A SunCam online continuing education course

Oil and Grease Removal

by

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Course Outline:

Overview of O&G Removal

This course starts with a little history on oil and grease (O&G) removal from wastewater and provides helpful definitions related to O&G removal.

History

The industrial revolution of the late 1700's spurred on the growth of cities into dense population centers. To offset the challenges of waste handling, indoor plumbing and sewer collection systems became common. Fat, oil, and grease (FOG) often became problematic in these systems for three main reasons:

1. Oil based products became increasingly useful and affordable, resulting in more FOG being washed down the drain.
2. When FOG cools, it can harden and block sewer pipes.
3. When discharged into the environment (e.g. river, lake), FOG pollutes the water body and drinking water sources.

Engineers, operators, and business owners came up with practical solutions to deal with the growing FOG problem and to keep the ever-growing sewer systems running. In 1883, Californian engineer Nathaniel T. Whiting gained the first patent for a device to separate out FOG from wastewater. He named it the "grease trap". This name is still used today.

Grease traps are designed to contain FOG at the source. They are usually located under a sink or on the drainpipe just outside a room where FOG may wash down the drain. The FOG becomes trapped in the device and thus does not enter the sewer system. By the early 1900's, grease traps were common across North America and Europe. See Figure 1 for an early example of a buried grease trap.

During World War II, oil and grease was used to help produce explosives. In many communities, the contents of grease traps were collected and sent to army ammunition factories. Also during that time period, new types of petroleum-based oils were developed and become common household items.

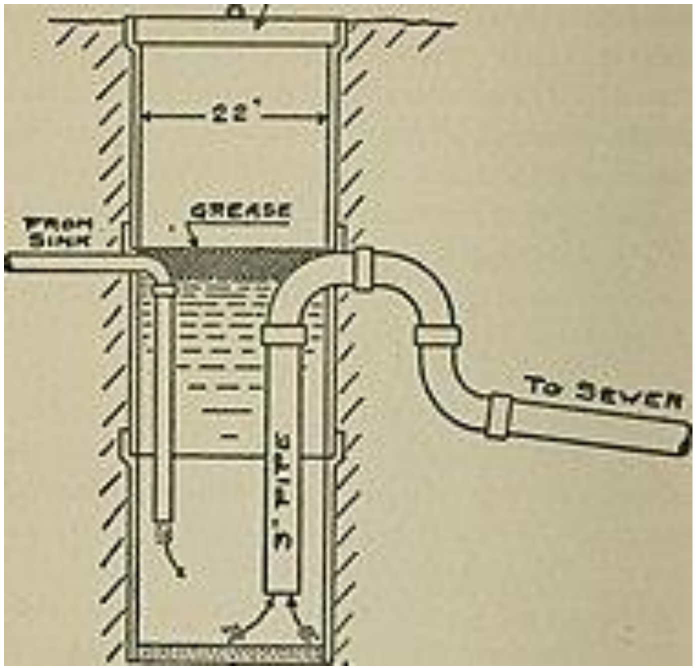


Figure 1: Example of buried grease trap design published in "The Farmer His Own Builder" in 1918.

Pollution from oil spills raised awareness of the harm that comes from releasing oily waste into natural areas. Starting in the 1970's, regulations became increasingly strict to protect the environment from oil and grease, including setting very low O&G concentration limits in wastewater effluents.

Today, O&G is recycled into biofuel, cogeneration of electricity and thermal energy, paint products, and soaps. New ways of recycling and reusing O&G emerge each year.

Key Terms

The words fat, oil, and grease have different meanings depending on the context. For example, saying “add more oil” has a different meaning when cooking versus managing a tank at an oil refinery. In the context of O&G removal from wastewater, the following definitions are offered:

Fat: Mostly saturated fatty acids which take a soft solid form at room temperature. A common form of fat is triglycerides, also called lipids, which is a form of stored energy in animals.

Oil: Mostly unsaturated fatty acids which take a liquid form at room temperature. Oil is extracted from animal fat, plant extracts, or petroleum based. Natural oil is mostly triglycerides.

Grease: Melted animal fat or a combination of natural minerals used for lubrication.

O&G: (Oil and Grease) The sum of liquid fat, oil and grease in wastewater.

FOG: (Fat, Oil, and Grease) Liquids and soft solids (floating or settled) in wastewater with an origin from animal, vegetable, food waste, and hydrocarbons of petroleum.

HEM: (Hexane Extractable Material) Measure of oil that is extracted using n-hexane but not evaporated at 85°C. Regulatory agencies often consider HEM to represent the total O&G.

SGT-HEM: (Silica Gel Treated Hexane Extractable Material) Measure of oil that is extracted using n-hexane but not evaporated at 85°C and not absorbed by silica gel. Regulatory agencies often consider SGT-HEM to represent the non-polar O&G, which are human-made and derived from petroleum products. SGT-HEM is the type of O&G of highest concern for potential environmental pollution.

Most natural fats and oils contain a complex mixture of triglycerides. A typical triglyceride molecule is shown in Figure 2.

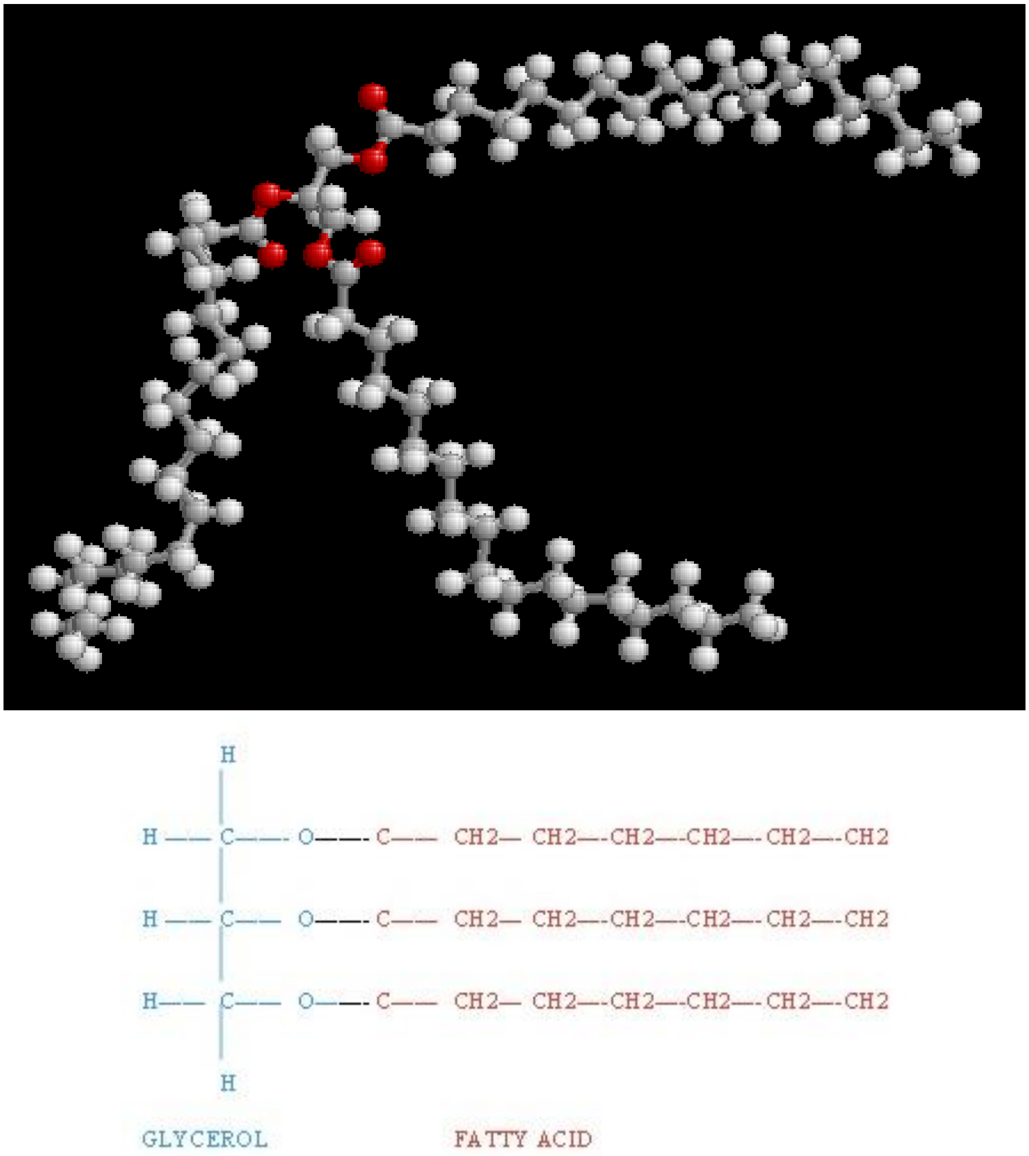


Figure 2: Top: Triglyceride model with oxygen atoms in red.
Bottom: Triglyceride molecule made of three fatty acids bonded to glycerol, which is a trihydroxy alcohol.

