Oleum Solutions

Final Report

Prepared for Robert Carnoske, MASA Food Truck

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I. Introduction

A. Project Background

MASA food truck is a South American fusion food truck located in Tulsa, Oklahoma. The owner, Robert Carnoske, serves empanadas, bacon bombs, and Cuban sandwiches. Mr. Carnoske cooks the empanadas and bacon bombs in his kitchen, and then freezes and stores them for future use. In the truck, he fries the frozen foods and serves them. Mr. Carnoske has asked Oleum Solutions to design a storage and filtration unit for MASA food truck. Oleum Solutions is part of a Biosystems and Agricultural Engineering senior design project at Oklahoma State University.

B. Mission Statement

Oleum Solutions strives to meet the needs of our customers with innovative, comprehensive solutions, while leaving a positive impact on the environment and community involved.

C. Problem Statement

Storing and managing hot cooking oil poses many problems, but when used in the confined spaces of a food truck, the problems are more numerous. Currently, MASA Food Truck uses two fryers that must be drained before moving the truck; the oil is drained into metal buckets that are not well insulated and must be treated with special care. The fryers are replaced about every 12 months, and fryer lids are not purchased. A secondary problem is filtering the oil to provide a longer life for the oil. Currently, there is no oil filtration system in the

MASA Food Truck. The objective for this project is to design an oil containment system that will be able to withstand the extreme temperatures of hot oil, as well as release pressure build up within the system due to the differential temperatures. The current system has a pressure release located within the lid, but an issue arises of hot oil spilling onto the food truck floor. Oil filtration is another objective of this project. MASA food truck would like to see a solution that incorporates a filtration system into the oil storage container. There will be two components to this project: oil storage and filtration.

D. Current Solution

Upon meeting the proprietor and operator of MASA food truck in Tulsa, the issues associated with storing and transporting hot cooking oil became clear. MASA prepares all of the empanadas in a separate kitchen, then freezes the empanadas to prevent waste. Fryers are used to cook the empanadas in the food truck upon reaching the destination.

Currently, conventional 40-pound kitchen fryers are used, but this leads to problems because these fryers are not made to withstand the battering that occurs while driving a food truck, and the fryers are not designed to fit inside the small spaces of the food truck. The issues with the current oil container include the gasket, the lack of pressure relief, the paint liner deteriorating, the paint, and the pail. The gasket does not stand up to the hot oil, and the lid lacks a pressure relief to prevent a vacuum. The “food grade” painted liner inside the pail does not stand up to the heat and is currently peeling off of the bucket. The paint on the

exterior of the pail also bubbles and peels, and the pail leaks where the walls meet the base of the pail.

Figure 1. Fryers currently in use

Figure 2. Current storage container

The customer would like a storage container with better insulation, handles, and seal. Ideally, the new storage container would be the same size as the current oil containers, so it can fit in the same place in the food truck.

II. Background Research

A. Patents

When searching for patents through Google Scholar, and using the term “food truck oil filtration”, several results came up that were related in some way to the design project. Many of the patents found on Google Scholar are close to what is needed for a solution, but are not exactly correct. They will, however, provide invaluable information towards the construction of the improved system. The first design found was a portable cooking oil filter apparatus (United States of America Patent No. 5,340,471, 1994), shown in Figure 3.

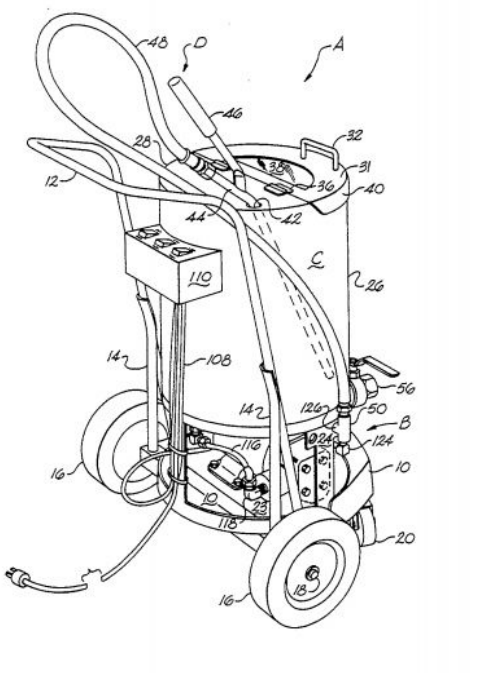

Figure 3. Patent 1- portable cooking oil filter

The design uses a container to store the used oil, a filtration system to filter the food particles out of the oil, as well as a pressurized system to pump either dirty oil out of the truck or clean oil back into the fryer. The design has a frame with wheels attached to it so that the system can be portable into and out of a restaurant. The patent description also included how the team took safety measures when dealing with moving and filtering the hot oil. Mostly these safety measures included reinforcing the areas that will be handled by the person operating the portable cooking oil filtration apparatus. The system also contains a sealable lid to keep the oil from spilling out during transportation. This patent is favorable because it discusses and describes several very important obstacles to the food truck industry. The most important feature of this patent is that it is a movable tank that can store used cooking oil from a deep fryer. Dealing with hot oil from the fryer is also a concern, and this patent addresses how they were able to overcome those issues. The sealable lid is a positive from this patent design. This patent is not favorable because of the size of the apparatus. The design is meant to be wheeled into a restaurant, set down next to the fryers, used, and then wheeled out again. In a full sized restaurant, using this non-permanent oil filtration system that will be gone after it is used, the size of the apparatus does not matter. In a food truck, size is the most important factor due to there being an extremely limited area to work in. The wheels on the tank are an easy way to transport the oil once it has been drained into the system, however, in a food

truck the container should not move once the truck is mobile. This is an easy solution to fix, as the wheels can be fitted with a locking mechanism, or the oil container can be detachable from the frame and the wheels so that the oil can be dumped out without worrying about the frame. This patent overall is very useful for the MASA food truck system.

The second patent that was related to the MASA Food truck project was a cooking oil storage and filtration system (United States of America Patent No. US 2015/0101972 A1, 2015) shown in Figure 4.

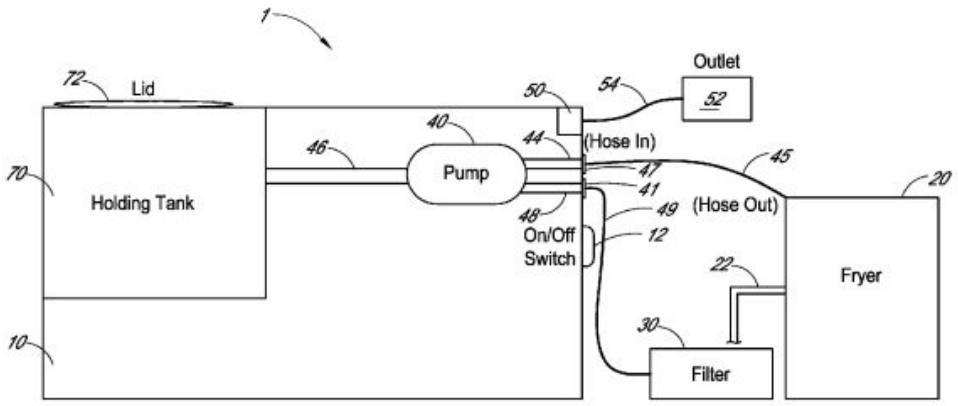

Figure 4. Patent 2- cooking oil storage and filtration system

Figure 4 shows the entire setup of the storage and filtration system, as well as the fryer itself. The most relevant point of this patent is the holding tank of the oil. The holding tank is contained within another container so that if there are any leaks from the holding tank, the oil does not splash everywhere. This is a big concern with the MASA food truck because when oil leaks in the truck, it slows

the whole operation down due to the time it takes to clean the food truck. This time could be better used to make empanadas, and therefore money, instead of cleaning oil.

The third patent found is useful in the fact that it details an oil storage tank that would be small enough to fit inside of a food truck. Figure 5 shows the grease tank and grease inlet for storing and securing oil (United States of America Patent No. US 6,227,405 B1, 2001).

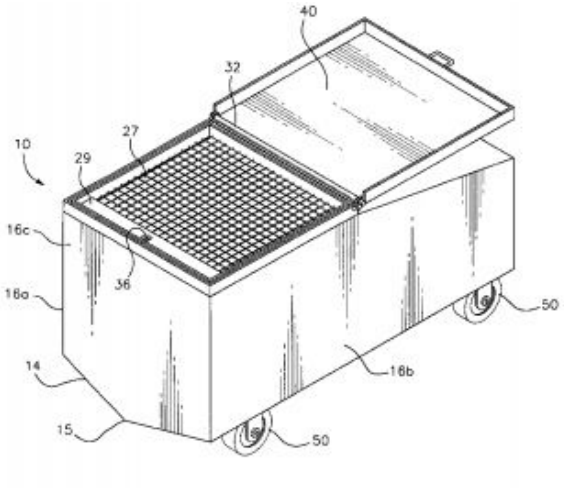

Figure 5. Patent 3- small oil tank

This design is useful because it illustrates a new form of containment system for cooking oil. This design allows for a tight seal so the oil does not spill and the O-ring that seals the oil is not exposed to the hot oil once it is in the container. The overall design of the container would not be useful due to the shape and the size; it would fit very awkwardly into a food truck.

The fourth patent found for the MASA food truck design project is the cooking oil storage and filtration system (United State of America Patent No.

US6,355,168B1, 2002). Figure 6 illustrates how mesh strainers and gravity are used to filter the cooking oil. This would be a cheap and easy way to filter the oil while inside the truck, but it is not a very space conscious design.

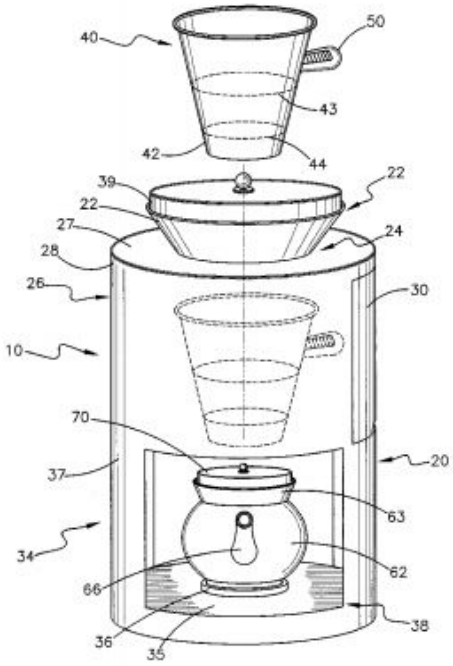

Figure 6. Patent 4- gravity fed system

Figure 7 shows a gravity fed filtration system similar to Figure 5. This system is a newer system than Figure 6 and is much more compact in size. Knowing that the gravity filtration system is not an outdated way to filter oil, adds another option to the design of our system. Also knowing that a smaller gravity filtered system is feasible is beneficial due to the fact that a food truck will have a limited amount of space.

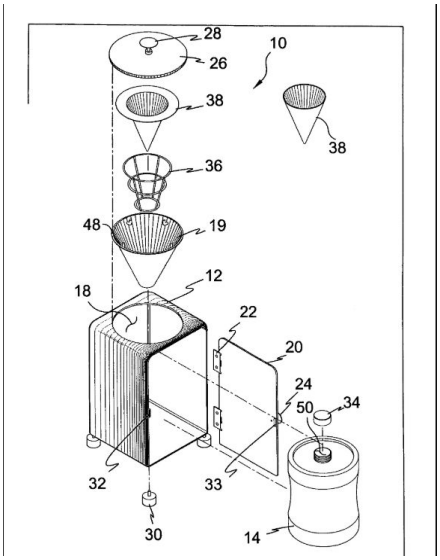

Figure 7. Patent 5- countertop gravity fed system

B. Filters

Filtering oil is necessary from more of a quality aspect than a food safety aspect. After oil has been used for a while, it can change the taste and texture of a product. Blumenthal's frying oil quality curve shows how the time the oil is heated affects the quality of the product (Fig 7).

