DECOLOURISATION OF DYE SOLUTION CONTAINING AZO ACID ORANGE 7 BY ELECTRICITY

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To my beloved mother and father

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ABSTRAK

Sisa berwarna daripada aktiviti industri memberi kesan kepada persekitaran dan kesihatan manusia. Pelbagai kaedah telah digunakan untuk menyahwarna sisa ini termaksuklah kaedah yang menggunakan aplikasi elektrik. Kajian ini dilaksanakan untuk menyelidik kelakuan larutan yang mengandungi bahan pewarna Azo asid oren 7 oleh elektrik. Fokus kajian ini menjurus kepada kesan penyahwarnaan oleh faktor ketumpatan arus elektirk, kepekatan pewarna dan tempoh aliran arus elektrik. Sel kimia yang mudah disediakan dengan menggunakan dua kepingan diperbuat daripada besi tulen dan besi campuran. Keberkesanan kaedah ini ditentukan melalui pengukuran peratus penyingkiran warna dan penyerapan. Peratus penyingkiran warna adalah lebih tinggi daripada peratus penyingkiran penyerapan. Semasa proses dijalankan apabila jumlah ketumpatan arus elektrik dan tempoh aliran arus elektrik semakin bertambah, penyahwarnaan turut meningkat. Berdasarkan analisis MINITAB^{TM}, ketumpatan arus elektrik, kepekatan pewarna dan tempoh aliran arus elektrik memang mempengaruhi peratus penyingkiran warna.. Kecekapan penyahwarnaan bagi kepekatan antara 100 mg/l dan 200 mg/l boleh ditingkatkan kepada 95% penyingkiran warna dan 88% penyingkiran penyerapan pada tempoh aliran arus elektrik 18 minit dan ketumpatan arus elektrik pada nilai 120 A/m^2.

ABSTRACT

Colouring effluent from industrial activities may affect environment and human health. Many methods have been used to decolourise such effluent including using electricity. This study was performed to investigate the behaviour of decolourisation of solution containing Azo Acid Orange 7. This study was focusing on the effect of decolourisation due to current density, dye concentration and duration of current flow. Simple electrochemical cell was prepared by using iron and steel plate electrode. The effectiveness of the method was determined by measuring percentage of colour and absorbance removal. The percentage of colour removal was higher then the percentage of absorbance removal. It is found that decolourisation was directly proportional to current density, duration of electric current flow and concentration of the dye. Based on MINITAB^{TM} analysis current density, duration and concentration does affecting the percentage of colour removal. The efficiency of decolourisation for 100 mg/l to 200 mg/l concentration was able to increase up to more 95% of colour removal and more than 88% of absorbance removal when duration was 18 minutes and current density was 120 A/m^2.

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Ao	-	Initial absorbance
A	-	Final absorbance
Co	-	Initial color (ADMI)
C	-	Final color (ADMI)

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CHAPTER 1

INTRODUCTION

1.1 Background

Colour is a visible pollutant and its presence not only hampers the aesthetic quality of surface waters but also affects and alters the aquatic ecosystem by reducing the penetration of light (Prabhakara et.al, 1990). The development of industry and improvement of human life, cause more and more dyes are used and needed. Dyes are coloured, ionising, aromatic organic compounds (Fessenden et.al, 1990). A wide variety of dyes are used by industry and released into the environment as industrial effluents. Textile are the industry that largely using this product. These dyes have to be highly stable in everyday use and resistant to microbial degradation. Azo dyes are the largest class of dyes used in industry. In general, bacteria are not able to degrade Azo dyes. However, some anaerobic bacteria in intestinal micro flora have been demonstrated to degrade a few Azo dyes. Under these conditions the Azo can be toxic and potentially carcinogenic (Maarit et.al, 2000).

Dyes caused serious environmental pollution and health problem in many ways. Highly colour dye wastewater, contain a large amount of chemical (Qian and Gu. , 1994). That's make the treatment of dye wastewater are important. The treatments of dye wastewater are expensive, so water –reused is attractive practice that able to give and operation and cost effective treatment system (Eroglu et.al, 1991). The treatments of textile wastewater are based on chemical and biological treatment (Nicolaou et.al, 1992).

