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Treatment of wastewater using Electrocoagulation

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ABSTRACT: In our study we have chosen electroplating wastewater as it contain heavy metals which when consume may affect the human health. And dye industrial water which may affect the aquatic plants and animals and collected leachates which has high organic contents and treated all the wastewater samples using one suitable technique called electro coagulation

KEYWORDS: Electroplating, Dye, Industrial Effluents, Electro-coagulation.

I. INTRODUCTION

One of the major challenges facing mankind today is to provide clean water to a vast majority of the population around the world. The need for clean water is particularly critical in Third-World Countries. Rivers, canals, estuaries and other water-bodies are being constantly polluted due to indiscriminate discharge of industrial effluents as well as other anthropogenic activities and natural processes. The reuse of wastewater has become an absolute necessity. There is, therefore, an urgent need to develop innovative, more effective and inexpensive techniques for treatment of wastewater. Electroplating is the process of depositing a coating having a desirable form by means of electrolysis i.e. by the use of electricity. Its purpose is generally to alter the characteristics of a surface so as to provide improved appearance, ability to withstand corrosive agents, resistance to abrasion, or other desired properties or a combination of them, although occasionally it is used simply to alter dimensions. The process involves the dissolving of metal at the anode and depositing at the cathode by passing electricity through the electrolytic bath. Electroplating industry consumes and discharge large volumes of wastewater. Use of various chemicals and metal salt creates pollution problems. Major pollution caused by rinse water, spray losses and solution dumping and leakages. Dyeing and finishing are the two important processes generally applied in most of the textile manufacturing industries. These two processes generate considerable amount of wastewater, which may contain strong color, suspended particles, high pH and high chemical oxygen demand (COD) concentration. Dyeing mainly aims at dissolving the dye in water, which will be transferred to the fabric to produce colored fabrics. The discharges of industrial wastewater containing dyes cause serious environmental-problems because of its toxicity and possible accumulation in the environment. The presence of even very low concentrations of dyes in water reduces light penetration through the water surface, precluding photosynthesis of the aqueous flora. Color in the effluent is one of the most noticeable indicators of water pollution and the discharge of highly colored dye effluents is aesthetically very unpleasing and can damages the receiving water body by hindering the penetration of light. Electro-coagulation technology offers an alternative to conventional coagulation process, where the metal salts are added to break the stable suspensions of the colloidal particles.

- 1) EC process involves three successive stages: formation of coagulants by electrolytic oxidation of the sacrificial electrode.
- 2) Destabilization of the contaminants, particulate suspension, and breaking of emulsions.
- 3) Aggregation of the destabilized phases to form flocs.

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II. COLLECTION OF SAMPLES

In our study the waste water which has low treatment efficiencies is to be identified based on its characteristics by studying various literature reviews and it is seen that industries like tannery industry, pulp industry, fertilizer manufacturing industry, textile industries effluents discharge was treated by several method and their treatment efficiencies is to be more than 90% but it is identified as the electroplating and dye industries effluent had a low treatment efficiencies of about only 80-85%. And the electroplating wastewater has more heavy metal which has more carcinogenic effects which causes various health problems. And also the effluent of dyes in waste water concentration reduces the photosynthesis process and also causes difficult for the survival of plants and aquatic organisms and we have collected the wastewaters near chintamani where the BSA electroplating industry discharge their water and in gridumal river were the dye effluents are discharged by sri jothi lakshmi industry. The collection of a representative sample is the most important function of an environmentalist, for general physical and chemical examination, the sample is collected in a clean bottle made up of a good quality glass fitted with a glass stopper. All the three types of sample (Grab, Composite, Integrated) are collected. And the leachates are collected from sewage treatment plant at vellakal

The electroplating industry “BSA electroplating and color coating” is located at solaiyalagapuram in Madurai. It is one of the electroplating industries which coat a large number of metals in a day in and around Madurai city. The industry discharges its effluent into river located at chintamani which is 15 km away from the industry without any treatment. The chintamani village has a major cultivation crop as asparagus which grows by the wastewater and it is one of the major populated city in which people depends on water for irrigation purposes, but it is where the effluent from BSA electroplating and color coating industry effluent discharged. The major constituent in electroplating industrial wastewater is heavy metal which leads to human health effects. The dye industry “Sri Jothi Lakshmi” is located near to mahal area in Madurai. The jothi lakshmi industry prepares dyes manually in various colors like red violet, pink and green and dyes to the silk clothes but they do not carry out any treatment process and have not taken preventive measure in discharging their effluents into the Gridumal River, which affects the direct sunlight to pass in to the river and slows down the photosynthesis process and also affects the aquatic flora and fauna.

