A LITERATURE REVIEW ON THE EVALUATION OF DESIGN PARAMETERS FOR MODERN GREASE TRAPS AND HIGH STRENGTH WASTES

Revised Final Report

Submitted to
Texas On-Site Wastewater Treatment Research Council
April 2001

Submitted by

Raghava R. Kommalapati, Ph.D., Assistant Professor
and
Rupel Johnson, Graduate Assistant
Department of Civil Engineering
PO Box 4249
Prairie View A&M University
Prairie View, TX-77446-4249

A Literature Review on
The Evaluation of Design Parameters for Modern Grease Traps and High Strength Wastes

Principal Investigator
Raghava R. Kommalapati
Department of Civil Engineering
Prairie View A&M University

INTRODUCTION

Wastewater from restaurants typically contains large amounts of organic matter (biochemical oxygen demand, BOD), greases and oils. The term oil and grease as commonly used includes fats, oils, waxes, and other related constituents found in wastewater. These are compounds (esters) of alcohol or glycerol with fatty acids. The glycerides of fatty acids that are liquid at ordinary temperatures are called oils and those that are solids are called grease (or fats). In the absence of industrial products, oil and grease is composed primarily of fatty matter from animal and vegetable sources and from hydrocarbons of petroleum origin. The oil and grease content of a wastewater is determined by extraction of the waste sample with trichlorofluoroethane. However due to the environmental problems associated with this solvent, alternative solvents are also used. The alternative solvent recommended by standard methods is a mixture of 80% *n*-hexane and 20% methyl-*tert*-butyl ether (Eaton et al., 1995). Oils and greases are defined by the method used for their determination unlike for other constituents. There are some methods to identify the composition of oil and grease.

Oils and greases may influence wastewater treatment systems if present in excessive amounts. They may interfere with aerobic and anaerobic biological processes and lead to decreased wastewater treatment efficiency. When discharged in wastewater or treated effluents, they may cause surface films and shoreline deposits leading to environmental degradation. The

significance of oil and grease becomes more critical for smaller systems such as septic tanks for individual homes, small communities or commercial facilities such as restaurants. If the greases and oils are allowed to enter the septic tank, there is the possibility that they can be discharged along with septic tank effluent to the soil absorption system. Greases and oils, along with the suspended solids, tend to accumulate on the surfaces of the soil absorption system and ultimately leading to a reduction in the infiltration capacity. Greases and oils are persistent for long time periods and could be troublesome. The concentration of oil and grease in wastewater from restaurants could vary from about 1000 mg/l to more than 2000 mg/l (Crites and Tchobanoglous, 1998). The effluent oil and grease concentration should be less than about 30 mg/l to avoid problems with downstream treatment units in decentralized wastewater treatment and disposal systems such as OSSF systems (Crites and Tchobanoglous, 1998). The removal of oil and grease content in wastewater is becoming more and more complex due to the increase in number of different types of oils and greases available and also due to the fact that some of these are soluble at relatively low temperatures.

Typically skimming or interceptor tanks are used to trap oils by flotation and grease by cooling and flotation. The important parameter for effective flotation is adequate detention time in the interceptor tank. A number of commercial oil and grease traps are available, though there have been concerns over the effectiveness due to limited detention time. However, the use of conventional septic tanks as interceptor tanks has proven to be very effective. Volume for grease interceptor tanks typically varies from 1 to 3 times the average daily flow rate (Crites and Tchobanoglous, 1998). There could be several other systems and designs available for oil and grease removal in the literature especially for on-site sewage disposal facilities. This report summarizes the literature available on the topic of modern grease trap design at on-site sewage

disposal systems. This literature review was conducted under a contract between Prairie View A&M University and the Texas On-site Wastewater Treatment Research Council (TOWTRC). The contract number is 582-0-83207. The objective of this contract is to perform a comprehensive review of all the literature available on the subject of parameters to use in the design of on-site sewage facility (OSSF) systems used for restaurants with modern grease traps and high strength wastes.

OBJECTIVES

The main objective of this study is to perform a comprehensive review of all the literature available on the subject of grease traps and high strength wastes with focus on the following specific objectives (TOWTRC contract 582-0-83207).

I. Review the literature on the subject of parameters to use in the design of on-site sewage facility (OSSF) systems used for restaurants with modern grease traps and high strength wastes.

II. Develop a bibliography of all references on the subject and list them alphabetically by author, and include title of article and an abstract or summary for all references.

