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Treatment of Edible oil Refinery Waste Water by Using Chemical and Biological Process

Dr. (Mrs.) Sarita Sharma, Dr. Ashok k. Sharma, Dr. Sanjay Verma, Himmat Singh Dodiya*
Associate Prof., Dept. of Chemical Engineering, Ujjain Engineering College, Ujjain, India
*M-Tech., Dept. of Chemical Engineering, Ujjain Engineering College, Ujjain, India
dodiya.himmat@gmail.com

Abstracts

The main objective of this study is aimed to investigate feasibility of the chemical and Aerobic biological process to treat oily wastewater from soya bean oil refinery. Effect of aeration and sludge concentrations are studied. The environmental impact of soybean oil refinery effluent cannot be over emphasized; hence the need for treatment measures to reduce these impacts before discharge. Therefore, this paper reviews the processing, purification of soya bean oil and the different methods of treatment applied to the soybean oil refinery effluent that is being generated. The basis of the proposed method for purification of wastewaters was a preliminary separation of clarified and neutralized wastewater by dint of concentrated lime, subsequently alum, Polyelectrolyte for water clarification and its additional neutralization was used.

Keywords : Oil refinery wastewater, lime, Polyelectrolyte, BOD, COD, oil and grease .

Introduction

The Indian soya bean refined oil processing industry is one of the largest in the world in terms of production, consumption, export and growth prospects. The oil processing industry in India is a sunrise sector that has gained prominence in recent years. Increase industrialization with literacy and affluence has given a considerable push to the oil processing industry growth. Mechanical life style and crave for comfort is pushing people towards ready to eat services. Wastewater generated from these industries depicts wide variation in strength and characteristics. Water being the primary ingredient is widely used as a cleaning agent in soya bean refined processing industry (vanerkara et al2013). Soya bean refined oil processing industry is a major issue of environmental concern in developing countries for the last three decades. The waste streams come out from oil refinery create serious environmental problem such as great threat to aquatic life due to its high organic content. Hence its treatment is essential prior to its disposal. The choice of effluent treatment method depends on the organic content present in the effluent and its discharge conditions.

Edible oil industry wastewaters mainly come from the degumming, deacidification, deodorization and neutralization steps (Rupani et al 2010). In the neutralization step sodium salts of free fatty acid soap stocks are produced whose splitting through the use of sulfuric acid generates highly acidic and oily wastewaters (Olafadehan and Jinadu et al 2012). Its characteristics depend largely on the type of oil processed and on the process implemented that are high in COD, oil and grease, sulphate and phosphate content, resulting in both high inorganic as well as organic loading of the relevant wastewater treatment.

Effluent from the vegetable oil industry used to be discharged directly into soil or groundwater. But due to the emergence of environmental consciousness the Pollution Control Boards have become stricter and imposed stringent norms. The studies have shown that fatty materials within waste streams from oil industries are readily biodegradable and it therefore follows that these effluents are amenable to biological treatment.95% of BOD in wastewaters from a soya bean oil refining plant is removed by using an activated sludge process (Aslan et al 2009).

During these processes by-products and wastes are formed. The operating conditions and processes carried out influence the amount and characteristics of the by-products and wastes formed. The wastewater varies both in quantity and characteristics from one oil industry to another. The composition of wastewater from the same industry also varies widely from day to day discussed types of physical, chemical and biological methods used for the oily wastewater treatment. Use of these methods, disposal and waste treatment still remain major challenges in the fats and oils industries (Chipasa et al 2001).

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Environmental risk of industrial activities associated with extraction, hydrocarbons, oil processing, transportations and refining. These industries have increased the threat of oil pollution to the environment and subsequently concomitant discharged into the natural environment creates major ecological problem throughout the world. The wastewater is detrimental and need to have a treatment before discharge into the environment.

