670	32815	2980	1493	51.00	1132	880
9/24/76	7.53			165030	104550			54.80	1192	927
9/30/76	7.22	5952	75397	92160	55850	3653	2147	57.50	1239	963
10/22/76	7.20	6190	123372	122250	74450	3427	2207	57.00	1202	934
11/ 1/76	7.22	4791	101149	127970	80070	3493	2200	60.00	1411	1097

FAPROWER

DATE	PH	ML COD	MLSS COD	TS	TVS	DS	VDS	DEPTH	AMMON	ANIT
6/ 1/76	7.73	1230	23256	21185	16010	2480	1153	57.50	405	315
6/15/76	7.49			9130	5070	1833	647	60.50		
6/22/76	7.10	898	6202					59.90	424	329
7/ 6/76	7.26	1146	20543	21345	15415	2027	767	60.00	371	288
7/13/76	7.32	984	24903	24640	18460	2060	833	56.50	446	346
7/20/76	7.25	957	23935	29830	22795	1720	647	59.00	460	357
7/27/76	7.31	1006	38965	33435	25530	1353	553	49.50	259	201
8/ 5/76	7.33	749	29615	22210	16780	1633	647	55.50	409	318
8/13/76	7.21	934	28654	27335	20020	5187	2320	60.00	494	384
8/24/76	7.42	746	12891	16680	12400	1877	767	60.00	409	318
9/ 8/76	7.43	979	32312	27415	20210			39.00	567	441
9/17/76	7.55	1329	37305	33815	24345	1913	773	33.50	633	496
9/24/76	7.44	1230	28378	33790	23295	1987	740	37.00	610	474
9/30/76	7.26	1521	29762	31367	22694	1867	787	46.00	402	312
10/22/76	.00							17.00		
11/ 1/76	7.31	1559	23180	26397	15813	2507	980	36.00	901	700

NURSERY I

DATE	PH	ML COD	MLSS COD	TS	TVS	DS	VDS	DEPTH	AMMON	ANIT
6/ 1/76	7.32	3557	26163	31310	21280	4687	1980	45.50	851	661
6/15/76	7.14							55.50		
6/22/76	7.00	1563	11046	13595	8320	3187	1367	55.00	716	556
7/ 6/76	7.27	2095	36434	36015	25920	3247	1427	29.00	712	553
7/13/76	7.33	5787	21790	21185	14365	3127	1247	43.50	1920	1493
7/20/76	7.34	1914	16602	14365	9400	3393	1313	49.50	943	733
7/27/76	7.35	1816	13164	18930	12800	3427	1547	55.30	1211	941
8/ 5/76	7.34	1021	15769	15935	10820	2080	867	52.00	610	474
8/13/76	7.35	1206	11538	12135	7765	2500	907	52.00	800	622
8/24/76	7.37	1139	17188	17565	11460	2653	1127	53.00	979	761
9/ 8/76	7.34	944	19359	19060	12920	1953	727	54.50	760	591
9/17/76	7.45	1080	19259	16030	10785	2147	360	54.00	729	567
9/24/76	7.45	932	15444	16620	11185	2133	647	53.50	743	577
9/30/76	7.34	1095	13492	15930	10615	2220	793	54.50	605	470
10/22/76	7.21	794	23372	23170	14395	1900	680		797	619
11/ 1/76	7.12	932	19540	21450	13855	1820	693	59.00	734	570

NURSERY II

DATE	PH	ML COD	MLSS COD	TS	TVS	DS	VDS	DEPTH	AMMON	ANIT
6/ 1/76	7.54	2964	33721	42250	28510	4100	1993	60.00	979	761
6/15/76	7.42							60.00		
6/22/76	7.10	3242	42248	50515	33955	3140	1547	60.00	1259	979
7/ 6/76	7.33	3043	34384	37595	24290	3800	1706	59.50	972	756
7/13/76	7.36	5551	40856	41115	28340	3613	1507	59.20	1361	1058
7/20/76	7.23	3164	46332	46380	31790	3347	1400	59.00	1426	1109
7/27/76	7.28	3301	43633	43775	30440	3467	1620	59.50	1460	1135
8/ 5/76	7.35	2490	40385	43105	30170	3393	1633	60.00	1222	950
8/13/76	7.30	2840	42692	51965	34270	2813	1293	60.00	1299	1010
8/24/76	7.32	2124	56250	50370	33855	2787	1373	59.00	1078	838
9/ 8/76	7.36	1654	33984	37975	26040	2867	1093	31.50	1366	1062
9/17/76	7.23	1693	31250	29065	19890	2333	1053	47.50	801	623
9/24/76	7.52	1091	15330	19070	12130	2327	747	59.50	1076	836
9/30/76	7.45	1448	22619	18890	12010	2427	920	59.50	711	553
10/22/76	7.24	1647	30268	26875	17975	2720	1080	60.50	1337	1039
11/ 1/76	7.23	1559	29502	31005	20575	2787	1133	53.50	1224	952

GROWER

DATE	PH	ML COD	MLSS COD	TS	TVS	DS	VDS	DEPTH	AMMON	ANIT
6/ 1/76	7.20	9091	43411	57120	31725	7553	3887	53.00	1544	1200
6/15/76	7.41							54.50		
6/22/76	7.25	8516	52713	56790	39190	8600	4287	55.00	2651	2061
7/ 6/76	7.36	6640	44186	50255	33900	7167	3540	52.00	1608	1250
7/13/76	7.23	2205	62257	51075	35745	6273	3080	52.50	1036	844
7/20/76	7.32	5469	47104	50030	37080	5407	2560	54.00	1780	1384
7/27/76	7.24	5039	48242	51620	37805	5340	2780	54.50	2092	1627
8/ 5/76	7.25	2829	19231	26545	18125	5487	2687	22.00	1499	1165
8/13/76	7.25	3191	15000	24805	16730	1700	640	47.00	1464	1138
8/24/76	7.34	4093	34373	41305	26350	6620	3713	55.00	1984	1543
9/ 8/76	7.56	3288	28125	28445	20205	3913	1307	53.50	1420	1104
9/17/76	7.51	5000	37891	45810	31970	5020	2600	52.50	1551	1206
9/24/76	7.44	5833	34363	46530	31035	6473	3460	53.00	2590	2014
9/30/76	7.64	6627	36905	44480	29870	6673	3473	52.00	2487	1934
10/22/76	7.35	3452	23372	24115	15735	4787	2260	56.30	1706	1326
11/ 1/76	7.15	5217	40230	43945	31750	5667	2813	37.50	2162	1681

FINISHER

DATE	PH	ML COD	MLSS COD	TS	TVS	DS	VDS	DEPTH	AMMON	ANIT
6/ 1/76	7.20	37652	83274	69340	49490	1310	4990	56.00	4266	3318
6/15/76	6.89	29492	108037	77400	50730	7590	2930	72.50	3716	2890
6/22/76	6.85	30314		75993	54678	9280	4675	78.50	4443	3455
7/ 6/76	6.90	27311	78013	125470	74835	8320	4330	52.50	3265	2539
7/13/76	7.04	28346	32539	100395	59190	7810	4200	46.50	2752	2140
7/20/76	7.03	29348	100145	103315	63525	8355	4014	51.00	2290	1781
7/27/76	7.00	25912	113737	128152	98192	6275	3365	49.50	3072	2389
8/ 5/76	7.04	20703	90698	93025	64935	8170	3990	50.00	2532	1969
8/13/76	7.30	11022	58527	71568	45525	4460	1750	59.00	2382	1852
8/24/76	7.37	9954	94779	103700	62410	4945	1755	54.00	2038	1585
9/ 8/76	7.43	8870	53025	77137	46452	5105	1685	54.00	1813	1410
9/17/76	7.39	13505	100390	123525	74180	5355	1970	50.50	2783	2164
9/24/76	7.40	13383		116880	76340	5440	1660	54.00	3396	2641
9/30/76	7.65	12460	101369	118598	75795	6010	2980	54.00	3190	2481
10/22/76	7.54			126320	74510			61.00		
11/ 1/76	7.61	19463	94253	128650	78060			65.00	3020	2348

APPENDIX E

DIGESTER FEED CHARACTERIZATION DATA

FEED ONE-SEVENTH FIRST REP

OBS	DATE	PH	CODSF	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1	7.15		4906							124	96.444
2	2			4906							124	96.444
3	3	7.15		4906							124	96.444
4	4	7.10		9813							223	173.444
5	5	7.10		9813							223	173.444
6	6	7.11		9255							233	181.222
7	7	7.14		9255							233	181.222
8	8											0.000
9	9	7.14		9666							259	201.444
10	10	7.57	1790	9338	12920	8585	10207	7900	2713	685	381	296.333
11	11	7.19	1790	9338	12920	8585	10207	7900	2713	685	381	296.333
12	12	7.69	1479		12085	9015	7960	5987	4125	3028	381	296.333
13	13		1479		12085	9015	7960	5987	4125	3028	381	296.333
14	14	7.63			9850	7045	7200	5693	2650	1352		0.000
15	15	7.75			9850	7045	7200	5693	2650	1352		0.000
16	16	7.68	2072	11554	7900	5790	6167	4760	1733	1030	438	340.667
17	17	7.68	2072	11554	7900	5790	6167	4760	1733	1030	438	340.667
18	18	7.53	1976	11111	11055	8015	9500	7633	1240	380	310	241.111
19	19		1976	11111	11055	8015	9500	7633	1240	380	310	241.111
20	20	7.72	2556	11265	13940	9120	11810	8800	1230	320	363	282.333
21	21	7.67	2556	11265	13940	9120	11810	8800	1230	320	363	282.333
22	22	7.76	2690	11260	10175	7305	9740	6895	1180	410	460	357.778
23	23	7.62	2690	11260	10175	7305	9740	6895	1180	410	460	357.778
24	24	7.73	2438	10584	10680	7795	9970	6965	1490	830	104	80.889
25	25	7.80	2436	10584	10680	7795	9970	6965	1490	830	104	80.889
26	26	7.64	2372	10584	10545	8060	8980	7740	400	320	409	318.111
27	27	7.76	2372	10584	10545	8060	8980	7740	400	320	409	318.111
28	28	7.63	1017	14786	20335	13775	13230				378	294.000
29	29	7.60	1017	14786	20335	13775	13230				378	294.000
30	30	7.66	2542	12451	13145	8680	8770				409	318.111
31	31	7.76	2542	12451	13145	8680	8770				409	318.111
32	32	7.64	2011	13016	15480	11130	13930	10330	1550	800	405	315.000
33	33	7.74	2011	13016	15480	11130	13930	10330	1550	800	405	315.000
34	34	7.67	1281	12549	11360	7985	10060	7415	1300	570	278	216.222
35	35	7.78	1281	12549	11360	7985	11140	7415	1300	570	278	216.222
36	36	7.75	1219	11050	15065	10460	14500	10100	1180	360	320	248.889
37	37		1219	11050	15065	10460	14500	10100	1180	360	320	248.889
38	38	7.76	1219	9338	12355		9720		1650	740	326	253.556
39	39	7.73	1219	9338	12355		9720		1650	740	326	253.556
40	40	7.58	1646	9268	9555	7170	7760	6300	1300	870	334	259.778
41	41		1646	9268	9555	7170	7760	6300	1300	870	334	259.778
42	42	7.68	1701	11060	10680	8010	9960	7620	1000	390	316	245.778
43	43	7.55	1701	11060	10680	8010	9960	7620	1000	390	316	245.778
44	44	7.71	1514	11220	10670	7735	8810	7475	1350	260	354	275.333
45	45	7.88	1514	11220	10670	7735	8810	7475	1350	260	354	275.333
46	46		1912	9268	9610	7030	7960	6500	1220	530	316	245.778
47	47	7.60	1912	9268	9610	7030	7960	6500	1220	530	316	245.778
48	48	7.27	1514	6929	7745	5580	6460	5070	1610	510	405	315.000
49	49	7.55	1514	6929	7745	5580	6460	5070	1610	510	405	315.000
50	50	7.86	2629	15748	12460	9390	11070	8950	1390	440	481	374.111
51	51	7.92	2629	15748	12460	9390	11070	8950	1390	440	481	374.111
52	52	7.71	1307	14163	13955	10550	12745	10090	1210	460		0.000
53	53		1307	14163	13955	10550	12745	10090	1210	460		0.000
54	54	7.40	1198	11984	16145	12020	14875	11490	1270	530	351	273.000
55	55		1198	11984	16145	12020	14875	11490	1270	530	351	273.000

FEED ONE-SEVENTH FIRST REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56		986	10895	20205	13685	19175	13325	1030	360	381	296,333
57	57		986	10895	20205	13685	19175	13325	1030	360	381	296,333
58	58	7,56	1312	10739	14440	10345	16320	9805	940	540	391	304,111
59	59		1312	10739	14440	10345	16320	9805	940	540	391	304,111
60	60	7,52	919	11829	12630	9335	14590	8495	1290	840	406	315,778
61	61		919	11829	12630	9335	14590	8495	1290	840	406	315,778
62	62	7.65	1012	9650	11260	8465	9800	7795	1460	670	368	286,222
63	63		1012	9650	11260	8465	9800	7795	1460	670	368	286,222
64	64	7.60	1453	11206	10560	7945	9850	6865	1810	1080	362	281,556
65	65	7,47	1453	11206	10560	7945	9850	6865	1810	1080	362	281,556
66	66	7,61	1354	14375	14455	11110	12995	10500	1460	610	376	292,444
67	67		1354	14375	14455	11110	12995	10500	1460	610	376	292,444
68	68	7,62	1608		11300	8435	10190	8035	1110	400	359	279,222
69	69		1608		11300	8435	10190	8035	1110	400	359	279,222
70	70	7,56	2431	10353	18430	11485	16760	10705	1670	780	455	353,889
71	71		2431	10353	18430	11485	16760	10705	1670	780	455	353,889
72	72	7,61	1012	9338	11735	8705	10890	8045	1580	660	371	288,556
73	73		1012	9338	11735	8705	10890	8045	1580	660	371	288,556
74	74	7.57	1842	14475	15360	11140	14110	10360	1730	780	425	330,556
75	75	7.52	1842	14475	15360	11140	14110	10360	1730	780	425	330,556
76	76	7.67	986	9764	10270	7740	8760	7190	1390	550	388	301,778
77	77		986	9764	10270	7740	8760	7190	1390	550	388	301,778
78	78	7.61	1738	9449	11895	8965	9740	8215	1640	750	384	298,667
79	79	7,80	1738	9449	11895	8965	9740	8215	1640	750	384	298,667
80	80	7,67	1811								419	325,889
81	81		1811								419	325,889
82	82	7.56	2730								445	346,111
83	83		2730								445	346,111

FEED ONE-SEVENTH SECOND REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1	7.15		4906							124	96.444
2	2	7.40	3073	12330	14930	9550	10930	8050	4000	1500	418	325.111
3	3		3073	12330	14930	9550	10930	8050	4000	1500	418	325.111
4	4	7.59	3073	12330	14930	9550	10930	8050	4000	1500	418	325.111
5	5		3073	12330	14930	9550	10930	8050	4000	1500	418	325.111
6	6	7.53	2314	9020	6950	5090	5000	4063	1927	1027	319	248.111
7	7	7.63	2314	9020	6950	5090	5000	4063	1927	1027	319	248.111
8	8											0.000
9	9	7.74	2314	9020	6950	5090	5000	4063	1927	1027	319	248.111
10	10	7.57	1790	9338	12920	8585	10207	7900	2713	685	381	296.333
11	11	7.19	1790	9338	12920	8585	10207	7900	2713	685	381	296.333
12	12	7.69	1479		12085	9015	7960	5987	4125	3028	381	296.333
13	13		1479		12085	9015	7960	5987	4125	3028	381	296.333
14	14	7.63			9850	7045	7200	5693	2650	1352		0.000
15	15	7.75			9850	7045	7200	5693	2650	1352		0.000
16	16	7.68	2072	11554	7900	5790	6167	4760	1733	1030	438	340.667
17	17	7.68	2072	11554	7900	5790	6167	4760	1733	1030	438	340.667
18	18	7.53	1976	11111	11055	8015	9500	7633	1240	380	310	241.111
19	19		1976	11111	11055	8015	9500	7633	1240	380	310	241.111
20	20	7.72	2556	11265	13940	9120	11810	8800	1230	320	363	282.333
21	21	7.67	2556	11265	13940	9120	11810	8800	1230	320	363	282.333
22	22	7.76	2690	11260	10175	7305	9740	6895	1180	410	460	357.778
23	23	7.62	2690	11260	10175	7305	9740	6895	1180	410	460	357.778
24	24	7.73	2438	10584	10680	7795	9970	6965	1490	830	104	80.889
25	25	7.80	2438	10584	10680	7795	9970	6965	1490	830	104	80.889
26	26	7.64	2372	10584	10545	8060	8980	7740	400	320	409	318.111
27	27	7.76	2372	10584	10545	8060	8980	7740	400	320	409	318.111
28	28	7.63	1017	14786	20335	13775	13230				378	294.000
29	29	7.60	1017	14786	20335	1377	13230				378	294.000
30	30	7.66	2542	12451	13145	8680	8770				409	318.111
31	31	7.76	2542	12451	13145	8680	8770				409	318.111
32	32	7.64	2011	13016	15480	11130	13930	10330	1550	800	405	315.000
33	33	7.74	2011	13016	15480	11130	13930	10330	1550	800	405	315.000
34	34	7.67	1281	12549	11360	7985	10060	7415	1300	570	278	216.222
35	35	7.78	1281	12549	11360	7985	10060	7415	1300	570	278	216.222
36	36	7.75	1219	11050	15065	10460	14500	10100	1180	360	320	248.889
37	37		1219	11050	15065	10460	14500	10100	1180	360	320	248.889
38	38	7.76	1219	9338	12355		9720		1650	740	326	253.556
39	39	7.73	1219	9338	12355		9720		1650	740	326	253.556
40	40	7.58	1646	9268	9555	7170	7760	6300	1300	870	334	259.778
41	41		1646	9268	9555	7170	7760	6300	1300	870	334	259.778
42	42	7.68	1701	11060	10680	8010	9960	7620	1000	390	316	245.778
43	43	7.55	1701	11060	10680	8010	9960	7620	1000	390	316	245.778
44	44	7.71	1514	11220	10670	7735	8810	7475	1350	260	354	275.333
45	45	7.88	1514	11220	10670	7735	8810	7475	1350	260	354	275.333
46	46		1912	9268	9610	7030	7960	6500	1220	530	316	245.778
47	47	7.60	1912	9268	9610	7030	7960	6500	1220	530	316	245.778
48	48	7.27	1514	6929	7745	5580	6460	5070	1610	510	405	315.000
49	49	7.55	1514	6929	7745	5580	6460	5070	1610	510	405	315.000
50	50	7.86	2629	15748	12460	9390	11070	8950	1390	440	481	374.111
51	51	7.92	2629	15748	12460	9390	11070	8950	1390	440	481	374.111
52	52	7.71	1307	14163	13955	10550	12745	10090	1210	460		0.000
53	53		1307	14163	13955	10550	12745	10090	1210	460		0.000
54	54	7.40	1198	11984	16145	12020	14875	11490	1270	530	351	273.000
55	55		1198	11984	16145	12020	14875	11490	1270	530	351	273.000

FEED ONE-SEVENTH SECOND REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56		986	10695	20205	13685	19175	13325	1030	360	381	296,333
57	57		986	10695	20205	13685	19175	13325	1030	360	381	296,333
58	58	7,56	1312	10739	14440	10345	16320	9805	940	540	391	304,111
59	59		1312	10739	14440	10345	16320	9805	940	540	391	304,111
60	60	7,52	919	11829	12630	9335	14590	8495	1290	840	406	315,778
61	61		919	11829	12630	9335	14590	8495	1290	840	406	315,778
62	62	7,65	1012	9650	11260	8465	9800	7795	1460	670	368	286,222
63	63		1012	9650	11260	8465	9800	7795	1460	670	368	286,222
64	64	7,60	1453	11206	10560	7945	9850	6865	1810	1080	362	281,556
65	65	7,47	1453	11206	10560	7945	9850	6865	1810	1080	362	281,556
66	66	7,61	1354	14375	14455	11110	12995	10500	1460	610	376	292,444
67	67		1354	14375	14455	11110	12995	10500	1460	610	376	292,444
68	68	7,62	1608		11300	8435	10190	8035	1110	400	359	279,222
69	69		1608		11300	8435	10190	8035	1110	400	359	279,222
70	70	7,56	2431	10353	18430	11485	16760	10705	1670	780	455	353,889
71	71		2431	10353	18430	11485	16760	10705	1670	780	455	353,889
72	72	7,61	1012	9338	11735	8705	10890	8045	1580	660	371	288,556
73	73		1012	9338	11735	8705	10890	8045	1580	660	371	288,556
74	74	7,57	1842	14475	15360	11140	14110	10360	1730	780	425	330,556
75	75	7,52	1842	14475	15360	11140	14110	10360	1730	780	425	330,556
76	76	7,67	986	9764	10270	7740	8760	7190	1390	550	388	301,778
77	77		986	9764	10270	7740	8760	7190	1390	550	388	301,778
78	78	7,61	1738	9449	11895	8965	9740	8215	1640	750	384	298,667
79	79	7,80	1738	9449	11895	8965	9740	8215	1640	750	384	298,667
80	80	7,67	1811								419	325,889
81	81		1811								419	325,889
82	82	7,56	2730								445	346,111
83	83		2730								445	346,111

FEED ONE-SEVENTH THIRD REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1		2337	12332	11420	9185	9990	8545	1430	640	447	347.667
2	2		2337	12332	11420	9185	9990	8545	1430	640	447	347.667
3	3		2337	12332	11420	9185	9990	8545	1430	640	447	347.667
4	4	7.57	3359	11304							447	347.667
5	5	7.53	3359	11304							447	347.667
6	6	7.49	3359	11304							447	347.667
7	7	7.69	3359	11304							447	347.667
8	8	7.73	2578	9565	9775	7310	8405	6670	1370	640	340	264.444
9	9	7.72	2578	9565	9775	7310	8405	6670	1370	640	340	264.444
10	10	7.59	2578	9565	9775	7310	8405	6670	1370	640	340	264.444
11	11	7.71	2578	9565	9775	7310	8405	6670	1370	640	340	264.444
12	12	7.59	2760	9486	11510	8900	10200	8290	1310	610	409	318.111
13	13	7.63	2760	9486	11510	8900	10200	8290	1310	610	409	318.111
14	14	7.44	2760	9486	11510	8900	10200	8290	1310	610	409	318.111
15	15	7.77	2760	9486	11510	8900	10200	8290	1310	610	409	318.111
16	16	7.53	2383	8254	9020	6520	7910	6110	1110	410	302	234.889
17	17		2383	8254	9020	6520	7910	6110	1110	410	302	234.889
18	18	7.28	2383	8254	9020	6520	7910	6110	1110	410	302	234.889
19	19	7.50	2383	8254	9020	6520	7910	6110	1110	410	302	234.889
20	20	7.94	2152		9630	6390	8400	5840	1400	550	430	334.444
21	21	7.69	2152		9630	6390	8400	5840	1400	550	430	334.444
22	22	7.72	2152		9630	6390	8400	5840	1400	550	430	334.444
23	23	7.72	2152		9630	6390	8400	5840	1400	550	430	334.444
24	24		983		10150	7485	8300	6605	1850	880	329	255.889
25	25	7.43	983		10150	7485	8300	6605	1850	880	329	255.889
26	26	7.61	983		10150	7485	8300	6605	1850	880	329	255.889
27	27	7.65	983		10150	7485	8300	6605	1850	880	329	255.889
28	28	7.48	2213	9524	9330	6715	7830	6125	1500	590	371	288.556
29	29	7.43	2213	9524	9330	6715	7830	6125	1500	590	371	288.556
30	30	7.54	2213	9524	9330	6715	7830	6125	1500	590	371	288.556
31	31		2213	9524	9330	6715	7830	6125	1500	590	371	288.556
32	32	7.42	1391	7874	11040	8330	9850	7950	1190	380	235	182.778
33	33		1391	7874	11040	8330	9850	7950	1190	380	235	182.778
34	34	7.52	1391	7874	11040	8330	9850	7950	1190	380	235	182.778
35	35	7.54	1391	7874	11040	8330	9850	7950	1190	380	235	182.778
36	36	7.58	1083	7044	11245	8240	10105	7250	1140	990	239	185.889
37	37	7.62	1083	7044	11245	8240	10105	7250	1140	990	239	185.889
38	38		1083	7044	11245	8240	10105	7250	1140	990	239	185.889
39	39	7.39	1083	7044	11245	8240	10105	7250	1140	990	239	185.889
40	40	7.79	992	7540	8660	6520	7640	6040	1020	480	212	164.889
41	41	7.48	992	7540	8660	6520	7640	6040	1020	480	212	164.889
42	42	7.56	992	7540	8660	6520	7640	6040	1020	480	212	164.889
43	43	7.62	992	7540	8660	6520	7640	6040	1020	480	212	164.889
44	44	7.80	754	9524	10130	7710	9390	7360	740	350	178	138.444
45	45	7.69	754	9524	10130	7710	9390	7360	740	350	178	138.444
46	46	7.74	754	9524	10130	7710	9390	7360	740	350	178	138.444
47	47	7.72	754	9524	10130	7710	9390	7360	740	350	178	138.444
48	48	7.76	1058	9412	10265	7790	9035	7180	1230	610	210	163.333
49	49	7.61	1058	9412	10265	7790	9035	7180	1230	610	210	163.333
50	50		1058	9412	10265	7790	9035	7180	1230	610	210	163.333
51	51	7.56	1058	9412	10265	7790	9035	7180	1230	610	210	163.333
52	52	7.53	684	9856	13875	10320	12855	9910	1020	410	402	312.667
53	53		684	9856	13875	10320	12855	9910	1020	410	402	312.667
54	54	7.43	684	9856	13875	10320	12855	9910	1020	410	402	312.667
55	55	7.45	684	9856	13875	10320	12855	9910	1020	410	402	312.667

FEED ONE-SEVENTH THIRD REP

OBS	DATE	PH	CODGP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56	7.66	1004	14632	12430	9040	11040	8410	1320	630	166	129.111
57	57	7.58	1004	14632	12430	9040	11040	8410	1320	630	166	129.111
58	58	7.42	1004	14632	12430	9040	11040	8410	1320	630	166	129.111
59	59	7.44	1004	14632	12430	9040	11040	8410	1320	630	166	129.111
60	60	7.79	988	10594	9855	7085	8815	6785	1040	300	217	168.778
61	61	7.69	988	10594	9855	7085	8815	6785	1040	300	217	168.778
62	62	7.68	988	10594	9855	7085	8815	6785	1040	300	217	168.778
63	63	7.61	988	10594	9855	7085	8815	6785	1040	300	217	168.778
64	64	7.64	838	9653	16105	11715	15135	11385	970	330	305	237.222
65	65	7.62	838	9653	16105	11715	15135	11385	970	330	305	237.222
66	66		838	9653	16105	11715	15135	11385	970	330	305	237.222
67	67		838	9653	16105	11715	15135	11385	970	330	305	237.222
68	68	7.86	849	8687	8615	6270	8045	6110	570	160	234	182.000
69	69	7.73	849	8687	8615	6270	8045	6110	570	160	234	182.000
70	70	7.62	849	8687	8615	6270	8045	6110	570	160	234	182.000
71	71	7.63	849	8687	8615	6270	8045	6110	570	160	234	182.000
72	72	7.67	491	6105	8380	5940	7550	5710	830	230	199	154.778
73	73	7.68	491	6105	8380	5940	7550	5710	830	230	199	154.778
74	74	7.67	491	6105	8380	5940	7550	5710	830	230	199	154.778
75	75	7.68	491	6105	8380	5940	7550	5710	830	230	199	154.778
76	76		532	6686	8950	5775	7920	5435	1030	342	281	218.556
77	77	7.73	532	6686	8950	5775	7920	5435	1030	342	281	218.556
78	78		532	6686	8950	5775	7920	5435	1030	342	281	218.556
79	79	7.75	532	6686	8950	5775	7920	5435	1030	342	281	218.556
80	80	7.55	618	11725	10330	7245	9250	6845	1080	400	312	242.667
81	81		618	11725	10330	7245	9250	6845	1080	400	312	242.667
82	82	7.26	618	11725	10330	7245	9250	6845	1080	400	312	242.667
83	83		618	11725	10330	7245	9250	6845	1080	400	312	242.667
84	84		525	9144	12080	8225	11300	7965	780	260	274	213.111
85	85	7.36	525	9144	12080	8225	11300	7965	780	260	274	213.111
86	86		525	9144	12080	8225	11300	7965	780	260	274	213.111
87	87		525	9144	12080	8225	11300	7965	780	260	274	213.111
88	88	7.64	614	8949	12645	8645	11755	8385	890	260	274	213.111
89	89	7.55	614	8949	12645	8645	11755	8385	890	260	274	213.111
90	90		614	8949	12645	8645	11755	8385	890	260	274	213.111
91	91		614	8949	12645	8645	11755	8385	890	260	274	213.111
92	92	7.62			8400	5875	7580	5595	820	280		0.000
93	93	7.65			8400	5875	7580	5595	820	280		0.000
94	94				8400	5875	7580	5595	820	280		0.000
95	95				8400	5875	7580	5595	820	280		0.000
96	96		385	7491	9500	6680	8600	6440	900	240		0.000
97	97	7.37	385	7491	9500	6680	8600	6440	900	240		0.000
98	98	7.39	385	7491	9500	6680	8600	6440	900	240		0.000
99	99		385	7491	9500	6680	8600	6440	900	240		0.000
100	100		552	6920	9349	5450						0.000
101	101		552	6920	9349	5450						0.000
102	102		552	6920	9349	5450						0.000
103	103	7.55	390	5588	7585	5045	6745	4815	840	230	132	102.667
104	104		390	5588	7585	5045	6745	4815	840	230	132	102.667
105	105		390	5588	7585	5045	6745	4815	840	230	132	102.667
106	106	7.42	390	5588	7585	5045	6745	4815	840	230	132	102.667
107	107	7.48	523	7129	7860	5420	7220	5140	640	280	176	136.889
108	108		523	7129	7860	5420	7220	5140	640	280	176	136.889
109	109	7.56	523	7129	7860	5420	7220	5140	640	280	176	136.889
110	110		523	7129	7860	5420	7220	5140	640	280	176	136.889

