Grease Interceptors

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The purpose of a grease interceptor is to intercept and collect free-floating fats, oils, and grease (FOG) from a commercial or institutional kitchen's wastewater discharge, thereby preventing the deposition of pipe-clogging FOG in the sanitary drainage system. Grease interceptors are required to receive the drainage from fixtures and equipment with FOG-laden wastes, including pot sinks, soup kettles or similar devices, wok stations, floor drains or sinks into which kettles are drained, automatic hood-wash units, pre-rinse sinks, and dishwashers without grinders. Residential dwellings seldom discharge FOG in such quantities as to warrant a grease interceptor.

Grease interceptors typically come in one of two basic types. The first type is called a hydromechanical grease interceptor (HGI), previously referred to as a grease trap. These are typically thermoplastic (such as high-density polyethylene [HDPE], low-density polyethylene [LDPE], or polypropylene) or prefabricated steel manufactured units, predominately located indoors at a centralized location in proximity to the fixtures served or at the discharging fixture point of use. They are relatively compact in size and utilize hydraulic flow characteristics, internal baffling, air entrainment, and the difference in the specific gravities between water and FOG to separate and retain FOG from the fixture waste stream. The standards governing the installation, testing, and maintenance of HGIs are PDI G101: *Testing and Rating Procedure for Grease Interceptors,* ASME A112.14.3: *Grease Interceptors,* and CSA B481: *Grease Interceptors.*

The second type is the gravity grease interceptor (GGI). These may be manufactured from fiberglass or thermoplastics or are engineered, prefabricated, or field-formed concrete-constructed units. They typically are located outside due to their large size and receive FOG discharge waste from all required fixtures within a given facility. GGIs use large volumes of water and retention time to separate FOG from the facility's waste stream prior to it entering the municipal drainage system. The standard for the design and construction of gravity grease interceptors is IAPMO/ANSI Z1001: *Prefabricated Gravity Grease Interceptors.*

Other FOG retention and removal devices are categorized as either grease removal devices (GRDs) or FOG disposal systems (FDSs).

Note: It is important to understand that FOG retention and removal are a continuing evolution of technology. The types of interceptors currently on the market may be proprietary and may include features specifically inherent to one particular manufacturer. The purpose of the equipment descriptions contained in this chapter is to expose the designer to the basic types of FOG treatment equipment presently available as currently defined and listed within the model codes.

PRINCIPLES OF OPERATION

Grease interceptors operate on the principle of separation by flotation alone over time or by fluid mechanical forces in conjunction with flotation according to Stokes' law.

All interceptor designs employ the difference between the specific gravity of water and that of the FOG. If the specific gravity of the FOG is close to that of water, the globules will rise more slowly. If the density difference between the grease and the water is larger, the rate of separation will be faster.

The rise rate of a FOG globule is inversely proportional to the viscosity of the wastewater. The rate of ascension will be faster when the carrier fluid is less viscous and vice versa. FOG globules rise more slowly at lower temperatures and more rapidly at higher temperatures. FOG, especially when hot or warm, has less drag, is lighter than water, and does not mix well with water. The final velocity for a spherical particle, known as its floating velocity, may be calculated using Newton's equation for frictional drag with the driving force, shown in Equation 8-1:

Equation 8-1

$$\frac{C_d\, A\, p\, v^2}{2} = (p_1 - p)\, g\, V$$

This yields the following mathematical relationship:

Equation 8-2

$$v = \sqrt{\frac{4}{3} \times \frac{g}{C_d} \times \frac{(p_1 - p)}{p} \times D}$$

where

C_d = Drag coefficient
A = Projected area of the particle, $pD^2/4$ for a sphere
v = Relative velocity between the particle and the fluid
p = Mass density of the fluid
p_1 = Mass density of the particle
g = Gravitational constant, 32.2 ft/s/s
D = Diameter of the particle
V = Volume of the particle, $13pr^3$ for a sphere (r = radius of the particle)

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Experimental values of the drag coefficient have been correlated with the Reynolds number, a dimensionless term expressing the ratio of inertia and viscous forces. (Note: Equation 8-2 applies to particles with diameters of 0.4 inch [10 mm] or smaller and involving Reynolds numbers less than 1. For larger diameters, there is a transition region; thereafter, Newton's law applies.) The expression for the Reynolds number (R = r v D/m) contains, in addition to the parameters defined above, the absolute viscosity. The drag coefficient has been demonstrated to equal 24/R (Stokes' law). When this value is substituted for C_d in Equation 8-2, the result is the following (Reynolds number <1):

Equation 8-3

$$v = \frac{g\,(p_1 - p)\,D^2}{18m}$$

The relationship of differential densities in Equation 8-3, which identifies the principle of separation in a grease interceptor, has been verified by a number of investigations for spheres and fluids of various types. An examination of this equation shows that the vertical velocity of a FOG globule in water depends on the density and diameter of the globule, the density and viscosity of the water, and the temperature of the water and FOG material. Specifically, the FOG globule's vertical velocity is highly dependent on the globule's diameter, with small globules rising much more slowly than larger ones. Thus, larger globules have a faster rate of ascension.

The effect of shape irregularity is most pronounced as the floating velocity increases. Since FOG particles in sanitary drainage systems have slow floating velocities, particle irregularity is of small importance.

Figure 8-1 shows the settling velocities of discrete spherical particles in still water. The heavy lines are for settling values computed using Equation 8-3 and for drag coefficients depending on the Reynolds number. Below a Reynolds number of 1, the settlement is according to Stokes' law. As noted above, as particle sizes and Reynolds numbers increase, there is first a transition stage, and then Newton's law applies. At water temperatures other than 50°F (10°C), the ratio of the settling velocities to those at 50°F (10°C) is approximately (T + 10)/60, where T is the water temperature. Sand grains and heavy floc particles settle in the transition region; however, most of the particles significant in the investigation of water treatment settle well within the Stokes' law region. Particles with irregular shapes settle somewhat more slowly than spheres of equivalent volume. If the volumetric concentration of the suspended particles exceeds about 1 percent, the settling is hindered to the extent that the velocities are reduced by 10 percent or more. Flotation is the opposite of settling insofar as the densities and particle sizes are known.

