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Best Management Practices for Grease Interceptors and Sanitary Sewer System Protection in Nashville, TN

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Worldwide, approximately 40-50% of annual Sanitary Sewer Systems blockages are caused by fat, oil, and grease. This research study reviewed the issue of fat, oil and grease produced by Food Service Establishments and the impact this has on Sanitary Sewer Systems and measures available as prevention. Additionally, this research focused on the EPA Code of Regulations and the Nashville, TN Code of Ordinances, that determine types of grease control systems, required maintenance, along with Food Service Establishments compliance, and implementation of Best Management Practices (BMPs). A survey of twenty (20) Food Service Establishments in Nashville, TN was conducted to understand the necessity for Grease Interceptors and other preventative measures such as self- managed Food Service Operation BMPs and their ability to prevent and protect the Sanitary Sewer System. The survey analysis details that Food Service Operations BMPs are sporadic at best and further research is needed in this area of Sanitary Sewer System protection.

Keywords: BMPs, Grease Interceptors, Sanitary Sewer, Food Service Operations

Introduction

Fat, Oil and Grease (FOG) in sewer systems are primarily discharged from Food Service Establishments (FSEs) [...] FOG deposits are responsible for approximately 40-50% of the annual blockage related to sanitary sewer overflows (SSOs) (He et al., 2017).

Sanitary sewer overflows (SSOs) are the discharge of untreated sewage to the environment prior to reaching the wastewater treatment plant. These unlawful discharges may spread high concentrations of pathogens, nutrients, and solids, resulting in a series of environmental problems that threaten human and environmental health. Approximately 23,000-75,000 SSO events are reported annually by the US EPA and release 3-10 billion gallons of untreated wastewater to the environment. Half of those SSOs are attributed to partial or full pipe blockages, which are triggered by the accumulation of insoluble fat, oil, and grease (FOG) deposits (Hao et al., 2017).

In order to protect SSOs, cities, and states derive their authority and establishes the basic structure for regulating discharges of pollutants into the waters from the Environmental Protection Agency, Code of Federal Regulations, Title, Part 403.5, National Pretreatment standards: Prohibited discharges (a)(1) General prohibitions. A User may not introduce into a POTW (Publicly Owned Treatment Works) any pollutant(s) which cause Pass Through or Interference. (B)(3) Solid or viscous pollutants in amounts which will obstruct the flow in the (POTW) resulting in Interference; (4) POTWs may develop Best Management Practices to Implement ((c)(1) and ((c)(2)…[wherein] each POTW with an approved pretreatment program shall continue to develop these limits and effectively enforce such limits (40 CFR 403.5 - National Pretreatment Standards, n.d.).

Metro Government of Nashville and Davison County, TN Code of Ordinances Chapter 15.04.310 defines, 'Pretreatment' as the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater to a less harmful state prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW. The reduction or alteration can be obtained by physical, chemical, or biological processes, process changes, or by other means, except as prohibited by 40 CFR Section 403.6(d). Additionally, Chapter 15.60, Industrial Waste Discharge, section 15.60.125 states, all food service establishments are required to comply with Operation Division Policy No. 2004-01: Metro Water Services Fats, Oils and Grease Management Policy (Mini TOC: Title 15 - WATER, SEWERS AND OTHER PUBLIC SERVICES | Code of Ordinances | Metro Government of Nashville and Davidson County, TN | Municode Library, n.d.).

Research Objective

The objective of this research is to identify the problem with FOG, the systems available to prevent build-up, and subsequent blockage of the local sanitary sewer system, and FSEs BMPs to prevent FOG from entering the SSO. Research primarily focused on the Nashville, TN, Metro Water Service, Fats, Oil, and Grease Management Policy, and a survey of Nashville FSEs; however, it did take a broader look at national standards for reference. The data compiled will be used to determine the self-management of BMPs and the following of grease interceptor servicing and cleaning requirements.