FEED ONE-SEVENTH THIRD REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
111	111		545	11220	12345	8450	11005	8030	1340	420	297	231.000
112	112	7.57	545	11220	12345	8450	11005	8030	1340	420	297	231.000
113	113		545	11220	12345	8450	11005	8030	1340	420	297	231.000
114	114	7.46	545	11220	12345	8450	11005	8030	1340	420	297	231.000
115	115		545	11220	12345	8450	11005	8030	1340	420	297	231.000
116	116	7.58	507	8301	13705	9188	12825	8818	880	370	322	250.444
117	117	7.58	507	8301	13705	9188	12825	8818	880	370	322	250.444
118	118		507	8301	13705	9188	12825	8818	880	370	322	250.444
119	119		507	8301	13705	9188	12825	8818	880	370	322	250.444
120	120	7.70	609	9510	13245	8485	12425	8195	820	290	350	272.222
121	121	7.64	609	9510	13245	8485	12425	8195	820	290	350	272.222
122	122	7.73	609	9510	13245	8485	12425	8195	820	290	350	272.222
123	123		609	9510	13245	8485	12425	8195	820	290	350	272.222
124	124		624	11019	12485	8635	11585	8325	900	310	380	295.556
125	125		624	11019	12485	8635	11585	8325	900	310	380	295.556
126	126		624	11019	12485	8635	11585	8325	900	310	380	295.556
127	127	7.55	624	11019	12485	8635	11585	8325	900	310	380	295.556
128	128		656	9630	11425	7870	10515	7530	910	290	317	246.556
129	129	7.58	656	9630	11425	7870	10515	7530	910	290	317	246.556
130	130		656	9630	11425	7870	10515	7530	910	290	317	246.556
131	131		656	9630	11425	7870	10515	7530	910	290	317	246.556
132	132	7.67	742	9804	11715	8125	10875	7885	840	240	283	220.111
133	133	7.63	742	9804	11715	8125	10875	7885	840	240	283	220.111
134	134		742	9804	11715	8125	10875	7885	840	240	283	220.111
135	135	7.69	742	9804	11715	8125	10875	7885	840	240	283	220.111
136	136		559	7451	12545	8500	11555	8210	990	290	347	269.889
137	137	7.57	559	7451	12545	8500	11555	8210	990	290	347	269.889
138	138		559	7451	12545	8500	11555	8210	990	290	347	269.889
139	139	7.44	559	7451	12545	8500	11555	8210	990	290	347	269.889
140	140	7.63	675	9902	12015	8425	11295	8085	720	340	302	234.889
141	141	7.96	675	9902	12015	8425	11295	8085	720	340	302	234.889
142	142		675	9902	12015	8425	11295	8085	720	340	302	234.889
143	143		675	9902	12015	8425	11295	8085	720	340	302	234.889
144	144		736		12620	8410	11900	8180	720	230	310	241.111
145	145	7.51	736		12620	8410	11900	8180	720	230	310	241.111
146	146	7.51	736		12620	8410	11900	8180	720	230	310	241.111
147	147		736		12620	8410	11900	8180	720	230	310	241.111
148	148		738	11597	11475	7530	10535	7210	940	320	224	174.222
149	149		738	11597	11475	7530	10535	7210	940	320	224	174.222
150	150	7.60	738	11597	11475	7530	10535	7210	940	320	224	174.222
151	151		738	11597	11475	7530	10535	7210	940	320	224	174.222
152	152		760		11800	7325	10630	6925	1170	410	308	239.556
153	153	7.41	760		11800	7325	10630	6925	1170	410	308	239.556
154	154	7.50	760		11800	7325	10630	6925	1170	410	308	239.556
155	155		760		11800	7325	10630	6925	1170	410	308	239.556
156	156	7.68	590	11303	15765	8800	15035	8510	730	290	312	242.667
157	157		590	11303	15765	8800	15035	8510	730	290	312	242.667
158	158		590	11303	15765	8800	15035	8510	730	290	312	242.667
159	159		590	11303	15765	8800	15035	8510	730	290	312	242.667

FEED ONE=FIFTH FIRST REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1		3531	17236	22130	15925	13750	14495	2480	1430	649	504.778
2	2		3716	21660	22130	15925	19650	14495	2480	1430	649	504.778
3	3		3716	21660	22130	15925	19650	14495	2480	1430	649	504.778
4	4	7.48	4084	17312							591	459.667
5	5	7.47	4084	17312							591	459.667
6	6	7.45	4084	17312							591	459.667
7	7	7.73	4084	17312							591	459.667
8	8	7.55	3594	13518	17035	13095	15069	12155	1980	940	535	416.111
9	9	7.62	3594	13518	17035	13095	15069	12155	1980	940	535	416.111
10	10	7.64	3594	13518	17035	13095	15069	12155	1980	940	535	416.111
11	11	7.72	3594	13518	17035	13095	15069	12155	1980	940	535	416.111
12	12	7.72	3906	12648	15105	11425	12435	9625	2670	1800	569	442.556
13	13	7.60	3906	12648	15105	11425	12435	9625	2670	1800	569	442.556
14	14	7.40	3906	12648	15105	11425	12435	9625	2670	1800	569	442.556
15	15	7.79	3906	12648	15105	11425	12435	9625	2670	1800	569	442.556
16	16	7.45	3223	11428	12530	8975	10540	8305	1550	670	537	417.667
17	17		3223	11428	12530	8975	10540	8305	1550	670	537	417.667
18	18	7.25	3223	11428	12530	8975	10540	8305	1550	670	537	417.667
19	19	7.46	3223	11428	12530	8975	10540	8305	1550	670	537	417.667
20	20	7.85	3150		11155	7755	9440	7325	1450	430	529	411.444
21	21	7.54	3150		11155	7755	9440	7325	1450	430	529	411.444
22	22	7.60	3150		11155	7755	9440	7325	1450	430	529	411.444
23	23	7.59	3150		11155	7755	9440	7325	1450	430	529	411.444
24	24		1394		17020	12485	15590	12015	1430	470	420	326.667
25	25	7.39	1394		17020	12485	15590	12015	1430	470	420	326.667
26	26	7.58	1394		17020	12485	15590	12015	1430	470	420	326.667
27	27	7.60	1394		17020	12485	13080	12015	1430	470	420	326.667
28	28	7.50	3083	13175	15885	11345	13750	10685	1610	660	506	393.556
29	29	7.44	3083	13175	15885	11345	13750	10685	1610	660	506	393.556
30	30	7.46	3083	13175	15885	11345	13750	10685	1610	660	506	393.556
31	31		3083	13175	15885	11345	13750	10685	1610	660	506	393.556
32	32	7.36	2205	11968	17480		15950		1530	420	370	287.778
33	33	7.46	2205	11968	17480		15950		1530	420	370	287.778
34	34	7.49	2205	11968	17480		15950		1530	420	370	287.778
35	35	7.53	2205	11968	17480		15950		1530	420	370	287.778
36	36	7.48	1492	13757	15390	11640	13880	11090	1510	550	339	263.667
37	37	7.51	1492	13757	15390	11640	13880	11090	1510	550	339	263.667
38	38		1492	13757	15390	11640	13880	11090	1510	550	339	263.667
39	39	7.32	1492	13757	15390	11640	13880	11090	1510	550	339	263.667
40	40	7.67	2190	10846	16515	11500	11503	10750	1480	750	368	286.222
41	41	7.44	2190	10846	16515	11500	11503	10750	1480	750	368	286.222
42	42	7.47	2190	10846	16515	11500	11503	10750	1480	750	368	286.222
43	43	7.58	2190	10846	16515	11500	11503	10750	1480	750	368	286.222
44	44	7.73	1339	12831	14330	10565	13090	9965	1140	600	274	213.111
45	45	7.59	1339	12831	14330	10565	13090	9965	1140	600	274	213.111
46	46	7.60	1339	12831	14330	10565	13090	9965	1140	600	274	213.111
47	47	7.67	1339	12831	14330	10565	13090	9965	1140	600	274	213.111
48	48	7.67	1744	10458	12970	9455	12040	8975	930	480	333	259.000
49	49	7.59	1744	10458	12970	9455	12040	8975	930	480	333	259.000
50	50		1744	10458	12970	9455	12040	8975	930	480	333	259.000
51	51	7.56	1744	10458	12970	9455	12040	8975	930	480	333	259.000
52	52	7.47	1172	15192	18850	14090	17030	13650	1330	440	467	363.222
53	53		1172	15192	18850	14090	17030	13650	1330	440	467	363.222
54	54	7.30	1172	15192	18850	14090	17030	13650	1330	440	467	363.222
55	55	7.37	1172	15192	18850	14090	17030	13650	1330	440	467	363.222

FEED ONE-FIFTH FIRST REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56	7.63	1625	18346	14955	10945	13790	10495	1200	450	325	252.778
57	57	7.54	1625	18346	14955	10945	13790	10495	1200	450	325	252.778
58	58	7.47	1625	18346	14955	10945	13790	10495	1200	450	325	252.778
59	59	7.45	1625	18346	14955	10945	13790	10495	1200	450	325	252.778
60	60	7.70	1469	14147	16100	11555	14670	11135	1430	420	399	310.333
61	61	7.63	1469	14147	16100	11555	14670	11135	1430	420	399	310.333
62	62	7.60	1469	14147	16100	11555	14670	11135	1430	420	399	310.333
63	63	7.60	1469	14147	16100	11555	14670	11135	1430	420	399	310.333

FEED ONE-FIFTH SECOND REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1	7.40	750	9690	10185	7130	9560	6870	840	260	307	238.778
2	2	7.64	750	9690	10185	7130	9560	6870	840	260	307	238.778
3	3	7.61	750	9690	10185	7130	9560	6870	840	260	307	238.778
4	4	7.66	750	9690	10185	7130	9560	6870	840	260	307	238.778
5	5		682	8527	10040	6715	8920	6305	1120	410	339	263.667
6	6	7.59	682	8527	10040	6715	8920	6305	1120	410	339	263.667
7	7		682	8527	10040	6715	8920	6305	1120	410	339	263.667
8	8	7.64	682	8527	10040	6715	8920	6305	1120	410	339	263.667
9	9	7.49	694	15245	15145	10810	13550	10260	1500	550	399	310.333
10	10		694	15245	15145	10810	13550	10260	1500	550	399	310.333
11	11	7.23	694	15245	15145	10810	13550	10260	1500	550	399	310.333
12	12		694	15245	15145	10810	13550	10260	1500	550	399	310.333
13	13		750	12192	14715	9780	13400	9500	980	280	372	289.333
14	14	7.37	750	12192	14715	9780	13400	9500	980	280	372	289.333
15	15		750	12192	14715	9780	13400	9500	980	280	372	289.333
16	16		750	12192	14715	9780	13400	9500	980	280	372	289.333
17	17	7.55	891	12711	14150	10015	13850	9715	1071	300	380	295.556
18	18	7.47	891	12711	14150	10015	13850	9715	1071	300	380	295.556
19	19		891	12711	14150	10015	13850	9715	1071	300	380	295.556
20	20		891	12711	14150	10015	13850	9715	1071	300	380	295.556
21	21	7.55			11725	8285	10240	7945	960	340		0.000
22	22	7.50			11725	8285	10240	7945	960	340		0.000
23	23				11725	8285	10240	7945	960	340		0.000
24	24				11725	8285	10240	7945	960	340		0.000
25	25		556	8864	10045	6780	9810	6460	1190	320		0.000
26	26	7.40	556	8864	10045	6780	9810	6460	1190	320		0.000
27	27	7.35	556	8864	10045	6780	9810	6460	1190	320		0.000
28	28		556	8864	10045	6780	9810	6460	1190	320		0.000
29	29		773	8941								0.000
30	30		773	8941								0.000
31	31		773	8941								0.000
32	32	7.49	562	7582	10165	6920	9350	5710	1210	330		0.000
33	33		562	7582	10165	6920	9350	5710	1210	330		0.000
34	34		562	7582	10165	6920	9350	5710	1210	330		0.000
35	35	7.33	562	7582	10165	6920	9350	5710	1210	330		0.000
36	36	7.75	720	8500	10745	7190	10620	6900	850	290		0.000
37	37		720	8500	10745	7190	10620	6900	850	290		0.000
38	38	7.60	720	8500	10745	7190	10620	6900	850	290		0.000
39	39		720	8500	10745	7190	10620	6900	850	290		0.000
40	40		677	15748	16180	10270	13190	9920	1270	350	455	353.889
41	41	7.41	677	15748	16180	10270	13190	9920	1270	350	455	353.889
42	42		677	15748	16180	10270	13190	9920	1270	350	455	353.889
43	43	7.42	677	15748	16180	10270	13190	9920	1270	350	455	353.889
44	44		677	15748	16180	10270	13190	9920	1270	350	455	353.889
45	45	7.50	767	12109	18635	12665	16140	12165	1210	500	388	301.778
46	46		767	12109	18635	12665	16140	12165	1210	500	388	301.778
47	47		767	12109	18635	12665	16140	12165	1210	500	388	301.778
48	48		767	12109	18635	12665	16140	12165	1210	500	388	301.778
49	49	7.65	899	14118	18745	12245	17675	11745	1070	500	578	449.556
50	50	7.55	899	14118	18745	12245	17675	11745	1070	500	578	449.556
51	51	7.66	899	14118	18745	12245	17675	11745	1070	500	578	449.556
52	52		899	14118	18745	12245	17675	11745	1070	500	578	449.556
53	53		1200	18200	20700	14325	19530	13955	1170	370	546	424.667
54	54		1200	18200	20700	14325	19530	13955	1170	370	546	424.667
55	55		1200	18200	20700	14325	19530	13955	1170	370	546	424.667

FEED ONE-FIFTH SECOND REP

OBS	DATE	PH	CODSF	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56	7.49	1200	16200	20700	14325	19530	13955	1170	370	546	424.667
57	57		1096	17669	19785	13025	18755	12725	1030	300	415	322.778
58	58	7.51	1096	17669	19785	13025	18755	12725	1030	300	415	322.778
59	59		1096	17669	19785	13025	18755	12725	1030	300	415	322.778
60	60		1096	17669	19785	13025	18755	12725	1030	300	415	322.778
61	61	7.59	1338	19418	19820	14020	17510	13660	1040	360	498	387.333
62	62	7.62	1338	19418	19820	14020	17510	13660	1040	360	498	387.333
63	63		1338	19418	19820	14020	17510	13660	1040	360	498	387.333
64	64		1338	19418	19820	14020	17510	13660	1040	360	498	387.333
65	65		817	11765	16485	11200	13940	10850	1150	350	441	343.000
66	66	7.51	817	11765	16485	11200	13940	10850	1150	350	441	343.000
67	67		817	11765	16485	11200	13940	10850	1150	350	441	343.000
68	68	7.47	817	11765	16485	11200	13940	10850	1150	350	441	343.000
69	69	7.56	974	13595	14955	9870	14280	9460	840	410	453	352.333
70	70	7.57	974	13595	14955	9870	14280	9460	840	410	453	352.333
71	71		974	13595	14955	9870	14280	9460	840	410	453	352.333
72	72		974	13595	14955	9870	14280	9460	840	410	453	352.333
73	73		986		19280	12285	18270	11955	820	330	445	346.111
74	74	7.47	986		19280	12285	18270	11955	820	330	445	346.111
75	75	7.53	986		19280	12285	18270	11955	820	330	445	346.111
76	76		986		19280	12285	18270	11955	820	330	445	346.111
77	77		903	19392	17115	10980	16105	10630	1010	350	289	224.778
78	78		903	19392	17115	10980	16105	10630	1010	350	289	224.778
79	79	7.54	903	19392	17115	10980	16105	10630	1010	350	289	224.778
80	80		903	19392	17115	10980	16105	10630	1010	350	289	224.778
81	81		1065		17890	11830	15060	11290	1140	540	437	339.889
82	82	7.37	1065		17890	11830	15060	11290	1140	540	437	339.889
83	83	7.45	1065		17890	11830	15060	11290	1140	540	437	339.889
84	84		1065		17890	11830	15060	11290	1140	540	437	339.889
85	85	7.58	852	12133	23745	13100	21450	12720	1000	380	555	431.667
86	86		852	12133	23745	13100	21450	12720	1000	380	555	431.667
87	87		852	12133	23745	13100	21450	12720	1000	380	555	431.667
88	88		852	12133	23745	13100	21450	12720	1000	380	555	431.667

FEED ONE-THIRD FIRST REP

OBS	DATE	PH	CODSP	CODT	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1	7.15		4906							124	96.444
2	2	7.15		4906							124	96.444
3	3	7.15		4906							124	96.444
4	4	7.10		9813							255	196.333
5	5	7.10		9813							255	198.333
6	6	7.11		9255							233	181.222
7	7	7.11		9255							233	181.222
8	8											0.000
9	9	7.14		9686							259	201.444
10	10	7.32	4980	25292	27360	19115	20173	15440	7187	3675		0.000
11	11	7.50	4980	25292	27360	19115	20173	15440	7187	3675		0.000
12	12	7.47	4747		30540	21955	20727	15513	9813	6442	780	606.667
13	13	7.47	4747		30540	21955	20727	15513	9813	6442	780	606.667
14	14	7.34			23715	16845	14320	10980	9395	5865		0.000
15	15	7.59			23715	16845	14320	10980	9395	5865		0.000
16	16	7.45	4661	25496	18805	13575	13167	9760			874	679.778
17	17	7.60	4661	25498	18805	13575	13167	9760			874	679.778
18	18	7.32	4032	28574	23490	16915	21060	15925	2430	990	596	463.556
19	19		4032	28574	23490	16915	21060	15925	2430	990	596	463.556
20	20	7.51	6640	36364	31975	21575	23410	20765	2430	810	801	623.000
21	21	7.58	6640	36364	31975	21575	23410	20765	2430	810	801	623.000
22	22	7.62	6732	38780	29810	20415	25490	19335	3090	1080	991	770.778
23	23	7.57	6732	38780	29810	20415	25490	19335	3090	1080	991	770.778
24	24	7.54	5525	33852	22220	16220	20040	14980	2460	1240	644	500.889
25	25	7.69	5525	33852	22220	16220	20040	14980	2460	1240	644	500.889
26	26	7.47	5771	33852	21965	15745	20840	14955	1450	790	805	626.111
27	27	7.66	5771	33852	21965	15745	20840	14955	1450	790	805	626.111
28	28	7.42	3735	26070	29140	20075	22460	11625	9990	8450	769	598.111
29	29	7.45	3735	26070	29140	20075	22460	11625	9990	8450	769	598.111
30	30	7.54	5681	24124	27590	19580	26700				978	760.667
31	31	7.60	5681	24124	27590	19580	26700				978	760.667
32	32	7.47	4206	28175	27340	19315	24670	18035	2670	1280	851	661.889
33	33	7.59	4206	28175	27340	19315	24670	18035	2670	1280	851	661.889
34	34	7.51	2745	27451	30165	19835	27615	18785	2550	1050	742	577.111
35	35	7.60	2745	27451	30165	19835	27615	18785	2550	1050	742	577.111
36	36	7.58	3346	22179	33290	22855	30580	21495	2710	1360	909	707.000
37	37		3346	22179	33290	22855	30580	21495	2710	1360	909	707.000
38	38	7.59	4124	32685	27905		24210		3290	1560	771	599.667
39	39	7.63	4124	32685	27905		24210		3290	1560	771	599.667
40	40	7.45	5350	33333	21285	15405	18180	13755	2800	1650	886	689.111
41	41		5350	33333	21285	15405	18180	13755	2800	1650	886	689.111
42	42	7.54	5597	27236	23500	16685	20870	15135	2570	1550	795	618.333
43	43	7.55	5597	27236	23500	16685	20870	15135	2570	1550	795	618.333
44	44	7.57	4382	23171	24845	17530	22180	16300	3010	1230	808	628.444
45	45	7.81	4382	23171	24845	17530	22180	16300	3010	1230	808	628.444
46	46		5578	24797	20375	14740	18660	14010	2280	730	744	578.667
47	47	7.59	5578	24797	20375	14740	18660	14010	2280	730	744	578.667
48	48	7.51	3984	28740	23425	17215	20830	16325	2670	890	911	708.556
49	49	7.51	3984	28740	23425	17215	20830	16325	2670	890	911	708.556
50	50	7.70	6773	18504	25715	18245	21190	17455	2810	790	1120	871.111
51	51	7.78	6773	18504	25715	18245	21190	17455	2810	790	1120	871.111
52	52	7.55	3280	29961	29960	21780	25870	20650	2460	1130		0.000
53	53		3280	29961	29960	21780	25870	20650	2460	1130		0.000
54	54	7.29	3750	26848	24895	17325	21800	15825	2900	1500	794	617.556
55	55		3750	26848	24895	17325	21800	15825	2900	1500	794	617.556

FEED ONE-THIRD FIRST REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56		3502	29921	37410	25465	35270	24515	2140	950	904	703.111
57	57		3502	29921	37410	25465	35270	24515	2140	950	904	703.111
58	58	7.42	4173	26018	38600		35970	27900	2630	1480	929	722.556
59	59		4173	26018	38600		35970	27900	2630	1480	929	722.556
60	60	7.36	2835	29961	37935	26610	34745	24760	3190	1850	832	647.111
61	61		2835	29961	37935	26610	34745	24760	3190	1850	832	647.111
62	62	7.46	3424	24903	25110	18455	22590	17055	3040	1400	763	593.444
63	63		3424	24903	25110	18455	22590	17055	3040	1400	763	593.444
64	64	7.36	4202	24514	26965	19785	23400	18185	3080	1600	845	657.222
65	65	7.44	4202	24514	26965	19785	23400	18185	3080	1600	845	657.222
66	66	7.46	5156	33333	41665	30810	36600	29750	2590	1060	855	665.000
67	67		5156	33333	41665	30810	36600	29750	2590	1060	855	665.000
68	68	7.42	4669		25060	18215	20150	17165	2790	1640	776	603.556
69	69		4669		25060	18215	20150	17165	2790	1640	776	603.556
70	70	7.46	6196	33333	35060	23780	31710	22300	3260	1480	1058	822.889
71	71		6196	33333	35060	23780	31710	22300	3260	1480	1058	822.889
72	72	7.46	3268	24124	29405	20505	25860	18675	3340	1830	920	715.556
73	73		3268	24124	29405	20505	25860	18675	3340	1830	920	715.556
74	74	7.43	4669	27237	29025	20305	25000	18535	3390	1770	858	667.333
75	75	7.48	4669	27237	29025	20305	25000	18535	3390	1770	858	667.333
76	76	7.44	3813	24016	25395	18860	22250	17300	2750	1560	846	658.000
77	77		3813	24016	25395	18860	22250	17300	2750	1560	846	658.000
78	78	7.44	4436	25197	28200	21100	27330	19520	2930	1580	870	676.667
79	79	7.69	4436	25197	28200	21100	27330	19520	2930	1580	870	676.667
80	80	7.50	5354								993	772.333
81	81		5354								993	772.333
82	82	7.35	7244								957	744.333
83	83		7244								957	744.333

FEED ONE-THIRD SECOND REP

OBS	DATE	PH	CODSP	CODPC	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1	7.10		4906							124	96.444
2	2		7424	33302	30710	21280	20800	19180	7100	2100	922	717.111
3	3	7.47	7424	33302	30710	21280	20800	19180	7100	2100	922	717.111
4	4		7424	33302	30710	21280	20800	19180	7100	2100	922	717.111
5	5		7424	33302	30710	21280	20800	19180	7100	2100	922	717.111
6	6	7.33	5882	24510	15625	11010	11967	8503	3940	2507	978	760.667
7	7	7.58	5882	24510	15625	11010	11967	8503	3940	2507	978	760.667
8	8											0.000
9	9	7.64	5882	24510	15625	11010	11967	8503	3940	2507	978	760.667
10	10	7.32	4980	25292	27360	19115	20173	15440	7187	3675		0.000
11	11	7.50	4980	25292	27360	19115	20173	15440	7187	3675		0.000
12	12	7.47	4747		30540	21955	20727	15513	9813	6442	780	606.667
13	13	7.47	4747		30540	21955	20727	15513	9813	6442	780	606.667
14	14	7.34			23715	16845	14320	10980	9395	5865		0.000
15	15	7.59			23715	16845	14320	10980	9395	5865		0.000
16	16	7.45	4661	25498	18805	13575	13167	9760			874	679.778
17	17	7.60	4661	25498	18805	13575	13167	9760			874	679.778
18	18	7.32	4032	28574	23490	16915	21060	15925	2430	990	596	463.556
19	19		4032	28574	23490	16915	21060	15925	2430	990	596	463.556
20	20	7.51	6640	36364	31975	21575	23410	20765	2430	810	801	623.000
21	21	7.56	6640	36364	31975	21575	23410	20765	2430	810	801	623.000
22	22	7.62	6732	38780	29810	20415	25490	19335	3090	1080	991	770.778
23	23	7.57	6732	38780	29810	20415	25490	19335	3090	1080	991	770.778
24	24	7.54	5525	33852	22220	16220	20040	14980	2460	1240	644	500.889
25	25	7.69	5525	33852	22220	16220	20040	14980	2460	1240	644	500.889
26	26	7.47	5771	33852	21965	15745	20840	14955	1450	790	805	626.111
27	27	7.66	5771	33852	21965	15745	20840	14955	1450	790	805	626.111
28	28	7.42	3735	26070	29140	20075	22460	11625	9990	8450	769	598.111
29	29	7.45	3735	26070	29140	20075	22460	11625	9990	8450	769	598.111
30	30	7.54	5681	24124	27590	19580	26700				978	760.667
31	31	7.60	5681	24124	27590	19580	26700				978	760.667
32	32	7.47	4206	28175	27340	19315	24670	18035	2670	1280	851	661.889
33	33	7.59	4206	28175	27340	19315	24670	18035	2670	1280	851	661.889
34	34	7.51	2745	27451	30165	19835	27615	18785	550		742	577.111
35	35	7.60	2745	27451	30165	19835	27615	18785	2550	1050	742	577.111
36	36	7.58	3346	22179	33290	22855	30580	21495	2710	1360	909	707.000
37	37		3346	22179	33290	22855	30580	21495	2710	1360	909	707.000
38	38	7.59	4124	32685	27905		24210		3290	1560	771	599.667
39	39	7.63	4124	32685	27905		24210		3290	1560	771	599.667
40	40	7.45	5350	33333	21285	15405	18180	13755	2800	1650	886	689.111
41	41		5350	33333	21285	15405	18180	13755	2800	1650	886	689.111
42	42	7.54	5597	27236	23500	16685	20870	15135	2570	1550	795	618.333
43	43	7.55	5597	27236	23500	16685	20870	15135	2570	1550	795	618.333
44	44	7.57	4382	23171	24845	17530	22180	16300	3010	1230	808	628.444
45	45	7.81	4382	23171	24845	17530	22180	16300	3010	1230	808	628.444
46	46		5578	24797	20375	14740	18660	14010	2280	730	744	578.667
47	47	7.59	5578	24797	20375	14740	18660	14010	2280	730	744	578.667
48	48	7.51	3984	28740	23425	17215	20830	16325	2670	890	911	708.556
49	49	7.51	3984	28740	23425	17215	20830	16325	2670	890	911	708.556
50	50	7.70	6773	18504	25715	18245	21190	17455	2810	790	1120	871.111
51	51	7.78	6773	18504	25715	18245	21190	17455	2810	790	1120	871.111
52	52	7.55	3280	29961	29960	21780	25870	20650	2460	1130		0.000
53	53		3280	29961	29960	21780	25870	20650	2460	1130		0.000
54	54	7.29	3750	26848	24895	17325	21800	15825	2900	1500	794	617.556
55	55		3750	26848	24895	17325	21800	15825	2900	1500	794	617.556

FEED ONE-THIRD SECOND REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56		3502	29921	37410	25465	35270	24515	2140	950	904	703.111
57	57		3502	29921	37410	25465	35270	24515	2140	950	904	703.111
58	58	7.42	4173	26018	38600		35970	27900	2630	1480	929	722.556
59	59		4173	26018	38600		35970	27900	2630	1480	929	722.556
60	60	7.36	2835	29961	37935	26610	34745	24760	3190	1850	832	647.111
61	61		2835	29961	37935	26610	34745	24760	3190	1850	832	647.111
62	62	7.46	3424	24903	25110	18455	22590	17055	3040	1400	763	593.444
63	63		3424	24903	25110	18455	22590	17055	3040	1400	763	593.444
64	64	7.36	4202	24514	26965	19785	23400	18185	3080	1600	845	657.222
65	65	7.44	4202	24514	26965	19785	23400	18185	3080	1600	845	657.222
66	66	7.46	5156	33333	41665	30810	36600	29750	2590	1060	855	665.000
67	67		5156	33333	41665	30810	36600	29750	2590	1060	855	665.000
68	68	7.42	4669		25060	18215	20150	17165	2790	1640	776	603.556
69	69		4669		25060	18215	20150	17165	2790	1640	776	603.556
70	70	7.46	6196	33333	35060	23780	31710	22300	3260	1480	1058	822.889
71	71		6196	33333	35060	23780	31710	22300	3260	1480	1058	822.889
72	72	7.46	3268	24124	29405	20505	25860	18675	3340	1830	920	715.556
73	73		3268	24124	29405	20505	25860	18675	3340	1830	920	715.556
74	74	7.43	4669	27237	29025	20305	25000	18535	3390	1770	858	667.333
75	75	7.48	4669	27237	29025	20305	25000	18535	3390	1770	858	667.333
76	76	7.44	3813	24016	25395	18860	22250	17300	2750	1560	846	658.000
77	77		3813	24016	25395	18860	22250	17300	2750	1560	846	658.000
78	78	7.44	4436	25197	28200	21100	27330	19520	2930	1580	870	676.667
79	79	7.69	4436	25197	28200	21100	27330	19520	2930	1580	870	676.667
80	80	7.50	5354								993	772.333
81	81		5354								993	772.333
82	82	7.35	7244								957	744.333
83	83		7244								957	744.333

