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AN OVERVIEW OF DISTILLERY SPENT WASH TREATMENT TECHNIQUES

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Abstract: Distillery spent wash is a liquid waste generated during the production of ethyl alcohol. It contains high concentrations of organic and inorganic pollutants due to which disposal of the same is a difficult task for an Environmental Engineer. Untreated spent wash disposed to the environment creates hazardous situation such as reduces soil alkalinity and increases water pollution. The treatment of distillery wastes is a priority area for the environmental sustenance. This Paper covers the overview of generation of distillery spent wash, effects on environment and treatment methods. The treatment methods are physicochemical methods, biological methods and methods given by Ministry of Environment, Forest and Climate Change (MOEFCC) and Central Pollution Control Board (CPCB) explained.

Keywords: Spent wash; spent wash generation; biological treatments; physicochemical treatments;

I. INTRODUCTION

India is a major producer of sugar and its by-products. It is one of the significant exporters of sugar in the world and contributes substantially to economic development. Production of ethyl alcohol in distilleries based on sugar cane molasses constitutes a major industry in Asia and South America. The world's total production of alcohol from cane molasses is more than 13 million m^3 /annum. Spent wash is the residual liquid waste generated during alcohol production and pollution caused by it is one of the most critical environmental issues. Despite standards imposed on effluent quality, untreated or partially treated effluent very often finds access to water courses. The distillery wastewater with its characteristic unpleasant odour poses a serious threat to the water quality in several regions around the globe. The ever increasing generation of distillery spent wash on the one hand and stringent legislative regulations of its disposal on the other has stimulated the need for developing new technologies to process this effluent efficiently and economically including plant growth and yield. It is highly acidic, deep brown in color and has high concentration of organic materials, total solids, suspended solids, chemical oxygen demand (COD) and biochemical oxygen demand (BOD). If untreated spent wash disposed into water it creates serious effects on the environment such as it will adversely effect on aquatic life, decreasing in the light penetration capacity in water bodies. High amount of BOD in the wastewater leads to the decomposition of organic matter under the anaerobic condition that produces highly objectionable products including Methane (CH_4), Ammonia (NH_3) and Hydrogen Sulphide (H_2S) gas. Also it is not suitable for drinking purpose and also corrodes the pipe line.

II. MANUFACTURING PROCESS (MOLASSES BASED)

A. Fermentation: Molasses is the chief raw material used for production of alcohol. Molasses contains about 50% total sugars, of which 30 to 33% are cane sugar and the rest are reducing sugar. During the fermentation, yeast strains of the species Saccharomyces cerevisieae, a living microorganism belonging to class fungi converts sugar present in the molasses such as sucrose or glucose in to alcohol.

B. Distillation: After fermentation, the next stage in the manufacturing process is to separate alcohol from fermented wash and to concentrate it to 95%. This is called Rectified Spirit (RS). For this purpose, method of distillation is employed. After separation of alcohol, the remaining part is the effluent of the process i.e. spent wash and spent lees.

III. TREATMENT OPTIONS OF DISTILLERY SPENTWASH

Current treatment options used to treat distillery spent wash includes physical, chemical, physicochemical and biological methods before its disposal. The selection of treatment methods depends on various factors viz. treatment efficiency, treatment cost, local geography, climate, landuse, regulatory constraints, and public acceptance of the treatment. Different treatment methodologies used to treat distillery spent includes physical, chemical, physicochemical and biological methods before its disposal. Ministry of Environment, Forest and Climate Change (MOEFCC) and Central Pollution Control Board (CPCB), had also recommended the other different technologies for spent wash treatment such as:

1. Composting
2. Ferti- irrigation and
3. One time land application
4. Biomethanation
5. Biocomposting
6. Re-boiler
7. Evaporation
8. Concentration and Incineration
9. Reverse Osmosis (RO) System

Various physicochemical methods such as adsorption, membrane, incineration, coagulation and flocculation have also been practiced for the treatment of distillery effluent. These processes are used generally after the primary anaerobic treatment in order to reduce COD and colour. These treatment technologies are discussed in detail in the following section.

