HANDLING AND DISPOSAL PRACTICES FOR DAF FLOAT

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ABSTRACT

One of the more commonly used unit operations for pretreating food processing wastewater is dissolved air flotation (DAF). Very high levels of removal of total suspended solids (TSS) and fats, oils and grease (FOG) can be achieved by this process at very reasonable capital costs. The major disadvantage to the DAF process is the handling and disposal of the material floated to the top of the unit, commonly termed float.

Acceptable float disposal practices in the past have included:

- co-rendering with other wastes
- land application
- incorporation into animal feed
- landfilling
- incineration

Recent changes in environmental regulations have minimized or eliminated the use of several of these disposal options. As a result, industries are searching for additional float disposal alternatives that are economical and satisfy current regulations.

This paper will examine traditional float disposal alternatives employed at a number of food processing plants. Developing float disposal technologies will be reviewed and described. Projections on future disposal options and regulations will also be made.

INTRODUCTION

A number of food processing industries produce wastewater with high le\ of fat, oil and grease (FOG). Waste solids, in the form of total suspended so (TSS), are often found in these wastewaters as well. Table 1 lists some of industries that produce FOG-laden wastewater.

Table 1. Food Industries Generating FOG Wastewater

Industry	Process	Typical FOG Levels
Meat and Poultry	Slaughtering, primary processing, and by - product processing	100 to 3,000 mg/l
Dairy	Milk processing, production of cheese and cultured milk products	50 to 1,000 mg/l
Ice Cream	Production of ice cream and novelty products	100 to 5,000 mg/l
Prepared Foods	Secondary processing, pre-cooking, and production of breaded and gravied products	50 to 500 mg/l
Seafood	Primary processing and packaging	50 to 1,000 mg/!
Baking	Production of various bakery products	50 to 3,000 mg/

Traditionally, gravity oil-water separators and various types of flotatic have been applied to wastewater to remove FOG and TSS. Along with the r of FOG and TSS comes a significant reduction in BOD and COD. The re floating materially, commonly referred to as float, generally has a high m level of 95% or more. The solids portion of the float contains flocculated grease, food particles, chemical precipitates and other inorganic solid: material is highly biodegradable and, if allowed to set for as little as severa will further separate into discernible water and concentrated float layers.

Because of the high biodegradability of float, disposal is usually accomplished as soon as possible after generation. Long-term storage is avoided to minimize the potential for odor generation. Disposal sources are usually selected to be within a reasonable haul distance to minimize the breakdown of the float and to minimize disposal costs.

FLOTATION TREATMENT

Flotation treatment of wastewater uses the buoyancy of gas to lift material in a liquid to the surface. The lifted material or pollutants can be a solid such as coagulated blood or starch granules. Colloidal solids and emulsified oils are generally not removed by flotation to a significant degree without the use of floc-forming chemicals. The key physical properties of the material to be floated that determine the size of gas bubble needed for effective flotation are:

- physical size
- density
- hydrophobic or hydrophilic character
- surface charge

As the gas bubbles contact the material to be floated, a bond is formed. If the combined density of the bonded bubble and the pollutant is less than the density of the bulk liquid, the combined material will float to the surface. Figure 1 shows the surface buildup of float on a circular DAF unit.

