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Physical, Biological and Chemical Treatment of Distillery Spentwash: A Review

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1. Abstract

Molasses based alcohol distilleries in India are one of the most polluting industries; In addition, they are high consumers of raw water. Growing scarcity of high-quality freshwater as well as stringent regulatory standards is compelling these units to explore appropriate water management options. This report provides an overview of the water use and effluent treatment status in Indian distilleries and the challenges faced by sector. Practices adopted by progressive Indian distilleries to minimize freshwater use are illustrated through case studies. Further, the R and D focus pertaining to waste water treatment and disposal is also summarized.

2. Introduction

Industrial waste is defined as waste generated or manufactured by industrial processes. Type of industrial waste include dirt and gravel, masnory and concrete, scraplumber, scrap metal, oil, solvents, chemicals, even vegetable matter from industries. Industrial waste may be sold, liquid or gaseous. It may be hazardous or non-hazardous. Distillery waste water is of the industrial waste which is hazardous in nature. It is most polluted waste product originated from molasses-based industries, sugar mills, fermentation industries. The distillery waste water is known as spent wash [1]. It has dark brown colour [2]. This is due to presence of high molecular weighted organic compounds [3]. Molasses from sugarcane industry is commonly used as raw material in production of ethanol, due to easy availability and low cost [4]. India is second largest producer of ethanol in Asia [2]. In year 1999 India had 285 distilleries producing 2.7 $\times 10^9$ liters of alcohol. While producing 2.7 $\times 10^9$L of alcohol, 4×1010 L of waste water had been produced (record of year 1999). As per record India has 319 distilleries with capacity of 3.25 billion liters of alcohol. The number has been grown upto 4×10^{10} L waste water to produce 3.25×10^9 L of alcohol (2004) [1]. As per Ministry of Environment and Forest (MOEF), government of India, alcohol distilleries are listed at the top of "Red Category" industries generate large amount of dark brown coloured water (Spent wash) with high BOD and COD. Because of using large quantity of water in distillery, it is essential to treat and reuse their waste water possess a serious pollution threat; thus, it is mandatory for distilleries to take appropriate measures [5]. Corporate Responsibility for Environment Protection (CREP) which stipulated that distillery should achieve zero discharge in inland surface watercourses by end of 2005(CPCB) [5]. Distillery effluent has adverse effect on environment. Through this study we will come across to know various methods and techniques to handle this loss. Proper associated with disposal methods adopted by Centarl Pollution Control Board (CPCB).

3. Characteristics of Distillery Spentwash

Distillery waste is the industrial hazardous waste. Distillery waste water is is one of the most polluted waste products to dispose because of the low PH, high temperature. Dark brown colour, high ash content and high percentage of dissolved organic and inorganic matter with high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values. Distillery waste water is also known as spent wash.

Table 1: Typical characteristics of spentwash

Parameters	Spentwash
Colour	Dark Brown
PH	4 – 4.5
Alkanity (mg/L)	3,500
Total Solids	10,00,000
BOD	45,000 – 60,000
Odour	Unpleasent Burnt Sugar
COD	80,000 – 1,20,000

4. Effect of Distillery Effluent

The watse distillery water discharged from factories can pollute lakes and rivers with substances like chemicals and dyes. This water pollution can kill the wild life and harm the overall ecosystem. And the effects of polluted water have left several plants and animal species endangered. Its direct disposal into environment is hazardous and has high potential of pollution [2]. The highly coloured components of the effluent can block out sunlight in the water bodies which in turn decrease both photosynthetic activity and dissolved oxygen concentration affecting aquatic life [6]. Distillery effluent disposed onland is equally hazardous to the vegetation [5]. Raw distillery effluent is highly toxic effect on the growth and germination of seed even at low concentration [7]. It also affects the ground water quality if it is disposed without proper monitoring. The molasses effluent that is disposed in canals or rivers produces obnoxious smell [8]. The unpleasant odor of the effluent is due to presence of putriciable organics like skatole, indole and other sulphur compounds [9]. These compounds have antioxidant properties, which render them toxic to many microorganisms such as those typically present in wastewater treatment process [10].

5. Treatment

Waste water treatment methods aim at the removal of unwanted compound in waste water for safe discharge into environment [2]. This waste water is globally treated with various treatments. This can be achieved by using physical, chemical and biological treatments.

5. 1. Physico - Chemical Treatment Technology for Distillery Waste Water

Removal of melanoidin from distillery effluent has been attempted, but with a limited success so far [11, 12]. Physiochemical treatment process such as adsorption, oxidation process, coagulation and flocculation are used for removal of melanoidins. This method has disadvantage. This method is high-cost technology. Physico-chemical treatment method is effective in both color and COD removal. Nevertheless, the drawbacks associated with these methods are excess use of chemicals, sludge generation with subsequent disposal problem, high operational cost and sensitivity to variable water input [13].

5.1.1. Adsorption

Activated carbon is a well-known adsorbent due to its extended surface area, microporous structure, high adsorption capacity and high degree of reactively. This helps to remove colour and specific organic pollutants [2]. Adsorption by commercially available powered activated carbons resulted in only 18% color removal, combined treatment using coagulation – flocculation with polyelectolyte followed by adsorption resulted in almost complete decolourization [14].

5.1.2 Coagulation and Flocculation

In this method coagulants are used to remove the disturbed contents [2]. Almost complete color removal (98%) of biologically treated distillery effluent has been reported with conventional coagulants such as ferrous sulfate, ferric sulfate and alum under alkaline conditions [15]. Coagulation studies on distillery effluent after aerobic – anaerobic treatment have also been conducted using bleaching powder followed by aluminum sulfate [16].

