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Wastewater fats oils and grease characterisation, removal and uses. A Review

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Abstract

Municipal wastewater contains a variety of organic and inorganic substances from domestic and industrial sources. The presence of fats, oils and grease (FOG) in municipal wastewater has proven to have adverse effects on the wastewater treatment plants and aquatic life in which it is sometimes discharged. There are different technologies used for the removal of FOG in municipal wastewater treatment all over the world. These technologies differ in the percentage removal of FOG hence an accurate method for determining the oil content of a wastewater is extremely important. A number of tests can be used for the determination of FOG, but most tests involve extraction of the oil from water with a preferential solvent. Some of those solvents can be hexane, petroleum ether, benzene, ethyl ether, chloroform, n-hexane and carbon tetrachloride. After FOG is found in wastewater effluents, it may be recovered and reused, nevertheless reduction or prevention of pollution at the source is a key element in any pollution control strategy. However, after FOG is found in the effluent, pre-treatment measures as well as control of FOG at the source may be introduced in wastewater treatment and the recovered FOG can be reused. A number of options for the use of recovered FOG include land fill, land application, composting, provision for manufacturing lubricants or industry soaps, incineration, anaerobic co-digestion, or biodiesel production.

Keywords:* *FOG, wastewater, removal, technology, reuse

Introduction

A large quantity of wastewaters is produced by urbanization growth and growth in human population which as a result limits a safe environment [1]. This causes an effluent of poorly treated wastewater which creates adverse conditions for water users downstream hence wastewater treatment technology is fast changing as to tackle the current day challenge. Sufficient treatment of wastewater before its disposal or reuse is essential in order to prevent contaminants from entering receiving water bodies [2].

Wastewater from household sewage and institutions is treated at municipal wastewater treatment plants. In Municipal wastewater, there is the primary treatment stage, secondary stage and the tertiary stage. The primary stage removes solid material from the wastewater, the secondary stage digests organic settled and floating organic material whereas the tertiary treatment disinfects the wastewater.

The successful removal of Fats, oils and grease is highly important because poorly removed FOG, negatively affects wastewater treatment plants and the aquatic habitat where it is discharged into [3]. There are different technologies used for the removal of FOG in municipal wastewater treatment all over the world; physical methods, chemical methods and biological methods which include aerobic technologies and anaerobic technologies. Aerobic wastewater treatment is wastewater treatment through bacteria that use oxygen for feeding and other microorganisms, whereas, anaerobic wastewater treatment is treatment with bacteria that do not utilize oxygen for feeding during wastewater treatment. The activated sludge and trickling filter are widely used technologies under the aerobic wastewater treatment technologies in municipal treatment systems that contain FOG. This two technologies have both been proven to remove FOG in large quantities. Additionally, the anaerobic filter reactors, anaerobic baffled reactors (ABRs), anaerobic lagoons, expanded granular sludge beds (EGSBs) and up-flow anaerobic sludge blanket are also known to remove FOG. Contrarily, how much FOG is removed by these technologies in municipal wastewater treatment differs and proves to be hard to detect unless the technologies are put in use under the exact same conditions which is sometimes difficult as some technologies work best in industrial wastewater or domestic wastewater only.

After FOG is removed from the wastewater treatment works, it may be recovered and reused. Uses for the recovered FOG include land application, anaerobic digestion and biogas production and bio diesel. However, in the absence of a market for FOG, a management authority is needed to provide rules, incentives, information and outreach, and enforcement. The high costs from sewer blockages summon a FOG management program that includes a regulatory approach to reduce plant maintenance costs and prevent damage to aquatic life. Different municipalities have different regulatory guidelines with regard to wastewater effluents containing FOG and the enforcement of such guidelines determines the amount of damage to aquatic life in areas where effluent containing FOG is discharged into nearby streams. If FOG is found in the effluent, pre-treatment measures as well as control of FOG at the source may be introduced in wastewater treatment [4].

Literature Review

In this paper, a review of different technologies used in the removal of FOG and the uses of recovered FOG will be summarised.

What is FOG?

FOG is short for fats oils and grease. FOG can come from both plant and animal fat in the form of food matter, oils, salad dressings, cheeses, sauces, butter and fried food. It can also come from liquids from synthetic matter such as detergents and soaps [5].