The treatment of this waste has been address by several techniques such as coagulation, biosorption, adsorption, filtration, screening and many more. Among the various techniques adsorption process is one of the effective methods for removing organic and inorganic pollutants in waterway system. The possibility of using inexpensive materials as alternatives was explored by many researchers in the past years (Husin et al 2011).
This wastewater has been reported to be treated by aerobic biological techniques. but the biological system malfunctions due to fluctuating load and characteristics of wastewater which fluctuates widely. It is hence preferable to provide primary physicochemical treatment to this wastewater prior subjecting it to the biological treatment. Physicochemical wastewater treatment is a frequently used technique in the area of wastewater treatment. Physicochemical wastewater treatment techniques are applied for the removal of heavy metals, oils and greases, suspended matter and emulating organic substances, organic and inorganic components, difficult to decompose, non polar organic substances, toxic pollutants or high salt concentrations, phosphorus. The physicochemical wastewater treatment techniques are used as pretreatment, final treatment as well as specific treatment for wastewater reuse as process water. Where the reduction in COD has been obtained 60% with alum dose of 200 mg/L. Physicochemical and combined biological treatment has been successfully applied to a oil processing industry wastewater for reuse quality (Vanerkar et al 2013).

Refining of soya bean oil

Edible oil refining can be done either chemically or physically. Degumming, chemical neutralization followed by physical refining of bleaching and deodorization, might be the most conventional process that is widely used. This process, as explained earlier, is objected to converting crude oil or fat into a more suitable form for the subsequent use. Typically, it will produce oils that have minimum colour and flavor because the minor compound, which is not desirable, has been removed during the process (Gunstone et al 2004). degumming process was intended to remove the phosphatides and mucilaginous material from crude oil by means of washing with water, dilute acid or sometimes dilute caustic lye 48% concentration. That phospholipids are powerful emulsifying agents, and that if not removed, will increase the refining losses and decrease the oil oxidative stability due to its ability to carry pro-oxidants associated metals (Gunstone et al 2004).
Neutralization process utilizes alkaline compounds to produce soap stock so that it can be separated from the oil body. Soap stock contains free acid in the form of sodium salt, which is mixed with triacylglycerols and phospholipids. This byproduct will then be acidified again to get the fatty acids that can be used for the soap manufacture or animal feed additives. The next stage namely bleaching is a process that is aimed to eliminate colour substances that are not desired in the oil. This process is done by mixing the oil with a small amount of adsorbent or can be done chemically (Ketare et al 1986). However the process in addition to using the adsorbent i.e. hydro-bleaching or chemical bleaching is not utilized on edible oil refining. The final process which is deodorization is designed to produce oil with a bland flavor, odors and good shelf life. This process usually undergoes high temperatures between 170-250ºC under reduced pressure to volatilize the oxidation products responsible for oil off flavors (Febrianto et al 2011).

Waste products from soya bean oil refining

This work presents the results of investigations on the chemical and biological treatment of soya oil refinery Wastewater. The refinery mentioned herein as the company Uses chemical and biological methods for the refining Of oils rapeseed, sunflower, soybean, palm, and hydrogenated. The acid wastewater is that stream coming from the soap stock splitting process, whereas the technological wastewater is that stream originating from all the factories (Bhatnagar and minocha et al 2006).

The acid wastewater coming from the oil refining plant is mixed with 10% calcium oxide lime (CaO) to adjust the pH to about 7-8 and 40% calcium chloride ($CaCl_2$) as a coagulating agent The reaction between the added calcium compounds and sodium salts and soaps in the wastewater leads to less soluble calcium soaps, sulfate and phosphate calcium salts. Since the interfacial film changes emulsion may break and the less soluble calcium salts absorb oily mattered other organic suspensions. In this way both the calcium salts and the adsorbed matter are removed from the acid wastewater stream. The removal efficiency of these calcium salts is limited by their solubility in water and medium strength and only a small fraction of reports are on low strength industrial wastewaters (Heponiemi et al 2011).