III. METHODOLOGY

A) DETERMINATION OF pH

pH is a term generally used to express the intensity of the acidic or alkaline condition of a solution. It is a way of expressing the hydrogen ion concentration. It is defined as the logarithm of reciprocal of the hydrogen ion concentration in moles per liter. The pH scale value ranges from 0 to 14; the value of 0 to less than 7 ranges indicates acidity and greater than 7 to 14 alkalinity. The pH value of 7 represents the neutral solution and it has little significance. In our study the meter reading is adjusted to pH 7 using calibrated knob for standardization, the unknown solution is taken in a clean beaker the electrode is immersed into the solution and the compensate knob to set temperature. And the meter reading is noted.

b) DETERMINATION OF TURBIDITY

Turbidity is caused in natural water by finely divided suspended particles of clay, loam and sand or by microorganisms. It is expressed in parts per million by weight as determined by optical observation. The allowable turbidity value in water is 5 to 10 NTU. In our study the cell is inserted into the cell holder and covered with light shield. And the instrument is allowed to warm up for 15 to 20 minutes. The needle is adjusted to zero on panel meter with the help of set zero control knobs. Then the standardized with standard solution of 40 NTU. Then the cell with known sample is inserted into cell holder and the reading is noted down in panel meter.

c) DETERMINATION OF HEAVY METALS

Heavy metals are metallic elements which are very toxic and have a high atomic weight and a relatively high density. The body needs many trace element heavy metals in small concentrations, but there are another 12 poisonous heavy metals, such as lead, mercury, cadmium, chromium and nickel which are bad for the body. These poisonous metals affect our

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enzyme systems and can also affect the metabolism of the body. They are highly toxic and can cause damaging effects to our body even at very low concentrations. Exposure to these elements may cause immediate as well as delayed adverse health effects like the risk of dermal damage, respiratory problems and several kinds of cancer. They tend to accumulate in the food chain and in the body. Once they enter our body they get stored in soft and hard tissues which can cause chronic health effects.

In our study the heavy metal concentration was found out using Atomic absorption spectrometer. At first the sample is digested and kept in the nebulizer and the value of heavy metal to be checked is selected in computer and by selecting the corresponding bulb is turned on that selects the wavelength to pass through the sample. And the heavy metal content is denoted in a digital meter. For this project we considered four toxic metals which are total chromium, cadmium, copper and nickel.

d) DETERMINATION OF TOTAL SUSPENDED SOLIDS

Total suspended solids is the dry weight of particles trapped by a filter. It is a water quality parameter used to assess the quality of wastewater after treatment plant. TSS was previously called non-filterable residue (NFR) but was changed to TSS because of ambiguity in other scientific disciplines.

e) DETERMINATION OF TOTAL DISSOLVED SOLIDS

Total dissolved solids is a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular suspended form. Although TDS is not generally considered as a primary pollutant it is used as an indication of aesthetic characteristics of drinking water. Primary source for TDS in receiving waters are agricultural and residential runoff, leaching of soil contamination and point source water pollution discharge from industrial or sewage treatment plants. In our present study to determine the amount of total dissolved solids present in the waste water a silica crucible is taken and its empty weight is taken as w_1 . About 100 ml of sample is filtered using filter paper, and the silica crucible along with the filtered water is placed in the water bath maintained at 90°C till the water is evaporated to dryness. After drying, the crucible is cooled to a little above the room temperature and kept in a desiccator for 1 hour, and that crucible is weighted as w_2 , the difference between w_1 and w_2 gives the value of total dissolved solids.

f) DETERMINATION OF CHEMICAL OXYGEN DEMAND

C.O.D is defined as the amount of oxygen, expressed in milligram per litre consumed under specific conditions in the oxidation of organic and oxidisable inorganic matter, corrected for the influence of chloride. It indicates the amount of oxygen required to oxidise the carbonaceous matter. C.O.D method recommended as a supplement to B.O.D test, the main advantage of C.O.D test, is that its determination takes 3 hours, compared to more than 5 days for the B.O.D. determination, it is used to measure the pollution strength of domestic and industrial waste.

IV. EXPERIMENTAL SETUP AND RESULTS

The experimental setup requires a DC power supply with a capacity up to 30V and 2 amps, and a magnetic stirrer of 1000 rpm, a beaker of 500ml capacity, a pair of wires, clamp and aluminum and iron electrodes.