Chemical Composition of FOG

FOG contains glycerol and fatty acids. A triglyceride on the other hand, is formed from one molecule of glycerol and three fatty acids. Glycerol is an organic, alcohol molecule with three hydroxyl (OH) groups, three carbons, and five hydrogens.

Fatty Acids

Oil and grease are chemically homogenous. When fats and oils hydrolase, they form free fatty acids. How much free fatty acids is present relies on time, temperature, moisture content. For example, a high moisture content in crude palm oil results in hydrolysis which in turn forms free fatty acids. The determination of free fatty acids is done by titration in the presence of a solvent which can be ethanol or diethyl ether. They can also be determined by gas chromatography analysis, which has a high susceptibility, and provides more accurate results. However, this method is appropriate for fats from food, oils such as olive, palm and sunflower oil. Triacylglycerol is the dominant part of FOG. They also come from plants and animals and are favourable in the production of biodiesel.

Physical Properties of FOG

At room temperature, FOG is colorless, odorless and tasteless. Even so, FOG is able to dissolve in soluble in organic solvents such as hexane, ether chloroform although it’s insoluble in water. The density of FOG is lesser than that of water hence FOG floats on the surface of water. FOG also forms an emulsion when mixed with soap or other emulsifying agents. Furthermore, FOG is highly viscous due to the presence of double bonds and fatty acids.

Where does FOG come from?

In municipality wastewater, FOG mostly comes from food preparation activities, generated primarily by food service establishments (FSE). FOG can also be from soaps and detergents from food service establishments, homes and institutions. Rarely, FOG in municipality wastewater can be from low-production industries such as small abattoirs and detergent manufacturers.

Problems caused by the presence of FOG

Sanitary Sewer Overflows

Most sewer overflows are caused by FOG all around the world. The sanitary overflows are the result of the accumulation of insoluble calcium salts of fatty acids that are formed by the reaction between fats, oils and grease (FOG) and calcium found in wastewaters. This can also lead to blockages, backups and pipe bursts. Within the UK, over 15million pounds is spent annually on reactive blockage clearance, along with the additional cost of cleaning up after flooding incidents. Where sanitary overflows are in towns, they do not only cause an unappealing sight, they sometimes obscure traffic.

Clogging of pipes

FOG blocks sewage pipes and the pipes at the wastewater treatment plant when it solidifies. The constant built up of FOG in this pipes reduces the pipe size and hence this leads to increased maintenance costs. In addition to that, the accumulated fat may break off and travel down the pipes and pile up at pinch points causing sewer blockage. Furthermore, when this FOG travelling in pipes solidifies, it causes blockage of pipes and hinders the wastewater flow. In addition to the problems of blockage, FOG deposits result in higher corrosion rates of pipework, increase the need for cleaning and maintenance, and significantly increase the volume of solid waste that reaches the WWTW. Also of concern is that grease may partially block screens and trickle filter systems, clog sludge pumps. This FOG can coagulate on the surfaces of different wastewater treatment plant machinery and surfaces reducing their performance which could result in the shutdown of the wastewater treatment plant.

Environmental Impacts of FOG discharged into streams

When inadequately treated wastewater containing FOG is discharged into the streams, it damages aquatic life. FOG forms a film that blocks enough sunlight to penetrate the water. The plants growing within may not get as enough nutrients which limits the oxygen absorbed and hence it negatively affects the aquatic life in such a stream. Furthermore, when large amounts of oils and greases are discharged to receiving waters from wastewater treatment systems, they increase BOD killing aquatic life. Even though different municipalities have passed legislation regarding effluent standards, discharge of poorly treated wastewater containing FOG is still visible in surface water globally.

Interference with wastewater treatment processes

The oily layer that the presence of FOG in discharge streams causes a reduction in dissolved oxygen consequently leading to a reduction in the biological activity of the treatment process due to the microbes being trapped in the oil film. FOG creates problems such as the production of foul odours that interfere with the proper operation of sewage treatment works in open wastewater treatment plants, particularly in the summer, flies maybe attracted to the smelly FOG inhibiting microorganisms. Moreover, FOG forms floating scum that disrupts wastewater treatment processes. There may be a shortage of oxygen creating problems for aerobic bacteria during wastewater treatment. This may result in a delay of the wastewater processes or stop the processes altogether.

