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Removal of Para Chlorophenol (PCP) From Wastewater Using Aluminium/Graphite Electrode by Electrochemical Method

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Abstract- An experimental study was conducted to evaluate the feasibility and application of aluminum/ Graphite Electrode in electrochemical method for the removal of Parachlorophenol from Wastewater under local conditions. Removal of PCP is important issue in the world, as PCP is carcinogenic, skin sensitive, bones and lungs damage compound. A sample was prepared in laboratory, obtained 1500 ml of 200ppm p-Cholorophenol and treated in reactor in which Aluminium electrodes & Graphite Electrode installed. Added 0. 5 gm NaCl into remedy as reaction enhancer. Factors affecting on the removal of Para Chlorophenol was investigated are; varying electric voltage (10 Volts,20 volts), varying treatment time (20 Min, 60 Min) and different electrodes (Aluminium, Graphite). After treatment sample was tested by Gas Chromatography which given PCP values (0.998-0.999). it was investigated from results that removal efficiency of Para Chloro phenol increased with increasing voltage supply (20 Volts), reaction time (60 Min) and Aluminium Electrode. According to these results, the effect of Treatment time on the removal of Parachlorophenol is more than Voltage and Aluminium Electrode. Aluminium electrode efficiency is high than Graphite. When we compare Time & voltage, time & different electrodes, then removal efficiency is maximum at higher time, higher voltage and by using Aluminium electrode.

Keywords: Electrochemical, Para Chlorophenol, Wastewater, Aluminium Electrode

I. INTRODUCTION

The present *Study* summarizes the results of an extensive dealing with electrochemical oxidation Techniques, which is proposed as an alternative for treating polluted wastes. Both the direct and indirect approaches are considered, and the role of electrode materials is Wastewaters Treatment is an important issue in these days in the world. More regulations are being forced, which continue on the need to create and utilization of advance treatment to manage contaminations from different waste streams [1].

Wastewater containing phenolic mixtures presents a genuine release issue because of their poor biodegradability, high poisonous and biological viewpoints [2]. Phenols are generally circulated as natural toxins. They exist in distinctive fixations in wastewaters arranged from numerous mechanical procedures, coking, manufacturing of elastic, plastics, paper, petrochemical, commercial gums , steel and from oil refineries as well as transformation procedures [3,4]. Phenolic compounds are considering major components of pollutant as they are adversely effect on living organisms at small traces and several of them have been classify as harmful pollutants because of their prospective destruction to human being [3]. Due to high toxicity of phenols, these compounds drainage was controlled under particular polices, as well as utilization of this compounds releasing Para Chlorophenol can be avoided by substituting all of them having safe chemical substances. [5]. The environmental protection agency (EPA) requires bringing down phenol in the wastewater to be less than 1mg/ L[1,6].

Wastewaters comprising phenols and other toxins require watchful remedy just before release in to the getting figures associated with drinking water. Carbon dioxide adsorption, solvent extraction, element oxidation, biological degrading and electrochemical techniques are the most options for eliminating phenol and phenolic materials from wastewaters [7–12]. These techniques are highly costly, poor results, along with long time treatment regarding toxic by-products [13]. Conversely, electrochemical techniques along with utilization of electrode is fast as well as not addition of harmful reagents. [14].

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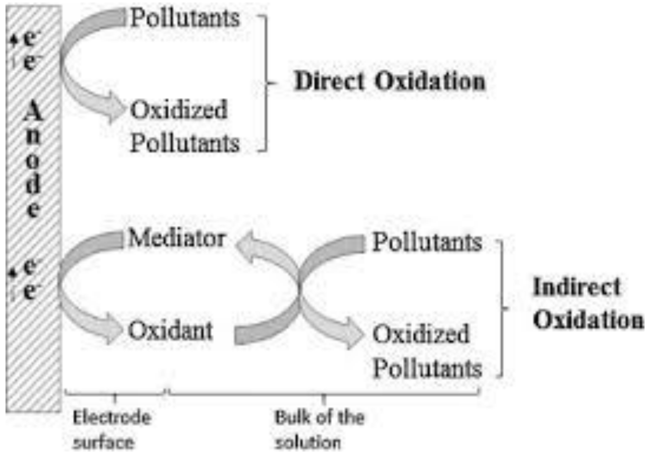

