Lost in the FOG?

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Imagine that the city council has finally accepted the case you have made for the critical need to develop strict local limits for fats, oils, and grease (FOG), as well as a grease-trap policy for food preparation operations. All those years of fielding early-morning telephone calls about plugged lines in the collection system and plugged sludge-transfer lines at the wastewater treatment plant (WWTP) are about to end, and the operations staff looks at you as a hero. The worst of your problems appears to be over. But before the euphoria wears off, get ready for the next big question: "Will you accept loads of hauled grease?"

Before answering that question, you need to know more about the FOG that may be hauled to the WWTP for disposal to protect the plant and optimize treatment. It's easy to become lost in the FOG, because these materials have diverse physical and chemical properties. FOG is not simply a single compound with a single set of distinctive characteristics. Rather, it is a family of chemicals for which the only common link may be solubility in hexane. Depending upon the species present in a particular batch of FOG, it may be

- congealable, solidifying at room temperature;
- floatable, with a specific gravity less than 1 g/mL;
- soluble (some FOG compounds, such as soaps, detergents, dispersants, and other surfactants, dissolve in water);
- emulsive, tending to form oil–water emulsions;
- of animal or vegetable origin (these materials usually are biodegradable);
- of petroleum or mineral origin (many carry volatile organics or other co-contaminants, and some are biodegradable);
- biodegradable (consumed by anaerobic or aerobic organisms as food);
- nonbiodegradable (inert and not consumed by anaerobic or aerobic organisms as food); and
- composed of materials that promote foaming.

What's on the Menu?

Restaurant owners who are required to operate a grease trap cannot dump FOG wastes into the sewer and must find another place to dispose of this material. Local rendering plants may accept this waste, but if a local rendering plant is not an option, where can generators dispose of FOG?

Waste haulers likely will want to dispose of FOG at the WWTP. FOG from food preparation and food processing is usually biodegradable, but it congeals and can plug sludge-transfer lines. Although hauling FOG to the WWTP protects sewers from plugging problems, it merely transfers FOG-related problems from the sewers to the WWTP.

At a time when energy costs are rising, energy recovery is especially beneficial. One of the desirable characteristics of biodegradable FOG is its high energy content. When digested under anaerobic conditions, FOG increases the digester methane yield and total quantity of gas produced. Upgrading digester mixing capabilities to handle FOG may benefit the WWTP utility through increased energy production.

Utilities planning a digester upgrade may want to consider egg-shaped digesters. The unique shape of such digesters is very efficient for mixing. The

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FOG can clog sludge transfer lines at a wastewater treatment plant.

City of Lincoln, Neb., built egg-shaped digesters and encourages haulers to bring FOG to its facility, because it boosts gas production from anaerobic digesters for the engine generators. An egg-shaped digester can become the heart of a hauled waste program.

Utilities that are building or upgrading existing pancake digesters — those with a diameter more than twice their depth — will find that FOG digestion is more difficult than digestion of primary and waste activated sludges. FOG tends to float, so the challenge is to break up the floating scum that forms. Operators can break up the scum cap by increasing the intensity of mixing in the digester. The overall intensity of the existing gas-mixing system can be increased or supplemented by a mechanical or pumped mixing system. Heating the FOG to more than 160° F (71° C) prior to injection into the digester will liquefy the FOG, promoting better FOG digestion from enhanced mixing, as well as even distribution of FOG throughout the digester volume.

If a plant plans to accept hauled FOG in the future, the utility may want to consider adding an equalization tank for the hauled waste. FOG is a high-energy material. Slug-loading the digester with FOG is not desirable, because it can lead to digester upsets or poor digestion of FOG. A FOG holding tank large enough to enable FOG to be fed continuously to the digesters at a low rate is recommended. The use of two holding–equalization tanks allows time for the FOG to separate from the water, at which point the separated water layer can be drained to the head of the plant. The thickened FOG layer then can be liquefied by heating for easy transfer into the digester.

Digester retention time also must be considered to meet the 40 *CFR* 503 Class B digestion criteria, so reducing FOG volume is a good idea. If FOG is not thickened to reduce the volume fed to the digester, additional thickening of waste activated or primary sludge should be considered to compensate for the added volume from hauled FOG.