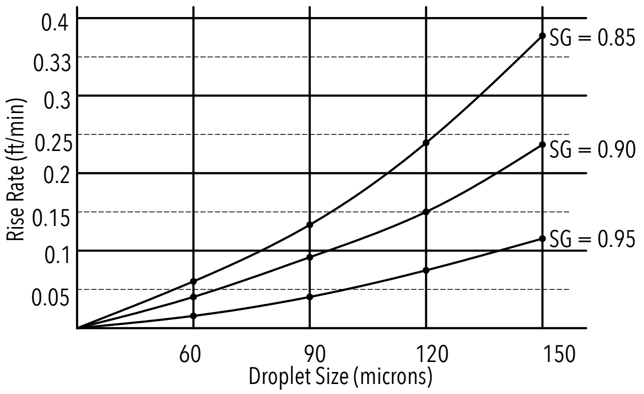

Figure 8-1 Rising and Settling Rates in Still Water

Retention Period

The retention period (P) is the theoretical time that water is held in the grease interceptor. The volume of the tank for the required retention period can be computed as follows:

Equation 8-4

$$V = QP$$

As an example, for a retention period (P) equal to 30 minutes and a flow rate (Q) of 35 gallons per minute (gpm), the tank volume is V = (35 x 30) = 1,050 gallons. (Divide by 7.48 to find the cubic feet [140.37 ft^3].)

Retention periods should be based on the peak flow during the retention period. In International Standard (SI) units, the denominator in Equation 8-4 becomes approximately unity (1).

Flow-Through Period

The actual time required for the water to flow through an existing tank is called the flow-through period. How closely this flow-through period approximates the retention period depends on the tank. A well-designed tank should provide a flow-through period at least equal to the required retention period.

Factors Affecting Flotation in the Ideal Basin

When designing the ideal separation basin, four parameters dictate effective FOG removal from the water: FOG droplet size distribution, droplet velocity, FOG concentration, and the condition of the FOG as it enters the basin. FOG can be present in five basic forms: oil-coated solids, free oil, mechanically emulsified, chemically emulsified, and dissolved. When designing the ideal basin, consider only free-floating FOG.

The ideal separation basin has no turbulence, short-circuiting, or eddies. The flow through the basin is laminar and distributed uniformly throughout the basin's cross-sectional area. The surface-loading rate is equal to the overflow rate. Free FOG is separated due to the difference in specific gravity between the FOG globule and the water. Other factors affecting the design of an ideal basin are influent concentration and temperature.

It is important to evaluate and quantify a basin design both analytically and hydraulically. The basin chamber (see Figure 8-2) is divided into two zones: the liquid treatment zone and the surface-loading area (FOG mat) where the separated FOG is stored. L is the length of the chamber or basin, and D is the liquid depth or the maximum distance the design FOG globule must rise to reach the FOG mat. V_h is the horizontal velocity of the water, and V_t is the vertical rise rate of the design FOG globule.

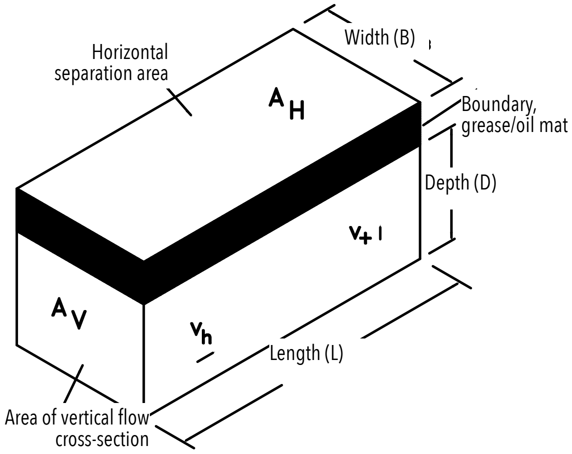

Figure 8-2 Cross-Section of a Grease Interceptor Chamber
V_t: Vertical component of grease/oil droplet velocity = terminal rise velocity of droplet (gravity separation)
V_h: Horizontal component of grease/oil droplet velocity = water velocity

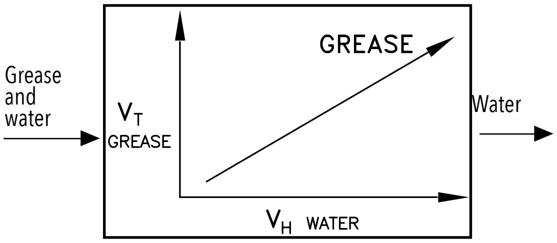

Figure 8-3 Trajectory Diagram

As noted, the separation of FOG from water by gravity differential can be expressed mathematically by Stokes' law, which can be used to calculate the rise rate of any FOG globule on the basis of its size and density and the density and viscosity of the water. (See Figure 8-1 for the rise rate versus globule size at a fixed design temperature.)

The primary function of a grease interceptor is to separate free-floating FOG from the wastewater. Such a unit does not separate soluble substances, and it does not break emulsions. Therefore, it never should be specified for these purposes. However, like any settling facility, the interceptor presents an environment in which suspended solids are settled coincident with the separation of the FOG in the influent.

The ability of an interceptor to perform its primary function depends on a number of factors. These include the type and state of FOG in the waste flow, the characteristics of the carrier stream, and the design and size of the unit. Due to the reliance on gravity differential separation, interceptor effectiveness has a practical limitation. In terms of FOG globule size, an interceptor will be effective over a globule diameter range having a lower limit of 0.015 centimeter (150 microns).

Gravity separation allows the removal of particles that exhibit densities different from their carrier fluid. Separation is accomplished by detaining the flow stream for a sufficient time to allow particles to separate out. Separation, or retention, time (T) is the theoretical time that water is held in the basin. A basin must be designed such that even if the FOG globule enters the chamber at the worst possible location (at the bottom), enough time will be available for the globule to rise the distance needed for capture (see Figure 8-3). If the FOG globule rate of rise (V_t) exceeds the retention time required for separation, the basin will experience pass-through or short-circuiting. Retention time can be expressed as:

Equation 8-5

$$V = QT$$

where

V = Volume of basin
Q = Design flow
T = Retention time

As previously noted, particles that rise to the surface of a liquid are said to possess rise rates, while particles that settle to the bottom exhibit settling rates. Both types obey Stokes' law, which establishes the theoretical terminal velocities of rising and/or settling particles. With a value of 0.015 centimeter for the diameter (D) of the globule, the rate of rise of oil globules in wastewater may be expressed in feet per minute as:

Equation 8-6

$$V_t = \frac{0.0241\,(S_w - S_o)}{u}$$

where

V_t = Rise rate of oil globule (0.015 centimeter in diameter) in the wastewater, ft/min
S_w = Specific gravity of wastewater at the design temperature of flow
S_o = Specific gravity of oil in the wastewater at the design temperature of flow
u = Absolute viscosity of the wastewater at the design temperature, poises

Example 8-1

The following example illustrates the application of the above equations for the design of a grease interceptor.

