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Carbon Electrodes for the Electro Accumulation of Potassium from Distillery Spentwash

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ABSTRACT: Disposal of distillery effluent through evaporation followed by the incineration results in scale formation on the surface of the evaporation and boiler tubes decreasing the boiler & evaporator efficiency and increasing maintenance cost. The potassium content of scale is 2,756 mg/kg (588 mg/kg in ash). The contribution of other alkali metals to the scale is insignificant. Hence, it is essential to remove potassium from spent wash. The present paper describes the process of electro-accumulation of the potassium from distillery spent wash using carbon electrode. Experiments were done by varying time and current density and the results show that the percent reduction of potassium was maximum 26 % at 12 A. and 15 % at 9 A applied current density. Percent reduction in COD was found to be 33.6 % at 12 A and minimum 22.58 % at 9 A applied current density for one hour.

KEYWORDS: Carbon electrode, Distillery spent wash, Electro-accumulation, Potassium

I. INTRODUCTION

The residual liquor remaining after the recovery of alcohol in distillery industry is termed as “spent wash”. Such wastewater is moderately acidic in nature (pH 4-5), have a high organic content, high ash content, and high concentration of mineral salts. Spent wash disposal even after conventional treatment is hazardous and has high pollution potential due to the accumulation of recalcitrant compounds.

In India, Central Pollution Control Board (CPCB) Government of India has given mandatory guide lines for the zero effluent discharge of distillery effluent in inland surface waters as per Corporate Responsibility of Environmental Protection (CREP) guidelines **[1]**

II. BACKGROUND

At present concentration followed by incineration are the technologies used to dispose the distillery effluent. It is known that this method achieve zero liquid discharge and also an energy generation technology i.e. distillery effluent (spentwash) is concentrated followed by incineration. This technology has drawbacks due to volatile alkali, alkaline metals and sulfates deposition on the surface of the boiler tubes and forming clinker/ scale. The scales reduce the heat transfer efficiency of the boiler **[2]** Formation of hard and thick clinker/scale is the main drawback of the incinerating technology. However, this technology is easy and energy recovering technology. The requirement of land and manpower is very low as compare to the bio-composting process.

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III. PRESENTATION OF THE MAIN CONTRIBUTION

To overcome the problems of the incineration and evaporation it is important to know the characteristics of the clinker and scale formed by the spent wash. Inductive coupled Plasma mass spectrometry analysis method of clinker analysis shows the highest concentration of the potassium (2700 - 3000 mg/lit). The contribution of other metals is very less, hence it is possible that, after removing of the potassium from the distillery spent wash the concentration followed by the incineration technology achieves the zero liquid discharge and increase the boiler efficiency.

Experiments of electro-accumulation were conducted using carbon electrode for potassium removal at laboratory scale. Literature suggests that metallic electrodes get dissolved during electrochemical treatment of spentwash **[3]** hence it is necessary to use a nonmetallic electrode for the treatment. Carbon electrode is one of the nonmetallic electrodes which does not take part in the reaction but acts as electrode. The electrical conductivity of carbon electrode is slightly less than that of the metal **[4]**. Considering its cheap cost and easy availability carbon electrode was used for the experiment.

IV. METHODOLOGY AND DISCUSSION

1 Materials:

Distillery effluent (raw spentwash) was obtained from Ghodganga Sahakari Sakhar Karkhana Distillery. Nhavra Tal.: Shirur Dist- Pune (Maharashtra) India. The spentwash was analyzed for potassium and Chemical Oxygen Demand (COD). The potassium was analyzed by 3500-K flame photometric method (Systronic make flame photometer model 128) and COD by dichromate method (5220-C Closed reflex titrimetric method) (APHA 2005). Distillery spent wash is acidic in nature with very high COD (1,00,000 – 1,20,000 mg/lit) and potassium concentration is 20,000 - 26,500 mg/l. Carbon electrode, DC power pack have current capacity 6.0 to 24.0 A and other accessories were made available from local market.