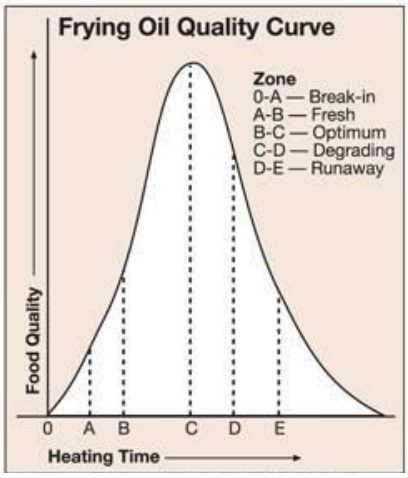

Figure 7. Blumenthal's frying oil quality curve

In general, there are two types of oil filtration systems: active and passive. The active systems remove certain oil soluble components from the oil. Passive systems only remove residual particles in the oil, mainly by the use of gravity. Examples of passive systems include screens, paper filters, and cloth filters (Stier, 2007). Both of these methods can help extend the usage time of the oil as well as the quality of it. Table 4 of Appendix H displays filters used for filtering cooking oil.

C. Food Safety Issues

It is recommended by the USDA to strain oil through cheesecloth or a sieve if the oil is going to be reused. Once it is filtered, it needs to be stored in a "sealed and light proof container" for up to 3 months maximum (USDA, 2012). USDA recommends that for best quality, the oil should be stored in a refrigerated area. Once the oil starts to be clouded, smell, or taste bad, it should be properly discarded.

In terms of the storage container, the FDA has regulations in place about the surface of the container since it is a food contact surface. According to the FDA Food Code 2017, food contact surfaces must be smooth, free of breaks, free of sharp internal angles, and finished to have smooth welds and joints.

The Oklahoma Department of Health Section 310:257 Subchapter 17 includes information about Mobile Food Establishment, but food trucks are held to the same standards as normal restaurants. Normal restaurants are defined in the Oklahoma Department of Health in Title 310 chapter 257, and storage

information is specifically in subchapter 7 (Oklahoma Department of Health, 2016).

Job hazards are anything at work with the potential to harm a worker either physically or mentally. This includes safety hazards, ergonomic hazards, and other health hazards. Safety hazards cause immediate accidents and injuries caused usually by equipment like knives and ovens. Ergonomic hazards cause sprains and strains caused by heavy lifting or repetitive tasks. Other health hazards include conditions that make you sick like noise, chemicals, heat, and stress.

The type of burn that is a possible safety hazard in the food truck is thermal burn. According to Occupational Safety and Health Administration (OSHA), thermal burns can be prevented by wearing personal protective equipment, using fire prevention tactics, and by having procedures and emergency action plans related to fire detection and protection. In this setting, personal protective equipment needed will be face, eye, and hand protection when dealing with hot oil and hot surfaces. Fire prevention tactics would include fire detection, job site hazards, and response equipment, and emergency action plans require step-by-step instructions for if a fire breaks out in the food truck. It is also important to keep the oil temperature below the smoke point so the oil does not burn and create smoke causing smoke inhalation.

Slips, trips, and falls are the second leading cause of workplace accidents behind motor vehicles according to OSHA. Slips are caused by too little friction or

traction between feet or footware and the walking or working surface. Common causes of slips in a restaurant are water, grease, oil, and food.Tripping is defined by foot or lower leg hitting the object as the upper body continues moving or stepping down to lower surface and losing balance. Trips are usually caused by uncovered hoses, cables, wire extension, irregularities in walking surface, and more. To diminish the risk of trips and slips, it is important to keep the food truck clean and organized, wear the right clothing and footwear, and practice safe walking practices.The most relevant parts of Title 310 Chapter 257 are listed in the Appendix G.

D. Oil

According to the oil spec sheet for a Frymaster® MJ35 40 lb fryer (Appendix A), the fryer can hold 15-20 liters of oil (4-5.3 gallons). In the MASA food truck there are two 40 lb fryers, so the maximum amount of oil to be stored from the fryers at one time would be about 12 gallons. There would potentially be a need for extra storage so there is more oil to add to the fryers if needed. The owner of MASA needs to be consulted to know how much extra oil is added and would need to be stored outside of the 12 gallons.

The density of different types of oils at a range of temperatures are listed in Appendix B. Data from the Physics Textbook accessed via hypertext, lists densities for oil that fall within the same ranges as listed by the University of Nebraska. The highest density listed in the table of densities from the University

of Nebraska Lincoln is 0.9398 g/ml. Assuming 40 liters of oil, the weight would be 82.70 pounds.

$$0.9398\frac{g}{mL}\left(\frac{1000\ mL}{1\ L}\right)(40\ L)\left(\frac{0.0022\ lb}{1\ g}\right) = 82.70\ lb$$

Eq. 1

E. Weight

The limiting factor for the weight of the equipment being designed is based on the person handling said equipment. Assuming that the person handling the equipment is someone of average strength, and taking into account the fact the buckets may have to be lifted and moved multiple times throughout the day, the oil storage equipment should not exceed 51 pounds. This value comes from the NIOSH lifting recommendations (Appendix C) for a typical industrial worker, occasionally lifting an object with no twisting of the back. These specifications allow for each storage container, filled with oil, to weigh 51 pounds. Assuming that there would be two containers each holding 41 pounds of oil, the container systems themselves could weigh 10 pounds, with a maximum weight of 15 pounds. The weight of the fryers is not a concern as they are not removed from the truck daily.

F. Fryers

Table 1 is a compilation of information from the spec sheets for four different 40 pound fryers. For each one, the material, fryer area, overall dimensions of the fryer, oil holding capacity in pounds and liters, and the gas

input rate are displayed. These values are being used to help design fryer solutions for the MASA food truck. Since the owner changes fryers every 15 months, it is important to look at the specifications of several different fryers. The spec sheet for the fryers are found in Appendix A and Appendixes D-F.

Table 1: Dimensions for Oil Fryers in the Market

			Dimensions				
Company	**Model**	**Material**	**Fryer Area**	**Overall Dimension**	**Oil Capacity (lbs)**	**Oil Capacity (L)**	**Gas Input Rate (BTU/hr)**
Pitco	40D	Stainless Steel	14" x 14"	15.5" w x 30.5" l x 45.75" h	40-45	22	107000
Imperial	IFS-40	Stainless Steel	14" x 14"	15.652" w x 31.5" l x 46" h	40	22	105000
Frymaster	MJ35	Stainless Steel	12" x 15"	15.5" w x 33.25" l x 45.75" h	30-40	15-20	110000
Atosa	ATFS-40	Stainless Steel	14" x 14"	15.6" w x 30.1" l x 44.4" h	40	22	102000

