Treatment of Wastewaters From Food Oil Processing Plants in Municipal Facilities

Institute of Shortening and Edible Oils, Inc.
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Preface

The continuing interest in adequate water pollution controls has led to regulations that control the constituents of industrial wastewaters discharged to municipal wastewater treatment systems. The purpose of this control is to prevent the introduction of pollutants that can not be transported or adequately treated in the municipal system. A number of municipalities have adopted limitations on the concentrations of total fats, oils and grease in industrial wastewaters discharged to municipal sewers. This emphasis on total fats, oils and grease (FOG) does not recognize the difference between food oils of animal and vegetable origin and oil and grease of petroleum origin. Food oils are effectively treated in municipal systems while petroleum oil and grease may be less amenable to treatment in such systems.

Adequate treatment of FOG of animal and vegetable origin in municipal wastewater treatment systems continues to be a matter of concern to public officials and regulatory agencies. However, this concern is caused by confusion and misunderstandings that are not supported by the available facts. This confusion results from misunderstandings about what happens to food oils in sewers and in municipal wastewater treatment plants, from misunderstandings about the biodegradability of food oils, and from the inability to distinguish between food oils and oil and grease of petroleum origin in the standard analytical test used to measure total fats, oils and greases in wastes.

The available data demonstrate that food oils are degradable and are satisfactorily treated in a typical municipal wastewater treatment system. Food oils are common constituents of municipal wastewaters from homes and restaurants. The wastewaters resulting from cooking, dishwashing, washing of clothes, garbage disposal and commercial food preparation contain food oils. The wastewater treatment technology required to treat food oils is not new, novel, or something different from the treatment utilized at municipal wastewater treatment plants. Municipal wastewater treatment plants are designed to treat conventional and compatible pollutants such as food oils.

The intent of this publication is to increase public awareness of the nature of the wastewater generated in a food oil processing plant, how such wastewaters are pretreated at the processing plant, and how they are treated in municipal wastewater treatment facilities.

This publication will be useful to all who want to know more about this topic such as concerned citizens, legal counsel who advise municipalities, individuals having responsibility for municipal wastewater treatment systems, federal and state regulatory personnel, and managers of processing plants that produce food oils. This publication contains information on food oil processing, municipal wastewater treatment facilities, control ordinances and analytical methods. Additional details may be found in the references listed at the end of the bulletin.

The Institute of Shortening and Edible Oils, Inc. gratefully acknowledges the assistance of Dr. Raymond C. Loehr, Environmental Engineering Program, University of Texas, Austin, Texas in preparing this publication.

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A. FOOD OILS

I. What Are Food Oils?

Food fats and oils are naturally occurring products that are essential nutrients in both human and animal diets. They provide the most concentrated source of energy of any foodstuff, supply essential fatty acids, are carriers for fat-soluble vitamins, and help make other foods more palatable. Fats and oils are present in varying amounts in many foods. The principal sources of food fats and oils in the diet are meats, dairy products, poultry, fish, nuts, and processed food oils. Most fresh or frozen fruits and vegetables contain no or only small amounts of fats and oils. Overall, fats and oils provide about 37% of the available calories in the current U.S. diet. A portion of these fats and oils end up in wastewater as part of the trimmings from food, as a result of food preparation and clean-up activities and from human wastes.

Food fats and oils are relatively insoluble in water. They have lower densities than water and, when not emulsified or finely dispersed, may float to the surface of water. At normal room temperatures they range in consistency from liquids to solid appearing substances. When liquid they are called "oils" and when solid, they are referred to as "fats." In this publication, the term food oil refers to fats and oils used for or in the preparation of food and that are produced by the edible oil industry.

Food oils are a principal and essential constituent of the human diet along with carbohydrates and proteins. Fats are a major source of energy, supplying about 9 kcal per gram compared to about 4 kcal per gram from proteins and carbohydrates.

Oil and grease of petroleum origin also are widely used by industry and the public. However, petroleum oil and grease are not part of the human diet, are not used as a food, and have a different chemical structure than food oils. Food oils and oil and grease of petroleum origin are similar only in very general characteristics such as feel and viscosity. The two types of oil are of different origin and are used for different purposes.

II. Food Oil Products

A wide variety of food oil products is offered to the public. Shortenings, margarines, butter, salad and cooking oils, mayonnaise, and French, Italian and other salad dressings are some of the products that are entirely fats and oils or contain fat or oil as a principal ingredient. Many of these products are sold in commercial quantities to food processors, snack food manufacturers, bakeries, restaurants, and institutions.

The oils and fats most frequently used for these products are obtained from soybeans, corn, cottonseed, olives, palm kernels, peanuts, coconuts, safflower seed, sunflower seed, pork fat, and beef tallow. Soybean oil is the most widely used food oil and comprises about 85% of the food oil produced in the United States.

III. Food Oil Consumption

Dietary fats have been characterized into what are termed "visible" and "invisible" sources of fat. Visible fats are defined for statistical reporting purposes as those that have been processed from animal tissues, oilseeds, or vegetable sources, and are used in such products as shortenings, margarine, and salad oil. These fats and oils comprise about 40% of the total food fats and oils in the U.S. diet. Invisible fats are consumed directly as part of the animal tissues or vegetables in the diet. These comprise the remaining 60% of the fat consumed in the U.S. diet.

In 1981, over 12 billion pounds of processed food oils were consumed in the United States (4). There has been an increase of 6.3 pounds per person per year in the total food oil purchased for consumption over the period of 1967 to 1980. During this period, the consumption of fats from visible sources increased 7.2 pounds per person per year. There also is a continued trend toward the consumption of products prepared from vegetable oils and away from those prepared from animal fats.

The consumer is utilizing increasing quantities of food oils and this increase is reflected in the need for the edible oil industry to process greater amounts of such oils. One consequence of such production is a greater amount of food oil processing wastewater which must be adequately treated before discharge to receiving waters.

B. FOOD OIL PROCESSING

I. General

The production of food oil products from animal fats and oils derived from oilseeds constitutes a major industry in the United States. The following description identifies the processes involved in the processing of animal fats and vegetable oils into food oils and the wastewaters that are generated by each process. Information about the characteristics of these wastewaters is presented in SECTION C.

Animal fats are separated from protein and other naturally occurring materials by rendering with dry heat or steam. Vegetable oils are obtained by the extraction of the oil from oilseeds. Historically, cold or hot extraction methods were used. These methods have been replaced with solvent extraction methods which provide a better oil yield. In this process the oil is extracted from the oilseed by hexane (a light organic solvent) and the hexane is then separated from the oil, recovered, and reused. Because of its high volatility, no detectable hexane residue remains in the finished oil after processing. These initial steps do not produce wastewaters with a significant oil content.

The objective of food oil processing is to separate the food oils from constituents that cause odor, color or objectionable taste. The fats and oils obtained from rendering or from the extraction of the oil seeds are termed "crude" fats and oils. Crude fats and oils contain varying but relatively small amounts of other naturally occurring materials that are removed through a series of subsequent processing steps.

Additional processing steps are used to adapt the oils to specific end uses. For example hydrogenation is used to improve the keeping qualities of fats and oils and to impart the semi-solid consistency to a fat or oil that is needed in margarine or in baking and frying fat. Modern processing of food fats and oils is the factor most responsible for upgrading the quality of the fat and oil consumed in the U.S. diet.

A food oil processing plant usually purchases the crude fats and oils and processes them into finished products such as salad and cooking oils, shortenings, margarine, salad dressing and related products. The typical steps that are involved are:

- receiving, storage and handling
- refining
- acidulation
- bleaching
- hydrogenation
- fractionation
- deodorization
- packaging

These steps are explained in subsequent paragraphs. Figure 1 illustrates a process flow diagram of a typical processing operation.

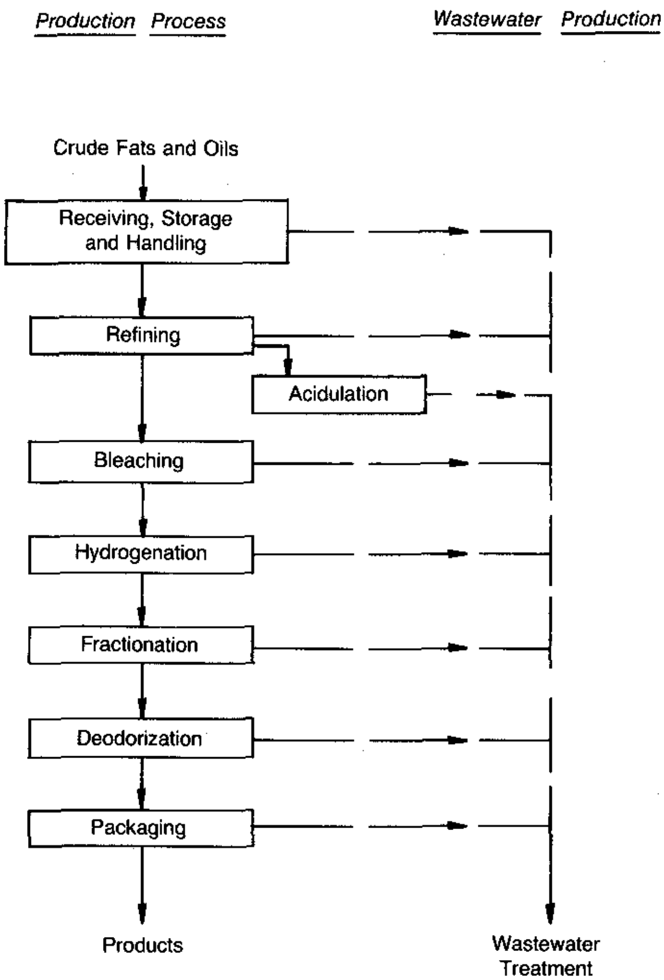
II. Receiving, Storage and Handling

Crude fats and oils arrive at a processing plant area by tank truck or rail car and are transferred to a storage area. After use, the tank trucks and rail cars are cleaned with hot water and detergents and the cleaning solutions disposed of to the waste treatment plant.