O&G Levels in Wastewater
O&G is very common and found in nearly all types of wastewater. Table 1 provides a list of wastewater sources and typical O&G concentrations. The concentrations vary greatly, so lab testing should be done whenever possible to confirm the actual values.

Table 1: Typical O&G Concentrations in WW

Industry or Waste Source	Concentration (mg/L)
Municipal Raw Sewage	10 -100
Beverage Manufacturing – Bottles	10 – 1,000
Beverage Manufacturing – Cans	10 – 2,000
Dairy Processing	100 – 2,000
Food Processing	100 – 1,000
Food Processing – Canned	100 – 2,000
Laundry Mats	100 – 2,000
Metal Cleaning – Rinse Water	10 – 1,000
Metal Cleaning – Concentrate	100 – 5,000
Metals Fabrication	10,000 – 100,000
Primary Metals – Concentrate	10,000 – 50,000
Primary Metals – Rinse Water	10 – 1,000
Oil Refineries	100 – 1,000
Snack & Chocolate Manufacturing	100 – 2,000
Textile	10 – 500

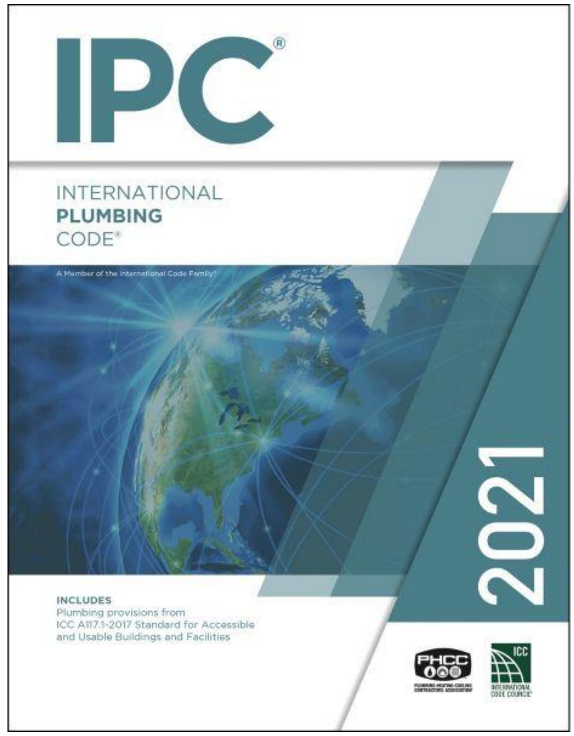
For beverage manufacturing, making aluminum cans typically results in higher O&G due to the high amounts of oil used in the can seamer process. This also applies to making canned products such as soups.

Metals fabrication results in oily wastewater due to the fluids required for metalworking processes, which are made from water soluble oils, non-dilutable straight oils, synthetic and semi-synthetic lubricants. Many are petroleum based oils.

O&G can exist in several different forms including free O&G, emulsified/dispersed oil, and dissolved oil. Each of these forms is explained later in this course. The processes required to remove O&G to an acceptable level depends on the initial O&G concentration and the forms of O&G in the wastewater.

Regulatory Requirements

Building Codes
The International Plumbing Code (IPC) has O&G removal specifications for buildings in Chapter 10 entitled "Traps, Interceptors, And Separators." In the United States, these specifications are adapted by many State Building Codes, County Ordinances, and City Ordinances, often with local amendments.



The IPC codes are most applicable to commercial buildings but are broadly written to apply to nearly any type of building. The following is an example of an IPC specification (1003.3.1):

> *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 in restaurants, hotel kitchens, hospitals, school kitchens, bars, factory cafeterias and clubs.*

Some states reference the Uniform Plumbing Code (UPC) instead of the IPC. The UPC includes Chapter 10 entitled "Traps and Interceptors". Both the IPC and UPC have replaced the term "grease trap" with "hydromechanical grease interceptor" and "grease interceptor" with "gravity grease interceptor". Both terms are used in this course.

Industrial buildings and factories have unique wastes and need to consider the following additional regulations for the discharge of wastewater.

Clean Water Act
Modern regulations for wastewater treatment, including O&G removal, started in 1972 as the Federal Water Pollution Control Act, which is now known as the Clean Water Act (CWA). This established and directed the Environmental Protection Agency (EPA) to develop and implement regulations for limiting pollutants discharged to surface waters.

The EPA has the legal authority to manage the following:

- National Pollutant Discharge Elimination System (NPDES) Program for regulating POTW WWTPs and direct industrial dischargers to surface waters. NPDES permits nearly always include specific O&G limits.
- National Industrial Pretreatment Program for regulating industrial wastewater discharges (indirect discharges) to POTWs. Industrial User Discharge Permits are issued to indirect dischargers, typically by Local Pretreatment Programs. The permits commonly include general O&G limits.

40 CFR Part 403

Starting in 1978, the EPA promulgated 40 CFR Part 403, General Pretreatment Regulations, which establishes general prohibitions against WWTP interference and pass-through, and sets national pretreatment standards for the discharge of incompatible pollutants from specific industrial categories.

The National Pretreatment Program has three objectives, per 40 CFR 403.2:

1. To prevent the introduction of pollutants into POTWs that will **interfere** with the operation of a POTW, including interference with its use or disposal of municipal sludge.
2. To prevent the introduction of pollutants into POTWs that will **pass through** the treatment works or otherwise be incompatible with such works.
3. To improve opportunities to recycle and **reclaim** wastewaters and sludge.

Section 40 CFR 403.5.b. prohibits the following O&G related pollutants from being discharged in amounts that could cause interference or pass through. These are non-polar types of O&G that are detected with the SGT-HEM method.

- Petroleum oil,
- Nonbiodegradable cutting oil, and
- Products of mineral oil origin.

Regulated pollutants found in IU permits fit into the following groups:

- Priority Pollutants: Metals (Fe, Pb) and Toxic Organics (solvents, pesticides)
- Conventional Pollutants: BOD_5, TSS, Fecal Coliform, pH, **O&G**, etc.
- Nonconventional Pollutants: Temperature, Dissolved Oxygen (DO), Turbidity, Total Residual Chlorine, Nutrients (P, N), etc.

O&G is a considered a “conventional pollutant”.

Industrial User Permits

Industrial and commercial entities that have an indirect discharge of wastewater are called Industrial Users (IUs) for permitting purposes. Most IUs have a wastewater treatment system that partially treats the wastewater before being discharged into the municipal sewer collection system. This is called an "industrial pretreatment system", or just a "pretreatment system". Pretreatment systems commonly include one or more processes for O&G removal.

Each IU is issued a discharge permit with conditions that include prohibitions, standards, and limits. The goal of a pretreatment system is to modify the wastewater so that the water quality consistently meets the permit conditions while also minimizing treatment costs and municipal discharge fees. Most pretreatment permits include a limit for O&G. Figure 3 is an example of discharge limits from an actual permit.

Parameters	Daily Max. (mg/L)	Max. Monthly Average (mg/L)	Monitoring Requirements (E, SC, S)
Biochemical Oxygen Demand (5-Day)	-----	250.0 *1	SC, *3
Total Suspended Solids	-----	250.0 *1	SC, *3
Oil & Grease	-----	100.0 *1	SC, *2
Cadmium	0.110	0.015	E, *3
Chromium	2.770	1.00	E, *3
Copper	3.38	2.07	E, *3
Cyanide	1.200	0.650	E, *2
Lead	0.690	0.430	E, *3
Nickel	3.980	1.50	E, *3
Silver	0.430	0.240	E, *3
Zinc	2.610	1.480	E, *3
TTO	2.130		E, *2
Temperature	140 °F		E, *2
Flow	REPORT ONLY		
pH Maximum (instantaneous)	12.0 S.U.		
pH Minimum (instantaneous)	5.0 S.U.		

E – Enforcement Monitoring
SC – Surcharge Monitoring *1
S – Self-Monitoring

Figure 3: Discharge limits section from an IU permit, with the O&G limit highlighted.
*1 indicates a surcharge fee applies for exceeding the limit.
*2 indicates samples are the collected by the grab method (not composite).