Slippery Business

Even with energy recovery as a potential bonus, a WWTP needs certain information before accepting FOG. Suppose a new industry wants to move to town or an existing industry wants to add a new production line that will generate an oily waste for disposal. The first determination should be whether the new waste originates from animal, vegetable, or mineral (petroleum) sources. Animal and vegetable oils are usually biodegradable, but they can pose a problem by congealing. Oils that congeal at sewer temperatures — lard and grease from restaurants, for example — can plug sewers. So the usual approaches for managing congealable oil and grease apply. The industrial waste producer should be required to remove FOG through pretreatment, because the floatable, congealable FOG eventually will cause blockages in the sewer system.

Even if the new waste does not congeal, it might float. In this case, it probably will not clog the sewer, but it can be a nuisance in the collection system. It will create a material-handling problem by accumulating on influent screens and wet wells or primary clarifiers as floating scum. Even FOG that does not congeal can become viscous and entrap other materials. As long as it does not congeal, however, it will not be in the same class as congealable grease. If the new waste is biodegradable, it can be accepted into the system and eventually will end up in the solids wastestream. The aforementioned anaerobic digester mixing and feeding issues apply to this material.

How do you know if the new oil or grease is biodegradable? If the oily material is purchased for use at the site, the original manufacturer can be contacted for information on its biodegradability. If it is a new product or byproduct, it may be necessary to run batch-scale treatability tests to prove that the material is biodegradable.

A respirometer can be used to demonstrate biodegradability. A test comparing biochemical oxygen demand (BOD) with chemical oxygen demand (COD) is also a reliable way to determine whether the new waste is biodegradable: If the BOD-to-COD ratio is more than 0.4, the material is readily biodegradable. A ratio lower than 0.4 indicates that the FOG is either partially nonbiodegradable or may be toxic to the organisms in the biological treatment system.

Further testing should be conducted to determine if a low ratio (less than 0.4) stems from a lack of microbial acclimation, rather than true toxicity. Standard BOD seed purchased for use in the lab may not have the same microbial population that will be used in your WWTP to biodegrade the FOG. Running a small pilot reactor to produce

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Grease balls like the ones pictured here form in the headworks of a wastewater treatment plant and periodically must be manually removed.

an acclimated microbial population for use as the seed culture in the BOD test can determine if acclimation is the issue. If the BOD-to-COD ratio remains low, operators should carefully run a series of BOD dilutions. If BOD increases with increasing dilution with an acclimated seed, toxicity is probably to blame. If the BOD remains constant but has a low BOD-to-COD ratio with increasing dilution in the BOD test, this would mean that the FOG is not readily biodegradable.

The wastewater utility pretreatment coordinator should decide whether the industrial waste producer, the wastewater utility lab, or both will conduct the needed tests. If the utility runs the tests, the pretreatment coordinator maintains data and quality control. If the industry runs the test, the coordinator should require documentation that proves the data are valid. The cost of these tests is always an issue, but the utility can recover the cost of the test from the waste producer, if desired.

Special Considerations for Surfactants

More questions arise if an industrial waste producer claims that its FOG is not a problem because it is a water-soluble surfactant. The first question to be answered is whether the surfactant is biodegradable. If so, the microbes in the treatment plant will destroy this material. If the surfactant is not biodegradable, it will pass through the WWTP and show up in the effluent. Nonbiodegradable surfactants should prompt another list of questions, such as the following:

- Is the surfactant toxic to aquatic biota?
- Will it increase the effluent chlorine demand?
- Does it have a high ultraviolet (UV) absorbance?
- Will it foam?

Surfactants are surface-active agents. Examples are soaps, detergents, and dispersants. All surfactants have hydrophobic (hates water) and hydrophilic (loves water) functional groups. Surfactants can emulsify oil and grease, keep suspended solids from settling, and create foam. Nonbiodegradable surfactants necessitate performing additional tests or collecting information from the waste producer. The presence of a surfactant does not necessarily mean that foaming will occur. Surfactants can be foaming, nonfoaming, or even antifoaming.

Materials that foam must be studied carefully to determine the foaming potential through the WWTP, with special focus on impacts during storm events and at the outfall structure into the river or stream. Reaeration, if required at the WWTP, creates turbulent conditions to transfer oxygen into water. Such conditions form a basic relationship: Surfactant plus turbulence equals foam. Special care is required for any surfactant that is a foaming agent, because it will probably create foam in the WWTP effluent. All National Pollutant Discharge Elimination System permits contain language that prohibits the formation of objectionable foam on the receiving stream surface. Foaming agents also can cause excessive foaming within the WWTP, which is frowned upon by regulators. The foam can carry fecal coliforms, contaminate stormwater systems, and possibly contribute to aquatic toxicity. Special care is especially necessary during wet weather events, when WWTPs may be faced with conditions (such as low hydraulic residence times) that are not optimal for biological treatment processes.