III. Indicate whether each reference has peer-review status

IV. Summarize findings on parameters used to design OSSF systems for restaurants with modern grease traps and high strength wastes based on what has already been studied.

V. Review the OSSF rules given in 30 Texas Administrative Code Chapter 285 and determine if the numbers used in the rules for design parameters for commercial facilities are appropriate based on the literature.

VI. Develop Recommendations for future research that would address issues identified in numbers IV and V above.

VII. Prepare a final bound report that will include the bibliography, a 3 to 10 page summary of the review and the recommendations developed in VI above and also prepare an electronic version.

LITERATURE SUMMARY

An exhaustive search for literature on the subject did not provide us with many publications on the subject of modern grease traps or even grease traps. We searched several databases including the one available at the Nation Small Flows Clearing House and yearly subject indexes of several journals in this field including Water Environment Federation (formerly water pollution control federation). We could find only hand full of articles and none on the design parameters. The following is a summary of the limited number of publications that we were able to find on the topic.

Origin of Grease

The term grease usually includes fats, oils, and waxes. Each of these is a long chain organic compound containing Carbon, Hydrogen, and oxygen. Generally fats are solid or semisolid at room temperature, while oils are liquid at the same temperature. Fats, oils, and greases (normally lumped together and called Fog) are split into two categories based on their origin. Animal and vegetable-based Fog is considered to be edible. Mineral (petroleum and coal sources) based Fog is not. Typically the municipal sewer utilities place a discharge limit of 100 mg/l regardless of origin (Stuth and Wecker, 1997). The edible fraction is separated into a

biodegradable (polar) component. Polarity of the molecule relates to its solubility in water. As a general rule, the greater the polarity, the greater the solubility and the easier to treat.

Problems Associated with Grease Traps

Grease residues originating from wastewater pretreatment unit, grease trap from restaurants and food industries represent more than 500.000 m^3 in France every year. Until recently, more than 2/3 of these residues were disposed of in landfill, but new regulation prohibits such final disposal (Grulois et al., 1994). Most of us know grease as a by-product of cooking. Grease is found in such things as: meat fats, food scraps, lard, baking goods, cooking oil, sauces, shortening, butter and margarine, dairy products and others.

Too often, grease is washed into the plumbing system, usually through the kitchen sink. Grease sticks to the insides of sewer pipes (both on your property and in the streets). Over time, the grease can build up and block the entire pipe. Home garbage disposals do not keep grease out of the plumbing system. They only shred solid material into smaller pieces and not prevent grease from going down the drain. Commercial additives, including detergents that claim to dissolve grease may pass down the line and cause problems in other areas (from a flyer on what restaurant and building owners need to know about grease traps or interceptors - exact citation not available). The results can be:

- Raw sewage overflowing in your home or your neighbor's home.
- An expensive and unpleasant cleanup that often must be paid for by you, the homeowner;
- Raw sewage overflowing into parks, yards, and streets;
- Potential contact with disease-causing organisms; and

- An increase in operation and maintenance costs for local sewer departments, which causes higher sewer bills for customers.

Grease and soap problems used to be confined to sewer lines serving restaurants or industrial dischargers. These materials were controlled somewhat by grease traps or grease interceptors. With the widespread use of home garbage disposal units, the problem has now spread throughout the entire collection. Grease traps are the part of the kitchen system that captures grease and oil from the wastewater flow. The grease and oil are stored in the trap (actually a tank) ranging from 10 gallons to 1000 gallons or more (big-dipper.com). Small inside grease traps are usually located in the kitchen floor preparation areas or near dishwashers. This type of grease trap requires frequent maintenance and is typically ineffective. Larger outside grease traps are usually located a few feet from the building exterior in parking, delivery or drive-through areas. While outside grease traps are more effective, they also require periodic maintenance.

Restaurant discharges into public sewers have been a problem for many years, but have become a greater problem with the larger number of full service fast food restaurants being built both in large cities and rural communities across the country. These restaurant typically discharge large amounts of suspended solids and oil & grease that will reduce the capacity of public sewers over time. The traditional treatment for this waste prior to discharge into the public sewer is a grease-trap that causes separation of the floatable and settleable materials. The discharge from a grease-trap comes from the clear-zone created by this separation process. Even though it is called a clear-zone, the water from this zone still usually includes a considerable amount of relatively low specific gravity suspended solids and high gravity oil & grease.