Without additional data describing the distribution of oil droplets and their diameters within a representative wastewater sample, it is not possible to quantitatively predict the effect that increased interceptor size or reduced flow and the subsequent increased retention time within the grease intercep-

Table 8-1 Travel Time for a Droplet to Rise 3 inches at 68°F

Droplet Diameter, microns	Rise Time of Oil, SG = 0.85, hr:min:sec
300	0:00:12
150	0:00:42
125	0:01:00
90	0:01:54
60	0:04:12
50	0:06:18
40	0:09:36
30	0:17:24
20	0:38:46
15	1:08:54
10	2:35:02
5	10:02:09
1	258:23:53
Droplet Diameter, microns	**Rise Time of Oil, SG = 0.90, hr:min:sec**
300	0:00:15
150	0:01:03
125	0:01:27
90	0:02:54
60	0:06:36
50	0:09:18
40	0:14:24
30	0:25:48
20	0:58:08
15	1:43:22
10	3:52:33
5	15:30:14
1	387:35:49

tor will have on the effluent concentration of the interceptor. However, experimental research on oil droplet rise time (see Table 8-1) illustrates the effect that increased interceptor size or reduced flow and the subsequent increased retention time within the grease interceptor will have on oil droplet removal. Following the logic in Table 8-1 allows the designer to improve the grease interceptor by increasing the interceptor volume or reducing flow and subsequently lowering horizontal velocity and increasing retention time.

Other data for this example is as follows:

- Specific gravity of grease/oil in wastewater: 0.9 (average)
- Temperature of wastewater and oil mixture: 68°F (average)
- Rate of rise of oil globules in the wastewater: use Equation 8-6
- Dimensions of a typical 20-gpm capacity grease interceptor: 22 inches long, 14 inches wide, 20 inches high
- Capacity: 21.33 gallons
- Fluid level: 16 inches
- Flow rate: 20 gpm
- Inlet/outlet: 2 inches
- The grease interceptor will operate when completely full and in a horizontal position.
- Inlet and outlet pipes are running full, and the interceptor is fully charged.
- FOG globules must rise a minimum distance of 3 inches from a point at the bottom of the inlet head of the interceptor to a point directly below the interceptor effluent outlet.

To solve, first determine the rate of rise of the oil globules: 150 micron = 0:01:03 minutes. Then determine the wastewater flow rate through a 20-gpm capacity grease interceptor:

- $V_h = L/T = 1.83\ ft^2/1.03$ minutes = 1.776 ft/min
- Wetted cross-sectional area of the separation basin: W × H = 14 in. × 16 in. = 224 $in.^2 \times 6.944 \times 10^{-3} = 1.55\ ft^2$
- Wastewater flow rate: $1.55\ ft^2 \times 1.776$ ft/min = 2.76 ft^3/min × 7.48 = 20.66 gpm

This example proves the critical elements in designing the ideal basin. FOG droplet size and velocity determine the minimum outlet elevation needed to capture the targeted FOG globule. This also establishes retention time as a key element in the design of a basin. The hydraulic environment of the separation chamber of the grease interceptor induces the separation of FOG and the deposition of solids. Stokes' law governs the rise and fall rates of an oil droplet or solid particle in the fluid stream.

The principles of flotation discussed above are applicable strictly to particles that are separate and distinct. If the wastewater mixture contains variously sized FOG droplets and solid particles distributed throughout the mixture, each droplet will (in accordance with Stokes' law) rise toward the surface or fall to the bottom at a rate depending on its diameter.

In strong concentrations of very small particles, as in turbid waters, hindered flotation takes place. This condition means that the faster-rising particles collide with the slower-rising particles with more or less agglomeration due to adhesion. The resulting larger particles float faster and coalesce into larger droplets with a higher rate of rise. The odds of such a collision depend on the droplet size distribution and the quantity of droplets in the mixture. This condition is particularly noticeable where the suspended particles are highly flocculent (i.e., composed of masses of very finely divided material). Therefore, a tank that is deep enough to allow agglomeration will have a blanket (or mass) of flocculent material receiving the suspended solids from the material rising from below or from the currents passing through it. Thus, the tank will lose masses of the agglomerated solids to the storage space above.

While the varying flotation rates among the particles are probably the most important factor in agglomeration, the varying liquid velocities throughout the tank have a similar effect, causing fast-moving particles to collide with slower-moving particles. Since flocculation can be assumed to continue throughout the entire flotation period, the amount of flocculation depends on the detention period. Accordingly, with a given overflow rate, a tank of considerable depth should be more efficient than a shallow unit. On the other hand, a decrease in the overflow rate might have the same effect. A flotation test might determine the point of agglomeration for a known water sample.

PRACTICAL DESIGN

While acquaintance with the theory of flotation is important to the engineer, several factors have prevented the direct application of this theory to the design of grease interceptors. Some turbulence is unavoidable at the inlet end of the tank. This effect is greatly reduced by good inlet design (including baffling) that distributes the influent as uniformly as practicable over the cross-section of the tank. The streamline flow at the outlet also encounters some interference, but this condition is less pronounced than the inlet turbulence and is reduced only by using overflow weirs or baffles. Density currents are caused by differences in the temperature, the density of the incoming wastewater, and the interceptor's contents. Incoming water has more suspended matter than the partially clarified contents of the tank. Therefore, the influent tends to form a relatively rapid current along the bottom of the tank, which may extend to the outlet. This condition is known as short-circuiting and occurs even with uniform collection at the outlet end.

Flocculation of suspended solids has been mentioned. Its effects, however, are difficult to predict.

In general, the engineer depends on experience as well as the code requirements of the various local health departments for the preferred retention and overflow rates. Depth already has been discussed as having some effect on the tank's efficiency—a smaller depth provides a shorter path for the rising particle to settle.

