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Treatment of Biomethanated distillery spent wash using Electro coagulation treatment technique

Pooja R. Chittaragi[1], Amar S. Byakodi[2]

[1]M. Tech Student, Angadi Institute of Technology and Management, Belagavi
[2]Assistant Professor, Department of Civil Engineering, Angadi Institute of Technology and Management, Belagavi

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Abstract: *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. Most of the industries use anaerobic digestion of spent wash for partial treatment, which produces methane as a by-product. The partially treated spent wash is called Biomethanated Spent wash and the same cannot be disposed directly into environment, since it has considerable concentration of organic and inorganic matter. The present study concentrates on further treatment of Biomethanated Spent wash using Electro coagulation process for further treatment, hence reducing the physico-chemical characteristics of Biomethanated spent wash. The maximum removal efficiency was obtained with a voltage of 15 volt and current density 17.6 mA/cm^{2}for electrolysis duration of 270 minutes.*

Key Words: Biomethanated spent wash, Electro coagulation and Stabilized Spent wash

1. INTRODUCTION

India is an agro based country, where most of the rural population depends on agriculture. India is the second largest sugarcane producer with nearly 5 million hectares of cultivated area. In India there are 579 sugar industries producing 14.5 million tonne of sugar by crushing 145 million tonnes of sugar cane annually. The annual byproduct production from these industries is 7 million tonnes of pressmud and 7.5 million tonnes of molasses [1]. Along with this, there are 298 Distilleries present in the country producing 3.2 billion liters of alcohol and 45 billion liters of spent wash annually. There are 129 Distilleries, which are using Anaerobic Digesters to partially treat the spent wash to convert it into Biomethanated spent wash. [2]

India is ranked fourth in the world for the production of Ethanol and second largest producer in Asia. Distilleries are listed at the top in the "Red Category" industries and having highly top 17th polluting industries by Ministry of Environment, Govt. of India. [3]

Karnataka Sugar industry ranks 3rd in terms of its contribution of sugar in the total sugar production in the country. The Sugar industry in Karnataka is able to manufacture sugar in such huge quantities due to the fact that sugarcane is abundantly available in the state. In fact, Karnataka stands 4th in the country in the cultivation of sugar cane.

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 odor 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. Spent wash having high Total Solids, Suspended Solids, Chemical oxygen demand and Biochemical oxygen demand and its effects are discussed below. [4]

- Discharge of spent wash with high TDS will adversely affect on aquatic life, not suitable for drinking purpose and also corrodes the pipe line.
- Suspended solids cause turbidity and results 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.
- Alkaline nature of spent wash will decreases in the plant growth.[4]

The main aim of the present work is to investigate the treatment of Biomethanated spent wash by the process of Electro coagulation to reduce the adverse environmental effects.

1.1 Generation of Ethyl Alcohol

The distillery use molasses as a raw material for production of alcohol. Molasses come from sugar manufacturing units, which are either based on sugarcane or beet sugar. Molasses is the mother liquor left out from sugar factory after sugar crystallization. The disaccharide present in molasses is first converted into monosaccharide and then converted into Alcohol. The main two steps involved in the manufacturing are Fermentation and Distillation.

1.1.1 Fermentation

Molasses is pumped to fermenters, diluted with water, inoculated with yeast culture and necessary nutrients are added. The fermentation period is about 24 to 30 hours and about 7.5 – 9.5 % alcohol is formed in the fermented wash.

1.1.2 Distillation

After completion of fermentation, distillation of fermented wash is done to recover aqueous alcohol as distillate. Rectification of aqueous alcohol is done to separate concentrated alcohol. The distilleries are adopting Multi Pressure Distillation (pressure and vacuum) technique to distill out the Rectified Spirit (RS) / Extra Neutral Alcohol (ENA) from the fermented wash.