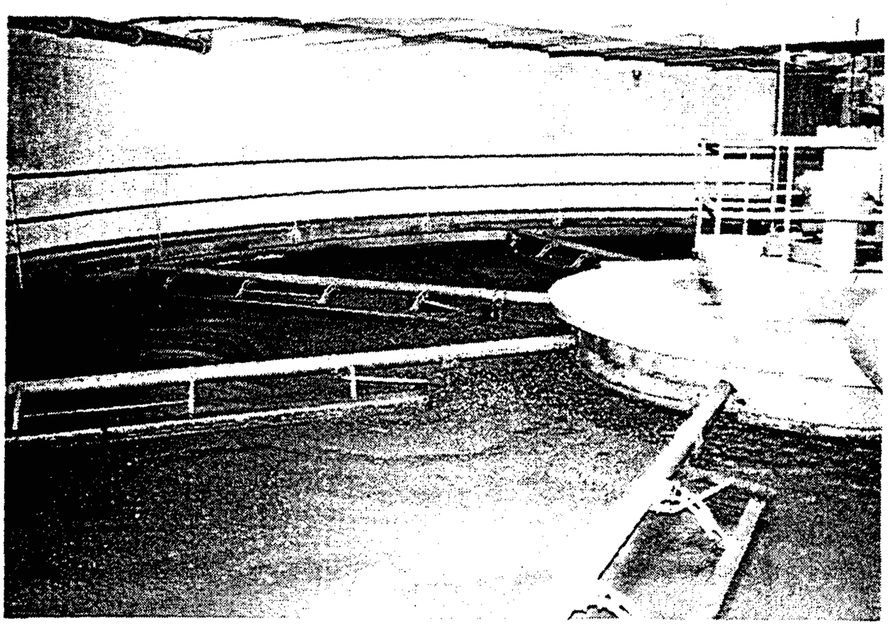

Figure 1. DAF Unit Float Development

The treatment of industrial wastewater via flotation has been practiced for many years. The earliest recorded use of a gas as a buoyant media to treat wastewater was detailed in a German patent in 1877[1]. In 1904, a U.S. patent was granted covering the use of mechanically dispersed gas bubbles to aid in flotation[1]. A number of U.S. patents were issued in the 1920's covering both electrolytic flotation and dispersed air flotation. It was not until the early 1930's that dissolved air flotation was introduced commercially.

The two most commonly applied flotation technologies today are dissolved air flotation (DAF) and dispersed air flotation. The principal difference between the two technologies is found in the method of bubble formation and release.

Dissolved air flotation employs a pressurization system to saturate a liquid with air at an elevated pressure (40 to 80 psig). The pressurized liquid is then introduced into the DAF unit through a pressure reducing device. The sudden drop in pressure causes the release of microbubbles from the supersaturated stream that rise to the surface. Although some or all of the influent wastewater has been used as the pressurized liquid, the most common approach is to pressurize some of the clarified DAF effluent and return it to the DAF unit inlet along with the influent wastewater (partial recycle). Figures 2 and 3 illustrate a circular and rectangular DAF unit respectively.

Dispersed air flotation employs a number of mechanical mixers or agitators within a tank to induce air into the wastewater. Operationally, the rotating impeller displaces wastewater from its center toward the periphery of the tank, causing a flow of air down the mixer shaft or standpipe. The air is violently mixed with the wastewater by the rotating impeller. The wastewater, now saturated with fine air bubbles, is forced outward and upward, creating a frothy surface mixture of air, water and pollutants.

Quite often, the efficiency of the flotation operation is improved through the addition of chemical reagent. By adding reagents to the influent wastewater, a number of physical-chemical reactions are promoted that assist in the flotation operation. Foremost among these would be the use of chemical reagents to bring emulsified oils together, to encourage the flocculation of colloidal solids and to reduce the surface charge of wastewater solids. The net result is the formation of a larger particle that is 'easier' for an air bubble to bond with.

As material is floated to the surface, it is removed and accumulated for disposal. The float, as it is called, is generally 2 to 5% total solids. Depending on the wastewater undergoing treatment, the specific makeup of the float will vary. Table 2 lists general characteristics of float obtained from treating the wastewater of several different industries.