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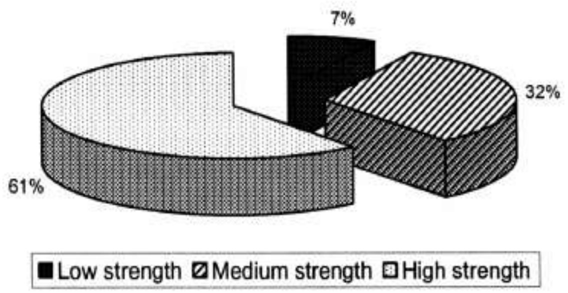

The wastewater originating from the oil refining and margarine plants and other factory installations flows into a sink basin and then into a stabilization tank where it is mixed with treated acid wastewater and wastewater from the centrifuge to obtain a uniform liquor and stabilized flow. Neutralization process utilises alkaline compounds to produce soap stock so that it can be separated from the oil body. Soap stock contains free acid in the form of sodium salt which is mixed with triacylglycerols and phospholipids. This byproduct will then be acidified again to get the fatty acids that can be used for the soap manufacture or animal feed additives.

Soya oil refinery effluent

Although the quantity of acidic wastewater is relatively low. The extent of its pollution load is larger than that of technological wastewater. The soya oil refining process is consists of several unit operations. The refining of soya oil results in the generation of different types of residue. Among the waste generated, soya oil refining effluent is considered the most harmful waste for the environment if discharged untreated. Soya oil refining effluent is a thick brownish liquid that contains high solids, oil and grease, COD and BOD values. Several treatment technologies have been used for treatment, since the direct discharge of effluent adversely affects the environment. Due to the presence of high total solids in refinery effluent attempts have been made to convert this waste into valuable products such as feed stock and organic fertilizer.Although refinery effluent iso rganic in nature,it is difficult to decompose in natural conditions(Francois et al 2010).

Effluent Characteristic:-

a) Physical Characteristics: i) Temperature ii) Turbidity iii) Colour

b) Chemical Characteristics: i) PH ii) Hardness iii) Dissolved Solids iv) Organic Characteristic

c) Biological Characteristics: i) Bacteria ii) Protozoan iii) Viruses iv) mlss

Parameter	Range
BOD (mg/L)	20-40
COD(mg/L)	100-250
TDS(ppm)	2000-5000
TS(mg/L)	0-100
Hardness(ppm)	100-400
Temperature(◦C)	25-35
pH	6.0-7.5
Oil & grease(mg/lit)	10

Soya oil refinery effluent management

Effluent management involves the typical handling of liquid waste. The mechanical technique often involves sedimentation, filtration and decolorization of effluent. Mechanical technique is normally at the first stage of purification process to remove suspended solid particles. This is called primary treatment. The commonly used devices include sieve, sedimentation bed and filter. Chemical and biological technique involves coagulation of finely dispersed and suspended solid particles, adsorption of the dissolved impurities such as heavy metals selective crystallization and reverse osmosis and ion-exchange processes (Costello et al 2003). Reverse osmosis is most often used at the final stage of effluent treatment. Secondary treatment is biological process following primary treatment. The forms of secondary biological process include activated sludge, press filters, contact stabilization etc. There are widely known methods of effluent treatment in Soya oil refining industries (Costello et al 2003).

1. Tank digestion and facultative ponds:

In this system raw effluent after oil trapping is pumped to a closed tank which has a retention time of about one days. The liquid is mixed by means of horizontal stirrers. The methane gas generated is flared off into the atmosphere but the flaring of the methane gas is unacceptable and calls for improvement on this method. Digested liquid is discharged into a holding pond before it is disposed on land.

2. Tank digestion and mechanical aeration:

This group consists of cooling acidification ponds an aeration pond. Raw effluent after oil trapping is pumped to the acidification pond through a cooling tower and

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retained for one to two days. It is then mixed with an equal volume of liquid from the aerobic digester before it is fed back to the digester and the achievement recorded indicates that the effluent water has been treated. The hydraulic retention time of the digester is about twenty days. The digested liquid is discharged to an aeration pond with two floating aerators. The liquid is aerated for twenty days before it is discharged (Chem. and Pharm et al 2011).

