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Batch Electrocoagulation Method on removal of Chemical Oxygen Demand and Ammoniacal Nitrogen of Dye Intermediate Industry Effluent.

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Abstract: The study was carried out on Dye Intermediate wastewater treated by EC (Electro-coagulation) for the removal of residual NH_3-N and COD on a laboratory scale. This study compares the treatment efficiency of NH_3-N removal by Electrocoagulation Method using different electrodes is performed at the same time interval. Raw wastewater showed NH_3-N around 1100-1200 mg/l. About 92.72% reduction in NH_3-N is observed by using Copper Electrodes as Cathode and Anode. Hence, it is suggested that Electrocoagulation process using copper electrodes proves to be more efficient treatment for NH_3-N and COD reduction and thereby improving biodegradability of the wastewater.

Keywords: Dye Intermediate wastewater, COD removal, NH_3-N removal, Electrocoagulation Process

1. Introduction

The chemical industry is of importance in terms of its impact on the environment. The wastewater from this industry are generally strong and may contain toxic pollutants. Chemical industrial wastes usually contain organic and inorganic matter in varying degrees of concentration. It contains acids, bases, toxic materials, and matter high in biological oxygen demand, colour, and low in suspended solids. Many materials in the chemical industry are toxic, mutagenic, carcinogenic or simply hardly biodegradable. Surfactants, emulsifiers and petroleum hydrocarbons that are being used in chemical industry reduce performance efficiency of many treatment unit operations (EPA, 1998). The best strategy to clean highly contaminated and toxic industrial wastewater is in general to treat them at the source (Peringer, 1997) and sometimes by applying onsite treatment within the production lines with recycling of treated effluent (Hu et al., 1999). Since these wastes differ from domestic sewage in general characteristics, pre-treatment is required to produce an equivalent effluent (Meric et al.,1999). In chemical industry, the high variability, stringent effluent permits, and extreme operating conditions define the practice of wastewater treatment (Bury et al., 2002). Hu et al. 1999 proposed concept to select the appropriate treatment process for chemical industrial wastewater based on molecular size and biodegradability of the pollutants.

The wastewater from dyes and their intermediate manufacturing industry causes serious impact on natural water bodies and land in the surrounding area. High values of COD and BOD, presence of particulate matter and sediments, chemicals which are dark in colour leading to turbidity in the effluents causes depletion of dissolved oxygen, which has an adverse effect on the marine ecological system. As dyes are designed to be chemically and photolytically stable, they are highly persistent in natural environments. The improper handling of hazardous chemicals in waste water also has some serious impact on the health and safety of workers putting them into the high-risk bracket for contracting skin diseases like chemical burns, irritation, ulcers, etc. and respiratory problems. The wastewater from dyes and their intermediate manufacturing industry causes serious impact on natural water bodies and land in the surrounding area. High values of COD and BOD, presence of particulate matter and sediments, chemicals which are dark in colour leading to turbidity in the effluents causes depletion of dissolved oxygen. Dye intermediate waste water contains high organic loading, due to the high organic load, toxicity or presence of bio recalcitrant compounds, biological processes cannot be used, since no COD removal is achieved biologically. Thus, a biological treatment is not feasible. In these cases, chemical pre-treatment can adequately reduce the COD prior to biological treatment.

Treatment processes reduces the concentrations of Chemicals in water, but the degree of efficiency is often a function of: a)chemical structure, b)cost, and c)energy. All treatment processes have some degree of side effects which includes generation of residuals or by-products and much more. Life-cycle analyses should be undertaken to ensure that the solutions for environmental control are not more risky than the problem. (**Shane Snyder,2008)** Source control of contaminants to wastewater treatment plants should always be considered when unknown or questionable occurrence in effluents is predicted or observed. Dye Intermediate processes wastewaters are very diverse in pollutants and their pH may or may not neutral.

2. MATERIALS AND METHODS

2.1 The Dye Intermediate Wastewater

The raw wastewater was obtained from a Dye Intermediate manufacturing industry located at Vapi, Gujarat, India. The company manufactures Various Dye Intermediate products. The NH_3-N of raw wastewater ranges about 1100 – 1200 mg/l. The characteristics range of secondary-treated wastewater collected from the unit used in the present study is shown in Table 1.