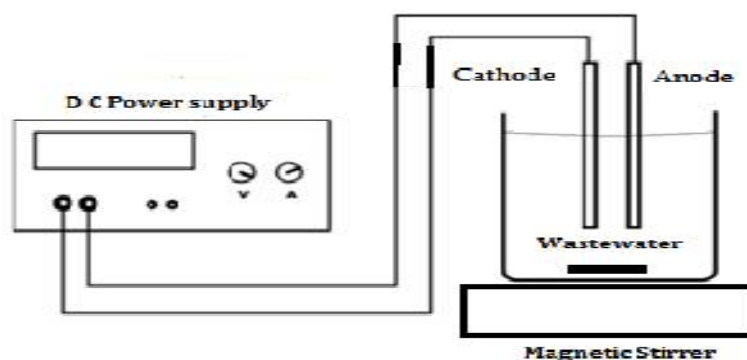


Fig 1 Block diagram of electrocoagulation

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EXPREIMENTAL SETUP FOR ELECTROPLATING WASTEWATER

Here the electroplating wastewater was treated using electro coagulation technique with iron as anode and aluminum as cathode. And a good efficiency was attained at 2 volts at 500 rpm with operating time as 30 minutes.

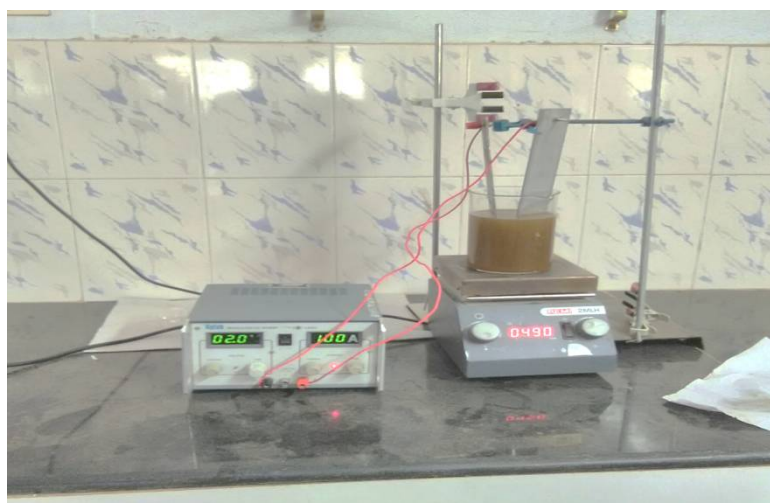


Fig 2 Experimental setup of electroplating wastewater

Table 1 comparison of initial and final values of electroplating wastewater

Volt	pH		Turbidity (NTU)		TSS (mg/l)		TDS (mg/l)		COD (mg/l)	
	Initial	final	Initial	final	Initial	Final	Initial	final	Initial	final
1	2.79	3.42	4	3.67	2500	1285	8600	5090	540	480
1.5	2.79	5	4	3.12	2500	790	8600	2080	540	345
2	2.79	6.69	4	2	2500	480	8600	1900	540	200

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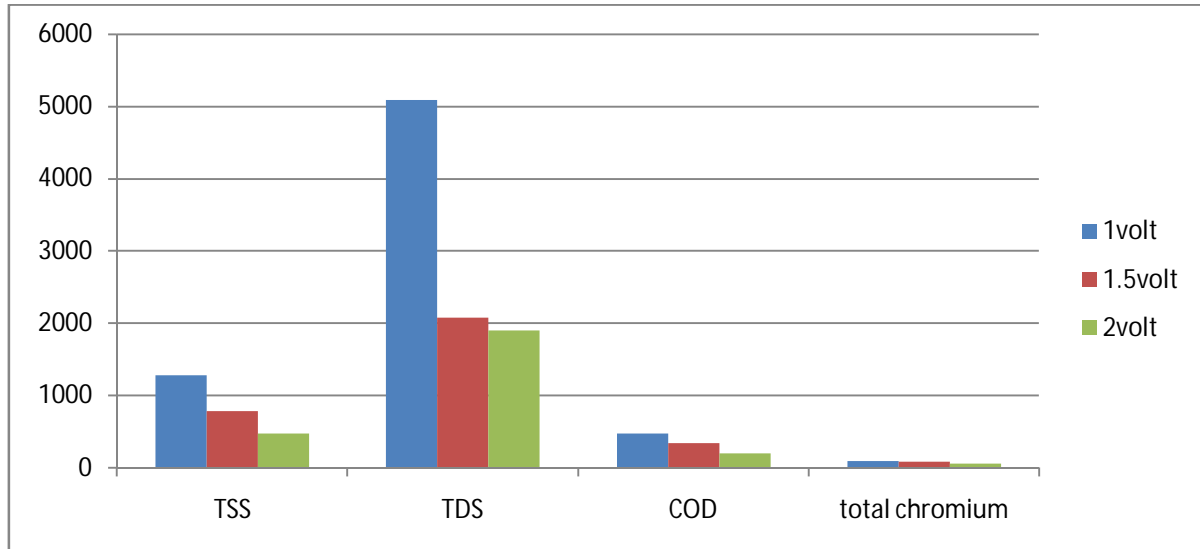