1.1.3 Ethanol

As process goes on, glucose is converted into ethyl alcohol and carbon dioxide. This carbon dioxide will remove as a gaseous form, which is collected separately. After sufficient conversion of glucose in to ethyl alcohol this solution is called beer solution. This solution is then passed through distillation column. Based on temperature difference ethyl alcohol is separated from beer solution and condensed to liquid form. The waste water from distillery column is called spent wash**.**

1.2 Generation of Spent wash

A thick viscous liquid remains at the bottom after the production of Alcohol, called as spent wash or alcohol distillery waste. Distillery waste in the form of 'spent wash' or 'stillage' is one of the most complex, troublesome and strongest industrial organic effluents. The polluting strength is very high due to the high content of complex biodegradable organic materials, such as sugar, lignin, hemicelluloses, dextrin, resins and organic acids. [5]

For every liter of alcohol, maximum 8 to 15 liters of spent wash is generated. The spent wash contains organic matters and nutrient minerals derived from the sugarcane.

The spent wash is an aerobically treated in the Digester. During this anaerobic degradation, the organic matters are converted into Biogas (55% methane).On an average for every 100 tonne of Sugarcane crushed will generate around 4.50 tonne of Molasses. Each tonne of Molasses produces 225 liters of alcohol.

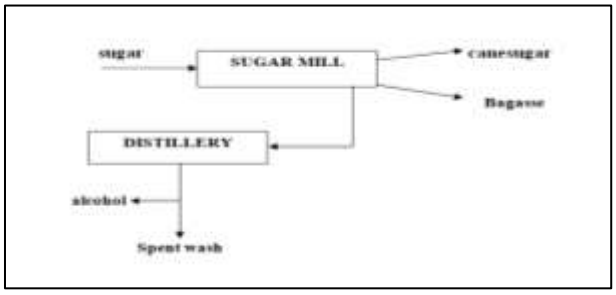

Figure 1: Generation of Spent Wash

Spent wash is the main waste stream

- It has a BOD_5 of about 30,000 to 60,000mg/liters
- COD of about 70,000 to 1,00,000 mg/liters
- pH – acidic (4 – 5)
- Colour- dark brown
- Odor – Objectionable

2. MATERIALS AND METHODOLOGY

2.1 Wastewater collection and analysis

Present study has been carried out in Angadi Institute of Technology and Management, Belagavi. Untreated Spent wash and Biomethanated Spent wash were for the study from Ugar Sugar Industry, which is located 118 km from the Angadi Institute of Technology and Management, Belagavi. The collected samples were stored in a refrigerator at 4^0C. The initial characteristics of Biomethanated spent wash are as follows.

2.2 Electro-coagulation Reactor

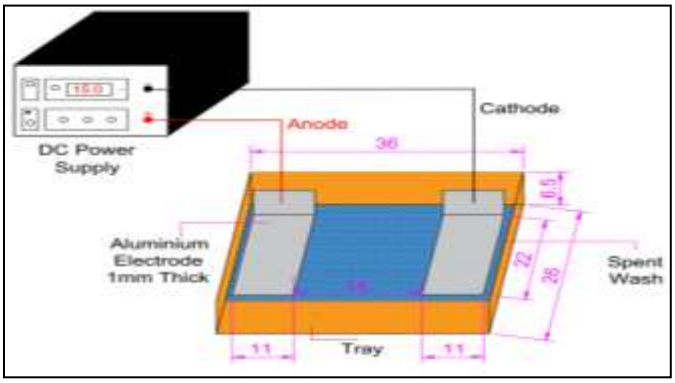

Figure 2: Line Diagram of Electro-coagulation Reactor

Electro-coagulation is one the methods used for the treatment of highly concentrated wastewater. For the present study, Electro-coagulation was carried out in a plastic tray of size 36 x 26 x 6.50 cm. Two Aluminum Electrodes were used of size 22 x 11 cm which was kept at a clear spacing of 14cms and thickness of electrodes was 1mm. These electrodes were connected to a DC supply, and voltage was maintained at 15 Volts along with current of 17.6 mA/cm^2. The working volume of Biomethanated Spent wash for the study was 1000 liters.

Preliminary analysis was carried out to determine the treatment of Biomethanated spent wash using Electrical Conductivity. Working volume of spent wash was added to the plastic tray and electrodes were connected to the DC supply as shown in the figure. Analysis of EC was carried out at every 30mins for duration of 270 minutes.

2.3 Procedure conducted for Electro-coagulation

Figure 3: Image of Electro-coagulation Reactor

Experiment was performed by taking 1000ml distillery Biomethanated spent wash in a plastic tray, combination of electrodes were used such as aluminum-aluminum (Al-Al). The direct current applied was 15 Volts with a current density 17.6 mA/cm^2. Power supply is applied started at t=0 and at a regular interval of 30 minutes sample was collected. The efficiency of electro-coagulation was determined by checking the Electric Conductivity for every 30 minutes from Conductivity meter. The reduction in Electric Conductivity was checked with the help of graph.