III. Project Tasks and Schedule

A. Work breakdown structure

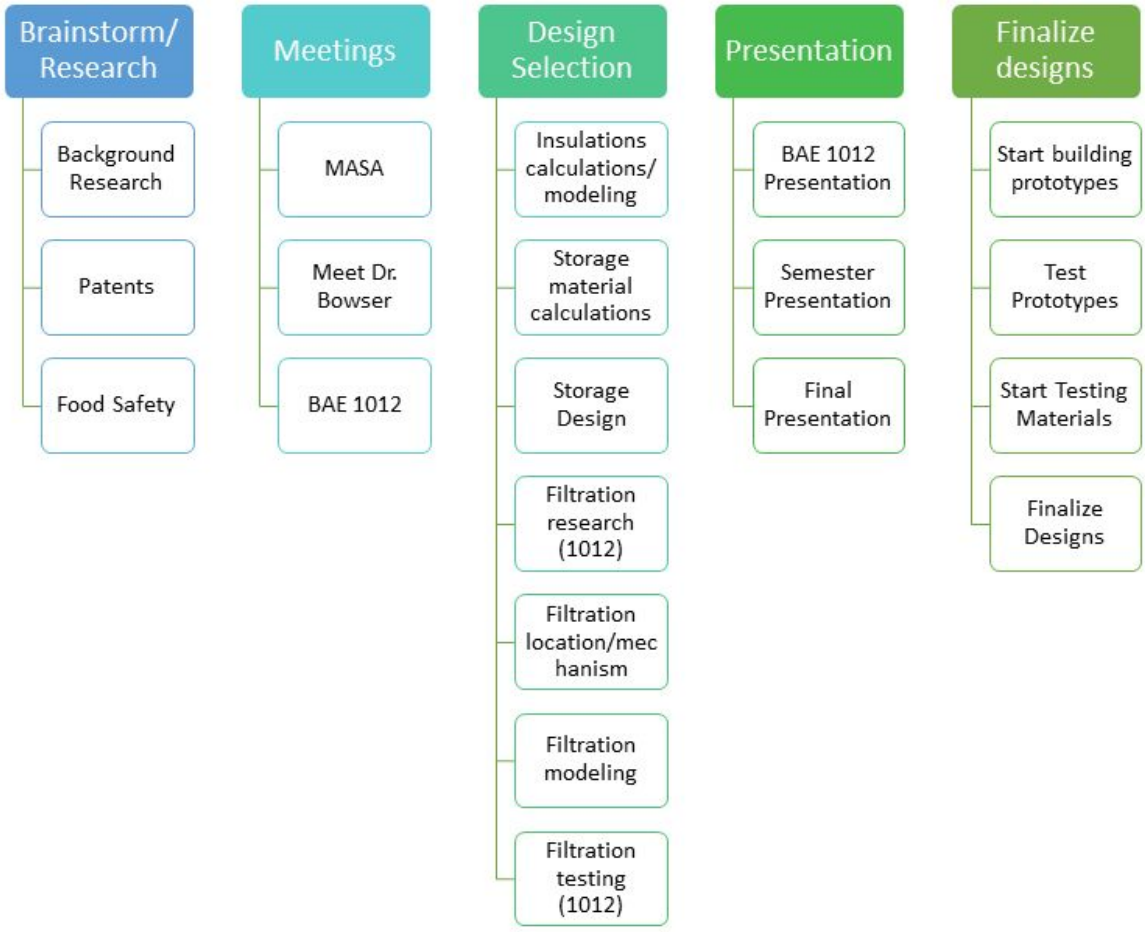

Figure 8. Work Breakdown Structure

B. Gantt Chart

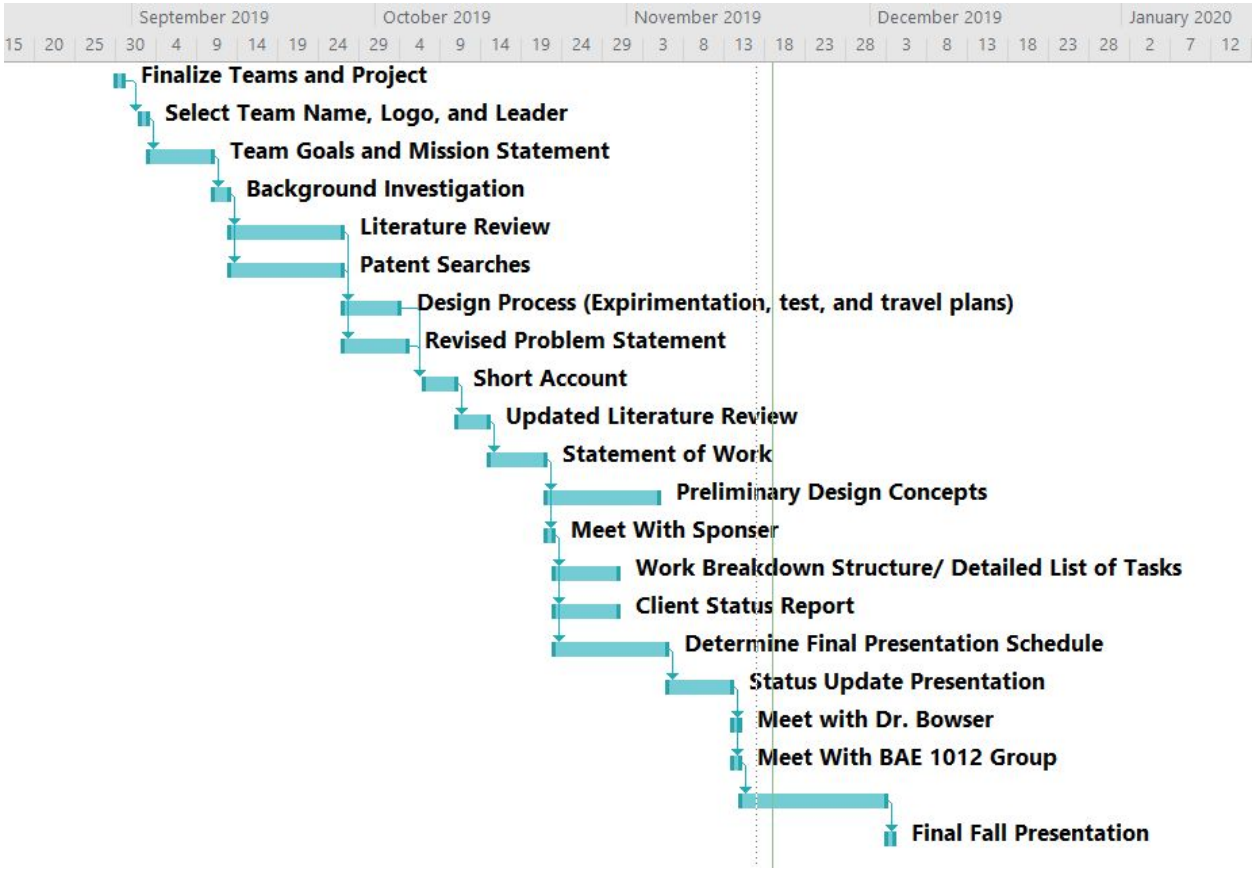

Figure 9. Gantt Chart Fall Semester

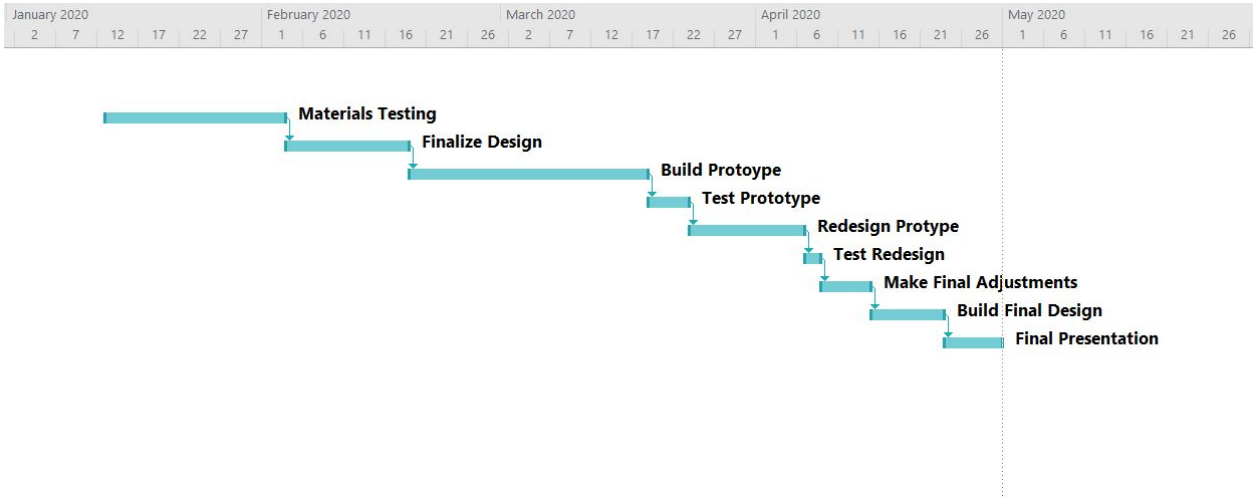

Figure 10. Gantt Spring Semester

Figures 9 and 10 are Gantt charts depicting the due dates set either by Dr. Weckler or ourselves for the Fall and Spring Semester. These schedules are subject to change.

IV. Generation of Concept Designs

The design concepts aim to solve the problem presented: storing, filtering, and maintaining hot oil in the confined spaces of a food truck. In order to do this, several solutions were considered and evaluated. Three main levels were proposed in the Fall of 2019: most expensive and comprehensive, less expensive, and the cheapest most basic solution.

The most expensive and comprehensive solution included an adjustable fryer lid and a storage container with a pump for filtration included. Teflon™ tubing connects to the oil outlet of the fryer and pumps the oil out using a gear pump. A gear pump is ideal for this solution because they are food safe, relatively inexpensive, and can withstand the heat of the oil. The oil is pumped through a filtration system to purify the oil. The filtration system would be integrated in the system, and the oil must pass through the filter before entering the storage container. The storage container size is determined by the amount of space available in the food truck, and by the weight limits determined from the NIOSH recommendations previously mentioned.

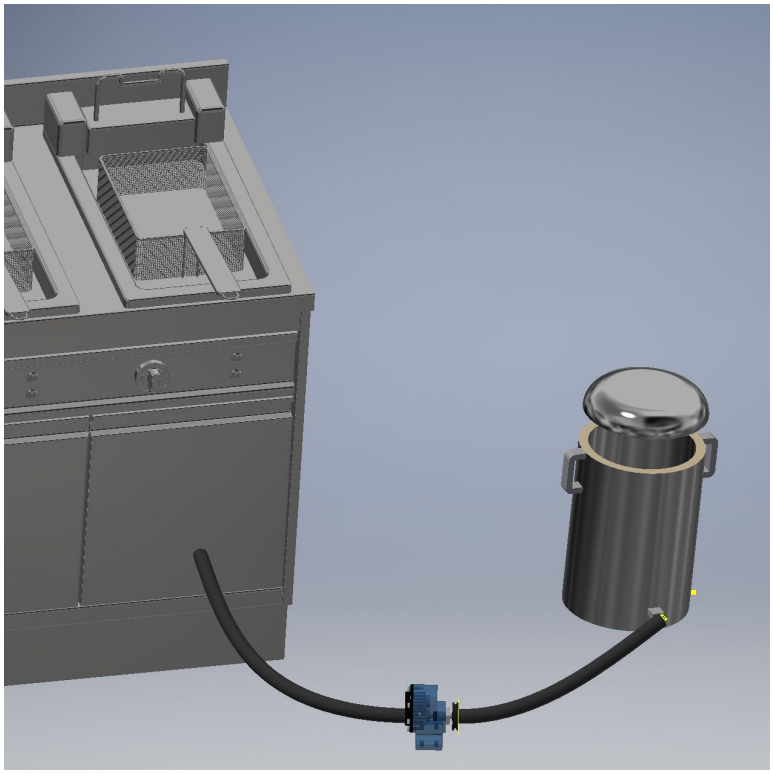

Figure 11. High tier option designed in Inventor

The mid-tier option included filtration and storage mechanism, and potentially a fryer lid depending on the cost. This filtration method would not include a pump and would rely on gravity to get the oil through the filter.

The most cost effective option will address the most basic problem faced in the food truck: the oil storage. This option contains only a storage solution that is better than the current storage solution in place in the food truck.

A. Lid

One problem currently faced in MASA food truck, is the lack of a lid for the fryers. Lids are not purchased with the fryers because new fryers are purchased every year to every year and a half. This means any lids purchased for specific fryers will become obsolete when the new fryers are purchased. To address this

problem, the lid designed must be adjustable to fit various sizes of fryers. Two solutions were proposed to solve this particular issue: a sliding size changing lid and a lid with a pneumatic seal.

The sliding size changing lid would function similar to a table with a leaf insert option. Pulling apart the lid would allow the user to insert an additional piece of the lid to change the size to fit the fryer.

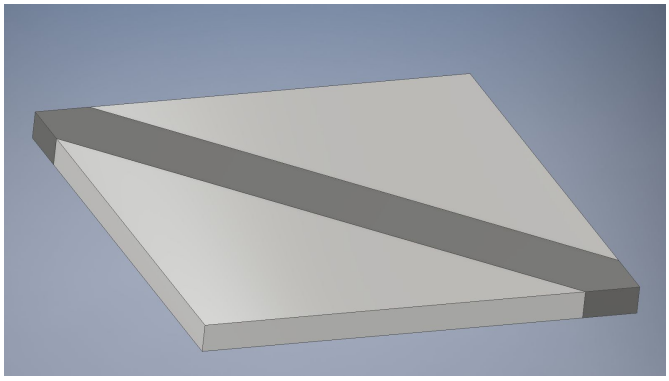

Figure 12. Medium tier lid option designed in Inventor with "leaf"

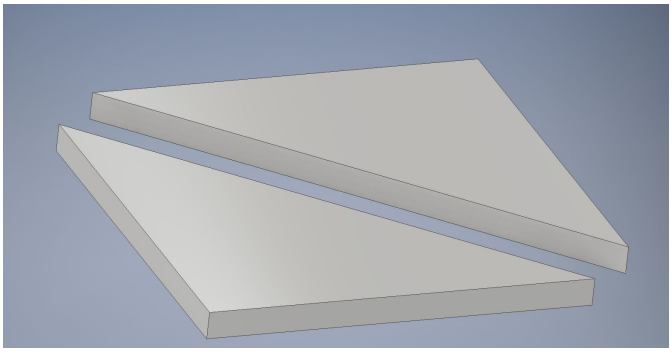

Figure 13.Middle tier option designed in Inventor without "leaf"

A pneumatic seal would contain a piece of metal surrounded by rubber that can inflate and deflate to fit the exposed area of the fryer. This would allow more or less air to be added to the tubing to allow the lid to fit a variety of fryers.

The pneumatic lid would require an inexpensive pump to be connected to the rubber tubing. Pneumatic seals are sometimes used in the food industry with some examples being their use in seals for smokehouse doors and seals for lids on wine fermenters (Pawling Engineered Products, 2012). Pneumatic seals can be made from various types of rubber, several of which are food safe. Special consideration must be given to the design of the corners of the seal as well as to the pressure differentials.