III. Refining

Refining is the process used to reduce the free fatty acid content and to remove other impurities. The most important and widespread method of refining is by treatment of the fat or oil with an alkali solution and is

FIGURE 1
FOOD OIL INDUSTRY-TYPICAL PROCESS FLOW DIAGRAM



called caustic refining. This converts free fatty acids into water-soluble soaps. Phosphatides, proteins and other substances are separated by the alkali solution. Oils low in phosphatide content (palm and coconut) may be refined using steam distillation rather than the alkali solution to remove the free fatty acids.

When the chemical reaction is complete, the mixture is centrifuged to separate the neutral oils from the water soluble compounds such as soaps, proteins and other material. The extraneous materials separated by centrifugation commonly are known as "soapstock." The soapstock is transferred to the acidulation process.

The separated neutral, refined oils are further processed by a water washing step to remove traces of alkali material or soaps that could cause deterioration of the product during later storage or processing. Wastewater from this step is discharged to sewers in some plants and in other plants it is transferred to the acidulation process. The washed oil is dried by vacuum before storage and further processing.

In addition to the wastewater from refining and oil washing operations, cleaning of equipment and the work area produces periodic quantities of wastewater for treatment.

IV. Acidulation

The alkaline soapstock from the caustic refining step is acidified (acidulated) to convert the soaps to fatty acids and oil. The soapstock may be heated to help release emulsified oil. Acidulation may occur at the plant generating the soapstock or it may occur at a central facility that receives soapstock from several plants.

Fatty acids and the oil from the acidified soapstock may be separated by a centrifuge, by gravity sedimentation or by both. The separated fatty acids are used in animal feed or as raw materials in a separate fatty acid processing plant for the manufacture of detergents, paints, plasticizers and a variety of needed products.

The wastewater from the acidulation step is acid, with a pH of about 2.0. The acidulation wastewater is neutralized before being discharged. Wastewater also results from periodic cleaning of equipment and the work area.

V. Bleaching

Bleaching is the process used to remove color pigments and to further purify the fat or oil. Bleaching is accomplished after the oil has been refined.

The usual method of bleaching is adsorption. Acid-activated bleaching earth or clay is the adsorbent material used most extensively. This substance consists primarily of hydrated aluminum silicate. Activated carbon also is used as a bleaching adsorbent to a limited extent.

The bleached oil is separated from the adsorbent material by filtration. After filtration the spent filter cake material, which can contain residual oil, usually is discarded as a slurry or as a solid. To date, it has not been economically feasible to recover the oil in the filter cake.

Wastewaters from the bleaching process include liquid waste from any filter cake oil recovery operation and those produced by equipment cleanup.

VI. Hydrogenation

Hydrogenation or "hardening" of an edible oil is the process by which hydrogen is added directly to points of unsaturation in the fatty acids. Hydrogenation converts liquid oils to semi-solid or solid fats suitable for manufacture of shortening and margarine. It also increases the stability of the fat or oil, that is, avoids or reduces rancidity.

In the process of hydrogenation, oil is combined with hydrogen gas at a suitable temperature and pressure in the presence of a catalyst. Under these conditions, the gaseous hydrogen reacts with the double bonds of the unsaturated fatty acids. The catalyst most widely used is nickel supported on inert material. The catalyst is removed from the fat after the hydrogenation processing is completed.

The only wastewater from the hydrogenation process is from the periodic cleaning operations.

VII. Fractionation

The most widely used form of fractionation is that of crystallization wherein a mixture of food oils is separated into two fractions with different melting temperatures. The term "dry fractionation" describes the process by which small quantities of higher melting food oils are crystallized and removed from edible oils by filtration to avoid clouding of the liquid at refrigeration temperatures.

Pressing is a fractionation process used to separate a small amount of liquid oil from a large quantity of solid fat. The process squeezes or "presses" the liquid oil from the solid fat by means of hydraulic pressure. This process is used commercially to produce hard butters used for confectionery coatings and similar products.

Solvent fractionation is the crystallization of a desired fraction from a food oil mixture dissolved in a suitable solvent. Fractions may be selectively crystallized at different temperatures after which the fractions are separated and the solvent removed. Solvent fractionation is practiced commercially to produce hard butters, specialty oils, and some salad oils.

Wastewater results primarily from equipment cleaning operations.

VIII. Deodorization

Deodorization is used to remove trace constituents that give rise to undesirable flavors and odors. The process removes the relatively volatile components from the fat or oil by steam distillation. Normally deodorization is carried out under vacuum in a closed vessel at high temperature to facilitate removal of the volatile substances and to avoid chemical decomposition of the fat.

Condensing equipment usually is installed to recover the bulk of the fatty material before it contacts any cooling water. The remaining FOG is condensed by the cooling water. After being condensed, the fatty material is removed from the liquid by skimming. Recovery of the fatty material can be on the order of 90 to 95%. The recovered material can be a source of vitamin E.

The wastewater generated by the process primarily is condenser cooling water, wastewater from direct-condensing sprays and from equipment cleaning.

IX. Packaging

The packaging of finished products involves mechanical treatment of processed oils and their conversion into consumer or commercial sized packages. The wastewaters from packaging operations result primarily from equipment cleaning. The quantity and characteristics of the wastewaters generated from packaging operations depend upon the type of material processed, the efficiency of the operation and the cleanliness required.

C. FOOD OIL PROCESSING WASTEWATER CHARACTERISTICS

Water, sodium hydroxide, sodium carbonate, phosphoric acid, and sulfuric acid diluted in water are the important chemicals used in food oil processing plants. These chemicals are neutralized before the wastewater is discharged. The used water at the food oil processing plant becomes wastewater containing the neutralized chemicals, impurities resulting from the processing steps, and heat. Some food oil inevitably is lost during the processing and is contained in the wastewater. In addition to wastewaters directly from the separate processes, plant wastewater also results from floor washing and cleaning of equipment. Wastewater from cleaning operations will contain constituents of the chemicals used for cleaning.

Water is used for temperature control in cooling and condensing operations. Wastewater generated from indirect heat exchangers will not have any changes in its characteristics, other than increased temperature, provided that no leaks occur from the processes to the cooling water.

Large volumes of wastewaters also originate in systems that create low pressures for deodorization or drying. Water vapor in these systems is condensed by sprays of cold water. Volatile matter from the processing steps can be a part of the vapors being condensed. Such condensing waters usually are passed through cooling towers and recycled. Some discharge to the plant wastewater must occur from such recirculating systems to avoid an intolerable increase in the minerals from the water supply and an excessive concentration of material which is condensed with the stream.

The important sources of the wastewater generated in a food oil processing plant have been identified in SECTION B. The major constituents in these wastewaters are readily biodegradable oxygen demanding organics such as fats and oils (commonly referred to as oil and grease in wastewater terminology) and suspended solids (SS). The quantity of biodegradable organics in the wastewater generated at a food oil processing plant is proportional to the quantity of product produced. A plant producing a greater quantity of product will have a larger quantity of biodegradable organics in its wastewater. The pH of the combined wastewaters is approximately neutral with the pH in the range of 6 to 9.

The wastewater characteristics from a particular food oil processing plant will be specific to that plant and will be a result of the type and quantity of products that are produced and the processes that are used.

D. MUNICIPAL WASTEWATER TREATMENT PROCESSES

I. Introduction

Every community produces liquid and solid wastes. These wastes come from the homes as well as from the commercial and industrial activities that exist in the community. The wastewater consists of the water supply of the community after it has been used in many ways. This wastewater is collected by a sewer system and transported to a publicly owned treatment works (POTW) for adequate treatment before it is discharged to receiving waters such as streams, lakes or estuaries. Groundwater that may infiltrate the sewers and urban storm water that enters the sewers also reach the POTW and are treated.

Wastewater is the used water from a community and consists of about 99.94 percent water by weight. The other constituents are dissolved or suspended in the water. The term suspended solids (SS) identifies the solids that are suspended in the wastewater.