Any industrial waste producer that discharges surfactants that are nonbiodegradable and foam — or which have a high COD or UV absorbance at 254 nm — should be required to develop a spill-containment and control plan whenever the surfactants are stored or produced in a concentrated solution. Equalization of the wastestream at the industrial site is another issue to consider. Concentrated discharges of nonbiodegradable material can cause WWTP problems. High-COD material can increase the chlorine demand during disinfection, and material that has a high UV absorbance can interfere with UV disinfection.

Petroleum Problems

Another type of FOG, mineral- or petroleum-based oils and grease, raises more potential red flags and related questions, but shouldn't be rejected automatically. Some oil and grease compounds are made from petroleum products and are very pure, with little to no contamination by the typical aromatic compounds found in petroleum. In fact, the authors once ran across a surfactant made from petroleum products that had none of the classic petroleum oil characteristics and was biodegradable. In that case, oil was cracked and broken down into ethylene, and the ethylene was used as the feedstock

PHOTO COURTESY OF BLACK & VEATCH CORP.

FOG can float, congeal, and adhere to collection system components. Pictured here is a lift station with a floating layer of FOG and some FOG-encrusted components.

to manufacture a surfactant with very specific properties. This was an uncommon situation but not an isolated incident.

Most petroleum fuel products contain some level of benzene, toluene, ethylbenzene, and xylene (commonly called BTEX) or other volatile organic compounds. These volatiles, which pose an explosion hazard in the sewer and pump stations, should be regulated or possibly prohibited. Typical pretreatment limits now being developed for petroleum-based FOG may be as low as 25 mg/L, which is the limit recommended by the U.S. Environmental Protection Agency in the 1980s. However, the sewer explosion prohibition (40 *CFR* 403) is always in place and supersedes any numerical local limit. Many petroleum products are biodegradable, as demonstrated by activated sludge treatment facilities serving refineries. However, even refineries remove as much floatable petroleum product as possible — not only for product recovery but also because of the potential for floatable oil and grease to be carried through the activated sludge treatment process into the plant effluent.

Emulsified oil and grease necessitate additional consideration. Food-based oils and grease should be consumed by the microbes in the WWTP. However, petroleum-based emulsions may de-emulsify in the WWTP into floatable oil, producing an oil scum that could escape into the effluent. Discharge requirements in National Pollutant Discharge Elimination System permits prohibit any visible oil sheen on a receiving stream.

Many machine and fabrication shops use cutting oils that may be of petroleum origin or biodegradable synthetic materials. Most such facilities catch and recycle these oils until they go sour, and many facilities have specific disposal procedures that do not include disposal to the sewer. If contacted by the industry, operators should be wary of batch dumps of these types of products, because the emulsified material may carry these oils into the activated sludge basin. And because biodegradability equals an increased oxygen demand, slug loads of emulsified oil can upset the activated sludge process from organic overloading. Biodegradable oils are only a problem if the microbes require an acclimation period. Storing the sour-oil waste at the industrial site and discharging it to the sewer slowly over several days can provide the necessary time for acclimation and equalization of the BOD load to the WWTP.

Besides having issues related to high BOD, some of these lubricants (oils and greases) may contain molybdenum and other additives that could threaten the quality of the WWTP biosolids. Molybdenum-bearing lubricants are a specific example of a broader issue. For example, petroleum-based FOG can carry other pollutants, such as organometallics and other non-FOG organics. So when inquiring about petroleum-based FOG, remember to ask for a complete chemical analysis of the petroleum product; the Material Safety Data Sheet does not provide a complete analysis.

Final FOG Facts

A wide range of materials can be classified as fats, oils, and grease, and FOG chemicals can have a wide range of properties. If the material is congealable at sewer temperatures, operators should strive to control its introduction into the sewer to avoid, or at least minimize, sewer plugging. If it doesn't congeal and is biodegradable, generally the only real issues are BOD loading and oxygen demand. Hauled FOG, for introduction into an anaerobic digester, can produce revenue, but only if the digester is designed to handle the FOG. Emulsified FOG and surfactants raise more questions and require additional investigation before being accepted into a WWTP. Operators should always determine the FOG's composition, how it is made, and whether it has any other special properties. Asking the right questions and talking with staff from another WWTP that accepts these wastes can keep pretreatment coordinators and other operations personnel from getting lost in the FOG.

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