Sample essay on biologically based on-site industrial wastewater treatment system...

Business, Industries

Abstract

Solid waste and wastewater are primary sources of pollution from food processing industries. The wastewaters usually contain high suspended solids, organic starch and sugars that may contain toxic substances to the environment. Solid wastes come from organic materials while the mechanical preparation processes need biological treatment before releases into the environment. When untreated, they find their way into other water plants like lakes and streams. Since they have higher nutrient content, they result of eutrophication of the water systems hence causing algal growth. It, therefore, compromises the stability of the aquatic ecosystems as the water quality is changed. It endangers the life of the aquatic flora and fauna. This paper analyzes the process of wastewater treatment adopted by the Grippo Potato Chip Co. Inc food industry.

Introduction

With the increased current in industrialization and population all in the society, there is a continuous increase in the need for fresh water. The reclamation and reuse of wastewater are, therefore, desirable when technically and economically feasible. Wastewater is, therefore suitable as an excellent water source for treatment and reuse. However, the treated water should be ensured to have satisfied the quality standards set by different health and quality agencies. The quality standard may vary depending on the need or the desired use of the treated water. As a result, various treatment methods undergo different process combinations.

The efficient management process of wastewater seems to be a significant

challenge to cross geographical boundaries. Individual food products from various food industries are also classified with equal ease. Tightening discharge standards and escalating haul-out cost time after time is forcing many food processors and manufacturers to adopt other solutions. Many have found a better and attractive alternative to wastewater treatment systems. These systems have proved to be installable and can be and operated on-site to produce cleaner, clearer and usable water. The reclaimed wastewater can be used and a residual sludge as well as other secondary benefits like fertilizer for agricultural purposes (Shah, 4).

Most food processing industries have typical contaminants that are monitored by municipal regulatory agencies to ensure the right standards for Total Suspended Solids, Biological Oxygen Demand, as well as Oils, Fats, and Grease. The wastewater treatment process can, therefore, be a simple and straightforward issue for the betterment of the environment. Ordinarily, the wastewater when not treated and disposed of to streams will subject the flow to pH adjustment and physical-chemical processes. It can cause the pollutants to form a floc or agglomerate for subsequent removal (Shah, 5).

Present scientific inventions have derived knowledge from other naturally occurring biological processes in water treatment. For instance, the knowledge of the complex natural wetlands processes has been incorporated into the integrated attempts of wastewater treatment. The interaction between water, plants, microorganisms and aquatic animals in the environment forms the basis of biological sewage treatment. They naturally interact with the soil, sun, sand and air to improve the water quality (Guy, 4).

Treatment of wastewater through a conventional method has gained success in water reclamation and reuse for recharging as well as receiving water. The primary method is therefore, employed by many industries and facilities in treating their wastewater. The primary methods are used from main skimming and settling methods to secondary processes. The secondary processes incorporate aerobic biological methods like activated sludge and trickling filter processes (Guy, 6). Others also add additional treatment systems such as membrane filtration or the sand to the conventional treatment train for the wastewater. It is mainly to achieve more stringent quality of the treated wastewater and standards that are required for portable and non-profitable reuse. The method is employed just to supplement.

The biological wastewater treatments have been adopted in many food and beverage industries in treating their waste water. In food processing, water is used majorly as an ingredient, intermediate and initial cleaning stage. It is also the most efficient primary transport of raw materials through the conveyors and the principal substance for the sanitation of the plants machinery and the general work areas. As a result, the extensive use of water requires the industry to give primary concern to treat the water and the wastewater. Cost-effective methods are hence required to be employed. It is suitable in every capacity possible for reducing the cost since the water is required in all the processes (Shah, 6). It is by embracing the biological wastewater treatment method that Grippo Potato Chip Co. Inc over the years made environmentally proactive investment according to Beckert magazine published in 2000.

Overall industrial process and the final product

The company manufactures potato chips and sells under its brand name for Ohio regional retail markets. It also works together with other food industries as it distributes snacks that have been produced by other food related companies. The choice to treat and reuse the wastewater has enabled the reduction of waste disposal expenses as the waste becomes beneficial for other purposes within the company enterprise.

The company has installed an 80 gallon/minute floatation system that was manufactured from Kenosha by Beckart Environmental Inc. This company is known for its experience of food industry waste treatment. It covers food industries like dressing, salad, fish processors and vegetable oil among other food industries. The food manufacturing process involves skinning and slicing of potatoes before they are washed and fried. The fried potato is then transferred to a double equalization tank fixed with air spurges at a different section of the plant. It is the equalization stage where the uniform stream is promoted and transferred to a mix and reaction tank. At this point, coagulation is done by the use of coagulant aiding food additives to emulsify the potato further to promote floc formation as the flavor is adjusted. The mixture is then transferred to the flotation clarifier for flocculation through addition of chemicals. The final food product is then packed and sold as food in the markets (Beckart magazine, 2).

