

Characteristic Study of Electroplating and Dye Industrial Effluents

S.Sivasangari ¹, S.Suseendhar ², K.Suresh kumar ³, N.Vijayaprasath ⁴, M.Thirumurugan⁵

Assistant Professor, Department of Civil Engineering, Sethu Institute of Technology, Madurai, India¹

UG Students, Department of Civil Engineering, Sethu Institute of Technology, Madurai, India ^{2,3,4,5}

ABSTRACT: The inherent drawbacks of conventional technologies for wastewater treatment which gives low treatment efficiency, and also the different treatment technique for different type of waste water made to a serious thinking of choosing an appropriate treatment technology. The present study aimed to analyze the characteristics of industrial wastewater, later to propose suitable treatment methodology. Here we have collected the wastewater samples discharged from Electroplating and Dye industries located in and around Madurai District. The characteristic tests of samples were carried out in laboratory, results after characteristic analysis of both electroplating and dye industrial 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. With the help of literature survey we have chosen treatment technology called Electro coagulation (EC). EC is an electrochemical technique for treating polluted water using electricity instead of expensive chemical reagents, an electric field is applied to the electrodes to induce the electrochemical reactions needed to achieve the 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 displeasing and can damages the receiving water body by hindering the penetration of light.

The discharge of effluent in to the water without treatment causes several health and environmental problems

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

hence the main objective in our study is to,

- To study the characteristics of waste water which has low treatment efficiencies.
- The present study is an attempt to determine the extent of pollution in the wastewater of a typical electroplating and dye industry without wastewater treatment and to compare the quality of its wastewater with treatment facilities.

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.

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

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

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 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 DISSOLVED OXYGEN

Oxygen is dissolved in most water in varying concentration. Solubility of oxygen depends on temperature, pressure and salinity of water. It is essential to the life of fish and other aquatic organisms. In industrial waters, dissolved oxygen is as it induces corrosion reactions.

e) 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.

f) 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.

g) 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.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

h) DETERMINATION OF COLOUR IN DYE EFFLUENT

In our study the concentration of dye is determined using spectrophotometer. Spectrophotometer is an experimental technique that is used to measure the concentration of solutes in a specific solution by calculating then amount of light absorbed those solutes. By analyzing the light that passing through the solution, we can identify particular dissolved substances in the solution and how concentrated those substances are.

IV. EXPERIMENTAL RESULTS

The physico-chemical characteristics of the wastewater were analyzed and tabulated as below. The parameters measured were, pH, turbidity, chemical oxygen demand (COD), dissolved oxygen (DO), various heavy metals concentration, total dissolved solids (TDS), total solids (TS) and total suspended solids (TSS).

Table 1 Characteristics of Electroplating Industrial Wastewater

Table 1 Characteristics of Electroplating Industrial Wastewater

PARAMETER	Indian Standards for Permissible Limits as per (IS : 3306 - 2003)	Sample
pH	5.50-9.00	2.79
Turbidity	5 -10NTU	4NTU
Cadmium	1.00 ppm	<0.01 ppm
Total Chromium	2.00 ppm	118.31 ppm
Copper	3.00 ppm	0.6 ppm
Lead	1.00 ppm	1.03 ppm
DO	4 mg/l	Nil
TSS	600 mg/l	2500 mg/l
TDS	3000 mg/l	20600 mg/l
COD	250 mg/l	540 mg/l

The standard unit of turbidity is that produced by one part of finely divided silica in a million parts of distilled water. The allowable turbidity limit in water is 5 to 10 NTU. And the turbidity data helps in determining the special treatment requirement for water before being used for water supply.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

➤The turbidity value of the electroplating wastewater is 4 NTU, as the turbidity range is not within the allowable turbidity limit of waste water the sample is identified as having more volume of suspended particles. The turbidity value of the dye wastewater is 16.8 NTU, as the turbidity range is not within the allowable turbidity limit of waste water the sample is identified as having more volume of suspended particles.