Fig.1. Direct and Indirect Oxidation Diagram

During electrochemical procedure, the actual air-borne pollutants tend to be damaged by means of both primary and indirect oxidation procedure. In primary anodic oxidation procedure, the actual air-borne pollutants tend to be initial adsorbed on anode floor and damaged through the anodic electron shift reaction. In indirect oxidation procedure, strong oxidants like hypochlorite/chlorine, ozone, hydrogen peroxide tend to be electrochemically produced [15,16]. This system is dealing with tannery wastewater using Ti/Pt in addition to Ti/Pt/Ir anodes. In the same way, tannery wastewater with first COD price regarding 9600 mg/L seemed to be cared for using graphite anode. With perfect recent (34 mA/cm2) occurrence in addition to 120 minute regarding electrolysis, a final COD regarding 59 mg/L seemed to be purchased [17]. done trials using 7 unique electrode materials with the destruction regarding spread chemical dyes. The top benefits ended up purchased in the chloride abundant moderate under acidic pH using Ti/Pt–Ir anode [18].

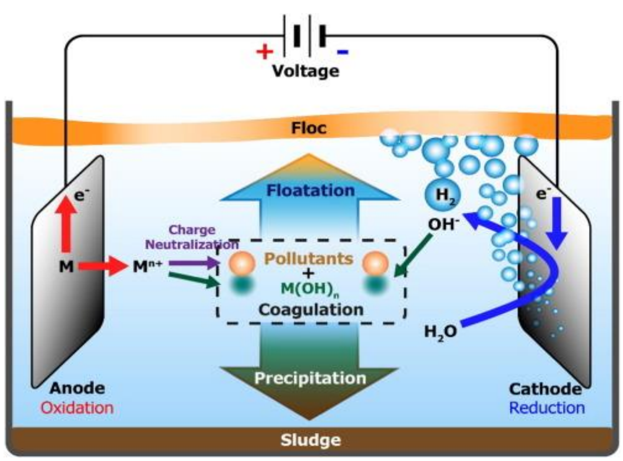

Fig.2.Process explanation Diagram of Electrochemical oxidation

Refinery throw away water consists of larger awareness of phenolics than some other effluents.

Table 1.1: Wastewater Data generated by the different refineries. [19]

Parameter	Values
BOD	150-250mg/L
COD	300-600mg/L
Phenol	20-200mg/L
Desalted water	100-300MG/L
Oil	5000MG/L
Benzene	1-100mg/L
Heavy Metal	0.1-100mg/L

Vlyssides in addition to Israilides [20] researched electrochemical destruction regarding fabric colouring in addition to polishing off wastewater using Ti/Pt anode. Towards the end regarding forty five minute regarding electrolysis, there was clearly 92% COD, 80. 2% BOD in addition to 94% colouring reduction with power consumption of 44 kWh/kg regarding COD treatment. Elimination and destruction associated with pollutant types can be carried out specifically or even not directly by means of electrochemical oxidation: decrease operations in an electrochemical cell without continual feed associated with redox chemical substances. Additionally, your higher selectivity of numerous electrochemical operations

Attractive aspects of electrochemical operations are usually:
1. Flexibility — immediate or even indirect oxidation and decrease, step splitting up, attention or even dilution, biocide features, applicability all phases of matters from lab scale to industrial level.
2. Power performance — electrochemical operations typically consume less power as special Electrode and tissue is designed for this operation.
3. Amenability to automation — the system untouched variables associated with electrochemical operations, e. g. electrode prospective and cell current, are usually specially ideal for assisting method automation.
4. Price tag usefulness — cell constructions and peripheral equipment are usually easy and, in the event properly made, additionally inexpensive. Such as electronic digital conductor (the electrode) and a good ion completing channel (the electrolyte). Meaning which the functionality associated with electrochemical operations which are easy to handle and control [21–28].

2. EXPERIMENTAL

We prepare synthetic sample of Chlorophenols in the laboratory Major goal was right here to remove p-Chlorophenols. Numerous approaches can be obtained to treat p-Chlorophenols. Electrochemical procedure was acquired for this reason. Electrodes associated with unique materials (Graphite, Aluminium) are employed to carry out experiment.
Share remedy in the phenol was made by with a weight of the filtered p-Chlorophenols in addition to dissolving the

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item throughout distilled water. Fresh types of the 200 ppm concentration have been attained simply by effective dilution. Reactors associated with rectangle-shaped condition in addition to 2000 ml potential in addition to electrodes composed of aluminium in addition to graphite have been employed. Mileage in between electrodes associated with Aluminium was with regards to 3 cm, length 13. 5 cm in addition to size was 3 cm. Mileage in between electrodes associated with graphite was with regards to a couple of. 5 cm, length 10 cm in addition to normal dimension was 0. 92 cm.

treated samples is characterized by Gas Chromatography.

