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An Analysis upon Impact of Distillery Industry Effluent on Environment

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Abstract – Growing industrial establishments can results in hazards on the local environment in the city if proper attention is not paid. One of the major pollution sources is Distillery effluent. The Distillery industries are rapidly expanding in sub metropolitan cities. They discharge their untreated wastes directly into the natural environments which cause various adverse effects on soil, water, air and health. It also affects the farm animals. They drink it and resulted in increased livestock mortality, poor health, and reduced milk yield. Even the human beings lived in Distillery Effluent Polluted Area are affected by skin allergies, headache, vomiting sensation, irritating eyes, fever and stomach pain. This kind of water have dissolved impurities like carbonate, bicarbonate, sulphate , chloride of Calcium , Magnesium , Iron, Sodium & Potassium and colloidal impurities like coloring matter, organic waste ,finely divided, silica & clay. In the present paper, chemical analysis of Distillery effluent and its impact on environment are discussed.. It is analyzed that distillery industry produces a huge amount of wastewater which is highly polluted and having very high Chemical & Biological Oxygen Demand (COD and BOD), dark brown reddish color and have high load of organic matter, when discharge into natural water bodies, causes severe environmental pollution. Some of the contaminants, such as certain level of minerals or compounds are not only harmful to health, but also create a long term effects.

India is the fourth largest producer of ethanol in the world and the second largest in Asia. Though, the alcohol production from starchy material is also practiced in India but on a very limited scale, most of the Indian distilleries use sugarcane molasses as raw material. Distillery ranks as the top most industry among the list of 17 heavily polluting industries identified by Ministry of Environment & Forests, Govt. of India.

The present study was conducted to find out the economic pollution reduction technique of distillery effluent that possesses a serious environmental problem. The distillery effluent is generally highly acidic (pH 3.8 - 4.4) with high rates of BOD 45000- 60000 mg/l & COD 70000 – 98000 mg/l and also suspended solids (2000 -14000 mg/l). Currently different treatment techniques are used to treat distillery effluent which includes fungal treatment, adsorption techniques, Electro sorption, filtration, biological treatment, etc. but no treatment method alone give the desired goal to treat the distillery effluent effectively and efficiently therefore further research study in this area should be carried out to prevent surface and ground water pollution.

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INTRODUCTION

Two major resources are water and air, which get polluted in one way or other. Water amongst these is of prime importance. Due to the fact that an estimated almost all diseases in developing countries are directly due to unsafe drinking water. Distillery industries are the agro-based industries with high organic and inorganic contents which are high strength wastes and difficult to dispose. Ethanol produces as a byproduct in the distilleries, create a great destruction of natural and human resources. Cane molasses also contains trace amount of dark brown pigment called melanoidins that impart color to the spent wash. Alcohol manufacture in distilleries consists of four main steps viz. feed preparation, fermentation, and distillation and packaging. Distillation step is the main source of wastewater generation, where the large volumes of dark brown effluent (termed as spent wash, stillage, slop or vinasse) is generated at the temperature range of 71–81°C. The spent wash is acidic and loaded with organic and inorganic salts, resulting in high electrical conductivity(EC). Distillery industry produces a huge amount of wastewater as calculated even after some ordinary treatment method. The effluted water is highly polluted and

having very high Chemical & Biological oxygen demand (COD and BOD), heavy load of organic matter, color and odour of the effluent is dark brown reddish color with unpleasant odour of Indole , Sketol and other sulphur compounds. The temperature of distillery effluent is about 25°C.

The pH value of the distillery effluent is alkaline and when discharge into natural water bodies, causes severe environmental pollution. This causes the declination in plant growth and crop growth.Besides the above pollutant, the distillery wastewater also has high amount of Potassium, Phosphorus & Sulphate content. In addition, spent wash contains low molecular weight compounds such as lactic acid, glycerol, ethanol and acetic acid& also contain small amount of heavy metals in water bodies causes several health problems. Heavy metals e.g. Hg, Cd, Cr can accumulate and they enter in food chain and biomagnifies to toxic level. Due to the increased pollution that arises from distillery effluent, there is the loss of soil fertility, loss of interaction within livestock and agriculture and biodiversity loss. Use of such water for irrigation purpose produces both beneficial and damaging effects on various crops and including vegetables. High BOD, COD and other organic compounds like phenols, lignin and oil and greases in spent wash are likely to deteriorate soil and environmental health .It also effect seed germination, speed of germination, peak value & germination value of wheat, pea plant & ladyfinger. Germination percentage decreases with the concentration of effluent they have bad effect on livestock's health, Farmer's health and soil fertility. Due to the effluent groundwater quality also depleted day by day. Distillery Effluent Polluted Area that can lead to eutrophication of water bodies.