Industrial Categories
The EPA created a list of industrial categories along with limits for typical pollutants for each category, as found in 40 CFR 405 to 471. There are 55 distinct industries (as of 2022). IUs that fit into these categories are called Categorical Industrial Users (CIUs). Table 2 provides a list of the categories with O&G regulations along with the O&G limits.

Most of the direct discharge (e.g. stream, river, lake) limits are "mass based" which means the O&G is to presented in terms of the load, or weight per day, such as lb/d, and the limit is based on the production volume. The following "pounds formula" converts concentration to load.

Load (lb/d) = conc. (mg/L) * flow (MGD) * 8.34

Example Problem 1
What is the load of 100 mg/L of O&G at 1 MGD?

Solution 1
The load Is calculated as follows:

Load (lb/d) = 100 mg/L * 1 MGD * 8.34 = **834 lb/d**

Table 2: Industrial Categories with O&G Limits					
40 CFR	Industrial Category	Existing Sources (PSES)	New Sources (PSNS)	O&G Limit (mg/L)	
				Direct Discharge	Pretreatment
407	Canned & Preserved Fruits & Veg.	X	X	20	Monitor
408	Canned & Preserved Seafood	X	X	Mass Based	Monitor
415	Inorganic Chemical Manufacturing	X	X	Mass Based	None
417	Soap & Detergent Manufacturing		X	Mass Based	Monitor
419	Petroleum Refining	X	X	15 and Various	100
420	Iron & Steel Manufacturing	X	X	Mass Based	Monitor
421	Nonferrous Metals Manufacturing	X	X	20 and Various	Monitor
423	Steam Electric Power Generation	X	X	20 daily max, 15 monthly avg	None
425	Leather Tanning & Finishing	X	X	Mass Based	None
428	Rubber Manufacturing		X	Mass Based	100
429	Timber Products Processing	X	X	Mass Based	100
432	Meat Products	X	X	Mass Based	Mass Based
433	Metal Finishing	X	X	52	None
435	Oil & Gas Extraction	X	X	72, 42, 35	None
437	Centralized Waste Treatment	X	X	205, 127 daily max, 50, 38 monthly avg	None
442	Transportation Equipment Cleaning	X	X	36. 20 daily max, 16, 9 monthly avg	None
443	Paving & Roof Materials Mfg.		X	Mass Based	100
457	Explosives Manufacturing		X	Mass Based	None
458	Carbon black Manufacturing		X	0	100
461	Battery Manufacturing	X	X	Mass Based	None
463	Plastics Molding & Forming	X	X	71, 29 daily max, 17 monthly avg	None
464	Metal Molding and Casting	X	X	Various	Various
465	Coil Coating	X	X	Mass Based	Mass Based
466	Porcelain Enameling	X	X	Mass Based	None
467	Aluminum Forming	X	X	Mass Based	Mass Based
468	Copper Forming	X	X	Mass Based	Mass Based
471	Nonferrous Metal, Form & Powders	X	X	Mass Based	None

Municipal WWTPs

Generally, POTWs have large wastewater treatment plants (WWTPs) that are designed to treat domestic/household sewage and biodegradable commercial/industrial sewage. The Code of Federal Regulations (CFR), title 40, section 401.16 (40 CFR 401.16), defines these five conventional pollutants that must be treated in a POTW WWTP:

1. Biochemical Oxygen Demand (BOD)
2. Total Suspended Solids (TSS)
3. Fecal Coliform (an indicator organism for the presence of fecal waste)
4. High/low pH
5. **Oil and Grease (O&G)**

Traditional techniques for removing O&G in POTW WWTP's include scum collection in clarifier tanks and activated sludge biological treatment. See Figures 4 and 5 for an example WWTPs with O&G removal processes highlighted.

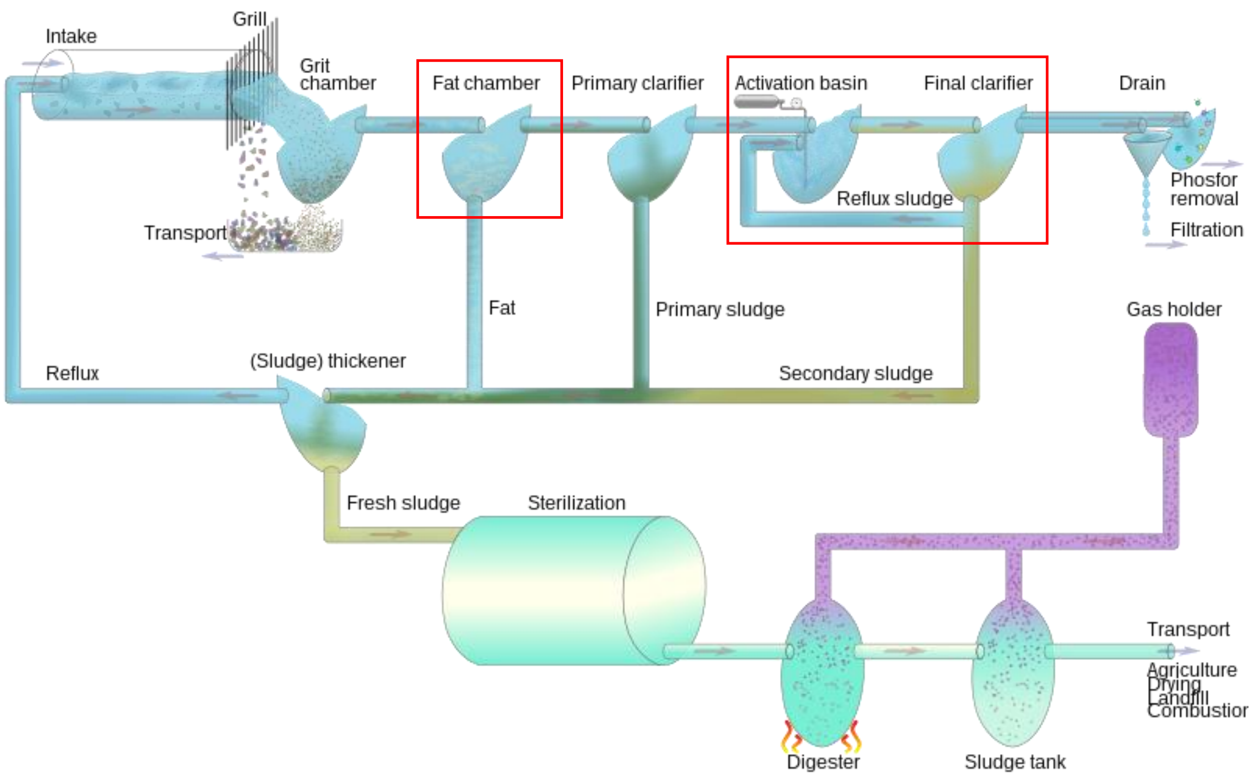


Figure 4: A WWTP flow diagram with processes that remove O&G highlighted red. The activated basin and final clarifier together form an activated sludge biological treatment process that breaks down various forms of O&G into secondary sludge.
Source: commons.wikimedia.org/wiki/File:Sewage_treatment_scheme.svg, Goran tek-en, CC-BY-SA-4.0