FOG Treatment

Removal of FOG at the source

Grease trap

The most effective way of removing FOG is to prevent it from entering the wastewater treatment system. Grease traps also called interceptors are plumbing devices below ground outside a food establishment facility that prevent FOG from entering the sewer network in order to prevent damage to sewage collection systems that flow into the wastewater treatment plant. Currently, animal fat is used as a test medium for minimum retention time however, many food service establishments use detergents, sanitizers and vegetable oils that effect emulsification characteristics such as the droplet size of FOG discharges and thus impact the separation ability. It was noted that grease interceptors have 80% elimination rate, however, no evidence was presented. Not all food establishment facilities have grease traps however all the wastewater goes to the wastewater treatment plant. Most small informal restaurants in big cities do not employ grease traps and frequently discharge their waste containing FOG in nearby drains or in sinks which is why FOG control is a concern in big cities with regularly mushrooming restaurants.

Removal within the wastewater treatment plant

FOG separator

A FOG separator is an additional compartment situated in a processing tank. This compartment aids in the initial settling of solids and the separation of water from FOG (mostly emulsified FOG). The water is directed from silt trap tank and allowed to retain in the sedimentation tank for about 4-6 hours. The emulsified FOG layer is then allowed to float at the surface of the water in the tank. The effluent then exits through the bottom of the sedimentation tank in order to avoid the FOG. This method is usually employed in the activated sludge process to avoid foaming in the secondary treatment that interferes with the control of sludge and poses environmental concerns if it overflows.

There are different types of FOG separators. One of them is the hydro mechanical type. The hydro mechanical type relies on the degree of warmth and gravity to separate the FOG form wastewater. It is usually made of steel or plastic and is located under sinks and FOG The second type of the grease trap is passive. Passive grease interceptors are designed to intercept and eliminate the FOG before it is discharged in the wastewater treatment system. This type of grease trap has two or more compartments. It works by allowing the larger amount of water flowing to slow down the water inside the trap hence the FOG becomes buoyant and separates. These grease traps are efficient allowing 90% of FOG to be collected out of the water. They help food service establishments in lowering the FOG that would otherwise enter the wastewater treatment system.

The third is an Automatic Grease Removal Unit (AGRU). This devices have the same primary function as manual grease removal devices. They also slow the flow and let the wastewater cool, isolated solids sink while water remains in the middle and FOGs float. However, automatic grease removal units use mechanical and electrical parts to really skim FOG out of the water. These devices are usually small yet very efficient in the removal of FOG. Grease trap waste was added as a co-substrate together with municipal wastewater sludge whereby a high volume of methane was produced. Once collected, grease trap wastes disposal options can be land application, landfilling, composting, rendering for manufacturing lubricants or industrial soaps, incineration, anaerobic co-digestion, or biodiesel production.

Tilting Plate Separators (TPS)

Tilting plates are used in the separation of oil form effluent water or suspended solids for oily water treatment in a wastewater treatment plant. Basically, the separation depends on the difference in gravity, which is the separation of two phases (liquid-liquid or solid-solid) is applied. The separation of oil from water relies on two processes, droplet settling and droplet coalescence. The plates are arranged parallel to one another and the underside of each parallel plate provides more surface for suspended oil droplets to coalesce into larger globules therefore the solids will slide down the topside of each plate.

The spacing of the corrugate plate has an impact on the droplets which have a settling or flotation velocity Vs>Q (flow)/A (area) are fully intercepted. The efficiency of the tilting plate in the removal of FOG depends highly on the design of the tilting plate. The inclination angle, the spacing between the plates and the length of the spacing affect the FOG removal percentage, as a result, the oil removal efficiency of TPS is 50->99%. The plate separator was first invented in the 1950`s and has greatly improved the effluent quality achieved by gravity separators from over 50mg/l and hence it is still greatly used to date.

Flotation

There are different types of flotation; dissolved air flotation, induced air flotation, electro flotation and nozzle air flotation.