2 Methods:

The schematic diagram of experimental setup is shown in figure 1. The experiments were conducted in a 500 ml glass beaker in batch mode of operation. The experiments were carried out with carbon-carbon electrode. Carbon electrode having dimension L -55.0mm and Ø 6.0 mm used. The area of electrode submerged in the sample was 28.26 mm^2 and the distance from bottom was 60.0 mm. Outer vessel dimensions were H-110.0mm and Ø 80.0 mm whereas inner vessel made up from plastic materials. Dimension of inner vessel were H-90.0 mm and Ø 60.0 mm with a distance of 40.0 mm between the two electrodes. The electrode was connected to the power pack for direct current (DC) mode. Inner compartment was prepared with sieve and wrapped with fine raw nylon cloth which acts as semi permeable membrane as a barrier to avoid fine mixing of ions. Sample was collected immediately after switch of the power pack for analysis.

Each experiment was carried out using 300 ml of distillery spent wash. The experiments were carried with variation of the applied current and time to study its effect on potassium and COD concentration.

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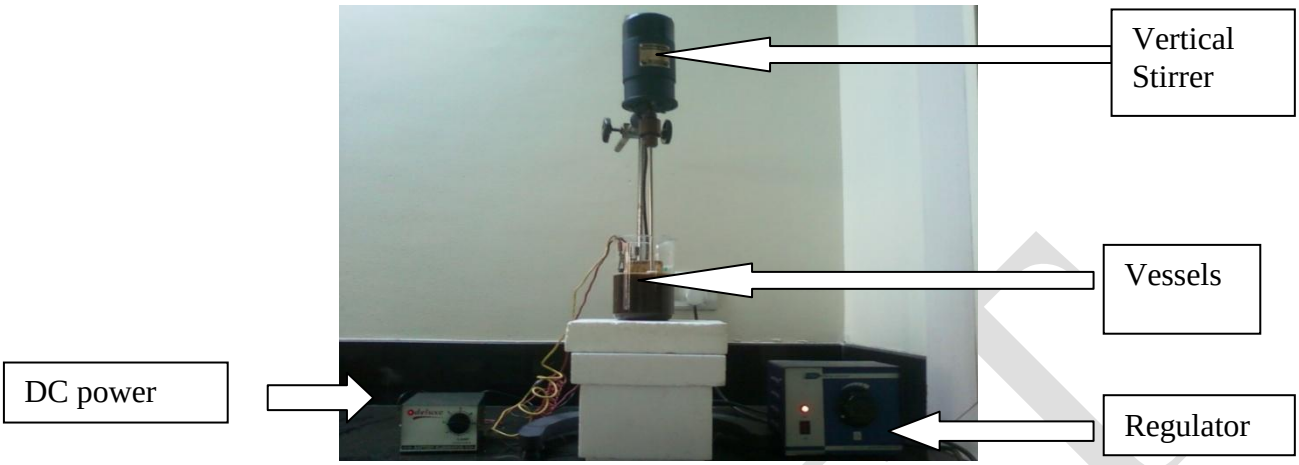

Figure: 1 Electro-coagulation Setup:

V. RESULTS AND DISCUSSION

Experiments were performed to study the decline/decrease of potassium concentration using batch mode of operation. The effect of the variation in applied current density and time on the concentration of the potassium and COD of the distillery raw spent wash has been studied.

3.1 Effect of applied current density on potassium:

The experiment was performed at different current of 9.0, 12.0, 15.0, 18.0 and 24.0 A. Raw spent wash (pH- 4.0) subjected to electrolysis for a period 1 h. without any pre-treatment. The Carbon electrodes were utilized as anode as well as cathode for the electrolysis. The results are shown in fig. 2. It was noticed that maximum potassium percent decrease was at 12 .0 A (22.20%) and at 15.0 A (18.86 %) applied current. This is due to the fact that with an increase in current density the anode dissolution is increased (Faraday law). In this case the maximum potential of dissolution of the anode is at 12.0 A and 15.0 A applied current density hence the potassium decrease is high. Potassium is decline at 18.0 A and 24.0A applied current density. This may be due to high movement of the ions which is due to increase in the applied current density and thus increase in attraction and collision of generated ions and the charged ions. These ions continuously keep on colliding due to less availability of the space, preventing accumulation on the surface of the electrode.**[3, 4]**