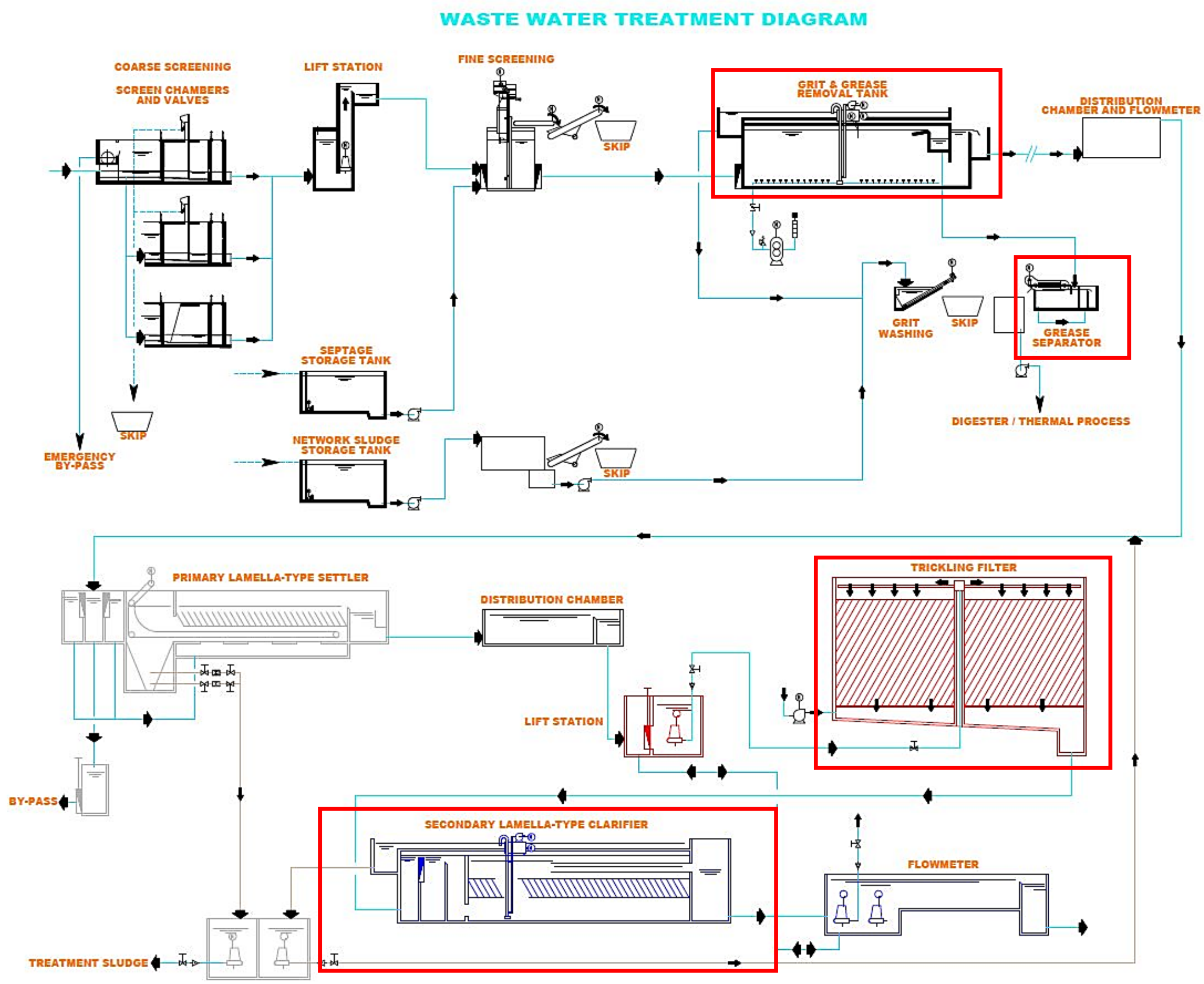


Figure 5: A WWTP flow diagram with processes that remove O&G highlighted red. The tricking filter and clarifier together form a biological treatment process that breaks down various forms of O&G into sludge that is settled and removed.

Source: https://commons.wikimedia.org/wiki/File:Diagramme_STEU_2.jpg, Hydrogaz, CC-BY-SA-4.0

Forms of O&G

O&G can be present in many different forms. The following are common forms (or types) of O&G in wastewater, starting with the easiest to remove and ending with the most difficult to remove.

Oil on Solids

Oil often adheres to the surface of sediments, food products, and debris, as shown in Figure 6. For example, in a steel fabrication shop the metal shavings in the wastewater may feel oily from the O&G on the surface. When the solids are removed, the oil on the solids gets removed at the same time. However, after the solids are removed there is still other types of oil in the wastewater that likely needs removal with other methods.

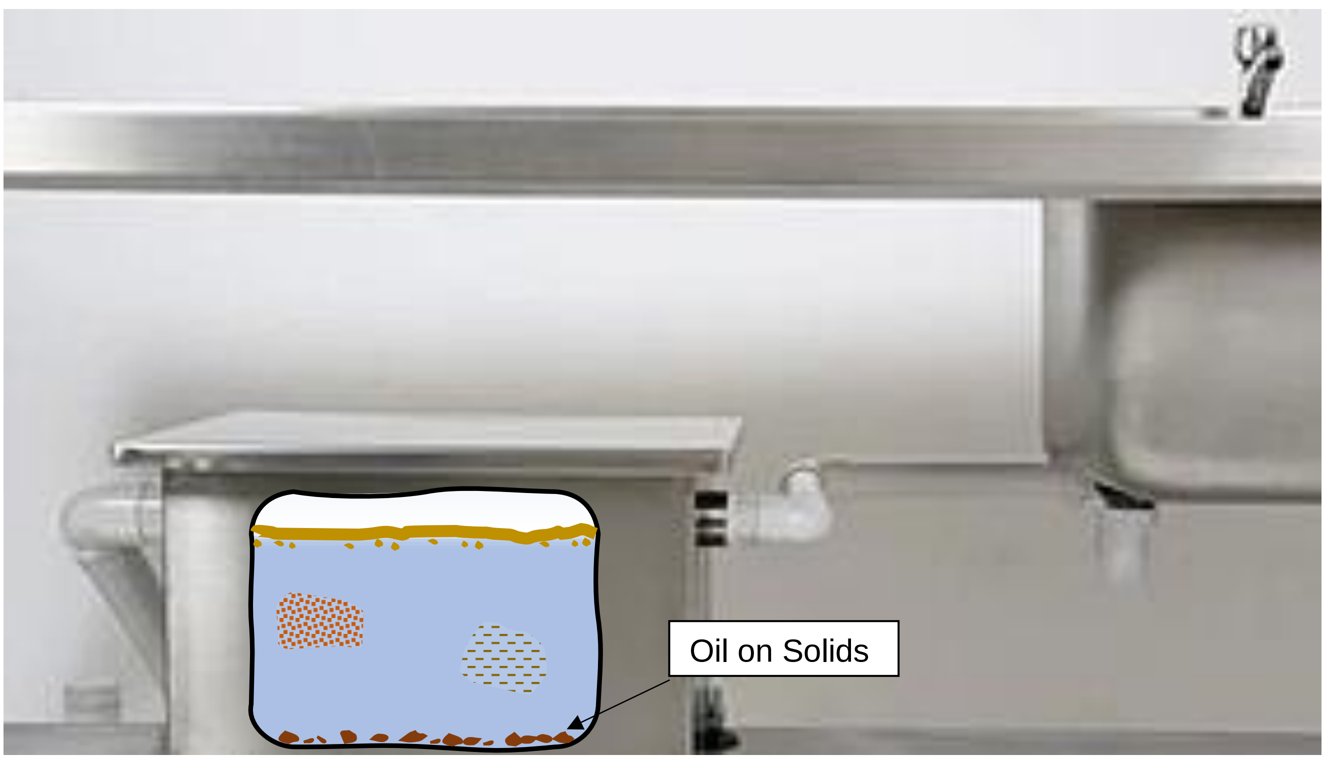


Figure 6: View inside a grease trap with oily solids at the bottom.
Source: https://commons.wikimedia.org/wiki/File:Grease_traps.jpeg, public domain, author additions

Free O&G

Free oil, also called floating oil, is less dense than water and thus rises to the surface under calm conditions. Free oil droplets may be around 150 microns or larger. However, once the oil droplets rise and combine (coalesce), the water surface turns into a continuous oil layer that is visibly separate from the water below. To capture free O&G, a large tank or chamber can be used to slow down the velocity so the oil rises to the surface, where it can be collected by various means. See Figure 7.