Sewer overflows and backups can cause health hazards, damage home interiors, and threaten the environment. An increasingly common cause of overflows is sewer pipes blocked by

grease. Grease gets into the sewer from household drains as well as from poorly maintained grease traps in restaurants and other businesses.

Grease traps are used in non-private establishments to remove excessive amounts of grease that may interfere with the proper drainage and treatment of wastewater. Local plumbing codes generally require the installation of a grease trap where there is sufficient amount of waste material. Typical applications include commercial/institutional kitchens and food processing plants. The waste discharge from these facilities usually contain high organic loads, including grease, oils, fats, and dissolved and suspended food particles, as well as detergent.

As cities encounter increasing difficulty dealing with the cost of servicing food processing facilities, there has been correlated increase in the adoption of pretreatment programs to coerce restaurants to do a better job or pay for service costs incurred (big-dipper.com). Problems commonly develop when greases, oils, and soaps cool and solidify and form a coating or deposit on sewer walls. The rate of buildup of grease deposit depends upon the amount of grease carried by the wastewater, the flow and velocity of the wastewater, and the size of the sewer. If the sewer changes slope (from steep to flat), intersects with another sewer, or has "dips" or other alignment irregularities, such factors can create grease deposits. Sewers larger than 18 inches in diameter tend to have fewer grease problems than smaller sewers simply because they usually flow more than one-half-full, with velocities high enough to prevent grease buildup (Hemeyer, 1995).

Causes of Restaurant Septic Field Failures: High Nutrients

The primary reason for restaurant septic field failure was effluent richness or effluent nutrient concentration. The amount and type of grease and nutrients disposed into the on-site

sewage disposal systems from the restaurants depend on the following factors (big-dipper.com): (i) Menu (ii) Management/Operating Practices (iii) Ware-Washing Equipment (iv) Production Equipment and (v) Restaurant type, i.e. fast food restaurant or full service restaurant.

Menu

The menu establishes the amount and types of nutrients that will be washed off of the cooking vessels and utensils. Fried chicken type fast food restaurants wash a lot of cooking grease and flour/breading down the drain. Breakfast biscuit restaurants wash a lot of cooking grease, flour and buttermilk products down the drain.

Management/Operating Practices

The single greatest factor attributed to affecting effluent quality is the management and operating practices of a restaurant. The care given to scrapping-out cooking pans into solid waste containers is a major consideration. The emptying of high Biochemical Oxygen Demand (BOD) waste such as leftover milk products or beverages into the solid waste containers instead of down the drain has a great affect on the effluent nutrient concentration. Management and operating practices are hard to control. They literally vary from day to day and restaurant-to-restaurant, even within successful chains. Because there is so much variability in management and operating practices, it is necessary to engineer-in control measures that: (i) automatically hold effluent discharge to minimum or (ii) Provide a great degree of on-site sewage treatment system over capacity.

Ware-Washing Equipment

Contrary to popular conception, floor drains receive comparatively little waste. The entry points for the greatest amount of effluent nutrients is: the multi-compartment pot wash sink and the pre-rinse sink at dishwashing.

Production Equipment

The types of cooking and food production equipment influence the amount and types of nutrient by-products. For example, fast-food hamburger restaurants utilize griddles for cooking hamburgers and frying French fries, apple pies and such. The scraping utensils and the fryer baskets are washed-out in the three-compartment pot sink. A fried chicken restaurant also utilizes fryer baskets that are washed-out in the three compartment wash sink. If it serves biscuits (as most do), the cooking trays, buttering equipment and mixing bowls are wash in the three-compartment sink. Thus it is easy to see how changes in production equipment restaurants are constantly changing their menu and their cooking equipment. The hamburger restaurant of ten years ago now serves breakfast and chicken and has a salad bar with thick oils and fat-rich future. No matter what changes occur, if you can control the three-compartment sink and the pre-rinse sink, you have controlled the effluent quality, or provide a great degree of on-site sewage treatment system over-capacity.

Restaurant Type

(a) Fast-food restaurants

These usually have one, three compartment pot wash sink, one hand-wash sink, approximately six floor drains and one mop sink. The vast majority (greater than 93%) of the grease/oils and foodstuffs enter through the three-compartment pot wash sink. This is the focus of the cleaning efforts in the kitchen. The more fryer-type cooking appliances, the higher levels of effluent grease and oils.