The tank's inlets and outlets also require careful consideration by the designer. The ideal inlet reduces the inlet velocity to prevent the pronounced currents toward the outlet, distributes the inlet water as uniformly as practical over the cross-section of the tank, and mixes the inlet water with the water already in the tank to prevent the entering water from short-circuiting toward the outlet.

GREASE INTERCEPTOR TYPES

Hydromechanical Grease Interceptors

For more than 100 years, grease interceptors have been used in plumbing drainage systems to prevent grease accumulations from clogging interconnecting sanitary piping and sewer lines. However, it wasn't until 1949 that a comprehensive standard for the basic testing and rating requirements for hydromechanical grease interceptors was developed. This standard is known as PDI G101. It has been widely recognized and is referenced in most plumbing codes, replicated in part in ASME A112.14.3, referred to in manufacturer literature, and was included in the basic testing and rating requirements of Military Specification MIL-T-18361 (which was cancelled without replacement in 1982).

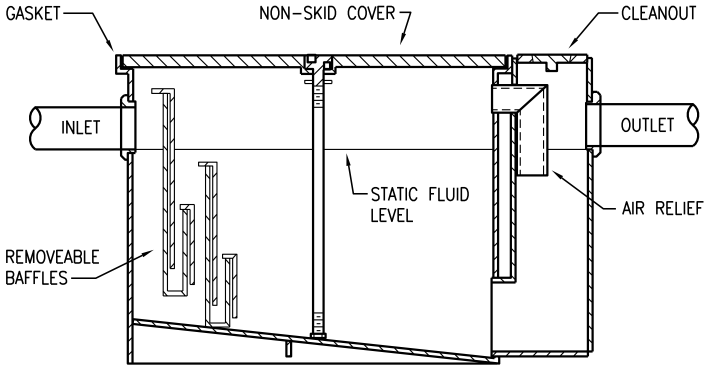

Figure 8-4 Hydromechanical Grease Interceptor

In 1994, the Plumbing and Drainage Institute agreed to work with the American Society of Mechanical Engineers (ASME International) for the development of an ANSI standard known as ASME A112.14.3, which was published in 2000. This standard replicates the requirements of PDI G101 for certification with three exceptions:

1. PDI G101 sets a minimum grease capacity of 2.25 pounds (1 kg) of grease for each 1 gpm (3.8 L/min), while ASME A112.14.3 sets the minimum capacity at 2 pounds (0.9 kg) of grease for each 1 gpm (3.8 L/min).
2. PDI G101 requires grease interceptors to be tested and rated with a vented (air intake) external flow control; ASME A112.14.3 distinguishes among four different types of units defined as follows:
   - Type A: Units with an external flow control with an air intake (vent), directly connected
   - Type B: Units with an external flow control without an air intake (vent), directly connected
   - Type C: Units without an external flow control, directly connected
   - Type D: Units without an external flow control, indirectly connected
3. ASME A112.14.3 requires a grease interceptor to be tested to its breakdown point (the increment preceding two successive increments in which either the average efficiency is less than 90 percent or the incremental efficiency is less than 80 percent). PDI G101-certified interceptors tested to the breakdown point are certified by flow rate stating, "Maximum Grease Capacity [- - - lbs]." Otherwise, all PDI G101-certified interceptors are tested to a minimum of 13 increments and conform with or exceed the following requirements:
   - Have an average efficiency of 90 percent or more at the rated grease retention capacity to the flow rate
   - Have an incremental efficiency of 80 percent or more
   - Have a minimum grease capacity per the standard, having retained not less than 2.25 pounds (1 kg) of grease for each 1 gpm (3.8 L/min) as determined during the test

In 2007, the Canadian Standards Association (CSA Group) published the first edition of CSA B481, which is a derivative of PDI G101 and ASME A112.14.3. Grease interceptors certified to this standard are required to be tested and rated in accordance with ASME A112.14.3.

Conventional hydromechanical interceptors (see Figure 8-4) are generally available with a rated flow capacity up to 100 gpm (6.31 L/s) for most applications. For flow rates above 100 gpm (6.31 L/s), designers may consider using multiple units in parallel from manufacturers that offer effective flow-splitting devices or fittings; however, it is recommended to consult manufacturers for appropriate solutions.

The internal designs of hydromechanical interceptors are similar. Inlet baffles, available in various arrangements, act to ensure at least 90 percent efficiency of grease removal per PDI G101, ASME A112.14.3, and CSA B481 testing. Long runs of pipe between the FOG source and the interceptor should be avoided to prevent FOG accumulation and mechanical emulsification prior to the wastewater entering the interceptor.

Grease is removed from a hydromechanical grease interceptor by opening the access cover and removing the accumulated FOG and solids from the interior (along with the removal of a perforated filter screen for cleaning if so equipped).

Semiautomatic Units

Semiautomatic units are typically hydromechanical interceptors in design. To remove the accumulated FOG, hot water is run into the interceptor, with an interceptor discharge valve closed to raise the water level, which displaces the FOG into a draw-off recovery cone or pyramid that is discharging through a draw-off hose to a FOG disposal container.

Grease Removal Devices

Grease removal devices also are typically hydromechanical interceptors that include electrically powered heating elements and skimming devices. ASME A112.14.4: *Grease Removal Devices* describes the design and testing requirements for GRDs. Two variations of this interceptor design are timer-controlled and sensor-controlled.

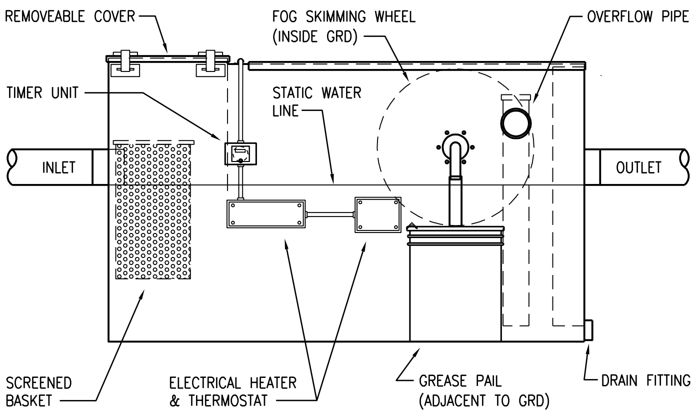

Figure 8-5 Timer-Controlled Grease Removal Device

In timer-controlled designs (see Figure 8-5), retained FOG is skimmed from the water in the interceptor by a powered skimming device on a time-controlled basis. The skimmed FOG is scraped or wiped from the skimmer surface and directed into a trough draining from the interceptor into a disposal container located adjacent to or attached to the interceptor. GRDs may be fitted with an electric immersion heater to elevate the water temperature in the interceptor to keep the FOG in a liquid state to facilitate skimming. A variation of this type utilizes a FOG-removal pump positioned inside or outside the interceptor that is controlled by a sensor or a timer device. The pump discharges to a tank adjacent to or attached to the interceptor.