3. RESULTS AND DISCUSSIONS

Present study has been carried out in Angadi Institute of Technology and Management, Belagavi. Untreated Spent wash and Biomethanated Spent wash were for the study from Ugar Sugar Industry, which is located 118 km from the Angadi Institute of Technology and Management, Belagavi. The collected samples were stored in a refrigerator at 4^{0}C.

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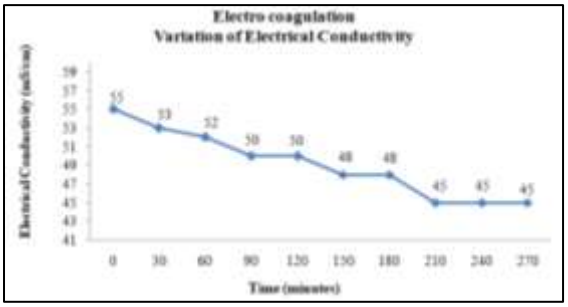
Table 1: Preliminary readings of Electro coagulation

SL. NO	Time (minutes)	Electric Conductivity (mS/cm)
1	0	55
2	30	53
3	60	52
4	90	50
5	120	50
6	150	48
7	180	48
8	210	45
9	240	45
10	270	45



Graph No.1: Effect of contact time on the variation of Electrical conductivity

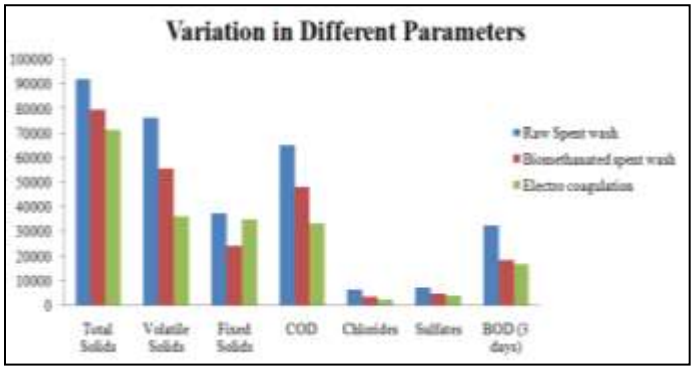
From the above table it is seen that, the rate of degradation of Electrical conductivity during the initial period was more and as the time continues the rate of degradation reduces. For the Biomethanated Spent wash, initial EC was 55 mS/cm and reduced to a value of 50 mS/cm within a period of 90 minutes. The experiment was carried for

duration of 270 minutes and EC has reduced to a constant value of 45 mS/cm.

Electrical Conductivity is dependent on the dissolved solids present in the spent wash; the precipitation of dissolved solids takes place and get effected when the current of 15 volts and 17.6 mA/cm^2 is passed through BMSW which decreases the amount of dissolved solids in spent wash.

Table 2: Variation of characteristics of spent wash for Electro coagulation

SL. No	Parameters (mg/liter)	Raw Spent wash	Biomethanated spent wash	Stabilized spent wash (Electro coagulation)
1	Total Solids	92000	79800	71200
2	Volatile Solids	76500	55800	36200
3	Fixed Solids	37200	24000	35000
4	COD	65200	48000	33000
5	Chlorides	6400	3498	2099
6	Sulfates	7100	4600	3825
7	BOD (3 days)	32200	18200	16700



Graph No.2: Variations in different parameters

4. CONCLUSIONS

Electro coagulation method is more effective method. The electro coagulation of Biomethanated rejected effluent of distillery was carried out using Al-Al electrodes in batch mode of operation and the optimum values of various operating parameters were obtained. The optimum efficiency was found to be at current density 17.9mA/cm^2 with the voltage of 15 volts. A 49.38 % COD, 48.14 % BOD (3 days) and 67.20 % Chlorides removal efficiency was obtained at an electrolysis time of 270 minutes using Al-Al electrode. It can be concluded that the electro coagulation technique can be successfully employed for the treatment of distillery effluent having high organic content.

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