Electrocoagulation -A Promising Technology for Sewage Treatment

Shah Kruna A.[1] Prof. M. J. Pandya[2]
[1]M. E. Student, [2]Asso. Professor
[1,2]Department of Environmental Engineering
[1,2]L. D. College of Engineering, Ahemedabad, India

Abstract — Treatment of sewage wastewater has become an absolute necessity because sewage is main point source pollutant on global scale. An innovative, cheap and effective method of purifying and cleaning wastewater before discharging into any other water system is needed. Wide ranges of wastewater treatment techniques are known which include biological process and physicochemical process. Study has been made to replace the biological treatment of sewage by electrochemical process with consideration to achieve desired water quality. Present study was conducted to investigate the applicability of the electro-coagulation technique for the treatment of sewage wastewater. In this study lab-scale electro-coagulation was carried out for the treatment of raw sewage wastewater at different operating time i.e 15min, 20min, 25min, 30min using Aluminum as Cathode and Mild steel as a Anode, with 15mm and 10 mm electrode spacing, supplying 24v and 10amp. It is observed that the batch which is operated at 10Amp for 30 min has maximum removal efficiency of COD & S.S i.e. 95% & 86% respectively at optimum pH 8.3.
Keywords: Sewage, Electro-Coagulation, COD removal

I. INTRODUCTION

Sewage is the main point source pollutant on a global scale [5]. So, direct discharge of raw or improperly treated sewage into the water body is one of the main sources of pollution [5]. Sewage normally consists of biological, chemical and physical constituents which usually high in Bio-chemical Oxygen demand (BOD), Chemical Oxygen Demand (COD) and Suspended Solids (SS). There are two main objectives of wastewater treatment, one is protecting the environment and other is conserving fresh water resources [1].

Nowadays, many treatment plants use the biological process in treating sewage water but there are also disadvantages for that process. Besides, this Conventional biological treatment needs aeration for days and growth of bacteria. To enhance the removal efficiency of Suspended Solids (SS) in conventional treatment, chemical coagulant such as alum, ferric chloride, ferric sulfate and lime are usually used resulting in suspended solid removal efficiency ranging between 80% to 90%. The major disadvantages of chemical precipitation process for the removal of SS and COD are that it involves the addition of chemicals which can be costly and result in the increase of Total Dissolve solids (TDS). Research in the past few decades, have shown that the Electro-Coagulation is a promising treatment method and have potential to treat variety type of wastewater including sewage.

Electro-coagulation treatment offers an alternative to the use of chemical coagulant such as metal salts or polymer for breaking the pollutants because during the Electro-coagulation process, the electrode can generate the metal hydroxides that destabilized and aggregate the suspended particles and precipitates. It is a complex process involving chemical and physical mechanism operating simultaneously to remove the organics from the sewage wastewater. It involves 3 successive stages

1) Formation of coagulants by Electrolytic oxidation of the sacrificial electrode such as mild steel.
2) Destabilization of contaminants, particulate suspension and breaking of emulsion.
3) Aggregation of destabilized phase to floc formation. (Mollah et al., 2014)

Main aim of the study is to investigate the potential of Electro-Coagulation process using Mild Steel electrodes in the removal of COD and SS from Domestic wastewater. The effect of electrolysis time, inter electrode distance for the removal of parameters are discussed.

II. MATERIALS AND METHODS

A. *Sewage Water Samples*

Raw sewage wastewater samples were collected from the Pirana 106 MLD sewage treatment plant located in Ahmedabad, Gujarat. The composition of sewage wastewater then characterized to identify the pH, SS, COD, TDS.

B. *Experimental Set-up*

The batch experimental set-up shown in Fig. 1. The Electrochemical unit consists of an Electrocoagulation cell, a DC power supply and the electrodes (4 Aluminum as cathode and 3 Mild Steel as anode). A Monopolar electrode having same dimensions (230mm X 170 mm X 3mm) as an anode and cathode which spacing of 10mm and 15 mm (depending on the experiment) between each other. The total effective area of electrode was 78200 mm2. All the electrodes were washed with dilute HCl before every experiment conducted.

