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Removal of Solids from Hospital Wastewater using Electrocoagulation

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Abstract:
The main objective of the study is to remove the solids present in Hospital waste water by electrocoagulation using Aluminum (Al) and iron (Fe) electrodes. Electrocoagulation is the electro-chemical process of treatment of wastewater. Hospital wastewater contain solids, BOD, COD, phenols, radioactive isotops, pathogens such as bacteria, viruses, blood, body fluid, sweat, contaminated organs, disinfectant, pharmaceuticals as well as hazardous chemicals can be effectively removed by Electrocoagulation method. The factors which affect electrocoagulation process are current density, treatment time, pH, distance between electrodes, initial concentration of the sample, conductivity of the solution, electrode material. In this study, Total dissolved solids, Suspended solids are removed from hospital wastewater by applying AC current through Al and Fe electrodes in sample. The maximum efficiency is obtained at 4.542 A/m^2 of current density and 45 minutes of reaction time. The percentage removal of Total dissolved solids, Suspended solids are 96.98% and 91.89% respectively.

Keywords: AC current, Elctrocoagulation, Hospital wastewater, Solid,

I. INTRODUCTION

The generation of wastewater effluent is increasing day by day due to development in medical services and products. The principal source of wastewater in hospitals are from surgery, drug treatments, radiology, laundry, operation room, chemical and biological laboratories, etc. The pollutants discharge in environment may cause serious threat to the environment as well as humans. Hospital wastewater effluents contain solids, BOD, COD, phenols, radioactive isotops, pathogens such as bacteria, viruses, blood, body fluid, sweat, contaminated organs, disinfectant, pharmaceuticals as well as hazardous chemicals, pathogenic microorganisms and other heavy metals and toxic chemical compounds such as Cu, Fe, Cd, Pb, Hg, Ni, Pt, Cyanide, Phenol. The wastewater can adversely affect ecology balance and public health. An effective treatment of the wastewater is must before discharge in to river or stream. Coagulation flocculation, ion exchange, absorption, chemical oxidation, reverse osmosis, filtration, ultrafiltration, adsorption, heat exchange, chemical precipitation are various methods used for the treatment of wastewater. Electrocoagulation is one of them. The treatment is highly adopted for the low operation and maintenance cost, high efficiency, lower sludge production, low chemical consumption, good settling capacity of sludge less treatment time as compared to other treatment. Electrocoagulation treatment is highly acceptable all over the world. Hospital wastewater after treatment can be used for agriculture or gardening purpose. It can also be used for flush in toilets, washing and cleaning floors. The sludge generated after the treatment process can be used as a construction material. Electrocoagulation technology is a treatment in which electrical current is used for the treatment of wastewater without adding any coagulant. When electric current was supplied in the reactor electrocoagulation occurs. The metal ions from anode losses electrons and gets combined with the ions present in wastewater. The reaction between ions takes place, results in the formation of flocs. Some settles at the bottom while some moves upward due to formation of hydrogen and oxygen bubbles at cathode. This hydrogen gas helps in the upward movement of water containing pollutants. The reaction between ions and the wastewater depends on the conductivity of the solution. Which impart the efficiency of the treatment. On the other hand, the cathode gains electron and gets reduced. Thereby making water better treated. The metal ions which forms at anode with (OH-) ions from the water to form highly charged coagulants which diminishing the stability of suspended particles, so that Al^{3+} reacts with OH^- to form Al $(OH)_3$ i.e. aluminum hydroxides, which is also an efficient coagulant. The various reactions involved in Electrocoagulation process are:

General reactions at anode:

$Al \rightarrow Al^{3+} + 3e$-

General reactions at cathode:

$3H_2O + 3e^- \rightarrow 3/2\ H_{2\,(g)} + 3OH^-$

Overall,

$Al^{3+} + 3H_2O \rightarrow Al(OH)_3 + 3H^+$

II. MATERIAL AND METHOD

A. Characteristics of the Hospital wastewater

The Hospital wastewater was collected from a reputed educational hospital in Pune. A characteristic of the wastewater is shown in table 1.

Table.1. Characteristics of Hospital wastewater

Sr. no.	Parameters	Quantity	Unit
1.	pH	7.5	--
2.	Total solids	640	mg/l
3.	Total dissolved solids	529	mg/l
4.	Suspended solids	111	mg/l
5.	BOD (3 days at 27°c)	282	mg/l
6.	COD	672	mg/l

B. Experimental Procedure

All tests were performed in laboratory at normal temperature and pressure. Electrodes and chemicals were purchase from Oswal Scientific Pune. An ammeter (10A) for measurement of current, two Rheostat (220 Ω) for control of current were used. Tests were performed in batch reactor. One liter of fresh sample was taken in Borosil glass beaker. Two electrodes Aluminum (Al) and Iron (Fe) were dipped in the sample. Electrodes are shown in Fig. 1. The surface area of Al and Fe electrodes was 66.04 cm^2 and weight of Al and Fe electrodes before treatment were12.48 gm. and 16.18 gm. Respectively. The distance between electrodes dipped in sample was 2.5 cm. AC current supply was used instead of DC current.

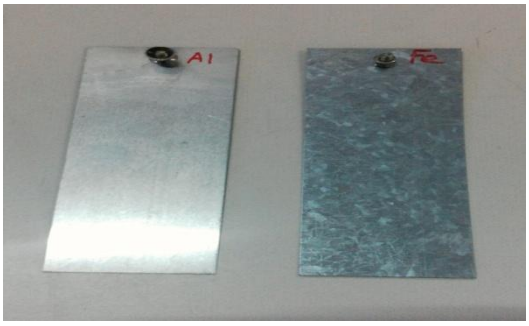


Figure.1. Aluminum and iron sacrificial electrodes

The studied parameters of the process are Total dissolved solids, suspended solids. The removal of studied parameters was observed at 1A, 2A and 3A of current and 15 min., 30 min. and 45 min. of reaction time. The electro coagulation setup is shown in fig. 2.

