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Potential Impacts of Sugarcane based Distillery Effluent on Public Health

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ABSTRACT

Distilleries are the main source of water pollution due to presence of number of pollutants like total hardness, total dissolved salts, biological oxygen demand and chemical oxygen demand and heavy metals into their effluents. There are about 295 distilleries in India mostly situated in Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu, Gujarat and Madhya Pradesh. In India, about 15,000 million liters of spent wash is produced annually. Molasses a by-product of sugar industry is used as a raw material by most of distilleries for production of ethanol by fermentation and distillation processes. The distillery effluent being rich in organic, inorganic as well as volatile material causes deterioration of ground water resources and surface water resources. The toxic materials present in spent wash discharged by distillery categorized as one of the highly polluting industry, enter into food chain due to percolation through soil and irrigation water causing health complications to the human-beings. Spent wash is hydrophilic viscous liquid waste with strong objectionable odor. Molasses based spent wash is highly recalcitrant waste product because of its melanoidin content which is a polymer formed by maillard aminocarbonyl reaction. The disposal of spent wash has becomes a major problem because of the ground water contamination but fresh and marine water pollution is gradually becoming a major threat. The water quality and human health are closely related. The water causes 75% of diseases to the human beings. It is estimated by World Health Organization (WHO) that the 2000 million people in the developing countries along-with India do not have access to safe drinking water, which is the cause of spreading of water borne diseases such as diarrhea and gastroenteritis. One distinct feature of spent wash is the high content of potassium salts which obviously originates from the cane sugar being rich in potash content. According to a study carried out by Muhammad Tariq Mahar et.al the presence of heavy metals in spent wash such as Cu, Cd, Cr, Co, Mn, Pb, Zn, Fe and As was observed higher than NEQS for industrial effluent whereas Tewari N et.al has studied the

removal of heavy metals such as Cu, Zn, Fe by using the natural adsorbents by comparative analysis. This warrants to espouse the safe and effective means of effluent treatment to fulfill both practical necessity and a corporate social responsibility for ensuring the prevention of public health and to contribute in accomplishing the Zero Liquid Discharge Target.

Keywords: Distillery Effluent, Public health, molasses, melanoidin, Zero Liquid Discharge.

INTRODUCTION

Distilleries are the main source of water pollution due to presence of number of pollutants like total hardness, total dissolved salts, biological oxygen demand and chemical oxygen demand and heavy metals into their effluents. There are about 295 distilleries in India mostly situated in Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu, Gujarat and Madhya Pradesh. In India, about 15,000 million liters of spent wash is produced annually. Molasses a by-product of sugar industry is used as a raw material by most of distilleries for production of ethanol by fermentation and distillation processes. The molasses contains about 40-50% sugar, which is diluted to bring sugar contents to 10-15% or 20-25^0 Brix for further fermentation process (Binkley and Wolfrom, 1983) Utilization of molasses for the production of ethanol in India will not only provide value-addition to the byproduct, it can also ensure better price stability and price realization of molasses for the sugar mills. This will improve the viability of the sugar mills, which will in turn benefit cane growers.

The process of fermentation and distillation is majorly responsible in release of recalcitrant spent wash. The distillery effluent being rich in organic, inorganic as well as volatile material causes deterioration of ground water resources and surface water resources. The toxic materials present in spent wash discharged by distillery categorized as one of the highly polluting industry, enter into food chain due to percolation through soil and irrigation water causing health complications to the human-beings.