(b) Full services restaurants

Restaurant offering table service with washed plate-ware such as Denny's Shoney's, Red-Lobster and other similar operators; the pre-rinse sink at dishwashing is a significant entry

point for effluent nutrients. Standard operating practice first has gross solids scrapped off soiled plate-ware at the pre-rinse sink. Third, the dishes are racked into the dishwater for washing. Nearly 90% of all effluent nutrients, fats, oils, greases and other foodstuffs, pass into the three-compartment sink (75%) and the pre-rinse sink at dishwashing (15%). In full-service restaurant, dishwashers generally discharge a low nutrient value product (big-dipper.com).

Grease Traps

The problems associated with the removal of oils and greases have been made more complex by the increase in the number of different types of oils and greases available for cooking (e.g.. olive oil, canola, lard etc.) The problem is complicated further because many of the oils are soluble at relatively low temperatures, which make their removal more difficult. Typically, skimming or grease traps are used to traps oils by flotation and grease by cooling and flotation. The quotients of the tank serve as a heat exchanger cooling the incoming liquid, which helps to solidify the greases. For flotation to be effective, the grease trap must detain the fluid for an adequate period of time (typically greater than 30 minutes).

The purpose of a grease trap is to intercept the liquid grease waste and/or garbage and retain it for a sufficient amount of time which allows for cool down of the greasy liquid, thus promoting separation and coagulation of the grease from the water. This detention time also allows for separation of the garbage from the waste.

A grease trap works by slowing down the flow of hot greasy water and allowing it to cool. As the hot water cools, the grease and oil separate and float to the top of the grease trap. The cooler water continues to flow down the pipe to the sewer. The grease is actually trapped by

"baffles" which cover the inlet and outlet of the tank, preventing grease from flowing out of the trap.

Grease traps and tanks were initiated at a time when most of the Fog used in the food industry was from animal fats. Logically the material came as a solid to semisolid, liquefied in the heating process, and any discharged would solidify in the tank. Today we find the majority of the industry using vegetable oils. Oils will separate, but not in the same manner as fats, so the efficiency of the trap may be reduced.

Grease Trap Installation

Grease traps are the part of the kitchen system that captures grease and oil from the wastewater flow. The grease and oil are stored in the trap (a holding tank) ranging from 10 gallons to 1000 gallons or more. Most uniform building codes or sewer-use ordinances require commercial and industrial dischargers to install grease traps or grease interceptors if grease is detected in wastewater discharges. These units are similar to septic tank and are designed to allow floatables (greases, oils, and soaps) to accumulate on the surface, and heavy solids to settle to the bottom. Floatables and solids must be removed on a regular basis

A grease trap typically consist of a single tank (usually a modified septic tank) which is installed on the graywater side of the septic system for the purpose of removing greases, oils and some food particles from the wash water before it enters the drain field. Adding a pump chamber downstream enhances some grease traps. Ideally, a pump chamber with a detention capacity of seven days is installed at the outlet of the grease trap. This chamber is equipped with a timing device capable of activating the pump 4 to 10 times per day over a seven-day period. From here,

the effluent is pumped into the inlet side of the black water (septic) tank. This method reduces shock loading to the black water system which otherwise occurs during peak business hours.

When using a grease trap it is important to separate the flow of black water (restroom) from graywater (other water). Perhaps the most important reason for separating graywater from black water is this: Should the graywater system fail to maintain effluent waste strength at level which are tolerable to the drain field, the grease trap (and pump tank if present) can be used as holding tanks. The effluent is then pumped out as needed and trucked to an authorized sewage disposal site. The advantage to this option is that while the pumping out of holding tanks is economically unfeasible when used for the total effluent output, the cost is often manageable when the graywater requires regular pumping.

Grease traps have a distinct advantage over grease interceptors, which are installed inside the building, in that they do not require maintenance by the restaurant staff, however they do require periodic monitoring. On the negative side, high temperatures and the use of liquid cooking oil sometimes prevent grease and oil from separating out sufficiently to protect the drain field.

An interceptor is a large device, which has two compartments. Grease traps or interceptors shall be used on kitchen waste lines from institutions, hotels, restaurants, schools with lunchrooms, and other places that may discharge large amounts of greases and oils to sewer. However, wastes from garbage grinders must not be allowed to enter a grease trap unless the grinder is connected to a separate, independent interceptor, the unit has been properly sized and approval has been obtained from the local agency. The trap or interceptor shall be installed near the plumbing fixture that discharges greasy wastewater and should be easily accessible for cleaning. For maximum grease removal, a dual-chamber interceptor is installed as close as

possible to the source of hot greasy wastes, the separated grease can be conveyed to the secondary chamber, where it accumulates, cools, and solidifies.