Further, its dark color hinders photosynthesis by blocking sunlight and is therefore deleterious to aquatic life. Wastewater can cause soil sodicity, salinity, contamination with a wide range of chemicals, water logging and an aerobiosis, loss of soil structure and increased susceptibility to erosion.

Water is one of the most important compounds required for every existing of life therefore adequate supply of fresh and clean water is a basic need for all human beings but According to the Natural Environmental Engineering and Research Institution (NEERI) Nagpur about 70% of all available water in India is polluted and therefore two third of all ailments in India such as Typhoid, Jaundice, Cholera, Diarrhea and Dysentery system is caused by contaminated water. These water borne diseases claims 1.5 million lives in India every year, which means three people die every 10 minutes due to contaminated water. The fact behind this is rapid industrialization which is one of the major causes of water pollution. The discharges of untreated and partially treated wastewater from various industries like chemical, pesticides, fertilizer, pulp and paper and sugar, etc., have polluted the aquatic bodies such as a river, pond and ditches.

Alcohol production from sugarcane molasses is an important distillery industry posses a high load of water pollution. In India there are around 295 distilleries with a total installed capacity of 3198 million liters per annum and a current yearly production of 1587 million liters alcohols. Liquid wastes from breweries and distilleries possess a characteristically high pollution load and have continued to pose a critical problem of environmental pollution. The high temperature of the waste waters may instantaneously kill fish and other aquatic organisms, thus destroying the flora and fauna of a river, when the wastewater is discharged into it. The spent wash generated is highly Acidic in nature (pH 4.0-4.3), Due to decomposition of soluble and suspended organic matters present in the wastewaters, high BOD (Biochemical Oxygen Demand) (45000-60000 ml/l) and COD (Chemical Oxygen Demand) (750000-98000 mg/l) of the wastewaters results, causing rapid depletion of the oxygen content of the water, thus creating a foul smell. This required that the effluents of the distillery are either treated or utilized profitably.

India produces about 2.75 billion litres of alcohol annually. The demand for potable alcohol has been ever increasing with the more liberal attitude, rising middle class (disposable income) and less taboo/stigma in Indian society. Though practiced all across the globe, the use of alcohol as blend in motor fuel was not permitted in India till recently, which resulted in under-capacity utilization of distillation facility. Due to government promoting ethanol to mix in petrol there will be drastic demand for ethanol, which could overcome the existing unutilized capacity and thus creating an excess demand. Spentwash generated from distillation process has very high pollution potential. Distillery spentwash is not only high on organic and inorganic loading, but also having dark brown colour even after bio-methanation. In some parts, where land application of distillery wastewater is practiced, the colour problem in groundwater is so acute that distilleries have to provide potable water to surrounding villages. Many physico-chemical and biological methods for the removal of colour from distillery spentwash were tried, but a cost effective and efficient treatment method is still awaited.

Healthy environment is of primary requirement for not just human beings but also for animals and plants and therefore, it should be held as sacred trust and it should be conserved and improved for the well being of present and future generations. Water pollution is defined as "anything causing or inducing objectionable conditions in any water source and affecting adversely, any use or usage to which the water there of may be put." Distillery industries are the agro-based industries with high organic and inorganic contains which are high strength based and difficult to disposed. Ethanol produces as high products in the distillery. Now a day's distillery Industry is the major source of water pollution. Basically distillery industry is related with fermentation

industry which is a biological process in which micro-organism to produce different types of alcoholic products. In distillery industry mainly wine, alcohol is produced the production capacity of this industry varies from thousands of lit/day.

The products which are obtain from distillery industry they will support several other industry like solvent for paint industry, sterilizing and antiseptic agent for medicines and hospitals, flavor enhancement for food industry, backing industry.