FEED ONE-THIRD THIRD REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1		5884	28727							954	742.000
2	2		5884	28727							954	742.000
3	3		5884	28727							954	742.000
4	4	7.41	6260	40514							1072	833.778
5	5	7.43	6260	40514							1072	833.778
6	6	7.45	6260	40514							1072	833.778
7	7	7.62	6260	40514							1072	833.778
8	8	7.48	6172	28656	26200	18740	23740	16990	3240	1880	874	679.778
9	9	7.58	6172	28656	26200	18740	23740	16990	3240	1880	874	679.778
10	10	7.45	6172	28656	26200	18740	23740	16990	3240	1880	874	679.778
11	11	7.62	6172	28656	26200	18740	23740	16990	3240	1880	874	679.778
12	12	7.69	7109	31225	29085	21815	26385	20375	2700	1440	901	700.778
13	13	7.52	7109	31225	29085	21815	26385	20375	2700	1440	901	700.778
14	14	7.35	7109	31225	29085	21815	26385	20375	2700	1440	901	700.778
15	15	7.74	7109	31225	29085	21815	26385	20375	2700	1440	901	700.778
16	16	7.36	5195	15667	17590	12475	15580	11475	2520	1050	823	640.111
17	17		5195	15667	17590	12475	15580	11475	2520	1050	823	640.111
18	18	7.33	5195	15667	17590	12475	15580	11475	2520	1050	823	640.111
19	19	7.52	5195	15667	17590	12475	15580	11475	2520	1050	823	640.111
20	20	7.80	4961		16375	11410	14550	10720	1820	690	1105	859.444
21	21	7.50	4961		16375	11410	14550	10720	1820	690	1105	859.444
22	22	7.62	4961		16375	11410	14550	10720	1820	690	1105	859.444
23	23	7.62	4961		16375	11410	14550	10720	1820	690	1105	859.444
24	24		2789		25280	18545	22800	17865	2180	680	808	628.444
25	25	7.43	2789		25280	18545	22800	17865	2180	680	808	628.444
26	26	7.65	2789		25280	18545	22800	17865	2180	680	808	628.444
27	27	7.65	2789		25280	18545	22800	17865	2180	680	808	628.444
28	28	7.34	5138	17460	23025	15720	20480	14410	2610	1310	810	630.000
29	29	7.35	5138	17460	23025	15720	20480	14410	2610	1310	810	630.000
30	30	7.41	5138	17460	23025	15720	20480	14410	2610	1310	810	630.000
31	31		5138	17460	23025	15720	20480	14410	2610	1310	810	630.000
32	32	7.32	4252	18898	21240	15590	18870	14770	2370	820	608	472.889
33	33	7.42	4252	18898	21240	15590	18870	14770	2370	820	608	472.889
34	34	7.51	4252	18898	21240	15590	18870	14770	2370	820	608	472.889
35	35	7.57	4252	18898	21240	15590	18870	14770	2370	820	608	472.889
36	36	7.41	3142	13095	20955	14955	20440	18665	2290	1060	611	475.222
37	37	7.46	3142	13095	20955	14955	20440	18665	2290	1060	611	475.222
38	38		3142	13095	20955	14955	20440	18865	2290	1060	611	475.222
39	39	7.40	3142	13095	20955	14955	20440	18665	2290	1060	611	475.222
40	40	7.56	3760	17262	24600	17750	22780	16700	1950	1050	595	462.778
41	41	7.40	3760	17262	24600	17750	22780	16700	1950	1050	595	462.778
42	42	7.43	3760	17262	24600	17750	22780	16700	1950	1050	595	462.778
43	43	7.56	3760	17262	24600	17750	22780	16700	1950	1050	595	462.778
44	44	7.62	2599	22817	25195	18845	23265	18015	1930	830	476	370.222
45	45	7.54	2599	22817	25195	18845	23265	18015	1930	830	476	370.222
46	46	7.66	2599	22817	25195	18845	23265	18015	1930	830	476	370.222
47	47	7.59	2599	22817	25195	18845	23265	18015	1930	830	476	370.222
48	48	7.58	3191	22941	24440	18000	22400	17180	2040	820	607	472.111
49	49	7.36	3191	22941	24440	18000	22400	17180	2040	820	607	472.111
50	50		3191	22941	24440	18000	22400	17180	2040	820	607	472.111
51	51	7.60	3191	22941	24440	18000	22400	17180	2040	820	607	472.111
52	52	7.36	2266	26058	31130	22490	29220	21660	1910	830	712	553.778
53	53		2266	26058	31130	22490	29220	21660	1910	830	712	553.778
54	54	7.34	2266	26058	31130	22490	29220	21660	1910	830	712	553.778
55	55	7.57	2266	26058	31130	22490	29220	21660	1910	830	712	553.778

FEED ONE-THIRD THIRD REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56	7.50	2708	31589	23035	16480	21175	15730	1860	750	486	378.000
57	57	7.48	2708	31589	23035	16480	21175	15730	1860	750	486	378.000
58	58	7.46	2708	31589	23035	16480	21175	15730	1860	750	486	378.000
59	59	7.56	2708	31589	23035	16480	21175	15730	1860	750	486	378.000
60	60	7.57	2669	17054	23650	17050	21690	16310	1960	740	458	356.222
61	61	7.45	2669	17054	23650	17050	21690	16310	1960	740	458	356.222
62	62	7.67	2669	17054	23650	17050	21690	16310	1960	740	458	356.222
63	63	7.46	2669	17054	23650	17050	21690	16310	1960	740	458	356.222
64	64		2574	22201	27125	18050	25715	17550	1410	500	659	512.556
65	65		2574	22201	27125	18050	25715	17550	1410	500	659	512.556
66	66		2574	22201	27125	18050	25715	17550	1410	500	659	512.556
67	67	7.56	2574	22201	27125	18050	25715	17550	1410	500	659	512.556
68	68	7.53	2831	25097	24775	18095	23135	17645	1640	450	608	472.889
69	69	7.56	2831	25097	24775	18095	23135	17645	1640	450	608	472.889
70	70	7.61	2831	25097	24775	18095	23135	17645	1640	450	608	472.889
71	71	7.55	2831	25097	24775	18095	23135	17645	1640	450	608	472.889
72	72	7.52	1432	15116	15830	11210	14400	10840	1430	370	461	358.556
73	73	7.59	1432	15116	15830	11210	14400	10840	1430	370	461	358.556
74	74	7.72	1432	15116	15830	11210	14400	10840	1430	370	461	358.556
75	75		1432	15116	15830	11210	14400	10840	1430	370	461	358.556
76	76	7.50	1189	17442	24960	16950	23390	16350	1570	600	555	431.667
77	77		1189	17442	24960	16950	23390	16350	1570	600	555	431.667
78	78	7.70	1189	17442	24960	16950	23390	16350	1570	600	555	431.667
79	79	7.47	1189	17442	24960	16950	23390	16350	1570	600	555	431.667
80	80		1364	23837	25510	17360	24090	16760	1420	600	638	496.222
81	81	7.25	1364	23837	25510	17360	24090	16760	1420	600	638	496.222
82	82		1364	23837	25510	17360	24090	16760	1420	600	638	496.222
83	83		1364	23837	25510	17360	24090	16760	1420	600	638	496.222
84	84	7.31	1380	19455	24960	16080	23660	15680	1300	400	557	433.222
85	85		1380	19455	24960	16080	23660	15680	1300	400	557	433.222
86	86		1380	19455	24960	16080	23660	15680	1300	400	557	433.222
87	87	7.48	1380	19455	24960	16080	23660	15680	1300	400	557	433.222
88	88	7.45	1588	14591	19755	13485	18140	13005	1490	480	610	474.444
89	89		1588	14591	19755	13485	18140	13005	1490	480	610	474.444
90	90		1588	14591	19755	13485	18140	13005	1490	480	610	474.444
91	91	7.49	1588	14591	19755	13485	18140	13005	1490	480	610	474.444
92	92	7.58			19785	12885	17990	12385	1400	500		0.000
93	93				19785	12885	17990	12385	1400	500		0.000
94	94				19785	12885	17990	12385	1400	500		0.000
95	95				19785	12885	17990	12385	1400	500		0.000
96	96		1053	15918	16440	11030	15110	10730	1330	300		0.000
97	97	7.34	1053	15918	16440	11030	15110	10730	1330	300		0.000
98	98	7.36	1053	15918	16440	11030	15110	10730	1330	300		0.000
99	99		1053	15918	16440	11030	15110	10730	1330	300		0.000
100	100		1288	16146	21813	12717						0.000
101	101		1288	16146	21813	12717						0.000
102	102		1288	16146	21813	12717						0.000
103	103	7.39	1049	13333	17970	12175	16680	10885	1290	420	329	255.889
104	104		1049	13333	17970	12175	16680	10885	1290	420	329	255.889
105	105		1049	13333	17970	12175	16680	10885	1290	420	329	255.889
106	106	7.36	1049	13333	17970	12175	16680	10885	1290	420	329	255.889
107	107	7.69	1162	16797	21915	15405	20140	15005	1160	400	370	287.778
108	108		1162	16797	21915	15405	20140	15005	1160	400	370	287.778
109	109	7.52	1162	16797	21915	15405	20140	15005	1160	400	370	287.778
110	110		1162	16797	21915	15405	20140	15005	1160	400	370	287.778

FEED ONE=THIRD THIRD REP

OBS	DATE	PH	CODSP	CODPL	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
111	111		1128	21289	27065	18105	25655	17515	1410	590	787	612.111
112	112	7.37	1128	21289	27065	18105	25655	17515	1410	590	787	612.111
113	113		1128	21289	27065	18105	25655	17515	1410	590	787	612.111
114	114	7.42	1128	21289	27065	18105	25655	17515	1410	590	787	612.111
115	115		1128	21289	27065	18105	25655	17515	1410	590	787	612.111
116	116	7.44	1378	21094	29760	19535	28340	19035	1420	500	648	504.000
117	117		1378	21094	29760	19535	28340	19035	1420	500	648	504.000
118	118		1378	21094	29760	19535	28340	19035	1420	500	648	504.000
119	119		1378	21094	29760	19535	28340	19035	1420	500	648	504.000
120	120	7.60	1199	20784	27815	17470	26455	17000	1360	470	768	597.333
121	121	7.56	1199	20784	27815	17470	26455	17000	1360	470	768	597.333
122	122	7.57	1199	20784	27815	17470	26455	17000	1360	470	768	597.333
123	123		1199	20784	27815	17470	26455	17000	1360	470	768	597.333
124	124		1679	22488	27530	18780	26100	18320	1430	460	730	567.778
125	125		1679	22488	27530	18780	26100	18320	1430	460	730	567.778
126	126		1679	22488	27530	18780	26100	18320	1430	460	730	567.778
127	127	7.52	1679	22488	27530	18780	26100	18320	1430	460	730	567.778
128	128		1605	23684	35235	21840	33965	21500	1270	340	690	536.667
129	129	7.49	1605	23684	35235	21840	33965	21500	1270	340	690	536.667
130	130		1605	23684	35235	21840	33965	21500	1270	340	690	536.667
131	131		1605	23684	35235	21840	33965	21500	1270	340	690	536.667
132	132	7.60	1930	19418	27905	18985	26390	18515	1330	470	657	511.000
133	133	7.56	1930	19418	27905	18985	26390	18515	1330	470	657	511.000
134	134		1930	19418	27905	18985	26390	18515	1330	470	657	511.000
135	135	7.60	1930	19418	27905	18985	26390	18515	1330	470	657	511.000
136	136		1299	22353	26875	17245	24810	16705	1570	540	733	570.111
137	137	7.45	1299	22353	26875	17245	24810	16705	1570	540	733	570.111
138	138		1299	22353	26875	17245	24810	16705	1570	540	733	570.111
139	139	7.43	1299	22353	26875	17245	24810	16705	1570	540	733	570.111
140	140	7.49	1719	20000	25565	16930	24070	16400	1300	530	626	486.889
141	141	7.63	1719	20000	25565	16930	24070	16400	1300	530	626	486.889
142	142		1719	20000	25565	16930	24070	16400	1300	530	626	486.889
143	143		1719	20000	25565	16930	24070	16400	1300	530	626	486.889
144	144				30040	19715	28880	19265	1230	450	669	520.333
145	145	7.36			30040	19715	28880	19265	1230	450	669	520.333
146	146	7.55			30040	19715	28880	19265	1230	450	669	520.333
147	147				30040	19715	28880	19265	1230	450	669	520.333
148	148		1559	24335	29930	18755	28410	18225	1520	530	465	361.667
149	149		1559	24335	29930	18755	28410	18225	1520	530	465	361.667
150	150	7.43	1559	24335	29930	18755	28410	18225	1520	530	465	361.667
151	151		1559	24335	29930	18755	28410	18225	1520	530	465	361.667
152	152		1901		39305	21140	37980	20390	1600	750	629	489.222
153	153	7.30	1901		39305	21140	37980	20390	1600	750	629	489.222
154	154	7.43	1901		39305	21140	37980	20390	1600	750	629	489.222
155	155		1901		39305	21140	37980	20390	1600	750	629	489.222
156	156	7.54	1724	23875	37505	22125	35815	21445	1690	680	876	681.333
157	157		1724	23875	37505	22125	35815	21445	1690	680	876	681.333
158	158		1724	23875	37505	22125	35815	21445	1690	680	876	681.333
159	159		1724	23875	37505	22125	35815	21445	1690	680	876	681.333

FEED ONE-HALF FIRST REP

OBS	DATE	PH	CODSP	CODTL	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1		8046	60869	43690	31715	38060	28135	5630	3580	1561	1214.11
2	2		8046	60869	43690	31715	38060	28135	5630	3580	1561	1214.11
3	3		8046	60869	43690	31715	38060	28135	5630	3580	1561	1214.11
4	4	7.35	10229	53557							1087	845.44
5	5	7.21	10229	53557							1087	845.44
6	6	7.35	10229	53557							1087	845.44
7	7	7.53	10229	53557							1087	845.44
8	8	7.44	9375	44071	39800	29505	35480	27625	4320	2880	1424	1107.56
9	9	7.50	9375	44071	39800	29505	35480	27625	4320	2880	1424	1107.56
10	10	7.51	9375	44071	39800	29505	35480	27625	4320	2880	1424	1107.56
11	11	7.68	9375	44071	39800	29505	35480	27625	4320	2880	1424	1107.56
12	12	7.55	10078	38340	37170	22225	33560	25545	3610	1680	1389	1080.33
13	13	7.43	10078	38340	37170	22225	33560	25545	3610	1680	1389	1080.33
14	14	7.27	10076	38340	37170	22225	33560	25545	3610	1680	1389	1080.33
15	15	7.74	10078	38340	37170	22225	33560	25545	3610	1680	1389	1080.33
16	16	7.32	7852	26587	29650	20350	26320	18870	3330	1480	943	733.44
17	17		7852	26587	29650	20350	26320	18870	3330	1480	943	733.44
18	18	7.34	7852	26587	29650	20350	26320	18870	3330	1480	943	733.44
19	19	7.64	7852	26587	29650	20350	26320	18870	3330	1480	943	733.44
20	20	7.71	8189		28055	19820	24665	18580	3390	1240	1583	1231.22
21	21	7.49	8189		28055	19820	24665	18580	3390	1240	1583	1231.22
22	22	7.51	8189		28055	19820	24665	18580	3390	1240	1583	1231.22
23	23	7.62	8189		28055	19820	24665	18580	3390	1240	1583	1231.22
24	24		4303		32820	23795	29590	22425	3230	1370	1119	870.33
25	25	7.41	4303		32820	23795	29590	22425	3230	1370	1119	870.33
26	26	7.67	4303		32820	23795	29590	22425	3230	1370	1119	870.33
27	27	7.68	4303		32820	23795	29590	22425	3230	1370	1119	870.33
28	28	7.31	8063	27381	31550	22730	27930	20770	3620	1960	1205	937.22
29	29	7.28	8063	27381	31550	22730	27930	20770	3620	1960	1205	937.22
30	30	7.35	8063	27381	31550	22730	27930	20770	3620	1960	1205	937.22
31	31		8063	27381	31550	22730	27930	20770	3620	1960	1205	937.22
32	32	7.28	6693	26740	30990	22585	26990	21765	3580	820	954	742.00
33	33	7.37	6693	28740	30990	22585	26990	21765	3580	820	954	742.00
34	35	7.48	6693	28740	30990	22585	26990	21765	3580	820	954	742.00
35	34	7.65	6693	28740	30990	22585	26990	21765	3580	820	954	742.00
36	36	7.36	5731	27778	36445	23160	32540	21910	1250	1840	996	774.67
37	37	7.42	5731	27778	36445	23160	32540	21910	1250	1840	996	774.67
38	38	7.41	5731	27778	36445	23160	32540	21910	1250	1840	996	774.67
39	39	7.46	5731	27778	36445	23160	32540	21910	1250	1840	996	774.67
40	40	7.46	5426	29365	35320	24925	32320	23355	3000	1570	818	636.22
41	41	7.32	5426	29365	35320	24925	32320	23355	3000	1570	818	636.22
42	42	7.43	5426	29365	35320	24925	32320	23355	3000	1570	818	636.22
43	43	7.56	5426	29365	35320	24925	32320	23355	3000	1570	818	636.22
44	44	7.53	4008	30423	31870	22460	28680	20840	3190	1620	759	590.33
45	45	7.50	4008	30423	31870	22460	28680	20840	3190	1620	759	590.33
46	46	7.51	4008	30423	31870	22460	28680	20840	3190	1620	759	590.33
47	47	7.69	4008	30423	31870	22460	28680	20840	3190	1620	759	590.33
48	48	7.52	5252	29020	29895	20975	26915	19655	2980	1320	1027	798.78
49	50	7.50	5252	29020	29895	20975	26915	19655	2980	1320	1027	798.78
50	51		5252	29020	29895	20975	26915	19655	2980	1320	1027	798.78
51	52	7.59	5252	29020	29895	20975	26915	19655	2980	1320	1027	798.78
52	53		3516	45513	46385	33115	44255	32195	2130	920	1121	871.89
53	54	7.28	3516	45513	46385	33115	44255	32195	2130	920	1121	871.89
54	55	7.44	3516	45513	46385	33115	44255	32195	2130	920	1121	871.89
55	56	7.47	4648	45995	43550	30160	41090	28950	2460	1210	694	539.78

FEED ONE-HALF FIRST REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	57	7.39	4648	45995	43550	30160	41090	28950	2460	1210	694	539.778
57	58	7.45	4648	45995	43550	30160	41090	28950	2460	1210	694	539.778
58	59	7.40	4648	45995	43550	30160	41090	28950	2460	1210	694	539.778
59	60	7.52	4199	39535	49830	35495	46970	34255	2860	1240	755	587.222
60	61	7.52	4199	39535	49830	35495	46970	34255	2860	1240	755	587.222
61	62	7.61	4199	39535	49830	35495	46970	34255	2860	1240	755	587.222
62	63	7.70	4199	39535	49830	35495	46970	34255	2860	1240	755	587.222

FEED ONE-HALF SECOND REP

OHS	DATE	PH	CODSP	CODPL	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1	7.71	2226	24031	26460	18465	24500	17615	1960	850	673	523.444
2	2	7.46	2226	24031	26460	18465	24500	17615	1960	850	673	523.444
3	3	7.57	2226	24031	26460	18465	24500	17615	1960	850	673	523.444
4	4	7.67	2226	24031	26460	18465	24500	17615	1960	850	673	523.444
5	5		2326	23256							764	594.222
6	6	7.46	2326	23256							764	594.222
7	7		2326	23256							764	594.222
8	8	7.60	2326	23256							764	594.222
9	9	7.39	2278	36692	35210	24180	34000	23300	1930	880	899	699.222
10	10		2278	36692	35210	24180	34000	23300	1930	880	899	699.222
11	11	7.25	2278	36692	35210	24180	34000	23300	1930	880	899	699.222
12	12		2278	36692	35210	24180	34000	23300	1930	880	899	699.222
13	13		2305	33722	34480	22600	32940	22010	1540	590	670	521.111
14	14	7.35	2305	33722	34480	22600	32940	22010	1540	590	670	521.111
15	15		2305	33722	34480	22600	32940	22010	1540	590	670	521.111
16	16		2305	33722	34480	22600	32940	22010	1540	590	670	521.111
17	17	7.47	2422	22827	34580	23690	33970	23060	1890	630	919	714.778
18	18	7.43	2422	22827	34580	23690	33970	23060	1890	630	919	714.778
19	19		2422	22827	34580	23690	33970	23060	1890	630	919	714.778
20	20		2422	22827	34580	23690	33970	23060	1890	630	919	714.778
21	21	7.43			31550	20385	29490	19695	1930	690		0.000
22	22	7.55			31550	20385	29490	19695	1930	690		0.000
23	23				31550	20385	29490	19695	1930	690		0.000
24	24				31550	20385	29490	19695	1930	690		0.000
25	25		1842	20974	23520	15795	22770	15355	1840	440		0.000
26	26	7.30	1842	20974	23520	15795	22770	15355	1840	440		0.000
27	27	7.38	1842	20974	23520	15795	22770	15355	1840	440		0.000
28	28		1842	20974	23520	15795	22770	15355	1840	440		0.000
29	29		1932	24219	32720	19075						0.000
30	30		1932	24219	32720	19075						0.000
31	31		1932	24219	32720	19075						0.000
32	32	7.37	1629	23529	28700	19090	27300	17370	1720	530	618	480.667
33	33		1629	23529	28700	19090	27300	17370	1720	530	618	480.667
34	34		1629	23529	28700	19090	27300	17370	1720	530	618	480.667
35	35	7.38	1629	23529	28700	19090	27300	17370	1720	530	618	480.667
36	36	7.64	2746	32812	34230	23280	32910	22840	1330	440		0.000
37	37		2746	32812	34230	23280	32910	22840	1330	440		0.000
38	38	7.50	2746	32812	34230	23280	32910	22840	1330	440		0.000
39	39		2746	32812	34230	23280	32910	22840	1330	440		0.000
40	40		1917	33984	43745	29205	40160	28465	1910	740	824	640.889
41	41	7.46	1917	33984	43745	29205	40160	28465	1910	740	824	640.889
42	42		1917	33984	43745	29205	40160	28465	1910	740	824	640.889
43	43	7.50	1917	33984	43745	29205	40160	28465	1910	740	824	640.889
44	44		1917	33984	43745	29205	40160	28465	1910	740	824	640.889
45	45	7.38	2030	37109	50310	30735	48370	30205	1940	530	1008	784.000
46	46		2030	37109	50310	30735	48370	30205	1940	530	1008	784.000
47	47		2030	37109	50310	30735	48370	30205	1940	530	1008	784.000
48	48		2030	37109	50310	30735	48370	30205	1940	530	1008	784.000
49	49	7.57	1910	31373	37985	24410	35220	23520	1740	890	1034	804.222
50	50	7.59	1910	31373	37985	24410	35220	23520	1740	890	1034	804.222
51	51	7.67	1910	31373	37985	24410	35220	23520	1740	890	1034	804.222
52	52		1910	31373	37985	24410	35220	23520	1740	890	1034	804.222
53	53		2852	36667	50280	32040	48520	31450	1760	590	1104	858.667
54	54		2852	36667	50280	32040	48520	31450	1760	590	1104	858.667
55	55		2852	36667	50280	32040	48520	31450	1760	590	1104	858.667

FEED ONE-HALF SECOND REP

OBS	DATE	PH	LIDSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56	7.56	2852	30667	50280	32040	46520	31450	1760	590	1104	858.667
57	57		2778	31481	53475	32890	50810	32430	1810	460	989	769.222
58	58	7.47	2778	31481	53475	32890	50810	32430	1810	460	989	769.222
59	59		2778	31481	53475	32890	50810	32430	1810	460	989	769.222
60	60		2778	31481	53475	32890	50810	32430	1810	460	989	769.222
61	61	7.56	3083	48627	42915	28260	41200	27510	1940	750	935	727.222
62	62	7.49	3083	46627	42915	28260	41200	27510	1940	750	935	727.222
63	63		3083	48627	42915	28260	41200	27510	1940	750	935	727.222
64	64	7.64	3083	48627	42915	28260	41200	27510	1940	750	935	727.222
65	65		2618	27843	43020	25875	40980	25165	2040	710	917	713.222
66	66	7.39	2618	27843	43020	25875	40980	25165	2040	710	917	713.222
67	67		2618	27843	43020	25875	40980	25165	2040	710	917	713.222
68	68	7.51	2618	27843	43020	25875	40980	25165	2040	710	917	713.222
69	69	7.42	2874	41569	41960	26490	40170	25680	1940	810	929	722.556
70	70	7.57	2874	41569	41960	26490	40170	25680	1940	810	929	722.556
71	71		2874	41569	41960	26490	40170	25680	1940	810	929	722.556
72	72		2874	41569	41960	26490	40170	25680	1940	810	929	722.556
73	73		3008		43255	27895	39610	27345	1800	550	1011	786.333
74	74	7.34	3008		43255	27895	39610	27345	1800	550	1011	786.333
75	75	7.45	3008		43255	27895	39610	27345	1800	550	1011	786.333
76	76		3008		43255	27895	39610	27345	1800	550	1011	786.333
77	77		2795	38783	37290	24210	35540	23530	1750	680	778	605.111
78	78		2795	38783	37290	24210	35540	23530	1750	680	778	605.111
79	79	7.44	2795	38783	37290	24210	35540	23530	1750	680	778	605.111
80	80		2795	38783	37290	24210	35540	23530	1750	680	778	605.111
81	81		2852		58760	32820	56770	31700	2150	1120	870	676.667
82	82	7.31	2852		58760	32820	56770	31700	2150	1120	870	676.667
83	83	7.45	2852		58760	32820	56770	31700	2150	1120	870	676.667
84	84		2852		58760	32820	56770	31700	2150	1120	870	676.667
85	85	7.45		37548	53675	29440	50830	28530	2160	910	1252	973.778
86	86			37548	53675	29440	50830	28530	2160	910	1252	973.778
87	87			37548	53675	29440	50830	28530	2160	910	1252	973.778
88	88			37548	53675	29440	50830	28530	2160	910	1252	973.778

FEED STRAIGHT FIRST REP

OBS	DATE	PH	CODSP	CODPL	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1	7.12	17530	77689	63750	45235	57827	42707			2690	2092.22
2	2	7.18	17530	77689	63750	45235	57827	42707			2690	2092.22
3	3	7.50	21875	65079	70975	47570	66260	45410	5170	2160	2100	1633.33
4	4		21875	65079	70975	47570	66260	45410	5170	2160	2100	1633.33
5	5	7.32	23913	64822	75065	46045	67970				2227	1732.11
6	6	7.48	23913	64822	75065	46045	67970				2227	1732.11
7	7	7.43	23327	70079	74450	51380	72650	48280	6590	3100	2990	2325.56
8	8	7.36	23327	70079	74450	51380	72650	48280	6590	3100	2990	2325.56
9	9	7.17	20817	79377	81155	56615	72120	53095	7620	3520	1983	1542.33
10	10	7.17	20817	79377	81155	56615	72120	53095	7620	3520	1983	1542.33
11	11	7.25	16775	79377	81155	55310	76260	52160	6390	3150	2690	2092.22
12	12	7.48	16775	79377	81155	55310	76260	52160	6390	3150	2690	2092.22
13	13	7.25	18093	80934	86630	59930	78510	56350	8120	3580	2646	2058.00
14	14	7.26	18093	80934	86630	59930	78510	56350	8120	3580	2646	2058.00
15	15	7.31	17315	80934	83140	55985	76010	52455	8130	3530	3868	3008.44
16	16	7.44	17315	80934	83140	55985	76010	52455	8130	3530	3868	3008.44
17	17	7.30	19048	71428	83925	56220	74395	50510	9530	5710	2883	2242.33
18	18	7.42	19048	71428	83925	56220	74395	50510	9530	5710	2883	2242.33
19	19	7.38	10392	67451	82590	55275	76070	52405	7090	2870	2586	2011.33
20	20	7.44	10392	67451	82590	55275	76070	52405	7090	2870	2586	2011.33
21	21	7.39	9144	73152	90830	61195	83370	57875	7200	3320	2330	1812.22
22	22		9144	73152	90830	61195	83370	57875	7200	3320	2330	1812.22
23	23	7.32	14591	60700	80860		73500		7830	3430	2480	1928.89
24	24	7.42	14591	60700	80860		73500		7830	3430	2480	1928.89
25	25	7.19	18724	71545	66770	46760	60400	44200	6710	2560	2535	1971.67
26	26		18724	71545	66770	46760	60400	44200	6710	2560	2535	1971.67
27	27	7.40	19136	63415	73780	49685	65900	45665	7800	4020	1960	1524.44
28	28	7.50	19136	63415	73780	49685	65900	45665	7800	4020	1960	1524.44
29	29	7.38	15538	65041	66365	45665	58715	41955	7650	3710	2920	2271.11
30	30	7.61	15538	65041	66365	45665	58715	41955	7650	3710	2920	2271.11
31	31		18127	61789	66575	46415	60320	42275	8180	4140	2557	1988.78
32	32	7.57	18127	61789	66575	46415	60320	42275	8180	4140	2557	1988.78
33	33	7.29	18526	55118	61815	44035	55565	42455	6250	1580	3261	2536.33
34	34	7.48	18526	55118	61815	44035	55565	42455	6250	1580	3261	2536.33
35	35	7.56	20518								3053	2374.56
36	36		20518								3053	2374.56
37	37	7.32	10000	76264	90585	63170	83345	60270	7240	2900		0.00
38	38		10000	76264	90585	63170	83345	60270	7240	2900		0.00
39	39	7.04	12305	70039	87330	59935	82740	56425	7950	3510	2099	1632.56
40	40		12305	70039	87330	59935	82740	56425	7950	3510	2099	1632.56
41	41		17704	84047	95040	63120	89310	59750	7970	3370	2840	2208.89
42	42		17704	84047	95040	63120	89310	59750	7970	3370	2840	2208.89
43	43	7.28	20276	80934	94520	63000	87840	60060	7210	2940	2557	1988.78
44	44		20276	80934	94520	63000	87840	60060	7210	2940	2557	1988.78
45	45	7.20	19685	86343	82335	56970	76720	54330	7280	2640	3123	2429.00
46	46		19685	86343	82335	56970	76720	54330	7280	2640	3123	2429.00
47	47	7.37	18677	116732	76875	53660	68815	50030	8060	3630	1944	1512.00
48	48		18677	116732	76875	53660	68815	50030	8060	3630	1944	1512.00
49	49	7.21	19261	66926	84275	57420	77365	54310	6910	3110	2535	1971.67
50	50	7.19	19261	66926	84275	57420	77365	54310	6910	3110	2535	1971.67
51	51	7.27	21875	62500	79845	56230	71525	51920	8320	4310	2706	2104.67
52	52		21875	62500	79845	56230	71525	51920	8320	4310	2706	2104.67
53	53	7.33	20428		86180	59035	78490	55195	7690	3840	2330	1812.22
54	54		20428		86180	59035	78490	55195	7690	3840	2330	1812.22
55	55	7.35	22157	66106	83220	57495	77690	54055	7620	3440	3134	2437.56

FEED STRAIGHT FIRST REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56		22157	66106	83220	57495	77690	54055	7620	3440	3134	2437.56
57	57	7.3[illegible]	18482	78933	87785	61725	82130	57305	8430	4420	3189	2480.33
58	58		18482	78933	87785	61725	82130	57305	8430	4420	3189	2480.33
59	59	7.26	18677	75598	87035	61120	79520	57190	7840	3930	3564	2772.00
60	60	7.36	18677	75598	87035	61120	79520	57190	7840	3930	3564	2772.00
61	61	7.3[illegible]	18482	86614	89515	62235	80700	56355	8390	5880	3070	2387.78
62	62		18482	86614	89515	62235	80700	56355	8390	5880	3070	2387.78
63	63	7.32	18288	76490	86275	61870	80460	57950	7910	3920	2664	2072.00
64	64	7.52	18288	76490	86275	61870	80460	57950	7910	3920	2664	2072.00
65	65	7.33	18898								2873	2234.56
66	66		18898								2873	2234.56
67	67	7.11	21260								2913	2265.67
68	68		21260								2913	2265.67