These food manufacturing processes requires the use of water at every stage. As the potatoes are washed, soil, sand, and other grit materials are released which can cause mechanical complications if not washed off. The peeling also mixes the water with other organic carbon materials like starch

and carbohydrates. The frying of the potato enables the release of oil in addition to grease used to soften the machine to overcome friction. The same water is used for cleaning of the company hence mixing the waste with sewage materials from the toilets and organic matter from the kitchen refuse. When the whole process is complete, the water leaving the factory is usually polluted and has toxic organic and inorganic wastes.

Strength and composition of the waste materials

The wastewater is mostly made up or organic carbon in particulate or solution form. Over 60% of the particulate form is usually sufficient to settle by suspension process. Smaller sized particles of between 1nm to 100 micrometer are generally in colloidal suspension. They become adsorbed during treatment in the activated sludge flocs (Shah, 7). The bulk of the waste matter contained biodegradable compounds consisting of amino acids, proteins, carbohydrates, peptides as well as fats and fatty acids. The carbon, nitrogen, and phosphorous is estimated to be ideal for the growth of bacteria in the activated sludge. There is also a small percentage of degradable and non-biodegradable carbon within the organic load of the wastewater. Aromatic compounds like toluene and benzene are also present but can be broken down by the help of bacterial activities.

Adverse impacts of the wastes to the environment

Majority of the pollutants when directly disposed of into streams without treatment will always endanger the aquatic flora and fauna. They compromise the water quality and deprive the water of oxygen as they rot and decompose. The marine and other aquatic animals hence die as a result

of starvation of oxygen as the decomposing materials have a high Biological Oxygen Demand (BOD). The high nutrient loading results to eutrophication that favors algal development at the expense of other aquatic life. The result is usually a change in the community structure of aquatic organisms. Their feeding patterns are interfered with as well as their breeding areas (Zhao et al., 12).

The waste materials also have a strong odor due to the release of poisonous gasses like ammonia. It thus reduces the quality of the atmospheric air and can cause respiratory complications to human health. Pools of untreated wastewater act as breeding sites for vectors of water-related diseases like mosquitoes and bilhazia. The quality of fresh water sources are also polluted leading to diseases like typhoid (Zhao et al., 14).

Operation parameters of the treatment plant

The wastewater is directed to through thorough treatment process in different stages of the treatment processes. The pretreatment begins by the coarse screening to remove the huge solid waste materials that would slow down the treatment process. Vertical/inclined bars are used filter the solid waste but are raked regularly. It is followed by the grit chamber process that removes smaller objects like soil and sand grains from the peeling of the potatoes. They are removed to prevent mechanical breakdown or to settling at the corner to cause the reduction in the flow capacity.

The grit chambers are the concrete-lined pond where the water flows smoothly at a low speed to allow the settling of the sand and other silt-sized particles. Air bubbles are injected into aerate and strip off the organic

materials from the surface. Down the grit chambers are comminutors for cutting and shredding the remaining solid materials not removed at the first stages of treatment. The treatment plant has six large basins to ensure flow equalization by storing excess wastewater. As the mixture flows into the sedimentation tank, light organic suspended solids are held for 2-3 hours. The materials settle here to form the sludge that is finally removed by pumps and mechanical scrapers.

The dissolve air floatation system is also incorporated at this point to separate floating fats, oil, solid wastes and grease from the waste stream flow. Here, the microscopic air bubbles float the solids wastes to the surface forming the sludge and is later scraped off into the sump for further biological processes. The flotation cell are v-shaped automatically eliminate from the vessel any solid matter that resist flotation. Within the v-shaped floatation cells are adjustable weirs and scrapers to ensure complete elimination of any dead zone in the sludge skimming process.

The water is then sprayed in the trickling filters made up of coarse stones around ten feet deep within a large circular concrete tank. As it trickles through the bed, slime is formed from the microorganisms. The filters are well aerated and hence enable the aerobic micro-organisms to feed on the organic materials still left in the wastewater. As the microbial film is regularly washed out, the wastewater is directed into the secondary filters to allow further sedimentation.

The water is then released into the active sludge stage where complex biological processes occur in the presence of oxygen. The sludge basin is dominated by over 300 species of autotrophic and heterotrophic bacteria.

Outside the basin is a bound of a membrane that regulates the flow of molecules and ions from the surrounding medium. The bacteria ingest small molecular weight compounds through the cell wall while large molecules are allowed to pass through by secretion process. The process is accompanied by enzymes that bind the bacteria together. The enzymes favor the breakdown into digestible monomers the large organic molecules for bacterial growth. As the heterotrophic bacteria feed on the organic carbon molecules, autotrophic bacteria take up the inorganic as nitrifying bacteria remove ammonia compounds.

