Effect of direct electric current on contaminants removal from the peat water with continuous system

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Abstract. This research was analysed the essentially of treat peat water using an electric current. Initially, the characterization of peat water was determined including of three parameters they are pH, colour, and conductivity solution exhibited values that exceeded the water standard limit. There are two factors influencing the electric coagulation such as electric current and voltage that were observed in the continuous study. The results obtained indicated that the majority of the electric current were very effective for removing TDS, and pH. The research variable for the voltage from 23.5 to 42.5 volt and the electric current from 2.2 to 4.1. The optimum electric current and voltage was found around 1.5 Ampere and 25 volt, it was exhibited at 4 L/minute. In unit study, continuous electric reactor showed that the optimal reduction on the 20 minutes treatment were found pH = 7, 256 ppm. It was meet to the minimum standard government permission.

1. Introduction
Electrochemically is one of the promising methods for treating hard-to-treat waste water streams. Electrochemical processes (electrolysis and electrocoagulation) have been successfully demonstrated for removing pollutants in various industrial wastewaters [1-3]. Generally, removal mechanisms reported in the electrolysis process are including the oxidation, reduction and decomposition processes, whereas the mechanisms in the electrocoagulation process included the coagulation, adsorption, precipitation and flotation [4-6]. Electrocoagulation utilizes iron anode to produce iron hydroxide flocks by reaction at the anode followed by electrolysis.

The electrocoagulation is simple and efficient method for the treatment of many water and wastewater. In the recent years, many investigations have been done, it focused on the using of the electrocoagulation owing to increase the effluent waste water in the environmental restrictions [7-9]. Electrocoagulation has been applied successfully to treat potable water, food and protein waste water [10-12] yeast waste water [13], urban wastewater [14], restaurant wastewater [8,15] tar sand and oil shale waste water [16]. The aims of this work is to study the possibility of using aluminium electrode for removal of peat water from simulated waste water by electric reactor method.
2. Experimental

The samples were collected from a peat water river and stored in a water drum. The untreated samples have high contaminants concentration according to pH and conductivity meter measurements. The physico-chemical properties of the samples before and after ER treatment are presented in Table 1. pH and Conductivity Water was measured before and after treatment to see the trend of percent removal of contaminants of the peat water. In this study, we made a variation of voltage, ten ER cells were constructed, reactor was made for 10 aluminum plates; 10 anodes and 20 cathodes. Cell A made of aluminum anodes (10 plates) and inert cathodes (10 plates). Cell Cathode (C) was similar to Cell Anode (A), but inert plates were used as anodes and aluminum plates as cathodes. Inert electrode material used in this study was commercially available dimensionally stable anode (DSA) electrodes. Aluminum alloy 1050 (99.5% Al) was used in the experiments. All electrode plates were 2 m long and 1 inch and 1.5 inch diameter. Distance between electrode plates was 0.6 cm. ER treatment was done in continuous cells where electrodes were arranged into monopolar configuration. Water volume during the treatment was 10,000 ml.

Samples were flowing inside the pipe during the ER treatment with flowrate 4L/minute. After the treatment, samples were entering the separator to separate the flocculation using settling gravity. Settling time after flocculation was 20 min. The samples were determined the pH and conductivity meter before and after treatment.

| No | Time | TDS  | Cond. | Res  | PH  | Voltage | Current | Flow Rate |
|----|------|------|-------|------|-----|---------|---------|-----------|
|    | Minute | ppm | Micro Siemens | Ohm |     | Volt | Ampere | lt/mnt    |
| 1  | 5     | 323,671 | 522,097 | 1915 | 5,8 | 23,5 | 2,2 | 0         |
|    | 10    | 320,804 | 521,986 | 1916 | 6 | 23,5 | 2,2 | 0         |
|    | 15    | 317,037 | 518,318 | 1929 | 6,1 | 23,5 | 2,2 | 0         |
| 2  | 5     | 321,098 | 519,018 | 1927 | 6,2 | 32 | 3,4 | 0         |
|    | 10    | 318,563 | 515,197 | 1941 | 6,2 | 32 | 3,4 | 0         |
|    | 15    | 316,901 | 512,863 | 1950 | 6,3 | 32 | 3,4 | 0         |
| 3  | 5     | 315,436 | 515,85 | 1939 | 6,2 | 45,5 | 4,1 | 0         |
|    | 10    | 311,732 | 509,721 | 1962 | 6,4 | 45,5 | 4,1 | 0         |
|    | 15    | 305,645 | 502,396 | 1990 | 6,5 | 45,5 | 4,1 | 0         |

Table 1. The condition of peat water before and after treatment.
2.1. Chemical analysis
The content of Peat water was determined the pH and conductivity meter from the samples. Dissolved aluminum samples were taken after the electrochemical treatment before slow settling stage. Conductivity was determined using a Conductivity Meter, and pH Meter by depoinovasi electronics.