FEED STRAIGHT SECOND REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1	7.10		4906							124	96.44
2	2		21890	45849	49270	34880	36900	30980	10200	3900	2403	1869.00
3	3	7.04	21890	45849	49270	34880	36900	30980	10200	3900	2403	1869.00
4	4		21890	45849	49270	34880	36900	30980	10200	3900	2403	1869.00
5	5		21890	45849	49270	34880	36900	30980	10200	3900	2403	1869.00
6	6	7.22	20784	56863	45630	32845	35520	26665	10360	6180	2736	2128.00
7	7	7.43	20784	56863	45630	32845	35520	26665	10360	6180	2736	2128.00
8	8											0.00
9	9	7.36	20784	56863	45630	32845	35520	26665	10360	6180	2736	2128.00
10	10	7.16	18353	62257	75530	49290	67867	48993	7663	297		0.00
11	11	7.49	18353	62257	75530	49290	67867	48993	7663	297		0.00
12	11	7.49	18353	62257	75530	49290	67867	48993	7663	297		0.00
13	12	7.52	9805		76325	50085	59980	44667	16345	5418	2388	1857.33
14	13		9805		76325	50085	59980	44667	16345	5418	2388	1857.33
15	14	7.23			71515	49860	59093	43767	12422	6093		0.00
16	15	7.64			71515	49860	59093	43767	12422	6093		0.00
17	16	7.12	17530	77689	63750	45235	57827	42707			2690	2092.22
18	17	7.18	17530	77689	63750	45235	57827	42707			2690	2092.22
19	18	7.50	21875	65079	70975	47570	66260	45410	5170	2160	2100	1633.33
20	19		21875	65079	70975	47570	66260	45410	5170	2160	2100	1633.33
21	20	7.32	23913	64822	75065	46045	67970				2227	1732.11
22	21	7.48	23913	64822	75065	46045	67970				2227	1732.11
23	22	7.43	23327	70079	74450	51380	72650	48280	6590	3100	2990	2325.56
24	23	7.36	23327	70079	74450	51380	72650	48280	6590	3100	2990	2325.56
25	24	7.17	20817	79377	81155	56615	72120	53095	7620	3520	1983	1542.33
26	25	7.17	20817	79377	81155	56615	72120	53095	7620	3520	1983	1542.33
27	26	7.25	18775	79377	81155	55310	76260	52160	6390	3150	2690	2092.22
28	27	7.48	18775	79377	81155	55310	76260	52160	6390	3150	2690	2092.22
29	28	7.25	18093	80934	86630	59930	78510	56350	8120	3580	2646	2058.00
30	29	7.26	18093	80934	86630	59930	78510	56350	8120	3580	2646	2058.00
31	30	7.31	17315	80934	83140	55985	76010	52455	8130	3530	3868	3008.44
32	31	7.44	17315	80934	83140	55985	76010	52455	8130	3530	3868	3008.44
33	32	7.30	19048	71428	83925	56220	74395	50510	9530	5710	2883	2242.33
34	33	7.42	19048	71428	83925	56220	74395	50510	9530	5710	2883	2242.33
35	34	7.38	10392	67451	82590	55275	76070	52405	7090	2870	2586	2011.33
36	35	7.44	10392	67451	82590	55275	76070	52405	7090	2870	2586	2011.33
37	36	7.39	9144	73152	90830	61195	83370	57875	7200	3320	2330	1812.22
38	37		9144	73152	90830	61195	83370	57875	7200	3320	2330	1812.22
39	38	7.32	14591	60700	80860		73500		7830	3430	2480	1928.89
40	39	7.42	14591	60700	80860		73500		7830	3430	2480	1928.89
41	40	7.19	18724	71545	66770	46760	60400	44200	6710	2560	2535	1971.67
42	41		18724	71545	66770	46760	60400	44200	6710	2560	2535	1971.67
43	42	7.40	19136	63415	73780	49685	65980	45665	7800	4020	1960	1524.44
44	43	7.50	19136	63415	73780	49685	65980	45665	7800	4020	1960	1524.44
45	44	7.38	15538	65041	66365	45665	65460	41955	7650	3710	2920	2271.11
46	45	7.61	15538	65041	66365	45665	58715	41955	7650	3710	2920	2271.11
47	46		18127	61789	66575	46415	60320	42275	8180	4140	2557	1988.78
48	47	7.57	18127	61789	66575	46415	60320	42275	8180	4140	2557	1988.78
49	48	7.29	18526	55118	61815	44035	55565	42455	6250	1580	3261	2536.33
50	49	7.48	18526	55118	61815	44035	55565	42455	6250	1580	3261	2536.33
51	50	7.56	20518								3053	2374.56
52	51		20518								3053	2374.56
53	52	7.32	10000	76264	90585	63170	83345	60270	7240	2900		0.00
54	53		10000	76264	90585	63170	83345	60270	7240	2900		0.00
55	54	7.04	12305	70039	87330	59935	82740	56425	7950	3510	2099	1632.56

FEED STRAIGHT SECOND REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	55		12305	70039	87330	59935	82740	56425	7950	3510	2099	1632.56
57	56		17704	84047	95040	63120	89310	59750	7970	3370	2840	2208.89
58	57		17704	84047	95040	63120	89310	59750	7970	3370	2840	2208.89
59	58	7.28	20276	80934	94520	63000	87840	60060	7210	2940	2557	1988.78
60	59		20276	80934	94520	63000	87840	60060	7210	2940	2557	1988.78
61	60	7.20	19685	86343	82335	56970	76720	54330	7280	2640	3123	2429.00
62	61		19685	86343	82335	56970	76720	54330	7280	2640	3123	2429.00
63	62	7.37	18677	116732	76875	53660	68815	50030	8060	3630	1944	1512.00
64	63		18677	116732	76875	53660	68815	50030	8060	3630	1944	1512.00
65	64	7.21	19261	66926	84275	57420	77365	54310	6910	3110	2535	1971.67
66	65	7.19	19261	66926	84275	57420	77365	54310	6910	3110	2535	1971.67
67	66	7.27	21875	62500	79845	56230	71525	51920	8320	4310	2706	2104.67
68	67		21875	62500	79845	56230	71525	51920	8320	4310	2706	2104.67
69	68	7.33	20428		86180	59035	78490	55195	7690	3840	2330	1812.22
70	69		20428		86180	59035	78490	55195	7690	3840	2330	1812.22
71	70	7.35	22157	66106	83220	57495	77690	54055	7620	3440	3134	2437.56
72	71		22157	66106	83220	57495	77690	54055	7620	3440	3134	2437.56
73	72	7.34	18482	78933	87785	61725	82130	57305	8430	4420	3189	2480.33
74	73		18482	78933	87785	61725	82130	57305	8430	4420	3189	2480.33
75	74	7.26	18677	75598	87035	61120	79520	57190	7840	3930	3564	2772.00
76	75	7.36	18677	75598	87035	61120	79520	57190	7840	3930	3564	2772.00
77	76	7.31	18482	86614	89515	62235	80700	56355	8390	5880	3070	2387.78
78	77		18482	86614	89515	62235	80700	56355	8390	5880	3070	2387.78
79	78	7.32	18288	76490	86275	61870	80460	57950	7910	3920	2664	2072.00
80	79	7.52	18288	76490	86275	61870	80460	57950	7910	3920	2664	2072.00
81	80	7.33	18898								2873	2234.56
82	81		18898								2873	2234.56
83	82	7.11	21260								2913	2265.67
84	83		21260								2913	2265.67

FEED STRAIGHT THIRD REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1		18391	71146	79560	53735	72260	49905	7300	4030	2584	2009.78
2	2		18391	71146	79560	53735	72260	49905	7300	4030	2584	2009,78
3	3		18391	71146	79560	53735	72260	49905	7300	4030	2584	2009,78
4	4		17748	64935							3383	2631,22
5	5		17748	64935							3383	2631,22
6	6		17748	64935							3383	2631,22
7	7		17748	64935							3383	2631,22
8	8	7.[illegible]	19922	67323	82460	59360	74610	55700	7850	3660	3201	2489,67
9	9	7.55	19922	67323	82460	59360	74610	55700	7850	3660	3201	2489,67
10	10	7.55	19922	67323	82460	59360	74610	55700	7850	3660	3201	2489,67
11	11	7.72	19922	67323	82460	59360	74610	55700	7850	3660	3201	2489,67
12	12	7.52	22070	65500	85185	58940	76995	54920	8190	4020	3023	2351,22
13	13	7.38	22070	65500	85165	58940	76995	54920	8190	4020	3023	2351,22
14	14	7.23	22070	65500	85185	58940	76995	54920	8190	4020	3023	2351,22
15	15	7.63	22070	65500	85185	58940	76995	54920	8190	4020	3023	2351,22
16	16	7.14	22558	53288	52010	36540	46580	34530	5430	2010	2237	1739,89
17	17		22556	53288	52010	36540	46580	34530	5430	2010	2237	1739,89
18	18	7.31	22558	53288	52010	36540	46580	34530	5430	2010	2237	1739,89
19	19	7.57	22558	53286	52010	36540	46580	34530	5430	2010	2237	1739,89
20	20	7.60	14370		60910	41865	53750	38725	7160	3140	2982	2319,33
21	21	7.43	14370		60910	41865	53750	38725	7160	3140	2982	2319,33
22	22	7.50	14370		60910	41865	53750	38725	7160	3140	2982	2319,33
23	23	7.58	14370		60910	41865	53750	38725	7160	3140	2982	2319,33
24	24		10956		68875	49470	63185	46910	5690	2560	2424	1885,33
25	25	7.36	10956		68875	49470	63185	46910	5690	2560	2424	1885,33
26	26	7.61	10956		68875	49470	63185	46910	5690	2560	2424	1885,33
27	27	7.58	10956		68875	49470	63185	46910	5690	2560	2424	1885,33
28	28	7.21	10540	50000	71685	48090	64535	44520	3570	3570	2444	1900,89
29	29	7.21	10540	50000	71685	48090	64535	44520	3570	3570	2444	1900,89
30	30	7.30	10540	50000	71685	48090	64535	44520	3570	3570	2444	1900,89
31	31		10540	50000	71685	48090	64535	44520	3570	3570	2444	1900,89
32	32	7.24	11811	59843	75615	49435	69995	47535	5620	1900	2550	1983,33
33	33	7.43	11811	59843	75615	49435	69995	47535	5620	1900	2550	1983,33
34	34	7.54	11811	59843	75615	49435	69995	47535	5620	1900	2550	1983,33
35	35	7.71	11811	59843	75615	49435	69995	47535	5620	1900	2550	1983,33
36	36	7.28	11166	38889	68955	44860	63395	42840	5560	2020	1893	1472,33
37	37	7.37	11166	38889	68955	44860	63395	42840	5560	2020	1893	1472,33
38	38		11166	38889	68955	44860	63395	42840	5560	2020	1893	1472,33
39	39	7.52	11166	38889	68955	44860	63395	42840	5560	2020	1893	1472,33
40	40	7.28	11783	57936	65380	42280	59440	39430	5940	2850	1813	1410,11
41	41	7.22	11783	57936	65380	42280	59440	39430	5940	2850	1813	1410,11
42	42	7.33	11783	57936	65380	42280	59440	39430	5940	2850	1813	1410,11
43	43	7.29	11783	57936	65380	42280	59440	39430	5940	2850	1813	1410,11
44	44	7.39	12460	53968	61280	42610	55070	39780	6210	2830	1686	1311,33
45	45	7.44	12460	53968	61280	42610	55070	39780	6210	2830	1686	1311,33
46	46	7.53	12460	53968	61280	42610	55070	39780	6210	2830	1686	1311,33
47	47	7.56	12460	53968	61280	42610	55070	39780	6210	2830	1686	1311,33
48	48	7.36	10775	63529	63200	44120	53380	39910	9820	4210	1620	1260,00
49	49	7.51	10775	63529	63200	44120	53380	39910	9820	4210	1620	1260,00
50	50		10775	63529	63200	44120	53380	39910	9820	4210	1620	1260,00
51	51	7.58	10775	63529	63200	44120	53380	39910	9820	4210	1620	1260,00
52	52	7.30	8438	57308	88660	58755	82650	55745	6010	3010	2242	1743,78
53	53		8438	57308	88660	58755	82650	55745	6010	3010	2242	1743,78
54	54	7.24	8438	57308	88660	58755	82650	55745	6010	3010	2242	1743,78
55	55	7.48	8438	57308	88660	58755	82650	55745	6010	3010	2242	1743,78

FEED STRAIGHT THIRD REP

OBS	DATE	PH	CODSP	CODYL	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56	7.31	11875	96899	80580	56470	74270	54080	6310	2390	1659	1290.33
57	57	7.35	11875	96899	80580	56470	74270	54080	6310	2390	1659	1290.33
58	58	7.35	11875	96899	80580	56470	74270	54080	6310	2390	1659	1290.33
59	59	7.34	11875	96899	80580	56470	74270	54080	6310	2390	1659	1290.33
60	60	7.33	9297	42636	70620	49770	66120	48060	4500	1710	1521	1183.00
61	61	7.40	9297	42636	70620	49770	66120	48060	4500	1710	1521	1183.00
62	62	7.58	9297	42636	70620	49770	66120	48060	4500	1710	1521	1183.00
63	63	7.70	9297	42636	70620	49770	66120	48060	4500	1710	1521	1183.00
64	64	7.21	12046	71815	92120	59920	87300	58260	4820	1660	2493	1939.00
65	65		12046	71815	92120	59920	87300	58260	4820	1660	2493	1939.00
66	66		12046	71815	92120	59920	87300	58260	4820	1660	2493	1939.00
67	67		12046	71815	92120	59920	87300	58260	4820	1660	2493	1939.00
68	68	7.46	9884	53282	109200	62150	107800	60560	4100	1590	1657	1288.78
69	69	7.50	9884	53282	109200	62150	107800	60560	4100	1590	1657	1288.78
70	70	7.61	9884	53282	109200	62150	107800	60560	4100	1590	1657	1288.78
71	71	7.60	9884	53282	109200	62150	107800	60560	4100	1590	1657	1288.78
72	72	7.33	5781	62791	61020	40120	57700	38790	3320	1330	1279	994.78
73	73	7.39	5781	62791	61020	40120	57700	38790	3320	1330	1279	994.78
74	74	7.59	5781	62791	61020	40120	57700	38790	3320	1330	1279	994.78
75	75	7.65	5781	62791	61020	40120	57700	38790	3320	1330	1279	994.78
76	76		6512	48062	78575	42915	75035	41725	3540	1190	1534	1193.11
77	77	7.39	6512	48062	78575	42915	75035	41725	3540	1190	1534	1193.11
78	78		6512	48062	78575	42915	75035	41725	3540	1190	1534	1193.11
79	79	7.62	6512	48062	78575	42915	75035	41725	3540	1190	1534	1193.11
80	80	7.41	6023	50388	74225	47230	71660	45940	3670	1290	1894	1473.11
81	81		6023	50388	74225	47230	71660	45940	3670	1290	1894	1473.11
82	82	7.39	6023	50388	74225	47230	71660	45940	3670	1290	1894	1473.11
83	83		6023	50388	74225	47230	71660	45940	3670	1290	1894	1473.11
84	84		6094	61478	74435	46085	70630	44965	3360	1120	2103	1635.67
85	85	7.45	6094	61478	74435	46085	70630	44965	3360	1120	2103	1635.67
86	86		6094	61478	74435	46085	70630	44965	3360	1120	2103	1635.67
87	87		6094	61478	74435	46085	70630	44965	3360	1120	2103	1635.67
88	88	7.44	5469	52918	78410	47260	74360	45970	3860	1290	1754	1364.22
89	89	7.47	5469	52918	78410	47260	74360	45970	3860	1290	1754	1364.22
90	90		5469	52918	78410	47260	74360	45970	3860	1290	1754	1364.22
91	91		5469	52918	78410	47260	74360	45970	3860	1290	1754	1364.22
92	92	7.36			65010	41065	61540	39955	3470	1110		0.00
93	93	7.48			65010	41065	61540	39955	3470	1110		0.00
94	94				65010	41065	61540	39955	3470	1110		0.00
95	95				65010	41065	61540	39955	3470	1110		0.00
96	96		4662	47191	60320	37305	57350	36465	2970	840		0.00
97	97	7.29	4662	47191	60320	37305	57350	36465	2970	840		0.00
98	98	7.37	4662	47191	60320	37305	57350	36465	2970	840		0.00
99	99		4662	47191	60320	37305	57350	36465	2970	840		0.00
100	100		3864	48435	65440	38150						0.00
101	101		3864	48435	65440	38150						0.00
102	102		3864	48435	65440	38150						0.00
103	103	7.27	4607	51765	71795	45110	68315	44160	3480	950	1194	928.67
104	104		4607	51765	71795	45110	68315	44160	3480	950	1194	928.67
105	105		4607	51765	71795	45110	68315	44160	3480	950	1194	928.67
106	106	7.40	4607	51765	71795	45110	68315	44160	3480	950	1194	928.67
107	107	7.50	6629	47866	79190	49520	75710	48280	3480	1240	1374	1068.67
108	108	7.52	6629	47866	79190	49520	75710	48280	3480	1240	1374	1068.67
109	109		6629	47866	79190	49520	75710	48280	3480	1240	1374	1068.67
110	110		6629	47866	79190	49520	75710	48280	3480	1240	1374	1068.67

FEED STRAIGHT THIRD REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
111	111	7,27	6541	68504	85710	55945	81500	54485	4210	1460	1908	1484,00
112	112		6541	68504	85710	55945	81500	54485	4210	1460	1908	1484,00
113	113	7,35	6541	68504	85710	55945	81500	54485	4210	1460	1908	1484,00
114	114		6541	68504	85710	55945	81500	54485	4210	1460	1908	1484,00
115	115	7.36	6541	68504	85710	55945	81500	54485	4210	1460	1908	1484,00
116	116		6842	62992	88200	58165	84340	56885	3860	1280	2094	1628,67
117	117		6842	62992	88200	58165	84340	56885	3860	1280	2094	1628,67
118	118		6842	62992	88200	58165	84340	56885	3860	1280	2094	1628,67
119	119	7,43	6842	62992	88200	58165	84340	56885	3860	1280	2094	1628,67
120	120	7,53	6667	65564	88800	55025					2016	1568,00
121	121	7,60	6667	65564	88800	55025					2016	1568,00
122	122		6667	65564	88800	55025					2016	1568,00
123	123		6667	65564	88800	55025					2016	1568,00

FEED FINISHER FIRST REP

OBS	DATE	PH	CODSF	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1		39273	113307	95890	64975	86740	59795	9150	5180	4440	3453.33
2	2		39273	113307	95890	64975	86740	59795	9150	5180	4440	3453.33
3	3		39273	113307	95890	64975	86740	59795	9150	5180	4440	3453.33
4	4	7.06	37023	96179							5637	4584.33
5	5	7.19	37023	96179							5637	4384.33
6	6	6.83	37023	96179							5637	4384.33
7	7	7.02	37023	96179							5637	4384.33
8	8	7.10	38281	80369	69340	49490	58030	44500	11310	4990	4266	3318.00
9	9	6.95	38281	80369	69340	49490	58030	44500	11310	4990	4266	3318.00
10	10	6.98	38281	80369	69340	49490	58030	44500	11310	4990	4266	3318.00
11	11	7.19	38281	80369	69340	49490	58030	44500	11310	4990	4266	3318.00
12	12	7.17	45703	108037	108700	73025	98200	68245	10500	4780	4348	3381.78
13	13	7.23	45703	108037	108700	73025	98200	68245	10500	4780	4348	3381.78
14	14	7.12	45703	108037	108700	73025	98200	68245	10500	4780	4348	3381.78
15	15	7.38	45703	108037	108700	73025	98200	68245	10500	4780	4348	3381.78
16	16	7.14	29492	108466	73400	50730	65810	47800	7590	2930	3083	2397.89
17	17		29492	108466	73400	50730	65810	47800	7590	2930	3083	2397.89
18	18	7.32	29492	108466	73400	50730	65810	47800	7590	2930	3083	2397.89
19	19	7.48	29492	108466	73400	50730	65810	47800	7590	2930	3083	2397.89
20	20	7.08	27559		71035	50670	62025	46540	9010	4130	4977	3871.00
21	21	7.37	27559		71035	50670	62025	46540	9010	4130	4977	3871.00
22	22	7.36	27559		71035	50670	62025	46540	9010	4130	4977	3871.00
23	23	7.51	27559		71035	50670	62025	46540	9010	4130	4977	3871.00
24	24		33068		80950	58685	71400	53465	9550	5220	3908	3039.56
25	25	7.15	33068		80950	58685	71400	53465	9550	5220	3908	3039.56
26	26	7.46	33068		80950	58685	71400	53465	9550	5220	3908	3039.56
27	27	7.49	33068		80950	58685	71400	53465	9550	5220	3908	3039.56
28	28	7.07	29425	82010	125470	74835	117150	70505	8320	4330	3265	2539.44
29	29	7.00	29425	82010	125470	74835	117150	70505	8320	4330	3265	2539.44
30	30	7.17	29425	82010	125470	74835	117150	70505	8320	4330	3265	2539.44
31	31		29425	82010	125470	74835	117150	70505	8320	4330	3265	2539.44
32	32	7.08	25197	74016	121850	66760					1538	1196.22
33	33	7.34	25197	74016	121850	66760					1538	1196.22
34	34	7.52	25197	74016	121850	66760					1538	1196.22
35	35	7.04	25197	74016	121850	66760					1538	1196.22
36	36		28063	66508							2707	2105.44
37	37		28063	86508							2707	2105.44
38	38		28063	86508							2707	2105.44
39	39		28063	86508							2707	2105.44
40	40	6.91	29199	78571	100395	59190	92230	54990	7810	4200	2589	2013.67
41	41	7.01	29199	78571	100395	59190	92230	54990	7810	4200	2589	2013.67
42	42	7.10	29199	78571	100395	59190	92230	54990	7810	4200	2589	2013.67
43	43	7.29	29199	78571	100395	59190	92230	54990	7810	4200	2589	2013.67
44	44	7.14	29497	91270	85370	56855	80400	53435	7680	3420	2581	2007.44
45	45	7.29	29497	91270	85370	56855	80400	53435	7680	3420	2581	2007.44
46	46	7.29	29497	91270	85370	56855	80400	53435	7680	3420	2581	2007.44
47	47	7.48	29497	91270	85370	56855	80400	53435	7680	3420	2581	2007.44
48	48	7.20	28553	109020	121260	70195	112230	65595	9030	4600	1998	1554.00
49	49	7.27	28553	109020	121260	70195	112230	65595	9030	4600	1998	1554.00
50	50		28553	109020	121260	70195	112230	65595	9030	4600	1998	1554.00
51	51	7.54	28553	109020	121260	70195	112230	65595	9030	4600	1998	1554.00
52	52	7.20	16229	105769	124200	105947	116610	101847	7590	4100	3274	2546.44
53	53		18229	105769	124200	105947	116610	101847	7590	4100	3274	2546.44
54	54	7.17	18229	105769	124200	105947	116610	101847	7590	4100	3274	2546.44
55	55	7.32	18229	105769	124200	105947	116610	101847	7590	4100	3274	2546.44

FEED FINISHER FIRST REP

OBS	DATE	PH	CODSF	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56	[illegible]	33594	121705	132105	90436	127145	87806	4960	2630	2871	2233.00
57	57	7.28	33594	121705	132105	90436	127145	87806	4960	2630	2871	2233.00
58	58	7.24	33594	121705	132105	90436	127145	87806	4960	2630	2871	2233.00
59	59	7.27	33594	121705	132105	90436	127145	87806	4960	2630	2871	2233.00
60	60	7.17	20703	90698	93025	64935	84855	60945	8170	3990	2532	1969.33
61	61	7.29	20703	90698	93025	64935	84855	60945	8170	3990	2532	1969.33
62	62	7.34	20703	90698	93025	64935	84855	60945	8170	3990	2532	1969.33
63	63	7.45	20703	90698	93025	64935	84855	60945	8170	3990	2532	1969.33

FEED FINISHER SECOND REP

OBS	DATE	PH	CODSH	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
1	1	7.48	10417	63566	67435	44420	64145	43090	3290	1330	2262	1759.33
2	2	7.47	10417	63566	67435	44420	64145	43090	3290	1330	2262	1759.33
3	3	7.51	10417	63566	67435	44420	64145	43090	3290	1330	2262	1759.33
4	4	7.58	10417	63566	67435	44420	64145	43090	3290	1330	2262	1759.33
5	5		11628	53488	75700	46630	70070	44460	5630	2170	2503	1946.78
6	6	7.40	11628	53488	75700	46630	70070	44460	5630	2170	2503	1946.78
7	7		11628	53488	75700	46630	70070	44460	5630	2170	2503	1946.78
8	8	7.56	11628	53488	75700	46630	70070	44460	5630	2170	2503	1946.78
9	9	7.37	12355	83721	115230	71850	109210	69580	6020	2270	2062	1603.78
10	10		12355	83721	115230	71850	109210	69580	6020	2270	2062	1603.78
11	11	7.34	12355	83721	115230	71850	109210	69580	6020	2270	2062	1603.78
12	12		12355	83721	115230	71850	109210	69580	6020	2270	2062	1603.78
13	13		7552	105836	91650	52970	87780	51730	3870	1240	2013	1565.67
14	14	7.42	7552	105836	91650	52970	87780	51730	3870	1240	2013	1565.67
15	15		7552	105836	91650	52970	87780	51730	3870	1240	2013	1565.67
16	16		7552	105836	91650	52970	87780	51730	3870	1240	2013	1565.67
17	17	7.41	13021	98833	117940	73850	114280	72640	3660	1210	2427	1887.67
18	18	7.52	13021	98833	117940	73850	114280	72640	3660	1210	2427	1887.67
19	19		13021	98833	117940	73850	114280	72640	3660	1210	2427	1887.67
20	20		13021	98833	117940	73850	114280	72640	3660	1210	2427	1887.67
21	21	7.46			74530	45830	69010	43930	5520	1900		0.00
22	22	7.54			74530	45830	69010	43930	5520	1900		0.00
23	23				74530	45830	69010	43930	5520	1900		0.00
24	24				74530	45830	69010	43930	5520	1900		0.00
25	25		8271	46442	79745	47075	75055	45605	4690	1470		0.00
26	26	7.43	8271	46442	79745	47075	75055	45605	4690	1470		0.00
27	27	7.54	8271	46442	79745	47075	75055	45605	4690	1470		0.00
28	28		8271	46442	79745	47075	75055	45605	4690	1470		0.00
29	29		9470	59608	73760	39800					1813	1410.11
30	30		9470	59608	73760	39800					1813	1410.11
31	31		9470	59608	73760	39800					1813	1410.11
32	32		9813	107812	122870	73475	117370	71475	5500	2000	2061	1603.00
33	33		9813	107812	122870	73475	117370	71475	5500	2000	2061	1603.00
34	34		9813	107812	122870	73475	117370	71475	5500	2000	2061	1603.00
35	35	7.53	9813	107812	122870	73475	117370	71475	5500	2000	2061	1603.00
36	36	7.60	17197	92969	124180	74885	118970	72945	5210	1940	3503	2724.56
37	37		17197	92969	124180	74885	118970	72945	5210	1940	3503	2724.56
38	38	7.60	17197	92969	124180	74685	118970	72945	5210	1940	3503	2724.56
39	39		17197	92969	124180	74885	118970	72945	5210	1940	3503	2724.56
40	40		13383		116880	76340	111440	74680	5440	1660	3396	2641.33
41	41		13383		116880	76340	111440	74680	5440	1660	3396	2641.33
42	42		13383		116880	76340	111440	74680	5440	1660	3396	2641.33
43	43		13383		116880	76340	111440	74680	5440	1660	3396	2641.33
44	44	7.43	13383		116880	76340	111440	74680	5440	1660	3396	2641.33
45	45	7.43	13534	101562	114420	75960	109260	74400	5160	1560	3339	2597.00
46	46		13534	101562	114420	75960	109260	74400	5160	1560	3339	2597.00
47	47		13534	101562	114420	75960	109260	74400	5160	1560	3339	2597.00
48	48		13534	101562	114420	75960	109260	74400	5160	1560	3339	2597.00
49	49		11386	101176	122775	75630	115610	71230	6860	4400	3041	2365.22
50	50	7.43	11386	101176	122775	75630	115610	71230	6860	4400	3041	2365.22
51	51	7.50	11386	101176	122775	75630	115610	71230	6860	4400	3041	2365.22
52	52		11386	101176	122775	75630	115610	71230	6860	4400	3041	2365.22
53	53											0.00
54	54											0.00
55	55		13559				64230		4710	2140	2920	2271.11

FEED FINISHER SECOND REP

OBS	DATE	PH	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT
56	56											0.00
57	57											0.00
58	58											0.00
59	59		13859				64230		4710	2140	2920	2271.11
60	60		13859				64230		4710	2140	2920	2271.11
61	61		13859				64230		4710	2140	2920	2271.11
62	62											0.00
63	63											0.00
64	64											0.00
65	65											0.00
66	66	7.54										0.00
67	67											0.00
68	68	7.63										0.00
69	69	7.44			133070	79300						0.00
70	70				133070	79300						0.00
71	71				133070	79300						0.00
72	72				133070	79300						0.00
73	73				119570	69720						0.00
74	74				119570	69720						0.00
75	75				119570	69720						0.00
76	76				119570	69720						0.00
77	77											0.00
78	78											0.00
79	79	7.59										0.00
80	80											0.00
81	81		20076	94253	128650	78060					2285	1777.22
82	82	7.55	20076	94253	128650	78060					2285	1777.22
83	83	7.66	20076	94253	128650	78060					2285	1777.22
84	84		20076	94253	128650	78060					2285	1777.22
85	85	7.61	18851	94253							3755	2920.56
86	86		18851	94253							3755	2920.56
87	87		18851	94253							3755	2920.56
88	88		18851	94253							3755	2920.56