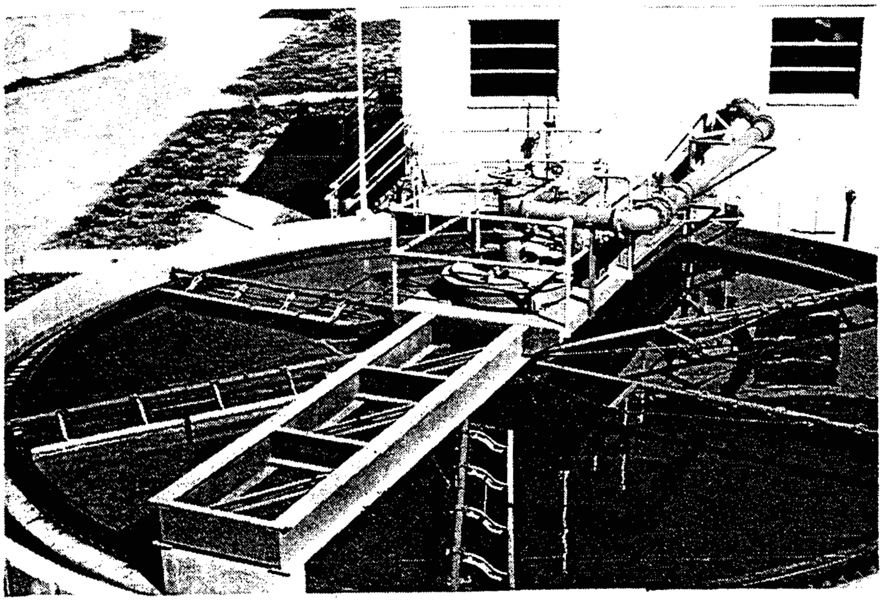

Figure 2. Circular DAF Unit (Eimco)

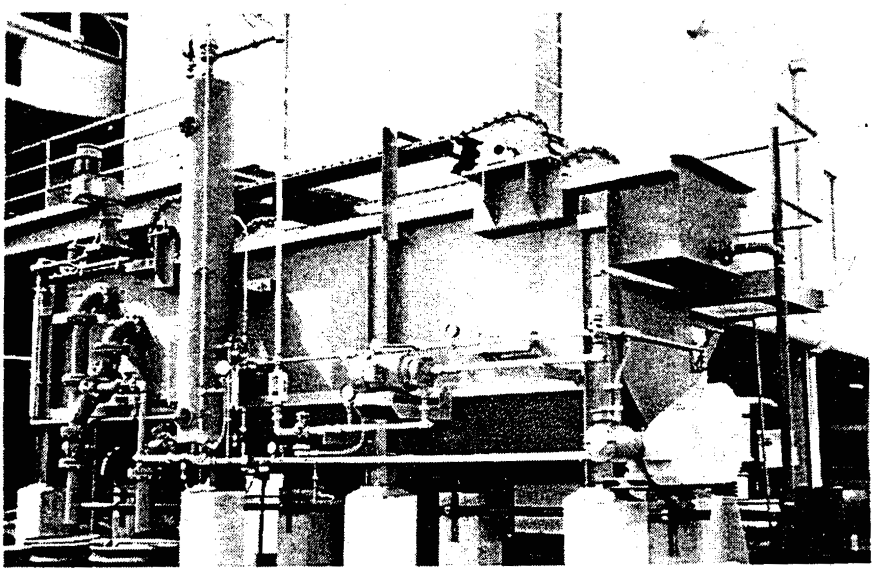

Figure 3. Rectangular DAF Unit (Envirex)

Table 2. Industrial Float Characteristics		
INDUSTRY	FOG %	TS %
Meat slaughtering & processing	0.5 to 3	0.5 to 5
Poultry slaughtering & processing	0.5 to 3	0.5 to 5
Poultry processing	0.1 to 2	0.5 to 3
Dairy (fluid milk & cheese)	0.1 to 2	0.5 to 3
Dairy ingredients	1 to 3	1 to 5
Ice Cream & novelty products	1 to 4	1 to 6

CONVENTIONAL FLOAT DISPOSAL OPTIONS

Industrial generators of float have, over the years, sought economical and convenient methods of disposal. Depending on geographic location, the disposal methods have been as simple as a give-away program to as complex as an oil recovery operation. Following are brief descriptions of float disposal options commonly used in the past.