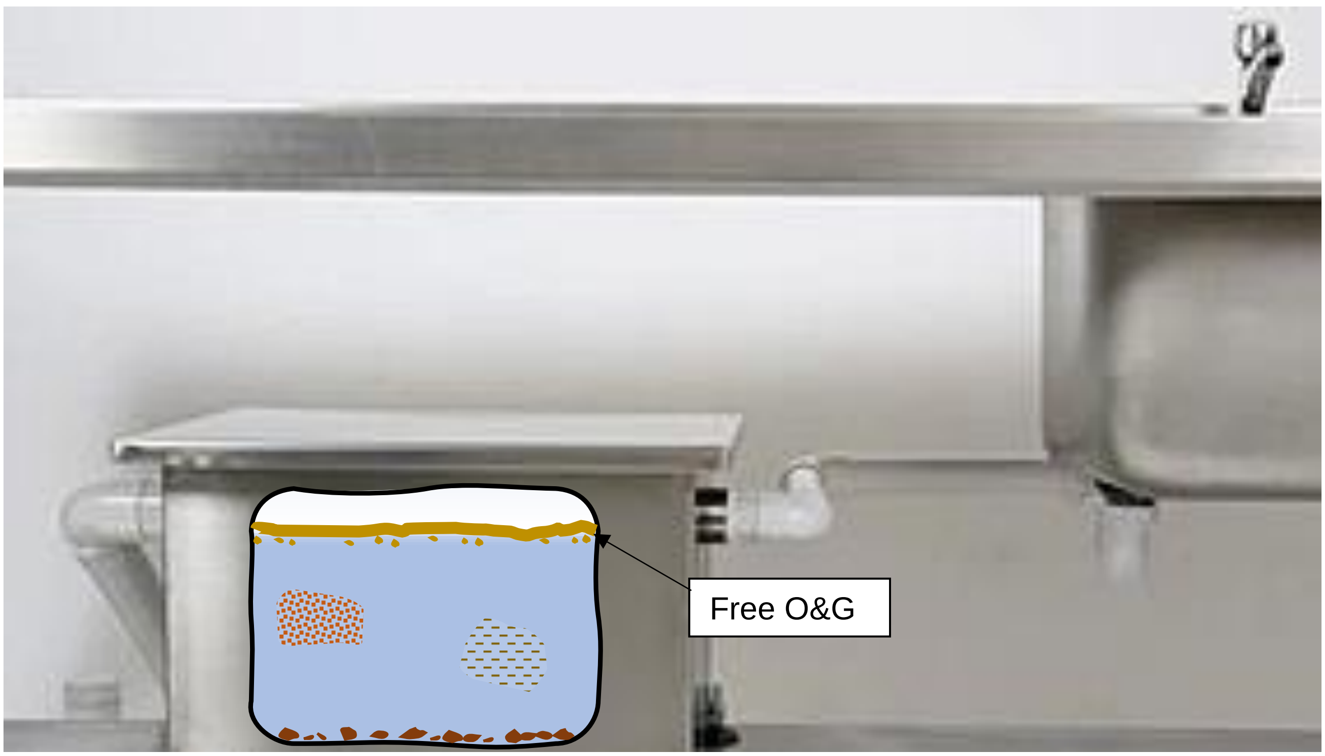


Figure 7: View inside a grease trap with free O&G at the top.
Source: https://commons.wikimedia.org/wiki/File:Grease_traps.jpeg, public domain, author additions

<u>Emulsified Oil</u>
Emulsified oil is tiny oil droplets (1 to 150 microns) that are dispersed in wastewater, as shown in Figure 8. The smaller the droplets, the more stable the emulsion. When oil drops contact one another, they may coalesce and become free oil that rises to the surface. Chemically emulsified oil contains oil droplets that repel one another and thus do not coalesce.

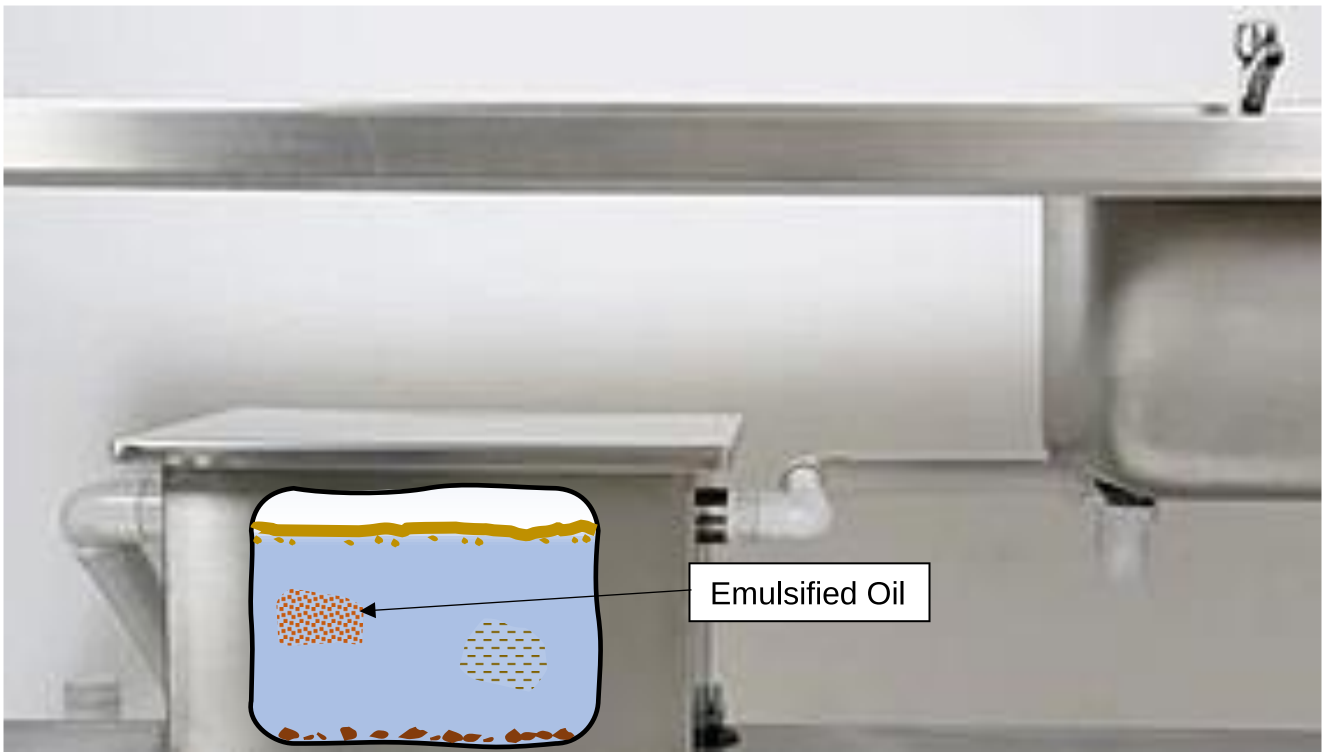


Figure 8: View inside a grease trap with emulsified oil suspended in the wastewater.
Source: https://commons.wikimedia.org/wiki/File:Grease_traps.jpeg, public domain, author additions

Emulsifiers are chemicals designed to stabilize and suspend particles in a liquid or paste. Most food and drink products contain emulsifiers. Emulsifier examples include:

- Lecithins: mixture of fats from canola, egg yolks, soybeans, and sunflower.
- Mono and Diglycerides: mixture of glycerol, natural fatty acids, and an organic acid.
- Polysorbates: viscous water-soluble liquid derived from ethoxylated sorbitan (a derivative of sorbitol) esterified with fatty acids.
- Sodium Stearoyl Lactylate (SSL): food additive used to improve the mix tolerance and volume of processed foods.

Emulsifiers also include surfactants, detergents, and soaps. Surfactants have hydrocarbon chains that keep oil droplets suspended, as shown in Figure 9. For example, sodium laurel sulfate has a lipophilic (oil attracting) end and a hydrophilic (water attracting) end. The lipophilic end of the chain enters the oil droplet, and the hydrophilic end sticks out in the wastewater. This creates a charge on the oil droplet which repels other oil droplets and keeps the oil droplets dispersed.

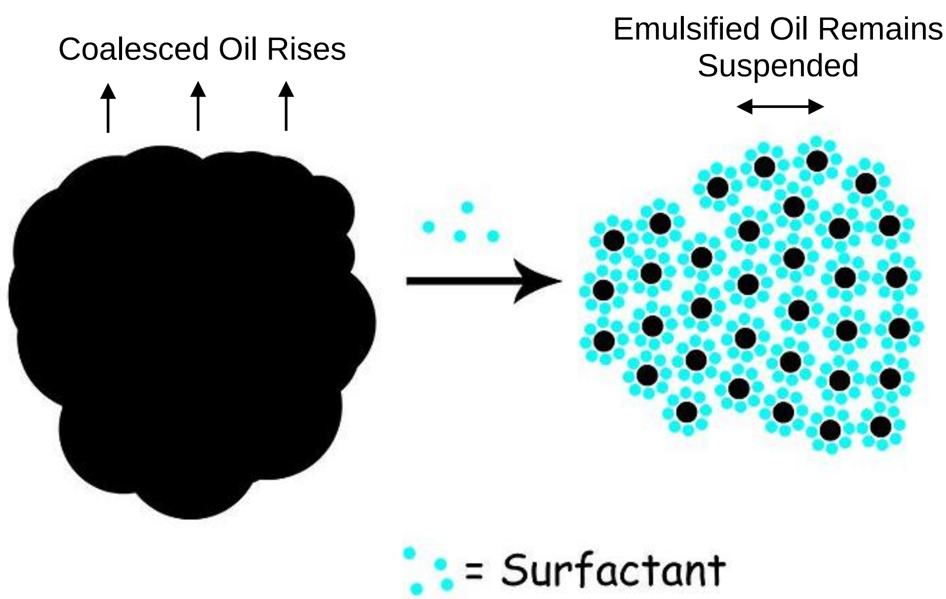


Figure 9: Coalesced oil (left) which stays suspended when a surfactant is introduced (right).
Source: https://commons.wikimedia.org/wiki/File:Oil_with_Surfactant.jpg, CC-BY-SA-3.0

The presence of emulsifiers in wastewater makes the removal of O&G more challenging.