A typical wastewater unit would have two systems to serve their wastewater disposal needs. A sanitary system for toilets, urinals and bathroom sinks, and a kitchen system for floor drains, dishwashers and prep-sinks (Figure 1).

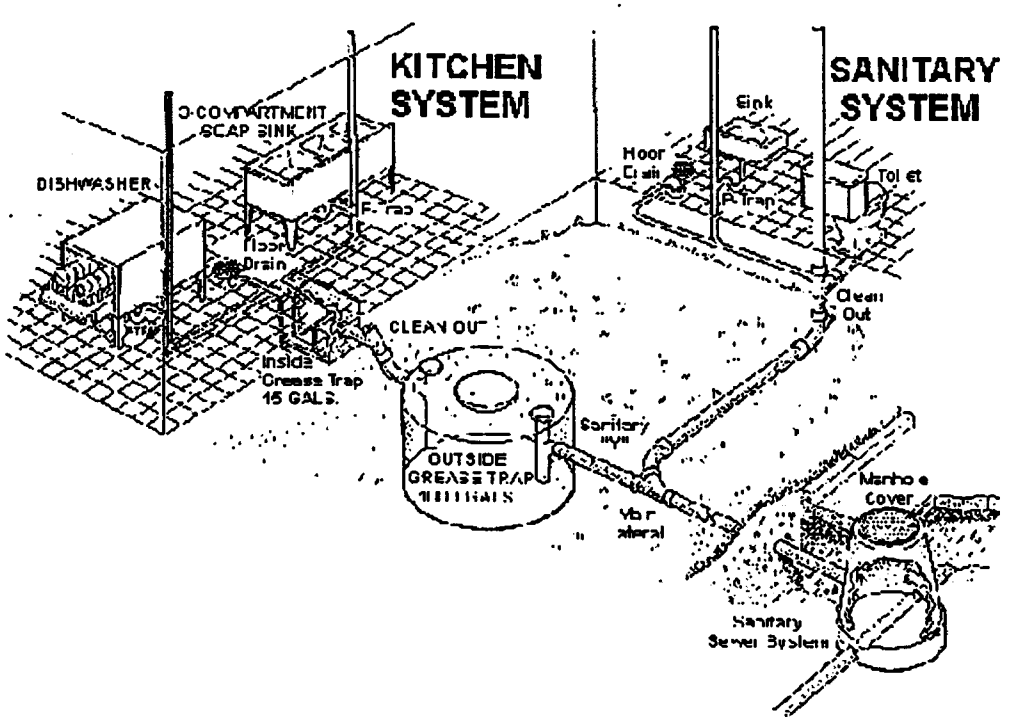

Figure 1 Typical Wastewater Disposal Unit with separate systems for Sanitary and Kitchen (adapted from Russellreid.com)

Sizing

Grease traps and grease interceptors are generally sized according to the local plumbing code. The different code variables include: number of meals per hour or seats, wastewater flow

rate, wastewater detention time, storage factor, and detention time. Both the following two methods are most commonly used for sizing of grease interceptors at restaurants.

Uniform Plumbing Code Sizing Method (Uniform Plumbing Code, Appendix H)

(D) * (MF) * (GL) * (RT) * (ST) = size of grease interceptor (gallons)

Where:
D = Total number of seats
MF = Meal factor, based on establishment type & average time per meal;
- 1.33 Fast Food/Cafeteria (45min)
- 1.0 Restaurant (60min)
- 0.67 Leisure dining (90min)
- 0.50 Dinner Club (120min)

GL = Gallons of wastewater per meal;
- 6 with dishwashing machine
- 5 without dishwashing machine
- 2 single service kitchen
- 1 Food waste disposer

RT = Retention time;
- 2.5 Commercial kitchen waste
- 1.5 Single service kitchen

ST = Storage factor, based on hours of operation;
- 1.0 operation of 8hrs
- 1.5 operation of 12hrs
- 2.0 operation of 16hrs
- 3.0 operation of 24hrs
- 1.5 single service kitchen

Environmental Protection Agency Method (US EPA 1980):

(D) * (GL) * (ST) * (HR/2) * (LF) = size of grease interceptor (gallons)

Where:

D = Number of seats in dining area
GL = Gallons of wastewater per meal, normally 5 gallons
ST = Storage capacity factor, min. 1.7, for onsite disposal 2.5
HR = Number of hours open

LF = Loading factor;
1.25 interstate freeways
1.0 other freeways
1.0 recreational areas
0.8 main highways
0.5 other highways

From the observation of the two methods it looks as if the uniform plumbing code method considers more factors than the EPA method and thus may provide a better and estimate for the volume of the grease interceptor. However, no such conclusions are made in the literature.