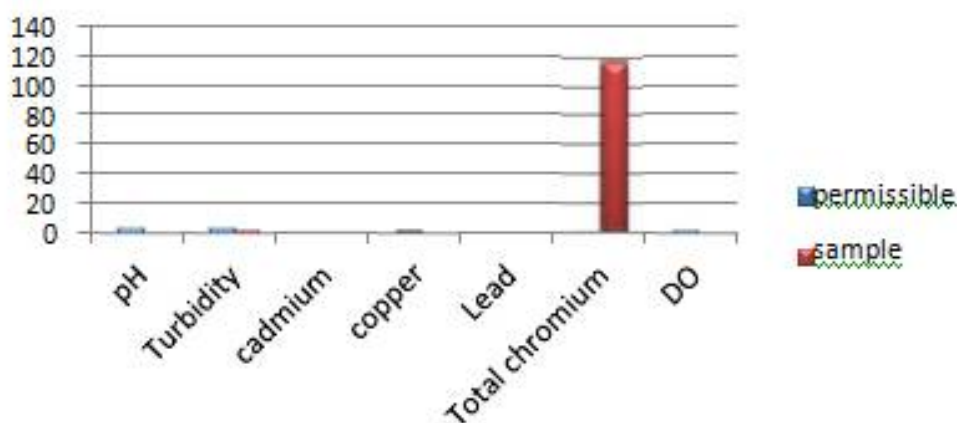


Fig 1 Comparison of Electroplating Sample values with permissible values

In raw water and domestic wastes dissolved oxygen is a factor which determines whether the biological processes undergoing a change are aerobic or anaerobic .It is very desirable that aerobic conditions are maintained. It is a test which can immediately indicate the sanitary status of a stream. Low values of dissolved oxygen adversely affect the portability of water and may cause death of aquatic life.

- Both the wastewater showed that the water has zero dissolved oxygen value.
- Minimum 4 ppm of DO should be maintained in the effluents which are disposed in the water bodies, as if the value of DO is nil then fishes could not survive if the DO is less than 4 ppm, which is also not satisfied here.

Table 2 Characteristics of Dye Industrial Wastewater

PARAMETER	Indian Standards for Maximum Permissible Limits as per (IS : 2490 – part I-1981)	Sample
pH	5.50-9.00	3.10
Turbidity	5 -10 NTU	16.8 NTU
COD	250 mg/l	520 mg/l
TDS	3000 mg/l	800mg/l
TSS	750 mg/l	1500mg/l
colour of dye(Hazen unit)	400	4746

The pH of the electroplating sample is 2.79; from the above table it is clear that the sample is acidic in nature so that it may be not suitable for drinking purposes. The pH of the dye sample is 3.10, from the table 4.3 it is clear that the sample is acidic in nature so that it may be not suitable for drinking purposes. The COD test is based on the concept that a large majority of organic compounds can be completely oxidized by the action of strong oxidizing agents in acidic medium. The quantity of oxygen required is proportional to organic matter.

A single wavelength of light is chosen to make the test effective. The desired wavelength is set the experimental

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

wavelength will always be different color than that of the sample. The blank is placed in the cell holder and the lid is shut. Digital meter can calibrate in the same way as the analog meter the digital meter. Reading is set to zero when blank is placed in holder using adjustment knobs.

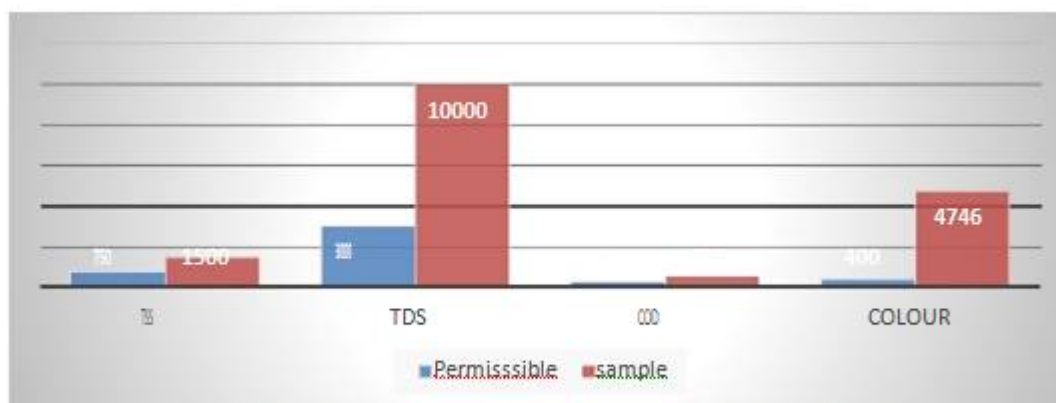


Fig 2 Comparison of Dye Sample values with permissible values

V. CONCLUSION

Results after characteristic analysis of both electroplating and dye industrial 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 **Electro coagulation (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. For more details about EC refer Annexure 1. Here it is concluded that both the electroplating effluent and the dye effluent can be treated by electro coagulation process. The experimental setup is to be done in the upcoming works so that we can treat all the standards of water by electro coagulation technique.