Dissolved Air Flotation (DAF)

Presently, one of the most commonly used method in separation of FOG and wastewater is dissolved air flotation (DAF). This method is a substitute for sedimentation but bears more benefits such as improved effluent quality, speedy start-up, elevated percentage of operation and heavier sludge. Dissolved air flotation (DAF) has been widely used as an alternative to sedimentation in the field of water treatment especially when water contains low density particles that have a tendency to settle very slowly or to float hence some municipal wastewater treatment plants use the dissolved air flotation technology in the secondary treatment. It can also be used as a pretreatment technology for an activated sludge wastewater treatment plant.

Induced Air Flotation

Although induced –air flotation is not complicated, the mechanism behind the fluid mechanics is. Induced-air flotation uses centrifugal force whereby gas is lead in at the bottom and at the top. Whilst, induced air flotation is among the most effective ways of removal of FOG from wastewater, its success relies on the inclusion of chemical additives or through the pre-treatment by dissolved air flotation. This is an expensive technology, hence many municipal wastewater treatment plants in developing countries are unfamiliar with it. Also, the nature of the FOG in wastewater determines how much FOG will be removed.

Chemical Coagulation

A substance that is put in to water to achieve coagulation-flocculation is called a coagulant. Aluminum sulfate (alum), ferric chloride and ferric sulfate are some of the common inorganic metal coagulants that exist. Coagulation is one of the most effective methods of FOG removal in wastewater. A study was conducted in 2015 in Malaysia found that coagulation is very successful in the elimination of Fog from wastewater. 80% of recyclable water and 20% of sludge from the grease filter wash water was recovered outstandingly and the water quality was the same as that of drinking water. Chemical technology is highly flexible and hence can remove emulsified oil and dissolved oil. Also, other problematic polymer can be removed by chemical technology and hence biodegradable organic polymer has been vastly popular in wastewater treatment of FOG recently. Even though chemical coagulation can be used in municipal wastewater treatment, it is not ideal. It is most suitable for industrial wastewater treatment.

Electrocoagulation

Electrocoagulation is a process in which suspended, emulsified and dissolved contaminants in the aqueous phase are destabilized through introducing an electric current. Aluminum or mild steel are commonly used as votive electrodes.Wastewater treatment by electrocoagulation was first performed in 1946. Electro-coagulation was used to treat refectory wastewater with high FOG content. During the study, different parameters such as pH, current density, reaction time and conductivity, electrode distance and inlet concentration. The optimum current density was 10-14 A m^{-2} within 30 min varying on the wastewater properties tested. FOG removal efficiency descended with increasing electrode distance. The optimal electrode distance was determined to be 10mm for this equipment in consideration of the treatment cost and efficiency together. The removal efficiency of FOG under normal conditions exceeded 95% .

Ultrafiltration (UF)

Ultrafiltration (UF) is one of the most prevailing processes for water and wastewater treatment. Over the past decade, this technology has experienced rapid development that has spanned a wide range of applications in various fields. Ultrafiltration is filtration on a molecular level based on a membrane that separates large and small molecules. It is a pressure-driven membrane process which can separate, concentrate and fractionate macromolecular solutes and suspended species in water. The degree of hydrophilicity, solution flow, pore size distribution and membrane pore size determine the Ultrafiltration membrane separation. The concentrate, which is as little as 5% of the original waste, can either be reused or incinerated. The residue from UF can be used in non-portable applications such as agricultural irrigation. Where even higher quality of permeate is required, it can be further treated by reverse osmosis or carbon absorption system. The disposal costs by incarnation are now only 5% of the original disposal costs. This work confirms the great advocacy of UF as tertiary treatment for water reuse and gives operational indications for future industrial-scale production of reclaimed water in municipal wastewater treatment.

Biological Treatment

Although biological treatment of oily wastewater is not well developed, recent activities in this area have removed notable percentages of FOG from wastewater. 80 to 90 percent of FOG can be removed with the help of microorganisms during biological treatment.

There are two forms of biological treatment; aerobic (in the presence of oxygen) and anaerobic (in the absence of oxygen).

Aerobic Treatment

Activated Sludge

In the activated sludge, a mixture of wastewater and biological sludge, composed of microorganisms is agitated and aerated over a suspended growth medium. Mechanical aeration is used to provide air to the mixture whereby the microorganisms are mixed thoroughly with the organic compounds and use this organic material as their food source. `FOG compounds are absorbed in wastewater through flocculation and then are metabolised slowly to form a biological floc, an active mass of microbes called activated sludge. To achieve better FOG removal, FOG wastewater maybe pre-treated by using dissolved air flotation before biological treatment. Furthermore, more than 90 percent of FOG can be removed by using alum and ferric chloride as coagulants in chemical coagulation during the pre-treatment of FOG wastewater.

