Toward Onsite Pretreatment of Effluent Containing Fats, Oils and Grease (FOG)

By Max Weiss

Historically, storage devices such as grease traps and interceptors (static and automatic, internal and external) have been employed to reduce fats, oils and grease (FOG), to prevent onsite drain blockages and to reduce downstream accumulations. Many jurisdictions are still encouraging or allowing these methods.

Onsite storage devices that only separate and retain FOG require emptying and transport of the contents to a proper disposal facility. The difference is actual pretreatment vs. storage.

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Current impetus for requiring pretreatment of effluent containing FOG, while continuing to include the reasons listed above, is principally the result of the passage of the Clean Water Act and the U.S. EPA Regulations implementing the Act.[1]

The Clean Water Act requires pretreatment of all discharges other than domestic discharges to Publicly Owned Treatment Works (POTW) "with a total design flow greater than 5 million gallons per day and receiving from Industrial Users, pollutants which pass through or interfere with the operation of the POTW."[2]

Manual disposal of accumulated FOG has its own set of problems. Solid waste legislation and regulations[3] require proper disposal of substances such as FOG. However, small quantities of FOG removed from gravity devices or coalescing devices frequently find their way to dumpsters, recycling vats (intended for edible oils only), toilets, floor drains, parking lot sumps, etc. This may constitute "disposal" in the mind of the person charged with cleaning the device, but this is not what is intended in pretreatment and solid waste requirements. Such action is also prohibited, and those found doing this are frequently prosecuted.

Because larger quantities of FOG removed from buried storage devices are less easily "disposed" of, and regulation of its discharge more controlled, opportunities for the shell game described above are fewer. But this also leads to higher disposal costs per unit of FOG. Vats and tanks (i.e. storage vessels of any size or description)—and pipes leading to and from them—do not complete pretreatment or disposal because they have not reduced the volume or mass, nor altered the character of the pollutant. Therefore such elements alone do not constitute pretreatment or disposal. They are simply extensions of storage.

Nature of FOG

Fats, oils and grease used to be simply different physical manifestations of the same substance: animal fats. Indeed, you will find some literature still referring to lower temperature and retention time as co-essential factors in good separation efficiencies.[4]

FOG is now comprised of principally complex manufactured vegetable oils, designed to strongly adhere to food. Making up a smaller portion are animal and fish fats and oils, and still lesser amounts of vegetable waxes, which are all quite similar chemically, being composed of carbon, hydrogen and oxygen in varying proportions.[5]

The basic structure of FOG is varying combinations of glycerols and fatty acids. However, as food science advances, and cooking oils become more and more efficient, the fatty acid chains become much more complex, and the adhesion characteristic becomes more pronounced. The more complex fatty acids are generally more stable; they are less likely to break down in the drainage system from the activity of indigenous planktonic (free) organisms or in the open environment.[6]

Realization of the persistent and sometimes toxic characteristics of FOG released in the environment has led the U.S. EPA's refusal[7] to differentiate between releases of FOG and petroleum-based oils under the Facility Response Plan rule, which the Agency put forth under Section 311 (j) of the Clean Water Act.[8]

When FOG was comprised mostly of animal fats, recycling for munitions, paints, resins, etc., was possible. Now the principal component of FOG is vegetable oils, which can contain various combustion by-products and cleaning agents, both of which can be independently toxic or hazardous in combination and can contain drain-borne organisms, some of which can be pathogenic.

Because much non-drain FOG is commonly recycled for cosmetics and animal feed supplements, most responsible rendering plants will not knowingly accept FOG from drainage sources. It is generally less expensive to acquire virgin vegetable oils and non-drain recycled oils for such uses than to identify and remove unacceptable elements accumulated in drainage environments.

Pretreatment

Pretreatment has been formally defined by the Code of Federal Regulations as, "the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW...The reduction or alteration may be obtained by physical, chemical or biological processes, process changes or by other means, except as prohibited by 403.6 (d)"[9] (*dilution*)." Congress originally established July 1, 1983, as the deadline for implementation of pretreatment standards by those required to establish them. The date was extended several times, but, most recently, Congress refused requests for further extensions.