In the aeration tank, the bacteria are concentrated to a flocculating material formed from the aggregates of the non-living polymers secreted by the bacteria. The bacteria however have a porous structure able to withstand the shear forces of water movement. Big and fine colloidal particles become entangled with the floc material where they are adsorbed. The activated sludge floc external surface is frequently colonized by microorganisms of higher trophic levels like rotifers and protozoa. These organisms feed on particulate matter and bacteria in the wastewater.

The aerobic bacteria consume and reduce the suspended solids in the wastewater that leads to oxygen reduction, referred to as the Biological Oxygen Demand (Shah, 34). The bacteria hence convert ammonia compounds to the nitrate substances. The nitrate compounds and other suspended solids are further reduced to nitrogen gas and other essential elements. At this point, the BOD is usually low but the water still contains lightweight aggregates of refractory organics, phosphorous and traces of nitrogen compounds (Guy, 19).

For the company, chemical treatment is only necessary when the excess treated water needs to be released in the Enterina Stream which runs adjacent to the treatment plant. Most of the water is however reused for purposes that do not require chemical treatment. However, the phosphorus can be removed by addition of lime, alum or ferric oxide (Zhao et al., 19). Activated carbon is used for adsorption in the absence of oxygen to remove the carbon refractory organics. To prevent eutrophication as well as algal bloom in the stream, the nitrogenous compounds in the form of ammonia is further subjected to biological processes. It can be achieved by extending the cell detention time in the activated sludge process for the last fifteen days of treatment. The bacteria then convert ammonia into water, nitrogen and carbon dioxide gasses. Small amount of organic materials like settled sewage as a food source for the bacteria. Ammonium stripping can also be employed to convert ammonium to ammonia and removed by blowing large air quantity through water.

Use of the end product

After treatment, the water is channeled back to the factory to be used for cleaning and engine cooling processes. Some of the water is directed to a fish pond where catfish is reared. The company now has enough excess water and plans to begin using the water for irrigation agricultural functions due to the scarcity of water in the northern part of Ohio. The plant also benefits from secondary products like sludge that is used as fertilizer for agricultural purposes.

Conclusion

Wastewater is considered water because of its interconnection with other water functions. Much of the water used by homes, industries, as well as businesses should be treated before released into the environment. Nature has amazing natural ability of coping with small amounts of pollutants and other waste materials as a result of anthropogenic activities. However, it will be too overwhelming if the billions of gallons daily produced are not treated as being released into the environment. The treatment plants therefore reduce the pollutants to a level nature can handle.

Solid waste and wastewater are primary sources of pollution from food processing industries. The wastewaters usually contain high suspended solids, organic starch and sugars that may contain toxic substances to the environment. Solid wastes come from organic materials while the mechanical preparation processes needs biological treatment before releases into the environment. When untreated, they find their ways into other water points like lakes and streams (Zhao et al., 21). Since they have high nutrient content, they result to eutrophication of the water systems hence causing algal growth. It thus compromises the stability of the aquatic ecosystems as the water quality is changed. It endangers the life of the aquatic flora and fauna.

Water treatment plants act as collection systems for the wastewater for smooth management. It is thus suitable for odor control as well as in prevention of disease breakout and other health related issues. Bio-solid handling is encouraged for the degradable organic waste materials which when not treated can be hazardous to the environment. The biological

processes designed for wastewater application in the food industries should, therefore, be very specific for the plant needs. With the primary concern to reduces pollution levels as a result of the wastewater, regulated constituents must have permissible pre-treatment system discharge level in the most cost-effective and direct way. The removal of the suspended solids, grease and oil, as well as the BOD can be implemented through dissolved air flotation processes. The total amount of raw materials used determines the amount of the organic solid and wastewater that needs to be treated.

Works cited

Beckart Environmental Inc report, Case Histories: How One Snack Food Maker Turned aWastewater Challenge Into a Business Opportunity, Food Processing Magazien

Shah Maulin, Enrichment of Activated Sludge Process in the Treatment of Industrial Waste Water. American Journal of Microbiological Research, 2014; 2(5): 131-137. doi: 10. 12691/ajmr-2-5-2.

Guy Melvin., Nutrient Removal Efficiency of Activated Sludge Plants Treating Industrial and Municipal Wastewater in Ghana, Journal of Environment Pollution and Human Health. 2014 2 (3). doi: 10. 12691/jephh-2-3-1

Université du Luxembourg. (2014, November 26). Microbial communities for health and environment: Precise measurements of microbial ecosystems. Science Daily. Retrieved November 28, 2014 from www. sciencedaily. com/releases/2014/11/141126075059. htm

Zhao, Lee. J., Maio, Fredrick., Guo, Johnson. B., Chao, . LeolPetrochemical wastewater treatment with a pilot-scale bioaugmented biological treatment

system. Journal of Zhejiang University Science A 8 ., (November 4th 2007). (11), 1831-1838.