The concentration of constituents in wastewater is low because of the small fraction of dissolved and suspended material in the wastewater. The concentrations commonly are expressed in terms of milligrams of a constituent per liter of water (mg/l). One mg/l of a constituent is equivalent to one part of the constituent (by weight) in one million parts of water. These units can be put in perspective by noting that one mg/l is the equivalent of one ounce in 7500 gallons, or in terms of parts per million, one inch in 16 miles. Wastewater treatment processes remove small quantities of potential pollutants from large quantities of used water.

Untreated wastewaters contain: (a) organic and inorganic compounds, (b) pathogenic or disease causing microorganisms, (c) aquatic nutrients such as nitrogen and phosphorus and (d) inert constituents such as sand and gravel. It is not only desirable but necessary that municipal wastewater be adequately treated to sustain the biological, chemical and physical integrity of the waters in the community, region and nation. Adequate treatment is now required by federal and state laws and regulations.

II. Purpose of Wastewater Treatment

The primary purpose of a POTW is to maintain sanitary conditions in the community and to remove constituents that can pollute streams and rivers and cause these waters to be unswimmable and unfishable. Polluted waters are harmful to fish and can interfere with the recreational value of the waters. Because dissolved oxygen is a key element for the existence of fish or other aquatic life, it is important to keep the dissolved oxygen concentration of streams and rivers at a high enough level that the fish can live. A minimum of 4 to 5 mg/l of dissolved oxygen usually is recommended to maintain good fish populations in streams and rivers.

When organic wastes enter a stream, the common bacteria in the stream use the wastes as food and use the dissolved oxygen in the water to digest the wastes. This can lower the dissolved oxygen concentration of the stream to the point that the many types of fish cannot live. The measurement of the oxygen used by the bacteria to consume the wastes is called the biochemical oxygen demand (BOD) test. The greater the quantity of organic matter in the wastes discharged to a stream, the more oxygen that will be used by the bacteria as they consume the wastes. The removal of biodegradable organic matter is a major goal of wastewater treatment. POTW's are designed so that the BOD of the treated effluent will not cause the dissolved oxygen of the stream to decrease to a concentration where fish are adversely affected or killed.

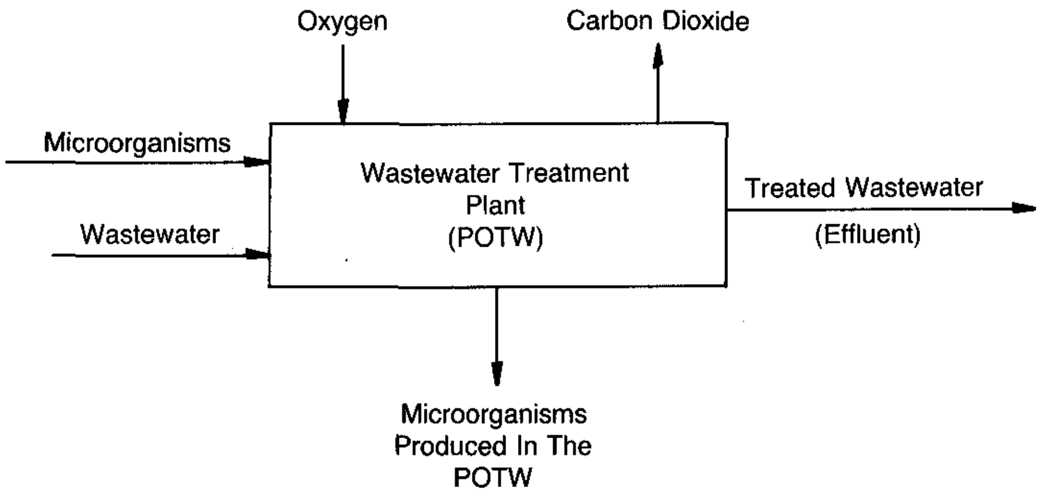
III. Wastewater Treatment Processes

General—What happens in a POTW is similar to what occurs naturally in a stream or lake. In such situations, the natural bacteria and other small organisms in these waters consume matter as a food source, utilize the dissolved oxygen and produce new microbial cells and other products. If there is adequate dissolved oxygen in the stream or river, aerobic microbial reactions predominate. In nature, the oxygen in a stream results from photosynthesis as aquatic plants use sunlight to convert carbon dioxide to oxygen and from absorption of oxygen from the atmosphere.

The function of a wastewater treatment plant (POTW) is to speed up the natural processes by which water

FIGURE 2

THE PROCESSES+ IN A WASTEWATER TREATMENT PLANT ARE SIMILAR TO THOSE THAT OCCUR IN NATURE



+Adapted from reference 13

purifies itself (Figure 2). In a POTW, the oxygen commonly is added by mechanical aeration devices and the biological treatment processes include agitation to increase the rate of waste stabilization. A large number and types of microorganisms are used. The excess microorganisms that are produced (commonly called biological sludge) are removed as a dilute slurry and are stabilized before disposal. A POTW also will contain settling units to remove settleable solids at varying points in the process.

The characteristics of untreated wastewater and of the treated effluent usually are described in concentration units, such as mg/l of BOD, SS or FOG. However, it is the total quantity of potential pollutants, such as the pounds or kilograms of BOD, SS or other parameters, that enters a POTW, and not the concentration, that is most important in terms of the design, operation and performance of the POTW. A high concentration of BOD or oil and grease in the influent wastewater is not of particular concern as long as the POTW is designed and operated to treat the total quantity, i.e., the pounds or kilograms, that enter the POTW each day.

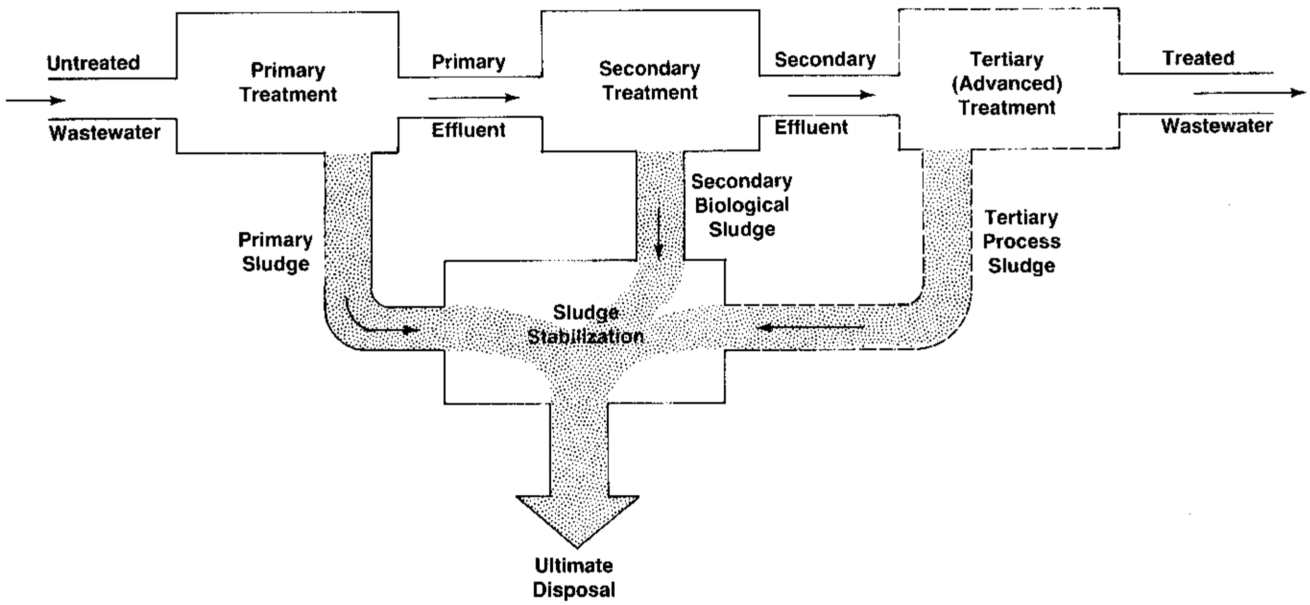
POTW's are designed and operated to treat conventional pollutants which are defined as biochemical oxygen demand (BOD), and suspended solids (SS), oil and grease, fecal coliform bacteria and pH. Such pollutants are normal constituents of the wastewater from homes, restaurants, food handling and processing operations and offices. Conventional pollutants are compatible with all of the processes used in a POTW. POTW's also remove varying amounts of toxic pollutants, such as some metals and synthetic organic chemicals, and nonconventional pollutants. Nonconventional pollutants are all pollutants not classified as either conventional or toxic pollutants. Examples include nitrogen, phosphorus and sulfur.

There are several major phases of treatment that cause the required degree of treatment to be achieved by a POTW. Simplistically, these can be described as primary, secondary, and tertiary or advanced wastewater treatment. In each of these phases, pollutants are removed from the wastewater and either are converted into gases such as carbon dioxide by biological decomposition or are concentrated as solids in a slurry (sludge) for subsequent handling and disposal. Physical, biological and chemical treatment processes are used to accomplish the needed treatment. Figure 3 identifies the general treatment process phases used at a POTW.