Sensor-controlled GRDs employ sensors or probes that sense the FOG level and initiate draw-off at a predetermined percentage of the interceptor's rated capacity. FOG is drawn from the FOG layer in the interceptor until water is detected by the sensor, which stops the cycle to ensure that water-free FOG is recovered. If required, an immersion heater is activated automatically at the onset of the draw-off cycle to liquefy FOG in the interceptor. In addition, if either the GRD grease collection reservoir (where recovered grease is stored pending removal) or the interceptor itself is near capacity, warning measures and unit shutdown are activated.

When GRDs are considered for installation, the manufacturer should be consulted regarding electrical and maintenance requirements. The plumbing engineer must coordinate these requirements with the appropriate trades to ensure proper installation. Those responsible for operating GRDs should be trained in their operation.

FOG Disposal Systems

A FOG disposal system [ASME A112.14.6: *FOG (Fats, Oils, and Greases) Disposal Systems*] is very similar to a hydromechanical interceptor in its operation. However, in addition to reducing FOG in effluent by separation, it automatically reduces FOG in effluent by mass and volume reduction, without the use of internal mechanical devices or manual FOG removal. This system is specifically engineered, and one type is configured to contain microorganisms that are used to oxidize FOG within the interceptor to permanently convert the FOG material into the by-products of digestion, a process otherwise referred to as bioremediation. (This is the same process used by municipal wastewater treatment plants.) Other FOG disposal systems utilize thermal or chemical methods of oxidation.

Figure 8-6 is an example of a bioremediation type of interceptor. The interceptor is divided into two main chambers, separated by baffles at the inlet and outlet sides. The baffle located at the inlet side of the interceptor acts to distribute the inflow evenly across the horizontal dimension of the interceptor. However, unlike conventional HGIs, a media chamber is its main compartment, which contains a coalescing media that is engineered to cause FOG to rise along the vertical surfaces of the media structure, where it comes into contact with microorganisms inhabiting a biofilm attached to the media. A wall-mounted shelf located above the interceptor supports a metering pump, timer, controls, and a bottle filled with a bacteria culture provided by the system manufacturer.

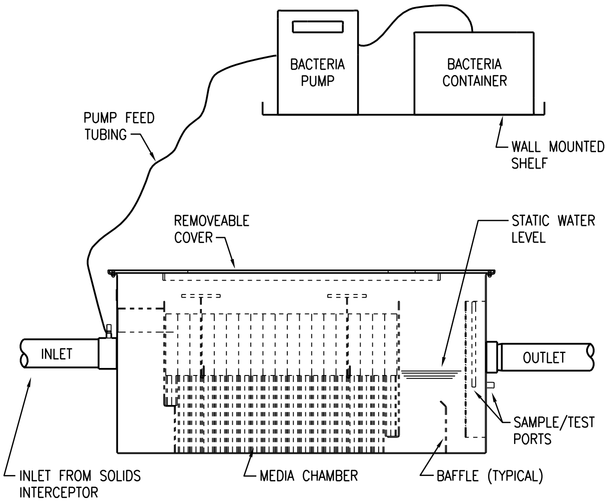

Figure 8-6 Bioremediation FOG Disposal System

As the FOG material collects in the biofilm, bacteria from the culture bottle (injected by the metering pump) break the bonds between fatty acids and glycerol and then the bonds between the hydrogen, carbon, and oxygen atoms of both, thereby reducing FOG volume. Drainage continues through the media chamber around the outlet baffle, where it then is discharged to the sanitary system.

Though FOG disposal systems significantly reduce the need for manual FOG removal or the handling of mechanically removed FOG materials, monitoring effluent quality, routine maintenance to remove undigested materials, and inspections to ensure that all components are clean and functioning properly are required and should be performed on a regular basis. Furthermore, it is essential that the plumbing engineer coordinate all electrical and equipment space allocation requirements with the appropriate trades to allow for the proper installation and functioning of a FOG disposal system.

FOG disposal systems are discussed further in Chapter 13.

Gravity Grease Interceptors

Gravity grease interceptors (see Figure 8-7) are commonly made of 4-inch (101.6-mm) thick minimum concrete walls, with interior concrete bulkheads that divide the interior into more than one chamber, where attenuating flow separates FOG by gravity. Property standards may allow other materials such as fiberglass, thermoplastic, and protected steel. Unlike HGIs, they do not contain or rely on external flow control devices for proper functioning.

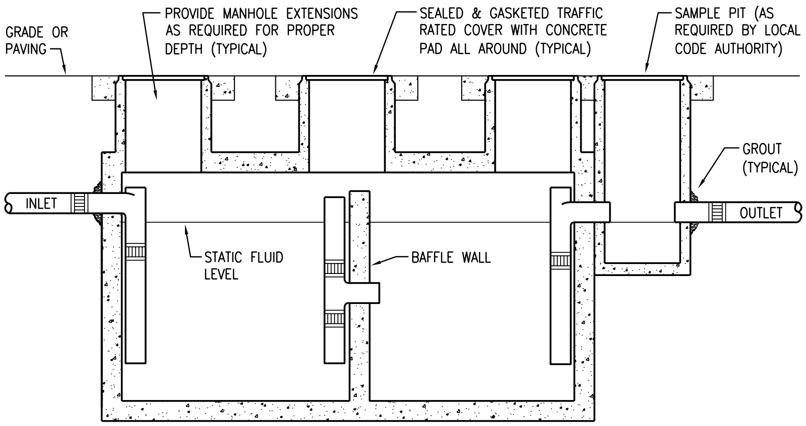

Figure 8-7 Gravity Grease Interceptor

GGIs typically are buried outside buildings where they are easily accessible for professional inspection and maintenance and away from food preparation areas. This eliminates possible food contamination during cleaning and prevents delays in kitchen operation. It is recommended that a GGI be located behind the facility, as close to the source of FOG as possible (e.g., directly behind the restaurant near the kitchen). If this cannot be achieved due to field conditions or other site constraints, a heat trace system can be installed along the grease waste piping to the inlet side of the GGI to help prevent FOG from solidifying before it enters the interceptor. Increasing the slope of the drain piping to the interceptor could be considered in lieu of heat tracing where allowable by the local code or authority having jurisdiction (AHJ). Alternatively, the designer could lay out the kitchen drainage fixtures such that the dishwasher is at the top of the line to flush out any potential accumulated grease in the plumbing system.