Grease Trap/Interceptor Operation and Maintenance

Responsibility for cleaning and maintaining grease traps or grease interceptors depend upon community policies: but many dischargers do not know how to nor do they bother to, properly clean and maintain grease traps and grease interceptors. Some industries, however, do an excellent job of this. Contents of trap can often help to reveal problems, which have developed in industrial increased sewer-use costs.

Grease traps and interceptors must be regularly and thoroughly cleaned. Merely pumping the liquid out of the trap or interceptor does not remove the grease or the solids. Frequency of cleaning may vary from twice monthly to once every six months, depending on the amount of grease in the wastewater and flow.

Field evaluations of grease traps and grease interceptors reveal that they may be undesirable or ineffective for some of the following reason (Hemeyer, 1995):

1. Dischargers (such as restaurants) do not properly clean and maintain facilities.

2. In spite of the installation and maintenance of facilities, grease problems can still develop in smaller sewers. Problems develop because the facility is too small, improperly maintained, or the wastewater temperature is too high the grease will not solidify until it reaches the sewer.
3. Undesirable side-effects may be produced by grease traps and interceptors in the collection system and the wastewater treatment plant:
    a. Solids deposited on the bottom of trap or interceptors begin to decompose. Such decomposition produces odors in the collection system; exerts a greater load on the wastewater treatment plant; and increases sewer use costs.
    b. Decomposing materials from the trap or interceptor may flow into the wastewater collection system, thus increasing production of hydrogen sulfide.
    c. When the trap or interceptor is cleaned, a large mass of undesirable material must be deposed of in a sanitary landfill.

Successful grease management is largely dependent on the employees. Restaurant managers must make sure that their employees understand the importance of proper grease management and those they do everything possible to keep problems from occurring. Remember, prevention pays, problems cost!

Pre-Treatment Systems

Automatic Removal Systems

In the southeastern United States, the three predominant pre-treatment systems for restaurants are: passive grease traps, large pre-cast grease traps and automatic grease/oils removal systems. Passive grease traps date back to 1885 when an U.S. patent was issued.

Today's small and large grease traps use the same basic operating design as last century's grease traps. Grease and oils are 12 to 15% lighter than water and immediately float to the surface inside a grease separator. The result is that the water is displaced at the bottom of the separator while the grease is held at the top of the separator. Since grease and oils fill from the "top down", it is frequently hard to measure the depth or fullness of the grease trap. The single most important aspect to understand is that as a grease trap fills, its separation efficiency diminishes. When a grease trap is full to capacity with retained grease or oils, there is no grease /oils separation occurring in the flow stream. This is what leads to considerable business for pipe cleaning services for restaurants (big-dipper.com).

Automatic pre-treatment systems can remove up to 90% of the grease/oils and a high quotient of the coarse solids from restaurant kitchen effluent. By locating the removal system at the primary point sources, gross solids and oils are captured immediately. A secondary effect of point-source automatic removal systems is they limit the amount of solids washed into the system. No flow will pass through them when their strainer basket is full. Restaurant personnel quickly conform to better ware-washing and pre-rinsing practices by sending fewer foodstuffs down the sink. The graphics in Figure 2 below illustrate the essential differences between grease traps and automatic removal units:

Grease Traps, Interceptors, and Automatic Removal Systems

	Passive Grease Interceptor (40 lb. unit)	Pre-Cast Concrete Grease Trap	Automatic Removal Unit
Grease Storage Capacity	5-7 Days	30-120 Days*	Unlimited
Fats/Oils Quality	Rancid	Rancid- Mixed with other food and detergent matter	Not Rancid- High Quality Fats
Disposal	Dumpster- Landfill (Illegal in most areas)	Pumpers with disposal permits or Treatment Plants	Recycled- Rendering Company

* Trapped Fats subject to hydrolysis, breakdown by chlorine agents & detergents. This breakdown passes water soluble fats & fat compounds out of grease trap.