In the primary treatment phase, physical processes, such as screening and sedimentation, separate the easily removed floatable and settleable solids from the wastewater. Such processes reduce the load on the remaining

FIGURE 3

GENERAL TREATMENT PROCESS PHASES THAT MAY BE USED AT A POTW



treatment processes and help reduce the wear and maintenance of pumps and other mechanical devices.

In the secondary treatment phase, biological treatment processes use common microorganisms to remove soluble organics and any remaining solids from the primary effluent. Generally, the treated wastewater from the secondary treatment phase (secondary effluent) has received satisfactory treatment and can be discharged. However, in those situations where additional treatment is needed to remove nitrogen or phosphorus, or specific industrial chemicals, additional physical, chemical or biological processes (tertiary or advanced treatment) are used.

POTW's are required to achieve the equivalent of secondary treatment or better. The minimum level of performance attainable by secondary treatment generally is defined as: (a) an effluent that has a 30-day average of oxygen demanding matter (BOD) and of suspended solids (SS) no greater than 30 mg/1 and a 7-day average of BOD and SS no greater than 45 mg/1, and (b) pollutant removal through a POTW that is no less than 85% removal of BOD and SS as a 30-day average.

Primary Treatment—Wastewater entering a POTW receives primary treatment to remove solids that can be screened out or that will float or settle. As municipal wastewater enters a POTW, it generally passes through a screen to remove objects (rags, sticks, boards) that may clog pumps and pipes. The wastewater then enters a grit chamber where the velocity of the wastewater is slowed long enough that sand and small stones that can cause excess wear on subsequent equipment are removed. A schematic of the primary processes in a POTW is presented in Figure 4. The materials removed by the screens and in the grit chamber are disposed of in a landfill.

After screening and grit removal, the wastewater still contains suspended solids and dissolved organic and inorganic pollutants. The suspended solids consist of organic and inorganic particles kept in suspension by the velocity of the wastewater in the sewers and pipes. Many of these suspended solids are removed in a primary sedimentation tank, a physical treatment process.

Sedimentation tanks are designed to reduce the velocity of the wastewater so that most of the heavier suspended solids can settle due to gravity and be removed from the bottom of the tank. Many solids less dense than water will float to the surface of the sedimentation tank and be removed by scrapers on the surface of the tank. Both the settled solids and the floatables are sent to a sludge treatment process for stabilization prior to ultimate disposal.

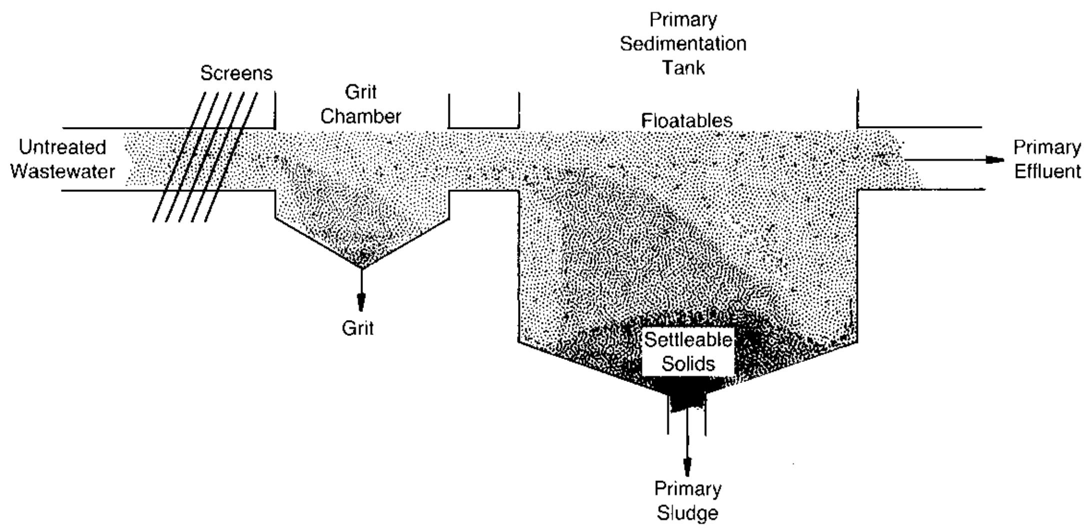
Primary sedimentation tanks are an important component of a POTW. They can remove as much as 50 to 60% of the suspended solids and 30 to 40% of the BOD in untreated municipal wastewater.

Secondary Treatment—Primary treatment alone is not adequate to protect receiving waters because dissolved organics and inorganics as well as some suspended solids are not removed in the primary sedimentation tank. Secondary treatment is used to remove almost all of the remaining organics and suspended solids.

Secondary treatment processes are aerobic biological

FIGURE 4

GENERAL PRIMARY TREATMENT PROCESSES USED AT A POTW



treatment processes that use common bacteria and other microorganisms to remove the biodegradable organics. The final products of a secondary process are carbon dioxide, treated water and more microorganisms. A schematic of the secondary treatment process is shown in Figure 5.

Trickling filters and the activated sludge process are the two major biological treatment processes used from secondary treatment at POTW's. Other biological treatment processes that can be used include oxidation ponds, aerated lagoons and oxidation ditches.

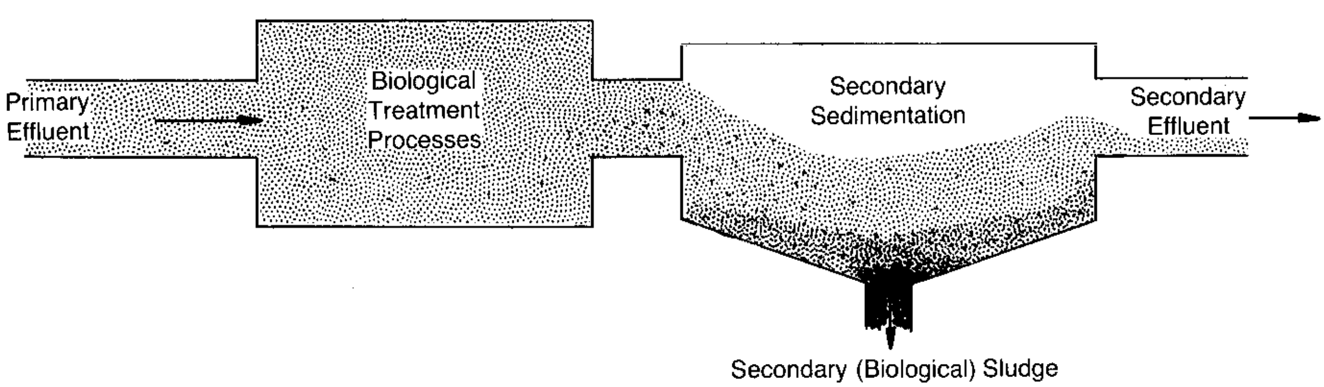
Because secondary treatment processes are aerobic processes, an adequate supply of oxygen is necessary. In addition, these processes must not be overloaded or else their performance will suffer.

The excess secondary sludge consists primarily of microorganisms from the biological processes and is sent to a sludge treatment process for stabilization before ultimate disposal (Figure 3).

Secondary treatment can be very effective and can produce an effluent that contains only a low concentration of oxygen demanding material (BOD) and suspended solids (SS). A well designed and operated POTW using the identified primary and secondary treatment processes should be able to remove 85 to 90% or more of the BOD and SS. Such performance usually is sufficient to meet the discharge permit conditions for the POTW. Before the treated effluent is discharged, chlorine can be added to kill disease producing organisms that may have survived the treatment processes.

FIGURE 5

SCHEMATIC OF THE SECONDARY TREATMENT PROCESSES USED AT A POTW



Tertiary Treatment—At locations where secondary treatment is not adequate to meet the discharge permit conditions of a POTW, additional treatment processes (tertiary or advanced treatment) are used. These are physical, chemical or biological treatment processes used to remove specific pollutants. Decisions to install tertiary treatment processes are not made lightly. Such processes usually are expensive to build and to operate. They also may produce sludges that require satisfactory treatment, handling and disposal.

The use of these processes is specific to a particular location and generalizations about the use of these processes at a POTW are difficult. The possible tertiary treatment processes are identified in Table 1.

TABLE 1

POSSIBLE TERTIARY TREATMENT PROCESSES

Carbon adsorption of soluble organics
Phosphorus removal
Nitrogen removal
Additional solids removal

Sludge Treatment and Disposal—POTW's produce sludge from primary, secondary and tertiary processes that must be handled in an environmentally sound manner. There are many methods and processes for the stabilization and ultimate disposal of sludge. The most common method consists of anaerobic digestion, followed either by dewatering and disposal or by direct disposal. Anaerobic digestion is a controlled biological treatment process that produces methane which can be used as a source of energy at a POTW. Land application of both liquid and dewatered stabilized sludge and incineration of dewatered sludge are the more common sludge disposal methods. The possible sludge stabilization, dewatering and ultimate disposal methods are indicated in Table 2.