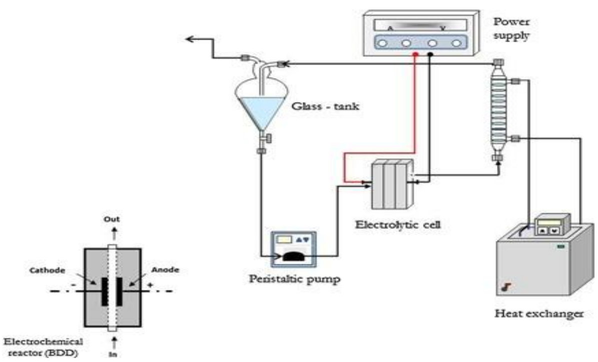


Fig.3.Bench Diagram of Electrochemical oxidation process

Laboratory work range reactor that contains Aluminium electrodes was obtained. 1500 ml associated with 200-ppm 4-cholorophenol remedy was put into reactor. 0. 5 gm NaCl was in addition put into remedy.

Analysis of variance (ANOVA) is a new statistical method and that is utilized to investigate in addition to type the relationship in between an answer varied in addition to a number of unbiased specifics. Every informative varied (factors) includes several types (levels). ANOVA assessments the null speculation null speculation the people methods of each and every levels are identical, as opposed to the alternative speculation option speculation of which one or more in the levels means will not be most identical.

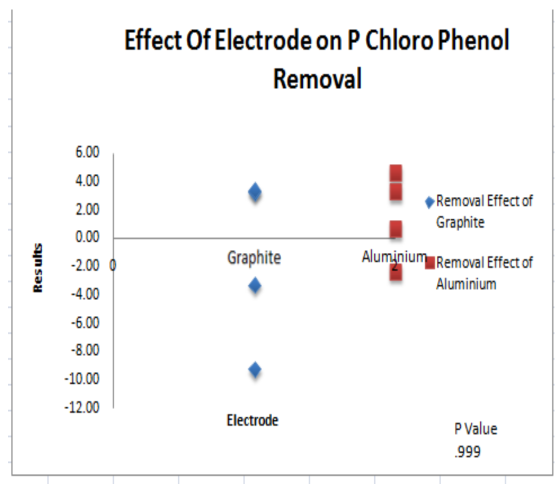
Factor A: Different types of electrodes (Graphite & Aluminium) **Factor B:** Therapy time period intended for Para Chloro Phenol removing (20 minutes, 60 minutes)

Factor c: Voltage change of which small sample is treated (10 V, 20 V)
We develop the design structure for the experimentation according to full factorial design method which says 3 factor having two levels totally need 8 runs. In these 8 runs we perform experimentation at different electrodes (Graphite, Aluminium), at different treatment time (20 min, 60 min) and at different voltage (10 V, 20 V). Firstly, we treat the sample for different Electrode (Graphite, Aluminium) for a specified period of time. Similarly, we performed the experiment for Varying Treatment time and Varying Voltage. We also performed the experimentation to see the interaction effect of time & electrode, time & voltage and voltage & electrode. After All we test the sample on Gas chromatograph to check the Para chloro phenol removal from the wastewater. The results obtained from Gas Chromatograph test were plotted in the form of graphs.

III. RESULTS AND DISCUSSION

3.1) Effect Of Electrode on Removal of P- chloro Phenol

The sample after treatment tested on Gas Chromatograph and the results obtained used in the Analysis of variance (ANOVA). Results are calculated in terms of effect of electrode on the removal efficiency of Para Chloro Phenol & p value. The results show that the effect of Aluminium electrode on the removal efficiency of Para Chlorophenols is more than Graphite electrode.
The P value is .999 which indicates that the effect of electrode on Para Chloro Phenol Removal more important and can't be neglected in the treatment of waste water.



3.2) Effect Of Time on Removal of P- chloro Phenol

In this experiment we treated the synthetic sample for 20 minutes and 60 minutes by electrochemical method and after the treatment we tested the sample on the Gas Chromatograph and the results obtained used in Analysis of variance and obtained the results in terms of effect of treatment time on the removal of Para Chloro Phenol. Results are utilised to generate the graph which shows that at lower treatment time the efficiency is less when we increase the treatment time of sample as a result Para Chlorophenols presence in the waste water decreases.