5.1.3 Oxidation

A combination of wet air and adsorption has been successfully used to demonstrate the removal of sulfates from distillery wastewater [2]. Wet air oxidation has been recommended as a part of a combined process scheme for treating an-aerobically digested spent wash [17].

Physico - chemical treatment methods are effective in both colour and COD removal. Considering the advantages and disadvantages of technologies, no single method can be used for removal of molasses waste water.

5. 2. Biological / Microbial Treatment

This treatment is proceeded with use of microorganisms because of their inherent capacity of metabolize a variety. Anaerobic treatment, activated sludge process, phytoremediation [2]. Pure bacterial culture for microbial treatment has been reported frequently in past and recent years. Under aerobic condition Bacillus sp. has been decolorize molasses wastewater up to 35.5% within 20 days at 55°C [1].

5.2.1 Anaerobic Treatment

The high organic content of molasses wastewater makes anaerobic treatment attractive in comparison to direct aerobic treatment. Molasses wastewater treatment using anaerobic process is a very re-emerging technology which presents interesting advantages as compared to classic aerobic treatment. In the process methane and carbon dioxide are generated [18]. This procedure produces very little sludge, requires less energy and can be successfully operated at a high loading rate; also, the biogas thus generated can be utilized for energy demands of the unit [19]. Further, low nutrient requirement and stabilized sludge production are other associated benefits [20].

5.2.2 Aerobic Treatment

Anaerobically treated distillery wastewater still contains high concentration of organic pollutants and then cannot be discharged directly. The partially treated spent wash has high BOD, COD and suspended solids. Therefore, aerobic treatment of sugarcane molasses wastewater has been mainly attempted for decolorization of the major colorant, melanoidins, and for reduction of COD and BOD [2].

5.2.3 Fungal Treatment

In recent years, several basidiomycetes and ascomycetes type fungi have been used in the decolorization of natural and synthetic melanoidin in connection with colour reduction of wastewaters from distilleries. The fungus has capability to purify the effluent by consumption of organic substances, thus reducing its COD and BOD, and at the same time to obtain some valuable product, such as fungal biomass for protein – rich animal feed or some specific fungal metabolite [1].

5.3. Potential Enzymatic Treatment

Although the enzymatic system is related with decolrization of melanodins is yet to be completely understood, and it seems greatly connected with fungal ligninoltic mechanisms. Decolourization by microbial methods includes the enzymatic breakdown of melanoidin and flocculation by microbially secreted substances [21].

5.4. Microbial Consortium Treatment

During last two decades, several attempts have been made to investigate the possibility of using cell immobilization in the technology of aerobic wastewater treatment [22–23]. A decolourization of 69% was obtained using 10% (w/v) soil and 12.5% (w/v) MSW after 7 days incubation.

Decolourization molasses spentwash in absence of any additional carbon or nitrogen source as inoculum. Proper treatments can reduce the effect of the distillery waste water. Production of alcohol and ethenol can possible through molasses-based distillery waste water.

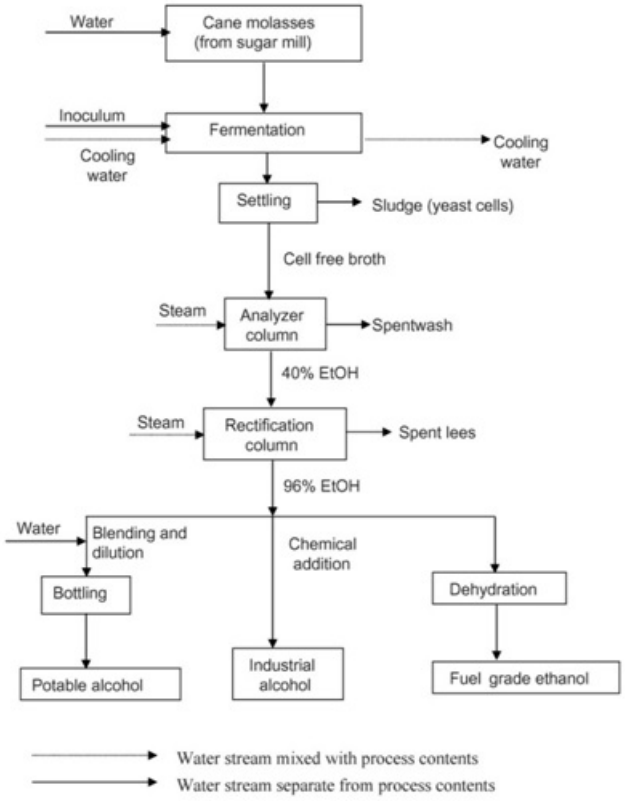

Figure 1: Distillery Spent wash process chart

6. Advantage

Using proper treatment modes, the danger from this waste water can be lowered to an extent. Biogas can be produced through this industrial waste.

Molasses based distillery waste water can produce alcohol and ethanol. Treatments can reduce the characteristics of the waste water, that it can be disposed directly.

Biological treatments are affordable to carry out operations for the waste water and reuse it.

7. Conclusion

The distillery waste water has many adverse effects on surrounding environment. By proper treatments and methods this can be control to a certain limit. This waste water contains low PH, high acidity which can be removed by number of biologica and physical

treatment technology. There are several initiatives being followed by Indian distilleries to minimize their water consumption and use it get energy in the form of biogas after digestion process.

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