APPENDIX F

DIGESTER RESPONSE DATA

ONE=SEVENTH FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	36.2		7.16	2917	843	6086	12475	4375	4310	3315	7120	1060	207	161.000	
2	2	36.8	260	7.13	2867	668									0.000	
3	3	36.0	304	7.08	2833	248									0.000	
4	4	34.5	318	7.06	2850	678	3759	10400	2735	2650	1965	6480	770	194	150.889	
5	5	33.8	530	7.04	3033	599									0.000	
6	6	35.0	731	7.00	3117	755									0.000	
7	7	35.0	822	7.04	3267	745								200	155.556	
8	8														0.000	
9	9	35.6		7.13	3400	606	3529	12620	2825	2787	1933	9473	1113	196	152.444	
10	10	35.5	574	7.15	3500	584									0.000	
11	11	35.5	290	7.07	3533	623	3294	12605	2420	3067	1760	9538	660		0.000	
12	12	36.1	312	7.14	3350	353									0.000	
13	13	36.0	247	7.21	3167	622									0.000	
14	14	37.0	239	7.11	3117	319	2667	10295	2400	2400	1640	7895	760		0.000	168
15	15	36.2	192	7.09	3067	549								277	215.444	
16	16	35.3	278	7.30	3050	635	3157	9765	2770	2120	1513	7645	1257	288	224.000	240
17	17	35.6	283	7.21	2867									287	223.222	
18	18	35.8	313	7.30	3517	711									0.000	
19	19	34.5	253	7.38	2817	751	3413	8705	2250	2260	1670	5570	580	265	206.111	
20	20	34.0	315	7.49	2750	595									0.000	
21	21	35.5	388	7.31	2833	790	3557	7935	2415	2930	1915	5020	500	290	225.556	144
22	22	33.6	295	7.26	2683	742									0.000	
23	23	36.6	410	7.28	2667	856	3504	7390	2290	2610	1910	4310	380	362	281.556	168
24	24	34.0	355	7.25	2733	801									0.000	
25	25	35.1	411	7.26	2700	875		7080	2450	2530	2110	2140	340		0.000	168
26	26	36.0	399	7.35	2583	830	2957								0.000	
27	27	34.0	320	7.37	2683	850									0.000	
28	28	33.2	472	7.41	3017	817									0.000	
29	29	35.0	398	7.36	2517	906									0.000	
30	30	36.0	385	7.35	2500	945									0.000	
31	31	35.5	329	7.40	2517	957									0.000	
32	32	34.9	337	7.32	2533	953	3658								0.000	
33	33	33.8	333	7.42	2417	950									0.000	
34	34	35.8	426	7.51	2483	1008									0.000	
35	35	34.0	527	7.41	2450	972	3566	5910	2685	3010	1935	3100	7	327	254.333	192
36	36	35.0	339	7.46	2400	972									0.000	
37	37	36.5	380	7.40	2367	902	3294	5225	2150	2170	1430	2860	720	421	327.444	
38	38	35.1	347	7.37	2367	934									0.000	
39	39	32.5	313	7.50	2717	950	3411	5725	3150	2160	2150	3060	1000	409	318.111	
40	40	34.5	383	7.21	2300	950									0.000	
41	41	33.5	329	7.43		1036									0.000	
42	42	34.8	393	7.38	2450	1080	3745	5315	2640	2500	2230	2320	410		0.000	
43	43	34.5	410	7.33	2367	1038									0.000	
44	44	33.0	291	7.41	2317	1080									0.000	
45	45	34.0	357	7.44	2333	1132									0.000	
46	46	36.5	427			1111									0.000	
47	47	35.8	375	7.62	2450	1255	4878	5455	3005	3630	2195	2120	810		0.000	
48	48	32.4	331	7.51	2333	1129									0.000	
49	49	32.0	274	7.43	2400	1149									0.000	
50	50	33.7	422	7.52	2300	1175									0.000	
51	51	36.8	428	7.48	2367	1175	4860	5520	2830	3500	2330	2170	500	366	284.667	
52	52	35.1	308	7.78	2433	1201									0.000	
53	53	35.9	376	7.48	2567	1201									0.000	
54	54	34.1	320	7.40		1220									0.000	
55	55	34.8	398			1235									0.000	

ONE-SEVENTH FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
56	56	33.6	331			1394									0.000	
57	57	32.8	363			1295									0.000	
58	58	35.0	448	7.63	2533										0.000	
59	59	35.8	420	7.40											0.000	
60	60	34.0	342	7.43	2650	1280	7360	7490	5135	5760	4385	1600	750	468	364.000	
61	61	34.8	375	7.42	2683	1270									0.000	
62	62	35.0	384	7.43		1255									0.000	
63	63	36.2	412	7.42	2667	1265	10039	9100	6455	7780	5715	1830	740	466	362.444	
64	64	36.4	396	7.52	2763	1194									0.000	
65	65	36.[illegible]	380	7.48	2783	1181	7953	8445	5925	7250	5565	1480	360	485	377.222	
66	66	34.3	340	7.62	2883	1226									0.000	
67	67	34.2	382			1167									0.000	
68	68	34.8	401	7.49	2767	1304									0.000	
69	69	34.8	361	7.41	2717	1191									0.000	
70	70	35.5	387	7.42	2867	1230	12383	8545	6030	8230	5680	1120	350	406	315.778	
71	71	34.5	366	7.36	2800	1096									0.000	
72	72	34.5	371	7.40	2933	1167	8560	8910		7200		1710	570	495	385.000	72
73	73	36.0	418	7.54	2250	1135									0.000	
74	74	36.1	433	7.58	2733	1000	8560	7840	5470	6490	5120	1220	350	502	390.444	240
75	75	35.6	432	7.42	2667	1012									0.000	
76	76	35.8	448	7.27		946									0.000	
77	77	35.2	419	7.55	2733	1039	11843	8105	5595	6540	5185	1260	850	438	340.667	240
78	78	34.0	422	7.48	2817	1098									0.000	
79	79	35.5	485	7.45	2483	1118	9344	9510	6710	8520	6180	1430	900	474	368.667	216
80	80	34.5	388	7.50	3050	1042									0.000	
81	81	34.5	397	7.42	2950	1089	9183	9090	6485	8180	5935	1390	550	473	367.889	216
82	82	36.5	473	7.54	2900	1089									0.000	
83	83	36.5	441	7.58	2850	837									0.000	
84	84	35.0	390	7.38	2733	973	7782	8795	6095	7580	5155	1760	940	483	375.667	

ONE-SEVENTH SECOND REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	35.5		7.79	4333	3202	16198	15680	8370	11450	5270	7700	3100	433	336.778	
2	2	34.6	220	7.55	4083	2996									0.000	
3	3	37.0	280	7.58	3683	2576									0.000	
4	4	36.0	268	7.52	3633	2782	10226	11880	6875	6850	5125	6100	1750	453	352.333	
5	5	34.5	300	7.57	3617	2622									0.000	
6	6	34.2	251	7.50	3600	2647									0.000	
7	7	33.9	251	7.64	3467	1765								398	309.556	
8	8														0.000	
9	9	35.1		7.76	3583	2647	9490	10345	6350	6040	4573	4305	310	459	357.000	
10	10	34.9	317	7.81	3550	2510									0.000	
11	11	34.5	336	7.56	3383	2335	8314	9205	5252	5607	3813	3598	1437		0.000	
12	12	35.0	386	7.74	3467	2196									0.000	
13	13	35.0	368	7.66		2000									0.000	
14	14	35.0	300	7.50	3233		7843	9445	5775	5293	3867	4162	1908		0.000	192
15	15	35.1	329	7.55	3283	1961								507	394.333	
16	16	36.0	398	7.66	3250	1865	8413	9395	5840	5167	3793	4228	2047	463	360.111	
17	17	36.5	389	7.52	3200									433	336.778	
18	18	35.0	395	7.62	3117	1620									0.000	
19	19	34.5	336	7.69	3217	1542	8968	8415	4770	5670	4350	2380	420	460	357.778	
20	20	34.2	370	7.61	3150	1270									0.000	
21	21	35.5	408	7.51	3133	1423	7589	7950	4700	5830	4220	2390	480	408	317.333	192
22	22	33.6	338	7.53	3050	1270									0.000	
23	23	37.5	459	7.52	3033	1289	7520	8080	4850	5950	4250	2260	600	481	374.111	144
24	24	35.0	400	7.48	3100	1172									0.000	
25	25	35.0	442	7.53	3050	1284		7645	4750	5730	3940	2510	810		0.000	192
26	26	36.0	422	7.52	3183	1225	7471								0.000	
27	27	34.5	355	7.63	3017	1146									0.000	
28	28	33.9		7.58	2917	1012									0.000	
29	29	34.3	398	7.56	2867	906									0.000	
30	30	36.0	427	7.52	2917	1181									0.000	
31	31	35.3	401	7.51	2967	1094									0.000	
32	32	34.5	387	7.52	2950	1265	6926								0.000	
33	33	33.8	383	7.44	3033	1221									0.000	
34	34	36.5	416	7.54	3067	1202									0.000	
35	35	35.3	352	7.47	3053	1230	8450	7955	5060	6630	4680	1580	380	394	306.444	
36	36	35.0	327	7.53	2933	1190									0.000	
37	37	36.7	351	7.49	3033	1039	6902	8225	5210	6890	4690	1760	520	518	402.889	
38	38	35.8	333	7.51	2883	1128									0.000	
39	39	33.0	301	7.53	2633	1124	7287	7545	4910	6260	4100	1930	810	409	318.111	
40	40	35.0	357	7.35	2983	1105									0.000	
41	41	33.5	311	7.46		1153									0.000	
42	42	34.1	345	7.44	2883	1165	8127	7955	5290	5970	4980	1660	310		0.000	
43	43	33.8	354	7.48	2883	1059									0.000	
44	44	33.5	289	7.59	2850	1314									0.000	
45	45	34.0	341	7.49	3033	1317									0.000	
46	46	36.8	429			1090									0.000	
47	47	35.8	365	7.67	3033	1255	7967	7835	4945	6610	4445	1420	500		0.000	
48	48	33.1	268	7.52	2983	1230									0.000	
49	49	31.0	275	7.63	3033	1250									0.000	
50	50	35.0	368	7.53	2950	1315									0.000	
51	51	35.8	417	7.53	2867	1175	7490	8145	5330	5590	4800	1800	530	495	385.000	
52	52	34.4	369	7.70	2917	1220									0.000	
53	53	35.0	407	7.51	2917	1201									0.000	
54	54	34.5	385	7.34		1181									0.000	
55	55	35.7	446			1175									0.000	

ONE-SEVENTH SECOND REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
56	56	34.2	363			1295									0.000	
57	57	32.9	406			1235									0.000	
58	58	35.4	504	7.45	2900										0.000	
59	59	35.0	461	7.38											0.000	
60	60	33.5	436	7.35	3000	1200	7680	8140	5435	7320	4775	1430	660	546	424.667	
61	61	34.3	454	7.40	3017	1190									0.000	
62	62	34.9	461	7.45		1176									0.000	
63	63	36.0	488	7.51	2983	1089	7160	7320	4700	6150	3960	1700	740	542	421.556	
64	64	35.5	455	7.50	3133	1083									0.000	
65	65	34.9	421	7.47	2967	1129	7428	7450	4960	6380	4320	1440	640	538	418.444	
66	66	33.4	366	7.60	2967	1167									0.000	
67	67	34.5	448			1148									0.000	
68	68	35.3	442	7.40	2950	1206									0.000	
69	69	35.2	403	7.41	2950	1074									0.000	
70	70	35.4	423	7.49	2967	1152	8047	6890	4655	5880	4335	1050	320	461	358.556	
71	71	34.9	419	7.38	2950	1124								498	387.333	
72	72	35.4	431	7.38	2883	1128	7938	7310	7480	5960	4180	1710	600	497	386.556	72
73	73	36.5	480	7.61	2417	1115									0.000	
74	74	35.9	476	7.51	2733	1059	6848	6610	4230	5470	3840	1140	390	438	340.667	120
75	75	36.5	507	7.32	2667	1031									0.000	
76	76	36.1	491	7.24		927									0.000	
77	77	34.9	418	7.46	2917	1098	7922	7345	4660	6080	4240	1270	420	520	404.444	168
78	78	33.5	440	7.39	3000	1078									0.000	
79	79	35.5	520	7.56	2967	1098	7259	6720	4375	5440	3895	1370	480	541	420.778	168
80	80	35.0	476	7.55	3133	1023									0.000	
81	81	35.2	483	7.41	2883	1012	7160	7775	5235	6380	4795	1430	440	472	367.111	168
82	82	36.9	533	7.56	2817	1089									0.000	
83	83	37.5	507	7.46	2883	1050									0.000	
84	84	35.6	377	7.37	2683	1012	6926	6745	4370	6000		1670		472	367.111	

ONE-SEVENTH THIRD REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	32.5		7.72	5033	3765	15350	16400	10785	10970	9515	3870	1270	302	234.889	168
2	2	37.5	669	7.80	5133	3687									0.000	
3	3	40.6	861	7.82		3563									0.000	
4	4	35.0	492	7.72		3640									0.000	
5	5	33.0	359	7.60	4650	3435	11641	12615	8000	9280	6730	3250	1270	687	534.333	
6	6	32.5	449	7.61	4617	3676									0.000	
7	7	36.5	659	7.52	4583	3399	12648	12055	7590	9070	6730	2860	860	787	612.111	
8	8	37.2	798	7.57	4583	2969									0.000	
9	9	36.4	711	7.57	4517	2791	11133	11165	7120	8850	6410	2530	710	737	573.222	
10	10	35.6	631	7.64	4533	2868									0.000	
11	11	34.4	581	7.61		2829									0.000	
12	12	35.7	628	7.58	4583	3047	10352	10935	6685	8350	5795	2930	890	616	479.111	
13	13	33.5	505	7.60	4433	2540									0.000	
14	14	34.7	512	7.43	4150	2648	9684	11125	7345	7640	6525	2570	820	674	524.222	
15	15	35.5	525	7.65	3883	2787									0.000	
16	16	35.0	476	7.62	3883	2637	10254	10635	6880	8460	6210	2380	670	604	469.778	
17	17	35.3	469			2059									0.000	
18	18	36.2	461	7.40	3817	2529									0.000	
19	19	36.5	428	7.56	3767	2126	7549	9140	5990	6080	5410	2290	580	608	472.889	
20	20	36.0	348	7.66	3700	2087									0.000	
21	21	35.2	367	7.58	3483	2047	9252	9450	6240	7180	5030	2610	1210	777	604.333	
22	22	33.8	342	7.54	3533	1850									0.000	
23	23	33.0	388	7.55	3400	1848	7490	8615	5430	6350	4750	2010	680	611	475.222	120
24	24	34.5	372	7.69	3417	2082									0.000	
25	25	34.4	318	7.55	3400	1751									0.000	
26	26	34.0	305	7.53	3433	1829	7586	7755	4850	5700	4220	2090	630	644	500.889	216
27	27	34.8	329	7.41	3333	1949									0.000	
28	28	34.9	331	7.38	3183	1909	7579	7070	4500	5130	4050	1720	450	474	368.667	264
29	29	34.3	378	7.35	3100	1858									0.000	
30	30	36.0	408	7.55	3167	1772	6085	7685	4260	4890	3680	1970	610	462	359.333	144
31	31	36.0	305	7.54	3233	1713									0.000	
32	32	36.3	400	7.57	3083	1508									0.000	
33	33	34.2	347	7.81	3150	1786	6415	7700		5540	4710		560	444	345.333	
34	34	35.0	346	7.46	2950	1575								437	339.889	
35	35	34.6	294	7.46	2950	1492	6550	6970		5230	4050		440	483	375.667	
36	36	35.2	303	7.52	3033	1508			4490			1930		521	405.222	144
37	37	34.5	302	7.48	3100	1500								488	379.556	
38	38	34.5	233	7.51	2933	1549	6431	6855	4565	5270					0.000	
39	39	34.5	282	7.49	2967	1601									0.000	
40	40	35.1	249	7.41	2783	1594	6457	6165	4005	4600		3430		447	347.667	120
41	41	35.0	288	7.45	2683	1561									0.000	
42	42	35.0	235	7.51	2567	1504	5391	5290	3285	3730	2865	1570	420	374	290.889	192
43	43	34.5	200	7.43	2683	1543									0.000	
44	44	35.0	205	7.48	2583	1492	7209	5700	3630	4450	3160	1570	470	415	322.778	192
45	45	36.1	254	7.59	2717	1349									0.000	
46	46	33.0	256	7.44	2683	1468									0.000	
47	47	34.8	208	7.52	2500	1437	5984	5650	3620	4140	3210	1400	410	361	280.778	168
48	48	36.0	229	7.47	2500	1319									0.000	
49	49	35.2	229	7.45	2483	1318	5659	5660	3725	4620	3445	1150	280	341	265.222	144
50	50	34.9	231	7.54	2433	1221									0.000	
51	51	36.2	253	7.53	2417	1347	7373	7000	4680	5560	4140	1560	540		0.000	168
52	52	36.5	233	7.47	2333	1269									0.000	
53	53	32.0	158	7.37	2433	1294									0.000	
54	54	31.0	169	7.37	2250	1274	6641	5415	3545	4950	3045	1010	500	428	332.889	144
55	55	32.3	211	7.36	2333	1289									0.000	

ONE-SEVENTH THIRD REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
56	56	33.0	272	7.37	2267	1226	6381	6235	4125	4610	3705	1360	420		0.000	144
57	57	33.6	327	7.50	2417	1245									0.000	
58	58	35.0	366	7.41	2433	1148	6070	6230	4160	5080	3760	1310	400	603	469.000	240
59	59	34.3	322	7.35	2283	1162								459	357.000	
60	60	33.5	260	7.32	2283	1167								459	357.000	
61	61	34.2	308	7.34	2267	1147	6549	5795	3915	5020	3545	1180	370	481	374.111	144
62	62	32.8	246	7.34	2083	1035								448	348.444	
63	63	35.0	280	7.36	2150	1062	4769	4510	2935	3160	2655	1100	280	448	348.444	168
64	64	34.0	271	7.39	2167										0.000	120
65	65	35.3	296	7.29	2167	1019								463	360.111	192
66	66	35.5	273	7.18											0.000	
67	67	36.0	249	7.15		898									0.000	
68	68	36.2	256	7.31	2150	927	4710	4800	3110	3490	2910	950	200	484	376.444	168
69	69	34.8	165	7.32	2083	827									0.000	
70	70	36.0	213	7.41	2133	942	5615	5060	3090	4130	2850	1010	240	478	371.778	144
71	71	30.2	105	7.34	2217	808									0.000	
72	72	33.8	150	7.50	2183	898	5444	5045	3205	4100	2965	1040	240		0.000	192
73	73	34.5	187	7.27	1983	904									0.000	
74	74	34.2	167	7.40	2050	898									0.000	
75	75	34.2	176	7.32	2033	872	5194	5110	3340	5610	2950	1110	390		0.000	192
76	76	34.3	217	7.27	2033	853								407	316.556	
77	77	34.0	169	7.25	2017	849	5194	4460	2900	3940	2620	1060	280	395	307.222	192
78	78	34.0	169	7.35	2033	906									0.000	
79	79	34.9	191	7.37	2000	992	6279	5095	3175	4500	2645	1160	530		0.000	168
80	80	34.0	168	7.40	2133	934								437	339.889	
81	81	34.0		7.27	2250	1008									0.000	
82	82	33.2	180	7.36	2133	888	7027	6155	4420	5240	4130	960	290		0.000	144
83	83	33.6	167	7.34	2017	946									0.000	
84	84	32.5	161	7.31	2200	917	5753	5985	4000	5030	3590	1150	410	439	341.444	156
85	85	33.4	196	7.31	2133	904									0.000	
86	86	34.1	215	7.30	2183	846	8308	7205	4850	6500	4450	900	400	411	319.667	144
87	87	35.5	224			946									0.000	
88	88	35.5	198	7.30		946									0.000	192
89	89	34.8	204	7.33	2200	891	6046	6610	4545	5420	4345	990	200	398	309.556	144
90	90	33.4	194	7.34	2100	935									0.000	
91	91	33.9	201	7.37	2133	897	7176	5860	3985	4830	3745	810	240		0.000	
92	92	34.2	213	7.37	2117	865								465	361.667	
93	93	32.5	166	7.36	2100	918	5703	6165	4130	4760	3830	1130	300		0.000	192
94	94	32.0	188	7.25	1933	859								458	356.222	
95	95	37.0	281	7.40		918									0.000	
96	96	33.1	151	7.36	1967	859	4844	5165	3595	4560	3255	880	340	394	306.444	168
97	97	32.5	121	7.36	1950	798									0.000	
98	98	35.0	206	7.29	2050	798	5603	6075	4310	4180	4050	1000	260	413	321.222	168
99	99	35.2	177	7.34	1900	833									0.000	
100	100	35.1	177	7.50	1950	717	5349	5075	3270	4650	3080	810	190		0.000	
101	101	35.6	178			739									0.000	
102	102	35.0	156	7.40	1983	775									0.000	
103	103	34.0	134	7.28	1983	814	5659	5363		4870		1020	380		0.000	192
104	104	32.0	100	7.35	2000	853									0.000	
105	105	33.0	159	7.44	1944	772	5174	4970	3315	3980	3065	800	250		0.000	168
106	106	31.8	136	7.28	1880	772								374	290.889	
107	107	33.3	177	7.28	1870	723	5234	6595	4665	5430	4485	720	180		0.000	168
108	108	34.5	213	7.33	1928	792									0.000	
109	109	33.6	191	7.23		734								374	290.889	
110	110	34.6	212	7.26	1944	811	4556	4535	2890	3920	2480	1100	410	434	337.556	216

ONE-SEVENTH THIRD REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
111	111	34.0	207	7.29	1883										0.000	
112	112	34.9	247			744									0.000	168
113	113	34.1	190												0.000	
114	114	33.4	213	7.27	1912	782	4903	5605	3450	4330	3140	880	310	367	285.444	168
115	115	33.5	173	7.20		763								434	337.556	
116	116	33.2	168	7.30	1944	836									0.000	
117	117	34.0	199	7.21	1944	859	5469	5820	4050	4420	3640	850	410	431	335.222	
118	118	31.2	135	7.23	820		385								0.000	
119	119	33.9	217	7.23	1928	830	5714	4780	3065	4140	2555	1220	510		0.000	144
120	120	33.0	169	7.37	1992	869								392	304.889	
121	121	33.2	223	7.26	1928	765	5373	5020		4110		910	260		0.000	168
122	122	34.0	253	7.26	1960	784									0.000	
123	123	34.7	233												0.000	
124	124	34.0	246	7.36	2137	914	6791	6220	3810	7420	3280	1290	530	393	305.667	
125	125	31.7	119	7.38	1912	821									0.000	
126	126	35.4	236	7.39	1960	989	6119	5615	3635	5060	3305	840	330	405	315.000	168
127	127	33.7	175	7.29	1880	914									0.000	
128	128	33.8	227	7.25	1864	896	5597	5350	3630	4630	3400	800	230	402	312.667	
129	129	32.5	154	7.30	1751	836									0.000	
130	130	32.0	159			799									0.000	
131	131	33.3	175	7.28	2000	892	4907	4845	3170	4580	2920	830	250	378	294.000	
132	132	33.0	184	7.43	1928	886									0.000	
133	133	35.0	195	7.39	2167	902	5789	6070	4115	5420	3735	870	380	364	283.111	240
134	134	35.0	236												0.000	
135	135	34.8	269	7.32	2073										0.000	
136	136	35.0	301												0.000	
137	137	34.0	248												0.000	
138	138	34.0	237												0.000	
139	139	34.2	226	7.32	2089										0.000	
140	140	34.2	230	7.24	2153	1098		5695	3575	4670	3005	1060	570	493	383.444	192
141	141	34.0	199	7.38	2150										0.000	
142	142	34.2	231												0.000	
143	143	34.0	226												0.000	
144	144	33.8	220	7.29	2167										0.000	
145	145	35.8	244	7.38	2233										0.000	
146	146	34.5	207	7.41	2150										0.000	
147	147	35.2	252			1255	5490	6300	4250	1180	3900	1030	350	405	315.000	168
148	148	35.0	206	7.50	2200										0.000	
149	149	34.4	232	7.32	2150										0.000	
150	150	35.8	243												0.000	
151	151	35.6	215	7.50	2150										0.000	
152	152	32.9	164												0.000	
153	153	35.6	220												0.000	
154	154	36.9	277	7.57	2185	1264	7072	6605	4295	6070	3895	910	400	375	291.667	216
155	155	35.0	200												0.000	
156	156	35.8	250	7.35	2283										0.000	
157	157	35.9	265												0.000	
158	158	35.0	275											726	564.667	
159	159	35.8	244	7.41	2185	1198	7757	6710	4395	6200	4155	1040	240	434	337.556	168

ONE-FIFTH FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	33.8		7.84	6583	4112	11873	13500	7935	8670	6655	4080	1280	313	243.444	192
2	2	35.8	562	7.77	6850	3571									0.000	
3	3	35.9	773	7.69		3410									0.000	
4	4	36.1	763	7.63		3870									0.000	
5	5	34.0	638	7.50	4983	3511	11260	11870	7055	8810	5645	3630	1410	678	527.333	
6	6	32.8	677	7.58	4900	3834									0.000	
7	7	34.6	765	7.18	4100	3004	10079	12505	6245	7140	5365	4680	880	949	738.111	
8	8	35.4	833	7.34	4333	3164									0.000	
9	9	34.5	724	7.31	4267	2868	11133	12165	6465	7610	5925	4030	540	839	652.556	
10	10	34.6	610	7.66	4467	3023									0.000	
11	11	35.0	613	7.53		2946									0.000	
12	12	35.5	571	7.47	4633	3008	11328	12515	6655	6420	6035	4130	620	764	594.222	
13	13	35.2	558	7.62	4850	2698									0.000	
14	14	35.8	665	7.38	4433	2727	9684	10655	5960	6710	5000	3660	960	800	622.222	
15	15	36.5	788	7.77	4500	3103									0.000	
16	16	35.8	723	7.67	4567	2832	11621	11850	6795	8890	6175	3420	620	779	605.889	
17	17	35.0	694												0.000	
18	18	35.5	710	7.52	4533	2922									0.000	
19	19	36.5	686	7.58	4217	2598	6765	11660	6570	6900	5620	3210	950	766	595.778	
20	20	36.2	610	7.69	4150	2598									0.000	
21	21	35.0	616	7.67	3800	2559	9449	9800	5820	6480	4780	3260	1040	938	729.556	
22	22	34.0	570	7.61	3850	2205									0.000	
23	23	33.3	542	7.57	3867	2593	8658	10240	5375	6610	4685	2950	690	747	581.000	120
24	24	34.7	588	7.72	3850	2549									0.000	
25	25	34.3	524	7.56	3800	2335									0.000	
26	26	34.0	494	7.58	4085	2257	7588	8180	4635	5540	3995	2640	640	833	647.889	240
27	27	35.0	518	7.50	3767	2421									0.000	
28	28	35.0	561	7.51	3783	2146	7185	7540	4285	5100	3865	2340	420	584	454.222	288
29	29	34.6	639	7.37	3667	2253									0.000	
30	30	36.1	688	7.63	3683	2143	7275	7150	4045	4560	3535	2590	510	647	503.222	168
31	31	35.9	847	7.58	3583	2055									0.000	
32	32	36.0	1114	7.60	3550	1984									0.000	
33	33	35.0	848	7.80	3300	2202	6812	6960	3990	4940	3270	2310	720	484	376.444	192
34	34	37.1	663	7.55	3483	2008								584	454.222	
35	35	36.2	623	7.55	3400	1809	5642	6895	4010	4340	3360	2410	650	626	486.889	168
36	36	36.5	575	7.62	3433	1838								609	473.667	
37	37	35.2	489	7.97	3317	1686								630	490.000	144
38	38	34.3	351	7.53	3367	1922	7922	6995	4335	4800	3735	2030	600		0.000	
39	39	35.0	470	7.51	3300	2055									0.000	
40	40	34.8	453	7.48	3300	1791	6142	6240	3735	4310		2210		586	455.778	240
41	41	34.9	475	7.53	3133	1719									0.000	
42	42	35.0	512	7.59	3150	1621	5234	5510	3135	3670	2575	2090	560	568	441.778	168
43	43	34.2	459	7.43	3067	1777									0.000	
44	44	35.6	478	7.50	3017	1550	5349	5260	3055	3310	2445	1970	610	653	507.889	212
45	45	35.9	504	7.66	3117	1548									0.000	
46	46	32.8	329	7.44	3100	1746									0.000	
47	47	35.5	571	7.38	2950	1142	6142	9825	5040	4680	4100	3900	940	655	509.444	216
48	48	37.0	438	7.29	2500	1457									0.000	
49	49	36.6	407	7.25	2583	1279	6356	8650	4616	4830	3665	3500	950	602	468.222	192
50	50	35.8	362	7.20	2383	1415									0.000	
51	51	36.8	377	7.24	2587	1328	6196	8520	4435	4800	3155	3950	1280		0.000	168
52	52	36.8	319	7.28	2450	1424									0.000	
53	53	33.0	213	7.24	2400	1588									0.000	
54	54	31.0	187	7.25	2383	1506	7645	9235	5025	5720	4305	2760	720	616	479.111	120
55	55	33.2	273	7.25	2450	1426									0.000	

ONE-FIFTH FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
56	56	33.3	348	7.28	2467	1264	5603	7805	4505	4020	3735	2800	770		0.000	162
57	57	35.0		7.53	2933	2996									0.000	
58	58	36.5	520	7.45	2467	1556	6070	6900	3820	4440	3240	2230	580	587	456.556	212
59	59	36.0	319	7.31	2717	1475								576	448.000	
60	60	34.2	300	7.32	2750	1618								620	482.222	
61	61	35.2	518	7.28	2700	1578	5137	7165	3530	4240	3100	1840	430	633	492.333	144
62	62	33.0	369	7.36	2717	1582								599	465.889	
63	63	36.0	495	7.45	2700	1448	5692	7035	4475	3630	4055	1950	420	561	436.333	264