Background

What is FOG

FOG is a mixture of fats, lipids, and oil generated from wastewater of Food Service Establishments (FSE) such as restaurants, bakeries, and coffee shops (Hao et al., 2017). Wastewater from restaurants typically contains large amounts of organic matter (biochemical oxygen demand, BOD), greases, and oils. The term oil and grease, as commonly used, includes fats, oils, waxes, and other related constituents found in wastewater. These are compounds (esters) of alcohol or glycerol with fatty acids. The glycerides of fatty acids that are liquid at ordinary temperatures are called oils, and those that are solids are called grease (or fats). In the absence of industrial products, oil and grease is composed primarily of fatty matter from animal and vegetable sources and hydrocarbons of petroleum origin. […] Oils and greases may influence wastewater treatment systems if present in excessive amounts. They may interfere with aerobic and anaerobic biological processes and lead to decreased wastewater treatment efficiency. When discharged in wastewater or treated effluents, they may cause surface films and shoreline deposits, leading to environmental degradation. […] Greases and oils are persistent for extended periods and could be troublesome. The concentration of oil and grease in

wastewater from restaurants could vary from about 1000 mg/I to more than 2000 mg/I. The effluent oil and grease concentration should be less than about 30 mg/1 to avoid problems with downstream treatment units in decentralized wastewater treatment and disposal systems such as OSSF systems (LitReviewOnTheEval.pdf, n.d.).

Why is FOG a Problem

Food Service Establishment's (FSE) drains and sewers often suffer from blockages caused by the accumulation of fat, oil, and grease (FOG), resulting in backup and flooding of wastewater on-site and within the local environment. These problems are generally caused by inadequate on-site pretreatment of the wastewater and, more importantly, by failure to take wastewater characteristics into account when designing the system (e.g., grease interceptors GI, grease removal units GRU, or biological additions)(Gurd et al., 2019).

It was initially hypothesized that FOG from FSE discharges interacts with calcium from wastewater, leading to the formation of the calcium-based fatty acid salts or FOG deposits through a saponification reaction. This hypothesis was later verified by the formation of FOG deposits under laboratory conditions from the reaction between free fatty acids (FFAs) and calcium chloride. These lab-based FOG deposits were shown to have a strong similarity to FOG deposits collected from sewer lines and pure calcium soaps using Fourier Transform Infrared (FTIR) analysis, which provided evidence that hardened FOG deposits were indeed born from saponification. The adhesive quality of the saponified solid material may be attributed to the composition of FFAs and the ratio of FOG/calcium involved in the saponification reaction (He et al., 2017).

FFAs are primarily generated from the hydrolysis of FOG. During the cooking process (e.g., deep fat frying, baking, and grilling), fast hydrolysis has been found to generate FFAs as soon as the fat comes in contact with moisture. Researchers have also suggested that FFAs may be produced through alkali driven hydrolysis in GIs near the inlet, along the sewer line due to prolonged contact or mixing between FOG and high moisture, and at sewer crowns due to the release of calcium hydroxide from concrete corrosion (He et al., 2017).

The debris layer found in sewer-based FOG deposits is suspected to result from the cleaning and sanitizing of nonfood-contact surfaces in the facility. Dirt and debris from floors, tables, and walls may be rinsed into sanitary sewers and accumulates at the FOG deposit site. Grit and rust from a wide variety of unknown sources that end up in sewers have also been found in FOG deposits. Although peptide and or proteins were detected in FOG deposits, no study has been performed to determine the original source of these compounds. Furthermore, the adsorption of hydrophobic substances between FOG and flushable consumer products (FCPs), such as toilet tissue and wet wipes, may also lead to the accumulation of FCPs as debris in FOG deposits. While there is no way to know how much debris will accumulate on the surface or internally within the FOG deposit core matrix, the tackiness and rheology of the typical FOG deposit will continue to attract and retain debris found in the typical sewer collection system and exacerbate the pipe blockage (He et al., 2017).

Grease Interceptors

Ideally, FOG would never go down the drain. However, at this time, most restaurants cannot keep 100% of FOG out of the collection system. This is why FOG removal devices and proper maintenance of these devices are so important (Tennessee Guidance Doc.pdf, n.d.).

Grease interceptors, either below the sink (flow-based grease interceptors or FGI) or outside and below ground (retention-based grease interceptors or RGI), are the primary approaches for removing FOG from FSE effluent. Both FGIs and RGIs work under the principles of gravity separation, which allows for the accumulation of FOG at the surface and the settling of food solids and kitchen debris at the bottom. The clarified water is then discharged to the sanitary sewer system. Depending on the size of food processing operations, the installation of GIs for FSEs (e.g., restaurants and hotels) is globally required by numerous municipalities (He et al., 2017).

