

ELECTROCOAGULATION OF WASTE WATER BY USING IRON AND ALUMINIUM ELECTRODE

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Abstract—Pollutants in drinking water above permissible level may prove to be hazardous to human health. The present study was carried out to assess the ability of electrocoagulation with Iron and Aluminium electrodes for water treatment process. Electrocoagulation presents a robust novel and innovative alternative in which a sacrificial metal anode doses water electrochemically. This has the major advantage of providing active cations required for coagulation, without increasing the salinity of the water. Electrocoagulation is a complex process with a multitude of mechanisms operating synergistically to remove pollutants from the water. A wide variety of opinions exist in the literature for key mechanisms and reactor configurations. A lack of a systematic approach has resulted in a myriad of designs for electrocoagulation reactors without due consideration of the complexity of the system. A systematic, holistic approach is required to understand electrocoagulation and its controlling parameters.

In this project, electrocoagulation with Iron and Aluminium electrodes will be carried out and a comparative study will be investigated. Several key parameters affecting the efficiency of electrocoagulation will be investigated with laboratory scale experiments in search of optional parameter values. Optimal values of parameters will be determined on the basis of the efficiency of hardness removal from ultrafine suspensions. Various parameters that would be studied are pH, chlorine content, alkalinity and Voltage. Parameters affecting electrocoagulation process, such as initial pH, applied voltage, COD and time of electrocoagulation process would be investigated

Keywords— Electrocoagulation, conventional coagulation, PH, electrolyte, composition, hardness, conductivity, turbidity

I. INTRODUCTION

Today water pollution is a major problem. People have been trying to find out of cost-effective and eas method to purify water. One such sustainable water treatment method is electrocoagulation (EC) which has the potential for treating a wide spectrum of contaminants in drinking water. Electrocoagulation (EC), also known as radio frequency diathermy or short wave electrolysis, is a technique used for wash water treatment, wastewater treatment, industrial processed water, and medical treatment. Electricity-based electrocoagulation technology removes contaminants that are impossible to remove by filtration or treatment systems, such as emulsified oil, total petroleum hydrocarbons, suspended solids, and heavy metals. Presently electrocoagulation is marketed by a small number of companies around the world as it is proving to be an effective method for the treatment of the turbid water for the clarity and purity of water. Since suspension of the clay particles in the water is main reason behind turbidity, EC treatment has been used to coagulate kaolinite and bentonite suspensions. A variety of designs have been employed with no dominant design. Often the electrocoagulation units are used simply as a replacement for chemical dosing systems and do not take advantage of the electrolytic gases produced in the electrocoagulation process. Electrocoagulation – electro floatation (ECF) technology is a treatment process of applying electrical current to treat and flocculate contaminants without having to add coagulants. Stated that coagulation occurs with the current being applied, capable of removing small particles since direct current applied, setting them into motion. Also electrocoagulation could reduce residue for waste production. Electrocoagulation has been proposed in recent years as an effective method to treat various wastewaters such as landfill leachate, restaurant wastewater, saline waste water, tar sand and oil shale wastewater, urban wastewater, laundry wastewater, nitrate and arsenic bearing wastewater and chemical mechanical polishing wastewater. Electrocoagulation consists of pairs of metal sheets called electrodes that are arranged in pairs of two – anodes and cathodes. Using the principles of electrochemistry, the cathode is oxidised (losses electrons), while the water is reduced (gains electrons), thereby making the wastewater better treated. When the

cathode electrons make contact with wastewater, the metal is emitted into apparatus. In addition, electrocoagulation – floatation is capable of reducing wastewater production from waste water treatment and also reduces the time necessary for the treatment. Electrocoagulation systems have been in existence for last many years, using a variety of objects to impart the electrical charge into water, including plates, balls, wire mesh, rods and tubes. With the latest technology, reduction of electricity requirements and miniaturisation of the needed power supplied, EC systems have now become within the reach of water treatment plants and industrial processes to remove heavy metals and COD.