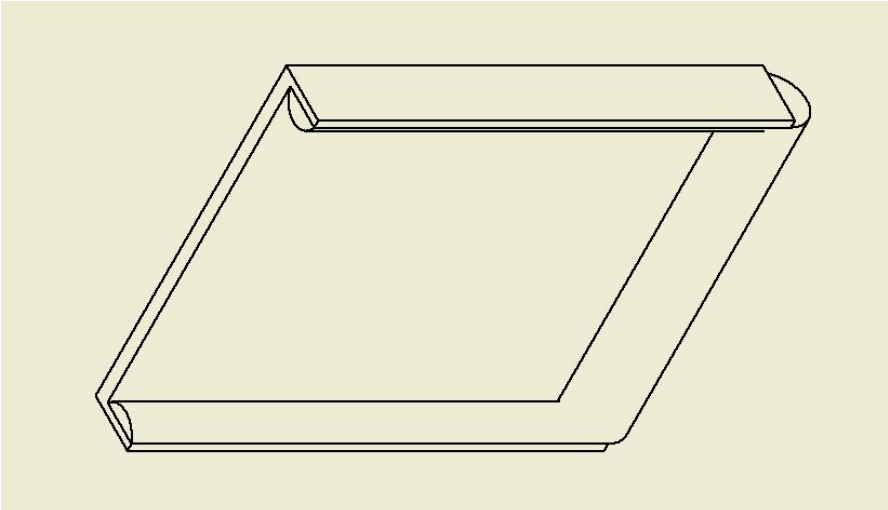

Figure 14. High tier lid option designed in Inventor from underneath

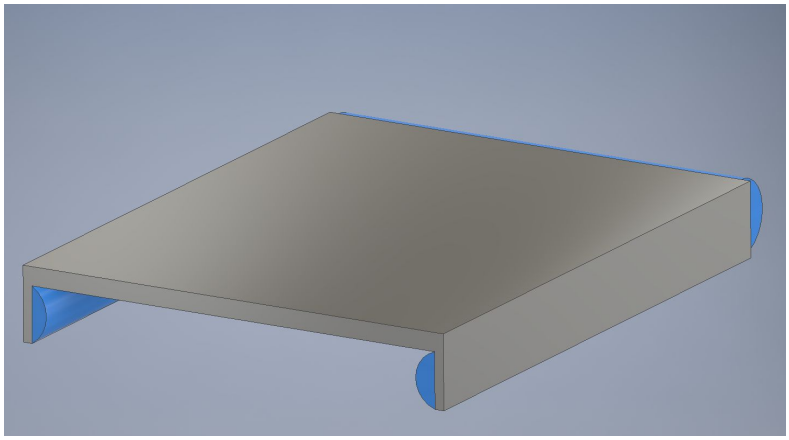

Figure 15. High tier lid option designed in Inventor from the top

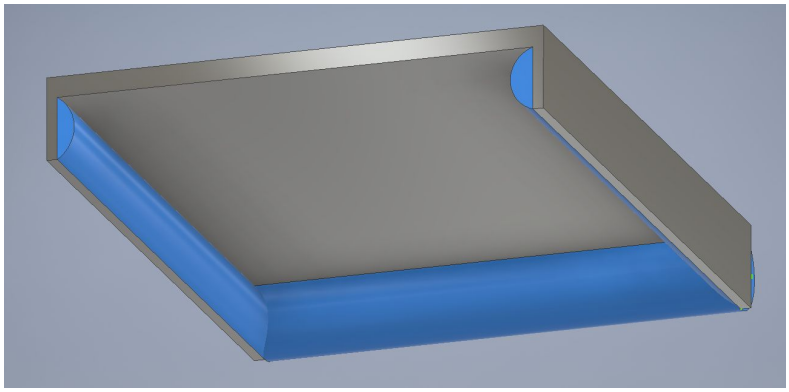

Figure 16. High tier lid option designed in Inventor from underneath

B. Storage

The storage container is the most essential part of any solution proposed for the problem. Since the current storage container is not fulfilling the needs of the MASA food truck, a better one must be designed. The improved storage container will be made of a material that can withstand the high temperatures of the cooking oil. Since the oil is used for cooking, the material must also be food safe to satisfy food safety laws. As calculated in early portions of the report (page 16), the storage container must be able to hold at least 24 gallons of oil. The amount of oil to be stored was determined by calculating the amount of oil in one fryer and doubling that value since there are two fryers.

Table 2: Materials for Storage Container

Material	Cost ($/lb)	Density (g/cm^3)	Melting Point	Thermal Conductivity
Polyethylene Terephthalate (PET)	0.85	1.37	240	0.4
Stainless Steel	1.63	7.98	2750	16.3
Aluminum	1.56	2.7	1220	237
Copper	2.68	8.96	1900	401

Table 2 shows several different materials that were considered for the construction of the storage container. Important factors for the comparison of the materials are cost, density, melting point and thermal conductivity. The melting point of the material must be above the temperature of the hot oil. If the system included a cooling system for the oil before it reached the storage container, then a lower melting point would be acceptable. Currently, the storage container was designed with a temperature of the hot oil being around 375 degrees Fahrenheit, excluding the PET from being a viable option. Thermal conductivity is an important consideration because it determines how hot the outside of the storage container will be. The higher the thermal conductivity, the hotter the outside of the container will be.

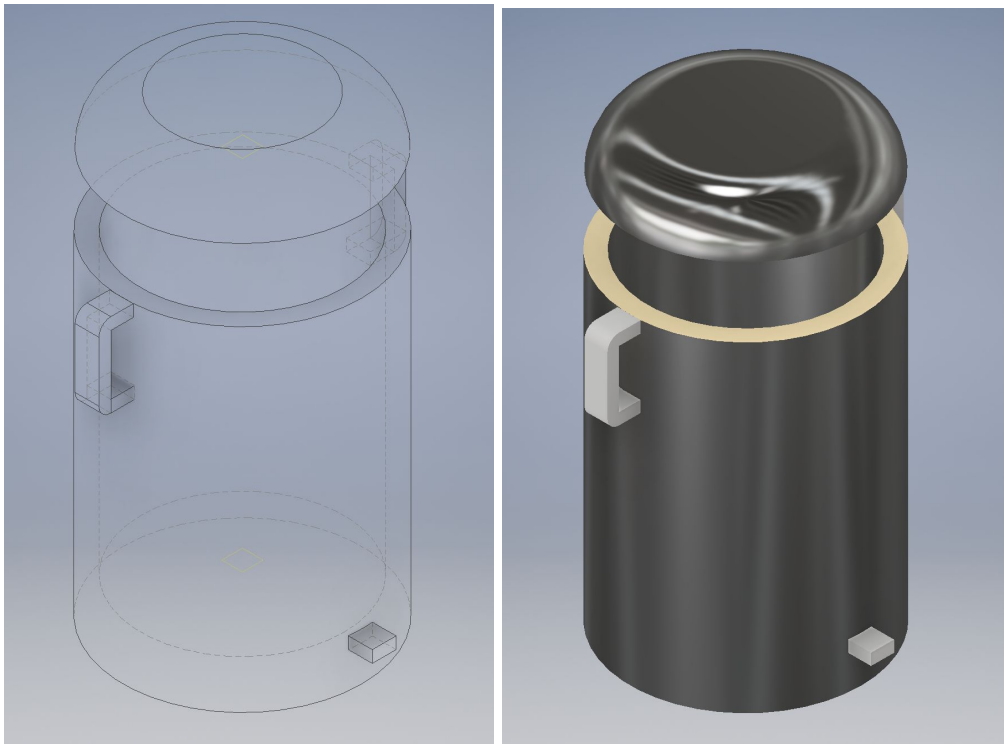

Figure 17. Storage container designed in Inventor

Another storage solution is to modify an already existing container. This solution is not included in the Fall 2019 report or the tiers that were presented to the client. This option was explored during Spring 2020. The team researched stainless steel containers that were approximately the same size as the current container. This included steel drums, kegs, stock pots, pails, fermenters, and milk transporters. Price, material, size, and ease of modifying, were big factors in selecting containers. A fermentor and a milk transporter were selected as the best options for a pre-made container. For these two containers, a breather valve would need to be installed.

Different insulation types were considered for the storage container. At first, a “koozie” design was the primary option, but after exploring material options, a closed-cell user friendly option was not found. With the guidance of Dr. Bowser, ceramic spray-on insulations were also researched. Finding pricing and specifications for these sprays proved to be difficult.

C. Seal for Container

The seal can be made from one of four different FDA approved materials: Silicone Rubber, Nitrile Rubber, EPDM Rubber, and Neoprene Rubber. Silicone rubber has the highest temperature range of the aforementioned FDA approved seals. With a temperature range from - 450 degrees Fahrenheit to 500 degrees Fahrenheit. The other rubber seals are only approved, at the highest, to 250 degrees Fahrenheit. These temperatures do not even come close to the temperature that MASA food truck fries their empanadas at, which is at 375

degrees Fahrenheit. The seal that is on MASA's current container is failing due to the high temperature at which the cooking oil is drained into the container. The current seal is most likely one of the materials that can't withstand temperatures higher than 250 degrees Fahrenheit and is therefore failing. The specific material that will be used for Oleum Solution's design is a material called Gylon®. Gylon® is sold in flat gaskets or in strips of tubing with adhesive already applied to the back side of the seal. Having the adhesive already on the back of the seal will make it very convenient to apply when assembling the prototype of the design.

The Parker O-ring Handbook was used to find more information regarding O-ring, the materials O-rings are made of, as well as how O-rings can fail. According to the Parker O-Ring Handbook, O-rings are a type of sealing mechanism used to stop the loss of gasses or fluids from a sealed container. O-rings are usually donut shaped and can be made from thermoplastics (Parker Hannifin Corporation, 2018). O-rings are beneficial because they can withstand a large variety of pressures, as well as temperatures. If a failure occurs in an O-ring, the failure is easy to identify, and the O-ring itself is easy to replace. O-rings work by having the pressure from inside the container push the rubber O-ring outwards to seal any gaps between the lid and body of a container. When considering using an O-ring to seal a container, it is important to know that the size and shape of the groove that the O-ring fits into doesn't matter so long as the container is able to produce the proper seal. Another important factor to be aware of when using an O-ring is that many times an O-ring will fail from

abrasion to the material it is made from. The edges of the lid and container should be smooth so that no sharp corners can damage the O-ring. Table 1-1 in the Parker O-ring Handbook compares O-rings to flat gaskets. O-rings can be used for static and moving applications, and O-rings have small space requirements to fit in a groove. Flat gaskets can only be used for static applications and require a large groove to fit into when compared to O-ring (Parker Hannifin Corporation, 2018). For the different materials that can be used for an O-ring, silicone-rubber has the highest temperature tolerance of all the materials. When an O-ring is exposed to high temperatures, physical changes cause the material to expand outward. These physical changes are mostly reversible, however, the chemical changes that happen to the ring are not reversible. The chemical changes to the material occur slowly and can change the hardness of the material. This change in hardness can affect the elasticity of the material and cause the seal quality to decrease over time. Proper maintenance and replacement of the O-ring is recommended for the best seal quality. O-rings have many advantages to them, and are one of the best sealant options for containers so long as the O-ring is maintained throughout its life and replaced when necessary.

Figure 18. Storage container designed in Inventor

D. Filtration & BAE 1012

The BAE 1012 Freshmen class was tasked with testing different methods of filtration to try and recommend the best kind of material to put in the system. To accomplish this, the freshmen team made a tri-blend oil mix, heated it, and poured it through four different materials. In order to quantify the effectiveness of each filter, increasing weights of bread crumbs and flour were added to the hot oil. The four filters tested were coffee filters, cheese cloth, wire mesh, and carbon filters. The weight of the filters were recorded before and after the addition of each oil mixture to quantify the amount of particulate filtered by the filters.