Typical Grease Trap and Grease Removal System Comparison

	Passive Grease Interceptor (20 GPM)	Pre-Cast Concrete Grease Trap	Automatic Removal Unit
Installation Cost:			
New Restaurant	$1000	$2500	$3800
Existing Facility	$1200	$5000 -15,000	$4000
Annual Disposal Costs	????	$ 1200- 24,000	$80
PROS	Cheap Purchase	Large	No disposal Problems-- Low Operating Costs
CONS	Almost Never Serviced Leads to Drain Clogs & Ineffective Grease Removal	High Disposal Costs Future Concerns Re: Pumping Disposal	Higher Initial Installation Cost

Figure 2: Essential Differences Between Grease Traps and Automatic Removal Systems (from Community Compliance Inc website)

Biological Treatment

Aerobic biological treatment might represent an attractive solution to handle grease residues. By using a specific acclimatized biomass, a significant amount of grease can be removed without any degradation by-products except for the biomass itself. It is cheaper than landfill disposal or incineration and takes up little space. Aeration pretreatment for commercial

restaurant wastewater using a microbubble aerator known commercially as AEROB-A-JET has been reported in the literature and suggest a dramatic removal of heavy FOG levels to easily manageable concentrations (Hoage and Johnson, 1997).

There is another report in the literature on the nibbler as a pre-treatment system, which is aerobic digester using up-flow aeration. The aerated liquid passes through a submerged, buoyant media. The Nibbler is capable of treating extremely high strength waste and absorbing shock loading, which occurs during peak business hours. The Nibbler reduces waste strength levels, producing an effluent, which is at or below household waste strength, as having a BOD_5 level not exceeding 230mg/l. A number of aerobic digesters have been developed in the past, however none have been very effective in handling the high waste strengths of restaurant. The Nibbler was designed specifically for this purpose.

Aerobic treatment can be highly effective, however, it increases the initial installation cost significantly and requires regular monitoring, including periodic laboratory analysis of effluent samples.

Lowry (1994) studied four treatment methods for lipids and food wastes in a grease trap environment. The four methods include vacuum pumping bacterial inoculation, aeration and a combination of both bacterial inoculation and aeration. Biochemical oxygen demand (BOD), total suspended solids (TSS) and other parameters were monitored. The results indicate that to a large degree all the four methods do provide reasonable treatment (ranging from 64- 86% removal of BOD and 35-82% TSS). The combination of bacterial inoculation and aeration showed poor performance. The other three methods all had very similar efficiency in reducing BOD and TSS.

CONCLUSIONS AND RECOMMENDATIONS

An important constituent of any scheme for protecting drain fields should be the education of the restaurant management and staff. Restaurant wastewater strength is significantly affected by certain practices such as the method and thoroughness of scraping dishes, whether the dishwasher uses chemical or hot water rinse, the amount of soap used, grease recycling, the use of certain cooking and cleaning products, etc. While this method is very effective and has most advantages from the standpoint of cost, it is perhaps the least reliable method due to high personnel turnover in restaurants.

Restaurant on-site sewage disposal systems should be designed for the estimated waste strength as well as effluent quantity. Those establishments with limited food preparation and which have effluent strength similar to residential effluent need no special treatment other than periodic monitoring. Restaurants producing high levels of grease and oils or high BOD_5 need to provide pre-treatment of the effluent prior to disposal. These types of establishments must be monitored and managed by competent professionals. It is important that the monitoring program be on going to provide for the changes in business practices or volumes as they occur.

The ultimate solution to grease problems is, of course, to educate sewer-users that grease, oil, fat, and soap should not be discharged into the sewer. Instead, these materials should be separated, salvaged, and recycled, as we now do for aluminum cans and paper.

Effective grease and soap control methods available to the collection system maintenance operator include a high-velocity cleaner, hydraulic-balling, power-rodding, and bacteria culturing.

There are many chemicals that have been sold in the past and are still being sold today which aid in the controlling grease and soap in sewers. These products are bio-acids, digesters,

enzymes, bacteria cultures, catalysts, caustics, hydroxides, and neutralizers. Many of the compounds claim to control odors, remove grease, eliminate roots, and accelerate activity in biological treatment processes in treatment plants.

Pretreatment systems such as automatic removal systems or biological pretreatment units could provide effective treatment for wastewater before it enters the septic tanks.

There are not any reports in the literature on the design of modern grease traps and a comprehensive study is needed immediately to come up with design guidelines and to establish long-term grease management strategies for on-site sewage disposal systems.