The tank (Figure 1) shall be of a monolithic body design, separated by a solid baffle into 2/3 total capacity inlet chamber and 1/3 total capacity outlet chamber. It shall have 24" access ways over each drop tee. Flow-through the baffles will be provided by a 90-degree sweep. All perforations and seems shall be sealed with hydraulic cement or welded. All piping shall be a minimum of schedule 40 PVC solvent welded; pipe clamps or hangers may be required. All parts of the system shall be made water and gas-tight from two-way cleanout upstream of the tank to two-way cleanout downstream of the tank, including andy risers to grade; proper venting allowed (FOG Management Policy_effective 07.01.14_stamped by Metro Clerk.pdf, n.d.).

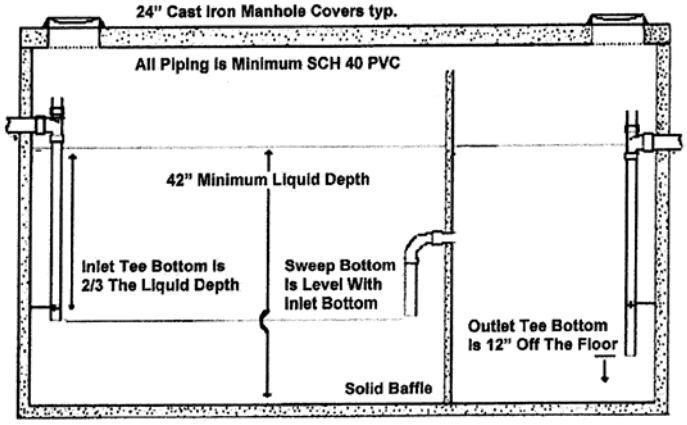

Figure 1: Grease Interceptor – Metro Water Services

How Grease Interceptors work

A grease trap or interceptor consists of an enclosed chamber, which is designed to separate and retain oil and grease from the kitchen wastewater. Separation is accomplished by virtue of the fact that fats and grease have a lower specific gravity (are less dense) than water and rise to the surface under favorable conditions. Treated wastewater passes through the chamber and on to the sewer. In order to ensure efficient operation, the separation device must be cleaned periodically to remove the accumulated grease and settled solids and to restore the required separation volume allowed (Tennessee Guidance Doc.pdf, n.d.). Grease traps and interceptors must be designed to satisfy three basic criteria in order to ensure effective separation: these are time, temperature, and turbulence (Tennessee Guidance Doc.pdf, n.d.).

1) Time. The separation device must provide sufficient retention time for emulsified grease and oil to separate and float to the surface of the chamber.
2) Temperature. The separation device must provide adequate volume to allow the wastewater to cool sufficiently for emulsified grease to separate.
3) Turbulence. Turbulence through the device must be controlled so that grease and solids

are not kept in suspension in the wastewater. Turbulence must be controlled, especially during high discharge rates associated with draining a triple sink or multiple fixtures simultaneously.

In addition, the grease trap or interceptor must provide sufficient storage capacity for accumulated grease (the floating particles) and solids (the settling particles) between cleanings allowed (Tennessee Guidance Doc.pdf, n.d.).

Grease Interceptor Cleaning and Maintenance Requirements

An obvious required cleaning interval of an interceptor is when it is full of FOG. Actually, however logical that statement first appears, it is false. When the interceptor is full, it is too late. It is too late to maintain water quality, and it is too late to prevent damage to the interceptor, the building's drainage piping, and the collection system. A rule of thumb, though not formally prescribed by code and rarely by pretreatment administrators, is 25 percent of the wetted area of the interceptor. That is, whenever accumulated material floating or at the interceptor bottom, whichever occurs first, or the two combined equal 25 percent of the vertical height of the wetted surface at static (non-flowing) conditions, the interceptor requires cleaning. […] All interceptors containing excessive FOG and aged FOG will demonstrate a dramatic reduction in separation and retention efficiency. In addition, the potential for interceptor and collection system obstruction increases exponentially with the duration of FOG retention (FACTS and MYTHS Grease Interceptor by Max Weiss, 2007).

The ultimate disposal of FOG is an essential part of a FOG control program. If grease trap pumpers do not do an adequate job of cleaning a grease interceptor/trap or if they discharge the contents of the grease trap into a manhole, the other aspects of the grease control program cannot be effective (Tennessee Guidance Doc.pdf, n.d.).