If a GGI is located in a traffic area, construction and access covers must be capable of withstanding the traffic load. Access for cleanout is also required.

GGIs in the form of prefabricated cylindrical protected steel tanks are also available (see Figure 8-8). Interceptors of this design are available with single and multiple chambers with internal baffles, vent connections, and manhole extensions as may be required for proper operation. They may be manufactured in single- and double-wall construction and can be equipped with steam or electric heating systems to facilitate FOG separation and extraction.

Protected steel tank GGIs may be built to UL specifications for structural and corrosion protection of the interior and exterior of the interceptor. Exterior corrosion protection is typically a two-part polyurethane, high-build coating with interior coating options of polyurethane, epoxy, or a proprietary material. When protected steel tank GGIs are considered for installation, the manufacturer should be consulted regarding venting and hold-down requirements for buoyancy.

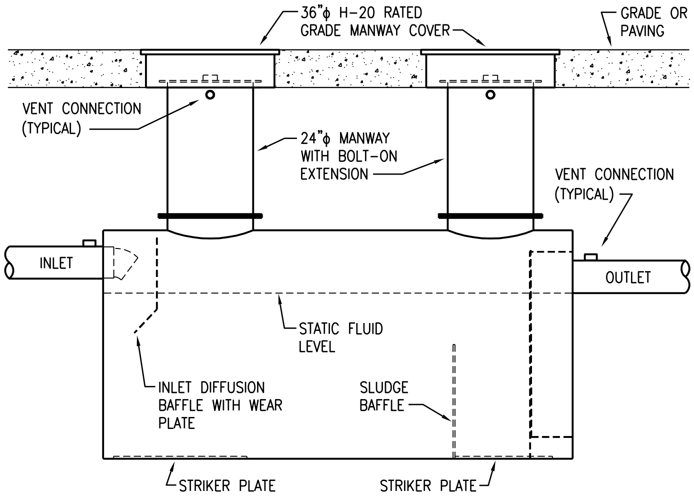

Figure 8-8 Prefabricated Steel Gravity Grease Interceptor

INSTALLATION

Most local administrative authorities require water from FOG-producing food service fixtures and equipment to discharge into an approved interceptor before entering the municipality's sanitary drainage system. Pretreatment regulations, with pretreatment coordinators having the final word, may include all kitchen discharges, including floor drains. If floor drains are connected to an interceptor, the interceptor must be recessed or below the floor.

It is recommended to locate the interceptor as close to the grease-producing fixtures as possible. Under-the-counter or above-slab interceptor installations are often possible adjacent to the grease-producing fixtures. This arrangement may combine venting of the fixtures with a common vent and trap downstream of the grease interceptor. Provided this arrangement is allowed by the applicable codes, special attention should be paid to the air inlets to control the air-injecting flow to avoid circuiting the building vent to the fixture.

Some practical considerations are important if an interceptor will be located near the fixtures it serves. For instance, if the interceptor is an under-the-counter, above-the-slab device, the engineer must leave space above the interceptor cover to allow FOG removal.

If the grease interceptor is located far from the fixtures it serves, the grease can cool and solidify in the waste lines upstream of the interceptor, causing clogging conditions and requiring more frequent cleaning of the waste lines. However, a heat trace system can be installed along the main waste line that is routed to the inlet side of the interceptor to keep the FOG from solidifying before it enters the interceptor.

Some ordinances do not allow the installation of interceptors where the surrounding temperatures under normal operating conditions are less than 40°F (4.4°C).

Some administrative authorities prohibit the discharge of food waste disposers through HGIs and GRDs because of the accumulation of food particles. Other jurisdictions allow this setup, provided that a solids interceptor or strainer basket is installed upstream to remove food particulates prior to the waste stream entering the interceptor. When allowed by the AHJ, connecting food waste disposers to HGIs and GRDs (in conjunction with a solids strainer) is recommended due to the fact that disposer waste discharge is a prime carrier of FOG-laden material.

The same situation is similar with respect to dishwashers. Some administrative authorities prohibit the discharge of dishwasher waste to HGIs and GRDs, while other jurisdictions allow it. It is recommended that dishwashers not be connected to HGIs or GRDs; although the high discharge waste temperature from a dishwasher may be beneficial to the FOG separation process by helping keep the FOG in a liquid state, the detergents used in dishwashing equipment can impair the device's ability to separate FOG.

FLOW CONTROL

Flow controls are best located immediately downstream of the last drain of the fixtures served prior to the interceptor. Flow control fittings are not commonly applied to floor drains or for fixtures that could flood.

Attention to manufacturer's instructions is necessary for the proper application of flow controls. The purpose of air-injecting flow controls is to cause air to be drawn into the flow downstream of the orifice, thereby promoting air-entrained flow at the interceptor's rated flow. The air entrained through the flow control aids FOG flotation by lifting and FOG particle agglomeration.

The air intake (vent) for the flow control, required by interceptors certified to PDI G101, CSA B481.1, and ASME A112.14.3 Type A, may terminate above the flood line of the sink as high as possible to prevent overflow, or it may terminate in a return bend at the same height on the outside of the building. A flow control air intake may connect to the vent stack if the fixtures are properly trapped. Illustrations of the correct placement of air-injecting flow controls appear in the appendix of the applicable standard.

Interceptors certified to ASME A112.14.3 Type B have an unvented external flow control. Interceptors certified to ASME A112.14.3 Types C and D do not have a vented or unvented external flow control fitting. Engineers should consult the manufacturer's installation instructions regarding the use, location, and installation of flow controls that are a part of a unit's certification type.