Dissolved Oil
Dissolved oil consists of small oil-based molecules (less than 5 microns) that stay suspended in the wastewater. See Figure 10 for a depiction of dissolved oil. Hydrocarbon examples include BETX (Benzene, Toluene, Ethylbenzene, and Xylene), NPD (naphthalene, phenanthrene, and dibenzotiophene), and PAH (polycyclic aromatic compounds). A hydrocarbon is an organic molecule with a chain or circle of only carbon and hydrogen atoms. Non-hydrocarbon examples of dissolved oil include organic acids and phenols.

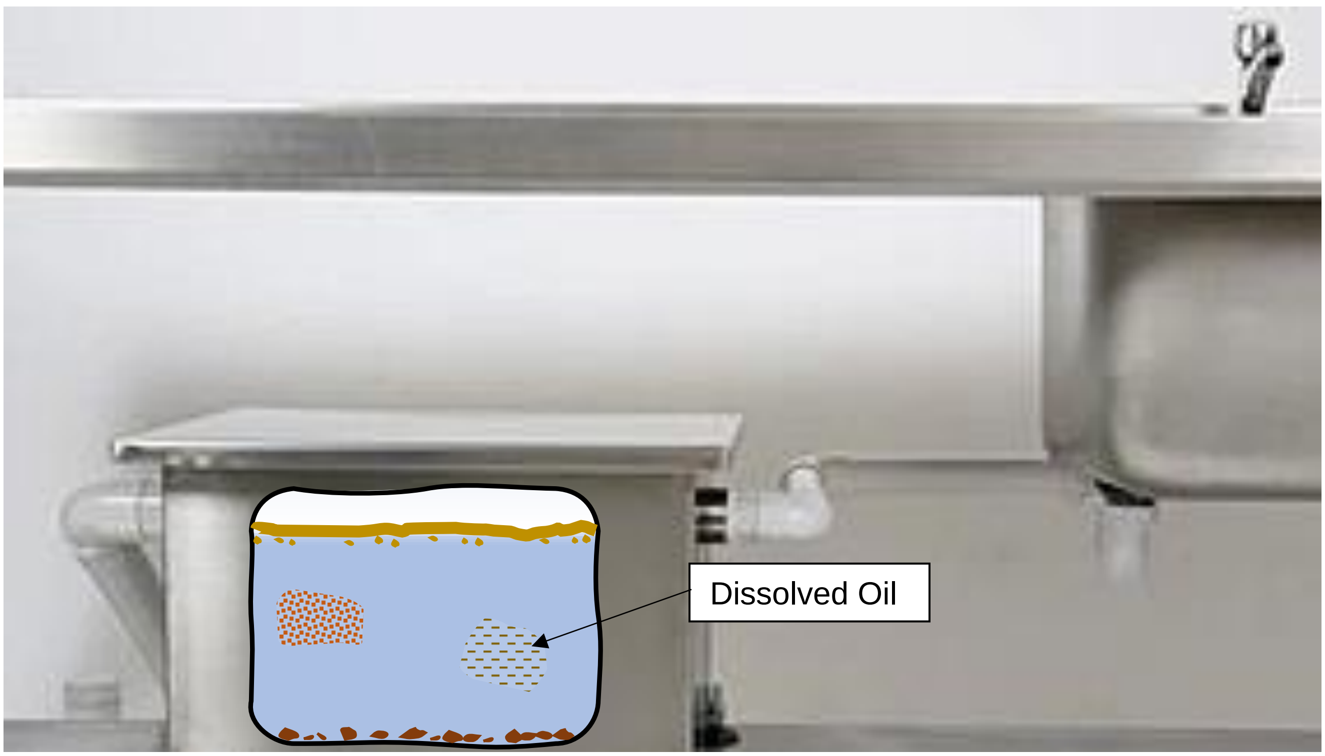


Figure 10: View inside a grease trap with dissolved oil suspended in the wastewater.
Source: https://commons.wikimedia.org/wiki/File:Grease_traps.jpeg, public domain, author additions

Total Oil
Based on the forms described above, the total oil in the wastewater can be defined as follows, with units of weight, volume, or concentration:

Total Oil = Oil on Solids + Free Oil + Emulsified/Dispersed Oil + Dissolved Oil

Note that Dissolved Oil is typically a small portion of the Total Oil.

O&G Removal Processes

There are numerous processes that can be utilized to remove O&G from wastewater. Table 3 provides an overview of common processes grouped by the main form of oil removed by the process. Common processes are in bold with detail pages that follow.

Table 3: Oil Removal Processes

Form of Oil Removed	Process Name	Type of Process	Typical Configuration
Free / Floating	**Grease Trap**	Physical	Under sink, buried on drain line
	Grease Interceptor	Physical	Buried tank, multi-chamber
	Oil Water Separator	Physical	Oil interceptor, coalescing, gravity, corrugated plate
	API Separator	Physical	Gravity separation
	Tilted Plate Separator	Physical	Parallel packs, small footprint
	Oil Skimmer	Physical	Belt, floating, rotating drum
	Air Flotation	Physical	Dissolved air flotation (DAF) or Suspended air flotation (SAF)
	Clarifier w/ Skimming	Physical	Circular or rectangular clarifiers with scum removal equipment
	Centrifuge	Physical	Disc-stack, decanter, coagulant
	Hydrocyclone	Physical	Vertical, angled
Emulsified	**pH Adjustment**	Chemical	Base or acid addition, followed by a Free Oil removal process
	Gas Flotation	Chemical	Pure oxygen or nitrogen injection, dissolved gas flotation (DGF)
	Coagulation	Chemical	Aluminum sulfate, iron salts, followed by sand filtration or clarification
	Flocculation	Chemical	Polymer added and mixed, followed by clarification
	Degreaser Agent	Chemical	Formulated for known surfactants
	Centrifuge	Physical	Disc-stack, decanter, w/ salt addition
	Electrodialysis	Chemical	ED stack, batch, or continuous; Electrolysis, electrochemical oxidation
Dissolved	**Adsorption**	Physical	Organoclays, Activated Carbon
	Membrane Filtration	Physical	MF, UF, NF, RO, Dynamic
	Suspended Growth	Biological	Activated sludge, oxidation ditch, SBR
	Attached Growth	Biological	Trickling filter, RBC, packed bed, MBBR
	Membrane Bioreactor	Biological	iMBR, sMBR, MF, UF
	Anaerobic Processes	Biological	Upflow filter, fluidized bed, UASB, digester, anoxic selector
	Electrodialysis	Chemical	See electrodialysis row above

Grease Trap (Hydromechanical Grease Interceptor)			
Function	**Type of Oil Removed**	**Configurations**	**Common Applications**
Air entrainment is caused, flow is reduced and wastewater cools. FOG rises and is trapped by baffles. Solids settle. Remaining wastewater flows under an outlet baffle to discharge.	• Free/floating • Fat • Oil on Solids	• Passive, manual • Removable screen or bucket • Automatic collection • Gravity, buried	• Below sinks • Restaurants • Cafeterias • Food processing rooms

Figure 11: Examples of simple grease traps with flow direction arrows in red.
The trap on the left has a removable bucket (with a discharge opening) for removal of collected FOG and solids.
Source: https://www.flickr.com/people/23116228@N07, gtzecosan, CC-BY-SA-4.0

Grease Interceptor (Gravity Grease Interceptor)			
Function	**Type of Oil Removed**	**Configurations**	**Common Applications**
Same function as a grease trap but on a larger scale, receiving flows from multiple rooms/sources, and often with multiple baffles chambers to increased removal efficiency.	• Free/floating • Fat • Oil on Solids	• 1, 2, or 3 chambers • Automatic collection • Gravity, buried • Solids pump-out	• Industrial facilities • Food processing rooms • Large restaurants