Microorganisms on the other hand can remove about 80 to 90 percent of FOG. In general, to achieve a strong elimination of FOG from wastewater coming from industries and entering the municipal wastewater treatment plant, the influent must be monitored by making sure the industries comply with the wastewater discharge standards, otherwise, the amount of FOG removed depends on the percentage of FOG in the influent and the capacity of the plant.

A study conducted in Shiraz in 2011 to determine the removal efficiency of FOG using activated sludge, found that the average removal efficiency was about 70%. The study was conducted studied from June 2011 to September 2011 and the removal efficiencies were studied. The FOG removal ability satisfied the effluent standards. FOG removal efficiency at the wastewater treatment plant ranges from 59 to 85 percent with 70 percent being the average. Conversely, it was also found that the removal efficacy of FOG using activated sludge, intensely leans on how much how much FOG is in the wastewater treatment facility hence the monitoring of influents particularly is crucial.

Trickling filter

A trickling filter (TF) is a floating fixed bed reactor made of different penetrable pressing matter such as rocks or plastic which supports aerobic condition by dispersal, forced aeration, natural displacement or splurge. They have been in use for more than 100 years and are used to remove organic matter from wastewater. Trickling filters offer relatively a good quality effluent compared to other technologies and they are uncomplicated to operate. However, they are suitable for treatment of low to medium strength municipal wastewaters. It has been noted that membrane methods remove about 90percent of FOG which is way better compared to activated sludge technologies receiving the same influent.

Anaerobic Treatment

Anaerobic digestion is a biochemical process of breakdown of complex insoluble organic matter with the help of a wide range of microbial communities in the absence of oxygen to form methane and carbon dioxide. Most biological processes depend on various factors such as temperature, pH, and availability of nutrients, carbon to nitrogen (C/N) and carbon to phosphorus (c/P) ratios, presence of inhibitory and toxic substances and so on. Similarly, anaerobic digestion depends on these factors. Often, if one or more of these parameters fluctuates, it creates a performance deterioration in the digesters. In addition, operational challenges such as the inhibition of acetoclastic and methanogenic bacteria, substrate, and product transport limitation, sludge flotation, digester foaming, blockages of pipes and pumps, and clogging of gas collection and handling systems may affect the performance efficiency of anaerobic digestion in the removal of FOG. Aerobic processes like the anaerobic-aerobic systems that use high rate bioreactors have been used for decades with some of its benefits being low sludge production, economical operation, energy from biogas production and low energy consumption. Furthermore, a variety of studies in recent years have demonstrated that anaerobic processes can be used to treat municipal wastewater effectively. Anaerobic digestion as a unit process in municipal wastewater treatment has been in use for many years now. It is employed for stabilization of sludge solids from primary and secondary sedimentation tanks either in closed digesters or open lagoons. Anaerobic digestion can recover a measurable amount of FOG that can be converted into biogas and bio-diesel which can save the environment from problems caused by landfilling using FOG.

Anaerobic lagoons

Anaerobic lagoons are large man-made ponds, typically ranging between 1-2 acres in size, and up to 20m deep. They are in-ground structures used in the treatment of municipal and industrial wastewaters using algae and bacteria. They are used widely for treatment of agricultural wastewater resulting from meat production particularly that of cows and pigs. They can also be used in the treatment of other industrial wastewater streams in municipal wastewater treatment as primary treatment. Basically, wastewater is piped into the bottom of the lagoon where it settles out to form an upper liquid layer and a semi-solid sludge layer. Oxygen is prevented from reaching the sludge layer by allowing a process of anaerobic digestion to break down the organic materials in the wastewater. This process can take as little as a few weeks on average to bring COD/BOD levels to the required range. Anaerobic bacteria thrive well in particular environmental conditions such as warm temperatures (85-95ºF). They also need a close to neutral pH which will increase the rate of anaerobic microorganism activity subsequently leading to a shorter wastewater detention time. A number of variations can restrict the degree of anaerobic respiration such as BOD/COD concentration and the presence of substances such as sodium, potassium, calcium and magnesium. Even though lagoons are easy to use and popular as they date decades back, currently they are mostly used in rural areas or developing countries.