The P value of the Time factor is also calculated which is .998 which shows that time is also most promising factor in electrochemical treatment process.

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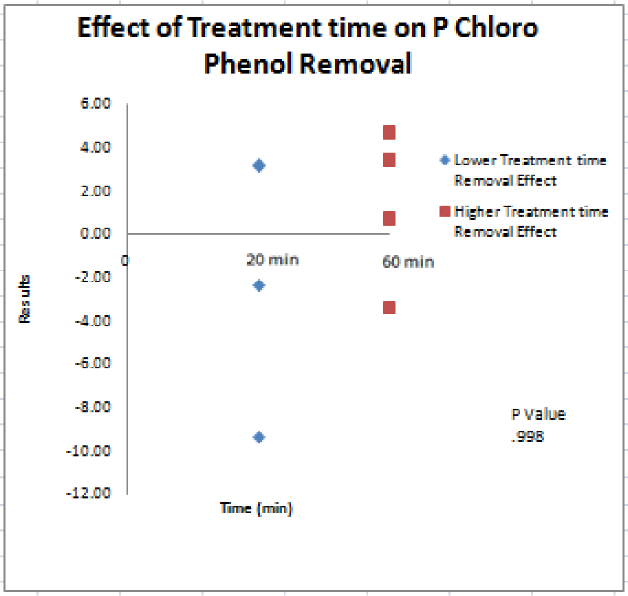
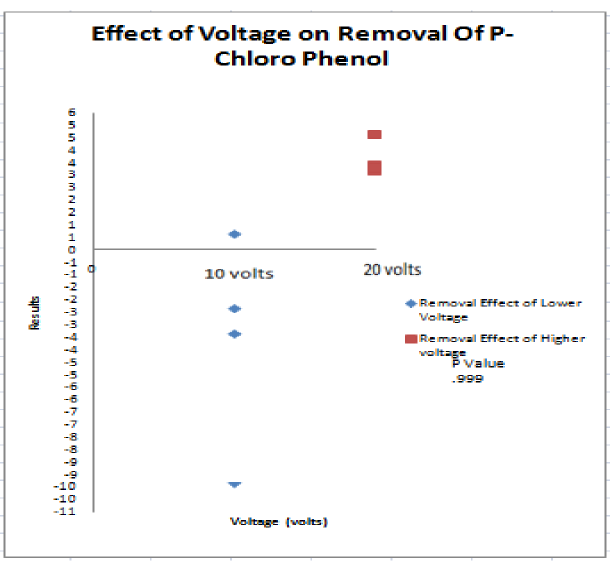


3.3) Effect of Voltage on Removal of P- chloro Phenol

The sample was treated for 10 Volts and 20 Volts. After that it was tested on the Gas Chromatograph and results were used in the analysis of variance (ANNOVA). The results in terms of effect of voltage on the removal of efficiency of Para Chloro Phenol are plotted in the graph which shows that at lower voltage (10 volts) removal efficiency is less as soon as we increase the voltage from 10 to 20 volts the removal of Para Chloro Phenol will increase which shown on the graph.

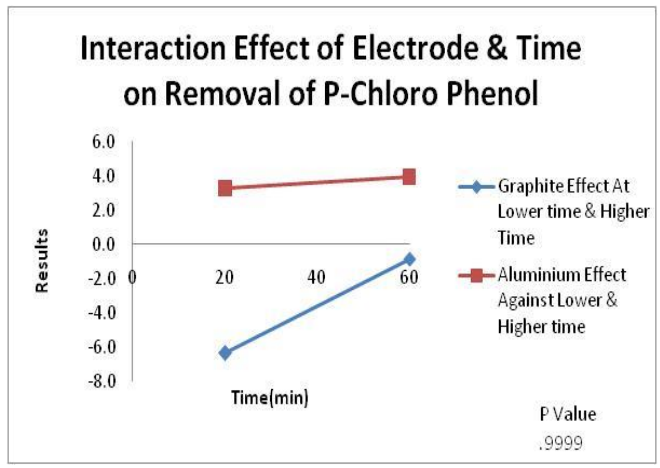
The P value of the Voltage factor is also calculated by using ANNOVA which is.999 which representing that it is also most important factor in the removing of Para Chloro Phenol.