Fig 3 comparison of parameters of electroplating wastewater with respect to volts

EXPREIMENTAL SETUP FOR DYE INDUSTRIAL WASTEWATER

Here the dye industrial wastewater was treated using electro coagulation technique with iron as anode and aluminum as cathode. And a good efficiency was attained at 1 volts at 500 rpm with operating time as 30 minutes.

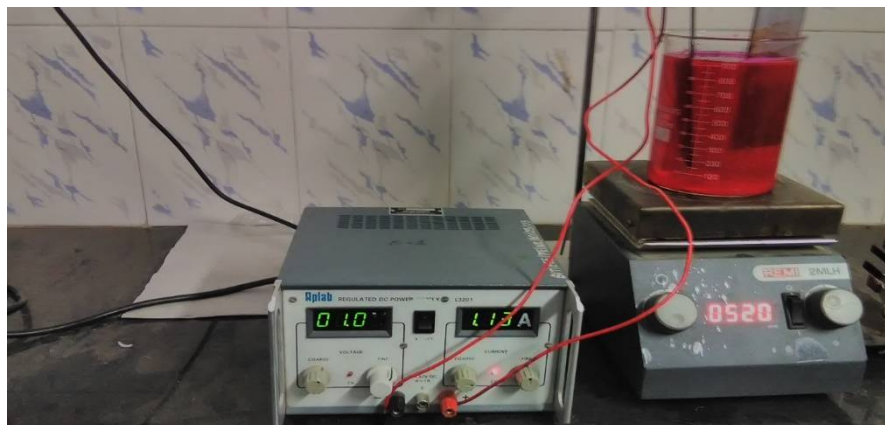


Fig 4 Experimental setup for dye wastewater

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Table 2 comparison of initial and final values of dye industrial wastewater

volt	pH		Turbidity (NTU)		TSS (mg/l)		TDS(mg/l)		COD(mg/l)	
	Initial	final	Initial	final	Initial	final	Initial	final	Initial	final
0.5	3.10	4.80	16.8	12.7	1290	620	800	690	520	300
1	3.10	6.36	16.8	9.12	1290	430	800	515	520	180

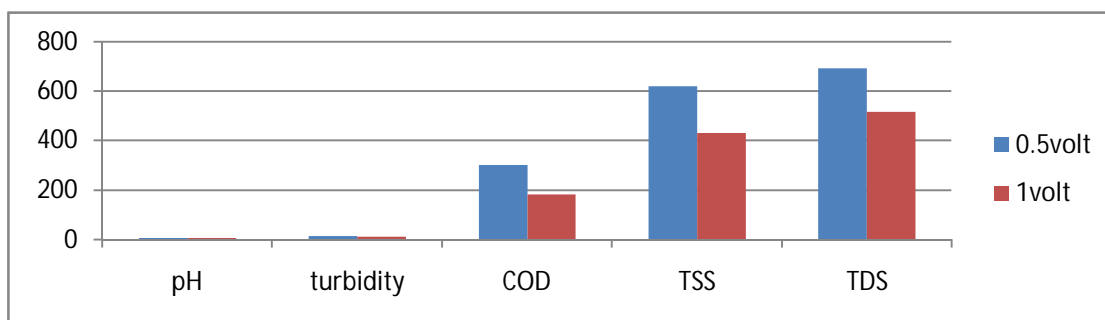


Fig 5 comparison of parameters of Dye industrial wastewater with respect to volts

EXPREIMENTAL SETUP FOR LEACHATE WASTEWATER

Here the leachate was treated using electro coagulation technique with iron as anode and aluminum as cathode. And a good efficiency was attained at 10 volts at 500 rpm with operating time as 30 minutes.