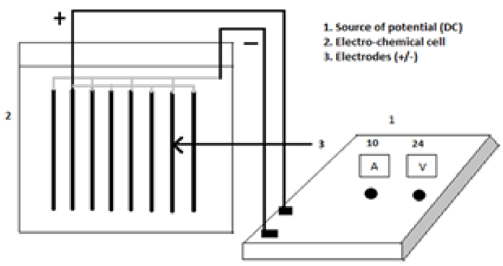

Fig. 1: Schematic diagram of experimental set-up

C. Specifications of lab-scale model

Sr No	Physical Features	Dimensions
1	Reactor Dimensions	380 X 235 X 255 mm^3
2	Liquid Depth	210mm
3	Width of Baffle	50mm
4	Volume of Reactor	22L
5	No of Electrode	4 Al + 3 MS
6	Electrode Dimensions	230mm x 170mm
7	Electrode Area	$78200mm^2$
8	Thickness of Electrode	3mm
9	Distance between Electrode	15 mm & 10mm

Table 1: SPECIFICATION OF LAB-SCALE REACTOR

D. Electrodes for Lab-scale Model

In the present work Aluminum used as Cathode and Mild steel used as Anode. Electrode design is one of the most important factor that affects the Electro-coagulation process. Electrode design affects the release of coagulants in the solution and the bubble type.

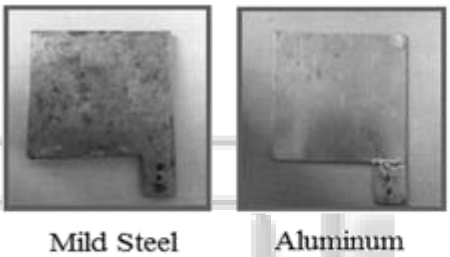

Fig. 2: Electrode Material

E. Experimental procedure

The experiments were carried out in a batch mode. Monopolar electrodes used with electrode distance 15mm and 10 mm. 10 Ampere and 24 volt are fixed in power supply unit. Each run was carried out at time interval of 15min, 20min, 25 min, and 30 min, once the DC power supply was started. Experiments were carried out to Determine the effect of electrode material, Electrocoagulation time, interelectrode distance and initial pH. After the experiment 500ml treated sample was taken from each plate and then kept undistributed for 60 min in order to allow the flocs to settle. Subsequently after settling the sample of supernatant was collected to perform the analysis of TDS, SS and COD.

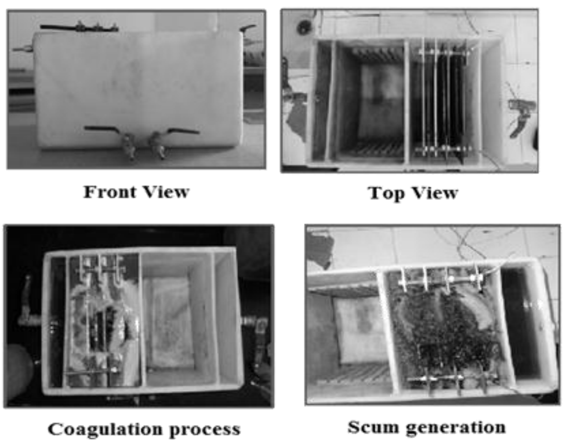

Fig. 3: Electrocoagulation Process

III. RESULTS AND CONCLUSION

A. Characteristics of raw sewage water

Parameter	Avg Value
COD(mg/L)	506
SS(mg/L)	182
TDS(mg/L)	847
pH	7.1

Table 2: Average raw sewage characteristics of 106 MLD, Pirana, Ahmedabad

Parameter	Avg Value
COD(mg/L)	506
SS(mg/L)	182
TDS(mg/L)	847
pH	7.1

B. Effect of electrolysis time

As shown in fig 4 as the time of electrolysis increase comparable changes in the removal efficiency of COD, SS, TDS and pH are observed. Reactive time also influence the treatment efficiency of Electrocoagulation Process because the more time consume the more production rate of hydroxyle and metal ions are produced on the electrodes.

Parameter	Raw	15 min	20min	25min	30min
COD(Mg/L)	457.6	52	31.2	26	20.8
% removal	-	88	93	94	95
SS(Mg/L)	440	120	120	60	60
% removal	-	72	72	86	86
TDS(Mg/L)	790	755	748	742	734
% removal	-	44	53	60	70
pH	7.6	8.0	8.1	8.1	8.3
Energy consumption(kwh/m^3)		6.31	8.42	10.52	12.6

Table 3: Effect of Electrocoagulation time on parameters

C. Effect of interelectrode distance

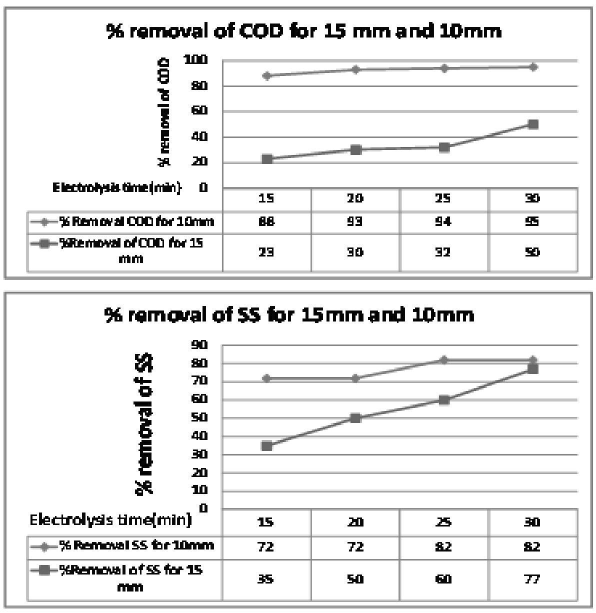

Fig. 4: Effect of inter electrode distance on COD

and SS removal using MS and Al electrode, current density 42A/m2 and for 15 min, 20min, 25min, 30min Ec time.

