DESIGN CONSIDERATIONS AND DISCUSSION OF LARGE OUTDOOR GREASE INTERCEPTORS

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INTRODUCTION

In many jurisdictions, there is a lack of clear regulatory guidance concerning the effective pretreatment of grease-laden wastewater from institutional and commercial food handling establishments. This manual strives to provide clarification on the field-proven performances of the available technologies.

The National Precast Concrete Association (NPCA) has produced this document due to a lack of definitive literature on the design, construction and operation of large, outdoor 'Grease Interceptors.' There is a pressing need to demystify the basic principles of grease interceptor operation and performance.

The vision for this document is for it to be an informational tool that helps specifiers and municipalities understand the best way to remove grease and solids from commercial and industrial wastes. This paper will discuss methods of achieving measurable, effective, efficient and safe grease/solids removal from wastewater flows that meet the country's tightening effluent discharge requirements.

Grease Removal

The purpose of a grease interceptor is to reduce to acceptable levels the amount of Animal and Vegetable Fats Oils and Greases (AVFOG) in wastewater in conformance with established standards. Grease interceptors should provide easy access for maintenance, be large enough to hold large quantities of grease (to reduce pumping/cleanout costs) and be outdoors to facilitate easy inspection and reduce the possibility of food contamination during cleanout.

Nonexistent, poor or ineffective grease removal from wastewater flows before they are discharged to public sewer systems results in the release of large quantities of grease into these systems. The grease eventually solidifies, causes stoppages within the piping networks and creates problems at treatment plants that are extremely costly and time-consuming.

Solidified grease can also cause sewer back ups that pose unnecessary health hazards as raw sewage backs up into residences or commercial establishments. The city of Stockton, California concluded that "properly plumbed [and maintained] … grease [interceptors] … do protect the sewer system and are justified for those sewer systems that are vulnerable to grease clogging." (Stockton Grease Trap Study)

Across the country, a Howard County Maryland family filed suit against the County Executive and Public Works Director claiming their children became seriously ill from a sewage spill caused by a grease blockage the county knew about but did not address. Clearly, prevention is preferable to the potential problems caused when a sanitary sewer line backs up.

User Pay

The general doctrine of most public or governmental bodies these days is one of "user pay," especially when it comes to garbage or waste. Therefore it makes sense that the persons or establishments that create waste grease should be responsible for its collection and disposal – and they shouldn't cause unnecessary tax payer expenditures to handle sewer blockages and grease overloads at sewer treatment plants.

DISCUSSION

Several studies were reviewed which used observation and sampling of field conditions (See Appendix A). In these studies, several similarities stand out. The sample data indicates that undersized interceptors or traps performed very poorly when compared to effluent quality guidelines. Only properly sized, outdoor grease interceptors provided acceptable effluent quality. For example, the city of Austin, Texas study concluded that **retention time was the single most important factor in grease removal, and that large volume outdoor grease interceptors are required for acceptable retention times.**

Care must be taken when comparing studies and testing methods evaluating the efficiency of FOG removal. Actual wastewater usually contains various emulsifying chemicals, and the mixture is agitated before discharge to the trap or interceptor. While it would be impractical to evaluate all the variables that make up wastewater, it is important to remember that increasing the retention time (by increasing size) allows time for the FOG's to separate.

Effluent Discharge Criteria

Regulatory bodies set different effluent discharge limits all around the country. Presently, there is no one recognized maximum allowable level of AVFOG discharge, although the different values are relatively similar. These similarities can provide the basis for one standard that satisfies all regulatory bodies. (If your local authority is not listed here and it publishes a maximum discharge standard, please forward it to NPCA for consideration in future updates to this paper.)

Some examples of jurisdictions which have stated measurable maximum allowable grease discharge requirements are as follows:

U.S. E.P.A.	150mg/l
Dallas, Texas	200mg/l
Toronto, Ontario	150mg/l
Austin, Texas	200mg/l
Fort Wayne, Indiana	200mg/l
Kansas City, Mo.	200mg/l
Stockton, Ca.	200mg/l

Jurisdictions that have maximum allowable grease discharge limits in the range of 150 to 200mg/l, and that measure and enforce these limits, can greatly reduce the costs associated with grease in a public sanitary sewer system.