The following are the Nashville Metro Water Service, Grease Interceptor Cleaning and Maintenance Requirements (FOG Management Policy effective 07.01.14_stamped by Metro Clerk.pdf, n.d.):

1. Cleaning / Pumping - Grease interceptors must have the complete contents pumped or cleaned at a frequency of not less than once every 90 days unless approved in writing by the Department of Water Services. Also, grease interceptors must have a complete pump of contents when the total accumulations of surface FOG (including floating solids) and settled solids combined reaches twenty-five percent (25%) of the grease interceptor's overall liquid depth. This criterion is referred to as the "25 Percent Rule".
2. Partial pump of interceptor contents or on-site pump & treatment of interceptor contents will not be allowed due to the reintroduction of fats, oils, and grease to the interceptor and pursuant to the Code Federal Regulation (CFR) § 403.5 (b) (8), which states "Specific prohibitions. In addition, the following pollutants shall not be introduced into a POTW: Any trucked or hauled pollutants, except at discharge points designated by the POTW".
3. The Grease interceptor effluent-tee will be inspected during cleaning and maintenance and the condition noted by the grease waste hauler's company or individual conducting the maintenance. The hauler or individual conducting the maintenance will contact the FSE to make them aware of any defects identified. Effluent-tees that are loose, defective, or not attached must be repaired or replaced immediately.
4. Grease Interceptors must have access manholes over the influent-tee and effluent-tee for inspection and ease of cleaning/maintenance. Access manholes are required for all compartments for complete cleaning.

5. Grease Interceptors must be "certified" annually by a Metro Water Services approved grease waste hauler or plumber.Best Management Practices (BMPs)

Preventing FOG build-up in the collection system is the goal of FOG control measures. Many cities have found that requiring restaurants to implement Best Management Practices (BMPs) is an effective tool in controlling FOG without requiring extensive monitoring. (Nashville > Water Services > Environmental Compliance, n.d.). Below is a consolidated list of 'typical' BMPs.

ID	Best Management Practices (BMPs)
•	***Food Service Operations BMPs***
1	Dry Wipe Pots, Pans & Dishware before washing
2	Training of Proper Grease Handling in Restaurant
3	Recycle Waste Cooking Oil
4	DO NOT pour Grease into Sinks or Floor Drains
5	'No Grease' Signs over Sinks & Drains
6	Strainers in Sinks to Prevent large Food Particles from Entering the Sewer System
7	Strainers in Floor Drains to Prevent large Food Particles from Entering the Sewer System
8	Grease & Oil Spill procedures to prevent entering the Drains
9	Ensure 'Food Grinder' is not attached to Sewer System
•	***Grease Interceptor BMPs***
10	Pump Out Grease Interceptors regularly
11	Clean Grease Interceptors regularly
12	Witness Grease Interceptor Pump Out/Cleaning
13	Retain Signed Copies of Grease Interceptor Pump Out Manifest
14	Grease Interceptor 'Certified' by Metro Water Services

Research Methodology

To fully understand the Foods Service Establishments approach to FOG prevention, twenty (20) Nashville restaurants completed a survey on the implementation and adherence to the Metro Water Services, Food Service Operations, and Grease Interceptor, Best Management Practices (BMPs). The twenty restaurants were a convenience sample and did not reflect a randomized sample of all restaurants in the city.

Food Service Operations BMP Survey Results

The first line of defense in preventing FOG entering the sanitary sewer system lies solely with FSEs Food Service Operations. By analyzing the survey data collected regarding Food Service Operations BMPs, a quick determination can be reached as to the FSEs' active participation towards FOG prevention. Food Service Operations BMPs were measured as to the percent 'active' across all twenty FSEs surveyed. As Figure 2 details, the results varied across each BMP, with some reaching a high percentage of 'active' status while others were nearly completely 'inactive.'