Municipalities, largely responsible for implementing and enforcing pretreatment programs, are beginning to require measured effluent, mandatory pumping schedules and proof of legal disposal. Results for the discharger are increased inconvenience, installation and maintenance costs, and surcharges and fines for excessive FOG levels in the discharger's effluent.

As both competition and environmental awareness increase in the food industry, the last thing a business owner needs is drainage or administrative problems from inadequate or improper pretreatment methods. Typically, business owners want the least expensive, most versatile, least intrusive and most dependable method of compliance possible. Conventional onsite storage and offsite disposal may not be the method most suitable to both business owners and municipalities.

The three elements of pretreatment are: Separation, Retention and Disposal.

Separation

Separation of FOG from the effluent with the greatest efficiency is essential to adequate performance of the other two steps. Efficiency of separation is measured in two parameters: proportion of the total pollutant present and time. The long-established standard for this measurement is PDI-G101.[10]

Separation efficiency is also a significant factor in overall size of the device used. If, in order to achieve acceptable performance, the design of the device requires substantial time to separate FOG from the effluent, the device will have to be of sufficient size to retain the effluent long enough to allow completion of the process.[11] To the degree the device relies on gravity alone, a greater volume will be required. With a larger volume comes a greater thermal mass of cooler water acting to further slow separation. Viscosity of FOG increases proportionately with decreases in temperature, and density of the material does not decrease concordantly. Therefore, separation times increase as water temperature decreases. This exponential growth is not infinite and eventually sufficient separation occurs. If food particles are present, which are generally heavier than water, and to which

This interactive bio-media, at the core of Jay R. Smith's Remediator®, separates and retains FOG from live discharge systems.

these new oils cling so well, adequate separation is even less likely in a cold environment.

A combination of coalescence and gravity in a smaller volume at higher temperatures produces higher separation efficiencies.[12]

Retention

Retention efficiency and capacity within the device over time is necessary to make the FOG available for removal and proper disposal. PDI-G101 protocols require retention capacity of two times the rated flow capacity in pounds of FOG, i.e., 35 gpm = 70 lbs.[13]

FOG does not float *on* water but *in* it. (With a specific gravity of 0.85, only 15 percent of FOG volume floats above the static water level and it is frequently liquid.) Boundary layer turbulence at interfaces of dissimilar fluids causes water moving past the floating FOG to effect flow of FOG at the boundary, and portions are eventually carried from the device by the flowing water.

The longer the FOG remains in the device, the more water-logged it becomes; surfactants have effect, food particles attach and draw portions of FOG downward into water with higher flow energy, and both are eventually carried from the device.

Devices incorporating various methods of coalescence are less subject to boundary layer flow effects because of physical structures such as coalescing plates, tubes, etc. However, these structures can interfere with manual removal of FOG resulting in inadequate cleaning and eventual sinking and migration of older FOG.

Designs for external interceptors came from modifications of septic tanks and were intended to capture a material (animal fats) with significantly different physical characteristics than FOG currently found in food facility effluent. Thus, performance of these devices[14] rarely meets the expectations of current pretreatment requirements.

Many communities have settled on 100 mg/L as a numerical standard effluent limitation for FOG. FOG begins to interfere with primary clarifier operation in treatment plants at concentrations greater than 300 mg/L and with sludge biological activity in concentrations greater than 50 mg/L.[15]

Disposal

Storage methods are dependent upon the services of a pumper truck and the availability of a legal disposal facility. In the past, disposal was accomplished in various ways such as onsite dumpsters, manholes and toilets, or offsite manholes, septage dumpsites, fields and landfills. Those methods of disposal are no longer legal, and enforcement is increasing as federal agencies put more pressure on states, counties and municipalities to comply with federal anti-pollution laws.

Disposal of FOG by deposit in landfills was a widely employed method of disposal and is still being used in some locations where enforcement of Solid Waste and Clean Water Act derivative regulations is lax.

However, landfills are prohibited from accepting "liquid or semi-liquid" waste materials.[16] The most commonly used test for "liquid or semi-liquid wastes" within the definition of "liquid or semi-liquid" is any substance that would fail the "paint filter test" at normal temperatures and pressures.[17] While methods exist for thickening liquid or semi-liquid wastes by mixing them with other substances, they are expensive and frequently fail when subjected to pressures from deep burial within the landfill, allowing subsequent escape of FOG to groundwater or the surface.