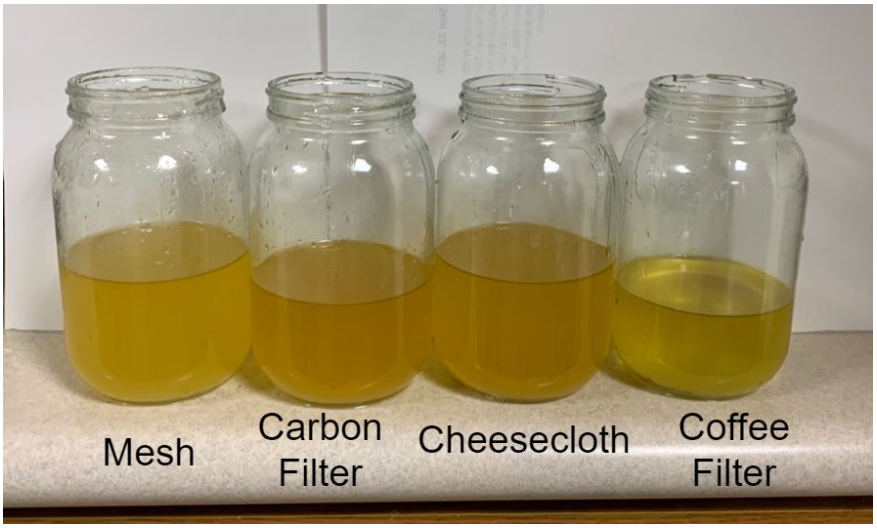

Figure 19. Oil testing results

The oil pictured in Figure 19 shows the results from the four filters (from left to right: metal mesh, carbon filter, cheesecloth, coffee filter) after the oil was poured through the filters. The coffee filter resulted in the cleanest looking oil and the greatest percentage weight of particulates removed, but took too long to be considered for use in the design. The second clearest cooking oil is the oil filtered through the metal mesh. Figure 20 shows the amount of time each filter took to have the oil drain through it. This was considered because the best filter for the system must be able to filter efficiently and quickly. Figure 21 shows the weight of the filters after having pure clean oil poured through them and the weight after having oil with particles poured through them. The weight captured by the filter provides insight into how much oil is being caught and retained in the filter as well as what percentage of the particles are being removed.

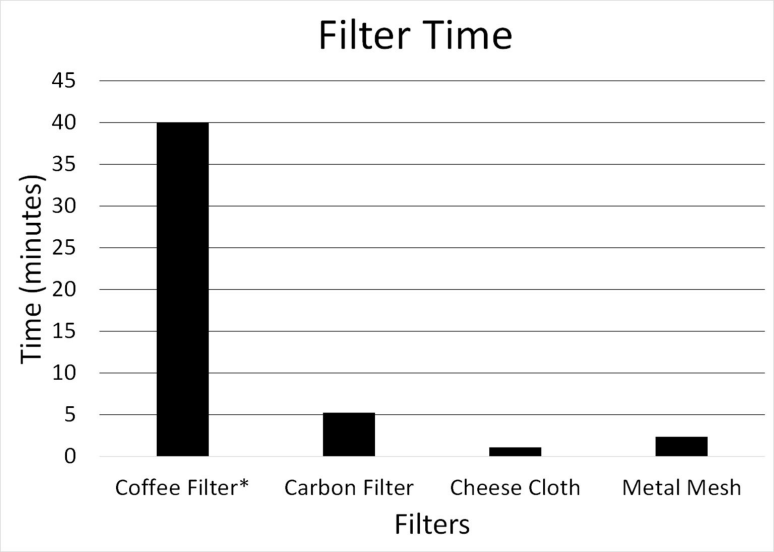

Figure 20. Oil testing time results

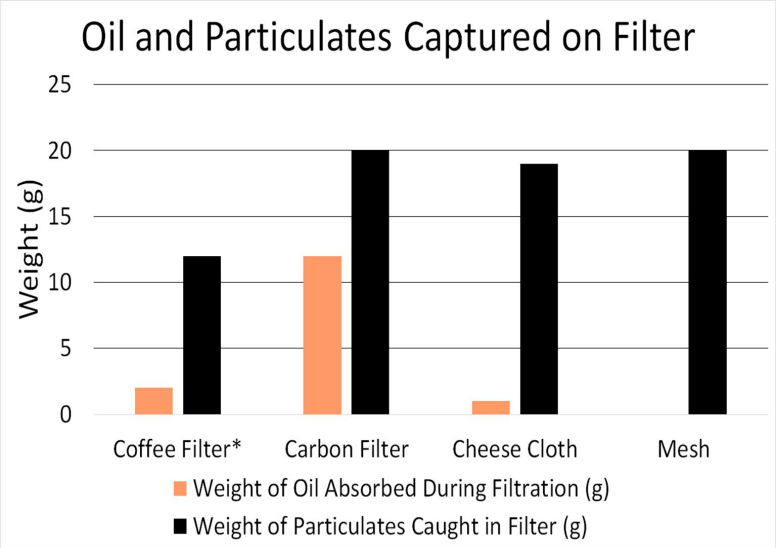

Figure 21. Oil testing weight results

Gear pumps, centrifugal pumps, and pressure pumps are the three options for the pump included in the filtration unit. The pump needs to be low cost, have sufficient head pressure to overcome filters, be corrosion resistant, temperature compatible, and be FDA grade. Cheap options can be found for gear pumps, and processing hot oil

does not tend to cause a problem. A lot of fryer pumps are gear pumps. Centrifugal pumps that process hot oil tend to be more expensive, but they are easy to maintain and compact. There are many options for pressure pumps, but most options are for water, There are various pressure pumps that can withstand high heat. A small air pump is also needed for the pneumatic seal. The air pump is used to fill and empty air in the pneumatic seal.

To connect the pump, the filter, and the container a tubing or hose needs to be made with a food-grade Teflon™ material to withstand the heat of boiling oil. Teflon™ can endure temperatures of up to 500 degrees Fahrenheit. The tubing will be between 5-10 feet and Teflon™ is also fairly flexible, which is necessary when working in a food truck.

E. Budget (2019)

In December 2019, three options were presented to the client including three different tiers. As mentioned before, the high tier will include a lid for the fryer, a storage container, and a pump for filtration. The middle tier will include a storage container and a lid for the fryer. The low tier will only include a storage container. Lower tiers will also include different materials to reduce cost. Table 3 displays an estimated budget for the three tiers and Table 4 shows a breakdown list of parts with prices. The high tier includes a pneumatic seal in its budget. The tiers are displayed in the tables below.

Table 3: High Tier, Medium Tier, & Low Tier Budgets

Part	High Tier	Mid Tier	Low Tier
Lid	$200.00	$125.00	-
Storage Container	$300.00	$300.00	$300
Seal	$150.00	$100	$100
Supplies	$200.00	$200	$150
Pump for seal	$30.00		-
Pump	$400.00	-	-
Total	$1,280.00	$725.00	$550.00
Total + 30%	$1,664.00	$942.50	$715.00

Table 4: Possible Parts and Materials

Part	Category	Min Price ($)	Max Price ($)
Gear Pump	Pump	$50.00	$3,000.00
Centrifugal Pump	Pump	$430.00	$35,000.00
Fryer Pump	Pump	$250.00	$500.00
Small Air Pump	Pump/Lid	$10.00	$70.00
NBR	Tubing	$3.00/ft	$13/foot
Teflon™	Tubing	1.83/ft	$3.00/ft
Gylon Silicone Rubber	Seal	$100.00	$100.00
Nitrile Rubber	Seal	$8.00	$30.00
EPDM Rubber	Seal	$3.00	$70.00
Neoprene Rubber	Seal	$10.00	$30.00
Stainless Steel	Storage/Lid	$300.00	$600.00
PET	Storage/Lid	$0.85/lb	$1.375/lb
Aluminum	Storage/Lid	$1.56/lb	N/A
Copper	Storage/Lid	$2.68/lb	N/A
Lever Lock Ring	Lid/Storage	$3.72	$34.00
Latches	Lid/Storage	$6.04/ 4 pk	$24/ latch
Pneumatic Seal	Seal	N/A	N/A

V. Selection of Designs

The design of the container was tailored specifically to the wishes of MASA Food Truck. Mr. Carnoske wanted the total cost of the project to remain at or below $500. To achieve this goal, a container that was already prefabricated was necessary to minimize the cost of materials. When considering designing a container, the steel was one of the most expensive pieces of the project. The milk transport container that was purchased is made out of food grade stainless steel, and is a thick enough gage that it will be able to withstand the temperature of the hot cooking oil. Another requirement for the MASA food truck was for the container to have sufficient hand holds in order to be lifted and moved easily. The milk container has two side handles, a bail handle, and a handle at the bottom of the container for ease of lifting. The milk container was able to meet the required specifications while staying well within the price range (Appendix I). The strainer for the oil filtration was selected based simply on how closely the diameter of the strainer matches the diameter of the milk container's opening. Selecting a strainer the same size as the milk container opening ensured the strainer would fit securely within the mouth of the milk container. The strainer was also selected so that a fine wire mesh could be attached to the strainer with as little modification to the strainer as possible. The strainer can be found in Appendix J. Another component needed is a breather vent, or relief valve, for the milk container. After conducting research, a ¾ inch pneumatic breather valve by speedaire was selected. The breather

vent will allow the necessary amount of air to flow between the container and the atmosphere to prevent a vacuum in the container, while still being an affordable option.

The insulation was one of the more difficult portions of selecting the design. Rubber and ceramic fiber materials were considered to begin with. These materials were problematic due to their low heat resistances and high porosity. Dr. Bowser suggested the use of ceramic spray on insulation. Spray on insulation would allow the insulation to be applied to the entire surface of the milk container, as well as being resistant to liquids, as it is not a fiber. Costs of materials from the larger, industrial suppliers were too high on all of the options found to be a good fit for the final design. More research was done for spray on insulation, and LizardSkin™ was found. LizardSkin™ is significantly cheaper than other spray on ceramic insulation, while still maintaining comparable heat resistance. The downside to LizardSkin™ is that a special sprayer must also be purchased in order to apply the product, but it was determined that the benefit of LizardSkin outweighed the additional cost of the sprayer. The spec sheet for Lizard Skin is found in Appendix K. Designs for this project were selected in order to maximize the specifications of MASA Food Truck while minimizing the total cost of the project. Table 5 displays the final list and cost of materials.

Table 5: Final Cost

Part	Price	Multiplied by 2
Storage Container	$135.20	$270.40
Insulation	$104.50	$104.50
Pressure Relief Valve	$5.22	$10.44
Supplies	N/A	N/A
Sum	$244.92	$385.34

VI. Fabrication and Validation

Once the design selections were made, they needed to be tested in order to ensure they were the best solution for the problem. In order to test the milk container, oil was heated in a 40 pound fryer to 300 degrees fahrenheit, then emptied into the milk container. The outside surface temperature of the milk container was taken periodically to assess what kind of insulation would be needed. The temperature of the outside surface increased from room temperature to about 270 degrees fahrenheit, indicating that insulation would be necessary to make the product safer.

When the milk container was tested with the hot oil, the lid was placed on the milk container and left. After several days, the lid was stuck to the container because a vacuum had formed due to the cooling of the oil in the container. The exact force required to move the lid was not measured, but it did require a rubber mallet to be removed. The formation of a vacuum served as proof for the need of a breather valve that will ensure a vacuum is not formed in the container.