Sr. No	Parameter	Method Specification	Method Used	Values	Permissible Limit
1.	pH	Standard Method by APHA Ed.22nd .2012,4500 - H+B	Glass Electrode	7.9-8.9	5.5-9
2.	TDS	Standard Method by APHA Ed.22nd .2012,2540 - C	Gravimetric Method	832 mg/L	2100 mg/L
3.	NH_4-N	Standard Method by APHA Ed.22nd .2012,4500 NH_3-B & C	Kjeldal method	1180 mg/L	50 mg/L
4.	COD	Standard Method by APHA Ed.22nd .2012,5220 - B	Open Reflux	386 mg/L	250mg/L
5.	BOD (3 Days at 27^{o}C)	IS 3025(Part 44)1993Amd.01	-	203 mg/L	30 mg/L

2.2 Electrocoagulation method

The sample of dye Intermediate wastewater sample having initial NH_3-N 1100 mg/l with Electrocoagulation Method were carried out in a 500ml glass reactor. Prior to the treatment pH in all the samples was adjusted Checked. Connect the electrodes to the D.C. supply through wires and immerse the electrodes in sample. Pass regulated current with the help of D.C supply and take samples at regular intervals. Take the sample from 5 cm above the bottom of the reactor. Collect the sample after treatment and allow it to cool down and allow the flocks to settle. Filter the sample through filter paper. Estimate the results of NH_4-N in mg/L.

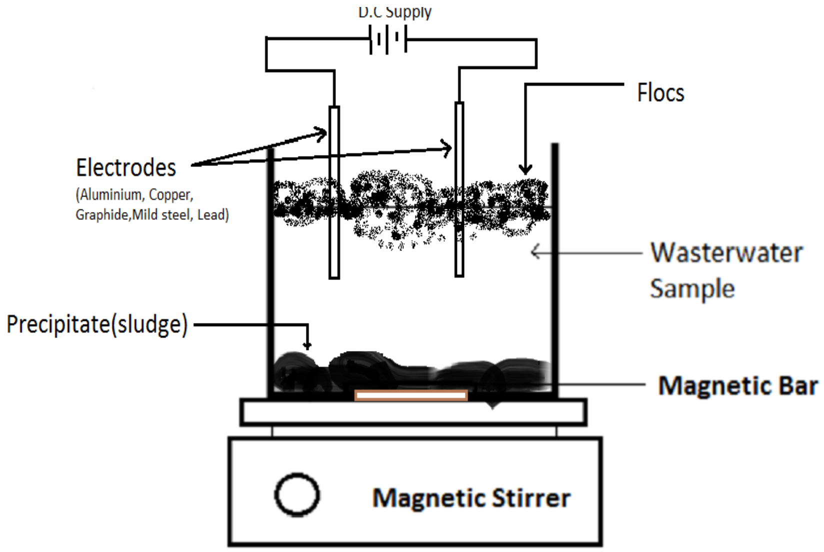

Figure 1: Experimental Setup For Electrocoagulation Process

2.4 Analytical Methods

Total Dissolved Solids, Chemical Oxygen Demand, Total Kjeldahl Nitrogen, pH tests were performed according to procedure described in standard methods.

3. Results & Discussion

The experimental work was oriented towards the best electrodes for electrocoagulation process that can be applied on the current wastewater to achieve best NH_3-N removal.

In this study, NH_3-N removal obtained is 92.72% by Copper Electrode at both cathode and anode & 48.38% by Stainless Steel Electrodes at both cathode and anode in Electrocoagulation process. The table.2 shows the results of maximum NH_3-N removal amongst all the sets of experiments using copper and Stainless steel electrodes at different time intervals.

Table: 2 NH_3-N Removal Achieved by Copper and Stainless Steel Electrodes both at cathode and anode at different time intervals at constant current of 1.48-1.5 A current, 9V, 27^0 temperature

Sr. No.	Time (hour)	NH_3-N removal by copper (mg/L)	% NH_3-N removal by copper	NH_3-N removal by SS (mg/L)	% NH_3-N removal by SS
1	0	1186	0	1165	0
2	1	903.21	23	1083	7.03
3	2	686.616	42	890.23	23.58
4	3	437.35	63	801.13	31.23
5	4	287.02	75	686.71	41.05
6	5	142.78	87	654.31	43.83
7	6	90.78	92.34	601.27	48.38

Following figure 2 (A) and Figure 2 (B) shows % NH_3-N and % COD removal by Copper and Stainless Steel electrodes as cathode and anode in EC

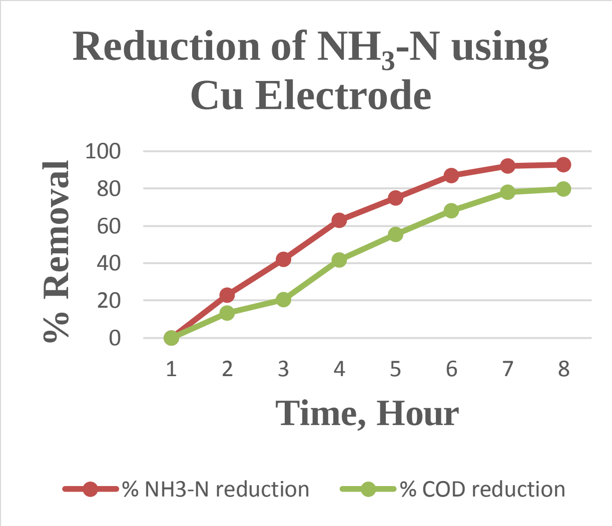

Figure 2 (A) % NH_3-N and % COD removal by Copper electrodes as cathode and anode in EC