Distillery industry is unique because it uses several waste products and the products of this industry are used in several other industries but still this industry has adverse effect on environment. The products of distillery industry are may be molasses or nonmolasses waste which are formed by fermentation process. If distillery industry uses molasses then its waste contain large amount of organic and inorganic when it mix with water then it causes water pollution.

The waste which is obtained from distillery industry when it mix with water then it will have extremely high BOD value and high COD, high chlorides and sulphates, dissolved solids, brown reddish colour with bad odour.

In India nearly about 200 distillery industries present which releases a thousand liter of waste, such huge amount of waste will cause serious hazard to environment, hence treatment of distillery waste should be essential. By proper treatment of effluent we can reduce the organic pollution in water up to some extent.

GROWTH OF INDIAN DISTILLERY INDUSTRY

The First distillery in the country was set up at Crwnpore (Kanpur) in 1805 by Carew & Co. Ltd., for manufacture of Rum for the army. The technique of fermentation, distillation and blending of alcoholic beverages was developed in India on the lines of practices adopted overseas particularly in Europe.

Distilleries manufacture rectified spirit and extra neutral alcohol for human consumption and for industrial utilization. The distillery industry today consists broadly of two parts, potable liquor and the industrial alcohol. The potable distillery producing Indian Made Foreign Liquor and Country Liquor has a steady but limited demand with a growth rate of about 7-10 per cent per annum. The industrial alcohol industry on the other hand, is showing a declining trend because of high price of Molasses which is invariantly used as substrate for production of alcohol. The alcohol produced is now being utilized in the ratio of approximately 52 per cent for potable and the balance 48 percent for industrial use. Apart from its use for beverage, medicinal, pharmaceutical and flavouring, alcohol constitutes the feedstock for large number of organic chemicals, which are used in manufacturing a wide variety of intermediates, drugs, rubber, pesticides, solvents etc.. with the advent of ethanol blending with petrol/ motor fuel, the requirement of ethanol/ industrial alcohol has increased manifold in the country to the extent that in case 5 % blending, if made mandatory all over the country, the sugar factory molasses available in the country shall not prove to be adequate for meeting the total requirement of ethanol including its use for potable liquors and other industrial uses. However, the notification no.G.S.R.705(E) dated 27th October, 2004, Ministry of Petroleum and Natural Gas, Government of India, mandates that 5% ethanol-blended petrol (E5), conforming to Bureau of Indian Standards specifications, shall be sold in the following ten states *viz.* Andhra Pradesh (except Chittor and Nellore districts); Goa; Gujarat; Haryana; Karnataka; Maharashtra; Punjab; Tamil Nadu (only in districts of Coimbatore, Dindigul, Erode, Kanayakumari, Nilgiri, Ramanathpuram, Tirunelveli, Tuticorin and Virudhunagar); Uttar Pradesh; and Uttaranchal and the following three union territories *viz.* Daman and Diu; Dadra and Nagar Haveli; and Chandigarh. It is also stipulated that government may extend above notification to all states and union territories in phase 2, and enhance the percentage of ethanol in the ethanol blended petrol from 5% to 10% in phase 3 (MoPNG, 2008). Due to government promoting ethanol to mix in petrol there will be drastic demand for ethanol, which could overcome the existing unutilized capacity and thus creating an excess demand. For example, according to the estimates prepared by the Ministry of Petroleum and Natural Gas, about 410 million litres of anhydrous ethanol (conforming to IS 321: 1964) shall be required to implement 5% blending in the above-mentioned 10 notified states.

Looking to its wide use, it can be inferred that the demand for alcohol is likely to increase in the country and so is the number of distilleries producing alcohol. All India Distillers Association (AIDA) and Ethanol India are predicting the birth of many new distilleries along with major expansion in capacity of existing distilleries (AIDA, 2008; Ethanol India, 2008).

IMPACT OF DISTILLERY EFFLUENT ON ENVIRONMENT

1. Discharge of wastewater with high TDS would have an adverse impact on aquatic life and to make unsuitable water for drinking purposes, if used for irrigation reduce the crop yield, corrosion in the water system and pipeline.

2. Suspended solids in wastewater reduce the light penetration and plant production as a

result, in receiving water by increasing turbidity it can also clog the fish gills.

3. 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 (CH4), Ammonia (NH3), and Hydrogen Sulphide (H2S) gas.