A) Physicochemical Methods

Physicochemical treatment methods are used at the initial stage of effluent treatment. Various physical treatment methods currently being used in distillery wastewater treatment are screening, flow equalization mixing, flotation, and sedimentation. For chemical wastewater treatment, compound like chlorine, oxygen, ozone and permanganate are added to wastewater to oxidize the wastewater components into carbon dioxide, water, inorganic matter and other harmless products. This method is used to remove pollutants viz., colour, turbidity, TSS and COD, at low level. Some of the physicochemical treatments are explained below.

1) Adsorbent Technique

Among the physicochemical treatment methods. A number of materials have been extensively investigated as adsorbents for water pollution control. Some of the important ones include silica gel, activated alumina, zeolites and activated carbon etc. Adsorption on activated carbon (AC) is widely used for removal of colour and specific organic pollutants. The adsorbent technique is one of best method for removal of pollutants from distillery spent wash and reuses the effluent characteristics so it could be used for irrigation to reduce pressure over normal irrigation water.

2) Membrane Technique

Membrane technology cannot directly apply to treat spent wash due to high organic load. It can be done in two stages treatment viz. biological stage and membrane bioreactor (MBR) process. The bioreactor and membrane bioreactor have two functions: (i) biological degradation of organic pollution is carried out in the bioreactor by adapted microorganisms; (ii) separation of microorganisms from the treated wastewater is performed by the membrane bioreactor process. The use of membranes to separate solids and treated wastewater is the main difference between MBRs and traditional treatment plants for which the efficiency of the final clarification step depends mainly on the activated sludge settling properties.

3) Incineration

Combustion (controlled burning) of wastes in properly designed and constructed furnace to sterile ash with proper care for air pollution and water pollution is called Incineration. The prime objective of incineration is waste destruction. It is also an effective method of on-site vinasse disposal.

4) Coagulation and flocculation

Coagulation is the use of chemicals to cause pollutants to agglomerate and subsequently settle out during sedimentation. Sometimes the plain sedimentation is not a very preferred method for the removal of smaller suspended particles when particles less than 50 μm in diameter cannot be expected. However, small colloidal particles can be removed by increasing the size, and are able to settle down. The colloids are separated from each other by zeta potential between colloids having negative charges. When coagulants are added, it reduces the zeta potential which causes agglomeration of colloids and form large particles (flocks). The pollutants are also entrapped in neutralized mass, as well as it is also carried to settle by sweeping. Various types of coagulants are used in practice. Coagulants generally used are classified as: inorganic and polymers (polyelectrolyte). The three main classifications of inorganic coagulants are aluminum derivatives, iron derivatives and lime. Coagulation and flocculation processes are used for removal of suspended, inert colloidal materials in distillery spent wash.

B) Biological Methods

Biological methods are depending upon the natural growth and selection of microbes in suspended culture. Biological methods are the best option because it is more eco-friendly. End products of the treatment are acceptable to the nature. These processes require low expenditures. Some of the drawback of these treatments are slow, more uncertainty and it can be affected by weather / temperature. Organic matter can be removed by using microorganisms (mostly bacteria, fungi, actinomycetis, etc). Organics get converted to gases that escaped the system such as biogas and methane which reduce stress of fuel consumption. Biological treatment based on anaerobic and aerobic action of microorganisms to treat high pollution load from distillery effluent such as spent wash.

1) Anaerobic Treatments

Anaerobic digestion is a natural process in which various microbial works in the absence of O_2. In the anaerobic digestion process, biogas and biomass are produced, while pathogenic and indecent organic matters are reduced. It have two major benefits reduction of pollution and generation of energy. Anaerobic treatment can be done by using conventional digester, di-phasic digestion, Up flow anaerobic sludge blanket reactor, fixed bed reactor, hybrid reactor.

2) Aerobic Treatments

Aerobic digestion is a natural process in which various microbial works in the presence of O_2. Aerobic treatments can be done by using ASP (Activated Sludge Process), TF (Trickling Filter), and RBC (Rotating Biological Contactor). The major advantages of this treatment is that requires minimum time for stabilization, no bad odour, more sludge to be handle and fast in nature compared to other processes.