The effect of interelectrode distance shows a significant result in this experiment.

Electrolysis time(min)	COD(% removal)		SS(%removal)	
	15mm	10mm	15mm	10mm
15	23	88	35	72
20	30	93	50	72
25	32	94	60	86
30	50	95	77	86

Table 4: Effect of electrolysis time on COD and SS removal

As shown in fig 4, when interelectrode distance increases the efficiency of COD and SS removal decreases slightly because the rate of electron transfer is become slower. Variations of the percentage removal with inter electrode distance is shown in figure below.

IV. CONCLUSION

In this study the EC process was found to be an effective method for the treatment of Domestic wastewater. The effect of operational conditions such as electrolysis time, pH and inter electrode distance on removal of COD and SS was examined. The result showed that the removal of COD and SS increase with increase electrolysis time except for pH and inter electrode distance. The highest removal efficiency of COD by 95%, SS by 82% occurred at 42A/m2 current density, 10mm electrode distance and pH 8.3 in 30min of operating time by Mild Steel electrode.

ACKNOWLEDGEMENT

It is indeed a great pleasure for me to express my deep and profound gratitude to Dr. N. S. Varandani, Head of Environmental Engineering Department,

LDCE for providing me an opportunity to work on the Dissertation titled “Comparative Study of Electro-Coagulation and Electro-Oxidation for Oxidation of Organics from Sewage”. Their faith in my abilities has led me to a path of confidence and determination. I express my deep gratitude to Prof. Minarva pandya, Prof.Huma Syed and Prof. Dimpi shah and Mrs Varsha for their stimulating support in various ways. I am also thankful to Sandip Parmar Student of L.D college of Engg who helped me in all way possible to conduct the study and all staff members of AMC 106MLD and 126MLD who helped me a lot for collecting fresh sewage whenever I needed. I equally Thanks to my Family members, to all my friends specially Prashant Thakkar, Monika panchani and other classmates i.e Nilesh, Harshit , Huzaifa, Dharmesh, Ketan, mitul for helping me to complete my work. Last but not the least; I am deeply thankful to all the known and unknown persons who have helped me a little or more towards completion of my task.To those I am sure to miss out, my sincerest apologies.

REFERENCES

[1] Bukhari, A, A. Investigation of the Electrocoagulation treatment process for the removal of TSS from municipal wastewater, bio resource technology, (2008), 99: 914-21

[2] C.sarala, domestic wastewater treatment by electrocoagulation with Fe-Fe electrodes, International Journal of engineering trends and technology, 31(4): 530-33, ,(2012),

[3] ESSEE 4 4th European summer school of electrochemical engineering.

[4] Gauha CHEN, Electrochemical technologies in wastewater treatment, Eco asia conference, pp 1-30, (29/10/2008)

[5] Gijzen, H, Anaerobic digestion for sustainable development: a natural approach. Water science and technology,vol 45, pp 321-28, (2002),

[6] Guohua Chen,1 Xueming Chen,2 and Po Lock Yue, Electro-coagulation and electro Flotation of Restaurant wastewater, JOURNAL OF ENVIRONMENTAL ENGINEERING, vol 126, pp,858-863, SEPTEMBER (2000)

[7] Kaan yetilmezsoy, decolorization and COD reduction of UASB pretreated poultry manure wastewater by electrocoagulation process: A post treatment study, journal of hazardous material), vol 162: pp 120-32, 2009

[8] Nasrullah et al., energy and environmental engineering journal, vol 1(1): 27-3, (2012)

[9] Nikolai P. Shapkin, Eugene K. Papynov, Irina G. Halchenko, Nellie N. Zhamskaya, Perfection of the Electrochemical Method of Sewage Treatment, J. Water Resource and Protection, pp 739-741, 2010

[10] Niraj S topare, sewage wastewater technologies, vol 1(1), pp18-24, 2011

[11] Polish. J of environmental student, (2011), 20(1): 173-79

WEB LINKS

[1] http://www.pjoes.com
[2] http://ascelibrary.org
[3] http://www.ijettjournal.org
[4] http://www.sciencedirect.com
[5] www.wikipedia.com