Grease Traps

It is evident, as revealed by these and other studies and through discussions with various authorities having jurisdiction (AHJ), that indoor "grease traps" do not adequately remove greases and solids from commercial/industrial waste flows to meet newer effluent discharge requirements. Towards this end, the city of Cary, North Carolina's Grease Code requires a minimum of twelve (12) minutes retention time, since large volumes of grease, which had been previously separated from the wastewater, were flushed out of the under-the-sink traps. Moreover, the city of Saint Petersburg, Florida has prohibited new installations of indoor "grease traps" and requires the large, outdoor grease interceptor for all new establishments. (Sec 27-227, 2(c)) The Johnson County, Kansas Environmental Department has also prohibited new installations of indoor grease traps, effective January 1, 2003. The City of Stockton, CA concluded in their study that small interceptors sized by PDI formulas have too short a retention time and further states, "a grease interceptor may not be installed in any part of a building where food is handled."

Factors Affecting Interceptor Sizing

Obviously, the properties of grease-laden water must be considered when determining the size of an effective grease interceptor. For instance, greases and oils have a lower specific gravity than water – when left undisturbed a grease-laden mixture will separate, the grease and oil floating to the top. Another factor to consider is the AVFOG's congealing temperature. Other factors affecting interceptor size include:

1. Retention Time: Retention time is the amount of time it takes one particle of influent to travel through the system and discharge out of the interceptor. It is a critical factor in removing an adequate amount of AVFOG. The wastewater entering an interceptor requires a certain amount of time for gravity separation of the AVFOG to occur. **Therefore, designing an interceptor to maximize retention time is the most important factor in its effectiveness.** The various studies and specifications referred to in this paper approach retention time differently and calculate differing retention times – however, all agree that the AVFOG must spend sufficient time in an interceptor to allow for gravity separation.

2. Flow rates: Wastewater flow rates and retention times are inversely proportional. The greater the flow rate, the lower the retention time. There is no singularly accepted method for calculating the anticipated flow rate but most studies and AHJ's agree that it must be taken into account when sizing an interceptor.

3. Concentration: The strength of influent waste is another important factor. An effective interceptor should be large enough to accumulate a significant amount of grease without affecting the retention effectiveness, but this should not be the predominant sizing factor, as cleaning frequencies should be factored in.

4. Pumping Frequency: The size shall be sufficient to optimize cleaning and pump outs (to reduce an owner's operating costs.)

5. Chemistry: Wastewater temperatures and emulsifying chemicals affect the rate at which greases and oils will separate from the wastewater. Therefore interceptors should be large

enough to act as a heat sink, giving new influent the time to cool and emulsifiers time to release their hold on greases and oils.

Physical Sizing of an Interceptor

While there are many different schools of thought as to sizing of grease interceptors, there are some consistent themes when comparing a number of proven formulas. Most of the proven sizing formulas take into account the maximum flow rate into the tank (influent). However, the method of establishing a specific influent flow rate differs from one AHJ to another. The Uniform Plumbing Code (UPC) calculates the influent flow rate as 6 gallons per meal if establishment has a dishwasher or 5 gallons per meal without a dishwasher. The EPA calculates the influent flow rate as 5 gallons per meal. Other AHJ's calculate this by taking the sum of the maximum flow rate per fixture over all fixtures such as sinks, dishwashers, floor drains etc. A table of typical fixture flow rates follows:

Typical Plumbing Fixture Flow Rates (from U.S. EPA)

Type of Fixture	GPM
Small residence or apartment sink	5
Large residence or dishwasher	10
Restaurant kitchen sink	15
Single compartment scullery sink	20
Double compartment scullery sink	25
2 single compartment sinks	25
2 double compartment sinks	35
Restaurant dishwasher (up to 30 gal. Cap.)	15
Restaurant dishwasher (30 to 50 gal. Cap.)	25
Restaurant dishwasher (50 to 100 gal. Cap.)	40
Floor drain	5

AHJ's throughout the country rely upon factors such as flow rates, fixture units, number of meals served and hours of operation to determine the retention time. An objective view at influent flow rate calculations results in a single fact: AHJ's agree that retention time is the single most important factor in determining interceptor size.