ANNEXURE I

EC was first proposed in London by Vik et al., in 1889 where a sewage treatment plant built and electrochemical treatment has been used via mixing the domestic wastewater with saline (sea)water (I.Kabdasl et al. 2012). The principle of electrocoagulation was first patented in 1906 by A. E. Dietrich and were used to treat bilge water from ships. In the United States J.T. Harries awarded a patent in 1909 for wastewater treatment by electrolysis using sacrificial aluminium and iron anodes. 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 process involves three successive stages: (a) Formation of coagulants by electrolytic oxidation of the 'sacrificial electrode; (b) Destabilization of the contaminants, particulate suspension, and breaking of emulsions; (c) Aggregation of the destabilized phases to form flocs. In electro-coagulation, coagulants are produced in situ within the reactor without direct addition of any chemicals. Coagulants are produced by electrolytic oxidation of appropriate anode materials, such as stainless steel, Aluminium, carbon, graphite, iron etc. Which result in formation of highly charged polymeric metal hydroxyl species. These species neutralize the electrostatic charges on the suspended solids and facilitate agglomeration resulting in separation from the aqueous phase. The technology removes metals, colloids particles and soluble organic pollutants from aqueous media by introducing highly charged polymeric hydroxide species.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

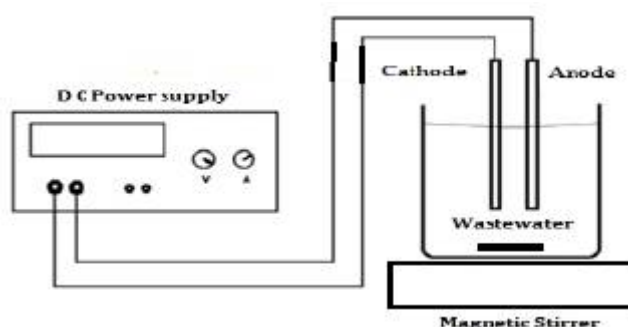


Fig 3 Schematic representation of electro coagulation

The highest efficiency is determined by using different electrodes and varying the volt given by DC power supply. Electro coagulation has the advantage of removing the smallest colloidal particles compared with traditional flocculation coagulation, such charged particles have a greater probability of being coagulated and destabilized because of the electric field that sets them in motion. In this method the water is pumped through a unit which consists of pairs of metal sheets called electrodes, that are arranged in pairs of two anodes and cathode electrodes made of iron or aluminum are installed. A direct current electric field is applied to the electrodes to induce the electrochemical reactions needed to achieve the coagulation. Treated water is discharged from the system for reuse or disposal. Concentrated contaminants in the form of bio solids are collected for disposal or reclamation. When the cathode electrode makes contact with the wastewater, the metal is emitted into the apparatus. Coagulation technology induces coagulation and precipitation of contaminants. In solution the positively charged ions are attracted with the negatively charged hydroxides to produce ionic hydroxides that have a strong attraction towards dispersed particles as well as counter ions to cause coagulation.

REFERENCES

- [1] S.kumarvermal; V.Khandegar,et.al. Removal of chromium from electroplating industry effluent using electro coagulation Journal of hazardous, toxic, and radioactive waste ASCE/ APRIL 2013.
- [2] Abhijit M. Deshpande Ramakant,et.al (2012), Treatment of pharmaceutical Wastewater by Electrochemical Method: Optimization of Operating parameters by response surface methodology. J.Hazard. Toxic radioactive. Waste, 16.316-326 Antony, S.P & Natesan, B.(2012).
- [3] Budiyo, I N Widiasta, and S.M. Hassani, M.R. Khoshchereh (2012); "treatment of dairy Industry Wastewater using electrocoagulation process"
- [4] E.N Vaikosen, et.al (2011); "Evaluation of pharmacognostical parameters and heavy metal in some locally manufactured herbal drugs,"
- [5] N. M salem, A. M. Awwad (2011); "Biosorption of Ni(II) from electroplating wastewater by modified (Eriobotrya Japonica) loquat bark"
- [6] Katal, R.; pahlavanzadesh, H. (2011), Influence of different combinations of aluminum and iron electrode on electrocoagulation efficiency: Application to the treatment of paper mill wastewater.
- [7] O. E. Abdel Salam N.A. Reiad b. M.M. Elshafei (2011); A study of the removal characteristics of heavy metal from wastewater by low-cost adsorbent
- [8] Dermentzis, K., Chistoforidis, et.al (2011) Removal of Hexavaent Chromium from electroplating wastewater by electrocoagulation
- [9] Heidmann, I.; Calmano, W. (2010), Removal of Ni, Cu and Cr from a galvanic wastewater in an electrocoagulation system with Fe-and Al-electrodes.
- [10] O. Apaydin u. Kurt, m.t. Gonullu, (2009) "An investigation on the treatment of tannery wastewater by electrocoagulation"
- [11] IS- 3306 (2003): Indian standard for industrial wastewater- specification, second revision IS 10500, ICS No. 13.060.20, January 2005.