Landfilling - Landfills were the most common disposal alternative for urban industries producing float. Viewed as a waste product, the float could easily be disposed of with other waste material at the local landfill for a nominal cost. All that was required in terms of capital equipment was some type of thickening or dewatering device and a dumpster. Commercial haulers were used to pick up and transport the float to the landfill. Landfill operators would then work the float into the more plentiful solid waste within the landfill.

Land Application - Land application of float has been used for decades, particularly by industries located in rural areas in close proximity to suitable land disposal sites. The method of float application depended on the physical characteristics of the float (liquid or dewatered), site topography and the type of vegetation present. Liquid application was the simplest, requiring only an application vehicle to distribute the float across the site. Float could be applied by subsurface injection or by surface distribution and incorporation. Dewatered float was normally surface-applied by manure spreaders and then turned under the soil. The major concerns with this alternative were the creation of pest problems, the potential for soil binding and the need to provide balanced nutritional conditions for the crop being grown.

Incineration - Because of the high BTU content of the float, typically 10,000 to 15,000 BTU per lb. of total dry solids, incineration has been used occasionally as a disposal method. Material handling issues are more of a concern with this

...tion than others, since many incinerators need a near constant feed for economical operation. However, the scarcity of industrial incinerators designed to handle liquid float and the transportation costs incurred transporting the material to the nearest incinerator have limited the use of this option.

Beneficial Reuse - Under the category of beneficial reuse are a number of disposal options that food processors have used for float disposal. Perhaps the most widely practiced has been the transfer of float to a rendering operation. The renderer would process this float along with other high FOG wastes and recover edible and/or inedible oils. The condition of the float (water content, presence of chemicals, degree of degradation, etc.) dictated the applicability of this option.

Composting is a organic waste stabilization technique that has been used for centuries. Recently, it has been employed to handle a wide range of industrial wastes that normally would have been handled by less suitable disposal methods.[2,3,4] The feasibility of composting is dependent upon many factors and requires in-depth evaluation before its use.[5]

Another beneficial reuse option practiced by food processors involved the use of float as an animal feed. Some rural food processors have been able to produce a float suitable for feeding to pigs. Again, the condition of the float and its desirability as a feed dictated the applicability of this option. Also, the availability of a sufficient number of local farmers willing to accept the material as it was generated was instrumental in the success of this option.

One of the more capital intensive beneficial reuse options involves the use of a centrifuge to process the float. The centrifuge is used to separate the float into three distinct phases - oil and fat, solids and water. The water would be discharged to a wastewater treatment system. The solids and the oil and fat would be sold as by-products to a renderer or some other end-user. A number of these systems have been operating successfully at poultry, pork and food processing plant.[6]

FLOAT DISPOSAL EXAMPLES

Stouffer Foods - Gaffney, SC

Stouffer produces over 100 different prepared food products at their Gaffney plant. All process and cleaning water is directed to a pretreatment plant consisting of fine screening, equalization, pH adjustment, chemical addition and dissolved air floatation. Pretreated wastewater is then discharged to the local POTW.

Typical wastewater characterization and treatment plant performance data are presented in Table 3.

Table 3. Plant Data	
Flow	750,000 gpd
TSS IN	2,000 mg/l
FOG IN	750 mg/l
TSS Removal	95% +
FOG Removal	95%

Float is removed from the rectangular DAF unit at 2 to 4% TS, chemicall conditioned and dewatered on a belt filter press. The dewatered material has a solids concentration of 22% to 25%. About 200,000 lbs. per week of dewatere float are transported in dumpsters and hauled to a local landfill for disposal.