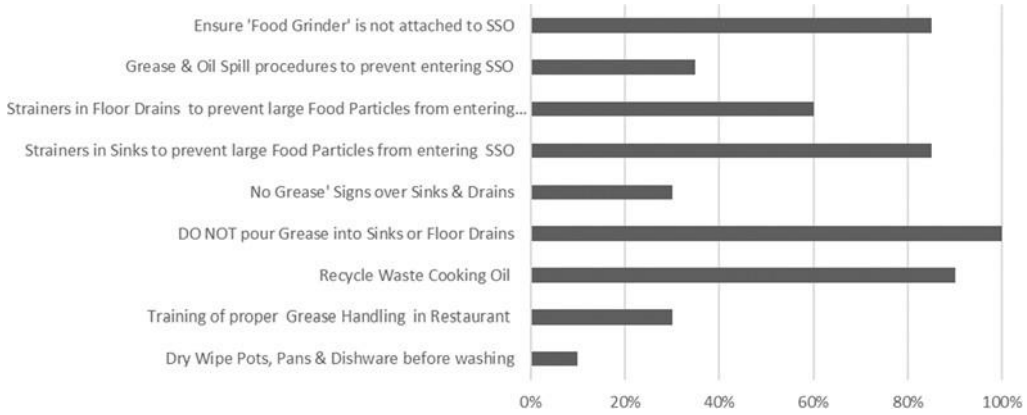

Figure 2: % of Active Food Service Operations BMPs across FSEs

To further understand the varied application of the Food Service Operations BMPs, Figure 3 displays the data as a percentage of 'active' BMPs by individual FSEs. This data provides a potential understanding of individual FSEs commitment towards the reduction of FOG. Additional research is warranted to determine the reasons for not implementing specific BMPs. In total, only an average of 58% of the Food Service Operations BMPs were active among the FSEs surveyed.

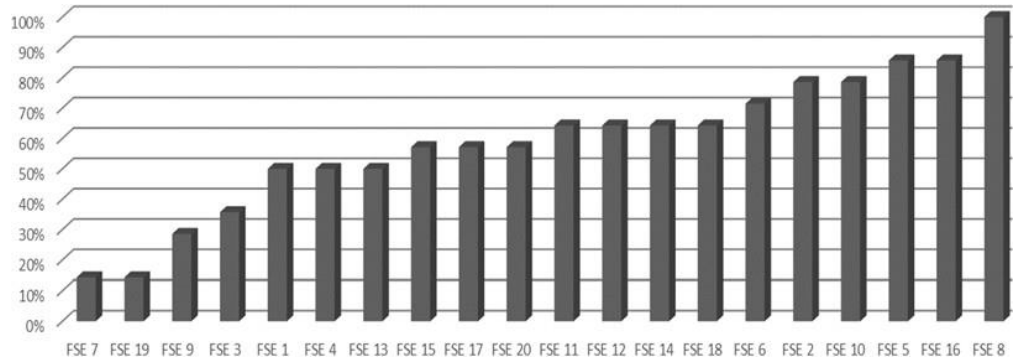

Figure 3: % of Active Food Service Operations BMPs by FSE

Grease Interceptor BMP Survey Results

The last line of defense in preventing FOG entering the sanitary sewer system lies solely with FSEs Grease Interceptor BMPs. By analyzing the survey data collected regarding Grease Interceptor BMPs, a quick determination can be reached as to the FSEs' active participation towards FOG prevention. Grease Interceptor BMPs were measured as to the percent *active* across all twenty FSEs surveyed. As Figure 4 details, the results varied across each BMP, with some reaching a high percentage of 'active' status while others were nearly completely 'inactive.'

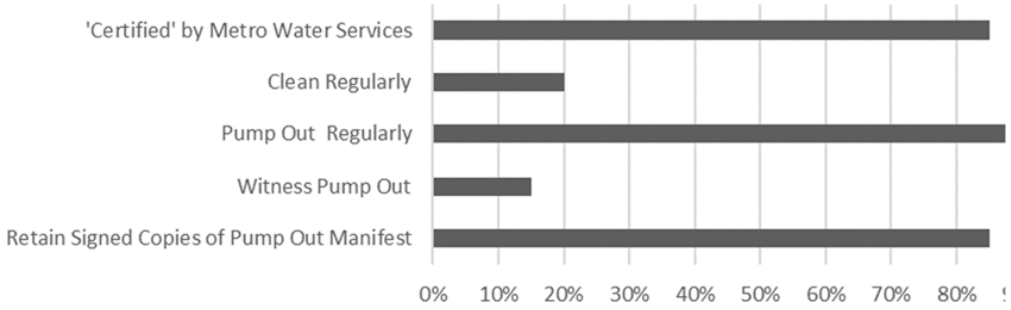

Figure 4: % of Active Grease Interceptor BMPs across FSEs

The percent of Grease Interceptor BMPs across FSEs demonstrates a high compliance to certification, pump out, and signed copies of pump out manifest, but a meager percentage of compliance to cleaning and witnessing the pump out. Further study may be needed to determine if this is due to not understanding the requirements versus only completing the items easily identified during random inspections. Additional data review of the percent of active grease interceptor BMPs by individual FSE demonstrates many are middle of the road with some at a high level of compliance. In contrast, several are not compliant at all. In total, only an average of 59% of the Grease Interceptor BMPs were active among the FSEs surveyed (see Figure 5).