C) Thermal

Thermolysis involves chemical decomposition, chemical reaction to form solid and thermal precipitation, caused by heat with the help of metal catalyst (Cu++ , Fe++ , MnO, CuO ,ZnO etc) . There is no oxidation reaction of the matter. Pollutant such as heavy metals when present are also trapped in solid residues. It may be economical and a good supplement to the biochemical oxidation processes. In this process, a considerable amount of organic substrate is obtained in the form of solid precipitates, which has moderate heating values [1].

D) Electrocoagulation

Electro coagulation method is more effective method for high organic content wastewater. Chittaragi and Baykodi (2018) investigated, electro coagulation of biomethanated rejected effluent of distillery using Al-Al electrodes could be useful for treatment of spent wash. After successful implementation of method there was reduction in COD by 49.38 %, BOD by 48.14% in 3 days. After biomethanation and tertiary treatment, the effluent still contains substantial amount of organic matter and requires further treatment before its discharge to the water body. The maximum COD removal obtained using Al-Al electrodes at the optimized values of the operating parameters was 99 %. It can be concluded that the electrocoagulaton technique can be successfully employed for the treatment of distillery effluent having high organic content [4].

E) Radiation

In this method the effluent was treated using an electron beam in combination with coagulant. Ultrasound technology was also applied for the treatment of distillery effluent and the results indicated that ultrasound treatment enhanced the biodegradability of the distillery waste water [2]. They stated that ultrasound is increasingly being seen as having a potential for the use in the treatment of water, wastewater and sewage sludge. Ultrasound irradiation effectively destructs the contaminants in water because of localized high concentrations of oxidizing species such as hydroxyl radicals and hydrogen peroxide in the solution, high-localized temperatures and pressures. However, the time-scale and the dissipated power necessary to obtain complete mineralization of the pollutants in the case of ultrasound treatment are not economically acceptable. Hence ultrasound is found more effective when used in combination with other conventional treatment processes than as a stand-alone process.

F) Composting

In this method of activated bioconversion heterotrophic microorganisms act on carbonaceous materials in the aerobic pathway, depending on the availability of the organic source and the presence of inorganic materials essential for their growth. Composting is particularly effective in converting the wet materials to a usable form thereby stabilizing the organic materials and destroying the pathogenic organisms in addition to significant drying of the wet substrates. In the composting process, under aerobic conditions, thermophilic biodegradation of organic wastes at 40- 60% moisture content occurs to form relatively stable, humus-like materials [3].

G) Biomethanation

Biomethanation is very effective process for the treatment of distillery spent wash. This process includes adapting the system to treat the spent wash without any dilution. Bio Methanation System is based on the concept of conversion organic matter into biogas. The process of conversion of organic matter into bio gas occurs through a group of bacteria. It has to be carried out anaerobically, since the bacteria which produce methane gas from effluent are strictly anaerobes.

IV. CONCLUSION

1. Distillery industries produces large quantities of waste water, it is essential to treat and reuse.
2. This review paper indicates that a wide range of biological as well as physicochemical treatments, over the years for the treatment of distillery spent wash.
3. Physicochemical treatment methods are effective in both colour and COD removal.
4. UASB bioreactor is practically used for industrial and municipal wastewater treatment; recently, anaerobic filter of fixed-film digester is emerging with better performance than the other high-rate anaerobic reactors.
5. Biological aerobic treatment employing fungi and bacteria has been investigated essentially to decolorize the distillery spent wash.
6. Thermal methods are costlier but very fast than biological methods. For less quantity of waste the chemical methods are suitable.
7. Adsorption using activated carbon is better choice before treating distillery spent wash before Electro coagulation.
8. Electro coagulation is an economical method for treatment of distillery spent wash but only problem is about secondary sludge developed during EC process.
9. No single technology can be employed for absolute treatment of distillery spent wash. There is a need to use a mix of treatment options with adequate protocols and guidelines so that spent wash can be gainfully utilized for biogas generation, bio-compost, ferti-irrigation and one time land application, irrigation.
10. Developing such an extensive and effective treatment will give the triple benefit of environmental protection, energy conservation and production of high value compounds.

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