VII. Engineering Social and Sustainability Impacts

Currently, this project is not expected to have any global impact because the design will only be implemented in one food truck. If the product gains popularity and spreads to other food trucks, the product may have a larger impact. In terms of economic impact, the design will potentially save money for MASA because the filtration system will allow oil to be used for longer and the improved storage container will prevent the loss of oil. The design will be a large upfront cost compared to the current solution in MASA, but over time, the cost will be worth the investment because it will extend the life of the cooking oil. Getting more uses out of the same oil will result in purchasing less oil throughout the year. The end of life of the design is important because the design will need to be properly disposed of in the designated areas. Some cost might be associated with the disposal of the design at the end of life. Environmental considerations associated with this project include the disposal of oil once the oil can no longer be used in the food truck. The new design could make it easier to recycle the used oil after it has been used completely since the oil will already be contained and transportable. The new design will also impact the environment by reducing the chance of oil spills since the oil will be contained. Other environmental issues are not a concern for this project until the product reaches end of life and must be properly disposed of.

No foreseeable ethical issues exist related to this project. The solution is a straightforward technical solution and does not pose any ethical dilemmas. Gross misuse of this product, like any product, could result in safety or ethical issues.

VIII. Final Design

After the final design was selected, the COVID-19 closed campus and prevented the team from constructing, testing, and changing the product themselves. Social distance guidelines also prevented the team from meeting with the client to discuss the final design and implement the product in the food truck.

A. Constructing Final Design

To construct the final design, Dr. Bowser and Dr. Weckler sprayed LizardSkin on the milk container, drilled a hole in the lid, and added the breather valve. A smaller valve was purchased to replace the ¾ inch valve originally purchased. Upon trying to fit the ¾ inch breather valve on the lid, Dr. Bowser and Dr. Weckler decided it was too large for the lid, and instead, they purchased a smaller ¼ inch breather valve. The breather valve was attached to the lid by drilling a hole and using a nut to attach the breather valve on the underside of the lid. The LizardSkin insulation was sprayed on the container using the sprayer purchased from the LizardSkin company. The handles of the container were not sprayed with LizardSkin to allow for easy gripping by the user. Everything was done again to a second container in order to have two containers that would hold the necessary amount of oil. The filtration component was not constructed due to the circumstances of COVID-19.

B. Testing Final Design

In order to test the effectiveness of the LizardSkin insulation, another test was conducted by heating oil in a fryer and emptying it into the container. Temperatures of

the container were recorded using a FLUKE 77 multimeter. The actual test was conducted by Dr. Weckler and Dr. Bowser, then the results were shared with the team for analysis. The exact times the temperatures were taken was not recorded because the main goal of this test was to determine whether one layer of LizardSkin was effective enough to keep the maximum temperature of the bucket within a safe range. The initial outside temperature of the bucket was 77 ℉. After 10 minutes of the hot oil being in the container, the outside of the container was 286 ℉. The results of the test after the application of LizardSkin indicate that a second coat should be applied to the outside of the containers. The results from the second test did not align with the expected results based on claims made by LizardSkin. Based on the information from the LizardSkin website, the outside temperature should have been reduced more after the application of the LizardSkin. Several pictures from the second test can be found in the appendix.

C. Implementation and Changes

Once the final design was constructed and tested, MASA food truck would have been contacted so that the team could bring the final product to the food truck in order to implement the design. The final product should be very simple to implement as the containers were designed to fit in the space already being utilized by Mr. Carnoske in order to store his current oil storage solution. If the team had been able to meet in person, a gravity fed filtration system could have been designed to fit inside the mouth of the container. The gravity filtration system would be constructed from a 7 inch pasta basket, lined with fine mesh, at the top of the container to help filter large particles out of

the oil. Another change that would have been implemented given more time and access, would be to test the container for durability. In order to do this, the team would have to put the container under extreme working conditions (high temperatures, being tossed around, undergoing some impacts) to see how the container would likely perform in the long term use.

Conclusions and Thanks

The design and construction of this project would not have been possible without the help and guidance of members of the Biosystems and Agricultural Engineering faculty, all the engineering professors throughout the years, and specifically Dr. Paul Weckler and Dr. Timothy Bowser from the Food and Agriculture Products Center. The team also greatly appreciates the support from the Food and Agricultural Products center for it’s resources and assistance.

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X. Appendix

Appendix A

DIMENSIONS

MODEL	OIL CAPACITY	OVERALL SIZE (cm)			DRAIN HEIGHT	NET WEIGHT	SHIPPING INFORMATION					
		HEIGHT	WIDTH	LENGTH			WEIGHT	CLASS	CU. FT.	DIMENSIONS		
Without Basket Lifts	min.-max. 30-40 lbs. (15-20 liters)	*46" (116.8 cm)	15-5/8" (40.0 cm)	31-1/2" (80.1 cm)	10-5/8" (27.0 cm) w/extension	145 lbs. (66 kg)	177 lbs. (80 kg)	85	19.47	H 42-1/2" (108 cm)	W 22" (56.0 cm)	L 36" (91.4 cm)
With Basket Lifts	min.-max. 30-40 lbs. (15-20 liters)	*47-5/8" (121.0 cm)	15-5/8" (40.0 cm)	34-1/2" (87.6 cm)	10-5/8" (27.0 cm) w/extension	185 lbs. (84 kg)	233 lbs. (106 kg)	85	19.47	42-1/2" (108 cm)	22" (56.0 cm	36" (91.4 cm)

*Height for units with filters -- see drawing for height of single non-filter units.

http://fm-xweb.frymaster.com/products/pdf%20files/mj35spec.pdf

Appendix B

Table 1

Oils	Density (g/cm^3)	Temp (°C)
coconut	0.925	15
cotton seed	0.926	16
olive	0.918	15

https://hypertextbook.com/facts/2000/IngaDorfman.shtml

TABLE 3

Density of Vegetable Oils

Temperature °C (°F)	Density (g/mL)						
	Crambe[a]	Rapeseed	Corn	Soybean	Milkweed[a]	Coconut	Lesquerella
23.9 (75.0)	0.9078	0.9073	0.9188	0.9193	0.9203		0.9398
37.8 (100.0)	0.8977	0.8987	0.9082	0.9082	0.9097	0.9107	0.9307
48.9 (120.0)	0.8898	0.8908	0.9028	0.9023	0.9018	0.9033	0.9229
60.0 (140.0)	0.8829	0.8839	0.8939	0.8939	0.8934	0.8949	0.9152
82.2 (180.0)	0.8681	0.8686	0.8800	0.8795	0.8790	0.8795	0.8999
100.0 (212.0)	0.8564	0.8579	0.8679	0.8674	0.8684	0.8669	0.8879
110.0 (230.0)	0.8501	0.8511	0.8610	0.8615	0.8605	0.8605	0.8830
Literature data		0.903–0.907	0.912–0.917	0.914–0.918		0.916–0.918	
Temp. (°C)[b]		25	25	25		25	

[a]By direct pycnometer determination. Other values by corrected hydrometer determination. [b]Ref. 6.

https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1016&context=chemeng_biomaterials

Appendix C

NIOSH Lifting Recommendations

NIOSH has developed a formula for assessing the hazard of a lifting situation. The formula looks at the following elements involved in the lift:

- distance the load is held in front of the body,
- height the load is lifted from and to,
- height of the load,
- frequency of lifting,
- the hand load coupling, and
- the amount of torso twisting that is involved with the load lifting motion.

Using these parameters NIOSH, has established that, for occasional lifting where the load is held close to the body, with no twisting, and at about waist height and where the load has good hand holds, the typical industrial worker could lift about 51 pounds without a significant increase in risk of injury. As these factors deviate from the ideal, the amount of weight that can safely be lifted by an employee is decreased.

A typical box of packed whole chickens or chicken parts can weigh between 40 and 80 pounds. It is obvious that even under ideal circumstances most employees are at an increased risk of back injury when lifting a load of 80 pounds, since this is about 1.6 times the NIOSH recommended limit of 51 pounds. In real life, employees must handle loads that are often held out and away from the body, lowered or lifted to low or elevated locations, involve twisting the torso to access the loading areas, are highly repetitious, and that are in boxes that may not have good handles. These real life situations reduce the amount that can be safely lifted.

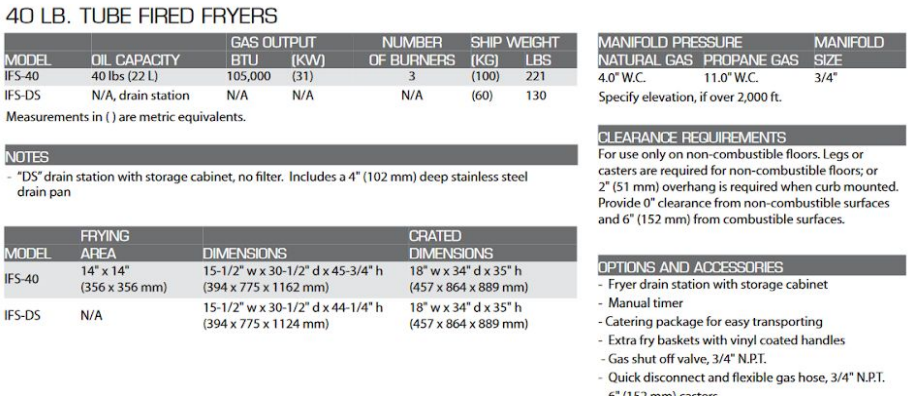
The NIOSH Lifting Recommendations can factor all of these reductions together and determine a weight that most people should be able to lift when performing a job the way it is normally performed. A typical recommended weight limit for a task where employees must repeatedly lift loads and place them to low locations, where torso twisting may be required, is about 8 to 12 pounds.

The amounts lifted in these typical boxes of chicken are 4 to 8 times this recommended value, and research indicates that many in the work force will be injured performing these types of lifting tasks.

This Applications Manual for the Revised NIOSH Lifting Equation will help determine safe load weights.

https://www.osha.gov/SLTC/etools/poultry/additional_material/niosh.html

Appendix D



40 LB. TUBE FIRED FRYERS

MODEL	OIL CAPACITY	GAS OUTPUT BTU	(KW)	NUMBER OF BURNERS	SHIP WEIGHT (KG)	LBS
IFS-40	40 lbs (22 L)	105,000	(31)	3	(100)	221
IFS-DS	N/A, drain station	N/A	N/A	N/A	(60)	130

Measurements in ( ) are metric equivalents.

MANIFOLD PRESSURE NATURAL GAS	PROPANE GAS	MANIFOLD SIZE
4.0" W.C.	11.0" W.C.	3/4"

Specify elevation, if over 2,000 ft.

NOTES

- "DS" drain station with storage cabinet, no filter. Includes a 4" (102 mm) deep stainless steel drain pan

CLEARANCE REQUIREMENTS

For use only on non-combustible floors. Legs or casters are required for non-combustible floors; or 2" (51 mm) overhang is required when curb mounted. Provide 0" clearance from non-combustible surfaces and 6" (152 mm) from combustible surfaces.