E. JOINT TREATMENT OF MUNICIPAL AND INDUSTRIAL WASTEWATER IN A POTW

I. General

Almost every POTW treats industrial wastewater along with the wastewater from homes, restaurants and commercial establishments. The pollutants in industrial wastewater can be grouped into two general categories: pollutants that are compatible with the POTW treatment processes and pollutants that are not. Compatible pollutants are those that are removed readily in a POTW such that a high degree of removal is achieved. Compatible pollutants for a POTW are the conventional pollutants: BOD, SS, oil and grease, fecal coliform bacteria and pH.

Many industries treat their own wastewater before discharging it to receiving water such as a stream, river or lake. Such treatment facilities are designed and operated to meet the effluent limitations permitted by state or federal regulations. These limitations have been developed to protect the chemical, physical and biological integrity of the receiving waters and are identified in the discharge permit given by the appropriate state pollution control agency to each industry that wishes to treat its own wastewater.

Other industries send their wastewater to a POTW for adequate treatment and ultimate discharge to surface waters. Treatment of wastewater at a POTW can be a feasible approach for many industries. If the wastewaters cause difficulty for a POTW or pass through the POTW without adequate treatment, the industry may be required to pretreat its wastewater before it is sent to the POTW. The options available to industry are summarized in Figure 6.

II. Pretreatment Standards

Pretreatment standards are used to protect POTW's and the environment from adverse impacts that may occur when industrial wastes impair the performance of a POTW. This protection is achieved by regulating the discharge of toxic wastes or unusually strong conventional wastes to a POTW.

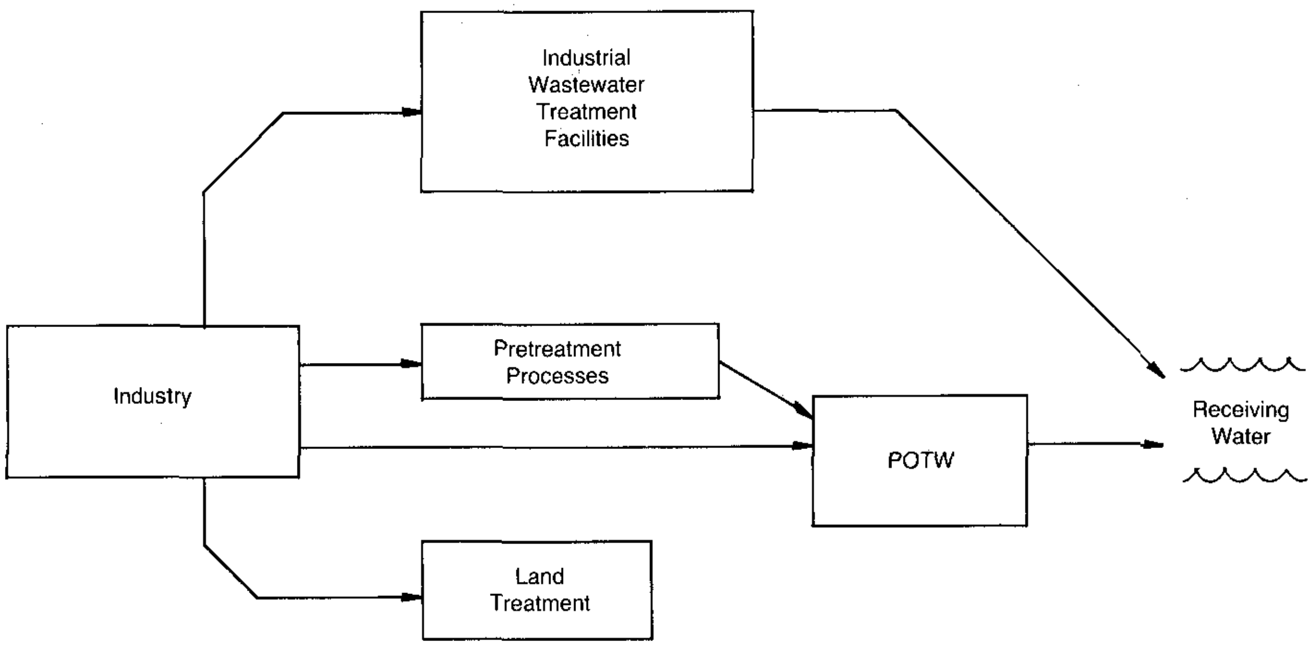
TABLE 2

SLUDGE STABILIZATION, DEWATERING AND DISPOSAL METHODS THAT CAN BE USED AT A POTW

Stabilization Methods	*Dewatering*	*Disposal*
Anaerobic digestion	Vacuum filtration	Incineration
Aerobic digestion	Sludge drying beds	Land Application
Composting	Filter presses	

FIGURE 6

OPTIONS FOR THE ENVIRONMENTALLY SOUND TREATMENT AND DISPOSAL OF INDUSTRIAL WASTEWATERS



The objectives of pretreatment standards are to: (a) prevent the introduction of pollutants which will interfere with the operation of the POTW so that it does not meet its permit requirements or which will contaminate the POTW sludge causing it to be unfit for disposal or beneficial use, (b) prevent the introduction of pollutants which will pass through the POTW in concentrations that have an adverse effect in a receiving water, (c) improve the opportunities to recycle and reclaim wastewaters and the sludges resulting from wastewater treatment and (d) provide for adequate treatment of industrial pollutants prior to discharge. Specifically, none of the following are to be introduced into a POTW:

(a) pollutants which could create a fire or explosion hazard in the sewers or in the POTW

(b) pollutants which could cause corrosive structural damage to the POTW

(c) solid or viscous pollutants in amounts which could clog sewers or obstruct the flow in a POTW

(d) heat in amounts which could inhibit biological activity in the POTW

(e) discharges of any pollutant in such volume or strength as to cause upset of the treatment processes and violation of the POTW permit conditions

In addition to these general pretreatment standards, there can be categorical pretreatment standards. Categorical standards are to control toxic pollutants that may be in the wastewater from a specific industry. No categorical wastewater pretreatment standards have been developed for the food oil processing industry and none are necessary. Such wastewaters are as biodegradable and treatable as those from homes and restaurants.

The legislative history of the federal water pollution control regulations makes it clear that Congress (a) intended that POTW's be used for the treatment of industrial wastes that can be treated by the processes at a POTW and (b) intended that industry should not be required to duplicate the treatment that can be achieved at a POTW if the wastes can be treated at the POTW. Discharge of compatible industrial wastewaters to a POTW can be a technically and economically feasible approach for both the municipality and an industry assuming that the appropriate general pretreatment standards are met. The use of a POTW by an industry will have mutual benefits to both the municipality and the industry through most economical utilization of the POTW.

F. FATS, OILS AND GREASE IN MUNICIPAL WASTEWATER

I. General

The fats, oils and grease (FOG) in municipal wastewater result from residential, commercial and industrial activities of the community. In domestic wastewater, FOG may average 30 to 50 mg/l. Wastewaters from communities containing certain industries may have higher concentrations.

The term FOG refers to a variety of materials which are grouped together because the methods of analysis measure the materials as a single entity. The term fat is used generally to identify food fats and oils of animal or vegetable origin which are solid at room temperature. These items can be liquid at higher temperatures. Oils commonly refer to similar items that are liquid at room temperature. Grease is a general term for solid or viscous materials of either petroleum, animal or vegetable origin. The terms are non-specific and overlap.

FOG in municipal wastewater is of animal and vegetable origin and of petroleum origin. Animal or vegetable FOG comes from food scraps, soap, human wastes, washwater from the cleaning of vegetables, utensils, clothing and skin, and from industries using or processing vegetable or animal components. Petroleum oil and grease in municipal wastewater may result from household, commercial and industrial discharges, from street runoff, and from direct discharge of crankcase and engine oils to municipal sewers.

Animal and vegetable FOG are natural constituents of municipal wastewater even when there are no significant industrial contributions. While they are present in wastewaters from food oil processing plants, they also occur in wastewaters from homes, restaurants, "fast food" establishments, and from industries such as meat packing, leather tanning, and food preparation.

Petroleum oil and grease will be present in wastewater from petroleum oil refineries and petrochemical plants and from metal machining and metal working operations. Used lubricating oil from automobiles and mowers may be deliberately disposed of to the sewer system by the public.

The solubility of FOG in water is only a few milligrams per liter. In wastewater, FOG generally occurs in small particles or droplets. Because of this small particle size and the presence of emulsifiers, the majority of wastewater FOG may not separate from the water even under very quiescent conditions.

II. Differences

The differences between food FOG and petroleum based oil and grease in wastewaters in terms of biodegradability, potential toxicity and taste and odor are important in the proper control and treatment of such FOG and in the impact of their discharge to streams and rivers.