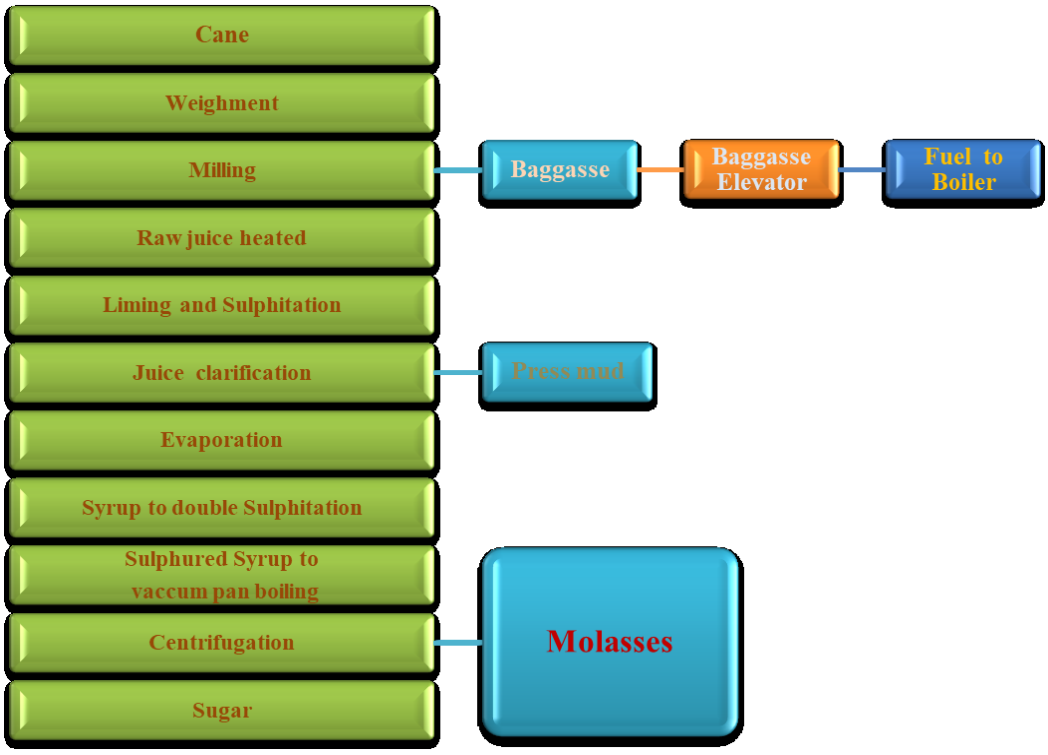

Fig.1 : Stages involved in the Sugar manufacturing Process

Spent wash is hydrophilic viscous liquid waste with strong objectionable odor (Chavan MN et al. July 2006). Molasses spent wash is highly recalcitrant waste product because of its melanoidin content which is a polymer formed by maillard aminocarbonyl reaction (Khandegar V 2012). The disposal of spenwash has become a major problem because of the ground water contamination but fresh and marine water pollution is gradually becoming a major threat (Binkley WA 1983). The awful dark brown color of distillery waste is due to molasses and tannins and most importantly due to formation of non–colored sugar like caramels, and decomposition product such as hydroxyl methyl furfural, colloidal nature of caramels and melanoidins. The characteristics of distillery spent wash depend on the quality of the feed stocks and the various aspects of the ethanol production process (Khuhawar MY et.al. 2011).

One distinct feature of spent wash is the high content of potassium salts which obviously originates from the cane sugar being rich in potash content. According to a study carried out by Muhammad Tariq Mahar et.al the presence of heavy metals in spent wash such as Cu, Cd, Cr, Co, Mn, Pb, Zn, Fe and As was observed higher than NEQS for industrial effluent whereas Tewari N et.al has studied the removal of heavy metals such as Cu, Zn, Fe by using the natural adsorbents by comparative analysis.

This warrants to espouse the safe and effective means of effluent treatment to fulfill both practical necessity and a corporate social responsibility for ensuring the prevention of public health and to contribute in accomplishing the Zero Liquid Discharge Target.