ONE-FIFTH SECOND REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSF	CODTL	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	34.0	320	7.65	5567	[illegible]	21332	13645	12560	15100	11940	2430	620		0.000	240
2	2	34.2		7.65	5467	5015									0.000	
3	3	34.1	303	7.65	4567	5000									0.000	
4	4	34.0	347	7.67	5817	4845	16667	17175	10960	15500	10190	2420	770		0.000	204
5	5	34.0	292	7.43	5633	4070								1000	777.778	
6	6	33.6	271	7.55	5650	4561	17636	15450	10840	12940	10100	2490	740	1048	815.111	312
7	7	33.8	263	7.74	5550	4027									0.000	
8	8	34.2	267	7.86	5300	4708	19574	14280	9720	12450	8880	2500	840		0.000	192
9	9	34.4	254	7.68	5367	4358								962	748.222	
10	10	33.2	240	7.73	5317	4264									0.000	
11	11	33.3	257	7.66	5133	3938	15251	13365	9280	11120	8710	2280	570	702	546.000	192
12	12	34.4	261	7.64	4567	3900									0.000	
13	13	33.0	237	7.65	4567	3764	13610	12550	8610	10140	7660	2530	950	962	748.222	168
14	14	33.7	262	7.71	4700	3462									0.000	
15	15	34.2	261	7.59	4417	3500	14038	15185	9015	11040	7785	2290	1230	905	703.889	
16	16	35.5	275			3359									0.000	
17	17	36.0	279	7.57		3205									0.000	
18	18	34.8	241	7.57	4233	3256	13760	11210	7530	9230	7020	2030	510	812	631.556	192
19	19	33.4	221	7.64	4417	3266									0.000	
20	20	34.4	218	7.44	4383	2624	12595	10960	7490	8900	6890	1800	600		0.000	
21	21	34.4	248	7.54	4363	2923								665	688.333	
22	22	32.3	177	7.63	3867	2969	12109	12780	8930	9640	8240	2170	690		0.000	180
23	23	32.0	169	7.40	4400	2734								812	631.556	
24	24	33.5	194	7.47		2461									0.000	
25	25	34.2	205	7.46	3417	2539	8789	8765	6020	6930	5180	1640	840	720	560.000	192
26	26	33.5	165	7.56	3583	2646									0.000	
27	27	35.0	167	7.43	3583	2335	6949	8470	5695	6780	5155	1860	540	712	553.778	168
28	28	35.3	153	7.45	3367	2364									0.000	
29	29	35.8	156	7.56	3550	2209	10465	9745	6585	8800	6225	1490	360		0.000	168
30	30	36.0	168			2218									0.000	
31	31	35.1	142	7.57	3883	2054									0.000	
32	32	34.0	124	7.48	3183	2248	9884	9055	6060	7810	5360	1850	700		0.000	216
33	33	32.0	119	7.45	3033	2248									0.000	
34	34	34.0	165			2124	9459	8895	6070	7480	5580	1490	490		0.000	
35	35	32.4	126	7.44	3695	1969								602	468.222	
36	36	33.5	148	7.48	3004	1992	12162	10560	7315	9120	6855	1430	460		0.000	
37	37	34.5	168	7.36		2008									0.000	
38	38	33.9	158	7.36		2046								524	407.556	
39	39	34.8	175	7.46	3406	1939	8494	7765	5520	6450	4950	1420	570	671	521.889	192
40	40	34.0	226	7.57	3535	1853									0.000	
41	41	35.0	287			1946									0.000	
42	42	34.2	253			2101									0.000	
43	43	34.0	233	7.29	3133	1985	10506	9065	6410	7470	5990	1310	420	560	435.556	
44	44	34.0	210	7.27		1908								625	486.111	
45	45	34.0	205	7.36	2876	1984									0.000	
46	46	34.4	263	7.19	2751	2031	10156	8085	5570	6790	5000	1270	570	602	468.222	
47	47	31.8	196	7.26	2844	1875								648	504.000	
48	48	34.4	300	7.44	2892	1853	10232	8535	5865	7340	5065	1650	800		0.000	216
49	49	33.5	229	7.35	3085	1853								598	465.111	
50	50	34.0	289	7.30	2892	1754	10634	9750	7290	7630	6860	1260	430		0.000	
51	51	34.4	324	7.32	2844	1791									0.000	
52	52	34.8	312												0.000	
53	53	35.6	364	7.29	2731	2052	8769	7925	5510	6750	5110	1290	400	604	469.778	
54	54	32.0	197			1866									0.000	
55	55	36.2	381	7.45	3020	2313	12164	11670	8565	10050	8115	1270	450	558	434.000	192

E=FIFTH SECOND REP

[illegible]	ATE	TEMP	[illegible]	P	ALK	C GSP	COD	TS	TVS	SS	VSS	NS	VDS	AMMON	ANIT	VA
56	56	33.2	[illegible]	7.23	[illegible]	2034									0.000	
57	57	35.2	331	7.27	29[illegible]	2239	10522	10035	7120	8960	653[illegible]	1440	590	512	398.222	
58	58	33.[illegible]	2[illegible]5	7.27	3053	2345									0.000	
59	59	32.1	1[illegible]9			1896									0.000	
60	60	33.5	245	7.2[illegible]	2933	2148	9071	9450	6815	8560	6455	1300	360		0.000	
61	61	33.0	232	7.35	3004	2159									0.000	
62	62	35.5	345	7.36	3283	2199	12782	11145	8125	9660	7485	1310	640	553	450.111	192
63	63	36.2	365												0.000	
64	64	35.9	3[illegible]1	7.36	3069										0.000	
65	65	35.[illegible]	393												0.000	
66	66	35.2	314												0.000	
67	67	34.9	344												0.000	
68	68	34.[illegible]	331	7.29	3109										0.000	
69	69	35.[illegible]	367	7.32	2826	2346	9318	8740	5950	7290	5520	1500	430	619	481.444	168
70	70	35.[illegible]	290	7.33	3250										0.000	
71	71	33.6	281												0.000	
72	72	35.9	345												0.000	
73	73	33.[illegible]	3[illegible]2	7.3	2933										0.000	
74	74	35.[illegible]	326	7.33	2900										0.000	
75	75	36.[illegible]	344	7.27	3050										0.000	
76	76	35.0	336			2666	9662	8535	5865	7090	5425	1250	440	537	417.667	240
77	77	35.[illegible]	265	7.56	2943										0.000	
78	78	35.1	318	7.43	2700										0.000	
79	79	36.0	348												0.000	
80	80	35.9	3[illegible]8	7.38	2633										0.000	
81	81	35.1	3[illegible]8												0.000	
82	82	35.4	276												0.000	
83	83	36.0	337	7.52	2692	2595	10722	9220	6540	8780	5910	1510	630	513	399.000	264
84	84	36.0	299												0.000	
85	85	35.[illegible]	326	7.32	2885										0.000	
86	86	35.5	337												0.000	
87	87	35.1	360											544	423.111	
88	88	36.0	339	7.42	2796	2129	11179	9400	6490	8280	6010	1470	480	574	446.444	264

E=THIRD FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CL SP	CODAL	TS	TVS	SS	VSS	DS	VDS	AMMON	AMIT	VA
1	1	37.0		7.16	2750	555	3464	9535	2250	1830	1360	7230	890	212	164.889	
2	2	37.0	265	7.16	2617	451									0.000	
3	3	36.0	271	7.07	2733										0.000	
4	4	34.5	155	7.22	2617	1053	2707	10480	2170	2050	1420	6910	750	202	157.111	
5	5	33.0	492	7.22	2700	543									0.000	
6	6	34.6	693	6.97	3333	676									0.000	
7	7	34.0	737	7.23	3600	667								171	133.000	
8	8														0.000	
9	9	35.0		7.07	3183	529	3216	11870	2735			10053		225	175.000	
10	10	35.0	683	7.09	3267	654									0.000	
11	11	35.0	376	7.01	3350	739	3600								0.000	
12	12	35.7	406	7.17	3433	470									0.000	
13	13	35.0	485	7.20		902									0.000	
14	14	35.0	572	7.07	3567	676	5804	14490	5915	4967	3587	9523	2328		0.000	192
15	15	36.3	724	7.17	3667	1216								409	318.111	
16	16	36.0	817	7.34	3733	1310	6823	13755	5190	4540	3260	9215	1930	457	355.444	144
17	17	36.0	816	7.22	3600									433	336.778	
18	18	36.0	860	7.43	3650	1383									0.000	
19	19	34.8	794	7.47	3867	1344	7540	11705	4595	5020	3845	6190	750	514	399.778	
20	20	34.5	1100	7.22	2917	1230									0.000	
21	21	35.0	997	7.32	3100	1443	7036	13015	5020	6200	3640	7220	1180	533	414.556	144
22	22	32.5	653	7.11	3167	1348									0.000	
23	23	36.5	932	7.16	3467	1545	8307	13045	5520	6320	4650	6380	870	664	516.444	144
24	24	35.0	935	7.23	3050	1445									0.000	
25	25	36.0	644	7.31	3900	1654		12045	5410	6030	4330	6010	1080		0.000	192
26	26	35.1	862	7.51	4083	1443	8327								0.000	
27	27	34.5	728	7.51	4367	1038									0.000	
28	28	33.7	733	7.55	4667	1751									0.000	
29	29	34.2	992	7.56	4250	1496									0.000	
30	30	35.5	941	7.55	4467	1831									0.000	
31	31	35.5	936	7.61	4383	1875									0.000	
32	32	35.8	914	7.56	4633	2043	10194								0.000	
33	33	34.5	842	7.69	4633	2035									0.000	
34	34	36.0	921	7.66	4617	2093									0.000	
35	35	34.9	605	7.59	4433	2123	11473	11275	6370	7500	5520	4110	850	669	520.333	216
36	36	34.5	621	7.73	4483	3075									0.000	
37	37	36.7	943	7.58	4800	1922	11843	12590	7475	8910	6405	4330	1070	830	645.556	
38	38	35.8	940	7.58	4783	1829									0.000	
39	39	33.9	862	7.57	4867	1899	12248	13335	8675	8570	7875	5920	800	792	616.000	
40	40	35.8	850	7.39	4817	1996									0.000	
41	41	34.0	830	7.64		2112									0.000	
42	42	34.6	916	7.64	5017	1926	13068	12785	8010	9490	7330	3640	680		0.000	
43	43	34.4	914	7.57	4717	2309									0.000	
44	44	33.8	756	7.64	5067	2373									0.000	
45	45	34.2	816	7.61	5083	2449									0.000	
46	46	36.5	942			2263									0.000	
47	47	34.9	830	7.60	5433	2351	13496	15375	10225	11250	9455	2970	770		0.000	
48	48	32.2	679	7.78	5400	2318									0.000	
49	49	31.3	720	7.66	5467	2379									0.000	
50	50	35.0	842	7.71	5450	2450									0.000	
51	51	36.5	1013	7.72	5533	2576	14024	14580	9355	11400	8605	3080	750	851	661.889	
52	52	35.0	871	7.77	5800	2716									0.000	
53	53	34.5	969	7.58	5750	2677									0.000	
54	54	33.6	921	7.48		2598									0.000	
55	55	35.2	1073			2669									0.000	

ONE-THIRD FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	AAIT	VA
56	56	34.5	945			3106									0.000	
57	57	33.6	952			2866									0.000	
58	58	35.2	1141	7.59	5717										0.000	
59	59	35.6	1162	7.53											0.000	
60	60	34.8	1040	7.58	5967	2680	14560	15380	10170	12490	9140	2940	1030	1097	853.222	
61	61	35.5	1098	7.74	5750	2782									0.000	
62	62	35.1	1126	7.66		2549									0.000	
63	63	37.0	1175	7.74	5833	3230	15564	14450	9515	12890	7975	3130	1540	1112	864.889	
64	64	36.5	1143	7.78		3110									0.000	
65	65	34.9	1006	7.55	5617	2441	12598	14610	10110	10400	9430	2620	680	1128	877.333	
66	66	33.2	957	7.76	5867	3113									0.000	
67	67	34.6	1090			3191									0.000	
68	68	34.5	1020	7.63	5767	3385									0.000	
69	69	34.8	1011	7.68	6100	2652									0.000	
70	70	35.9	1040	7.66	6350	3594	14862	16055	10050	13970	9390	2230	660	1041	809.667	
71	71	34.0	1033	7.62	6250	3333									0.000	
72	72	34.9	1046	7.56	6200	3507	14475	16885	11480	12310	10520	3040	960	1130	878.889	120
73	73	36.1	1150	7.74	6233	3808									0.000	
74	74	35.8	1120	7.61	5750	3373	14008	15735	12910	13730	12290	1960	620	959	745.889	120
75	75	34.7	1022	7.54	5600	3152									0.000	
76	76	34.5	1115	7.46		3050									0.000	
77	77	34.3	1000	7.66	5750	3529	16000	15140	10590	12850	9930	2510	660	959	745.889	240
78	78	33.0	1043	7.60	6283	3490									0.000	
79	79	34.4	1154	7.64	6500	3647	16062	18600	12240	15780	11780	2700	460	1133	881.222	216
80	80	33.0	1387	7.75	6250	3591									0.000	
81	81	35.0	1232	7.50	6033	3891	16496	18620	13580	14620	12630	3020	950	1052	818.222	312
82	82	37.0	1290	7.62	6500	3774									0.000	
83	83	36.5	1170	7.67	7417	3852									0.000	
84	84	33.8	974	7.54	6000	3619									0.000	

[illegible]E-1-THRD SECOND REP

DAYS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	33.5		7.[illegible]	[illegible]	3399	13764	16200		8600		7400	3500	461	358.556	
2	2	34.2	56	7.72	4117	3111									0.000	
3	3	34.[illegible]	88	7.58	4550	3187									0.000	
4	4	34.5	752	7.55	5017	3346	13554	13765	7740	9200	4940	6700	2800	525	408.333	
5	5	34.[illegible]	816	7.73	5950	3184									0.000	
6	6	34.5	869	7.59	4600	3196									0.000	
7	7	34.2	875	7.67	4417	2431								545	423.889	
8	8														0.000	
9	9	35.0		7.83	4733	3431	13412	14745	9365	8493	3895	6100	5470	630	490.000	
10	10	34.5	760	7.75	4033	3373									0.000	
11	11	35.5	808	7.59	4350	3424	13020	13065	8000	8620	5940	4465	2060		0.000	
12	12	34.2	853	7.81	4533	3216									0.000	
13	13	35.0	1270	7.72		2863									0.000	
14	14	35.[illegible]	847	7.53	4933		14431	14495	9250	9893	7207	4602	2043		0.000	
15	15	34.0		7.62	5200	3333								828	644.000	
16	16	34.2	956	7.76	5117	3056	15238	12670	7795	7987	5760	4683	3112	814	633.111	
17	17	34.2	935	7.59	4967									759	590.333	
18	18	35.1	944	7.81	4517	2609									0.000	
19	19	35.5	1074	7.87	5350	2411	12778	12620	7500	8740	6730	2790	770	821	638.556	216
20	20	35.[illegible]	1067	7.72	5083	2266									0.000	
21	21	35.5	1119	7.62	5300	2411	11067	12250	7355	9240	6385	3710	970	780	606.667	168
22	22	35.0	1074	7.69	5117	1914									0.000	
23	23	35.0	1092	7.64	5233	2461	11575	11875	7225	9260				927	721.000	216
24	24	34.5	1075	7.55	5233	1953									0.000	
25	25	35.2	1243	7.58	5450	1945		12710	7910	9520	6980	3190	930		0.000	216
26	26	35.0	1162	7.73	5467	1976	10584								0.000	
27	27	34.6	1091	7.64	5250	2253									0.000	
28	28	33.5	1157	7.76	5067	1751									0.000	
29	29	35.4	1041	7.72	5550	3268									0.000	
30	30	35.2	1178	7.65	5700	2244									0.000	
31	31	35.[illegible]	1191	7.59	5417	2148									0.000	
32	32	35.1	1129	7.65	5483	2374	11984	11690	6925	8610					0.000	
33	33	34.6	1074	7.66	5750	2248									0.000	
34	34	35.5	1110	7.86	5564	2442									0.000	
35	35	35.7	1002	7.64	5417	2222	12093	13395	8900	10465	7910	2930	990	828	644.000	192
36	36	35.5	1051	7.77	5750	2361									0.000	
37	37	35.5	962	7.7[illegible]	5733	1922	10824	13305	8910	9570	8050	2590	860	980	762.222	
38	38	35.0	1033	7.72	5767	1556									0.000	
39	39	31.0	954	7.7[illegible]	5267	1938	11163	11965	8090	9470	7190	2600	900	823	640.111	
40	40	37.0	1059	7.50	5983	1589									0.000	
41	41	31.5	804	7.65		2390									0.000	
42	42	33.5	1056	7.61	5500	1780	12271	14580	10195	10870	9505	2450	690		0.000	
43	43	33.2	973	7.58	5283	2288									0.000	
44	44	34.2	1006	7.73	5400	2542								841	654.111	
45	45	34.2	1010	7.61	5333	3210									0.000	
46	46	34.4	1111			3045									0.000	
47	47	33.3		7.79	5617		11670	12535	8650	9630	7310	2500	1340		0.000	
48	48	34.2	961	7.67	5317	2460									0.000	
49	49	32.5	960	7.74	5350	2661									0.000	
50	50	34.5	1065	7.82	6033	2629									0.000	
51	51	34.6	1053	7.52	5833	3028	10677	11255	7430	7500	6680	2350	750	956	743.556	
52	52	34.5	1042	7.83	5750	3386									0.000	
53	53	34.7	1077	7.62	5150	3169									0.000	
54	54	34.8	1071	7.49		2953									0.000	
55	55	34.6	1141			3028									0.000	

ONE-THIRD SECOND REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	COMPL	TS	TVS	SS	VSS	S	VDS	AMMO	AVIT	VA
56	56	34.4	[illegible]			3066									0.000	
57	57	34.5	122[illegible]			3108									0.000	
58	58	35.2	1321	7.7[illegible]	5617										0.000	
59	59	34.6	1303	7.53											0.000	
60	60	34.2	1346	7.67	5517	2560	11940	11055	7360	8600	6100	2640	1260	1146	892.889	
61	61	34.5	1389	7.66	5650	3064									0.000	
62	62	34.8	1313	7.73		2431									0.000	
63	63	35.5	1085	7.78	5650	3035	10564	10675	6770	8270	4980	3020	1790	1145	889.000	
64	64	35.5	1144	7.61		2677									0.000	
65	65	35.3	1366	7.62	5417	2244	10079	10730	7320	7230	6350	2340	970	1115	867.222	
66	66	35.0	1318	7.76	5750	2802									0.000	
67	67	35.0	1317			2451									0.000	
68	68	34.5	1196	7.65	5633	3074									0.000	
69	69	34.9	1336	7.70	5750	2276									0.000	
70	70	35.0	1344	7.68	5733	2695	11719	11560	7870	8200	7180	2250	690	1058	822.889	
71	71	34.5	1391	7.70	5667	3098									0.000	
72	72	33.5	1414	7.69	5600	2802	11673	10720	6965	8150	6195	2750	770	1196	930.222	120
73	73	35.7	1425	7.69		3346									0.000	
74	74	33.8	1393	7.65	5367	3020	10272	9775	6325	7330	5615	2100	710	930	725.333	168
75	75	34.5	1249	7.54	5383	2879									0.000	
76	76	34.0	1413	7.64		2705									0.000	
77	77	34.2	1436	7.78	5417	2986	11242	10695	7260	8320	6560	6460	700	1052	818.222	192
78	78	32.5	1455	7.62	5600	2980									0.000	
79	79	34.3	1538	7.66	5567	3020	10965	10405	6770	7980	5810	2700	960	1005	781.667	216
80	80	33.5	1544	7.79	5550	2934									0.000	
81	81	34.8	1589	7.50	5533	2957	9961	11565	7155	7969	6095	3030	1060	1209	940.333	240
82	82	35.0	1658	7.60	6133	3152									0.000	
83	83	34.0	1662	7.65	5400	3268									0.000	
84	84	34.3	1254	7.61	5133	3074	14475	11270	7640	9050	4510	4190	3130	1229	955.889	

[illegible]

OBS	DATE	TEMP	[illegible]	PH	ALK	[illegible]	COD	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	35.0		7.65	5717	4575	13833	[illegible]	8735	10560	7365	3800	1370	302	234.889	192
2	2	36.1	1372	7.70	5633	4614									0.000	
3	3	34.9	1337	7.73		4444									0.000	
4	4	35.5	1357	7.68		4636									0.000	
5	5	34.5	1567	7.40	5717	3931	13168	12955	8605	9640	6915	3390	1090	855	665.000	
6	6	33.5	1546	7.55	5733	5336									0.000	
7	7	33.9	1440	7.54	5767	4466	13439	12365	7535	9370	6645	3020	890	1070	832.222	
8	8	35.9	1569	7.59	5716	4219									0.000	
9	9	35.3	1598	7.52	6133	3953	13867	12146	7650	9010	6770	2960	860	1046	813.556	
10	10	34.0	1472	7.69	5950	4031									0.000	
11	11	34.4	1466	7.59		4075									0.000	
12	12	35.2	1536	7.56	5717	4258	12305	10575	7455	9350	6565	3560	890	846	658.000	
13	13	34.8	1579	7.60	5767	3770									0.000	
14	14	36.0	1714	7.44	5900	3952	11858	12875	8500	8650	7400	3290	1100	999	777.000	
15	15	35.3	1713	7.64	5683	4210									0.000	
16	16	34.8	1454	7.70	5917	3627	12598	12535	8050	10150	7300	3240	750	1016	790.222	
17	17	35.0	1355			3510									0.000	
18	18	35.8	1335	7.39	5033	4025									0.000	
19	19	36.7	1207	7.59	5500	3113	10882	12135	8010	8210	7210	2860	800	936	728.000	
20	20	36.3	1537	7.73	5383	3113									0.000	
21	21	35.	1113	7.63	5363	3150	11614	12755	8600	9490	7310	3290	1290	1105	859.444	
22	22	33.5	955	7.63	5483	2795									0.000	
23	23	33.8	953	7.65	5567	3677	11965	12270	7960	9390	7130	2790	850	1061	825.222	144
24	24	35.9	1003	7.65	5417	3710									0.000	
25	25	36.1	944	7.54	5457	3502									0.000	
26	26	34.8	955	7.56	5363	3463	11478	11390	7415	6850	6205	3410	1210	1187	923.222	264
27	27	36.1	949	7.50	5500	3484									0.000	
28	28	36.0	1003	7.44	5417	3602	13484	11640	7690	9240	7080	2610	610	873	679.000	336
29	29	36.3	1107	7.46	5183	3202									0.000	
30	30	37.9	1196	7.51	5183	3532	12500	11780	8135	9320	7305	2660	730	811	630.778	216
31	31	35.8	1051	7.62	5383	3399									0.000	
32	32	35.8	1001	7.59	5267	2437									0.000	
33	33	35.2	970	7.75	5200	2421	12599	11715	8000	9520	6990	2570	1010	781	607.444	168
34	34	36.5	985	7.55	5517	3266								805	626.111	
35	35	36.2	934	7.54	5250	3482	12549					2960		958	745.111	192
36	36	36.1	936	7.66	5217	3210								942	732.667	
37	37	35.2	858	7.58	5283	3529								945	735.000	
38	38	35.0	850	7.59	5550	3529	13647	12265	8975	9700	7675	2370	1000		0.000	216
39	39	35.3	860	7.61	4983	3360									0.000	
40	40	35.4	762	7.40	5417	3346	15433	12545	9000	10073	8240	2700	760	866	573.556	192
41	41	36.2	644	7.56	4833	3241									0.000	
42	42	36.2	1400	7.55	4650	3164	12031	11045	7590	8780	6980	2320	610	870	676.667	336
43	43	35.5	744	7.49	4750	3398									0.000	
44	44	36.2	791	7.44	4633	3140	14419	12030	8715	9090	7955	2240	760	935	727.222	240
45	45	36.8	870	7.67	4717	3135									0.000	
46	46	33.5	649	7.49	4750	3254									0.000	
47	47	36.0	806	7.51	4650	3425	14173	12775	9055	10150	8395	2270	660	828	644.000	168
48	48	38.0	987	7.49	4667	3307									0.000	
49	49	36.4	832	7.52	4450	3178	11938	11695	7530	9110	6460	2490	1070	674	524.222	192
50	50	35.9	763	7.64	4417	2907									0.000	
51	51	36.5	992	7.56	4667	3391	14588	13280	9180	10750	8210	2430	970		0.000	168
52	52	38.0	965	7.52	4833	3159									0.000	
53	53	34.2	725	7.49	4717	3372									0.000	
54	54	31.5	653	7.44	4633	3050	14826	12595	9265	11020	8565	1710	700	918	714.000	192
55	55	34.0	798	7.42	4617	3086									0.000	

ONE=THIRD THIRD REF

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
56	56	34.5	[illegible]	7.41	4583	3266	10895	10640	7320	6350	6490	2310	830		0.000	192
57	57	33.0	[illegible]	[illegible]	4317	2879									0.000	
58	58	33.5	628	7.34	6100	2646	37043	36475	27365	33960	26725	1510	640		0.000	144
59	59	36.5	942	7.44	4700	2793								878	682.889	
60	60	35.0	752	7.37	5383	2843								981	763.000	
61	61	32.3	714	7.36	5517	2608	29116	28600	21430	26010	20720	1790	710	929	722.556	144
62	62	31.5	723	7.37	5517	2500								794	617.556	
63	63	33.0	775	7.36	5517	2394	14769	22890	16915	19930	16395	1860	520	1103	857.889	192
64	64	32.5	717	7.39	4917	2124									0.000	192
65	65	36.5	969	7.32	5183	3000	15077	16320	10915	12160	10125	1920	700	921	716.333	216
66	66	38.0	1091	7.26		2374									0.000	
67	67	36.5	952	7.27		3494									0.000	
68	68	38.3	854	7.38	5633	3243	19691	18105	12585	15860	12115	1590	470	668	519.556	120
69	69	36.0	626	7.34	5100	3615									0.000	
70	70	37.8	813	7.41	5517	3538	21231	19520	13270	16530	1270	1840	570	948	737.333	204
71	71	30.5	403	7.38	5633	3423									0.000	
72	72	34.8	715	7.46	5467	3726	17117	20155	13460	17130	13030	1650	430		0.000	168
73	73	36.0	693	7.35	5717	3615									0.000	
74	74	35.0	541	7.36	5700	3803									0.000	
75	75	35.0	574	7.33	5300	3760	18450	18590	13315	17970	12595	1960	720		0.000	288
76	76	35.0	495	7.38	5500	3566								770	598.889	
77	77	35.0	497	7.33	5250	3416	18217	16430	11460	16130	10770	2120	690	891	693.000	288
78	78	33.6	497	7.46	5483	3530									0.000	
79	79	35.2	488	7.43	5150	4047	22093	19055	13570	17200	12900	1930	670		0.000	168
80	80	35.4	441	7.37	5200	3813								885	688.333	
81	81	34.2	415	7.33	4917	3798									0.000	
82	82	33.8	446	7.36	5400	3591	19112	19240	14085	17760	13555	1670	530	661	514.111	216
83	83	34.6	419	7.55	4650	3591									0.000	
84	84	33.6	[illegible]	7.52	4850	3456	17857	15900	11230	14350	10610	2040	620	866	673.556	312
85	85	34.5	445	7.53	5250	3462									0.000	
86	86	35.0	454	7.50	5317	3423	24038	19890	14330	17960	13500	2290	830	866	673.556	216
87	87	36.3	492			3591									0.000	
88	88	35.6	391	7.51		3591									0.000	144
89	89	34.7	392	7.34	5333	3643	24419	20395	15015	18150	14635	1610	380	922	717.111	192
90	90	33.5	347	7.48	5267	3740									0.000	
91	91	34.8	347	7.36	4683	3053		17865	12520	15040	11970	1510	550		0.000	192
92	92	36.0	297	7.40	4850	3346								855	665.000	
93	93	33.0	199	7.39	4683	3438	17578	19025	13875	17140	13265	1780	610		0.000	168
94	94	37.0	407	7.41	4700	3398								836	650.222	
95	95	33.2	197	7.42		3393									0.000	
96	96	34.3	257	7.43	4317	3203	14844	15700	11465	14230	10595	1640	870	775	602.778	192
97	97	33.8	218	7.36	4483	3268									0.000	
98	98	35.2	316	7.31	4467	3035	16537	16290	11865	14510	11115	1930	750	760	591.111	
99	99														0.000	
100	100	35.1		7.36	3850	3023	15504	13320	9510	12100	9110	1430	400		0.000	
101	101	35.8	296			2840									0.000	
102	102	35.5	237	7.35	6217	3101									0.000	
103	103	34.2	174	7.32	3900	2752	15698	13895	9880	13100	9250	1510	630		0.000	216
104	104	32.2	149	7.34	4400	2984									0.000	
105	105	34.2	301	7.37	4131	2625	16409	14640	10500	12910	9990	1490	510		0.000	
106	106	33.5	199	7.25	4258	2510								695	540.556	
107	107	33.6	246	7.27	4322	2734	15820	15785	11420	14720	10990	1420	430		0.000	168
108	108	34.5	317	7.30	4306	2973									0.000	
109	109	34.0	267	7.32		2973								674	524.222	
110	110	32.0	178	7.36	4258	2818	16216	15265	11270	13870	10610	1510	660	771	599.667	

ONE=THIRD THIRD REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
111	111	34.0	298	7.34	4209										0.000	
112	112	36.0	413			2901									0.000	168
113	113	35.0	310												0.000	
114	114	35.4	406	7.30	4579	3168	22763	21245	15520	18340	14930	1480	590	707	549.889	360
115	115	36.1	435	7.30		3053								840	653.333	
116	116	33.4	276	7.35	5093	3268									0.000	
117	117	35.0	417	7.26	5029	3398	18945	19315	13735	18250	13325	1440	410	794	617.556	
118	118	32.2	249	7.34	5013	3086								717	557.667	
119	119	31.0	260	7.25	4884	3089	20463	17675	12300	17120	11710	1460	590		0.000	216
120	120	32.5	355	7.39	4620	3282								788	612.889	
121	121	32.5	405	7.26	5302	2985	20149	22190	16540	17630	16180	1520	360		0.000	168
122	122	34.2	476	7.30	5109	3134									0.000	
123	123	35.0	452												0.000	
124	124	35.0	389	7.47	5061	3619	18470	19200	13845	17720	13295	1590	550	781	607.444	280
125	125	32.9	512	7.43	3984	373'									0.000	
126	126	35.0	809	7.55	4001	417	17537	15140	11380	13430	10730	1770	650	819	637.000	192
127	127	33.0	910	7.26	3727	3843									0.000	
128	128	34.8	1253	7.27	3631	3806	13806	12430	9285	10750	8635	1720	650	804	625.333	
129	129	33.6	871	7.37	3760	3494									0.000	
130	130	32.0	745			3234									0.000	
131	131	33.0	717	7.20	3867	3643	15242	12860	9630	11530	9090	1750	540	743	577.889	
132	132	34.2	706	7.38	3792	3727									0.000	
133	133	35.4	670	7.44	4033	3647	15038	13925	10590	11500	9680	1750	910	814	633.111	192
134	134	34.9	560												0.000	
135	135	36.0	696	7.26	3679										0.000	
136	136	35.4	602												0.000	
137	137	35.8	699												0.000	
138	138	34.5	631												0.000	
139	139	35.0	600	7.33	3640										0.000	
140	140	34.6	610	7.41	3776	3371	14962	14300	9945	11570	9235	1520	710	921	716.333	216
141	141	34.1	572	7.46	3683										0.000	
142	142	34.1	633												0.000	
143	143	34.9	666												0.000	
144	144	34.6	634	7.32	3917										0.000	
145	145	36.0	706	7.34	3833										0.000	
146	146	35.0	548	7.30	3750										0.000	
147	147	35.3	652			4000	14706	12785	9730	10180	9160	1660	570	769	598.111	216
148	148	33.8	427	7.58	3800										0.000	
149	149	35.0	640	7.29	3667										0.000	
150	150	35.6	596												0.000	
151	151	36.5	596	7.46	4033										0.000	
152	152	34.3	526												0.000	
153	153	37.5	645												0.000	
154	154	35.4	644	7.54	3808	4023	15970	12230	8855	11120	7975	1700	880	752	584.889	216
155	155	36.5	579												0.000	
156	156	35.8	639	7.38	4233										0.000	
157	157	35.0	689												0.000	
158	158	36.6	740											814	633.111	
159	159	34.5	598	7.42	3985	3878	18821	15625	11420	13410	10820	1940	600	852	662.667	240