Food FOG are degraded by microorganisms in secondary treatment processes at rates comparable to many other organics such as proteins and carbohydrates. This is to be expected since food FOG are part of almost all foodstuffs eaten by man. They also are an essential part of human and animal diets. If food FOG are digested and absorbed in the intenstinal tract of man and animals, it is reasonable to expect that food FOG will be broken down in secondary biological waste treatment processes by the common bacteria in such processes. Because oils and greases of petroleum origin have a different chemical structure, they can degrade less rapidly than many other organics, including FOG of animal and vegetable origin.

Certain constituents of oils of petroleum origin can be toxic to aquatic organisms. Food FOG are not toxic to microorganisms or to aquatic life.

Components of petroleum oil and grease can give an objectionable flavor to the flesh of fish and can cause objectionable tastes and odors in water supplies. Food FOG have not been implicated in such problems.

G. MEASUREMENT OF OIL AND GREASE IN WASTEWATERS

Responsible control of FOG in wastewater requires being able to differentiate between the FOG of food and vegetable origin and the oil and grease of petroleum origin. However, the routine analytical method for total FOG (15) does not distinguish between these kinds of FOG in wastewater. Unlike other measurements of water quality that measure specific chemical elements, compounds or groups of compounds, fats, oils and grease are defined by the method used for their measurement. As a result, the term FOG includes a large number of diverse compounds. By definition, FOG includes any materials that are soluble in the solvent used for the extraction of the FOG under the circumstances of the test. In the determination of FOG, an absolute quantity of a specific substance is not measured. Rather groups of substances with similar physical characteristics are determined quantitatively based upon their common solubility in the solvent that is used in the method of analysis (15). The extracted material will include oil and grease of petroleum origin and FOG of animal or vegetable origin. The method of analysis measures free FOG and FOG in particles and in microbial cells.

FOG of animal or vegetable origin can be separated from the extracted total FOG by adsorption of granular silica gel. Oil and grease of petroleum origin do not adsorb to the silica gel. The oil and grease not removed by the silica gel are designated hydrocarbons and of petroleum origin. Thus there are available analytical methods to determine total FOG, oil and grease of petroleum origin (hydrocarbons) and, by difference, FOG of animal or vegetable origin.

H. EXPERIENCE AND CONCERNS

FOG of animal and vegetable origin have been a part of municipal wastewater since sewers and wastewater treatment have been used. Generally such FOG are transported and treated without difficulty. However, in the early decades of wastewater treatment, a number of concerns were expressed about FOG in municipal sewers and in POTW's, based upon experience at that time. These concerns were related to possible obstruction of sewers by congealed FOG, difficulties with mechanical equipment in sedimentation tanks, accumulation in secondary biological treatment processes and accumulation of scum in anaerobic digestion. Now, however, modern operating practices and pretreatment standards have these concerns under control. These concerns and approaches to overcome them are discussed in subsequent paragraphs.

I. Sewers

Incidents of semi-solid accumulations of FOG in sewers have been mentioned in the earlier decades by municipal sewer maintenance personnel. However, actual obstructions caused by FOG have been documented in only a few cases. Generally such accumulations have occurred as a result of a spill or from the discharge of floatable oil. The use of grease interceptors or traps at restaurants and appropriate industries to remove such floatables has practically eliminated these instances. Reports of more recent sewer stoppages indicate that when they do occur, such stoppages occur in small sewers serving residences and apartments. In contrast, when a large municipal sewer system handling the wastes from a food oil processing plant was evaluated (7), no unusual sewer cleaning and maintenance problems were noted. Many food FOG are liquid or in suspension at temperatures found in sewers. The velocity of the wastewater in the sewers will transport emulsified and dispersed food FOG in the municipal sewers and minimize deposition and the formation of possible obstructions.

Pipe obstruction problems which have been encountered at some POTW's involve plugging of the lines used to transfer sludge and floatables from the primary sedimentation basins to an anaerobic digester. Glass-lined pipe and heated piping are now commonly used to avoid such problems.

II. Secondary Treatment Processes

It has been inferred that excess quantities of FOG in activated sludge systems will reduce the density of the biological sludge so that the sludge will not settle well in secondary sedimentation basins and that excess quantities in trickling filters will coat the attached microorganisms, thereby reducing the oxygen transfer and the efficiency of the process. While theoretically this can happen, this situation is very rare. Floating biological sludge in sedimentation tanks is more likely to be caused by gas production in the settled sludge than by excess FOG in the sludge. Documented cases of floating sludge and reduced oxygen transfer caused by excess FOG at full scale POTW are very difficult to find.

FOG of animal and vegetable origin is readily biodegradable and biological treatment of food oil processing wastewaters is the most common method of treating such wastewaters. Secondary biological treatment processes, such as activated sludge units and trickling filters, can achieve satisfactory treatment of food FOG. The treatment of grease and oil of petroleum origin in secondary biological processes frequently is less successful because of the low rate of biodegradation of such material.

III. Sludge Stabilization Processes

In many POTW's the floatables and settled solids from primary and secondary sedimentation tanks are stabilized by anaerobic digestion. In this process these solids are held in large tanks for 15 to 30 or more days and anaerobic bacteria convert some of the organic matter to methane gas which can be used as a fuel at the POTW.

In the early unmixed and unheated anaerobic digesters, floating scum, which contained measurable concentrations of FOG, would accumulate, cause digester shut down and require mechanical removal of the scum and settled solids. Digesters designed and built at POTW's in the past few decades now heat and mix the digester contents and avoid these problems.

These changes, heating and mixing, enhance the breakdown of food FOG into methane gas. As a result, the accumulation of scum containing FOG in anaerobic digesters now is a rare occurrence. If scum does accumulate, it generally is related to the failure of the equipment used to heat and mix the digesters. Petroleum based oil and grease are not broken down under anaerobic conditions.

IV. Summary

The concerns related to FOG in POTW's, such as sewer obstructions, accumulation in biological treatment processes, reduced process efficiency and scum in digesters, can be caused by spills, by floatable FOG, by older design and operational practices, and by oil and grease of petroleum origin. The problems have not been due to the inability of POTW processing to adequately treat food FOG or wastewaters from food oil processing plants but rather have been due to inadequate earlier POTW controls and design information. Now adequate pretreatment controls are available to avoid the spills, the floatables and variable loads. In addition, better design information and operational experience exists to avoid the other problems.

I. PRETREATMENT

The control of FOG in municipal wastewater has been a continuing requirement by municipalities. Pretreatment regulations in many cities have included: (a) limitations on total oil and grease discharged to a POTW, (b) limitations of a particular type of oil, such as petroleum based oils discharged to a POTW, and (c) requirements to remove floatable fats, oils and grease.

Any required removal of FOG should take place as close as possible to its source of generation. This can result in less contaminated FOG that can be recovered or reused. The simplest form of FOG removal is the grease interceptor or grease trap. These devices are designed to collect and retain floatable FOG. Grease interceptors can be small units such as may be used in restaurants, hotels and service stations or large sedimentation/separation tanks that are used at industries. The collected FOG must be removed periodically to maintain the removal efficiency of the units.

Free FOG, i.e., FOG that is not emulsified, presents no serious problem in a POTW because it can float to the surface of sedimentation tanks where it can be skimmed from the surface. Emulsified oil will not be readily removed in sedimentation tanks but can be degraded in biological treatment processes.

Before any pretreatment method for FOG is selected or installed, characterization and treatability studies should be performed so that an effective and efficient FOG removal process will be used. To avoid interference with most POTW's, removal of floatable material and possibly adjustment of pH constitutes the degree of pretreatment needed for food oil processing wastewaters.

J. TREATABILITY OF FOOD OILS

I. General

Wastewater treatment for the removal of FOG must be appropriate for the physical form of FOG that is present. FOG in wastewater can exist in several forms: (a) as suspended particles, (b) as attached to other particles, and (c) as part of an emulsion. FOG that exists as suspended particles or attached to other particles will either float, settle or remain in suspension depending on the relative density of the particles and the turbulence of the flow. If the flow is tranquil, such as in a primary sedimentation tank (Figures 3 and 4), the FOG can float to the surface of such tanks where it is removed by skimming. Heavier particles containing FOG can settle to the bottom of sedimentation tanks where they are removed as part of the sludge which ultimately is stabilized by aerobic or anaerobic digestion.

FOG that exists in very small particles or as an emulsion will not be removed in reasonable periods of time in primary sedimentation tanks and will remain in the primary effluent. The FOG that is not removed in primary treatment will flow to a secondary treatment unit, such as an activated sludge unit or a trickling filter. The microorganisms in the secondary biological treatment unit will consume and remove the remaining FOG.

All FOG constituents are not removed by the microorganisms at the same rate. Those constituents that are easy for the microorganisms to consume and degrade, such as food FOG, are removed at a faster rate than those which are harder for the microorganisms to degrade, such as oil and grease of petroleum origin.

II. Biological Treatment

As discussed earlier (Figure 2), in aerobic biological treatment processes, microorganisms (bacteria and higher organisms) convert the organic matter in wastewater to natural end products such as carbon dioxide and water and produce more microorganisms. The ability of a compound to be used by these microorganisms is referred to as biodegradability.