II. MATERIAL AND METHOD

SAMPLE OF WASTE WATER:-

A waste water sample of Kitchen water is collected and a sample of 1000 ml from it will be tested for parameters like hardness, alkalinity, pH and chlorine content.



Fig1 .Supernatant ready for EC treatment

Electrode Material:-

We will use Iron and Aluminium electrodes to carry out this experiment. Both Iron and Aluminium have been proven to be very effective, as explained in this report. Many researchers have confirmed the usefulness of these electrodes as they generate Al^{3+} and Fe^{3+} species which are less soluble. Aluminium electrodes prove to be capable of removing the dispersed particles because of the aluminium hydroxide species derived by them. One of the benefits of using Al electrodes in the physical property point of view is, it doesn't colour the supernatant. Use of these electrodes has been found effective form the removal of metals like Cu^{2+} and Zn^{2+} from the waste water. The use of Al and Fe electrodes have been proved effective in many industrial and domestic waste water treatment along with various pollutants.

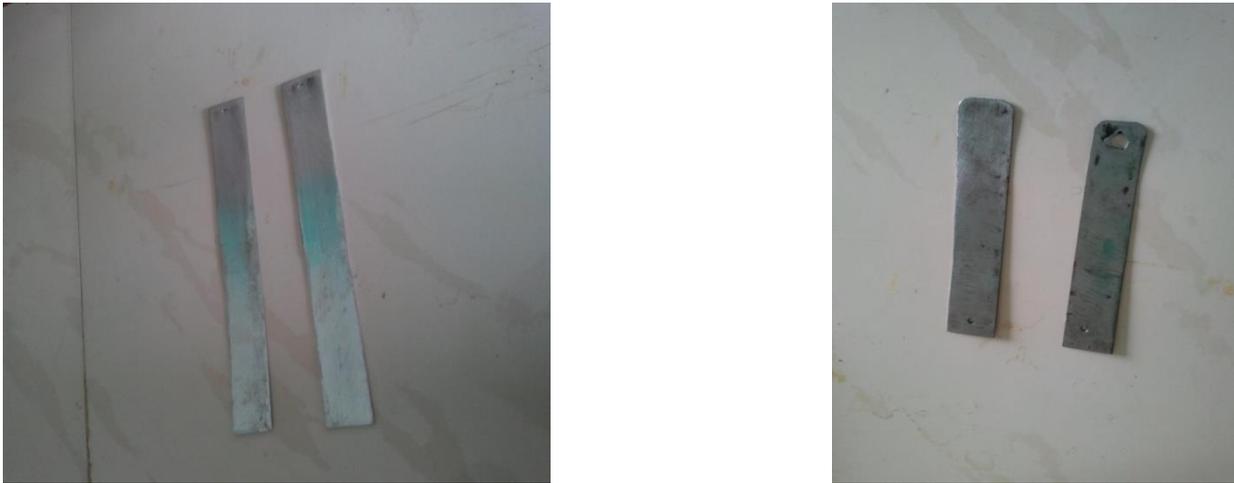


Figure2: Aluminium electrode (left) & Iron electrode (right).



Figure3: Aluminium electrode after experimental run

Experimental Method: -

One litre glass beaker is used as the EC cell with kitchen waste water sample. Two electrodes (of iron and aluminium separately) of size 10cm x 2cm x 0.15 cm for iron and of size 15cm x 2cm x 0.15cm for aluminium were used with depth of immersion 8 cm. The distance between the two electrodes was kept at 5 cm as the maximum removal efficiency was observed at 5cm before. An external DC supply was used to provide the desired voltage.

Experimental procedure:-

The experimentation was done with the sample taken in the beaker and the current was passed through the reactor at different values 15v, 20v, 25v and 30v, for the different time intervals of 5 min, 10min, 15min and 20min. For each voltage value, the current was allowed to pass for the four time intervals mentioned above. The supernatant was sampled in every experimental run for lab analysis at the above mentioned time intervals and were tested to take the altered values of pH, alkalinity and hardness.