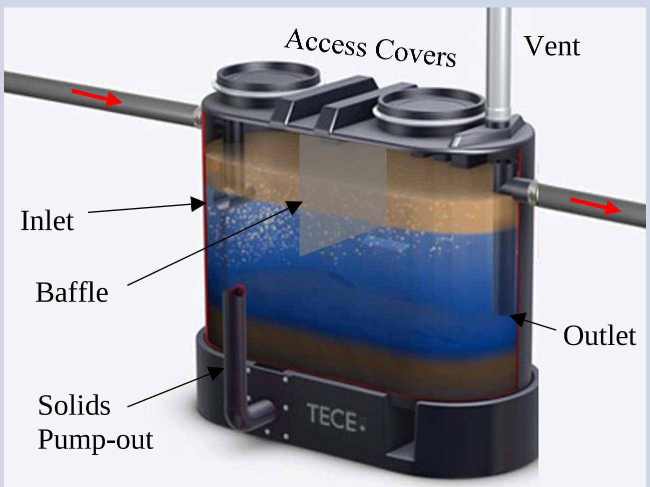


Figure 12: On left, a grease interceptor with major components labeled.
On right, a vacuum truck removing the contents of a grease interceptor which serves the red building.
Source: https://commons.wikimedia.org/wiki/File:Fettabscheider1.jpg, TECE Basika, CC-BY-SA-3.0

Oil Water Separator			
Function	**Type of Oil Removed**	**Configurations**	**Common Applications**
Same function as a grease interceptor and with coalescing media or other features added to enhance the removal and storage of free oil.	• Free/floating • Oil on Solids	• 1, 2, or 3 chambers • Coalescing media • Inclined plates • Filter media • Pre-settling chamber • Oil storage chamber	• Industrial facilities • Petroleum storage and handling facilities • Remediation of petroleum-contaminated sites • Vehicle & Aircraft fueling, maintenance and washing

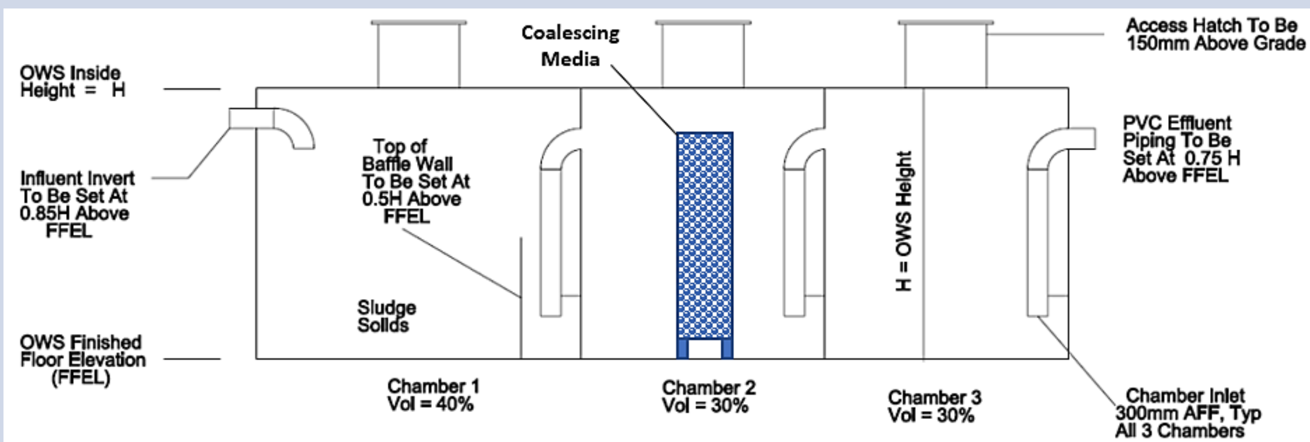


Figure 13: Oil water separator design with three chambers and coalescing media.
Source: https://www.tad.usace.army.mil/Portals/53/docs/TAA/AEDDesignRequirements, public domain

American Petroleum Institute (API) Separator			
Function	**Type of Oil Removed**	**Configurations**	**Common Applications**
Similar function as a grease interceptor but in an open top vault or tank with surface skimming, solids scraping, a sludge hopper, and an overflow weir.	• Free/floating • Oil on Solids	• Pre-screening • Flow distribution • Rotating pipe skimmer • Cover, odor control • Chain and scraper	• Oil refineries • Petroleum storage and handling facilities • Remediation of petroleum-contaminated sites

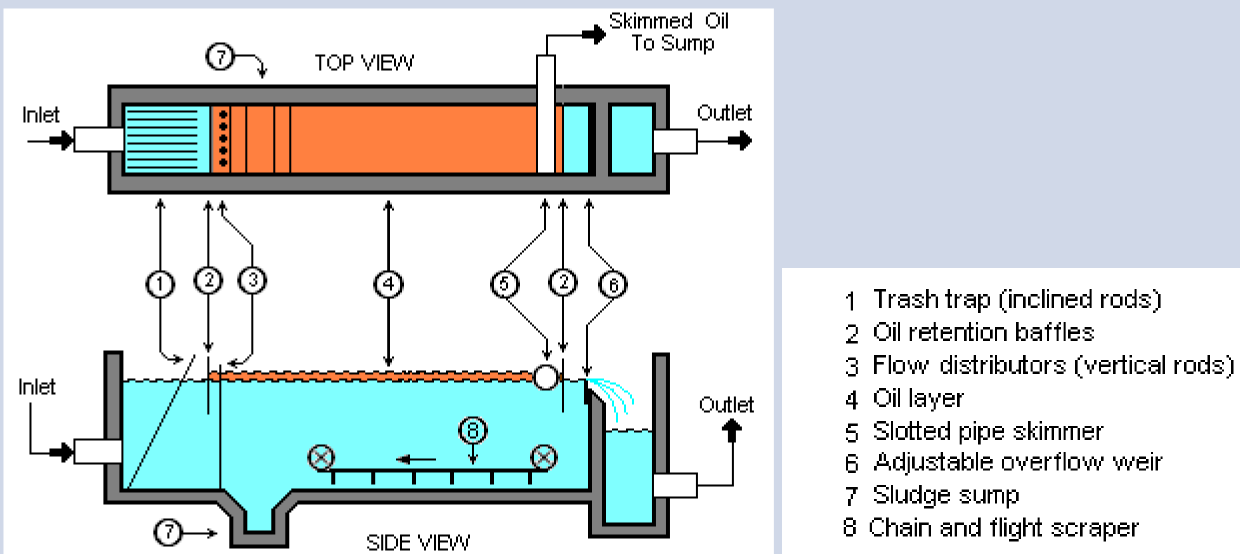


Figure 14: Typical API separator with labels. The scraper can collect O&G at the surface and sludge at the floor.
Source: https://commons.wikimedia.org/wiki/File:API_Separator.png, Mbeychok CC-BY-SA-3.0

pH Adjustment			
Function	**Type of Oil Removed**	**Configurations**	**Common Applications**
Modify the pH of the wastewater to cause emulsified oil to break free from surfactants and emulsifiers. Typically, the pH is lowered below 5. This is followed by a free oil removal process.	• Emulsified	• Acid metering, aka acid cracking • Carbon dioxide • Temperature & pH adjustments	• Oil refineries • Industrial facilities • Food processing facilities • Manufacturing facilities • Municipal WWTP's