3.4) Effect of Electrode & Time on removal of P- chloro Phenol

In this experiment we treated the sample for two parameters e.g. electrode and time. We treated the sample at fixed time 20 min & 60 min by using Graphite & Aluminium Electrode. The sample was tested after on Gas Chromatograph to check the efficiency of treatment. The results are shown on the graph which shows that for the same treatment time the removal results obtained by using Aluminium are more promising the Graphite electrode.

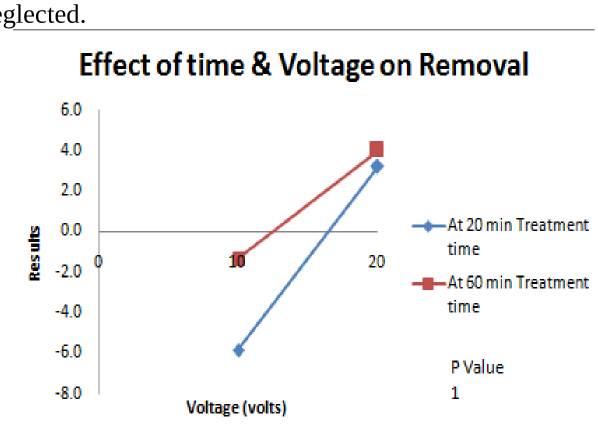
The P value calculated by using ANNOVA for interaction effect of electrode & time is .9999 which indicate that it is also important factor for removing the Para Chloro Phenol



3.5) Effect of Time & Voltage on Removal of P- chloro Phenol

Treating the synthetic sample at fixed time & voltage and after treatment the results were checked on the GC and then plotted on graph which shows that at higher voltage and time the removal efficiency of Para Chlorophenols are more than at lower time and voltage.

The P value for interaction factor of time & voltage is one which shows that it is more important factor cannot be neglected.



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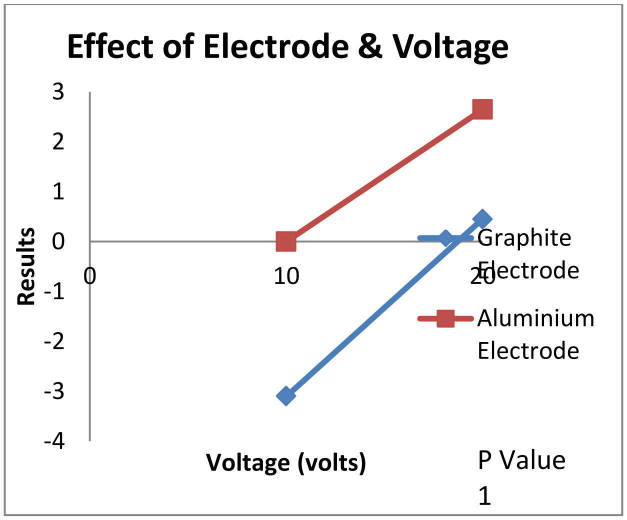
3.6) Effect of Electrode & Voltage on Removal of P-chloro Phenol

To check the interaction effect of the electrode & voltage on the removal of Para chloro Phenol treat the sample at fixed voltage for Aluminium & Graphite electrode. The results obtained were plotted which shows that using Aluminium electrode more removal efficiency as compared to Graphite electrode.

Using ANNOVA P value for interaction factor of voltage and electrode is calculated which is one shows that it is more important factor.



IV. CONCLUSION

Wastewater cure has become a challenge over the many years on account of different influent element and also real features and also strict effluent polices. This electrochemical process is going to be better than physicochemical as well as membrane layer technology simply because they make use of the electron because unique reagent and also they can't produce reliable residues. The luxury of electrochemical practice within the different functions is going to be large efficiency, Effortless operations, Compact features no spend technology. This method is also made for onsite cure, especially throughout small-scale utilize.

The P value indicates that the entire factor either they are individually e.g. electrode, time, voltage or an interaction effect e.g. electrode & time, voltage & time, electrode & voltage most important in the treatment of waste water. The results obtain much better by using Aluminium electrode, higher treatment time and at higher voltage. More efficiency in the results can be obtained by using the Electrode of much better quality than Graphite & Aluminium like Boron Doped Diamond, Platinum, Copper and Zinc electrode. And also the better efficiency can be achieved by increasing the treatment time and increasing the rate of voltages.

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