Enhancement of COD Removal Efficiency From Coal Gasifier Effluent using Electrocoagulation

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Abstract

In the present work, an attempt was made for the treatment of coal gasifier effluent using electrocoagulation technique with brass electrodes as sacrificial anode in bipolar connection system. The effects of operating parameters such as pH, voltage and electrolysis duration on the removal of COD were investigated. The optimum value for each operating variable was experimentally determined. The optimum values of voltage, initial pH and electrolysis time were found to be 6V, 7.0, 45 mins and its current density is 32.5 A/cm2 respectively. The experiments revealed that COD in aqueous phase was effectively removed. The analysis of the treated water showed that the maximum COD removal efficiencies were 73.8% respectively at optimum conditions. The effluent was very clear and its quality meets the discharge standard. Consequently, the electrocoagulation process can be considered as a reliable, safe and cost effective method for the treatment of coal gasifier effluent.

Keywords: Coal gasifier Effluent, Electrocoagulation, Brass Electrode, COD

I. INTRODUCTION

The coal gasification industry in India has been rapidly developed and played an important role in new clean and renewable energy market in recent years (1). However, the arbitrary discharge of coal gasification wastewater (CGW) would cause a serious environmental problem, due to the presence of complicated and considerable amounts of toxic compounds such as sulphates and chlorides compounds (2). Conventional treatment of CGW includes a series of biological treatment (mostly anoxic–oxic process and activated sludge process) (3) after a physical-chemical, pretreatment to reduce the concentrations sulphates and chlorides,. The biologically pretreated CGW still contains a large number of toxic and refractory compounds as well as their derivatives, with lower biodegradability than the raw wastewater. Meanwhile, Great attention has been given to the anaerobic digestion method, due to its capability to increase the degradation rate of refractory compounds and improve degradation of CGW (4). However, the removal efficiency of phenolic compounds was still less than 65% even at a prolonged HRT of 48 h in two-continuous thermophilic anaerobic UASB process. As regards nitrogen compounds, which exhibited poor removal efficiency in an aerobic process needed to be removed by the followed aerobic treatment in order to meet the requirement of concerned standard. Therefore, there is a need for an improved process with the merits of anaerobic that is more practical in terms of investment costs and efficient removal nitrogen for advanced treatment of real biologically pretreated CGW.

Electro coagulation (EC) is a process in which the anode material undergoes oxidation with the formation of various monomeric and polymeric metal hydrolyzed species. These metal hydroxides remove organics from wastewater by sweep coagulation and/or by aggregating with the colloidal particles present in the wastewater to form bigger size floss which ultimately are removed by settling [5]. During EC, coagulants are obtained in situ by the dissolution of the anode.Hence, In the present study an attempt was made on the evaluation of the efficiency of the electrocoagulation process of treatment of coal gasifier industry wastewater using brass electrodes.

II. METHODOLOGY

Materials

A. Description Of Experimental Setup:

For the batch electrocoagulation, the reactor made up of glass material with the volume of 2lit was used. The working volume of the reactor was 1L. The EC unit consisted of two brass electrodes connected as a bipolar system in the reactor and DC power supply. The dimensions of the electrodes were 8cm x 3cm x 1mm. The schematic representation of the experimental setup is shown in Fig 1. After the initial characterization of wastewater, batch experimental studies were conducted to optimize the various parameters such as pH, electrolysis time (ET) and voltage. Experiments were performed with two electrodes connected to the DC power supply to determine optimum conditions. The space between the two electrodes was maintained 1cm in all the experiments. In each run the voltage was varied to a desired value of 3, 4.5, 6, 7.5 and 9V. To maintain homogenous mixing of the reactor content, magnetic stirring unit is used. The wastewater concentration was reduced to half the strength throughout the study to reduce the time and current consumption and to obtain better efficiency [6]. The EC experiments were performed for 60 mins and in each run sample were collected at every 15 minsinterval for necessary analysis.

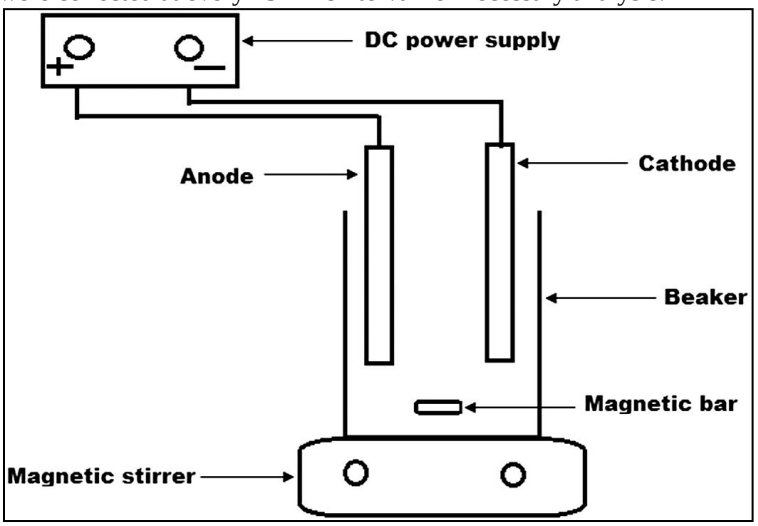

Fig. 1: Batch Mode Electrocoagulation Experimental Setup

III. RESULTS & DISCUSSION

A. Wastewater characteristics:

A sample was taken from the industrial waste water to analyze various parameters[7]. The values of various parameters as shown in Table 1 before the treatment of sample water.