3.2 Effect of the applied current on COD:

It was noticed that the maximum COD was decreased at 12.0 A (22.58%) and 15.0 A (27.81 %) applied current. This may be due to maximum anode dissolution at 12.0 A applied current. After 15.0 A applied current, the COD reduction gets decreased as it may be due to increasing the applied current the ionization potential get increased but due to the less distance between the electrodes and the available surface area of the electrode is low. The results are shown in figure 2

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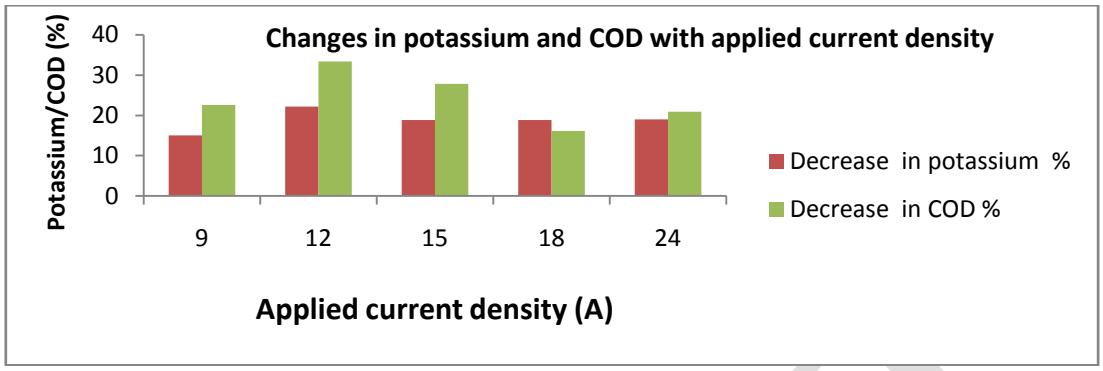

Fig.2 Effect of the applied current density on the percentage reduction in spentwash potassium and COD

3.4 Effect of the electro accumulation time on potassium concentration:

For above experiment, the optimum applied current value obtained were 12.0 A and 15.0 A. This experiment was performed to check the effect of different time duration (in hrs) of the electrolysis on the potassium accumulation. Electro accumulation duration applied at 12 .0 A and 15.0 A current was varied from 1 hr to 5hrs. The results are shown in figure 3

Maximum reduction in potassium was found at 4 h (27.54 %@ 12.0 A) and 3 hrs (26.41% @ 15.0 A). It may be due to the generation of large number of ions from carbon electrode during the optimized electrolysis time