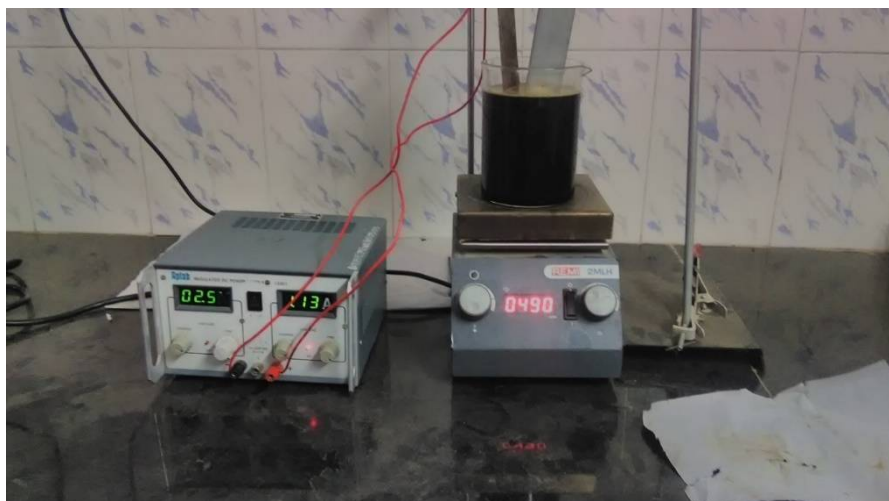


Fig 6 Experimental setup of leachate wastewater

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Table 3 Comparison of initial and final value of leachates

volt	pH		Turbidity (NTU)		TSS (mg/l)		TDS(mg/l)		COD(mg/l)	
	Initial	final	Initial	final	Initial	final	Initial	final	Initial	final
2.5	3.4	4.8	27.8	15.7	780	690	5890	5000	720	609
5	3.4	5.5	27.8	11.3	780	600	5890	4860	720	530
7.5	3.4	7	27.8	10.9	780	554	5890	3090	720	367
10	3.4	7.32	27.8	8.96	780	400	5890	2870	720	200

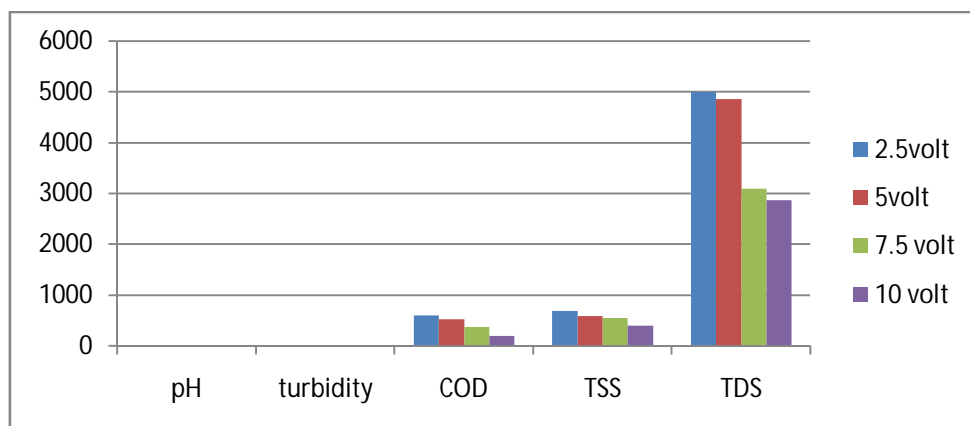


Fig 7 comparison of parameters of Leachate with respect to volts

V. CONCLUSION

Results after characteristic analysis of electroplating, dye industrial and leachates effluents shows that most of their parameters were above permissible limits. Hence they must be treated properly before discharging, and such treatment technology must be effective and efficient for both the effluents. Most of the journals assured that removal of color, heavy metals, toxicity etc... cannot be removed efficiently via conventional treatment methods. With the help of literature survey we have chosen treatment technology called **electrocoagulation (EC)**. Electro-coagulation technology offers an alternative to conventional coagulation process, where the metal salts are added to break the stable suspensions of the colloidal particles. EC is an electrochemical technique for treating polluted water using electricity instead of expensive chemical reagents. Here it is concluded that all the three types of effluent can be treated by electrocoagulation process. And in our upcoming projects a treatment plant using electrocoagulation is to be built and all the types of wastewater in and around Madurai can be treated by electrocoagulation technique.

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