Evidence of the removal of organic matter by microorganisms (biodegradability) can be obtained in a number of ways. The BOD test is one measure. Observing the removals of a compound in laboratory and research treatability studies is another. A third, and more meaningful way, is to determine the removals that occur in full scale treatment plants, such as POTW's.

BOD Biodegradability—The BOD test (SECTION D) is a measure of the oxygen used by bacteria to consume organic matter. The greater the BOD per unit weight of a compound, the greater will be its biodegradability since a greater fraction of the compound can be utilized by microorganisms and exert an oxygen demand (BOD).

The biodegradability of food oils and petroleum based oils as measured by the BOD test has been determined (2) and summary data are presented in Table 3. As the data note, the food oils have a higher biodegradability, in terms of BOD per unit of oil tested, than do petroleum based oils. Soybean oil has a biodegradability similar to that of the other food oils identified in Table 3. The summary data also demonstrate that food oils can be metabolized by microorganisms and therefore can be treated in secondary biological wastewater treatment processes at a POTW.

Treatability Studies—Controlled treatability studies (3,6) have demonstrated that FOG of animal and vegetable origin can be treated in the biological treatment processes used at POTW's. A study of the treatability of the FOG in edible oil processing and soap manufacturing wastewaters (6) found that such FOG: (a) was readily degraded by bacteria in the activated sludge process, even at liquid temperatures as low as 12°C (54°F) and (b) had no adverse effect on the oxygen transfer in the process. The study concluded that such wastes are readily treated when mixed with municipal wastewaters.

In another study (3) emulsified food oils were able to be treated satisfactorily in an activated sludge unit. The food oils did not exhibit any inhibition to the microorganisms in the activated sludge unit.

Full Scale Plants—Information is available on the removal of FOG at POTW's. A detailed analysis of FOG removal has been made at a POTW over a two day period (5). Light industry and meat processing plants were the major industrial contributors to the POTW wastewater. The following average FOG removal efficiencies were observed: primary treatment—45%, secondary treatment—74% and overall removal—84%.

Other, more comprehensive data are available. In response to a need for guidance in establishing national standards for POTW's, a survey was sponsored to obtain data on FOG removal at municipal plants that used biological treatment. Data from 55 plants were obtained. The results of the survey have been analyzed (16). The effluent FOG concentrations usually averaged less than 10 mg/l. The FOG concentration in the wastewater entering the POTW's ranged from 10 to 162 mg/l. At all but one plant, the average percent FOG removal was equal to or greater than the average percent BOD removal at each plant.

In the national survey, the POTW that had the highest concentration of FOG in the influent wastewater was the Sacramento County, California plant. This facility received about 6 percent of its flow from an industry which processed coconut oil and animal and other vegetable FOG. On some days, the FOG content of the influent was 200 mg/l. The average performance of this plant and that of other POTW's in California are presented in Table 4. In spite of high FOG concentrations in the Sacramento County influent, highly effective BOD_5 and FOG removals were obtained.

The analysis of the national survey data concluded that there was no evidence that percent FOG removal was related to the influent FOG concentrations. POTW's

TABLE 3

BOD OF FOOD OILS AND PETROLEUM BASED OILS⁺

TYPE OF OIL	*BIODEGRADABILITY MEASURED AS BOD⁺⁺*
Food Oils	
Butterfat	1.79
Coconut Oil	1.77
Corn Oil	1.88
Herring Oil	1.71
Palm Oil	2.00
Petroleum Based Oils	
Fuel Oil	0.98
Machine Oil	0.29
Mineral Oil	0.31

⁺Adapted from reference 2. Compounds with a higher value are more biodegradable since a greater fraction of the compound can be utilized by microorganisms and exert an oxygen demand (BOD).
⁺⁺Average BOD in terms of grams of BOD_5 per gram of oil tested

TABLE 4

AVERAGE BOD AND FOG REMOVALS AT FIVE CALIFORNIA POTW's*

POTW	Percent Removal BOD_5	Percent Removal FOG
San Jose Creek	98	99
Sacramento County	96	96
San Jose	88	96
Palo Alto	93	93
Sacramento City	92	93

*Data from the 1975 national survey and adapted from reference 16.

receiving untreated wastewater with FOG concentrations as high as 163 and 94 mg/l had average FOG concentrations in their secondary effluent of 9 and 1 mg/l respectively. However, plants having untreated wastewater FOG concentrations of about 20 mg/l had effluent FOG concentrations of 10 to 12 mg/l. These differences indicate that factors other than the influent FOG concentrations affect the performance of the POTW's. Such factors include the liquid and solid retention times in the POTW's and the removal of the floatable FOG from the sedimentation tanks.

The analysis (16) indicated that POTW's should be able to accept and satisfactorily treat much higher concentrations of biodegradable FOG than normally are received.

More recently the United States Environmental Protection Agency conducted an extensive study of fifty POTW's (11) to determine their performance in treating conventional pollutants and selected toxic and nonconventional pollutants. FOG was one of the over 120 pollutants analyzed. At each POTW a minimum of six days of 24 hour sampling were involved.

The untreated wastewater entering the POTW's had FOG concentrations that ranged from 13 to 206 mg/l with the average being 52 mg/l. The FOG concentrations in the secondary effluent ranged from 3 to 55 mg/l with the average being 11 mg/l. Equally important is the fact that 66% of the POTW's had effluent FOG concentrations of 10 mg/l or less. The data from this EPA study supported the conclusion from the previous evaluation (16) that the percent FOG removal achieved by the POTW was not related to the FOG concentration in the wastewater entering the POTW.

In addition, the EPA undertook a very detailed 30 day study (10) of a large municipal activated sludge POTW. About 50% of the flow and 65% of the BOD entering this plant came from industry. The secondary effluent from this POTW had an average FOG concentration of 7 mg/l during this study.

III. Summary

Municipal wastewater treatment plants (POTW's) are designed to treat conventional pollutants such as BOD, suspended solids, and food oil and grease. The available results from laboratory as well as full scale, field wastewater treatment plants demonstrate that FOG can be satisfactorily treated by the treatment processes used in POTW's.

K. MUNICIPAL ORDINANCES

Municipal ordinances controlling the discharge of waste into sewers and POTW's prohibit items that will obstruct sewers or interfere with the operation of a POTW (general pretreatment standards) (SECTION E). The ordinances may include categorical pretreatment standards to control toxic pollutants from a specific industry. No categorical pretreatment standards have been developed for the food oil processing industry and none are necessary.

Some ordinances have included a provision limiting the concentration of FOG that can be discharged to municipal sewers by industry. This limit frequently has been cited as 100 mg/l and has been on total FOG—both food FOG and petroleum based oil and grease. This limit is totally arbitrary and was based upon very fragmentary information that was then available over forty years ago. There currently is no information to indicate that such a limit is needed or desirable. As has been discussed in SECTION J, there is ample information that demonstrates that FOG of food origin can be treated in municipal wastewater treatment facilities. The available data support recommendations (8) by the U.S. Environmental Protection Agency (EPA) that there be no concentration or mass discharge limitations to POTW's for FOG of animal or vegetable origin. EPA does recommend limitations (8) for FOG of petroleum origin.

High concentrations of food oils discharged to a

POTW are not necessarily undesirable or bad. A municipal treatment authority charges its industrial customers to treat compatible wastes. Where the strength of such wastes in the influent exceeds that of domestic sanitary sewage, a surcharge usually is charged to the industry to pay for the treatment of the higher concentrations. A variety of wastewater service charges can be considered for industrial discharges (14). Such charges are for the services rendered in treating larger flows and higher concentration wastes. The charges result in all parties paying their fair share.

It is appropriate to consider a pretreatment provision that limits the discharge of floatable FOG to municipal sewers. The simplest technology to control floatable FOG is the "grease trap" or grease interceptor. Such units should be installed in restaurants, machine shops, garages, food and food oil processing plants and other facilities that discharge floatable FOG. The grease traps must be cleaned regularly and properly so that the device will be effective.

Only simple provisions need be in a municipal ordinance to control the discharge of wastewaters from food oil processing plants. The basic provisions require the removal of floatable FOG before the wastewater is discharged to the POTW and require that highly variable discharges of flow and organics be minimized. No limitations on the non-floatable or dispersed FOG of animal or vegetable origin need be included. Suggested wording of such provisions is presented in Appendix A.

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APPENDIX A

LANGUAGE FOR A MUNICIPAL ORDINANCE TO CONTROL OIL-BEARING WASTEWATERS

The language recommended for a municipal ordinance is that included in the suggested ordinance contained in the Water Pollution Control Federation Manual of Practice No. 3, *Regulation of Sewer Use*. The limitations suggested by the WPCF accomplish the purpose of adequate control without being unnecessarily restrictive. A municipality may not have an ordinance suitably structured to use the suggested language specifically but with appropriate adjustments the concepts can be incorporated. The WPCF ordinance addresses the three limitations on FOG which are necessary.

Floatable Oil Restrictions
Petroleum Oil Restrictions
Slug Load Restrictions

These are covered in the following parts of the ordinance:

Floatable Oil

Article V, Section 4. (c)

Note a preamble to this section introduces a list of limited materials including: Wastewater from industrial plants containing floatable oils, fat, or grease.