Beatreme Food Ingredients - Vesper, WI

Beatreme Food Ingredients processes a wide variety of food products int dry powders. Some of the materials they process are whey, lactose, butter fa cocoa mixes and various cheeses. Cleaning water from the dryers and blender is directed to plant drains that convey the wastewater to a sewer leading to th onsite wastewater treatment plant. There, wastewater is screened, pretreated wit a circular DAF unit and treated further with a package activated sludge plan Effluent is discharged to the local POTW.

Typical wastewater characterization and DAF system performance data ar presented in Table 4.

Table 4. Plant Data	
Flow	45,000 gpd
TSS IN	2,500 mg/l
FOG IN	600 mg/l
TSS Removed	85% +
FOG Removed	80% +

Float is transferred from the circular DAF unit at 1 to 3% TS and discharge to a storage tank below the DAF unit. About once a week, a tanker truck picks u the float and waste activated sludge and takes them to agricultural land where the are either surface applied to alfalfa cropland or spray irrigated over alfalfa ar corn. About 15,000 gallons are disposed of each week.

Beatreme has had to develop a very proactive disposal program combining the efforts of a public relations specialist, local agricultural agents, state regulatory personnel, a part-time Beatreme employee and local farmers. As many as 7 disposal sites are involved in the land application program. Detailed records are kept on each site, tracking the amount of material applied each year and issuing monthly summary reports to each participating farmer. Monitoring wells at each disposal site are also used to check groundwater quality.

John Morrell & Co. - Sioux Falls, SD

John Morrell operates an integrated beef/pork/lamb slaughterhouse and meat products processing plant, handling over 14,000 animals per production day. In addition to the slaughtering and processing operations, Morrell also has a number of smokehouses and a complete rendering plant onsite. Wastewaters generated by the various operations are separated into a process wastewater stream and a grease-bearing stream. The latter stream is chemically conditioned with lime and polymer and pretreated with two circular (each 60' diameter) DAF units.

Typical wastewater characterization and treatment plant performance data are presented in Table 5.

Table 5. Plant Data

Flow	1.6 mgd
TSS IN	1,700 mg/l
FOG IN	1,500 mg/l
TSS Removal	85 +
FOG Removal	85

About 30,000 gallons of 4 to 6% TS float is produced each production day. The float is then pumped to the dewatering building, combined with waste aerobic and anaerobic sludge and dewatered with a belt filter press. The dewatered material at 20 to 25% TS is trucked to a nearby municipal landfill. Morrell had previously investigated the alternative of producing a pelletized soil additive with their waste material, but economic factors caused abandonment of the idea. Currently, Morrell is moving ahead with the design of a biofermentation system to combine the float with paunch manure, waste activated sludge and other selected solid wastes and to convert the mixture to a marketable soil additive.

FLOAT DISPOSAL TRENDS

Changes in regulations and economic conditions have forced industrial generators of float to aggressively seek better float disposal options or to reconsider the use of flotation pretreatment systems. The float disposal practices that many employed in the 1980's most likely cannot be used in the 1990's.

Landfilling of float is one disposal option that will be used much less in the future. Float is inherently difficult to dewater and contains a high percentage of moisture. As a result, it is very difficult to produce the 40% TS dewatered material that most landfills require as a minimum. In addition, the number of landfills is rapidly declining, creating increased competition for landfill capacity and much higher disposal costs. The remaining landfills prefer to not accept wastes such as float that are so biodegradable and potentially troublesome.

Rendering of float has been a preferred float disposal option for many food producers for years. Renderers have, in the past, been very willing to accept float along with other more valuable renderable wastes. In some cases where a large volume of high-quality float was available, the renderer would pick it up separately. However, renderers today view the processing of float as an undesirable and potentially harmful activity. The high moisture content causes an increase in processing costs. The presence of chemicals and high levels of fatty acids (float breakdown products) results in the production of lower-grade, less valuable end products. More and more renderers are refusing to accept float.