Formulas for Calculating Interceptor Size

Our research has found these calculations to be most commonly used, or those for which the AHJ has performed documented research. This is not intended to be an exhaustive list:

- **Johnson County, Kansas Sanitation Division**
  - The total size of the grease interceptor must be 30 times the maximum influent flow rate. This is the total size, not the grease capacity.

- **Uniform Plumbing Code (Appendix H):**

$$\left(\#Meals/peak.hour\right)*\left(flow.rate\right)*\left(retention.time\right)*\left(storage.factor\right)$$

where:

#meals/peak hr.= total number of seats

Flow rate (with dishwasher) = 6 gallons

Retention time (with dishwasher) = 2.5

Storage factor (16 hours of operation) = 2

- **United States Environmental Protection Agency (USEPA)**

$$\left(\#seats\right)*\left(gal/meal\right)*\left(storage.factor\right)*\left(\frac{hours.open}{2}\right)*\left(loading.factor\right)$$

where:

#gal/meal = 5

Storage Factor = 1.7

Hours Open = 8

Loading factor = 1

- **Washington Suburban Sanitary Commission**

$$\left(Max.flow.rate\right)*\left(Diversity.factor\right)*\left(\mathrm{Re}tention.time\right)$$

In this sizing formula, the maximum flow rate is defined as the sum total flow rate calculated by individual fixture discharge sizes. The diversity factor and retention time are as follows:

Diversity Factor = 0.2 for light grease
0.3 for moderate grease
0.4 for heavy grease

Retention time = 24 minutes standard (to be no shorter than 8min)

- **Austin, Texas**

$$\frac{\left(Total.fixture.units.value\right)*7.5*\left(12\min\right)}{2.5}$$

Here, the total fixture units refers to the UPC calculation based on the number of sinks, dishwashers, etc. 12 minutes refers to retention time.

- **Stockton, California**

$$(Total.\max imum.flow)*(10\min)$$

The total maximum flow in this formula refers to the total gallons per minute of grease-laden water discharged to the tank.

Interceptor Size Comparisons - Example

It may not be immediately obvious, but a grease interceptor sized according to one standard may need to be sized differently when another standard is applied, even if all the variables are the same. For example, a small restaurant (A), a medium sized restaurant (B), and a large restaurant (C) have the following characteristics:

Restaurant	No. of Seats	Number of meals per peak hour	No. of Sinks	(D)ouble Sinks or (S)ingle ?	No. of Dishwashers	Dishwasher Capacity (EPA) (gal)	No.of Floor Drains	Influent Discharge Rate (EPA)	Influent Discharge Rate (UPC)	Total Fixture Units (UPC)
A	20	20	2	S	1	30	1	45	50	11
B	100	100	3	D	2	40	3	140	123	30
C	200	200	6	D	5	75	5	400	275	67

Table 2 – Influent Discharge Calculations for Restaurants A, B & C

As **Table 2** shows, the hypothetical influent discharge calculated using this data varies depending on whether the UPC or EPA formulas are used. This will undoubtedly have an effect of the interceptor sized for each restaurant. Moreover, the interceptor size required by each of the municipalities discussed earlier will also differ for each restaurant. **Table 3** calculates the size (in gallons) of the grease interceptor each municipality would require:

Restaurant	Johnson County, Kansas Sanitation Division	UPC	EPA	Washington Suburban Sanitary Commission	Austin, Texas	Stockton, California
A	1350	600	680	432	396	450
B	4200	3000	3400	1344	1080	1400
C	12000	6000	6800	3840	2412	4000

Table 3 – Grease Interceptor Size (Gal)

To understand the varying sizes presented here, it is important to note that each jurisdiction requires distinct interior designs and baffling systems that may affect the minimum required sizes. When designing to a particular formula, it is important to contact the appropriate jurisdiction for the most recent grease interceptor design criteria.