MODEL	FRYING AREA	DIMENSIONS	CRATED DIMENSIONS
IFS-40	14" x 14" (356 x 356 mm)	15-1/2" w x 30-1/2" d x 45-3/4" h (394 x 775 x 1162 mm)	18" w x 34" d x 35" h (457 x 864 x 889 mm)
IFS-DS	N/A	15-1/2" w x 30-1/2" d x 44-1/4" h (394 x 775 x 1124 mm)	18" w x 34" d x 35" h (457 x 864 x 889 mm)

OPTIONS AND ACCESSORIES

- Fryer drain station with storage cabinet
- Manual timer
- Catering package for easy transporting
- Extra fry baskets with vinyl coated handles
- Gas shut off valve, 3/4" N.P.T.
- Quick disconnect and flexible gas hose, 3/4" N.P.T.

https://www.imperialrange.com/PDFs/40fryer.pdf

Appendix E

INDIVIDUAL FRYER SPECIFICATIONS

Frying Area	Cook Depth	Oil Capacity	Gas Input Rate / Hr	Burner Pressure Nat	Burner Pressure LP
14 x 14 in (35.6 x 35.6 cm)	4 - 6 in (10.2 - 15.2cm)	40 - 45 Lbs (18 - 20 kg)	107,000 BTUs (31.4 kW) (113 MJ)	4" W.C. (10 mbars / 1 kPa)	10" W.C. (25 mbars / 2.4 kPa)

FRYER SHIPPING INFORMATION (Approximate)

Shipping Weight	Shipping Crate Size H x W x L	Shipping Cube
181 Lbs (82.1 kg)	36 x 19 x 46 in (116.8 x 48.3 x 91.4 cm)	18.2 ft^3. (0.5m^3)

CLEARANCES

Front min.	Floor min.	Combustible material		Non-Combustible material		Fryer Flue Area
		Sides min.	Rear min.	Sides min.	Rear min.	
30" (76.2 cm)	6" (15.25 cm)	6" (15.2cm)	6" (15.2cm)	0"	0"	Do not block / restrict flue gases from flowing into hood or install vent hood drains over the flue.

SHORT FORM SPECIFICATION

Provide 40D tube-fired gas fryer. Fryer shall have an atmospheric burner system combined with four stainless steel tubes utilizing high temperature alloy stainless steel baffles. Fryer shall have a deep cool zone; minimum 20% of total oil capacity. Fryer cooking area shall be 14" x 14" (35.6 x 35.6 cm) with a cooking depth of 4 - 6" (10.2 - 15.2 cm). Heat transfer area shall be a minimum of 575 square inches (3,709 sq cm).

TYPICAL APPLICATION

Frying a wide variety of foods in a limited amount of space. Frying that requires a medium volume production rate.

https://cdnimg.webstaurantstore.com/documents/specsheets/61440d_specsheet.pdf

Appendix F

Model	Burners and Control Method	Gas type	Intake-tube pressure (in.W.C.)	Per BTU B.T.U./h	Total BTU B.T.U./h	Nozzle No.	Net weight (LBS)
ATFS-40	3 Burners Independent Manual control	NG	4	34,000	102,000	#36	134.5
		LP	10	30,000	90,000	#52	
ATFS-50	4 Burners Independent Manual control	NG	4	34,000	136,000	#36	145.5
		LP	10	30,000	120,000	#52	
ATFS-75	5 Burners Independent Manual control	NG	4	34,000	170,000	#36	165.3
		LP	10	30,000	150,000	#52	

https://cdn.shopify.com/s/files/1/0950/0340/files/SPEC_ATO_ATF-40.pdf?94167

14728584367048

Appendix G

- **310:257-5-24.** Food storage containers, identified with common name of food Except for containers holding food that can be readily and unmistakably recognized such as dry pasta, working containers holding food or food ingredients that are removed from their original packages for use in the food establishment, such as cooking oils, flour, herbs, potato flakes, salt, spices, and sugar, shall be identified with the common name of the food. [Source: Added at 23 Ok Reg 2358, eff 6-25-06; Amended at 28 Ok Reg 2289, eff 11-1-11; Amended at 33 Ok Reg 1520, eff 9-11-16]
- **310:257-7-1.** Characteristics P Materials that are used in the construction of utensils and food-contact surfaces of equipment may not allow the migration of deleterious substances or impart colors, odors, or tastes to food and under normal use conditions shall be: (1) Safe; (2) Durable, corrosion-resistant, and

nonabsorbent; (3) Sufficient in weight and thickness to withstand repeated warewashing; (4) Finished to have a smooth, easily cleanable surface; and; (5) Resistant to pitting, chipping, crazing, scratching, scoring, distortion, and decomposition. [Source: Added at 23 Ok Reg 2358, eff 6-25-06]

- **310:257-7-15.** Food-contact surfaces Pf (a) Multiuse food-contact surfaces shall be: (1) Smooth; (2) Free of breaks, open seams, cracks, chips, inclusions, pits, and similar imperfections; (3) Free of sharp internal angles, corners, and crevices; (4) Finished to have smooth welds and joints; and (5) Except as specified in (b) of this Section, accessible for cleaning and inspection by one of the following methods: (A) Without being disassembled, (B) By disassembling without the use of tools, or (C) By easy disassembling with the use of handheld tools commonly available to maintenance and cleaning personnel such as screwdrivers, pliers, open-end wrenches, and Allen wrenches. (b) OAC 310:257-7-15(a)(5) of this Section does not apply to cooking oil storage tanks, distribution lines for cooking oils, or beverage syrup lines or tubes. [Source: Added at 23 Ok Reg 2358, eff 6-25-06]
- **310:257-7-17.** "V" threads, use limitation Except for hot oil cooking or filtering equipment, "V" type threads may not be used on food-contact surfaces. [Source: Added at 23 Ok Reg 2358, eff 6-25-06]
- **310:257-7-18.** Hot oil filtering equipment Hot oil filtering equipment shall meet the characteristics specified under OAC 310:257-7-15 or OAC 310:257-7-16 and

shall be readily accessible for filter replacement and cleaning of the filter. [Source: Added at 23 Ok Reg 2358, eff 6-25-06]

- **310:257-7-83.** Equipment food-contact surfaces and utensils (a) P Equipment food-contact surfaces and utensils shall be cleaned and sanitized:
    - (4) In equipment such as ice bins and beverage dispensing nozzles and enclosed components of equipment such as ice makers, cooking oil storage tanks and distribution lines, beverage and syrup dispensing lines or tubes, coffee bean grinders, and water vending equipment: (A) At a frequency specified by the manufacturer, or (B) Absent manufacturer specifications, at a frequency necessary to preclude accumulation of soil or mold. [Source: Added at 23 Ok Reg 2358, eff 6-25-06; Amended at 26 Ok Reg 1477, eff 6-11-09; Amended at 28 Ok Reg 2289, eff 11-1-11; Amended at 33 Ok Reg 1520, eff 9-11-16]
- The Tulsa Department of Health published a paper that includes common violations found in food trucks. “Food contact surfaces shall be smooth and constructed with safe, durable, corrosion-resistant, and non-absorbent materials (Mobile Food Establishment Guide, 2013).” This is the same information listed in Title 310 Chapter 257. Hot oil filtering equipment must also meet these guidelines as well as the CIP equipment guidelines. Furthermore, the Tulsa Department of Health has a document on their website titled Mobile Food Establishment Construction, Equipment and Operation Guidelines. Like the document listing common violations in food trucks, this document just lists certain

parts of Title 310 Chapter 10 (Tulsa Department of Health, 2018). The most relevant parts of Title 310 Chapter 257 are listed in the Appendix G.

- According to the Oklahoma State Department of Health, to prevent the spread of pathogens, it is necessary to take action when dealing with sick employees. It is the person in charge's responsibility to restrict or exclude a food employee when the employee has symptoms of vomiting or diarrhea, have symptoms of a sore throat with a fever, or have an infected skin lesion containing pus. Employees experiencing sneezing, coughing, or runny nose causing discharge from the eyes, nose, or mouth may not work with exposed food. It is mandatory to wash hands after touching bare human body parts aside from clean hands, using the toilet room, after working with raw and ready-to eat food, and more. Employees need to keep their fingernails trimmed and filed and wear clean outer clothing. When preparing food jewelry, fingernail polish, or artificial fingernails cannot be worn, unless gloves are worn. Equipment food-contact surfaces and utensils should also be cleaned and sanitized regularly according to the Oklahoma State Department of Health.

Appendix H

Table 2. Lids

Product	Price	Pros	Cons	Product Description	Website
Avantco 266211 Fryer Cover	$39.99	Relatively cheap Rated 4.8/5 by 18 reviews One review said it was used in a food truck Makes fryer a shelf “We have a mobile kitchen and it does keep most of the oil from sloshing out, but it would be better with some sort of gasket to seal.”	Does not seal on the fryer well enough to keep oil from sloshing out Just rests on top of the fryer No handle on the top	Protect your fry tanks from dust and airborne contaminants during off hours with the Avantco 2662111 fryer cover! This fryer cover fits neatly on top of your FF300 or FF400 deep fryer so that you can keep your fry tanks clean and safe for cooking.	https://www.webstaurantstore.com
Pitco B2101501-C 15 1/2" x 24 1/4" Stainless Steel Fryer Cover	$203.99	There are no reviews listed on the site for this product There is a handle on top which makes it easy to remove	It looks like this product does not have a seal Expensive	Protect your fry tanks from airborne contaminants during off hours with Pitco's B2101501-C tank cover! Comprised of 18 gauge stainless steel, this cover is both sturdy and easy to clean. Designed to fit a variety of Pitco fryers without basket lifts, this cover will keep your fry tanks clean and safe for cooking each and every day.	https://www.webstaurantstore.com
Cooking Performance Group 390147 Tank Cover for CPG-F-25 C Countertop Fryer	$48.99	The lid has a lip that sits half an inch above the actual lid which would make it better at keeping oil from sloshing out There are no reviews listed on the site for this product There is a handle on top that makes it easy to remove	Does not have a seal around the edge to keep oil from spilling out	Keep your tank clean and free of dust and other contaminants from settling inside with this 390147 tank cover! Compatible with your Cooking Performance Group CPG-F-25C countertop fryer, this tank cover is an absolute necessity during off hours.	https://www.cookingperformancegroup.com

Avantco fryer lid

Pitco fryer lid

. Cooking Performance Group

Table 3. Storage Containers

Product	Price	Pros	Cons	Product Description	Link
MirOil Low Profile Fryer Oil Transporter	$143.99	Easy to filter Easy to store Easy to convey the oil to	Lid has a gasket that does not stand up to the hot oil Hole on lid will slosh around oil when transported Pot is too hot to handle after pouring the oil Handles make it awkward for one person to pour It is short and wide which takes up floor space	Thanks to its low profile, handling fryer oil is convenient and safe with this MirOil 60L 55 lb. filter pot! This 55 lb. capacity pot allows you to filter hot oil safely. Its convenient, low profile design will fit under drain valves. This pot features an enamel exterior and gasketed safety lid. Filter bag and frame sold separately.	https://www.webstaurantstore.com
MirOil 30L 6 Gallon Utility Pail	$83.99	Taller and narrow Better handles for easy one person pour	Lid has a gasket that does not stand up to the hot oil No breather or hole to per-vent a vacuum Painted liner inside the pail that does not stand up to the heat Paint on exterior will bubble and peel Pail ultimately leaks where the walls meet the base of the pail	If you use a fryer in your kitchen, it's important to have a way to safely and efficiently store and transport spent oil. This 6 gallon utility pail is an excellent solution and makes a great companion for filtering, collecting, and moving oil when it has reached the end of its usable life. The pail's intuitive design features, like a side handle and a lid that's connected to the bucket body, make oil removal easy, safe, and efficient.	https://www.webstaurantstore.coml

Keg	$100-$200	No splash while truck is moving Can store very hot liquids Different shapes and sizes in the market	Not made specifically for hot oil Handles might get too hot to handle Heavy	In recent times, a keg is often constructed of stainless steel. It is commonly used to store, transport, and serve beer. Other alcoholic or non-alcoholic drinks, carbonated or noncarbonated, may be housed in a keg as well. Carbonated drinks are generally kept under pressure in order to maintain carbon dioxide in solution, preventing the beverage from becoming flat.	https://www.kegoutlet.com
Steel Jerry Can	$180	No splash Stainless Steel Easy to carry	Not made for hot oil Only hold 10.6 gallons	A jerrycan (also written as jerry can or jerrican) is a robust liquid container made from pressed steel. It was designed in Germany in the 1930s for military use to hold 20 litres (4.4 imp gal; 5.3 US gal) of fuel	https://www.ebay.com
Stock Pot	$100-200	Can store very hot liquids Variety with Designs	Lid cannot be secured properly Easy to spill Hard to carry Not made specifically for storing hot oil	A stock pot is traditionally used to make stock or broth, which can be the basis for cooking more complex recipes. It is a wide pot with a flat bottom, straight sides, a wide opening to the full diameter of the pot, two handles on the sides, and a lid with a handle on top.	https://www.google.com