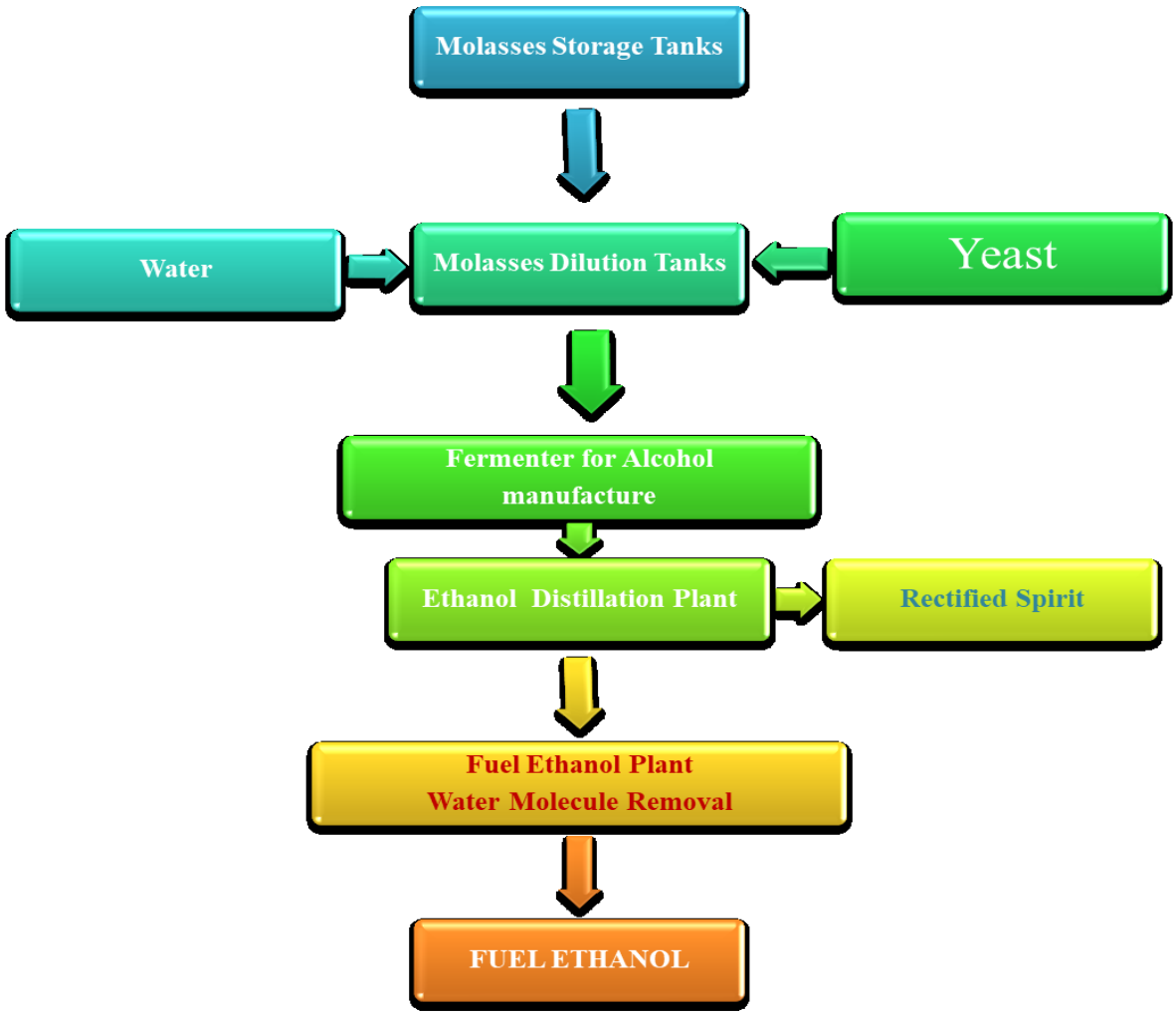

Fig. 2: Ethanol Manufacturing Process Flow Chart

Table 1: Typical Characteristics of spent wash from various types of manufacturing process

S. NO.	PARAMETER	BATCH PROCESS	CONTINUOUS PROCESS	BIO-STILL PROCESS
1	Volume L/L alcohol	14-15	10-12	7-9
2	Color	Dark brown	Dark brown	Dark brown
3	pH	3.7-4.5	4.0-4.3	4.0-4.2
4	COD mg/L	80000-100000	110000-130000	140000-160000
5	BOD mg/L	45000-50000	55000-65000	60000-70000
6	Solids			
	Total	90000-120000	130000-160000	160000-210000
	Total Volatile mg/L	60000-70000	60000-75000	80000-90000
	Inorganic dissolved mg/L	30000-40000	35000-45000	60000-90000
7	Chlorides mg/L	5000-6000	6000-7500	10000-12000
8	Sulphates mg/L	4000-8000	4500-8500	8000-10000
9	Total Nitrogen mg/L	1000-1200	1000-1400	2000-2500
10	Potassium mg/L	8000-12000	10000-14000	20000-22000
11	Phosphorus mg/L	200-300	300-500	1600-2000
12	Sodium mg/L	400-600	1400-1500	1200-1500
13	Calcium mg/L	2000-3500	4500-6000	5000-5600

Source : *Technical EIA Guidance Manual for Distillery Industry September 2009, Draft report prepared on "Development of Methodology for Environmental Auditing" by Dr. B. Subba Rao of EPRF, Sangli, for CPCB.*

Public Health

Public health is "the science and art of preventing disease, prolonging life and promoting health through the organized efforts and informed choices of society, organizations, public and private, communities and individuals." (Winslow, 1920). The dimensions of health can encompass "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"(What is Public Health 2017). Public health incorporates the interdisciplinary approaches of epidemiology, biostatistics and health services, environmental health, community health, behavioral health, health economics, public policy, insurance medicine and occupational health (respectively occupational medicine) are important subfields (Community health Pages).

The water quality and human health are closely related. The water causes 75% of diseases to the human beings. It is estimated by World Health Organization (WHO) that the 2000 million people in the developing countries along-with India do not have access to safe drinking water, which is the cause of spreading of water borne diseases such as diarrhoea and gastroenteritis.