ONE-HALF FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	37.0		7.78	5683	4537	16120	18585	10525	12600	9335	4690	1190	395	307.22	204
2	2	37.3	1515	8.06	6550	4460									0.00	
3	3	37.2	1446	7.91		3487									0.00	
4	4	38.0	1737	7.90		4751									0.00	
5	5	36.8	1627	7.86	6700	4160	16794	16825	10155	12060	8985	4610	1170	1201	934.11	
6	6	36.0	1773	7.93	6800	4901									0.00	
7	7	36.0	1880	7.62	7117	4032	16403	16360	9990	11960	9070	3760	920	1294	1006.44	
8	8	36.9	2036	7.88	7167	4492									0.00	
9	9	35.6	2084	7.75	7667	5078	16602	17755	10560	13050	9550	3630	1010	1614	1255.33	
10	10	36.0	2125	7.75	7617	4070									0.00	
11	11	34.8	2112	7.72		3643									0.00	
12	12	35.4	2112	7.69	7867	5273	17188	17055	10720	13340	9850	3890	870	1137	884.33	
13	13	36.0	2172	7.85	8217	4682									0.00	
14	14	37.1	1388	7.63	8100	5099	16996	19085	12290	14510	10660	4600	1630	1323	1029.00	
15	15	36.3	2243	7.81	7767	5040									0.00	
16	16	34.3	1770	7.77	7817	4707	22168	21425	14210	18130	13190	4250	1020	1412	1098.22	
17	17	34.2	1677	7.74		4569									0.00	
18	18	35.8	1796	7.48	7733	5431									0.00	
19	19	37.1	1743	7.75	7900	4134	15784	19840	13515	14700	12495	3880	1020	1005	781.67	
20	20	35.5	1727	7.84	7550	4528									0.00	
21	21	34.2	1664	7.76	9550	4961	17126	21210	14720	16450	13060	3860	1660	1164	905.33	
22	22	33.8	1387	7.79	7717	4606									0.00	
23	23	33.5	1331	7.86	7967	3988	19163	19585	13020	15840	11820	4000	1200		0.00	288
24	24	35.1	1528	7.73	7750	5155									0.00	
25	25	35.3	1348	7.62	7933	4786									0.00	
26	26	34.1	1506	7.69	7667	5136	18872	18600	12415	15210	11345	3730	1070	1431	1113.00	312
27	27	35.0	1239	7.64	7783	5492									0.00	
28	28	35.2	1278	7.52	7883	4547	19193	18545	12635	14220	11735	3680	900	1154	897.56	240
29	29	35.2	1342	7.64	7483	3913									0.00	
30	30	36.0	1630	7.69	7483	4841	19048	18435	12685	18860	11535	3630	1150	1109	862.56	264
31	31	35.5	1677	7.70	7817	4427									0.00	
32	32	35.6	1706	7.70	7683	4444									0.00	
33	33	34.6	1457	7.86	7850	5119	20536	19500	13720	16410	12600	3420	1120	1350	1050.00	264
34	34	35.8	1129	7.67	7650	4961								1164	905.33	
35	35	35.8	1322	7.66	7517	4241	19747	20885	14765	17220	13615	3370	1150	1074	835.33	240
36	36	35.9	1291	7.62	7750	4922								1296	1008.00	
37	37	35.5	1285	7.66	7717	5216								1271	988.56	
38	38	35.0	950	7.64	7433	3647	19412	20125	14455	16530	13195	3420	1260		0.00	288
39	39	35.8	1312	7.68	7233	5020									0.00	
40	40	36.0	1252	7.64	7313	5315	21457	21100	15440	17440	14310	3250	1130	1187	923.22	360
41	41	35.9	1260	7.65	7333	5059									0.00	
42	42	35.6	1640	7.69	7150	4609	20117	19665	13395	15050	12385	3100	1010	1095	851.67	336
43	43	35.0	1146	7.60	6967	5547									0.00	
44	44	35.5	1256	7.60	7000	4690	21318	18555	13425	16430	12175	3350	1250	1071	833.00	228
45	45	36.0	1189	7.69	7183	3928									0.00	
46	46	33.3	696	7.60	6950	5238									0.00	
47	47	36.0	1386	7.66	6817	5118	23031	17565	12420	14290	11190	3190	1230	1132	880.44	216
48	48	38.5	1583	7.66	6883	4764									0.00	
49	49	36.6	1308	7.62	6783	4922	18798	18235	12585	15130	11275	3270	1310	994	773.11	336
50	50	35.8	1242	7.68	6667	4302									0.00	
51	51	36.5	1413	7.66	6867	5058	20392	17850	12680	14410	11680	3150	1000		0.00	288
52	52	37.9	1498	7.58	6883	4283									0.00	
53	53	33.8	1134	7.50	6750	4863									0.00	
54	54	32.0	1074	7.60	6633	4556	20656	17015	12425	15340	11365	3130	1060	1388	1079.56	168
55	55	33.3	1207	7.52	6517	4609									0.00	

ONE-HALF FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
56	56	33.2	1425	7.41	6767	4241	21595	19555	14505	16210	13575	2810	930		0.00	240
57	57	35.0	1535	7.56	6583	4358									0.00	
58	58	37.0	1693	7.59	6550	4202	19650	17925	13010	15070	11750	3010	1260	1521	1183.00	240
59	59	36.0	1647	7.60	6433	4629								1393	1083.44	
60	60	34.3	1431	7.53	6667	4921								1521	1183.00	
61	61	35.5	1558	7.51	6467	5118	19902	19050	14305	15650	13165	2750	1140	1323	1029.00	216
62	62	33.6	1315	7.54	6483	4766								1366	1062.44	
63	63	36.8	1545	7.54	6467	4633	19615	18790	14140	14520	13400	2580	740	1311	1019.67	240

ONE-HALF SECOND REP

OBS	DATE	TEMP	GAS	PH	ALK	C?.SP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	34.0	617	7.72	6133	4459	16699	15515	9995	13070	9230	2440	760		0.000	192
2	2	35.[illegible]	752	7.5[illegible]	5957	4308									0.000	
3	3	34.8	686	7.57	5967	3680									0.000	
4	4	34.5	752	7.55	5950	4264	14729	13775	9050	13090	8250	2360	800		0.000	252
5	5	35.0	701	7.57	5650	4070								1269	987.000	
6	6	34.6	729	7.52	5633	4103	14341	12610	8320	10620	7610	3150	710	1134	882.000	432
7	7	34.0	762	7.55	5667	3912									0.000	
8	8	35.[illegible]	821	7.51	5633	4552	16667	13535	8995	11400	7995	3080	1000		0.000	192
9	9	34.9	833	7.55	5450	3969								1146	891.333	
10	10	34.[illegible]	791	7.43	5400	3992									0.000	
11	11	33.2	852	7.50	5367	3822	12162	12755	7780	9340	6840	2850	940	839	652.556	216
12	12	34.7	666	7.44	5433	3900									0.000	
13	13	33.5	840	7.36	5350	3649	11660	13115	8870	9530	7770	3140	1100	1134	882.000	
14	14	34.2	919	7.39	5417	3577									0.000	
15	15	35.0	992	7.46	5250	3615	12692	12425	8075	9710	6875	2790	1200	1114	866.444	440
16	16	36.1	944			3628									0.000	
17	17	35.8	978	7.64		3629									0.000	264
18	18	35.0	1049	7.42	5350	3760	12403	11010	7100	8130	6360	2750	740	1021	794.111	192
19	19	33.3	931	7.44	5300	3617									0.000	
20	20	34.8	692	7.44	5150	3626	12023	12235	8130	9440	7280	2500	850		0.000	216
21	21	35.0	942	7.50	5183	3590								1224	952.000	
22	22	33.1	757	7.52	4983	3672	13281	13455	9065	10490	8106	2880	950		0.000	168
23	23	36.1	962	7.41	5117	3555								1248	970.667	
24	24	35.2	687	7.49		3750									0.000	
25	25	35.9	636	7.50	5033	3398	11523	11785	8050	9300	6720	2650	1330	1130	878.889	240
26	26	38.1	641	7.48	4967	3735									0.000	
27	27	34.4	810	7.45	5000	3385	11284	10810	7100	8800	5780	2920	1320	1036	805.778	216
28	28	35.5	660	7.53	4900	3488									0.000	
29	29	35.0	720	7.46	5117	3605	13372	13220	8970	10710	8160	2460	810		0.000	192
30	30	35.1	740			3346									0.000	
31	31	34.5	666	7.43	5067	3682									0.000	
32	32	33.2	557	7.44	4767	3527	14341	12730	8760	10410	7910	2530	850		0.000	264
33	33	32.0	550	7.46	4800	3682									0.000	
34	34	33.5	721	7.44	4691	3784	13514	12310	8585	10170	7765	2370	820		0.000	192
35	35	33.9	726	7.40	4499	3822								989	769.222	
36	36	34.0	788	7.42	4836	3438	14648	13810	9855	11840	9075	2500	780		0.000	
37	37	35.0	910	7.47	4675	3552									0.000	
38	38	34.2	662	7.42		3436								955	742.778	
39	39	32.0	592	7.42	4627	3514	13320	12170	9040	9830	8460	2180	580	1181	918.556	192
40	40	33.7	605	7.36	4370	3436									0.000	
41	41	35.0	1109			3473									0.000	
42	42	35.0	1174			4086									0.000	
43	43	35.4	1199	7.32	4772	3740	16537	14820	10860	12060	10000	2280	860	952	740.444	192
44	44	36.7	1196	7.40		3740								1028	799.556	
45	45	33.4	888	7.41	4708	4047									0.000	
46	46	36.6	1122	7.39	4788	4180	16016	13245	9485	11790	8665	2300	820	1161	903.000	
47	47	32.2	837	7.37	4627	4023								1120	871.111	
48	48	33.2	929	7.38	4706	3977	15058	12415	8895	9740	7995	2160	900		0.000	216
49	49	32.0	780	7.55	4772	4015								1184	920.889	
50	50	32.4	922	7.40	4981	3769	17351	14880	11065	12820	10325	2340	740		0.000	
51	51	33.8	1064	7.42	4836	3769									0.000	
52	52	33.6	1036												0.000	
53	53	35.5		7.49	5366	5522	16657	16690	12480	14240	11760	2240	720	1255	976.111	
54	54	34.2		7.76	5173	5000									0.000	
55	55	34.0	799	7.46	5736	6007	23134	22350	16125	19010	14985	3810	1140	1269	987.000	

ONE-HALF SECOND REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
56	56	34.0		7.46	6250	5784									0.00	
57	57	33.9	852	7.50	6234	5696	33022	28890	22025	24690	21135	2730	890	1139	885.89	
58	58	34.2	871	7.52	6700	5651									0.00	
59	59	32.7	766			5613									0.00	
60	60	32.8	972	7.50	7163	6208	27135	30015	22540	27320	21760	2660	780	1204	936.44	
61	61	34.0	1084	7.56	6941	6458									0.00	
62	62	35.2	1270	7.62	7250	6353	25564	25920	19060	23690	18020	2630	1040	1201	934.11	216
63	63	35.6	1151												0.00	
64	64	36.2	1393	7.47	6893										0.00	
65	65	35.0													0.00	
66	66	35.7	1034												0.00	
67	67	33.5	624												0.00	
68	68	34.9	910	7.55	6989										0.00	
69	69	35.1	1160	7.48	7439	5071	29167	29235	20685	25450	19625	2310	1060	1325	1030.56	216
70	70	34.0	1035	7.54	6950										0.00	
71	71	34.0	1146												0.00	
72	72	35.0	1192												0.00	
73	73	34.0	1110	7.53	8550										0.00	
74	74	34.5	995	7.56	7350										0.00	
75	75	35.8	1067	7.53	6433										0.00	
76	76	35.0	1116			7412	23529	21990	15370	19860	14530	2460	840	1121	871.89	264
77	77	35.0	923	7.60	6500										0.00	
76	78	35.0	1100	7.44	6533										0.00	
79	79	37.2	1202												0.00	
80	80	36.9	1032	7.54	6633										0.00	
81	81	34.8	993												0.00	
82	82	35.8	1092												0.00	
83	83	35.2	1158	7.60	6262	6973	23954	19185	13225	18820	12285	2020	940	1185	921.67	240
84	84	36.1	1038												0.00	
85	85	35.6	1149	7.51	6750										0.00	
86	86	35.2	1223												0.00	
87	87	34.5	1200											1181	918.56	
88	88	35.0	1146	7.63	6619	6426	24905	23360	15995	22900	15105	2370	890	1286	1000.22	288

STRAIGHT FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	37.5		7.88	4900	2976	10952	14630	8835	8567	6167	6063	2668	829	644.78	
2	2	36.5	1825	7.78	5233									736	572.44	
3	3	36.0	2135	7.87	5617	2530									0.00	
4	4	35.9	2330	7.90	6333	3241	18254	17760	10500	11600	9560	3900	940	1050	816.67	240
5	5	35.5	2480	7.85	6567	2103									0.00	
6	6	35.5	2685	7.75	6950	3162	18656	17095	10580	13170	9070	4770	1510	1172	911.56	216
7	7	32.0	2485	7.81	7283	2461									0.00	
8	8	37.5	2550	7.78	7433	3130	15669	17555	11025	13460	9765	4240	1260	1319	1025.89	216
9	9	34.9	2500	7.76	7817	2812									0.00	
10	10	35.8	2625	7.79	10317	3580		18010	11025	13260	9765	4240	1330		0.00	216
11	11	37.0	3015	7.89	9017	3083	19300								0.00	
12	12	34.1	2475	7.84	9433	4269									0.00	
13	13	35.0	2425	7.87	11250	4786									0.00	
14	14	35.6	2480	7.80	10117	5590									0.00	
15	15	36.1	2800	7.82	10533	5511									0.00	
16	16	35.5	2645	7.89	10700	6094									0.00	
17	17	35.0	2550	7.84	11200	7237	27860	25695	16340	19150					0.00	
18	18	34.4	2810	7.86	11767	7674									0.00	
19	19	35.3	2895	7.91	11667	7287									0.00	
20	20	34.9	3160	7.95	12133	7936	29457	30165	20075	24070	17565	6160	2510	1966	1529.11	1512
21	21	35.8	3200	7.96	12433	8492									0.00	
22	22	37.5	3440	7.90	13033	6510	34902	30350	20700	24340	17940	6590	2760	2006	1560.22	
23	23	36.5	3110	8.00	12800	5058									0.00	
24	24	33.0	2655	8.04	13133	7132	34496	32015	22110	26080	19840	6080	2270	2560	1991.11	
25	25	36.0	2750	7.88	13583	6202									0.00	
26	26	34.5	2590	8.02		9402									0.00	
27	27	35.0	3070	7.92	14900	6610	42629	37690	26790	30430	24940	6100	1850		0.00	
28	28	35.0	3265	7.92	14750	9746									0.00	
29	29	33.8	3110	8.03	14433	7966									0.00	
30	30	35.0	2785	7.96	15450	14156									0.00	
31	31	37.6	3720			12510									0.00	
32	32	35.9	3480	8.14	15467	11952	43089	43235	30825	36520	28845	5270	1980		0.00	
33	33	33.0	2575	8.17	16133	10161									0.00	
34	34	33.0	2300	8.05	16867	12742									0.00	
35	35	35.2	2925	8.04	16467	15777									0.00	
36	36	35.2	3090	8.09	16683	11793	47410	43740	30440	35720	27800	6850	2640	2602	2023.78	
37	37	34.8	2797	8.12	17033	13701									0.00	
38	38	34.3	3010	7.91	17467	17480									0.00	
39	39	34.7	3002	7.84		14488									0.00	
40	40	34.5	3012			9721									0.00	
41	41	33.9	2870			16419									0.00	
42	42	33.5	3084			15777									0.00	
43	43	36.1	3611	8.01	18500										0.00	
44	44	35.9	3558	7.93											0.00	
45	45	34.3	3022	7.96	18883	18720	56400	53175	37895	47800	35425	8260	2470	3612	2809.33	
46	46	35.0	2963	8.04	19233	18226									0.00	
47	47	35.0	2870	7.99		15686									0.00	
48	48	36.2	3264	8.06	20250	16965	70817	55785	38705	50290	35875	6920	2830	3228	2510.67	
49	49	36.1	3152	7.93		16850									0.00	
50	50	35.2	2690	7.90	18917	16693	74803	59300	42445	52960	39095	7340	3350	3799	2954.78	
51	51	34.2	2361	7.99	19300	18521									0.00	
52	52	34.9	2653			19300									0.00	
53	53	35.0	2821	8.07	20067	17432									0.00	
54	54	35.2	2544	8.05	21133	16562									0.00	
55	55	35.2	2492	7.98	20467	25781	73725	64250	46995	53600	44105	6750	2890	3404	2647.56	

STRAIGHT FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
56	56	35.1	2394	7.91	20733	24941									0.00	
57	57	35.2	3107	7.69	20433	14008	95720	74480	52875	68100	49665	8120	3210	3134	2437.56	680
58	58	36.0	2505	7.94		23398								3397	2642.11	
59	59	36.8	2487	7.88	20200	20392	69261	66335	47880	58590	44860	7490	3020	3557	2766.56	2480
60	60	36.5	2337	7.86	20150	21206									0.00	
61	61	36.8	2230	7.85		25483									0.00	
62	62	36.5	2023	7.95	20950	27255	158431	77765	58170	71550	55090	7210	3080	3580	2784.44	3880
63	63	34.6	2799	8.11	17967	24510									0.00	
64	64	35.4	2055	8.01	20950	24510	67954	71836	53025	66260	49185	9130	3840	3871	3010.78	4224
65	65	34.8	1968	7.88	21733	23359									0.00	
66	66	35.5	2197	7.72	20533	24903	77043	69770	51175	65700	47105	8900	4070	3466	2695.78	2160
67	67	37.8	2495	7.76	20750	25486									0.00	
68	68	35.5	2008	7.92	21500	26654									0.00	
69	69	34.0	2325	7.99		23930	76264	80905	57505	74220	53995	7830	3510	3547	2758.78	

STRAIGHT SECOND REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	A II	VA
1	1	35.6		7.43	4183	3614	15637	21100		11600		9500	2000	516	401.33	
2	2	35.8	350	7.55	4250	3416									0.00	
3	3	36.0	785	7.56	4317	4103				11495					0.00	
4	4	35.1	1080	7.52	5383	4624	17744	19395	12120	18600	8920	7900	3200	707	549.89	
5	5	35.5	1501	7.58	4600	4757									0.00	
6	6	34.5	2410	7.62	6517	5470									0.00	
7	7	36.0	2890	7.77	6800	4000								927	721.00	
8	9	36.0		7.93	7683	5431	19686	19400	12205	12080	9225	6680	2980	1232	958.22	
9	10	35.5	2350	7.87	7850	5720									0.00	
10	11	34.2	2410	7.76	8133	6187	19922	20085	12970	14120	10380	5965	2590		0.00	
11	12	35.5	2750	7.85	9267	6627									0.00	
12	13	34.5	2610	7.95		6314									0.00	
13	14	36.0	1955	7.78	9183	5100	20392	20630	13115	13887	10993	6743	2122		0.00	264
14	15	36.2	1970	7.77	9700	8000								1994	1550.89	
15	16	35.5	2040	7.80	10033	8413	25498	24225	16005	15720	11553	8505	4452	1848	1437.33	
16	17	36.5	2120	7.79	10100									1651	1284.11	
17	18	35.5	2165	7.85	10533	6719									0.00	
18	19	35.1	1950	7.82	11100	7194	29762	27485	17465	20880	15845	4520	1620	2118	1647.33	356
19	20	35.5	2110	7.82	11583	7232									0.00	
20	21	35.1	2300	7.67	10350	8932	39526	28525	18015	22900	15665	6380	2350	1874	1457.56	
21	22	33.5	2175	7.70	12200	8594									0.00	
22	23	37.0	2790	7.77	12133	9803	32087	27795	18070	21180	15680	6230	2390	2552	1984.89	
23	24	34.8	2800	7.78	12417	9141									0.00	
24	25	36.0	2770	7.79	11483	9961		29770	19435	23910	16935	6370	2500		0.00	360
25	26	36.5	3310	7.91	12183	8221	34241								0.00	
26	27	34.0	2930	7.96	13533	8854									0.00	
27	28	33.5	3080	8.02	13383	8405									0.00	
28	29	35.4	2755	7.99	14750	10551									0.00	
29	30	36.4	3525	7.99	14833	9134									0.00	
30	31	36.2	3555	8.03	15500	8984									0.00	
31	32	34.0	2725	7.92	15550	10039	40467	38350	25995	31560					0.00	
32	33	33.5	2720	7.96	15567	11163									0.00	
33	34	36.0	3025	8.00	16067	11163									0.00	
34	35	35.0	3000	8.03	16217	11190	62015	48215	33400	40560	30970	7280	2430	2602	2023.78	1656
35	36	36.5	2920	8.23	16383	13175									0.00	
36	37	37.5	2865	7.98	17133	9333	50980	47505	32515	41810	29735	6890	2780	3809	2962.56	
37	38	37.0	2920	8.04	17250	7704									0.00	
38	39	33.5	2375	8.06	17400	9845	44186	47345	32905	45180	30445	6940	2460	2700	2100.00	
39	40	35.1	2565	7.84	17383	9147									0.00	
40	41	34.6	2370	7.98		13864									0.00	
41	42	35.1	2785	8.01	20533	10340	67729	58780	38740	53520	36720	6400	2020		0.00	
42	43	35.0	3040	7.99	18567	14576									0.00	
43	44	34.1	2770	8.03	19383	20085									0.00	
44	45	34.0		7.97	18600	17613									0.00	
45	46	37.5	3280			19095									0.00	
46	47	34.9	3110	8.10	18333	14821	86992	52625	36570	46215	32660	10030	3910		0.00	
47	48	32.8	2285	8.09	18767	15000									0.00	
48	49	31.7	2105	8.05	18817	16935									0.00	
49	50	35.0	2650	8.11	18683	14821									0.00	
50	51	34.8	2960	8.11	18717	15458	53785	45426	30675	38740	27775	7300	2900	3166	2462.44	
51	52	34.3	2788	8.14	18800	16693									0.00	
52	53	35.8	3116	7.95	18150	20787									0.00	
53	54	34.5	3053	7.88		15748									0.00	
54	55	32.5	2801			9721									0.00	
55	56	34.1	2685			15777									0.00	

STRAIGHT SECOND REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	A.IT	VA
56	57	35.5	2943			16414									0.00	
57	58	36.0	3525	8.08	19567										0.00	
58	59	35.7	3288	7.96											0.00	
59	60	34.3	2780	8.04	20100	17920	69600	56100	40390	50380	37580	6960	2810	3515	2733.89	
60	61	35.4	2752	8.13	19983	20645									0.00	
61	62	35.0	2669	8.06		17098									0.00	
62	63	36.5	2965	8.14	19900	17743	70817	60125	43445	55250	40155	7330	3290	2557	1988.78	
63	64	36.1	2848	8.08		25984									0.00	
64	65	35.2	2531	8.02	19467	17323	74803	59785	44130	53050	41360	7520	2770	3261	2536.33	
65	66	34.6	2376	8.00	19500	16654									0.00	
66	67	35.0	2718			16654									0.00	
67	68	35.1	2967	8.06	20167	18988									0.00	
68	69	35.4	2925	8.04	21667	13594									0.00	
69	70	33.5	2984	7.97	22000	16406	89412	21820	61160	79520	58310	6800	2850	2883	2242.33	
70	71	33.0	3010	7.89	20933	17255									0.00	
71	72	33.0	4110	7.97	20250	20233	84825	70005	51565	61870	47815	8920	3750	3182	2474.89	2080
72	73	34.0	3952	7.95		14808									0.00	
73	74	35.2	4184	8.01	18933	12418	74708	67110	48210	61910	45640	7480	2570	2799	2177.00	1296
74	75	35.2	3871	7.93	19017	13230									0.00	
75	76	35.0	3128	7.97		10232									0.00	
76	77	35.8	2711	8.05	23217	12157	55686	56510	39700	49190	37580	7120	2120	2872	2233.78	1360
77	78	34.6	2799	8.11	17967	8824									0.00	
78	79	34.9	2550	8.20	18117	12549	56371	57075	39685	48210	37005	8100	2680	3182	2474.89	1608
79	80	32.3	2471	8.13	17233	12355									0.00	
80	81	36.4	3070	7.93	17050	11868	68482	42475	29075	35720	25445	9700	3630	3036	2361.33	1080
81	82	35.5	2460	7.85	17217	14591									0.00	
82	83	31.5	2573	8.03	15759										0.00	
83	84	34.0	2325	7.99	18850	16148	73152	66630	47405	60910		6160		3476	2703.56	

STRAIGHT THIRD REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
1	1	37.8		7.88	6600	3456	19015	19150	12500	14680	10870	4520	1630	335	260.56	192
2	2	36.5	2162	7.73	7000	3417									0.00	
3	3	38.9	2745	7.92		3678									0.00	
4	4	38.9	2953	7.77		5134									0.00	
5	5	35.0	2351	7.65	8117	9389	20611	19700	12960	15200	11290	4300	1670	1329	1033.67	
6	6	33.3	2407	7.67	8567	5059									0.00	
7	7	32.4	2531	7.67	8617	5217	22134	20645	13495	16800	12155	4430	1340	1553	1207.89	
8	8	38.5	3940	7.73	9250	6172									0.00	
9	9	34.2	3305	7.66	10100	6434	22656	26290	18460	22250	16240	5990	2220	1807	1405.44	
10	10	32.8	2749	7.76	10317	6899									0.00	
11	11	37.2	3548	7.84		6356									0.00	
12	12	33.4	2788	7.72	11000	6719	27539	26720	18010	21040	15940	6220	2070	1447	1125.44	
13	13	35.8	2831	7.77	11650	6905									0.00	
14	14	36.0	2872	7.65	11750	6877	25823	26955	17210	20250	13980	6850	3230	2029	1578.11	
15	15	36.4	3191	7.89	12100	8103									0.00	
16	16	35.5	2976	7.89	12067	8086	32682	30655	20755	27550	18505	6350	2250	2011	1564.11	
17	17	[illegible]	2802	7.85		8510									0.00	
18	18	[illegible]	3250	7.74	11967	7412									0.00	
19	19	37.1	3216	7.92	12100	7874	24967	30050	20890	20200	18670	5850	2220	1710	1330.00	
20	20	36.4	3317	8.01	12350	7874									0.00	
21	21	36.0	3418	8.00	12800	8031	25197	31515	21855	24560	19115	6370	2740	2402	1868.22	
22	22	[illegible]	2377	8.03	12433	7402									0.00	
23	23	[illegible]	2246	7.94	12983	7354	35668	36280	25130	29290	23080	5850	2050	2434	1893.11	384
24	24	[illegible]	2632	7.85	13117	6109									0.00	
25	25	35.7	2645	7.84	13683	5836									0.00	
26	26	35.0	2568	7.88	13767	9728	34241	34715	24105	28140	22195	6160	1910	2689	2091.44	840
27	27	35.2	2441	7.87	13717	7756									0.00	
28	28	35.5	2449	7.89	13417	7913	34252	34870	24615	29940	22875	5410	1740	2054	1597.56	360
29	29	35.5	2509	7.74	13483	7905									0.00	
30	30	36.5	3010	7.80	13967	9206	36111	37575	25680	31080	23960	5900	1720	2265	1761.67	
31	31	36.0	3042	7.91	14467	8775									0.00	
32	32	36.0	3060	7.80	14450										0.00	
33	33	35.0	2573	7.91		9087	41865	41875	29885	35360	27445	6340	2440	1895	1473.89	720
34	34	36.8	2573	7.88	13267	8583								2018	1569.56	
35	35	36.8	2344	7.93	14550	9222	37549	45635	32585	39240	30335	6120	2250	2350	1827.78	402
36	36	37.5	2374	7.88	15033	9144								2226	1731.33	
37	37	36.4	2072	7.96	14650	10824								2463	1915.67	
38	38	36.4	1549	7.94	15233	7843	47059	47715	34535	39990	31975	6340	2560		0.00	720
39	39	37.0	2186	7.93	14017	11858									0.00	
40	40	36.5	2188	7.83	14033	8819	45669	47940	34545	41910	32345	5870	2200	2232	1736.00	936
41	41	36.0	2128	7.83	15167	7352									0.00	
42	42	35.2	2219	7.91	14926	6984	48047	50640	36035	45110	34025	5730	2010	2023	1573.44	760
43	43	35.0	2044	7.83	15253	11719									0.00	
44	44	36.2	2254	7.83	14383	10543	53101	43230	31220	42320	29200	5900	2020	2546	1980.22	912
45	45	37.5	2416	7.85	14783	10000									0.00	
46	46	33.5	1692	7.77	15767	8016									0.00	
47	47	36.0	2308	7.87	13983	9370	47638	45355	32785	38650	30385	6330	2400	2178	1694.00	288
48	48	36.5	2441	7.88	14717	9370									0.00	
49	49	36.6	2296	7.87	14183	9922	39922	39825	28490	34290	25840	6410	2650	2096	1630.22	432
50	50	35.3	2203	7.89	15017	9147									0.00	
51	51	36.5	1990	7.82	14317	9341	53856	47865	34290	40630	32060	6300	2230		0.00	384
52	52	37.5	2513	7.82	14500	8256									0.00	
53	53	34.5	1779	7.73	14750	9490									0.00	
54	54	32.2	1730	7.81	14567	10425	55598	48440		43000		5440	2200	2754	2142.00	522
55	55	33.6	1929	7.84	15583	10938									0.00	

