A New Approach to Wastewater Treatment

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The U.S. rendering industry recycles over 50 billion pounds of animal by-products every year. This contributes over $2.5 billion annually to the gross national product. While rendering processes convert this large mass of inedible materials into marketable products, they also produce large volumes of high strength industrial wastewater. Moreover, significant amounts of fats, oils, and greases (FOG) and proteins remain in the wastewater. Removing such materials from wastewater results in a more efficient recycling process along with helping comply with regulatory agencies.

The rendering industry produces wastewater with high loads of total suspended solids (TSS), FOG, proteins, and dissolved organic molecules, which contribute to chemical oxygen demand (COD) and biological oxygen demand (BOD). The type and degree of rendering wastewater treatment required depends on where the plant discharges its effluent and how strict local agencies are. If a plant discharges its wastewater to the local city sewer and publicly owned treatment works (POTW), removal of FOG and some TSS is often sufficient. On the other hand, if a plant discharges directly into a river, stream, or other surface water body, most contaminants have to be removed and a National Pollutant Discharge Elimination System permit is needed. The other alternative is to discharge wastewater in large lagoons.

Rendering wastewater treatment is a multi-step process. First, wastewater has to be collected in an appropriately sized equalization tank. Large particles, hair, bones, and fat chunks should be removed with appropriate screens and fat/oil traps. FOG, suspended solids, and some proteins should also be removed in the primary treatment step. Chemical coagulation, flocculation, and flotation systems are best suited for such treatment.

The secondary step is the removal of dissolved organic materials, which is best accomplished with the appropriate biological treatment. Finally, disinfection of the final effluent may be required if high levels of bacteria are detected.

No matter where rendering wastewater is discharged, new regulations encourage primary treatment to reduce the amount of TSS, FOG, and BOD/COD in the effluent. This step helps with the odor problem and significantly reduces potential fees and fines from the regulatory agencies. At the same time, the better the primary treatment, the easier the secondary treatment gets.

Rendering wastewater presents many challenges to the classical primary treatment technologies and flotation systems. Rendering wastewater contains very high amounts of contaminants, up to 500 times higher than in the municipal or low strength industrial wastewater influents. Depending on what is processed, the wastewater influent can change hourly, daily, or weekly. The space available for the wastewater plant is often very limited. Wastewater treatment produces large amounts of sludge with low solids content that have to be dewatered before recycling of FOG or proteins is possible. The cost of coagulants and flocculants needed for primary treatment can also be very high.

It would be advantageous to design and develop rendering wastewater primary treatment systems that would answer these challenges. A system with a small footprint that can respond quickly to changing wastewater strength, produce sludge with high solids loading, and help save the cost of treatment chemicals would be quite desirable. Clean Water Technology responded to these challenges, resulting in the development of new primary and secondary treatment systems.

New Primary Treatment Technologies

Sedimentation is one of the favorite gravity-separation methods to remove contaminants in water treatment. Most FOG has low density and cannot be separated by sedimentation from water streams. Thus, flotation is a much more suitable technique to remove oil and particles with low density from water during or after de-emulsification. Flotation is a process in which one or more specific particulate constituents of a slurry or suspension of finely dispersed particles or droplets become attached to gas bubbles so that they can be separated from the water and/or other constituents. Gas/particle aggregates float to the top of the flotation vessel where they are separated from water and other non-floatable constituents.

One of the key steps in the flotation method is the introduction of air bubbles into water. In early flotation machines, coarse bubbles (two to five millimeters) were introduced into the contaminated water by blowing air through canvas or other porous material. In some impeller-based machines, air could be introduced from the atmosphere without compressors or blowers. This type of flotation, in which impeller action is used to provide bubbles, is known as induced air flotation and also produces fairly coarse bubbles. Another flotation method, called dissolved air flotation (DAF), is much more common in the treatment of oily wastewater. In DAF, a stream of wastewater is saturated with air at elevated pressures up to five atmospheres (70 pounds per square inch). Bubbles are formed by a reduction in pressure as the pre-saturated water is forced to flow through needle valves or specific orifices. Small bubbles are formed, and continuously flowing particles are brought into contact with the bubbles. There is a price to pay for having such small bubbles (up to 20 microns): such bubbles rise very slowly to the surface of the tank. This is the main driver of the large dimensions for DAF tanks. Air solubility also limits the amount of gas and gas bubbles availability. Furthermore, to avoid clogging of orifices, only a small fraction of pretreated water is aerated and then recycled into the tank where bubbles nucleate under already preformed flocs. Therefore, the number of bubbles is limited and treatment of high strength industrial wastewater with high TSS and FOG loads is very inefficient. This makes the DAF a poor alternative for this kind of wastewater.