The parameters varied were the current and time. Current was varied from 15v to 30v. And the time allowed to get varied from 5 min to 20 min. The consequent changes in the other parameters were recorded after every 5 min for each voltage change and the readings were noted down from the lab tests carried out on each sample. For each voltage, the readings were taken in the tabular form. The hardness values were tested by titration process and pH values were recorded by the digital pH meter.



Figure4: Experimental setup

III. DISCUSSION / ANALYSIS

Observation Table:-

A) For Aluminium Electrode

Taken sample was tested at 15V, 20V, 25V and 30V for 5, 10, 15, 20 min (i.e. intervals of 5 min). The following observations were recorded which clearly state that the parameters- pH, Alkalinity, Hardness and Chlorine content, get reduced with respect to the applied voltage.

For 15 Volts:-

Time (min)	pH	Alkalinity (mg/lit)	Chlorine content (mg/lit)	Hardness (mg/lit)	Hardness Removal Efficiency(%)
Natural Water	8.2	70	204.93	2766.33	0.00
5	8.1	66	194.94	2371.33	14.27
10	8.1	64	189.94	2011.38	27.29
15	8.0	63.81	187.70	1651.04	40.31
20	7.8	63.05	184.25	1421.04	48.63

Table 5.1: Variation in parameters for 15V

This table shows that the parameters pH, Alkalinity, Hardness, Chlorine content of the taken sample were higher initially and get reduced with respect to the applied voltage for the given time intervals.

For 20 Volts:-

Time (min)	pH	Alkalinity (mg/lit)	Chlorine content (mg/lit)	Hardness (mg/lit)	Hardness Removal Efficiency(%)
5	8.0	62.87	175.61	1575.00	43.06
10	7.8	61.71	167.85	1455.00	47.40
15	7.7	60.85	163.21	1291.00	53.33
20	7.8	58.95	160.11	1080.00	60.95

Table 5.2: Variation in parameters for 20V

From the above table it can be said that pH, alkalinity, hardness and chlorine content of the taken sample were higher at initial stage and get reduced more as compared to the initially applied voltage of 15 volts, with respect the applied voltage of 20 volts for the given time intervals.

For 25 Volts:-

Time (min)	pH	Alkalinity (mg/lit)	Chlorine content (mg/lit)	Hardness (mg/lit)	Hardness Removal Efficiency(%)
5	7.9	60.41	155.43	1311.00	52.60

10	7.7	59.66	151.61	1152.00	58.35
15	7.6	58.44	148.34	995.00	64.03
20	7.5	56.31	145.11	810.00	70.71

Table 5.3: Variation in parameters for 25V

From the above table it can be said that pH, alkalinity, hardness and chlorine content of the taken sample were higher at initial stage and get reduced more as compared to the previously applied voltage of 20 volts, with respect the applied voltage of 25 volts for the given time intervals.

For 30 Volts:-

Time (min)	pH	Alkalinity (mg/lit)	Chlorine content (mg/lit)	Hardness (mg/lit)	Hardness Removal Efficiency(%)
5	7.8	58.32	149.61	1095.00	60.41
10	7.6	56.88	147.30	893.00	67.71
15	7.5	53.01	138.80	765.00	72.34
20	7.2	51.21	130.11	659.00	76.77

Table 5.4: Variation in parameters for 30V

From the above table it can be said that pH, alkalinity, hardness and chlorine content of the taken sample were higher at initial stage and get reduced more as compared to the previously applied voltage of 25 volts, with respect the applied voltage of 30 volts for the given time intervals. From this it can be said it reaches to the permissible limits of parameters, like for hardness it's 200-700 mg/lit and for pH it's around 7.

B) For Iron Electrode.

