Study and Their Treatment Analysis of Surface Water in Hyderabad City Zone by Electro-Coagulation Method

Prof. Anand K Sheelvanth1 V.Saikiran2 CH Saikrishna3 D.Balshetty4 V.Uday Kumar5

1,2,3,4,5Department of Civil Engineering

Vidya Jyothi Institute of Technology, Hyderabad, India

Abstract — Electrolytic treatment of surface water utilizes the electric energy to removal the pollutants in the form of TDS from the surface water. Considerable efforts have been made to purify the different types of Surface water using various electrolytic treatment devices, apparatus and reactors. The present review focuses on the recent development in the electrolytic treatments considering the views of the past work in this field. Most studies have been performed on iron, steel, aluminium and zinc electrodes using various current densities and electrolysis time. Moreover, these studies have been carried out on the removal of different physico-chemical, heavy metals and microbiological parameters using different types of Surface water. In this review the main emphasis has been given to the removal of physico-chemical parameters viz., colour, turbidity, EC, TSS, BOD, COD and heavy metals of the Surface water. The literature on the electrolytic treatment methods using different types of Surface water is surveyed and physico-chemical parameters of Surface water are reviewed. Besides this impact of current density, electrode types, time of electric current application along with the removal efficiency are also discussed in the present review. Additionally, various aspects of the electrolytic treatment of Surface water like impact of temperature, coagulation and flocculation rate are also discussed to make the literature more specific and generalization to understand the electrolytic treatment of Surface water. Therefore, the future directions of the research could be focused on the more efficient removal of pollutants from the Surface water using electrolytic technology in order to achieve the safe limits of Surface water for the reuse and discharge as per water quality standards.

Keywords: Coagulation, Electrochemical Treatment, Electrocoagulation, Electrode, Surface Water Treatment

I. INTRODUCTION

Water is clear colourless liquid, odourless and tasteless when pure, that occurs as rain, snow, and ice. Forms rivers, lakes, and seas, and is essential for life. Naturally occurring water picks up color and taste from substances in its environment. The World’s total water sources are estimated to be 1.36 x 108 M ha-m. Among these water sources, about 97.2% is saline water and mainly available in oceans, and only 2.8% is available as fresh water. Out of these 2.8% of fresh water, about 2.2% is available as surface water and 0.6% as ground water. Out of this 2.2% of surface water, 2.15% is fresh water in glaciers and icecaps and only of the order of 0.01% is available in lakes and streams, the remaining 0.04% being in other forms. Out of 0.6% of stored ground water, only about 0.25% can be economically extracted with the present technology. Pollution is the act of making something impure or unclean, or cause harm to an area of the natural environment, usually by introducing chemicals, waste products, or similarly damaging poisonous substances. Many industries introduce unused raw materials, useless byproducts, and process aid chemicals to the water streams causing water pollution. One of such industries is the chemical and petroleum industries.

II. TREATMENT TECHNOLOGIES

Treatment of water is one of the serious problems. Various treatment technologies such as physico-chemical treatment, composting and biological treatment are available for the treatment of Surface Water. Owing to the high organic matter, Surface Water is well suited for biological treatment. A wide range of Surface Water treatment techniques are known which includes biological processes for nitrification, denitrification and phosphorous removal; as well as a range of physico-chemical processes that require chemical additions. Physico-chemical treatment processes like coagulation/flocculation and membrane process are required to remove suspended, colloidal, and dissolved constituents. Coagulation/flocculation is a frequently applied process in the primary purification of Surface Waters.

Among various physico-chemical treatment methods, adsorption has found to be attractive for the removal of Organic compounds in Surface Waters.

The commonly used physico-chemical treatment processes are filtration, air stripping, ion-exchange, chemical precipitation, chemical oxidation, carbon adsorption, ultrafiltration, reverse osmosis, electro-dialysis, volatilization and gas stripping. A host of very promising techniques based on electrochemical technology are being developed and existing ones improved that do not require chemical additions. These include Electrocoagulation, Electro-flotation, Electro-decantation, and others. Even though one of these, Electrocoagulation, has reached profitable commercialization, it has received very little scientific attention. This process has the potential to extensively eliminate the disadvantages of the classical treatment techniques [5]. Conventionally, physical and chemical processes, such as adsorption, chemical oxidation and biochemical treatment methods treat the effluent.
III. OBJECTIVES
The main objective of the study is to explore the possible use of Electrocoagulation (EC) as a novel treatment option for treating the Surface Water, with the following objectives.
1) To determine various physico-chemical parameters of Surface Water.
2) To arrive at optimum electrolysis time and pH for efficient treatment of Copper and Aluminium electrodes.
3) To study the effect of different cell voltages in batch mode under optimum operating conditions (time, pH) for Copper and Aluminium electrodes.
4) To find out the removal efficiency at varying voltages with respect to COD, Total Solids, Total Dissolved Solids, Suspended Solids, Chloride, Sulphate and Phosphate keeping optimum time and pH.
5) To compare the Anode dissolution and Energy consumption of both Copper and Aluminium electrodes.

IV. MATERIALS AND METHODOLOGY
A. Components of Electrocoagulation Unit
The components of Electrocoagulation unit are discussed below:
1) Electrochemical Reactor
Electrolysis experiments are carried out in a cylindrical shape borosil glass reactor of 1 liter capacity.
2) Electrodes
The key for an efficient electrolytic treatment is strongly based on the Anode material. Electrode assembly is the heart of treatment facility. Therefore, the appropriate selection of Anode material is very important. The most common electrode materials used for Electrocoagulation are Aluminium, copper, stainless steel and Copper. They are cheap, readily available, and proven effective. Hence in the present study Copper and Aluminium plates are selected as Anode electrode material. Experiments are carried out firstly with Copper plates as electrode material with dimension of 10cm×5cm and later with Aluminium plates with same dimension as shown in Plate No. 3.1 and Plate No. 3.2. The shape of electrode is rectangular ‘I’ section with thickness of 1mm and are placed 1cm apart. At the end of each experimental run, the electrodes are washed thoroughly with water to remove any solid residues on the surfaces, dried and re-weighted.