Expanded granular sludge beds (EGSBs)

The EGBS are seen nowadays as affordable, powerful and more well-known technology because they utilize a fluidized bed which generates higher treatment rates (95%) [33]. In EGBS, wastewater is recirculated through the system to enhance stronger exposure to the sludge. It is advised that, since the efficiency of the bioreactor depends on the FOG/COD, the ratio of the two should be <0.2 [34]. In cases whereby the FOG/COD ratio is above 0.2, the removal efficiency becomes low as a result of biomass washout. On the contrary, the EGSB requires a dissolved air flotation (DAF) alongside it for the optimal removal of FOG as the EGSB`s performance is not to diminish with time because of the prime quality of FOG. Anaerobic digestion can also be employed to pre-treat wastewater before EGBS is exercised to enhance its effectiveness.

Upflow Anaerobic Sludge Blanket (UASB)

The up flow anaerobic sludge blanket was developed in 1980 by Lettinga and is a method that is mostly used in the industrial wastewater treatment, however it can also be used in municipal wastewater treatment of low contaminant strength. Its benefits are that it produces less sludge and it requires less energy and surface are. Also, it has the capability of producing energy and not consuming it during the treatment of wastewater. Methane gas is a strong biogas that is produced during this process. It can be collected and used as a fuel for cooking, lighting and heating. Also, it has other benefits such as its uncomplicated configuration, simple and inexpensive construction and maintenance, minimal land demand and little sludge production. Moreover, it is very strong in chemical removal efficiency and can withstand the different altercations in temperature, pH and the concentration of influent. Even though the UASB has such significant benefits, its effluent contains low volumes of BOD which means it requires further treatment. The treatment required according to specified effluent standards can be achieved by using the activated sludge technology.

Anaerobic baffled reactors (ABRs)

An anaerobic baffled reactor is a modified septic tank that has a series of baffles which are arranged in a manner to force wastewater to flow over and between the baffles extending over the full surface of baffles allowing contact between influent wastewater and biomass. Anaerobic baffled reactors have both the benefits of the up flow anaerobic sludge process and the anaerobic filter. Some of its other benefits are that it reduces the energy required for the treatment of wastewater and generation of bioenergy in the form of methane. Nonetheless, the ABR are not effective in the removal of FOG. The average removal efficiency for oil was 41% in hog farming effluents with ABR as the first stage in the biological treatment. The ABR composed of three chambers working as the first stage of a biological treatment system for swine wastewater over a period of 116 days. The average value of the volumetric organic loading rate (VOLR) was 17.8 kg COD total $m^{-3}d^{-1}$, the biological organic loading rates (BOLR) based on total and filtered COD influents of 14381 mgL^{-1} and 3610 mgL^{-1}, respectively were: 1.3 kg COD total kg TVS d^{-1}. , respectively, and the hydraulic loading rate (HLR) was about 1.4 $m^3m^{-3}d^{-1}$. The average removal efficiency for total COD was about 80% at a hydraulic retention time (HRT) of about 18 hours. The average alkalinity in the effluent was 3801 $mgCaC0_3\ L^{-1}$.

Anaerobic filter reactors

Anaerobic filter reactor is a fixed bed biological reactor with loosely or tightly packed material such as plastics, sand stone, granular activated carbon, granite, quartz or reticulated foam polymers. The packed materials allow microorganisms to join and form a medium like a biofilm resulting in an anaerobic channel mat. An anaerobic filter is a fixed bed biological reactor made of packed material produced using any non-degradable, shaped material or polymer that has a high surface area to volume ratio. The filter material occupies 60%-70% of the total reactor volume (Moran 2018). It has one or more filtration chambers in series. The material can be made of different matter such as plastics, sand stone, granular activated carbon, granite, quartz or reticulated foam polymers. The packed materials permit anaerobic microorganisms to join and develop like a biofilm, producing an anaerobic channel mat. When wastewater passes through the medium, on the materials laid out, the organic matters are dispersed into the biofilm, gathered around the granules and changed into organic acids, methane and other products.