MirOil oil transporter

MirOil utility pail

Steel Jerry Can

Keg

Stock Po

Table 4. Filters

Product	Price	Pros	Cons	Product Description	Link
Integrated Filtration System	$10,000-$30,000	Can filter while fryer works Safe Quickest Best filtration	Expensive Only good in individual machine Would have to build onto existing fryer	Deluxe frying equipment often comes with a filtration system already installed in the unit. These units take all the extra work out of filtering your oil and make filtration as easy as pressing a button. This is by far the easiest and quickest way to filter oil several times a day. If your restaurant filters a lot of oil, consider springing for a fryer with built in filtration system.	www.webstaurantstore.com
Portable Filtration Machine	$2,000-$3,000	Great for frying often Oil last longer Quick Keeps fryers clean Can filter hot oil	Expensive Takes time	The most versatile filtration method on this list, a portable filtration machine fits underneath most fryers and electrically pumps oil through a filter and back into the fryer. There's no risk, and all pouring and pumping is done automatically. These units end up paying for themselves within a year or two. So if you go through a lot of oil in your shop, consider purchasing a portable filtration machine.	https://www.webstaurantstore.com
Coffee Filter	$2- $10	Can withstand heat Can be reusable	Not suitable for large amounts of oil Can only filter small amounts at a time	A coffee filter is a coffee-brewing utensil, usually made of disposable paper. This enables it to trap the coffee grounds and allow the liquid coffee to flow through.	https://www.google.com
Frymaster Filter Magic Fryer Filter Powder Packet	$53.10	Keeps oil fresh for longer Prevents loss of oil through food absorption Easy to use	Does not filter completely Only helps filtering oil	Boost the filtering power of your built-in or portable fryer oil filtration machines with this filter powder! A great investment to save you money on the cost of oil, this powder keeps oil fresh for a longer period of time while also preventing the loss of oil through absorption into food. Your customers will notice the improved food quality, and your staff will appreciate the ease of use of this fryer filter powder. Simply sprinkle it in your oil before you fry, and you're done!	https://www.webstaurantstore.com

Filter Pot	$143.99	Inexpensive Safe Can withstand hot oil Can also be used as storage	Chance for oil splattering Slow Drain Small	Filter Pots fit underneath the fryer, and oil drains through their filter. This method is similar to the cone filter but safer because you're bringing the filter to the oil instead of the other way around. These units are a little more expensive than cone filters, but if you don't fry that often, they're the fastest and safest way to keep your oil clean.	ttps://www.webstaurantstore.com
Reusable Filter Bag	$65	Reusable	Cannot use with boiling hot oil Manual Does not filter fine sediment	Keep your oil clean and your fried foods crisp, delicious and protected from flavor contamination with this MirOil B6PS EZ Flow filter assembly! It includes an 11" x 9" x 7" reusable bag that saves you the replacement costs associated with paper filters while providing an added layer of safety by accommodating effective filtration at bath water temperatures. The bag easily attaches to the holder frame with a series of reinforced snaps and is great for filtering out heavy crumb loads.	https://www.webstaurantstore.com
Skimmer	$3.79	Filters	Doesn't filter fine sediment Oil degrades quickly Particle build up Manual Not great for constant frying	When it comes to removing sediment from oil, some cooks will use a skimmer and only a skimmer. While this method does take care of the large chunks of food floating at the top of the oil, it doesn't prevent particle build-up at the base of the fryer. Skimmers are good for spot-checking, but bad for filtration. If you want to save money on oil, you'll need something more powerful than this	https://www.tigerchef.com

Figure 17. Portable oil filtration system

Figure 18. FIltration powder

Figure 19. Filter pot

Figure 20. Filter bag

Figure 21. Skimmer

Appendix I

https://www.shenandoahhomesteadsupply.com/collections/frontpage/products/stainless-steel-milk-transport-and-collection-cans?variant=15466194436190

Appendix J

Description

An indispensable tool for home and commercial kitchens, this small pasta basket is great for cooking and straining small amounts of pasta, dumplings, and more. Thanks to the stainless steel construction, this pasta basket is strong enough to withstand high temperatures while maintaining its shape.

Winco MPN-67 Features:

- Material: Stainless Steel
- Color: Silver
- Normal Mesh
- Height: 7"
- Diameter: 6-1/2"

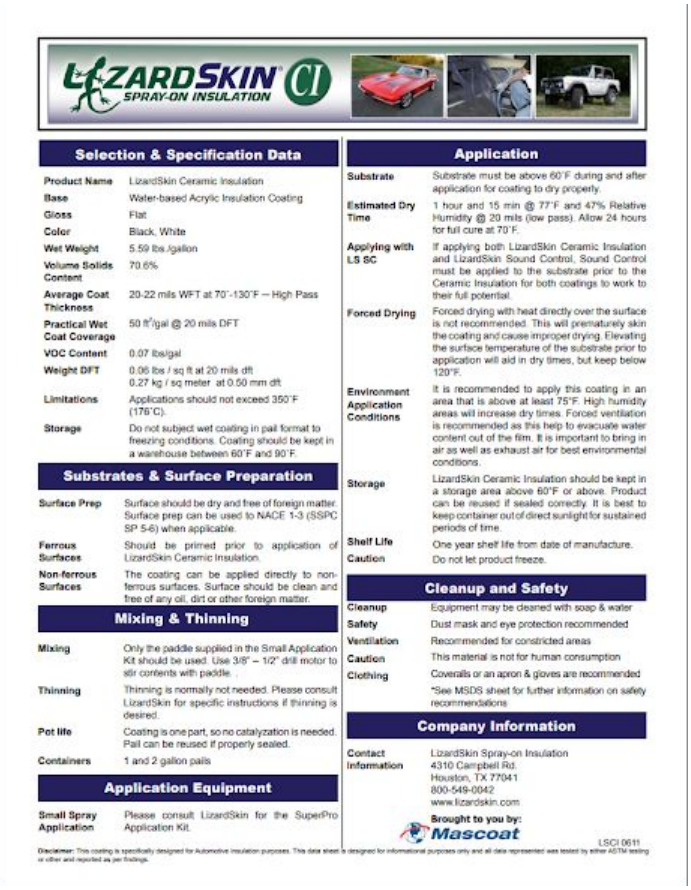
Winco MPN-67 Benefits

- Fits Standard Cookers
- Angled Handle

Specification

Ship Weight	4 LB
Manufacturer	Winco
Model Number	MPN-67
Manufacturer Part #	MPN-67
Oversized Shipping	No
Hazardous Material	No
Base Material	Stainless Steel
Color	Silver
NSF Listed	No
Mesh Type	Normal
Height	7"
Diameter	6-1/2"

Appendix K



LIZARDSKIN CI
SPRAY-ON INSULATION

Selection & Specification Data

Product Name	LizardSkin Ceramic Insulation
Base	Water-based Acrylic Insulation Coating
Gloss	Flat
Color	Black, White
Wet Weight	5.59 lbs./gallon
Volume Solids Content	70.6%
Average Coat Thickness	20-22 mils WFT at 70˚-130˚F – High Pass
Practical Wet Coat Coverage	50 ft²/gal @ 20 mils DFT
VOC Content	0.07 lbs/gal
Weight DFT	0.06 lbs / sq ft at 20 mils dft 0.27 kg / sq meter at 0.50 mm dft
Limitations	Applications should not exceed 350˚F (176˚C).
Storage	Do not subject wet coating in pail format to freezing conditions. Coating should be kept in a warehouse between 60˚F and 90˚F.

Substrates & Surface Preparation

Surface Prep	Surface should be dry and free of foreign matter. Surface prep can be used to NACE 1-3 (SSPC SP 5-6) when applicable.
Ferrous Surfaces	Should be primed prior to application of LizardSkin Ceramic Insulation.
Non-ferrous Surfaces	The coating can be applied directly to non-ferrous surfaces. Surface should be clean and free of any oil, dirt or other foreign matter.

Mixing & Thinning

Mixing	Only the paddle supplied in the Small Application Kit should be used. Use 3/8" – 1/2" drill motor to stir contents with paddle. .
Thinning	Thinning is normally not needed. Please consult LizardSkin for specific instructions if thinning is desired.
Pot life	Coating is one part, so no catalyzation is needed. Pail can be reused if properly sealed.
Containers	1 and 2 gallon pails

Application Equipment

Small Spray Application	Please consult LizardSkin for the SuperPro Application Kit.

Application

Substrate	Substrate must be above 60˚F during and after application for coating to dry properly.
Estimated Dry Time	1 hour and 15 min @ 77˚F and 47% Relative Humidity @ 20 mils (low pass). Allow 24 hours for full cure at 70˚F.
Applying with LS SC	If applying both LizardSkin Ceramic Insulation and LizardSkin Sound Control, Sound Control must be applied to the substrate prior to the Ceramic Insulation for both coatings to work to their full potential.
Forced Drying	Forced drying with heat directly over the surface is not recommended. This will prematurely skin the coating and cause improper drying. Elevating the surface temperature of the substrate prior to application will aid in dry times, but keep below 120˚F.
Environment Application Conditions	It is recommended to apply this coating in an area that is above at least 75˚F. High humidity areas will increase dry times. Forced ventilation is recommended as this help to evacuate water content out of the film. It is important to bring in air as well as exhaust air for best environmental conditions.
Storage	LizardSkin Ceramic Insulation should be kept in a storage area above 60˚F or above. Product can be reused if sealed correctly. It is best to keep container out of direct sunlight for sustained periods of time.
Shelf Life	One year shelf life from date of manufacture.
Caution	Do not let product freeze.

Cleanup and Safety

Cleanup	Equipment may be cleaned with soap & water
Safety	Dust mask and eye protection recommended
Ventilation	Recommended for constricted areas
Caution	This material is not for human consumption
Clothing	Coveralls or an apron & gloves are recommended
	*See MSDS sheet for further information on safety recommendations

Company Information

Contact Information	LizardSkin Spray-on Insulation 4310 Campbell Rd. Houston, TX 77041 800-549-0042 www.lizardskin.com

Brought to you by: Mascoat

LSCI 0611

Disclaimer: This coating is specifically designed for Automotive insulation purposes. This data sheet is designed for informational purposes only and all data represented was tested by either ASTM testing or other and reported as per findings.

Appendix L

Speedaire #1EJT9 Specifications

ZORO #: G1980973 MFR #: 1EJT9

Item: Breather Vent	**Function**: Reduce Pressure
Type: Pneumatic	**NPT Port (In.)**: 3/4
Hex (In.): 1-1/16	**Max. Temp.**: 300 F
Microns: 40	**Max. Pressure (PSI)**: 150
Fitting Material: Nickel Plated Steel	**Length (In.)**: 1-1/16
Element Material: Bronze	**Country of Origin (subject to change)**: Taiwan, Province of China

Help us improve our product information

Appendix M


FLUKE
.077
ON


FLUKE
.315


FLUKE 77 SERIES II MULTIMETER
.256 VDC
OFF
300 mV
Ω
RANGE
AUTORANGE
TOUCH HOLD
10A
FUSED
ON