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Because of the changed composition of FOG and more stringent pollution laws, dumping—other than in Class II landfills where all leachate is captured and treated—is disappearing as a disposal option, and alternative offsite methods such as incineration or chemical alteration are more expensive and limited.

Onsite sensibilities

Onsite pretreatment of effluent containing FOG makes logistical, financial and environmental sense if it can be conducted reliably to incorporate all three elements of pretreatment—separation, retention and disposal—without extensive operator attention and maintenance or additional expense.

One method of onsite pretreatment receiving growing attention is biochemical disassembly of the FOG molecule, leaving no material requiring storage or disposal. Bacteria (in optimal conditions) disassemble the molecules of FOG first by breaking the bond between the glycerol and fatty acids, then by breaking the bonds in the fatty acid chains by a process called beta-oxidation.[18] This process continues until carbon, oxygen and hydrogen atoms are released in the forms of carbon dioxide and water.

Initial commercial application of biochemistry to FOG disposal involved adding bacteria or enzymes to existing grease traps, interceptors and drains. The application of bacteria or enzymes (additives) to drain systems, grease traps and interceptors unquestionably affect the accumulation of FOG within the system or device, but the process is not controlled or contained. Biochemical additives facilitate transport of FOG from conventional storage devices by breaking the bond between glycerol and fatty acids, rendering both substances semi-soluble, allowing re-combination in greater density once dilution takes place downstream. Grease traps and interceptors store pollutants; sewer lines transport pollutants, and neither is a suitable place to conduct biochemical processes.[19] Only fully engineered, tested devices and processes should be utilized for pollution reduction and elimination. Many jurisdictions, having recognized disadvantages of biological additives in uncontrolled applications to grease trap and interceptors, discourage or ban their use in lieu of regular cleaning and proper disposal.

One such engineered and tested onsite system is the Remediator® manufactured by Jay R. Smith Mfg. Co. in Montgomery, Ala. Designed principally as a bioreactor, engineered to separate and retain FOG from live discharge streams, and installed as an appliance, the device has been tested for separation and retention in accordance with PDI G-101. It has also been tested for construction and effluent quality in accordance with IAPMO IGC125-98, File No. 3782 (test data is available). It routinely produces effluent FOG quantities in the 20 to 30 mg/L range at 20 to 75 gpm rates without requiring periodic cleaning or pumping. Other manufacturers are developing and testing similar technologies.

Just as with other classifications of discharge, onsite treatment for general pollutants such as FOG via engineered systems is the logical intersection of administrative, environmental, financial and FOG evolution. PME

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Endnotes

1 33 U.S.C. 1251 et. seq.; 40 CFR Part 403
2 40 CFR 403.8 (a)
3 42 U.S.C., Ch. 82, 6903, et. seq.
4 *PM Engineer,* June 1998, pp. 38-41
5 *Wastewater Engineering,* Metcalf & Eddy, 3rd Ed., p. 66
6 Federal Register: Oct. 20, 1997; Vol. 62, No. 202; pp. [5]407-54543
7 Ibid.
8 33 U.S.C. 1321 et. seq.; 40 CFR Part 112
9 40 CFR, 403.3, (1) (q)
10 Plumbing and Drainage Institute, 45 Bristol Drive, Suite 101, South Easton, MA 02375
11 American Society of Plumbing Engineers, *ASPE Data Book*, Ch. 35, Grease Interceptors, p. 35.3
12 Industrial Testing Laboratories, Inc., Jay R. Smith Model No. 8970-35, Report No. 96-07-02895, 8/19/96
13 PDI-G101, Sec. 7.9, Table 1
14 Typically 200 to 300 mg/L; Personal conversation, L.B. McGill, Environmental Quality Specialist, Houston, Texas
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16 40 CFR Parts 240-247
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18 Forster, C.F. 1992. Oils, Fats and Greases in Wastewater Treatment. J. Chem. Tech. Biotech. 55:402-404
19 Report on Microbiological Products for Grease Traps, P. 10, William W. Mohn, Department of Microbiology, University of British Columbia, April 16, 1996