Article V, Section 6.

Grease, oil, and sand interceptors shall be provided when, in the opinion of the [Superintendent], they are necessary for the proper handling of liquid wastes containing floatable grease in excessive amounts, as specified in Section 4(c), or any flammable wastes, sand, or other harmful ingredients; except that such interceptors shall not be required for private living quarters or dwelling units.

Article I, Section 6 Note: From the definitions section.

"Floatable oil" is oil, fat, or grease in a physical state such that it will separate by gravity from wastewater by treatment in an approved pretreatment facility. A wastewater shall be considered free of floatable oil if it is properly pretreated and the wastewater does not interfere with the collection system.

Petroleum Oil Restriction

Article V, Section 4. (b)

Note: A preamble to this section introduces a list of limited materials including: Wastewater containing more than 25 milligrams per liter of petroleum oil, nonbiodegradable cutting oils, or products of mineral oil origin.

Slug Loads

Article V, Section 4. (h)

Note: A preamble to this section introduces a list of limited materials including: quantities of flow, concentrations, or both which constitute a "slug" as defined therein.

Article V, Section 3. (d)

Note: A preamble to this section introduces a list of prohibited materials including: No person shall discharge solid or viscous substances in quantities or of such size capable of causing obstruction to the flow in sewers.

For purpose of helping those who would like to better understand the ordinance provision listed above, each of the provisions is discussed in the following paragraphs.

Floatable Oil Restrictions

In application of the ordinance a decision would have to be made to whether or not an industrial wastewater contains sufficient floatable oil to warrant the installation of an interceptor. Section 6 provides for the [Superintendent] to make that decision. It is implied that the [Superintendent] would also make a decision as to whether or not an existing interceptor was performing satisfactorily. In making this decision the [Superintendent] would have the opportunity to use the results of sampling and analysis for floatable oil. An analytical procedure for floatable oil is contained in Standard Methods for the Examination of Water and Wastewater (15). The concentration to trigger a decision to require installation of an interceptor or improvement of an existing interceptor is a judgmental matter and is recommended to be a decision of the [Superintendent]. The [Superintendent] also may judge the adequacy of the interceptor on the basis of engineering design standards.

Petroleum Oil Restrictions

The concentration of floatable oil in the ordinance language suggested above applies to both petroleum and food oils.

Slug Load Provisions

A provision to control slug loads of floatable oil is incidentally provided by the prohibition of discharge of floatable oil in the suggested ordinance.

Dispersed food oil is included in the BOD test and therefore is taken care of by limitations on BOD provided in user permits or effluent limitations.

APPENDIX B

COMMON WASTE TREATMENT TERMINOLOGY

Activated Sludge is an aerobic biological secondary treatment process that removes organic matter from wastewater by using biologically active sludge.
Aerobic is a term used to describe biological treatment processes in which air or oxygen is supplied for the biological degradation of organic matter.
Aerobic Digestion is an aerobic process that is used for sludge stabilization.
Anaerobic is at term used to describe biological treatment processes in which no air or oxygen is supplied for the biological degradation of organic matter.
Anaerobic Digestion is a controlled anaerobic biological sludge stabilization process. Methane is produced and can be used as an auxiliary energy supply at a POTW.
Aquatic Plants grow in sunlit waters. They are a food for fish and small aquatic animals and, like all plants, put oxygen in the water. Upon decay they exert an oxygen demand.
Bacteria are small living organisms used to treat the organic constituents of wastewater.
BOD, or biochemical oxygen demand, is a measure of the dissolved oxygen required by organisms for the aerobic decomposition of organic matter present in water. It is used to measure the oxygen demanding pollution potential of an untreated or a treated wastewater and to determine the efficiency of a POTW.
Carbon Adsorption is an advanced treatment process in which activated carbon removes dissolved matter from wastewater.
Chlorination is the addition of chlorine gas to treated wastewater to kill infectious organisms.
Coagulation is the clumping together of solids to make them settle faster. Coagulation can occur naturally such as in the activated sludge process or can result from the use of chemicals such as lime, alum and iron salts.
Combined Sewers carry both municipal wastewater and storm water.
Dewatering is the separation of the water from a sludge to concentrate the solids and reduce the volume of residual solids requiring ultimate disposal. The separated liquid is returned to the POTW for further treatment.
Diffused Aeration occurs when air under pressure is forced into an aeration tank. The air is pumped through a pipe and out through holes in the side of the pipe or a specific diffuser.
Digestion of sludge takes place when organic matter decomposes, resulting in partial gasification, liquefaction, and mineralization of the sludge constituents. As a result, the sludge is stabilized.
Effluent is the liquid that results from a treatment process.
Eutrophication is the normally slow aging process by which a lake evolves into a bog or marsh and ultimately disappears. During eutrophication the lake becomes rich in nutrients, especially nitrogen and phosphorus, and algae and aquatic plant life become abundant. Eutrophication may be accelerated by nutrients discharged in treated wastewater.
Fats, Oils, and Grease are of animal and vegetable as well as of petroleum origin. They are groups of substances with similar physical characteristics that are determined quantitatively based on their common solubility of the solvent used for their extraction from a sample.
Flocculation is the process by which particles in wastewater are increased in size by chemical, physical, or biological action.
Incompatible pollutants are those which have the potential to interfere with a POTW or pass through a POTW largely untreated.
Interceptor sewers collect the flows from main and trunk sewers and carry them to the POTW.
Interference results from the addition of pollutants that cause a POTW to do an inadequate job of achieving the performance for which it was designed. As a result, the POTW is not able to meet its permit requirements.
Land Treatment is the application of wastewater to soil for treatment, reuse, or recharge of groundwater.
Mechanical Aeration uses mechanical energy to inject air into wastewater to supply the oxygen for aerobic processes.
Mixed Liquor is a mixture of activated sludge and wastewater undergoing activated sludge treatment in an aeration tank.
Nitrogenous Wastes are wastes of animal or plant origin that contain a significant concentration of nitrogen.
Nutrients are elements or compounds essential as raw materials for organism growth and development; for example, carbon, oxygen, nitrogen and phosphorus.
Organic Matter is the organic content of plant or animal matter and originates from domestic or industrial sources.
Oxidation Ponds are man-made ponds in which wastewater is treated by a combination of bacteria and other organisms. The oxygen is supplied primarily by algae that grow in the pond.
Pass-Through refers to the fact that many toxic industrial pollutants do not receive adequate treatment in most POTW's. These pollutants therefore can pass through a POTW in quantities and concentrations that can be harmful to the environment and that would be unacceptable under regulations controlling industrial wastes discharged directly to receiving waters.
Phosphorus is an element that is essential to life but also contributes to the eutrophication of lakes and other bodies of water.
Pollution results when municipal or industrial wastes or discharges reach surface or ground water, making it less desirable for domestic, recreational, industrial, or wildlife uses.
POTW (publicly owned treatment works) is a municipal wastewater treatment system which contains tanks, screens, biological treatment and other processes used to remove pollutants from wastewater.
Pretreatment means the reduction of the amount of pollutants, the elimination of pollutants or the alteration of the nature of pollutant properties in wastewater prior to discharge or otherwise introducing such pollutants into a POTW.
Primary treatment removes the material that will settle or float. Physical processes are used for this purpose.
Receiving Waters are rivers, lakes, oceans, or other surface waters that receive treated or untreated wastewaters.
Salts are minerals. The salt content of wastewater increases as it passes over and through the ground and as it is used in household, commercial establishments and industry.
Sanitary Sewers carry only domestic wastewater. The storm water runoff is taken care of by a separate storm water sewer system.
Secondary Treatment follows primary treatment and is the second step in most wastewater treatment systems. Aerobic biological treatment processes are used for secondary treatment.
Sedimentation removes solids from wastewaters by gravity. The wastewater enters tanks where the solids settle to the bottom or float to the top as scum. The scum is skimmed off the top and solids on the bottom are removed for stabilization prior to ultimate disposal.
Septic Tanks are used for domestic wastes when a sewer is not available to carry them to a POTW. The wastes are piped to underground tanks directly from a home or homes. Microorganisms decompose the organic waste and the sludge settles on the bottom of the tank. The effluent flows out of the septic tank into the ground through drains. The sludge is pumped out of the tanks, usually by commercial firms, at regular intervals.
Sewers are a system of pipes that collect and deliver wastewater to treatment plants.
Sludge is the solid matter that settles to the bottom of sedimentation tanks.
Storm Sewers are a separate system of pipes that carry only storm runoff from buildings and land.
Suspended Solids are small particles present in wastewater that are kept in suspension by the velocity of the flow or by agitation. Suspended solids can be removed in sedimentation tanks or by other physical treatment processes.
Trickling Filters are an aerobic biological secondary treatment process consisting of rock, stone or plastic media. The wastewater is trickled over the media and the microorganisms that grow on the media decompose and remove the organic matter from the wastewater.