4. Low Dissolved Oxygen (DO) in water bodies affect the aquatic life as DO drops fish and other species are threatened and may get killed.

5. Fall in DO levels causes undesirable odors, tastes and reduce the acceptability of water for domestic purpose.

6. In steam generation, DO is one of the most important factors causing corrosion of the boiler material.

7. Generally, industrial wastewater changes pH level of the receiving water body. Such changes can affect the ecological aquatic system; excessive acidity particularly can result in the release of hydrogen sulphide (H2S) to air.

8. The alkaline nature of wastewater causes declination in plant growth and crop growth.

9. Color and odor of the effluent of the distillery were red brown in color with the unpleasant odor of Indol, Sketol and other sulphur compounds.

10. Spent wash is a complex, multi component stream that is known to cause considerable fouling.

IMPACT OF DISTILLERY INDUSTRY EFFLUENT ON FERTILITY OF SOIL AND CROPS

Environmental pollution caused by the release of a wide range of compounds as a consequence of industrialization has assumed serious proportions (Jain et al., 2005). All the industries consume huge quantity of water and throw back almost an equal quantity of effluent which contains highly toxic materials in dissolved or suspended form (Kolhe et al., 2008). Water pollution disturbs the natural balance of ecosystem inside, resulting in the death of various aquatic species. Moreover, it also reduces the potential of water as a resource for the various uses. This is because pollution causes the water to become unsuitable for various uses and also difficult and more expensive to treat to accept quality for use. Aquatic organisms, including fish, accumulate pollutants directly from contaminated water and indirectly via food chain. Various kinds of pollutants build up in food chain and are responsible for adverse effects and death in the aquatic organisms. Fish are widely used to evaluate the health of aquatic ecosystem and physiological changes serve as biomarkers of environmental pollution (Camargo and Martinez, 2007). Moreover, certain insects and plankton species are recognized as bio-indicator species of aquatic pollution.

Distillery industries are high income paid as well as high pollution loaded industry. The ethanol produced from molasses which comes out from sugarcane industry waste. In distillery industry processing, cleaning the floor, cooling water and spend wash around 60 to 100 liters of waste water generated to produce 1 liters of alcohol. The raw spent wash generated after fermentation and distillation is acidic in nature having dark brown colour with unpleasant odour, high COD and BOD (1,00,000 and 45,000 mg/l) as well as high dissolved and suspended solid. Spentwash as a distillery waste is posing disposal problem. Regular application of distillery effluent may affect soil physical and chemical properties viz., infiltration rate, hydraulic conductivity, water retention capacity, electrical conductivity, pH, availability of nutrients and also results in adverse effects on microbial biomass and population which might alter the fertility status of the soil. The various metallic and nonmetallic elements act as nutrients but at the higher concentration they show toxic effects on seed germination and seedling growth, ultimately adversely affecting plant growth and yield. Om et al. (1994), while studying the combined effect of different concentrations of wastes of distillery and sugar mill, observed inhibition of seed germination, seedling growth and biomass in okra (Abelmoschus esculentus L.). In the distillery effluent, various metals/nonmetals individually may not be toxic to the plant but in combination they may be toxic. On the other hand Zalawadia et al. (1996) studied the inhibitory effect of distillery effluent in combination with fertilizer on plants as well as on soil properties. Experiments conducted by Dutta and Boissya (1999) for studying the effect of low concentration of paper mill effluent on growth and field

S.No	Parameters	Parameter
1	Color	Brown
2	Odure	alcoholic
3	pH	3.5
4	DO	1.5
5	BOD	5970mg/l
6	COD	3682 mg/l
7	Oil and Grease	12mg/l
8	Temperature	80°C
9	Electrical Conductivity	2.23Scm^{-1}
10	Total dissolved Solid	1480 mg/l
11	Suspended Solid	790
12	Dissolved Solid	1650
13	Chloride	250
14	Calcium	261 mg/l
15	Magnesium	68 mg/l
16	Sulphate	419 mg/l
17	Iron	2.8 mg/l
18	Lead	0.065 mg/l
19	Zinc	0.26 mg/l
20	Copper	0.135 mg/l
21	Potassium	113 mg/l
22	Phosphate	4.9mg/l

Table 1: Average physicochemical parameter of distillery industry waste water.