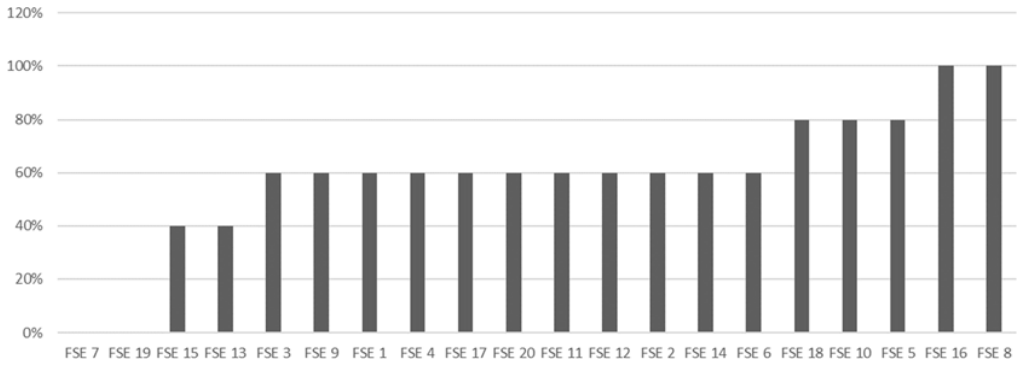

Figure 5: % of Active Grease Interceptor BMPs by FSE

Additional conclusions could also be reached that even with the static presence of the Grease Interceptor, Food Service Operations still plays a pivotal role in the effectiveness of this equipment. As Figure 6 illustrates, FSEs with a low percentage of active Food Service BMPs, are also prone to a lower percentage of active Grease Interceptor BMPs, resulting in FOG entering the Sanitary Sewer System. This data could even support the argument of the ordinance inspector being the actual last line of defense in holding FSEs accountable to the Grease Interceptor BMPs.

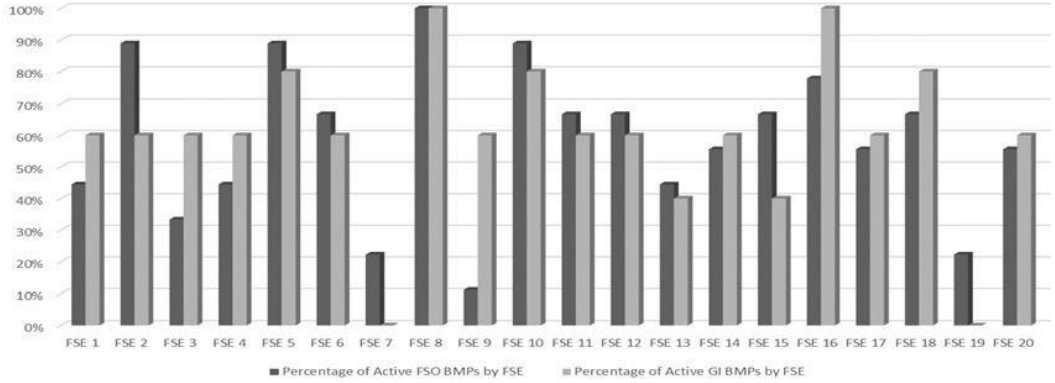

Figure 6: % of Active Grease Interceptor compared to Active Food Service Operations BMPs by FSE

Conclusion

Problems caused by wastewater from Food Service Establishments have served as the basis for ordinances and regulations governing the discharge of grease materials to the sanitary sewer system. This type of waste has forced just about every jurisdiction to require best management practices and installation of grease interceptors anywhere there is a commercial or industrial kitchen or any other FOG-producing activity going on (Sweet, 2008). As shown by the survey results, the following of BMPs established as the first line of defense by Food Service Establishments is sporadic. Further research may be necessary to determine the reasons, especially as compliance is tough to manage by local officials on a day to day basis. Therefore, this research concludes that Grease Interceptors are, in fact, functioning as the last line of defense in preventing FOG build-up and subsequent blockage of the sanitary sewer system.

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