To answer these problems, cavitation, jet, and centrifugal flotation systems have been developed. In these systems, centrifugal forces have been used to produce smaller bubbles, which were created mechanically. Centrifugal flotation systems are based on liquid hydrocyclone technology. Contact of air, contaminants, and chemicals occurs inside the hydrocyclone column under the influence of centrifugal forces. Solid/liquid separation occurs inside the column, resulting in much faster response flotation units with a smaller footprint. Flotation tanks are only used for sludge skimming. However, larger bubbles cannot remove small particles and DAF still produces wastewater with much better contaminant removal efficiencies.

Engineers at Clean Water Technology developed and implemented a system that combines the best features of centrifugal and DAF. Compressed air and treatment chemicals are introduced at the same time into the heads of the liquid hydrocyclones. Therefore, solids floc nucleation occurs at the same time as bubble nucleation. This results in very large air-filled, easy-to-float flocs. The gas energy mixing (GEM) system heads are designed to allow modification of the mixing energy from very high for inorganic coagulants, such as aluminum sulfate mixing, to very low for the final flocculant addition and floc formation. This results in very efficient, tailored mixing of treatment chemicals and lower dosages. In this way, 100 percent of the influent is pressurized and more oxygen ends up in the water, slowing down anaerobic degradation and odor problems. The centrifugal force inside the hydrocyclone helps dewater flocs with much higher final solids loading in the skimmed sludge.

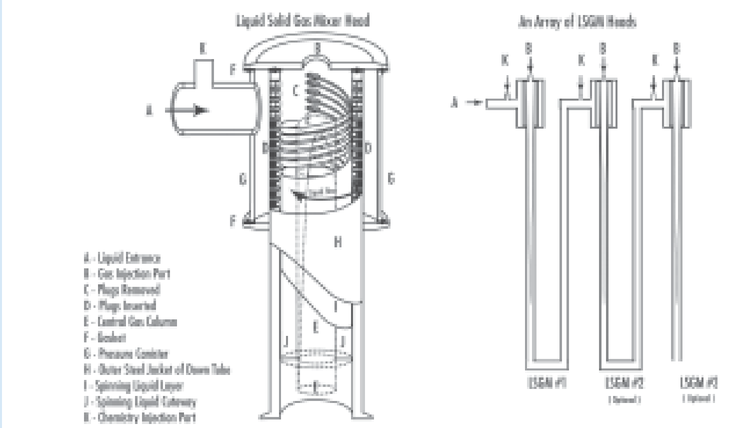
The GEM System and Rendering Industry

The GEM system answered most of the rendering industry's effluent treatment challenges. The system has a footprint that is 10 to 30 percent of other flotation technologies; can handle high strength influents with up to 100,000 milligram (mg)/l of TSS and 70,000 mg/l of FOG; and responds rapidly (in seconds) to changes in incoming wastewater. In addition, the system produces sludge with solids loading up to four times higher than that of other flotation technologies, and the residual contaminants removal rates are as low as 10 mg/l of TSS and 1 mg/l of FOG.

GEM systems have been installed at John Kuhni and Sons' new Utah plant, San Jose Tallow in California, and most recently at Anamax in DeForest, WI. An older version of this technology has been operating for several years at many rendering facilities, such as Salinas Tallow in Salinas, CA, and California By-Products in Fresno, CA.

At San Jose Tallow's rendering plant, influent with extreme amounts of materials is often treated. TSS as high as 75,000 mg/l and FOG over 30,000 mg/l are common, with COD over 60,000 mg/l. TSS after treatment is usually below 20 mg/l and FOG is below 10 mg/l, with COD below 5,000 mg/l. Solids loading in freshly skimmed sludge is between 18 and 25 percent solids, which is five times higher than with other flotation systems. Overnight drainage can concentrate solids loading to over 30 percent.

The GEM System



John Kuhni and Sons' new plant in southern Utah has a different problem. The nearest municipal POTW is over 40 miles away, making transporting the wastewater labor intensive and costly (50,000 gallons of effluents per day). Due to expected expansions that include eventual discharge to a local stream, the system also had to be flexible. The GEM system is an integral part of the rendering plant's current wastewater treatment process, cleaning it from TSS and FOG before transport to the POTW. The system started processing 20 gallons per minute and is capable of processing up to 50 gallons per minute, when needed.

When necessary, such as rendering solids for animal feed, the chemical coagulants and flocculants used in the GEM system are generally regarded as safe (GRAS) by the Food and Drug Administration. Due to the way the system mixes the chemicals with the waste stream, the chemical injection offers more cost efficient savings for the customer on chemical consumption. Older flotation systems often apply inorganic aluminum or ferric-based coagulants, which at high dosages are not GRAS. Most current GEM system customers recycle the sludge.

To summarize, the GEM system offers an effective solution for wastewater treatment in the rendering industry. The system is able to handle very dirty wastewater while occupying a very little footprint, is chemical efficient, and produces a much drier sludge. ❖