Anaerobic filter reactors have been very popular lately because of their many advantages. They require little nutrients, they produce less sludge and they are able to recover energy in the form of methane. On the contrary, the piling of non-biodegradable solids which causes physical problems particularly, creates channeling and flow shortcutting making anaerobic filter reactors a debatable choice in FOG removal.

FOG Reuse

Studies from all around the world show that FOG waste has a very high energy output. Compounding grease trap waste when digesting sewage expands the methane potential and methane flex during anaerobic co-digestion.

A number of benefits exist for the use of reclaimed FOG like bio-diesel production, anaerobic co-digestion, composting, land application, land fill, provision for manufacturing lubricants or industry soaps and incineration. Nonetheless, the contrast and quality of the byproducts of FOG depends on methods and styles of measuring, assessing and reporting. Furthermore the flex and efficacy of was noted to vary considerably and was dependent on the specifications of the process and the components of reclaimed FOG.

Land Application

Although land application is one of the cheapest and fastest ways to dispose of FOG, it is closely monitored which regulates disposal quantities. While land application has been proven to enhance soil organic content, and avert nitrogen leaching, caution should be exercised when it`s used because its immense fat content may provide a layer around soil particles and hence adversely affect crop production.

Biogas production

Sludge is a byproduct of physical, chemical and biological wastewater treatment processes. After the sludge is produced during wastewater treatment, it is digested to decrease the quantity of final waste and convert the constituents of organic sludge into biogas which can be used. This is commonly known as anaerobic digestion. A growing number of anaerobic digestion plants are being constructed to create clean and renewable energy and help to prevent FOG being disposed at landfills, however, AD has been used in the UK from the1800s. FOG from the foodservice industry has been referenced to up biogas production by 30% or more when added straight to the digester and wastewater treatment plants will possibly reach more than 50% of their electricity demand by this exercise.On the other hand, some researches have raised a considerable concern regarding co-digestion and sludge from FOG. Alarmingly, it hinders the generation of methane during the addition of FOG at high concentrations or loading rates. The digestion of FOG can be done under medium temperatures ranging 25◦C to 40◦C or temperatures above 50◦C.

Bio diesel

The FOG reclaimed from grease interceptors can be used for biodiesel production. Biodiesel is a renewable fuel for diesel engines that can be manufactured from alkyl monoesters of grease, plant and animal fat. It is prepared through a process called transesterification which is whereby vegetable oils, animal fats or waste-cooking oils are converted into biodiesel in the presence of an alcohol such as methanol or ethanol and a catalyst such as an acid or base catalyst with glycerol as a byproduct. Because of its internal high moisture content and the dormancy of lipases connected with food residuals in the grease interceptors, FOG derived bio diesel is a better choice than its competitors. It was noted in a study that FOG derived bio diesel, has a high oxidative stability, flash point, cetane number and total emissions .Furthermore, most of the FOG-derived biodiesel fuel met the recommendations of the international standards as well as conventional diesel. Additionally, because of its lesser price, FOG-derived biodiesel showed that FOG is

a strong competitor to other biodiesel feedstock. Looking at the prevailing concerns about depletion of diesel sources, pollution and the rising cost of diesel, biodiesel is an attractive substitute for motor fuel of compression ignition engines today and in the coming future.

Conclusion

The presence of fats, oils and grease in wastewater has been found to have many adverse effects on the sewer, the wastewater treatment plant and the environment in which it is discharged. It is also seen that the removal of FOG basically depends on physical and chemical characteristics of FOG, environmental conditions, the performance of the wastewater treatment plant and the efficiency of each method employed. Furthermore, laws imposed on food industries disposing FOG into wastewater, and how reinforced are those laws plays a major role in the amount of FOG discharged into the wastewater treatment plant.In developed countries, FOG that is reclaimed is used in many ways which does not only save the environment from damage caused by the discharge of FOG in streams, but benefits the countries economically. On the contrary, as much as reclaiming FOG is highly beneficial, it is an expensive process that also needs particularly trained personnel which in most cases, developing countries lack. Because of the growing market for FOG, Slowly, countries are processing reclaimed FOG which could see no wastewater containing FOG discharge into the environment which could be a better solution for the whole ecosystem.

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