(a) Acidic phase:
This is the first phase of the anaerobic digestion process. It is a very rapid process whereby acid bacteria converts the organic components of the waste into volatile fatty acids which in turn acts as substrate for the next phase of the anaerobic process. The pH of the system is depressed during volatile fatty acids formation. The phase is not susceptible to environmental influence in that changes in environmental conditions like temperature do not affect its required performance so open ponds are suitable and cost effective. At the start anaerobic liquid is run down to the pond and then mixed with clarification waste. The mixture is left over night to react. Recycling of anaerobic liquid helps to supply seed bacteria for continuous acidification cools hot effluent and improves the pH (Chem. and Pharm. et al 2011).

(b) Aerobic phase:
For a 20 ton fresh fruit Bunch per hour oil mill an aerobic lagoon with 20 days retention at 0.1 kg BOD: kg mixed liquid suspended solid (MLSS), a minimum of two 11 KW mechanical aerators can be used. An extended aeration process is advantageous in the following ways. Operation is simple and the problem of solid generation and handling are reduced. Nitrogen destruction efficiencies are high Power requirement is not critical Construction costs are low Land usage is reasonable After sedimentation the discharge from the digester is dumped in the aeration lagoon at the start. Twin aerators operate continuously to provide mixing and oxygen transfers. The lagoon discharge is passed through a sedimentation tank and the settled suspended sludge is at present recycled to the acidification pond but can be used as fertilizer because of its high nitrogen content (Muro et al 2005).

Process flow of the biological treatment plant

The liquid discharged from the tank is transferred to a sedimentation tank. The supernatant liquid from this tank overflows to the aeration lagoon. The concentrated digested liquid is recirculated into the digestion tank to maintain a constant level of suspended solids in the digestion tank. When solids level exceeds the desired concentration, some of it is taken off into the sludge storage tank and sent to the decanter for dewatering. The sludge cake produced is mixed with fiber until a moisture content of about 60% is obtained. This mixture is then placed in the composting tank (Muro1 et al 2005).

The extent of conversion of the organic matter is measured by the ratio of BOD to COD. The ratio BOD: COD > 0.6 is ideal for biological waste treatment. It was also found out that the aerobic treatment method is more effective and has a high process. Process for biological treatment plant rate and enhances maximum destruction of carcinogenic products. Biological treatment of the effluent is wider range if the acidic and methanogenic phases of carried out in filter bed, biological pond. Bio-filter and digestion are separated. After anaerobic digestion, aeration is commonly used. Bio-filters are concrete wall the waste is normally still too strong for discharge to reservoirs with perforated bottom, filled with packing of waterway and extended aeration and sedimentation various sizes and inhabited by micro organisms. The provides a supernatant of low BOD. The settled solids microbes form a thin layer on packing surface. This from the anaerobic and aerobic digestion process are effluent water is evenly distributed on the filter bed-layer higher in nitrogen content than raw waste and are to ensure contact with the microbes(Nicolella at al 2000). In all these effluent types, it is evident that anaerobic what actually happens is that the different oil digestion is the most attractive biological process as it mill effluent management methods are selected to optimize requires minimum power input. Unfortunately, it the BOD, the COD, total solids (TS), suspended solids operates within a relatively narrow range of physical (SS), oil and grease (O & G), Ammonical nitrogen, pH, conditions. However, the process is more stable with temperature and cost (Chipasa et al 2001).

Conclusion

The world's soya bean oil demand is increasing generation of wastewater is also increasing. If they are discharged untreated, they may cause serious problem and deteriorates the environment in contact. Thus environmental management through waste management should be given main emphasis. There is a need of appropriate waste minimization or recycling technology which should be easy to operate and cost effective. As soya oil refinery effluent is non toxic and considered as a good source of organic nutrients land application of soya oil refinery effluent can be a suitable waste management. From the studies it can be concluded that the oil refining wastewater is easily amenable to chemical and biological treatment.

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