Pumpout

The above results give a range of acceptable interceptor sizes proven effective by various AHJ's. The effectiveness of each unit is directly related to the amount of grease it receives, the maximum flow rate through it, and the cleaning frequency.

The cost per pumpout can be relatively high compared to the original cost of the structure. This is especially true of smaller expensive interceptors less than 1000 gallons. It is effective to keep ongoing pumpout costs at a minimum by installing a grease interceptor with sufficient volume to contain impurities longer. A larger interceptor that requires fewer pumpings per year can be cost effective for the owner.

With this in mind, many AHJ's have specified minimum sizes for their grease interceptors. Any of the above formulas would provide adequate grease removal, but all would require different pumpout frequencies. One exception is noted: Restaurant (A) should have a minimum 750 gal interceptor. This minimum size is consistent with the minimum sizes specified by UPC, EPA, and various cities throughout the country.

Simple Structural Design Considerations

The following two facts help determine placement of an interceptor:

1. Grease interceptors are large, heavy and contain a wide variety of contaminants. Consequently, interceptors should be located outdoors of an establishment, especially food preparation establishments.

2. Grease-laden water should flow to the interceptor driven by gravity. Consequently, the interceptor should be placed at a lower elevation than the establishment.

For these reasons, it is most effective to bury an interceptor outdoors. This means that an interceptor must be designed to sustain not only the pressures of the liquids within it, but also the earth pressures around and over it. However, the interceptor should be buried close to the establishment, and frequently this means that it will be in an area of vehicular traffic. If this is true, the interceptor will need to have a structural "traffic rating."

When considering the structural needs for burial, it should also be noted that access to the interceptor for cleaning will be required. These accesses should be readily available to the maintenance personnel and may also need to be "traffic rated." Frequently the best solution for these access points is a steel or cast iron frame and cover.

Interior Design of an Interceptor

It is generally accepted that a grease interceptor should have sufficient retention time to allow for settling and the liquid depth should be between 30" and 72". These figures ensure a retention time that gives grease time to separate.

Another important factor in the design of an interceptor is partitioning and baffling. Various regulations and studies discuss the need for one or two partitions and their effect on grease removal. What is clear is that there should be at least one partition wall in an interceptor to keep floating grease away from the outlet. There should also be an inlet baffle designed to divert incoming flows from a straight-line path to the outlet. An outlet baffle keeps grease that gets past the partition from escaping out of the interceptor. Studies have shown that performance can be further enhanced with the use of effluent filters on the outlet. This is of particular significance where additional protection is desirable for on-site disposal situations.

All components should be made of durable materials.

Venting and Odor Control

Odor issues with outdoor interceptors can be eliminated with a properly designed grease interceptor and the associated building's plumbing/venting system. Most building codes require the interceptor be vented back through the inlet plumbing and to a roof vent. In almost all cases odor problems are

caused by improper venting of the building's plumbing system. This causes the gases to build up in the interceptor and allows them to escape leading to odor problems. Proper building ventilation and interceptor design along with gastight manhole covers will prevent odors from escaping the interceptor and allow them to escape through the roof vents.

Clean out accesses must also be considered when designing an interceptor. They must allow enough room for a pumper to effectively break up the grease mat. They should also be located so that the inlet and outlet baffles can be accessed and there should not be more than 10 feet between any two accesses for grease removal reasons.

Operation

The manner in which the establishment handles grease is critical to the effective performance of an interceptor. A plan for handling greases and oils that are waste but not part of the wastewater flows must be developed and followed. Kitchen pretreatment is by far the most effective means of grease and oil removal. It would be difficult and expensive to design and maintain interceptors for receiving grease volumes from anything other than necessary wash-up and cleaning. Employees should be made aware that excessive use of water or emulsifying detergents could detrimentally affect the performance of an otherwise effective interceptor.