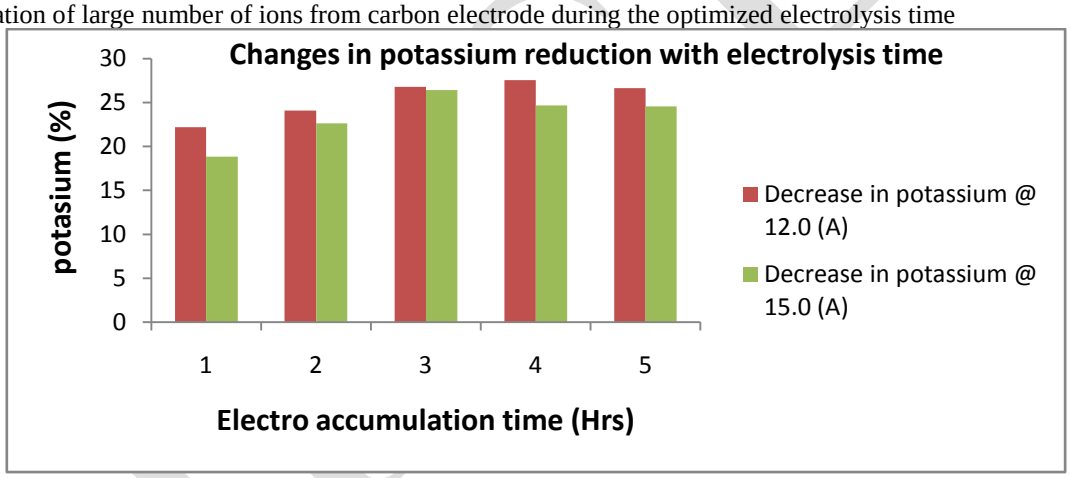

Fig. 3.Changes in potassium reduction percent with electrolysis time

3.5 Effect of the electro accumulation time on COD reduction:

Decrease in COD at 12.0A current was found maximum (40%) at 3 hrs among varied time duration (from 1 hr to 5 hr). It was observed that COD reduction was directly proportional to electrolysis time till 3hrs. After 3 hrs there was decrease in COD removal efficiency, this may be due to saturation of available surface area of the electrode for the coagulation of available ions in the spent wash. The results are given in graphical representation as shown in Fig. 4

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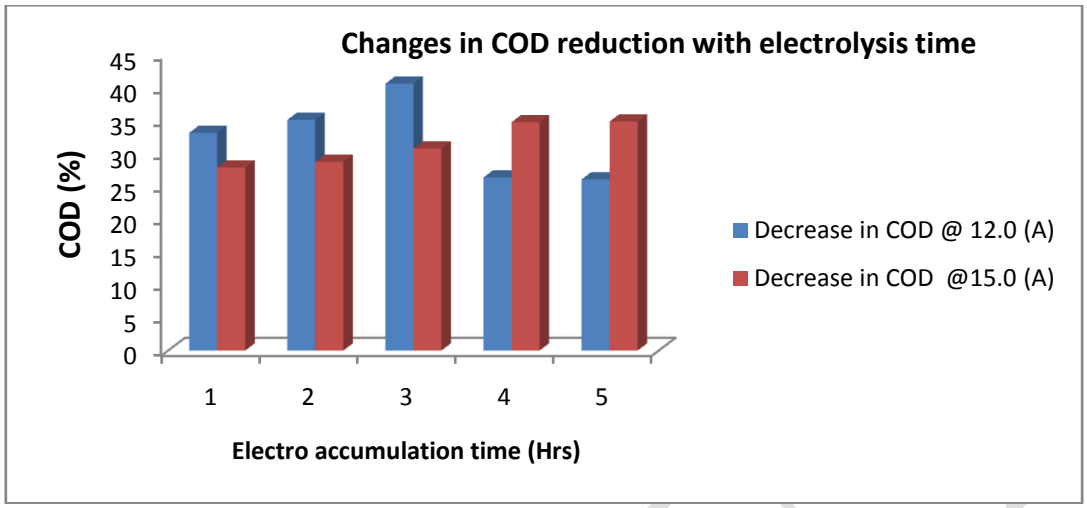

Fig. 4. Effect of the duration of the electrolysis on the percent reduction of the COD:

VI CONCLUSION

The removal of the potassium from distillery Spentwash is possible through electro accumulation with carbon-carbon electrode. The distillery raw spent wash can be directly treated with electro accumulation treatment of potassium and COD (i.e. without any pre-treatment). Maximum removal of potassium was observed up to 22% at 12.0 A. applied current density. COD was decreased up to 33.6% at 12.0 A. applied current density. Optimized time for the removal of the potassium were 3hrs at applied current density of 12.0 A. It can be concluded that the carbon electrode accumulate the potassium from the distillery effluent by the electro accumulation technology and thereby reducing the scale formation of potassium on the boiler tubes during the incineration. Thus electro accumulation treatment technology for potassium removal shows promising future. Further studies should include treatment of potassium from less complex wastewater (like Spent wash) using electrolysis.

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