GUIDELINES FOR SIZING

The local authority having jurisdiction has the final say in the sizing of a grease interceptor, so always contact the AHJ to determine which code or method to use before beginning the design. However, categorizing a design size based on the type of interceptor may lead to either an undersized or oversized installation. Since most interceptors are proprietary in nature and designed differently by each manufacturer, it is recommended to consult with the manufacturer to determine the necessary capacity for the application.

Gravity Grease Interceptors

The 2015 Uniform Plumbing Code establishes the volume of a GGI based on a table of drainage fixture units (DFUs), as shown in Table 8-2. Where DFUs are not known, the interceptor shall be sized based on the maximum DFUs allowed for the pipe size connected to the inlet of the interceptor (refer to Table 703.2 in the 2015 UPC).

The 2015 International Plumbing Code introduced a new section (1003.3.6) governing requirements for GGIs. The sizing requirement simply states "shall be determined by multiplying the peak drain flow into the interceptor in gallons per minute by a retention time of 30 minutes."

Table 8-2 Gravity Grease Interceptor Volumes

Drainage Fixture Units (DFUs)[1,3]	Interceptor Volume (gal)[2]
8	500
21	750
35	1,000
90	1,250
172	1,500
216	2,000
307	2,500
342	3,000
428	4,000
576	5,000
750	7,500
2,112	10,000
2,640	15,000

For SI units: 1 gallon = 3.785 L

[1] The maximum allowable DFUs plumbed to the kitchen drain lines that will be connected to the grease interceptor

[2] This size is based on DFUs, the pipe size from UPC Table 703.2 (2015 UPC), and useful tables for flow in half-full pipes. Based on a 30-minute retention time. Rounded up to the nominal interceptor volume.

[3] Where the flow rate of directly connected fixture(s) or appliance(s) have no assigned DFU values, the additional grease interceptor volume shall be based on the known flow rate multiplied by 30 minutes.

Hydromechanical Grease Interceptors

The following sizing procedure for HGIs may be used as method to calculate the flow rate in gpm for the connected fixtures and equipment.

Example 8-2

Assume a single-fixture installation. Size the grease interceptor for a three-compartment pot (scullery) sink, with each compartment being 18 × 24 × 12 inches.

1. Determine the sink volume:
   - Cubic contents of one sink compartment = 18 × 24 × 12 = 5,184 in.^{3}
   - Cubic contents of three sink compartments = 3 × 5,184 = 15,552 in.^{3}
   - Contents expressed in gallons = 15,552 in.^{3}/231 = 67.3 gal
2. Add the total potable water supply that could be discharged independent of the fixture calculated above, including manufacturer-rated appliances such as water wash exhaust hoods.
3. Determine the fixture load. A sink (or fixture) seldom is filled to the brim, and dishes, pots, or pans displace approximately 25 percent of the water. Therefore, 75 percent of the actual fixture capacity should be used to establish the drainage load: 0.75 × 67.3 gal = 50.8 gal.
4. Calculate the flow rate based on drain time, typically one or two minutes. Flow rate is calculated by dividing the drainage load in gallons by the drain time in minutes. Therefore, the flow for this example would be 50 gpm (3.15 L/s) for one-minute drainage or 25 gpm (1.58 L/s) for two-minute drainage.
5. Select a hydromechanical interceptor with a rated capacity of 50 gpm for one-minute flow or 25 gpm for two-minute flow.

Sizing a hydromechanical grease interceptor by flow rate according to Example 8-2 is mandatory, yielding many options for grease interceptors that are certified at the calculated flow rate but also are certified at the minimum grease storage capacity. Selecting an HGI that can only store the minimum required amount of FOG may be problematic in that the food service establishment could be required to conduct maintenance on a biweekly, weekly, or even daily basis. The following optional selection method for HGIs allows an engineer to calculate the potential daily grease load that may be anticipated from a given food service establishment to select an interceptor that meets the minimum required flow rate previously established with a larger grease storage capacity.

CODE REQUIREMENTS

The necessity to verify all state and local jurisdictional requirements prior to the start of any food service facility design cannot be emphasized enough. Although state and model plumbing codes provide information with respect to interceptor requirements and regulations, local health departments and administrative AHJs have likely established their own guidelines and requirements for interceptors and, therefore, also should be consulted at the start of the design. It is up to the plumbing engineer to pull together the various agency requirements to design a code-compliant system while incorporating any additional governing requirements and regulations.

Following are itemized lists incorporating the major provisions of the model plumbing codes and are included herein as an abbreviated design guide for the engineer when specifying sizing. It is important to review the applicable code in effect in the area for any variation from this generalized list.

Uniform Plumbing Code Requirements for Interceptors

1. Grease interceptors are not required in individual dwelling units or residential dwellings.
2. Water closets, urinals, and other plumbing fixtures conveying human waste shall not drain into or through any interceptor.
3. Each fixture discharging into an interceptor shall be individually trapped and vented in an approved manner.
4. Grease waste lines leading from floor drains, floor sinks, and other fixtures or equipment in serving establishments such as restaurants, cafes, lunch counters, cafeterias, bars, clubs, hotels, hospitals, sanitariums, factory or school kitchens, or other establishments where grease may be introduced into the drainage or sewage system shall be connected through an approved interceptor.

5. Unless specifically required or permitted by the AHJ, no food waste disposal unit or dishwasher shall be connected to or discharge into any grease interceptor. Commercial food waste disposers shall be permitted to discharge directly into the building drainage system. (Exception: Food waste disposers shall be permitted to discharge to grease interceptors that are designed to receive the discharge of food waste.)
6. The waste discharge from a dishwasher may be drained into the sanitary waste system through a gravity grease interceptor when approved by the AHJ.
7. Plumbing fixtures or equipment connected to Type A and B hydromechanical grease interceptors shall discharge through an approved type of vented flow control installed in a readily accessible and visible location. Flow control devices shall be designed and installed so the total flow through such a device or devices shall at no time be greater than the rated flow of the connected grease interceptor. No flow control device having adjustable or removable parts shall be approved. The vented flow control device shall be located such that no system vent shall be between the flow control and the grease interceptor inlet. The vent or air inlet of the flow control device shall connect with the sanitary drainage vent system as elsewhere required by this code or shall terminate through the roof of the building and shall not terminate to the free atmosphere inside the building. (Exception: Listed grease interceptors with integral flow controls or restricting devices shall be installed in an accessible location in accordance with the manufacturer's instructions.)
8. A vent shall be installed downstream of hydromechanical grease interceptors.
9. The grease collected from a grease interceptor must not be introduced into any drainage piping or public or private sewer.
10. Each gravity grease interceptor shall be so installed and connected that it shall be at all times easily accessible for inspection, cleaning, and the removal of intercepted grease. No gravity grease interceptor shall be installed in any part of a building where food is handled.
11. Gravity grease interceptors shall be placed as close as practical to the fixtures they serve.
12. Each business establishment for which a gravity grease interceptor is required shall have an interceptor that shall serve only that establishment unless otherwise approved by the AHJ.
13. Gravity grease interceptors shall be located so as to be readily accessible to the equipment required for maintenance and designed to retain grease until accumulations can be removed by pumping the interceptor.