NPK contents in rice showed increase in growth and yield of crop. The time has come to look back to time tested effect of polluted water on the crops. One thing is certain that crops grown with wastewater are healthy and beneficial since they recharge the soil. Billions of microorganisms are activated in healthy soil for the benefit of the farming community. Some time waste water acts as a good soil conditioner and improves the physical, chemical and biological properties of the soil. The regular and untreated discharges distillery industry effects the crops growth and also effect the fertility and productivity of soil.

METHODOLOGY

Sample of wastewater was collected in a clean glass or plastic container (the lid, seal and bottle was rinsed with boiling water before use) and stored below 4°C at the point where it is discharged into the holding dam as agreed with the managers and proprietors, the name/addresses of the studied distillery plant is not disclosed in this paper. Sampling was done at the interval of 2 hours start at 9:00 am to 5:00 pm. Standard procedure for chemical analysis of sample were used.

RESULT -

The effluent taken from various sites of distillery at different times are analyzed. The value of DO, COD & BOD was determined by volumetric analysis and a graph was plotted between times of sample collection and concentration in ppm. The plot is a zig – zag line which means that effluent varies with the time period. Effluent water is found to be highly polluted and having very high Chemical & Biological Oxygen Demand (COD and BOD), dark brown reddish color and have high load of organic. When discharge into natural water bodies, causes severe environmental pollution and produce adverse effect. Some of the contaminants, such as certain level of minerals or compounds are not harmful to health, even create a long term effects. Color and odour of the effluent of distillery was red brown in color with unpleasant odor of Indol, Sketol and other sulphur compounds. Temperature of distillery effluent was about 25°C. The average pH value of the distillery effluent was 8.3. It means all samples are alkaline in nature and high pH causes declination in growth plant and crop growth. So, treatment must be needed, before discharge the effluent in water bodies. pH must be balanced otherwise highly alkaline water create large pollution. Treated effluent could be used for agricultural purpose. The range of Dissolved Oxygen in the distillery effluent was around 0.2; meanwhile the recommended BIS range is 4 - 6. The absence of D.O. is possibly due to high organic load. The value of BOD in distillery effluent was around 545 ppm and the recommended value of BIS is about 30. This indicates high organic load. Similar effect was seen on COD level, the COD value of the Distillery effluent was around 2402 mg/l while the recommended level by BIS is 250 only; this high amount is due to high organic load. BIS recommended total solid in distillery effluent in the range of 100 ppm the average value came out ~257.

S. No.	Parameter	Sample 1	Sample 2	Sample3	Sample4	Sample5
1.	T ° C	25.51	25.62	24.59	24.63	24.55
2.	Color	Reddish	Reddish	Reddish	Reddish	Reddish
3.	pH	8.01	7.70	7.42	8.41	8.43
4.	D.O.(ppm)	0.1032	0.2064	0.4128	0.1032	0.2064
5.	B.O.D.(ppm)	546	534	552	540	564
6.	C.O.D.(ppm)	2396	2400	2408	2400	2404
7.	T.S.(ppm)	5000	5040	4720	4992	5088
8.	T.S.S.(ppm)	300	310	250	260	310

Table-2 Chemical analysis of Effluent Sample.

CONCLUSION

Distillery industry plays an important role for us and several products we obtain from it , but due to excessive use of its products large scale production is required. To meet this huge demand large scale industrial setup is must which results in excessive amount of waste effluent which is not properly treated and directly drained out to water sources which hazardously affecting the quality of water hence to overcome this problem treatment of waste effluent from distillery industry is must required.

The characteristic of spent wash do not allow its discharge into a water body, hence it requires treatment. Biological treatment, especially with pure cultures, appears promising and possibly cost-effective for color removal; however, the initiatives are mainly confined to laboratory trials. Adsorbents like activated carbon that result in almost complete decolonization are not cost effective for treating the enormous volumes of spent wash typically generated in a distillery.

Thus, there is scope for examining low cost adsorbents, including wastes generated in other industrial processes / operations. The production of distillery must be incorporated in the design to accommodate the increased amount of effluent. Extensive research has been conceded out on healing of distillery wastes in many parts of the world. Effluent in an organic nutrient solution, it has a wide spectrum of utility. There have been some attempts to use spent wash as substrate for yeast growth or for biochemical production.

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