Taken sample was tested at 15V, 20V, 25V and 30V for 5, 10, 15, 20 min (i.e. intervals of 5 min). The following observations were recorded which clearly state that the parameters- pH, Alkalinity, Hardness and Chlorine content, get reduced with respect to the applied voltage.

For 15 Volts:-

Time (min)	pH	Alkalinity (mg/lit)	Chlorine content (mg/lit)	Hardness (mg/lit)	Hardness Removal Efficiency(%)
Natural Water	8.2	70	204.93	2766.33	0.00
5	8.0	63.27	189.04	2011.23	27.29
10	8.0	62.05	188.85	1731.22	37.41
15	7.9	61.85	186.04	1551.22	43.92
20	7.9	61.15	184.00	1301.22	52.96

Table 5.5: Variation in parameters for 15V

This table shows that the parameters pH, Alkalinity, Hardness, Chlorine content of the taken sample were higher initially and get reduced with respect to the applied voltage for the given time intervals.

For 20 Volts:-

Time (min)	pH	Alkalinity (mg/lit)	Chlorine content (mg/lit)	Hardness (mg/lit)	Hardness Removal Efficiency(%)
5	8.0	59.20	173.23	1151.22	58.38
10	7.7	57.06	164.45	1001.22	63.80
15	7.6	55.94	161.02	931.22	66.33
20	7.6	55.04	158.22	895.31	67.63

Table 5.6: Variation in parameters for 20V

From the above table it can be said that pH, alkalinity, hardness and chlorine content of the taken sample were higher at initial stage and get reduced more as compared to the initially applied voltage of 15 volts, with respect the applied voltage of 20 volts for the given time intervals

For 25 Volts:-

Time (min)	pH	Alkalinity (mg/lit)	Chlorine content (mg/lit)	Hardness (mg/lit)	Hardness Removal Efficiency(%)
5	7.8	58.20	171.12	1001.12	63.81
10	7.9	55.10	168.13	931.15	66.33
15	7.6	54.22	165.18	830.89	69.96
20	7.5	52.31	158.00	780.15	71.79

Table 5.7: Variation in parameters for 25V

From the above table it can be said that pH, alkalinity, hardness and chlorine content of the taken sample were higher at initial stage and get reduced more as compared to the previously applied voltage of 20 volts, with respect the applied voltage of 25 volts for the given time intervals.

For 30 Volts:-

Time (min)	pH	Alkalinity (mg/lit)	Chlorine content (mg/lit)	Hardness (mg/lit)	Hardness Removal Efficiency(%)
5	7.8	57.68	165.13	951.83	65.59
10	7.6	54.34	149.23	800.00	71.08
15	7.4	51.12	131.88	705.12	74.51
20	7.1	49.00	115.00	550.16	80.11

Table 5.8: Variation in parameters for 30V

From the above table it can be said that pH, alkalinity, hardness and chlorine content of the taken sample were higher at initial stage and get reduced more as compared to the previously applied voltage of 25 volts, with respect the applied voltage of 30 volts for the given time intervals. From this it can be said it reaches to the permissible limits of parameters, like for hardness it's 200-700 mg/lit and for pH it's around 7.

IV Conclusion

Electrocoagulation is an efficient process to treat waste water characterized by the presence of high concentration of hardness and chlorine content with more than normal pH. In this connection the study was conducted for treatment of kitchen waste water by applying electrocoagulation method. In this study initial parameters like initial pH, hardness, alkalinity and chlorine content were compared for iron and aluminium electrodes. It showed that that hardness removal capability for iron electrode was more as compared to aluminium electrode. The final pH at 30 volts for iron was at 7.1 and that for aluminium was 7.2. Similarly the hardness at the same voltage of 30 volts for iron was 550.78 mg/lit and 659 mg/lit for aluminium electrode for time interval of 20 minutes for each. Thus this indicates that the iron electrode performed more effectively when it came to hardness removal for the same sample.

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