Table – 1
Characteristics Of Coal Gasifier Effluent. (All Units Mg/L, Except Ph)

S.NO	*Parameter*	*Untreated effluent before treatment*
1	*pH*	*9.30*
2	*TSS*	*1,620*
3	*TDS*	*5,600*
4	*BOD*	*80*
5	*COD*	*17,807*
6	*Sulfates*	*3,292*
7	*Chlorides*	*480*

B. Effect of pH:

pH is an important parameter for the electrocoagulation process. Initial experiments were conducted at an original solution pH 9.3. The COD removal efficiency 39.6 % was obtained at an initial pH (9.3), for brass electrodes respectively. Further

experiments were conducted at different pH (9, 8, 7 and 6) by brass electrodes to study the effect of pH on the EC process and the results are shown in Fig.2 respectively. The electrolysis was performed for 45 mins with a constant current density of 16 mA/cm2 (0.32 A), agitation speed was kept constant at 500 rpm and the spacing between the electrodes was 1 cm. It can be noticed from Fig. 2 that pH of the coal gasifier had a significant effect on the COD removal efficiency.

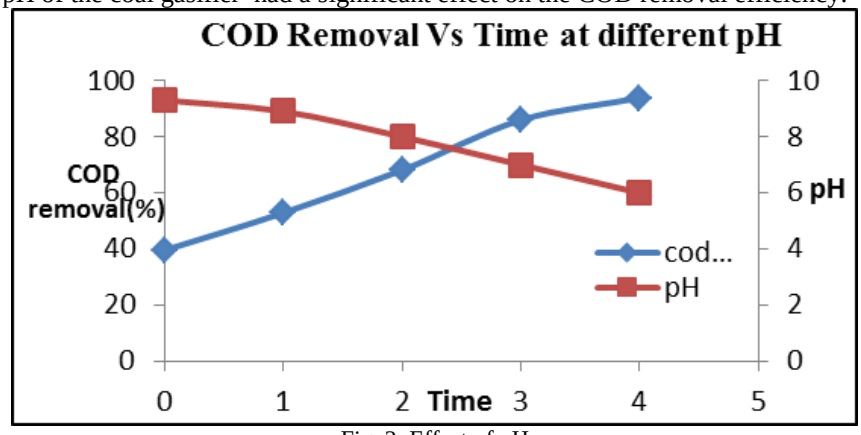

Fig. 2: Effect of pH

C. Effect of Voltage:

Voltage is an important parameter for the electrocoagulation process. Initial experiments were conducted at an original solution Voltage 6. The COD removal efficiency 40 % was obtained at initial Voltage (9), for brass electrodes respectively. Further experiments were conducted at different Voltages (3, 4.5, 6, 7.5and 9) by brass electrodes to study the effect of Voltage on the EC process and the results are shown in Fig.3 respectively. The electrolysis was performed for 45mins with a constant current density of 16 mA/cm^2 (0.32 A), agitation speed was kept constant at 500 rpm and the spacing between the electrodes was 1 cm.

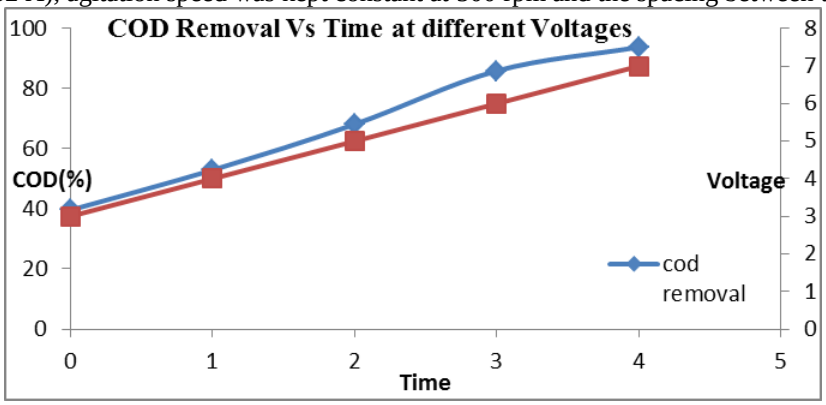

Fig. 3: Effect of Voltage

D. Effect of Electrolysis Time:

The effluent treated with brass electrode as anode, appeared White first and then turned blue. This white and blue color must have resulted from brass ions generated during the EC process. It has a relatively high solubility at acidic or neutral conditions and can be oxidized easily into Cu3+ by dissolved oxygen in water. The effect of time was studying at a constant current density of 16 mA/cm2 (0.32 A). The electrolysis time has a significant effect on the pollutant removal. When the electrolysis time changed from 10-60mins, the removal of COD from 17807 to 420 mg/L was obtained at 45mins.

Table – 2

S.NO	*Parameter*	*Untreated effluent before treatment*	*Treated effluent after treatment*	*BIS Standards*
1	*pH*	*9.30*	*7.0*	*6.0-9.0*
2	*TSS*	*1,620*	*40*	*600*
3	*TDS*	*5,600*	*900*	*2100*
4	*DO*	*1.8*	*4.5*	*4-6*
5	*BOD*	*80*	*55*	*50*
6	*COD*	*17,807*	*320*	*250*
7	*Sulfates*	*3,292*	*400*	*1000*
8	*Chlorides*	*480*	*180*	*600*

IV. CONCLUSION

Based on the experimental findings, the electrolysis duration of 45mins, pH 7.0 and 6V were found to be the critical operating parameters for the treatment of wastewater usingbrass as electrode material. Maximum COD removal of 73.8%was obtained at theseoptimum operating conditions. Hence, it can be concluded thatthe electrocoagulation technology using brass electrodesappears to be a feasible alternative for the treatment of pharmaindustry wastewater.

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