Figure.2. Experimental Setup

The maximum efficiency is obtained at 4.542 A/m^2 of current density and 45 minutes of reaction time. The percentage removal of Total dissolved solids, Suspended solids are 96.98% and 91.89% respectively. The sample before and after treatment is shown in figure 3.

Figure.3. Sample before and after treatment

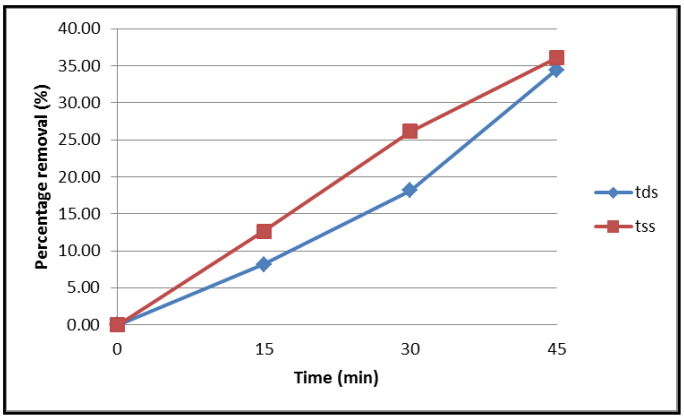
III. RESULTS AND DISCUSSION

According to the study the removal efficiency of the wastewater were analyzed at 7.5 pH, 1A, 2A and 3A of current and 15 min, 30 min and 45 min of reaction time. Table 2.

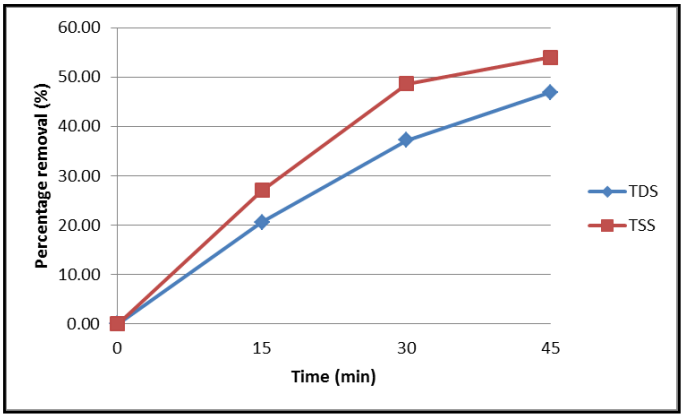
Table.2. Percentage removal of solids by electrocoagulation process

Sr. No.	Current (A)	Time (min)	TDS%	SS%
1.	1	15	8.13	12.61
2.	1	30	18.15	26.13
3.	1	45	34.40	36.04
4.	2	15	20.60	27.03
5.	2	30	37.24	48.65
6.	2	45	46.88	73.87
7.	3	15	48.96	54.95
8.	3	30	88.85	80.18
9.	3	45	96.98	91.89

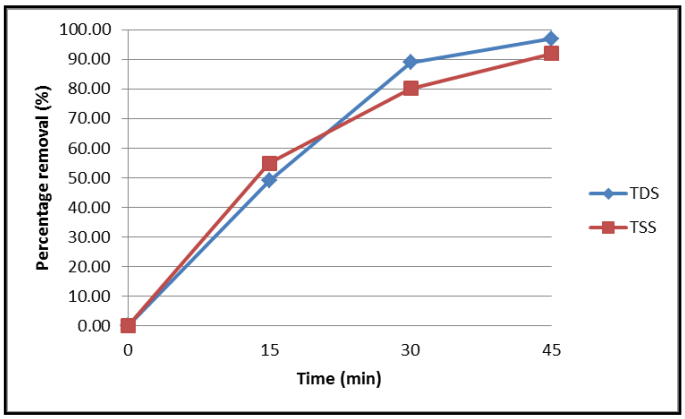
From above observations, it is found that the treatment efficiency of the sample is increases by increasing current density and operation time. AC supply was used instead of DC because an oxide layer is formed on the surface of anode, which decreased the transfer of electrons from anode to solution. Hence, efficiency of the process decreases.



Graph 1: Percentage removal of Total dissolved solid and Suspended solid during electrocoagulation process at 1A current



Graph 2: Percentage removal of Total dissolved solid and Suspended solid during electrocoagulation process at 2A current



Graph 3: Percentage removal of Total dissolved solid and Suspended solid during electrocoagulation process at 3A current

According to graph, between Time and percentage removal of Total solid, Total dissolved solid and Suspended solid at 1A, 2A and 3A current, the percentage removal of TDS is maximum at 3A current and 45 minutes of treatment time. Maximum removal of TDS found out is 96.98% while percentage removal of suspended solids is 91.89.

IV. CONCLUSION

The Electrocoagulation process is prove to be effective treatment method amongst all. It is found that the treatment efficiency of the sample is increases by increasing current density and operation time. The maximum removal of TDS and SS at 3A of current and 45 minutes of treatment time are 96.98% and 91.89% respectively. The removal efficiency also depends on the distance between electrodes and arrangement of the electrodes. The distance should not be less than 1 cm and more than 5cm.

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