The most promising float disposal options will be those that meet current and future regulations at an economic cost. Among the options to be considered are:

<u>Land Application</u> - Float disposal on farm land will remain as a viable option for industry. Regulations will most likely determine the application rate, expressed in terms of pounds of FOG (or N or P) applied per acre per year. Operation of the land application sites will be strictly controlled to prevent the creation of pest, odor or soil binding problems. Groundwater protection regulations may require the installation of multiple groundwater monitoring wells around each land application site. In addition, groundwater sampling and analysis may be required on a frequent basis ranging from quarterly to annually. Both cropping patterns and weather conditions may necessitate the use of multiple fields and onsite storage. Extensive soil sampling and analysis will be required for the various application sites. For industrial plants that experience severe winter conditions, an alternative float disposal method will be needed for those extended periods when the farm fields cannot be used.

<u>Incineration</u> - Incineration as a float disposal option is limited primarily by the scarcity of incinerators and by the incompatabilty of the liquid float with the operational characteristics of most incineration systems. Unfortunately, most

incinerators are designed to handle relatively dry solid waste and not liquid wastes. As a result, very few commercial or municipal incinerators will accept float. Perhaps the concept of centralized industrial recovery and treatment plants will advance the development of this option by providing commercial incinerators in urban areas to serve concentrations of float producers.

Anaerobic Digestion - Float is very amenable to biological degradation, particularly under an anaerobic regime. As long as the anaerobic process employs vigorous mixing and a high level of anaerobic microorganisms, significant FOG and BOD reductions can be achieved (greater than 75%). A number of municipalities operate anaerobic digesters that accept readily biodegradable and non-toxic industrial wastes. The waste is jointly treated with waste aerobic sludge produced by the municipality's wastewater treatment system. Following the prescribed length of anaerobic biodegradation, the stabilized anaerobic sludge is then handled by the municipality in their normal manner.

Alternatively, the float could be treated in an anaerobic system constructed by the industry. The approach would be similar to that described for the municipal system except that the system would be much smaller and handle only biodegradable industrial wastes. The major negative to this alternative is that waste anaerobic sludge will need to be disposed of. However, anaerobic sludge is much easier to land apply than the raw float.

Oil Recovery - Some industries currently process float with a three-phase centrifuge, dividing the float into water, oil and fat and solids components. The water is discharged to a sewer and the waste solids and oil and fat are sold as byproducts.

This approach requires the design and construction of a centrifuge float treatment system. It is more capital cost-intensive than most other options and requires the use of a treatment system operator. In addition, pilot-testing is normally needed to allow proper sizing and selection of the various system components. However, if a market exists for the recovered fat and solids, it is a float disposal option worth consideration.

Aerobic Composting - Composting has been used form many years to stabilize organic wastes. A recently introduced proprietary process is available to aerobically stabilize float in combination with other waste materials. Using European technology that has been operating for over 25 years, float is combined with sawdust, paunch manure, screenings and other waste material. The combined waste is aerated and actively managed for a period of 4 to 5 days. The resulting stabilized material can then be marketed and sold as compost for residential and agricultural application. At least two full-scale systems are currently under design for a major U.S. meat processor.

Waste Minimization - Although not a float disposal alternative, the potential impact of waste minimization must be considered in all float disposal evaluations. Every attempt must be made to minimize the generation of the wastes that contribute to float. Source reduction must be a goal of all corporate environmental programs.

CONCLUSIONS

Float disposal alternatives are becoming fewer in number and less attractive economically. What used to be a relatively straight-forward disposal problem has become a much more difficult problem to deal with. Land application and renderer disposal are losing favor as the two most popular disposal alternatives. Landfill disposal is no longer a viable option in many cities concerned about extending the operating life of their landfills.

Today, industrial generators of float must accept the hard economics of their predicament. The loss or reduction of traditional disposal alternatives coupled with increasingly more restrictive disposal regulations have driven up the cost of float disposal. Industries must now seek innovative and unique disposal options such as composting or anaerobic digestion. Implementation of an effective waste minimization program will help in holding down the costs of float disposal.

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