The guidelines used by the Texas On-site Wastewater Treatment Research Council seem to be from the uniform plumbing code, which is one of the two design methods that we found in the literature, the other is recommended by Environmental Protection Agency.

With the very limited amount of literature available it is not possible to evaluate the suitability of the OSSF rules given in 30 Texas Administrative Code Chapter 285.

BIBLIOGRAPHY

Batten, W. C. (1989). Chemicals in Kitchen the Effects of Grease Removal. Thermaco, Inc. Asheboro, NC.

Boffa, W., (1982). Automatic Pump Station Cleaning Eliminates Grease Nuisance, Water Engineering and Management, Vol 139 No 1, pp 16. **(Status-not sure)**

Crites and Tchobanoglous, (1998) *Small and Decentralized Wastewater Management Systems*, McGraw Hill, New York, NY **(Book)**

Eaton, Clesceri and Greenberg (1995), *Standard Methods for the Examination of Water and Wastewater,* 19th edition, APHA, AWWA and WEF **(Peer reviewed)**

Hemeyer, J. (1995). Grease Control, MRWA Today, Minnesota Rural Water Association, pp 36.

Hoage, T.R. and Johnson P. (1997), Aeration Pretreatment for Commercial Restaurants, Fifth Annual Texas On-Site Wastewater Treatment Research Council Conference, April 1997, Plano, TX. From the web site (**no peer review**). (http://members.aol.com/jitdsm/sas/Aeration_Pretreatment/pretreatment.htm).

Gaus, L.& Jones, M. (1991, October 7-10). Grease Trap Installation, Certification, and Maintenance Requirements Program for Food Service Establishments Discharging to Sewer System. WPCF Conference, Toronto, Canada. **(Proceedings).**

Grease Traps and Grease Management Guidelines. (1991). South Carolina Department of Health and Environmental Control.

Grulois, P., Alric, Virlorgett, F., Bridoux, G., Manerm, J. (1994, October 15-19). A New Biological Aerobic Process for Grease Removal. Water Federation 67th Annual Conference & Exposition. Chicago, IL. **(Proceedings-peer reviewed)**

Kirkup R.E., and Nelson L.R. (1977), City Fights Grease and Odor Problems in Sewer System, Public Works Magazine, October 1977 (**no peer review**).

Lowry S. (1994). Comparison of four Treatment Methods for the Removal of Lipids and Food Waste in a Grease Trap Environment, Masters Thesis, Department of Environmental Sciences, Texas Christian University. Obtained from the web site (peer reviewed) (http://members.aol.com/jitdsm/sas/Lowry_Paper/lowry.htm).

Metacalf & Eddy, Techobanoglous & Burton. (1991). Wastewater Engineering: Treatment, Disposal and Reuse (3rd ed.). New York: McGraw-Hill. **(Book)**

Stuth, W.L. & Guichard, M. (1989). Managing Grease and Oil in Restaurant Waste. Proceeding 6th Northwest On-Site Wastewater Treatment Short Course (Ed, Seabloom, R.W.) September 1997, pp 341. **(Proceedings-no peer review)**

Stuth W.L. and Wecker, S.C. (1997). Grease and Oil Problems in the On-site Industry, Proceeding 9th Northwest On-Site Wastewater Treatment Short Course (Eds, Seabloom and Lenning) September 1989, pp 98. **(Proceedings-no peer review).**

Uniform Plumbing Code, Exact year of the citation not available but it is printed every few years.

US EPA (1980). On-site Wastewater Treatment and Disposal Systems, US EPA, Office of Water Program Operations, EPA 625/1-80-012 **(peer reviewed)**

William, S. and Stephen, M. (1997, September 22-23). Grease and Oil Problems In The On-Site Industry. 9th Northwest On-Site Wastewater treatment Short Course and Equipment Exhibition. Seattle, Washington. **(Proceedings-no peer review)**

Wong, M., Ngie-Hing, Lowhorn, R. (1998). Total Suspended Solids Oil and Grease Removal by a Grease Trap Effluent Filter. Proceedings of the Eleventh On-Site Wastewater Treatment Conference, PP 92. **(Proceedings-no peer-review)**

Websites

http://www.big-dipper.com/kitflow.htm
http://www.environ.wa.gov.au/pubs/wtrack/wtrack_1.htm
http://www.russellreid.com/restaurant/trap/index.html
http://www.wef.org