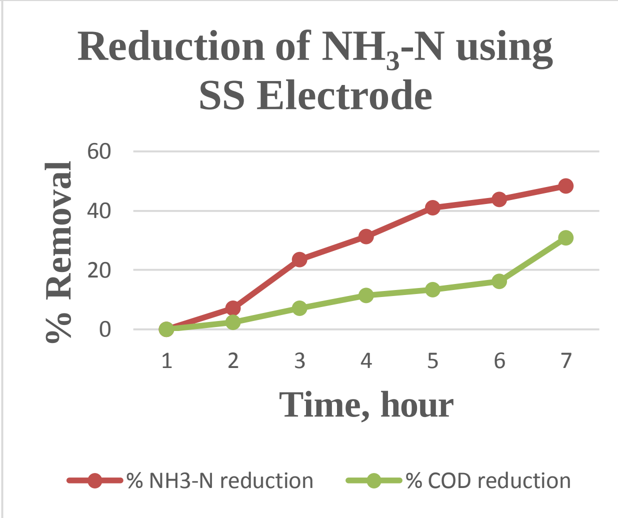

Figure 2 (B) % NH_3-N and % COD removal by Stainless Steel electrodes as cathode and anode in EC

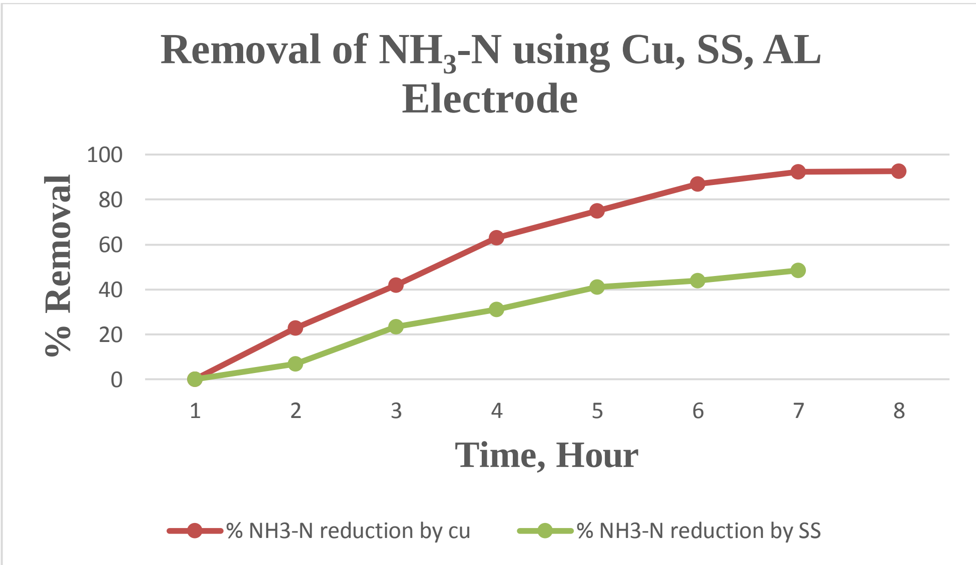

Figure 3. Comparing % reduction of NH_3-N by Copper and Stainless Steel Electrodes in Electrocoagulation Process

4. CONCLUSION

Using of different electrodes such as Cu and SS was applied for the removal of the NH_4-N from wastewater sample collected for a comparative study. In this study, different experiments were conducted keeping current and voltage conditions same throughout and electrodes were used as pair of anode and cathode both as same i.e. anode: Cu, cathode: Cu. At different time interval such as 1,2, 3, 4, 5, 6 and 7 hours samples were collected after treatment and were tested for NH_4-N removal and COD removal. The study concludes in the development of a hybrid process in reduction of one environmental problem of the industries generating ammonical wastewater.

The removal of NH_4-N from Dye Intermediate wastewater was conducted successfully on a laboratory sale. The Scope of this research or experiment was to study the Electrocoagulation process for the treatment of Dye Intermediate wastewater. The experiments showed that highest removal of ammonical nitrogen by using Copper electrodes at the treatment time of 6 hours. Also the production of sludge at the bottom was noticed that is only 8.4% of the total volume of treatment wastewater.

Based on the results of the experimental tests, the following conclusions could be drawn:

- Using Cu electrodes, the most efficient combination for NH_4-N removal was obtained at 1.48-1.50 A current, 9V Voltage, 27^0C Temperature and 0.5 gm of NaCl compared to the other combinations of electrodes studied.

- pH value does not change much even after treatment time of 6 hour for treatment of sample.

- Electrochemical Process using Cu electrode gives maximum reduction up to 92.72 % whereas COD reduction at that time was upto 79.76 % .

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