The study of Potential Public health impacts involves following stages :

- Identification : of probable health hazards, source of pollutants
- Quantification : Consequence analysis to assess the impacts
- Evaluation : seriousness of health impacts, acute or chronic

The harmful effects on human body depending on the physico-chemical characteristics of water are summarized below:

Table 2: Effect of Polluted Water on Human Health

PARAMETERS	PROBABLE HEALTH EFFECTS
Colour	Makes water aesthetically undesirable
Odour	Makes water aesthetically undesirable
Taste	Makes water aesthetically undesirable
Turbidity	High turbidity increases contamination/pollution
pH	Indicative of acidic or alkaline waters, affects taste and corrode water supply system
Hardness	Affects water supply system (scaling), excessive soap consumption, calcification of arteries, may cause urinary concretions, diseases of kidney or bladder and stomach disorder
Iron (Fe)	Gives bitter-sweet astringent taste causes staining of laundry and porcelain. In traces it is essential for nutrition

Chloride (Cl)	May be injurious to some people suffering from diseases of hearts and kidneys. Taste, indigestion, corrosion and palatability are affected
Total Dissolved Solids (TDS)	Palatability decreases and may cause gastro-intestinal irritation in human, may have laxative effect particularly upon transits
Calcium (Ca)	Insufficiency causes severe rickets; excess causes concretions in the body such as kidney or bladder stones and irritation in urinary passages. Essential for nervous and muscular system, cardiac functions and in coagulation of blood
Magnesium (Mg)	Its salts are cathartic and diuretic. High concentration may cause laxative effect particularly on new users. Mg deficiency is associated with structural and functional changes. It is essential as an activator of many enzyme systems
Copper (Cu)	Astringent taste but essential element in human metabolism. Deficiency results in nutritional anemia in infants. Large amount may result in liver damage, cause CNS irritation and depression. In water supply system, it enhances corrosion of aluminum particular
Sulphate (SO_4)	Causes gastro intestinal irritation with Mg or Na can have a cathartic effect on users. Conc. more than 750 mg/L along with Mg may have laxative effect
Nitrate (NO_3)	Causes infant methaemoglobinaemia (Blue Babies) at very high conc., causes gastric cancer and adversely affects CNS and cardiovascular system
Flouride (F)	Reduces dental carries, very high concentration may cause crippling skeletal fluorosis. Less than 1.0 mg/L is essential
Cadmium (Cd)	Acute toxicity may be associated with renal, arterial hypertension, itai-itai disease. Cd salts cause cramps, nausea, vomiting and diarrhea
Lead (Pb)	Toxic in acute and chronic exposures, burning in mouth, severe inflammation of gastro-intestinal tract with vomiting and diarrhea, chronic toxicity produces nausea, severe abdominal pain, paralysis, mental confusion, visual disturbances, anemia etc
Zinc (Zn)	An essential element in human metabolism. Taste threshold for Zn occurs at about 5 mg/L, imparts astringent taste to water
Chromium (Cr)	Hexavalent state of Cr produces lung tumors, can produce coetaneous and nasal mucous membrane ulcers and dermatitis
Arsenic (As)	Causes skin damage, circulatory problems and risk of skin cancer
Antimony (Sb)	Increase in blood cholestorel, decrease in blood sugar
Aluminum (Al)	Leads to neurological disorders
Barium (Ba)	Increases blood pressure
Beryllium (Be)	Is carcinogenic (cancerous)
Cyanide (CN)	Causes nerve damage, thyroid problem
Mercury (Hg)	Neurological and renal disturbances. Excess causes gonad toxic and mutagenic effects and disturbs the cholesterol metabolism
Manganese (Mn)	Essential as a cofactor in enzyme systems and metabolism processes. Excess causes change in appetite and reduction in metabolism of iron to form hemoglobin. Imparts undesirable taste and stains plumbing fixtures and laundry
Selenium (Se)	Leads to hair, finger loss, numbness in fingers or toes, circulatory problems
Boron (B)	Affects CNS, may cause nausea, cramps, convulsions, coma, etc
Alkalinity	Imparts unpleasant taste, may be deleterious to humans in presence of high pH, hardness & TDS
Pesticides	Imparts toxicity when it accumulates in organs of human body affecting immune and nervous systems. May be carcinogenic
Phosphate(PO4)	High conc. may cause vomiting and diarrhea, stimulate secondary hyperthyroidism and bone loss
Sodium (Na)	Harmful to persons suffering from cardiac, renal and circulatory diseases
Potassium (K)	An essential nutritional element but in excess is laxative
Nickel (Ni)	Non-toxic element but may be carcinogenic (cancerous), can react with DNA resulting in DNA damage

Source : Drinking Water Specification: IS: 10500, 1992

Mitigation measures

1) Bio-methanation followed by evaporation and complete composting.
2) Concentration of raw spent wash/ biomethanated effluent and burning the same in boiler to generate power.
3) Anaerobic Treatment of spent wash

CONCLUSION

The treatment of distillery spent wash by anaerobic technologies will not only prevent wastewater from being an environmental public health hazard but also help the industries in revenue generation by production of methane as a by-product.

Water management approach makes significant contribution in managing as well as mitigating the risk involved with public health. Hence the efficient anaerobic technologies for the treatment of spentwash would eventually decrease the risk of contamination of ground water in the proximity of sugar industry and help in management of acute or chronic environmental public health issues which may otherwise take place in near future..

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Conflicts of interest: Not declared

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