Maintenance and Testing

All interceptors require a certain amount of maintenance to maintain an acceptable level of effluent AVFOG. This requires a certain frequency of pumping and inspection which is hard for any AHJ to predict for a new installation and it can be difficult for an AHJ to ensure compliance. For these reasons, it may be best to require the owner or establishment to obtain and maintain a maintenance contract with a qualified (and possibly approved) waste removal business. In fact, many jurisdictions require such contracts for the maintenance of grease interceptors because of the lack of accountability associated with the maintenance of indoor grease traps. For new installations, a monthly or bi-monthly cleaning may be required until the maintenance company can establish a predictable level of AVFOG accumulation for that particular facility. Thereafter, required cleanings may be extended until such a point where the optimum pumping frequency is found. The AHJ may also require either the owner or the maintenance company to notify the AHJ when a scheduled cleaning is performed (or missed) or when a contract is not renewed.

Automated monitoring systems are now available that monitor the levels of FOG's and solids in the tank. They allow the establishments to keep good maintenance records, and optimize pumping costs. These systems provide documentation for the AHJ and can even be monitored offsite by an AHJ or a management company.

CONCLUSION

There are many important factors in effective grease/oil removal from wastewater flows. Not all studies or AHJ's agree on all these factors or on their order of importance, but there are enough similarities to draw a number of conclusions.

Large outdoor grease interceptors are the best method for AHJ's to pre-treat kitchen waste. Every independent study that we've encountered regarding interceptor performance concludes that only large outdoor interceptors can provide a level of acceptable AVFOG removal. These studies were all conducted by agencies with maximum allowable discharge requirements.

Only large outdoor interceptors can provide maintenance accountability because of their reliance on third party maintenance contractors. When maintenance is provided by a third party the invoicing process creates a paper trail that can be relied upon by the AHJ to prove that maintenance is occurring. This assurance does not exist for self-maintained grease traps.

Finally, outdoor interceptors provide a level of health safety that indoor traps cannot provide. By physically removing the collection, maintenance and disposal of grease outside the kitchen area, outdoor interceptors eliminate the health concerns created by providing these functions in the same workspace as food preparation.

Glossary

Baffle: A device either installed after construction or built into the interceptor used to modify the wastewater flow pattern.

Clear space: Volume of liquid within an interceptor that is free of FOG and solids.

FOG: animal and vegetable fats, oils and grease used for the preparation of and resulting from the cooking of food. Its composition is principally complex manufactured vegetable oils with smaller proportions of fish oils and animal fats. Also present are food particles, detergents, suspended solids, and emulsified grease particles. The FOG produced by cooking, such as chicken fat and animal fats from frying hamburgers solidify in the piping network at lower temperatures and may be solely responsible for the sewer stoppages.

Fixtures: pot sinks, preparation sinks, and dishwashers.

Flow rate: amount of wastewater flow

GPM: Gallons per minute; flow rate unit

Grease interceptor: a containment structure installed outside a building and specifically designed to trap food related suspended grease and solids before discharging into the sanitary sewer system. They are usually constructed of precast concrete.

Grease trap: a small containment structure designed to withhold portions of suspended grease and solids produced by food facilities before they enter the building plumbing. These are located inside facilities near the grease source.

Influent: FOG-laden wastewater discharged into the interceptor from food preparation areas.

Invert: the bottom, inside of a pipe.

Loading level: the average concentration of FOG in one gallon of wastewater discharging into the interceptor.

Loading rate: the frequency in which FOG laden wastewater enters the interceptor

Pumpout: To completely empty a grease interceptor, to include the scraping of the sidewalls

Retention time: the amount of time wastewater spends in the interceptor from the instant it leaves the inlet pipe to the time it enters the outlet pipe.

UPC: Uniform Plumbing Code

Wetted capacity: The total volume of liquid measured from the top of the sludge accumulation on bottom to the top of the liquid line.

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