2.2. The variable of the research
The research variables were conducted to optimized the unit. The variables covered; electric current, voltage and running times of the reaction.

3. Results and discussion
3.1. Peat water characterization
The surface of water originating from the peat land of Riau was taken from Kampar river along the Kampar River on several occasions as the main sample. The characterization of peat water was carried out at the sampling point (in-situ measurement) using conductivity and pH meter. Three parameters were successfully determined, including pH, voltage, current, and conductivity were measured at the sampling point. Acidic pH of the peat water was predicted due to the composition of the surrounding peat soil itself which had been formed by decaying material possessing humic substances [3]. Besides that, humic substances also lead to high the organic content as humic substances are comprised of numerous oxygen containing functional group and fractions (humic acid, fulvic acids and humin) with different molecular weights. Moreover, composition of peat soil may also have an impact on the aluminium ion concentration of peat water [5].
All the three parameters were indicated comply to the standard limit. These parameters were pH, TDS and alum that showed values of 6.9, 140 ppm, and 25,439 grams respectively while the standard limit of these parameters are 6.5 - 9.0, 1500 ppm accordingly.

3.2. Effect of electric voltage for contaminant removal
Electric voltage is adjusted to desired the removal level by increasing the voltage Influence of initial voltage for reduction of TDS and pH, Al ion were investigated. Figure 1 to Figure 4 below, displayed the percentage removal of TDS, and alum ion against pH respectively.

![Figure 1](image_url)  
**Figure 1.** Effect of voltage to TDS removal.
Based on the results of research, with increasing of the voltage will remove the TDS solution, within 20 minutes first and stable until the chatode losses. The better removal, it showing for 45 volt to decrease the TDS solution from 317 to 305 ppm.

3.3. Effect of electrict current to TDS removal
The results of the research, giving the graph is as below;

![Graph](image1.png)

**Figure 2.** Effect of current on TDS removal.

Based on the graph, it can be explained that with the increasing of the electric current, will remove that TDS level from 310 ppm to 305 ppm with using 4,2 electric current. The following graph explained the correlation between voltage to ampere.

![Graph](image2.png)

**Figure 3.** Correlation between electric current and voltage.

When voltage increase, the current increased as well, it is show the results that more current will get more voltage and will increase the removal level.
Based on the results, it shows that the trend when voltage increase will increase the pH to the limit pH as comply to the government regulation.

3.4. Life time of the cathode
According to the results for the 220 voltage and 1.8 Ampere, the contaminant has reduced from 322 ppm to 140 ppm during 6 hours more and pH have increased from 5.9 to 6.9 for 20 minutes first and stable until 85 minutes and increased more until 6.9 after 6 hours running.

4. Conclusions
This study analyzed the effect of electric reactor construction on contaminants removal. Ten cells of reactor were studied: one only had aluminum electrodes, one had aluminum anodes and inert cathodes, and one had inert anodes and aluminum cathodes. The main parameters measured were final pH, TDS and times of the water produced. The following conclusions can be made from the results:

Aluminum dissolved from the Cells A was constructed from aluminum anodes and inert cathodes followed theoretical values calculated according to Faraday’s law.

| No | Quantity/pcs | Length/cm | weight/ gr before 42 hours | Weight losses ( gr) |
|----|--------------|-----------|----------------------------|--------------------|
| 1  | 1            | 185       | 175,13                     | 25,439             |
| 2  | 5            | 185       | 149,691                    | 127,465            |
Aluminum dissolved from the cathodes did not follow electric charge per volume linearly. Low initial pH (pH 5.8) increased the dissolving reaction rate, probably because the hydroxyl ions produced were consumed by the acidic water.

The efficiency of aluminum in TDS removal was similar in all, cell constructions in the pH range tested. According to these results, the efficiency of electric reactor cannot be enhanced significantly by using either aluminum anodes or cathodes or both.

The results of this research indicate that reactions between TDS and aluminum occur in the bulk water and not on the electrode surface. It seems that destabilization mechanisms of TDS are similar compared to chemical coagulation. According to the results, optimum TDS matter can be obtained simultaneously with minimum residual metal concentrations when surface water is treated with electric reactor. The potential applications of water after the treatment could be potable water or industrial fresh water.

Acknowledgements
We would like to thank our team research member, the dprm ristek dikti for financial support for this research. The authors would like to thank all students.

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