STRAIGHT THIRD REP

OBS	DATE	TEMP	GAS	PH	ALK	CUDSP	CUDML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANIT	VA
56	56	33.0	2266	7.80	16533	8638	62257	56815	42040	52620	39080	6140	2360		0.00	480
57	57	35.2	2194	7.78	7333	13230									0.00	
58	58	35.5	2134	7.80	15583	9961	74708	63075	45435	62870	42905	6350	2530	2091	1626.33	440
59	59	35.8	2137	7.72	15217	10352								2380	1851.11	
60	60	36.5	2768	7.80	15417	12667								2661	2069.67	
61	61	37.0	2475	7.83	14350	12667	58235	54790	39465	55440	37175	6150	2290	2770	2154.44	800
62	62	34.2	1886	7.83	14600	12656								2689	2091.44	
63	63	37.0	2267	7.81	15000	9421	52692	50680	37270	50960	36330	2130	940	2287	1778.78	432
64	64	36.3	2202	7.84	15150	9035									0.00	268
65	65	37.0	2270	7.84	14167	10077	55769	51035	37345	43760	35795	4670	1550	2325	1808.33	
66	66	39.0	2792	7.78	12162										0.00	
67	67	38.5	2497	7.73	13629										0.00	
68	68	37.5	2262	7.87	14400	11815	51351	48330	36055	48490	34465	4590	1590	2726	2120.22	264
69	69	36.5	1629	7.74	14633	12385									0.00	
70	70	38.8	972	7.83	15583	14385	73846	62165	45140	57250	43670	3910	1470	2795	2172.33	288
71	71	30.5	1397	7.78	15167	10769									0.00	
72	72	36.0	2113	7.77	14883	13938	62162	54275	40020	52350	38490	4000	1530		0.00	312
73	73	37.5	2410	7.68	15100	13077									0.00	
74	74	36.5	1923	7.70	15150	13089									0.00	
75	75	35.2	1927	7.68	15683	13256	53488	51275	36910	56270	34520	5500	2390		0.00	528
76	76	36.0	1725	7.89	14333	9302								2530	1967.78	
77	77	35.0	1581	7.83	14550	12404	76744	53725	39930	54380	38480	4160	1450	2675	2080.56	648
78	78	35.3	1582	7.80	14300	10878									0.00	
79	79	36.1	1567	7.88	13633	13463	56589	49715	36055	47310	33865	5170	2190		0.00	576
80	80	36.0	1628	7.75	13400	13385								3142	2443.78	
81	81	35.5	1309	7.77	13817	13798									0.00	
82	82	35.0	1406	7.83	14783	12201	72587	60275	44530	56930	42710	4930	1820		0.00	720
83	83	35.0	1385	7.81	13033	12818									0.00	
84	84	34.8	1444	7.71	13917	12394	48262	47625	34695	43180	32595	5390	2100	2682	2086.00	264
85	85	35.7	1492	7.84	13750	12538									0.00	
86	86	36.8		7.82	14650	13385	56923	56775	42030	52920	39680	4850	2350	2361	1836.33	216
87	87	37.5	1589			12664									0.00	
88	88	37.6	1370	7.85		13591									0.00	
89	89	36.8	1304	7.70	15767	13488	65116	58795	42950	50610	41250	4900	1700	2393	1861.22	400
90	90	35.0	1238	7.73	13333	12137									0.00	
91	91	34.5	1051	7.69	13550	11145	57252	57550	42030	50750	40230	4570	1800		0.00	264
92	92	34.8	1111	7.78	14000	12308								2682	2086.00	
93	93	32.5	846	7.72	14167	11953	57812	59530	42780	59980	41200	4260	1580		0.00	
94	94	37.0	1309	7.69	14483	12578								2411	1875.22	
95	95	35.0	961	7.74		11484									0.00	
96	96	34.8		7.78	12383	11406	46094	46300	34150	41130	32950	3910	1200	2293	1783.44	440
97	97	34.5		7.71	13033	11829									0.00	
98	98	36.9	1137	7.71	13067	11673	49805	44960	33050	41860	31190	4650	1860	2326	1809.11	
99	99														0.00	
100	100	35.8		7.79	15100	12016	59690	64885	44135	62910	42955	3400	1180		0.00	1728
101	101	36.0	1036			12062									0.00	
102	102	35.1	938	7.76	15367	12016									0.00	
103	103	34.0	836	7.69	14450	12403	56589	59410	40915	58330	39375	3880	1540		0.00	
104	104	31.2	923	7.70	17583	12946									0.00	
105	105	35.5	1353	7.70	16276	13668	58687	68790	43920	68730	42220	3990	1700		0.00	408
106	106	34.0	1025	7.60	15633	12664								2164	1683.11	
107	107	34.4	1152	7.75	15601	13516	70270	68420	44215	70820	42725	3340	1490		0.00	264
108	108	34.9	1068	7.72		13668									0.00	
109	109	33.9	911	7.72		14208								2037	1584.33	
110	110	36.0		7.72	16982	16680	67954	67890	46360	65590	44760	4240	1600		0.00	216

STRAIGHT THIRD REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VFS	AMMON	ANIT	VA
111	111	32.5	705	7.69	16982										0.00	
112	112	34.0	1109			13740									0.00	240
113	113	36.0	1299							73100					0.00	
114	114	34.9	1239	7.60	17239	13893	77043	75365	48880	73100	47510	3750	1370	2316	1801.33	
115	115	34.4	1146	7.69		14046								2539	1974.78	
116	116	34.1	1046	7.66	19023	15720									0.00	
117	117	35.2	1192	7.61	18316	16250	125781	85530	51690	79540	50080	4050	1610	2574	2002.[illegible]	
118	118	33.5	927	7.65	18171	16719								2771	2155.22	
119	119	35.0	1149	7.79	17946	16525	78764	73840	48430	73990	44710	6120	3720		0.[illegible]	288
120	120	34.5	942	7.76	18637	13900								2610	2030.[illegible]	
121	121	34.0	1115	7.65	18846	15373	70896	81640	51335	79500	49545	4090	1790		0.00	288
122	122	36.0	1267	7.74	20533	15970									0.00	
123	123	35.9	1066												0.00	

FINISHER FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	[illegible]	[illegible]	[illegible]	VA
1	1								15665			4610			0.00	
2	2	35.2	2286	7.75	9717	6930		23840		19440	14465		1200		[illegible]	
3	3	36.5	3429	7.90		6245									[illegible]	
4	4	37.5	4140	7.77		8199									[illegible]	
5	5	36.2	3059	7.68	11500	10534	33015	28490	19280	23500	16340	8040	2940	2255	1753.69	
6	6	34.8	2929	7.60	12419	13123									0.00	
7	7	33.3	2658	7.50	13017	13280	35573	30090	19960	24050	17180	6860	2780	2722	2117.11	
8	8	35.4	3268	7.55	14067	15625									0.00	
9	9	35.8	3347	7.51	14333	16434	38281	31560	21075	25820	18565	6660	2510	2672	2078.22	
10	10	34.5	3148	7.64	15317	16744									0.00	
11	11	34.2	3050	7.56		17984									0.00	
12	12	34.9	3389	7.65	15650	17813	46609	39065	26556	31150	22826	8490	3730	2722	2117.11	
13	13	37.6	3823	7.71	15917	20635									0.00	
14	14	36.9	3324	7.65	16783	19763	52174	41600	28965	31810	23855	9630	5110	3102	2412.67	
15	15	37.0	4199	7.98	17050	20632									0.00	
16	16	35.2	3529	7.68	17933	21172	54492	48880	33185	42080	29895	8830	3290	2902	2257.11	
17	17	36.0	3963												0.00	
18	18	36.5	4067	7.75	18700	22667									0.00	
19	19	37.0	3537	7.99	19367	20787	46470	55745	40170	44430	37750	6400	2420	2853	2219.00	
20	20	37.0	3528	7.99	19283	21575									0.00	
21	21	36.0	3709	7.76	19467	22205	44488	58845	43310	53530	38840	8860	4470	4505	3503.89	
22	22	34.3	2254	8.04	19567	22520									0.00	
23	23	34.2	1995	8.02	19683	23735	62840	59770	41510	53510	37050	9890	4460	3567	2774.33	4776
24	24	36.1	2192	7.89	19583	23268									0.00	
25	25	35.0	2106	7.94	20167	23346									0.00	
26	26	34.5	1988	7.90	20183	24436	65370	53800	37135	45440	33355	9360	3780	3599	2799.22	4296
27	27	35.4	2156	7.88	20300	29685									0.00	
28	28	35.6	2209	7.93	20650	25590	75394	63070	46390	50380	42900	8070	3490	3398	2642.89	1520
29	29	35.5	2043	7.83	20583	26350									0.00	
30	30	36.5	2267	7.99	22033	28042	64550	61090	44775	55000	41435	7750	3340	3183	2475.67	760
31	31	35.9	2049	7.90	21833	25033									0.00	
32	32	36.0	2023	7.78	21383	26455									0.00	
33	33	35.5	1700	7.89	23200	31878	85450	73540	53420	65250	49350	9440	4070	3662	2848.22	
34	34	33.0	1226	7.80	22967	29134								3369	2620.33	
35	35	37.0	1558	7.88	23750	29702	79766	74990		65240		9750	4630	3865	3006.11	7120
36	36	34.4	1509	7.75	22250	30253								3492	2716.00	
37	37	37.5	1301	7.93	20833	32680								3944	3067.56	10392
38	38	37.8	1079	7.81	21017	32418	83922	67270	48505	59200	43375	10470	5130		0.00	
39	39	36.2	1205	7.81	21267	35310									0.00	
40	40	36.2	1095	7.69	22100	32808	93701	80465	58385	72600	53945	10280	4440	3693	2872.33	6568
41	41	36.0	1036	7.67	21433	31357									0.00	
42	42	35.5	1024	7.69	21667	33073	71875	75400	54030	62380	49960	9630	4070	3604	2803.11	6920
43	43	35.2	1010	7.61	22450	35677									0.00	
44	44	35.5	1159	7.60	21067	34625	123256	71200	51435	69710	46595	9830	4840	3898	3031.78	5760
45	45	37.5	1219	7.63	21317	37037									0.00	
46	46	32.8	634	7.54	20533	36508									0.00	
47	47	34.0	654	7.54	22567	30709	86614	88980	60125	81970	55115	9410	5010	3767	2929.89	1968
48	48	37.2	1482	7.51	22467	35171									0.00	
49	49	36.5	1097	7.50	21367	35142	78294	73160	55325	70170	49615	10730	5710	3574	2779.78	9840
50	50	35.5	984	7.60	21567	37209									0.00	
51	51	36.8	1040	7.58	20933	37855	94902	84390	62410	74730	60220	5640	2190		0.00	2160
52	52	38.2	1046	7.54	21200	38630									0.00	
53	53	34.2	532	7.45	20700	40000									0.00	
54	54	31.5	598	7.53	22117	37838	117374	91350		82040		9310	4610	4203	3269.00	7880
55	55	34.0	913	7.49	23033	41146									0.00	

FINISHER FIRST REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANTI	VA
56	56	34.0	1108	7.50	22983	40986	100389	111665	63830	88790	76740	[illegible]	[illegible]		0.00	
57	57	36.0	1089	7.44	23717	44358									0.00	
58	58	37.5	1046	7.60	23633	42802	101946	103535	69600	99710	62810	11480	[illegible]	[illegible]	3687.40	1080
59	59	37.3	834	7.55	23150	43359								[illegible]	3269.00	
60	60	36.3	742	7.57	24450	44575								[illegible]	3195.11	
61	61	37.5	749	7.57	24467	43529	110980	106590	73425	109090	67395	11120	[illegible]	6446	3459.56	8880
62	62	36.0	449	7.59	23067	43750								4436	3450.22	
63	63	38.0	857	7.41	27117	39897	115385	107705	77265	100040	73725	7380	[illegible]	[illegible]	[illegible]	2520
64	64		692	7.60	40633	37838	133977	169200	132090	174260	128440	7580	[illegible]	[illegible]	3724.00	6520

FINISHER SECOND REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	ANII	VA
1	1	28.9	326	7.69	9333	9978	28861	32745	20265	29690	19075	3050	1190		0.00	192
2	2	30.0	664	7.47	7567	3615									0.00	
3	3	30.0	762	7.40	8367	4189									0.00	
4	4	31.0	1117	7.46	9200	4380	43798	53640	34665	57100	33485	3780	1180		0.00	384
5	5	31.0	1289	7.54	13950	4225								1476	1148.00	
6	6	31.0	1483	7.50	12450	4714	58915	54155	35675	55740	34375	3960	1300	1521	1183.00	528
7	7	31.0		7.56	11633	4599									0.00	
8	8	31.0	2494	7.73	18250	4864	88372	69740	44005	72470	42715	4180	1290		0.00	216
9	9	31.0	2615	7.56	15367	4124								1492	1160.44	
10	10	30.1	2007	7.57	16867	4225									0.00	
11	11	29.5	1880	7.62	19983	4208	46332	55270	35355	52470	34245	4490	1110	1166	906.89	180
12	12	33.8		7.65	8500	6100									0.00	
13	13	33.9	1026	7.76	8417	6390	19691	20810	13925	15710	12455	4620	1470	1913	1487.89	192
14	14	33.8		7.78	8450	6192									0.00	
15	15	35.0		7.69	9617	7077	32308	28190	19500	23910	17500	5960	2000	1898	1476.22	
16	16	36.0	1879			6795									0.00	
17	17	35.0	841	7.71		8108									0.00	360
18	18	33.3		7.34	11067	5194	43411	41965	27000	34390	25580	5590	1420	1582	1230.44	216
19	19	30.1	1564	7.57	7767	5267									0.00	
20	20	31.0	1805	7.46	8800	5114	37023	33580	21995	27070	18825	7420	3170		0.00	264
21	21	30.0	1567	7.51	9833	5385								1766	1373.56	
22	22	28.5	1344	7.46	9383	5469	31250	32425	20970	26560	19870	5760	1100		0.00	
23	23	33.5	1885	7.53	9600	6719								1809	1407.00	
24	24	35.4	1923	7.57		6406									0.00	
25	25	36.9	2097	7.64	8583	7031	28125	31500	20850	24380	17540	5580	3310	1815	1411.67	288
26	26	37.5	1751	7.78	9767	7782									0.00	
27	27	31.0	1206	7.64	8417	7626	17121	19280	11765	13920	10045	5620	1720	1969	1531.44	
28	28	36.5	1443	7.63	10350	8217									0.00	
29	29	39.1	1915	7.65	10767	9612	68760	35550	23930	27240	22550	5760	1380		0.00	
30	30	35.2	1105			9650									0.00	
31	31	34.5	790	7.69	11567	10620									0.00	
32	32	34.0	945	7.64	11300	11240	37984	39280	27955	31540	26345	5500	1610		0.00	
33	33	31.0	471	7.56	12467	12093									0.00	
34	34	34.5	1027	7.58	11809	12278	41699	42930	30755	39110	28875	5840	1880		0.00	1440
35	35	36.5	1393	7.51	11938	12201								2421	1883.00	
36	36	34.2	1458	7.57	12195	12969	47104	45240	32210	40110	30370	5590	1840		0.00	624
37	37	38.5	1806	7.65	14672										0.00	
38	38	35.0	1129	7.69	15753									2356	1832.44	
39	39	34.2	524	7.68	13801	13822	60232	52900	40980	48200	38960	5900	2020	2434	1893.11	320
40	40	35.5	1441	7.59	14090	16988									0.00	
41	41	36.0	1815			17557									0.00	
42	42	34.0				20545									0.00	
43	43	34.0	1259	7.56	20678	18321	117510	120295	79450	117250	76920	6230	2530	2832	2202.67	1224
44	44	35.0	1097	7.75		14809								2991	2326.33	
45	45	35.0	947	7.69	22975	17588									0.00	
46	46	40.0	1341	7.67	22381	29219	148438	118490	81905	112320	79765	5080	2140	3272	2544.89	
47	47	32.0	359	7.61	21288	24062								3335	2593.89	
48	48	37.0	899	7.93	23056	25483	104247	118130	80170	118460	77560	6610	2610		0.00	288
49	49	34.7	719	7.77	24100	26409								3245	2523.89	
50	50	35.4	1140	7.64	20774	25970	97015	113545	78800	105160	76540	6240	2260		0.00	216
51	51	37.8	1017	7.75	21658	23134									0.00	
52	52	37.0	765												0.00	
53	53														0.00	
54	54		1154												0.00	
55	55		417			25970	101492	125200	83800	107850	80910	6520	2890	2974	2313.11	

FINISHER SECOND REP

OBS	DATE	TEMP	GAS	PH	ALK	CODSP	CODML	TS	TVS	SS	VSS	DS	VDS	AMMON	AMIT	VA
56	56														0.00	
57	57		1804												0.00	
58	58														0.00	
59	59	34.5													0.00	
60	60	34.5	584	7.50	14500	11896	43866	58205	38320	53070	36620	6140	17[illegible]	1809	1407.00	1000
61	61	34.5	655	7.60	14942	12768									0.00	
62	62	34.7	800	7.80	13898	13158	48872	52315	34935	45480	32565	6140	2370	2342	1821.56	288
63	63	36.5	931												0.00	
64	64	37.2	1174	7.56	15536										0.00	
65	65	34.0	873												0.00	
66	66	35.0	1115												0.00	
67	67	35.0	1302												0.00	
68	68	36.0	1500	7.72	17834										0.00	
69	69	37.5	1950	7.81	17625	17121	77273	85720	60265	79120	56565	7240	3700	3199	2488.11	336
70	70	34.2	1391	7.69	19217										0.00	
71	71	36.0													0.00	
72	72														0.00	
73	73	39.0		7.72	18850										0.00	
74	74	35.5	965	7.80	17933										0.00	
75	75	35.3	798	7.67	15817										0.00	
76	76	35.6	939			25569	92549	87475	65895	81770	63665	3750	2230	3029	2355.89	624
77	77	35.8	993	7.68	18333										0.00	
78	78	33.9	1320	7.56	18200										0.00	
79	79	36.1	1390												0.00	
80	80	36.5	1320		18083										0.00	
81	81	35.0	1320												0.00	
82	82	36.0	1241												0.00	
83	83	37.1	1485	7.84	18187	27586	102662	94645	68910	93990	65970	6550	2900	3389	2635.89	672
84	84	35.1	1178												0.00	
85	85	35.0	1209	7.76	19250										0.00	
86	86	36.0	1238												0.00	
87	87	35.2	1200											3869	3009.22	
88	88	36.0	1100	7.77	20180	28517	126996	119610	87995	115540	83795	9280	4200	3806	2900.22	1176

APPENDIX G

PROCEDURE FOR DETERMINING GAS COMPOSITION

AND GAS COMPOSITION DATA

1. Procedure used to determine gas composition.

Table XXXI presents the column retention times determined during preliminary testing for common components of digester gas. Retention time and mass spectrometer information was used to identify gas components. Figure 44 is a typical chromatogram obtained when analyzing the gas samples from the digesters. The areas under the peaks on chromatograms were calculated by the triangulation method. These values were used to calculate the percentage of each component gas present. Figure 45 shows the components of the characteristic mass spectrometer readout for the samples. The peak numbers shown in Figure 45 correspond to the peaks identified in Figure 44. The background profile of the mass spectrometer readout was subtracted from all other profiles to obtain a corrected mass spectrometer profile used to identify component gases.

2. Table XXXII presents the gas composition data.

TABLE XXXI

RETENTION TIMES OF COMMON DIGESTER GASES IN GAS CHROMATOGRAPH COLUMN

Gases	Column Retention Time	
	Chart Travel (cm)	Elapse Time (min)
O_2	0.6-0.7	1.0-1.2
CH_4	1.1-1.2	1.9-2.0
CO_2	2.2-2.3	3.8-3.9
H_2S	11.5-11.6	19.7-19.9

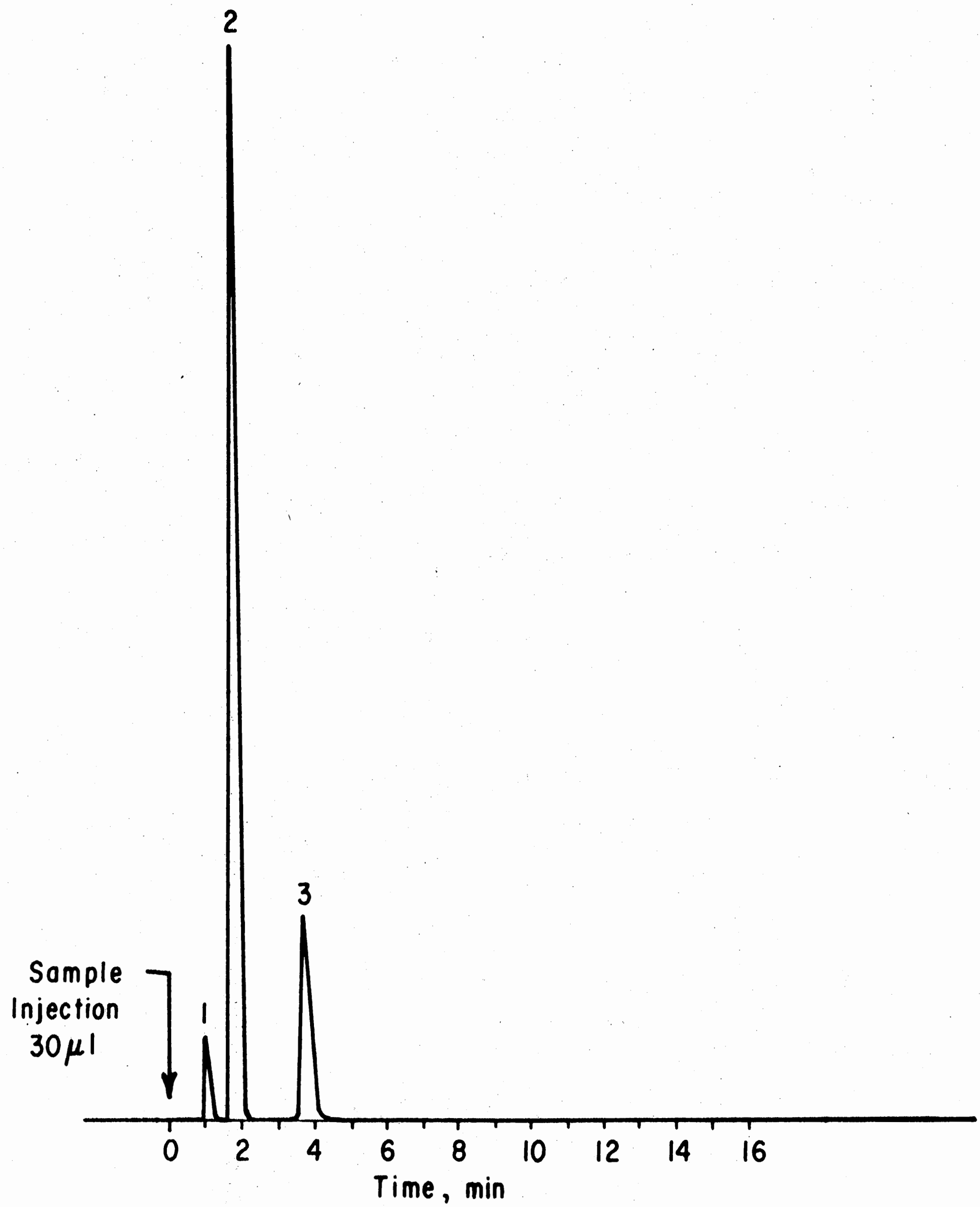

Figure 44. Typical Chromatogram for a Sample of Digester Gas

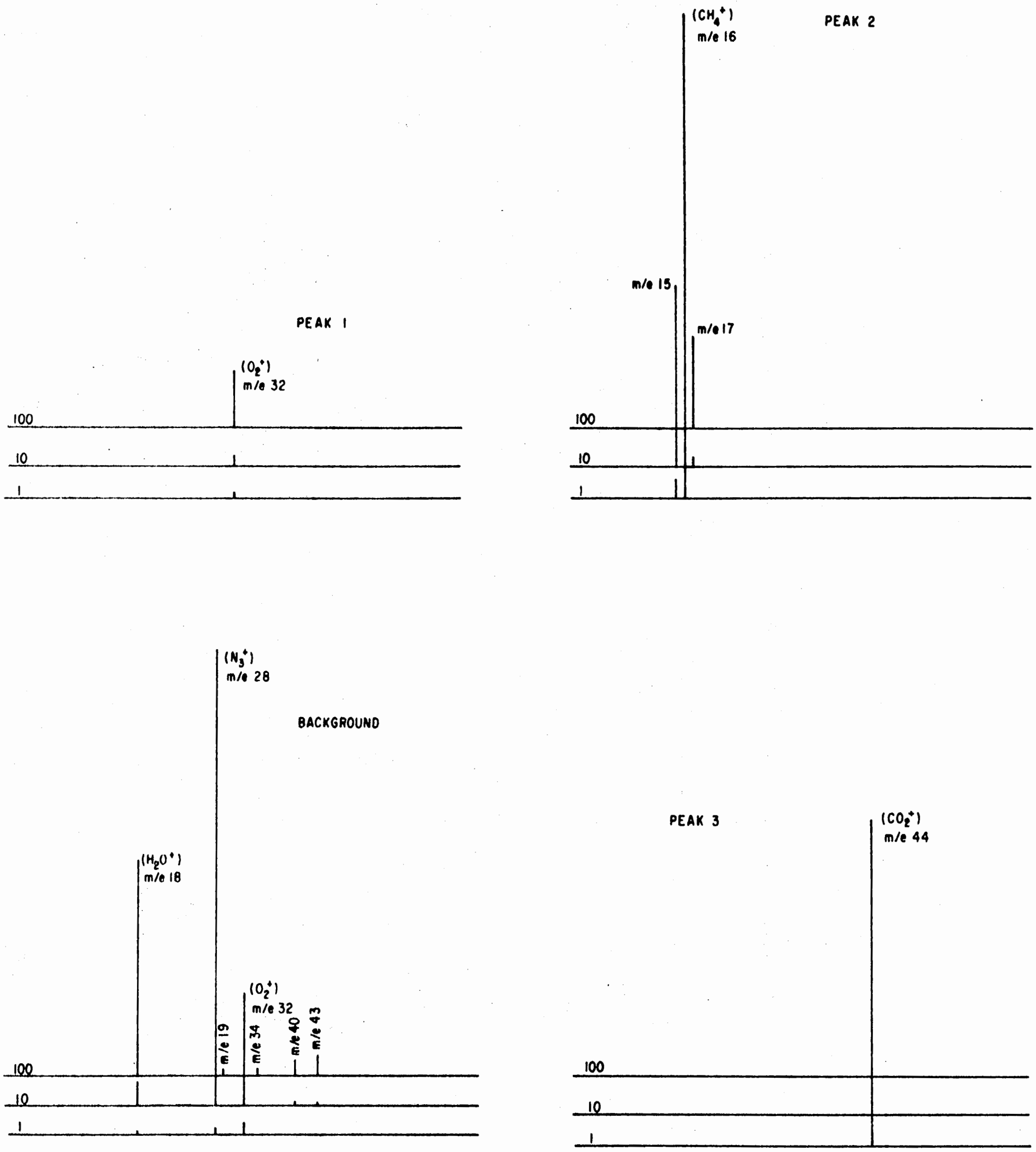

Figure 45. Characteristic Mass Spectrometer Readout for a Sample of Digester Gas

TABLE XXXII

GAS COMPOSITION DATA

Date	1/7 O_2 (%)	1/7 CH_4 (%)	1/7 CO_2 (%)	1/5 O_2 (%)	1/5 CH_4 (%)	1/5 CO_2 (%)	1/3 O_2 (%)	1/3 CH_4 (%)	1/3 CO_2 (%)	1/2 O_2 (%)	1/2 CH_4 (%)	1/2 CO_2 (%)
10/18/76	22.14	62.14	15.73	5.05	75.16	19.79	2.65	65.66	31.70	5.35	62.54	32.11
10/21/76	11.12	72.84	16.03	6.92	73.36	19.72	3.54	67.44	29.00	1.87	61.33	36.80
10/26/76	6.52	77.90	15.57	5.71	73.47	20.82	2.71	65.84	31.45	4.82	64.51	30.66
10/28/76	6.89	79.60	13.51	7.25	73.97	18.78	2.96	65.70	31.33	2.56	61.52	35.92
11/ 2/76	6.34	79.13	14.54	6.04	73.33	20.63	2.35	65.20	32.44	1.73	60.90	37.37
11/ 4/76	7.25	72.86	19.89	6.31	75.89	17.80	3.00	67.31	29.69	2.10	62.70	35.20
11/ 9/76	8.12	77.32	14.56	6.47	75.82	17.71	2.63	69.60	27.77	1.65	59.73	38.62
11/10/76	6.42	75.53	18.05	6.34	75.60	18.06	2.02	68.05	29.92	1.73	62.82	35.45

APPENDIX H

STATISTICAL ANALYSES RELATED TO GAS COMPOSITION AND LOADING RATE

1.

TABLE XXXIII

ANALYSIS OF VARIANCE OF EFFECT OF DILUTION
OR LOADING RATE ON GAS METHANE CONTENT

Source	df	SS	MS	F
Total	30	1134.7	37.8	
Dilution	3	1047.9	349.3	108.6*
Error	27	86.8	3.2	

*Indicates significance at $\alpha = 0.01$.

2. Duncan's new multiple range test for making comparisons among treatment means (Steel and Torrie, 1960).

   a. Determine

$$s_{\bar{x}} = \sqrt{(\text{error mean square})/r}$$

where: $s_{\bar{x}}$ = sample standard deviations

r = number of replications

$$s_{\bar{x}} = \sqrt{\frac{3.2}{2}\left(\frac{1}{7} + \frac{1}{8}\right)}$$

$s_{\bar{x}} = 0.65\%$ with error degrees of freedom = 27

Value of p	2	3	4
SSR	3.9	4.09	4.19
LSR	2.5	2.60	2.70

where: p = number of means for range being tested,

SSR = significant standard ranges, $\alpha = 0.01$,

LSR = least significant ranges (LSR = $s_{\bar{x}}$ x SSR).

b. Rank the means:

1/7	1/5	1/3	1/2
76.2	74.6	66.9	62.0

c. Test the differences:

1/7 - 1/2 = 14.2 > 2.7; significant

1/7 - 1/3 = 9.4 > 2.6; significant

1/7 - 1/5 = 1.6 < 2.5; not significant

1/5 - 1/2 = 12.6 > 2.6; significant

1/5 - 1/3 = 7.7 > 2.5; significant

1/3 - 1/2 = 4.8 > 2.5; significant

3. The effect of dilution or loading rate on gas methane content was described by the following polynominal regression equation.

$$MC = 85.8 - 0.016\ DLR + 0.0000026\ DLR^2 \qquad (2)$$

where,

MC = methane content, %,

DLR = daily loading rate, mg TS/ℓ of digester.

Correlation coefficient (R^2) = 0.84, and standard error = 2.50%.

Table XXXIV shows analysis of variance of regression.

TABLE XXXIV

ANALYSIS OF VARIANCE OF REGRESSION EQUATION FOR METHANE CONTENT VERSUS DAILY LOADING RATE

Source	df	SS	MS	F
Total	30	11347333.4	4796396.0	76.5*
Regression	2	9592792.1	62662.2	
Error	28	1754541.3		

*Indicates significance at $\alpha = 0.01$.

APPENDIX I

SAMPLE CALCULATIONS FOR ADJUSTING DAILY GAS PRODUCTION

Sample Calculations

Given: Feed TS = 61,000 mg TS/ℓ

Gas = 850 mℓ/ℓ of digester/day

Detention Time (DT) = 20 days

Required: (a) Daily Loading Rate (DLR)

(b) Adjusted Gas Production (AGP)

Solution: (a) Loading Rate

$$DLR = \frac{TS}{DT}$$

$$DLR = \frac{61,000}{20}$$

DLR = 3050 mg TS/ℓ of digester

(c) Adjusted Gas Production

$$AGP = Gas \times \frac{1000}{LR}$$

$$AGP = 850 \times \frac{1000}{3050}$$

AGP = 279 mℓ or 0.28 ℓ/1000 mg TS/ℓ of digester/day.

APPENDIX J

STATISTICAL ANALYSES RELATED TO GAS PRODUCTION AND LOADING RATE

TABLE XXXV

ANALYSIS OF VARIANCE OF EFFECT OF DILUTION OR LOADING RATE ON TOTAL GAS PRODUCTION[1]

Source	df	SS	MS	F
Total	8	2489	311	
Segment	1	139	139	0.45
Dilution	2	822	411	1.34
Error	5	1528	306	

[1]Total gas production values were adjusted to a common base of mℓ/1000 TS/ℓ of digester for the purpose of comparison. Data for the 1/5 and 1/2 dilutions were not included because of the lack of repetitions.

VITA[2]

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Doctor of Philosophy

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