International Plumbing Code Requirements for Hydromechanical Grease Interceptors

1. Grease interceptors are not required in individual dwelling units or private living quarters.
2. A grease interceptor or automatic grease removal device shall be required to receive the drainage from fixtures and equipment with grease-laden waste located in food preparation areas such as restaurants, hotel kitchens, hospitals, school kitchens, bars, factory cafeterias, and clubs. The fixtures include pre-rinse sinks, soup kettles or similar devices, wok stations, floor drains or sinks to which kettles are drained, automatic hood wash units, and dishwashers without pre-rinse sinks.
3. Where food waste disposal units are connected to grease interceptors, a solids interceptor shall separate the discharge before connecting to the interceptor. Solids interceptors and grease interceptors shall be sized and rated for the discharge of the food waste grinder.
4. Grease interceptors shall be equipped with devices to control the rate of water flow so that the water flow does not exceed the rated flow. The flow control device shall be vented and terminate not less than 6 inches above the flood rim level or be installed in accordance with the manufacturer's instructions.
5. Hydromechanical grease interceptors shall have the minimum grease retention capacity for the flow-through rates indicated in Table 8-3.

Table 8-3 Minimum Grease Retention Capacity per the IPC

Total Flow-Through Rating, gpm	Grease Retention Capacity, lbs
4	8
6	12
7	14
9	18
10	20
12	24
14	28
15	30
18	36
20	40
25	50
35	70
50	100
75	150
100	200

OPERATION AND MAINTENANCE

Efficient grease interceptor function is directly related to proper operation and maintenance. Most FOG control ordinances contain operation measures called best management practices, which, if followed, minimize FOG contributions to the collection system.

Grease interceptor maintenance consists mainly of removing collected FOG. Intervals between cleaning are governed by two factors: capacity and chemistry. Regarding capacity, many municipalities use the 25 percent rule. When collected FOG and precipitates reach 25 percent of the wetted vertical dimension of the interceptor, service is required. Accumulations greater than 25 percent affect flow characteristics and diminish separation and retention efficiency. Manufacturers provide grease storage capacities for their products, and the engineer is advised to review manufacturers' certified test reports and consult with manufacturers to determine the actual percentage of capacity a particular model has achieved.

FOG is not a stable compound in an aqueous environment. Hydrolysis begins upon FOG's first contact with water, resulting in disassembly of the triglyceride molecule comprising the FOG. Cleaning products and bacteria in a grease interceptor accelerate decomposition, which results in pH decline, oxygen depletion, and the alteration of specific gravity. A lack of regular service can result in the release of system-damaging compounds, noxious odors, and excessive interceptor corrosion.

Adequate maintenance is critical to efficient grease interceptor operation. The disposal of accumulated FOG must be in accordance with local regulations. FOG should not be poured down any drain or in any sewer line, deposited on soil surfaces, or buried. FOG should be disposed of via a licensed collection service.

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Expiration date: Continuing education credit will be given for this examination through **March 31, 2018**.

CE Questions — "Grease Interceptors" (CEU 245)

1. The vertical velocity of a FOG globule in water depends on ________.
   a. density and diameter of the globule
   b. density and viscosity of the water
   c. temperature of the water and FOG material
   d. all of the above

2. How long will it take a 60-micron oil droplet to rise 3 inches at 68°F if the specific gravity of the oil is 0.90?
   a. 0:04:12
   b. 0:06:36
   c. 0:02:54
   d. 0:06:18

3. Which of the following standards governs the installation, testing, and maintenance of HGIs?
   a. PDI G101: Testing and Rating Procedure for Grease Interceptors
   b. ASME A112.14.3: Grease Interceptors
   c. CSA B481: Grease Interceptors
   d. all of the above

4. The separation of FOG from water by gravity differential can be expressed mathematically by ________.
   a. Stokes' law
   b. Reynolds number
   c. Newton's law
   d. Manning formula

5. ________ determine the minimum outlet elevation needed to capture the targeted FOG globule in an ideal basin.
   a. FOG droplet size and velocity
   b. specific gravity and FOG droplet size
   c. velocity and specific gravity
   d. FOG droplet size and viscosity

6. The rise rate of a FOG globule is inversely proportional to the ________ of the wastewater.
   a. density
   b. viscosity
   c. flow
   d. specific gravity

7. According to the UPC, which of the following cannot drain into or through any grease interceptor?
   a. water closets
   b. clothes washers
   c. urinals
   d. both a and c

8. Conventional hydromechanical interceptors are generally available with a rated flow capacity up to ________ for most applications.
   a. 10 gpm
   b. 100 gpm
   c. 1,000 gpm
   d. 10,000 gpm

9. What is the minimum grease retention capacity for a hydromechanical grease interceptor with a 9-gpm total flow-through rate per the IPC?
   a. 8 lbs
   b. 12 lbs
   c. 14 lbs
   d. 18 lbs

10. What is the maximum number of DFUs allowed for the pipe size connected to the inlet of a 1,250-gallon gravity grease interceptor according to the UPC?
    a. 35
    b. 90
    c. 172
    d. 216

11. Some ordinances do not allow the installation of grease interceptors where the surrounding temperature under normal operating conditions is less than ________.
    a. 50°F
    b. 45°F
    c. 40°F
    d. 35°F

12. According to ASME A112.14.3, a ________ grease interceptor is a unit without an external flow control, directly connected.
    a. Type A
    b. Type B
    c. Type C
    d. Type D