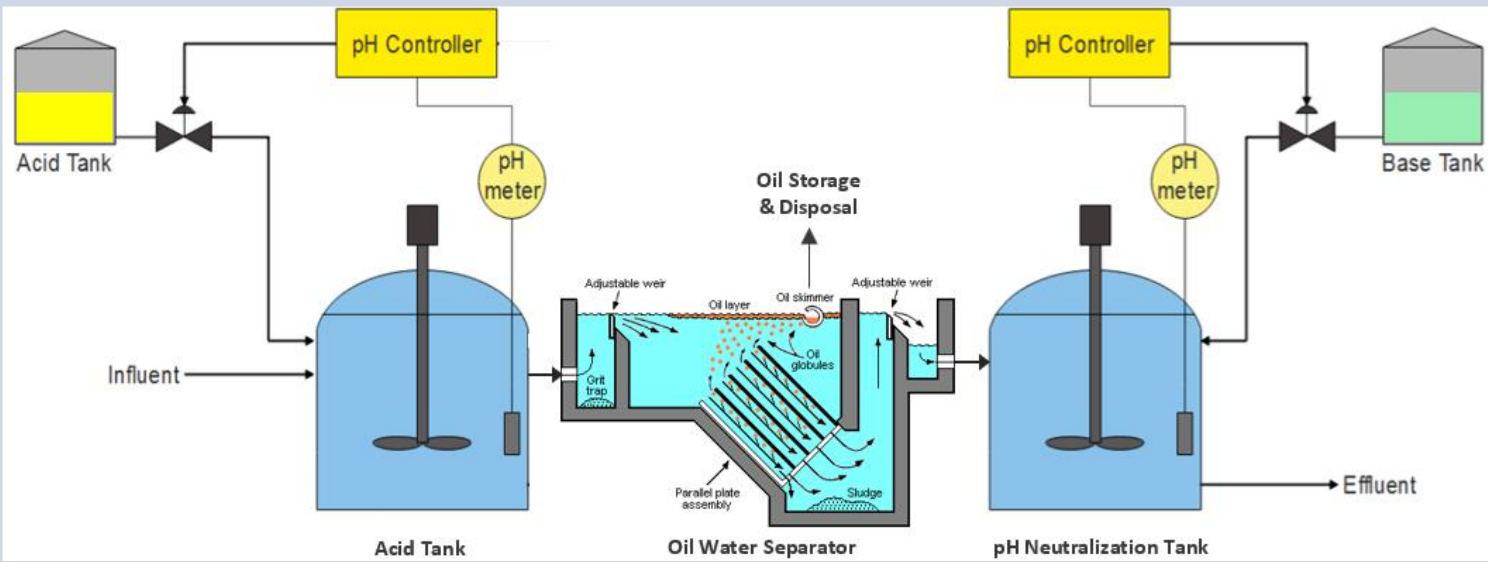


Figure 15: pH Adjustment system starting with acid to lower pH, oil removal, then base to raise pH back to neutral.
Source: https://commons.wikimedia.org/wiki/File:Parallel_Plate_Separator.png, modified, Mbeychok CC-BY-SA-3.0

Adsorption			
Function	**Type of Oil Removed**	**Configurations**	**Common Applications**
Wastewater is passed through filter media and O&G is adsorbed (adhered) to the media surface and removed by backwash, media regeneration, or media replacement.	• Emulsified • Dissolved	• Organoclays • Bentonite Powder • Activated Carbon • Oleophilic Media • Fixed-bed, fluid-bed	• Industrial facilities • Manufacturing facilities • Pretreatment for membranes • Boiler blowdown • Vehicle maintenance areas

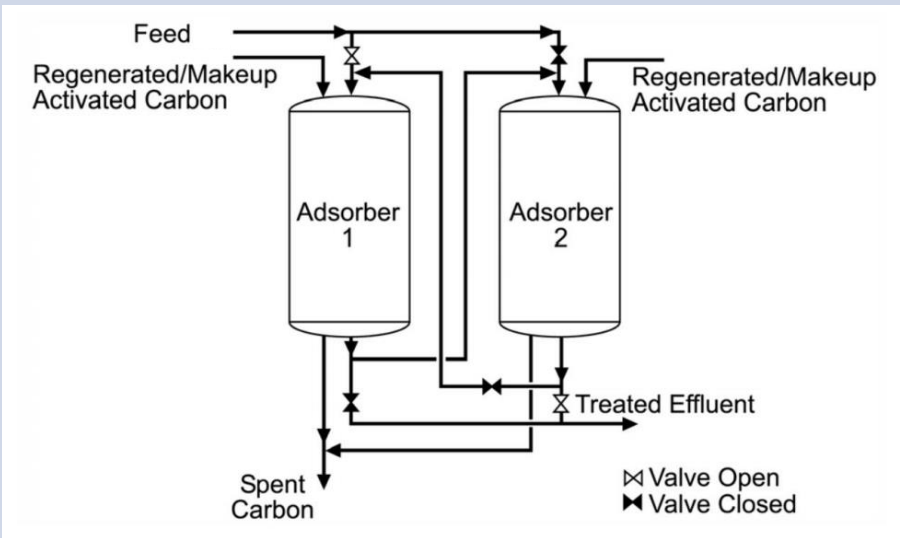


Figure 16: On left, a fluid-bed adsorption system. Media is continuously transferred to and from a regeneration chamber. On right, organoclay filled cartridge filters, each rated for approximately 2 gpm.
Source: EPA Air Pollution Control Cost Manual, Chapter 1, EPA/452/B-02-001; /www.ecologixsystems.com/mcm-organoclay-cartridges/

Membrane Filtration			
Function	**Type of Oil Removed**	**Configurations**	**Common Applications**
Blocks O&G and other pollutants from passing through small very openings in the membrane. O&G is removed through a concentrate stream. Permeate has reuse potential.	• Free/floating • Emulsified • Dissolved	• Micro-filtration (MF) • Ultra-filtration (UF) • Nano-filtration (NF) • Reverse osmosis (RO) • Membrane bioreactor • Dynamic/vibrating	• Industrial facilities • Manufacturing facilities • Municipal WWTP's

Figure 17: Ultrafiltration membranes (horizontal green tubes) for wastewater treatment.
Source: https://commons.wikimedia.org/wiki/File:Wastewater_UF_membrane_system,_Aquabio.jpg, Aquabio Ltd., CC-BY-SA-3.0

Sizing a Gravity Grease Interceptor

Table 4 summarizes different methods used to size a gravity grease interceptor.

Table 4: Summary of Gravity Grease Interceptor Sizing Options

Method	Basis	Formula (V = gallons)	Applications	Source
1	No. of Meals & Dishwashers	V = M x W x R x S M = meals/hr W = 6 gal comm. w/ dishw. = 2 gal single serve = +1 gal food disposer R = 1.5 hrs commercial = 2.5 hrs single serve S = 1 for 8 hr shift = 1.5 for single serve = 2 for 16 hr shift = 3 for 24 hr shift	Kitchens, Cafeterias, Restaurants	Municipal Codes
2	5 Hours	V = G x 0.75 x P x D G = water use, gal/hr P = 1.9 peak factor D = 5 hrs	Small Facilities	Municipal Codes
3	No. of DFU's & Pipe Size	UPC Table 1014.3.6	Commercial Facilities	UPC
4	30 Minutes	V = P * 30 min P = gpm, peak ww flow, or half full pipe capacity	Large Facilities	IPC & UPC
5	Min. Volume	V = 750 gal w/o basis = 500 gal w/ basis & seal	Small Facilities	Municipal Codes
6	Temperature	$V = V_H * T_H / (T_F - T_N)$ V_H = gal, hot ww in T_H = temp, hot ww in T_F = temp, desired, e.g. 120°F T_N = temp, normal ww	Hot Water Dumps, CIP	Author
7	Reference	$V = V_R * (P / P_R)$ V_R = gal, vol of ref. P = gpm, peak ww flow P_R = gpm, peak of ref.	New Facility	Author
8	Lab Testing	$V = P * T_{req}$ P = gpm, peak ww flow T_{req} = min, per lab tests	Existing Facility	Author

Method 4, a 30 minute volume at peak flow, is the most simple and common method.

Example Problem 2

A commercial restaurant has mop sink (3 DFU's), two food prep sinks (3 DFU's), two dishwashers (2 DFU's), and five floor drains (2 DFU's each). The restaurant serves 16 hours a day and up to 40 meals per hour. Potable water consumption averages 10 gpm during operations. Peak wastewater flow is estimated at 40 gpm. Calculate the grease interceptor volume using Methods 1 through 5. Chose the most conservative volume.

For Method 3, UPC Table 1014.3.6 is copied here (round up):

TABLE 1014.3.6
GRAVITY GREASE INTERCEPTOR SIZING

DRAINAGE FIXTURE UNITS[1, 3] (DFUs)	INTERCEPTOR VOLUME[2] (gallons)
8	500
21	750
35	1000
90	1250
172	1500
216	2000
307	2500
342	3000
428	4000
576	5000
720	7500
2112	10 000
2640	15 000

For SI units: 1 gallon = 3.785 L

Solution 2

Calculations for the five methods are presented In Table 5. The volume required varies from 720 gallons with Method 1 to 2,250 gallons with Method 2. A volume of 2,250 gallons is chosen since it is the most conservative (the largest).

Table 5: Grease Interceptor Volumes for Problem 2

Method	Basis	Formula (V = gallons)	Volume Required (gal)	Chosen Volume (gal)
1	No. of Meals & Dishwashers	V = M x W x R x S M = 40 meals/hr W = 6 gal R = 1.5 hrs S = 2 V = 20 x 6 x 1.5 x 2	720	
2	5 Hours	V = G x 0.75 x P x D G = 10*60 gal/hr P = 1.9 peak factor D = 5 hrs V = 10*60 x 0.75 x 1.9 x 5	2,250	
3	No. of DFU's & Pipe Size	DFU's = 3 + 2*3 + 2*2 + 5*2 = 23 UPC Table 1014.3.6	1,000	**2,250**
4	30 Minutes	V = P * 30 min P = 40 gpm V = 40 * 30 min	1,200	
5	Min. Volume	V = 750 gal	750	

Helpful References

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