Plate 3.1 Copper plate

Plate 3.2 Aluminium Plate

V. EXPERIMENTAL METHODOLOGY
The study consists of lab-scale batch system, which is composed of an electrolysis cell, a power supply system and a magnetic stirrer unit. The electrolysis cell made of borosil glass beaker with an effective volume of 1L and with bipolar electrodes in parallel connection. Schematic diagram is shown in Fig 3.2. The Copper cathode and Copper Anode consist of pieces of Copper electrodes separated by a space of 1 cm and dipped in the Surface Water. The electrodes are connected to the positive and negative terminals of the DC power supply in laboratory as shown in fig No.3.3. In this study, an individual effect of Cell Voltage, applied pH and Electrolysis time are studied. Each experiment is a batch operation, for every 20 minutes samples are drawn and COD is measured. At the end of each experimental (i.e. after Electrocoagulation) run, the sample is transferred into another beaker and kept undisturbed for 30 minutes in order to allow the flocs that formed during Electrocoagulation to settle down. When too large current is used, there is a high chance of wasting Electrical Energy in heating up the water. More importantly, a too large current density would result in a significant decrease current efficiency.

Fig. 3.2: Schematic diagram of Experimental Reactor Setup

Fig. 3.3: Experimental Setup of Electrocoagulation Unit in laboratory
VI. RESULT AND DISCUSSIONS

A. Effects of Operating Parameters

The Electrocoagulation process is affected by several operating parameters, such as initial pH, applied current density and electrolysis time. In the present study all these have been explored in order to evaluate efficient treatment for Surface Water.

B. Effect Of Electrolysis Time (ET)

The batch study is conducted with a working volume of the reactor of about 1000mL. The initial sets of experiments are carried out using Copper electrodes and later by using Aluminium at the existing Surface Water sample pH 13.3. Experiments are performed, by varying the voltage that is at 8V and 10V using the Copper electrodes for 3 hours (180 minutes) and samples are collected at regular interval of 20 minutes and analyzed for COD to calculate the COD removal efficiency and same process is repeated for Al electrode.

It is established that pH is an important operating factor influencing the performance of Electrocoagulation processes. To examine its effect, individual experiments are conducted by varying Surface Water pH 6.0, 7.0, 8.0, 9.0, 10.0 and 11.0. From the experimental results the optimum time obtained for both the electrodes are 120 min. The pH of Surface Water is adjusted by adding 0.1 N Sodium Hydroxide or 0.1 N Hydrochloric acid to get the desired pH throughout each run. Experiments are performed at pH 6, 7, 8, 9, 10 and 11 at fixed voltage i.e. 10V and the samples are collected for every 20 minutes and analyzed for COD.

C. Anode Dissolution

Anode dissolution is obtained by calculating the weight difference of electrode before and after each experiment. Table 4.9 and Figure 4.17 represent the value of Anode dissolution of Copper and Aluminium electrode. The values are found different at different voltages for both the electrodes. The low Anode dissolution is observed for Copper and Aluminium electrode at 10V. The high value of Anode dissolution is found at 16V for both the electrodes, but compared to Aluminium electrode the Copper electrode showed the maximum COD removal efficiency.

VII. CONCLUSIONS

On analyzing the results based on the laboratory experiments conducted, the following conclusions are drawn:

- The maximum COD removal efficiency of 58.47% (8V) and 65% (10V) for Copper whereas 32.7% (8V) 38% (10V) for Aluminium is achieved in 120 minutes of electrolysis duration at a pH of 13.3 (sample pH) which is considered as Optimum Electrolysis Time for both electrodes.
- It is found that Copper and Aluminium electrode showed maximum COD removal efficiency of 71.07% and 61.26% at pH 9.0 and 7.0 at a constant voltage of 10V.
- Voltage value of 16V is found to be Optimum Voltage for both the Electrodes.
- With Copper electrodes at optimum pH of 9, 16V and time of 120minutes the maximum removal efficiency of COD 79.86%, TS 62.80%, TDS 67.52%, SS 75.83%, chloride 70.17%, sulphate 62.81% and phosphate 71.11% respectively.
- With Aluminium electrodes at optimum pH of 7, 16V and time of 120minutes the maximum removal efficiency of COD 63.20%, TS 47.60%, TDS 55.11%, SS 59.55%, chloride 53.65%, sulphate 54.78% and phosphate 53.38% respectively.
- It is observed that high Anode dissolution of Copper and Aluminium electrodes 1.51g/L and 1.22g/L respectively, at a optimum pH of 9 and 7, time of 120minutes at 16V.
- The Energy consumption is found to be more for Aluminium electrode that is 13.49 kWh/kg of COD than for Copper electrode with 10.81 kWh/kg of COD at 16V.
- Compared to Aluminium electrode, Copper electrodes found to be more efficient electrode material in treatment of Surface Water in terms of removal of COD, TS, TDS, SS and phosphate.

REFERENCES

Study and Their Treatment Analysis of Surface Water in Hyderabad City Zone by Electro-Coagulation Method
(IJSRD/Vol. 11/Issue 3/2023/018)

All rights reserved by www.ijsrd.com