One of alternative way that has been used to treat dye wastewater is by using system that used electric energy (Daneshvar et.al, 2004). Example of method that used electric energy is electrocoagulation, electrolysis and many more. This study was using the application of electrolchemical to treat coloured wastewater. This system has been in existence for many years. The process is based on principles involving responses of water contaminants to strong electric fields. According to Daneshvar et.al (2004), the chemistry, pH, particle size and chemical constituent of wastewater are influencing this process. The range of current density, duration of current flow and dye concentration was used for this study was based on study done by Daneshvar .et.al. But the study done by Daneshvar was using Acid Red 14, while for this study Azo Acid Orange 7 was used. Azo Acid orange 7 was used to determined the applicability of the process to others type of colours. Azo dye was chosen because almost half of the dyes used in textile industry are Azo type and it caused environmental problem when 15% of it discharge into the environment without proper treatment (Mat Daud, 2003)

The test was conducted by using plate steel cathodes and plate iron anode with size 50 mm x 50 mm x 1 mm and distance between electrode is 3 cm. Artificial wastewater was prepared by mixing Azo acid orange 7 dye with discharged water. The concentration of the artificial wastewater was between 25 mg/l to 200 mg/l. Volumes of artificial wastewater that was used for each test was 500 ml. Current density that was used between 40 A/m^2 to 240 A/m^2. The duration of current flow for each test were with in 5 to 25 minutes, each stage required different sample. The initial and final absorbance and colour for each sample were determined in order to determine the behaviour of decolourisation of the sample. The initial and final absorbance was determined by using UV/VIS spectrophotometer Jasco model 7800 to calculate the percentage of absorbance removal. Colour was measured to determined the physical condition of the sample in term of it colour. Absorbance was measured to determine the concentration of sample. Value of colour must equal to value of absorbance. By measuring the absorbance at the same time it able to conform value of colour that has been obtained. The percentage of removal was determined by using formula below:

$$\text{Absorbance removal (\%)} = \frac{A_o - A}{A_o} \times 100 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(1)$$

A_o = initial absorbance

A = final absorbance

The initial and final colour was determined by using DR/4000 (Hach) spectrophotometer. The percentage of colour removal was determined by using formula below:

$$\text{Colour removal (\%)} = \frac{C_o - C}{C_o} \times 100 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

C_o = initial colour (ADMI)

C = final colour (ADMI)

Laboratory works were divided into two stages, which was preliminary laboratory test and final laboratory test. Results obtain in preliminary laboratory test and final laboratory test was used in the MINITAB^{TM} analysis. Based on the result of the

MINITAB^{TM} analysis, the most significance factor that influencing decolourisation of Azo acid orange 7 was able to obtain.

1.2 Problem statement

Fabrics are important to all humankind. People used fabric to make clothes and others household equipment. Due to high demand of fabric a lot of fabrics are made to fulfil this demand. In the process of making fabric a lot of colours were used in dyeing process. In the dyeing process highly coloured wastewater were produced as the process involved a lot of water. According to Jabatan Alam Sekitar, Malaysia is experiencing rapid economic growth of textile industries and this caused a lot of highly coloured textile effluent produced.

The wastewater effluents from the dyeing process are colourful and their decolourisations are very important before discharge. Dyes need to be treat before discharge because it affects the environment and human health (Zee et.al 2002). In order to have sustainable development this effluent must be treated, as the effluent is aesthetically unpleasant when discharge to receiving water and can be polluted.

Various physical and biological technique such as membrane filtration, electrolysis, flocculation, ion exchange, oxidation, aerobic, anaerobic, anoxic and biodegradation were used to removes the dye from the effluent. According to Daneshvar et.al, (2004), the effective methods are by using activated carbon or oxidation process but the cost are really high. As an alternative method which using electric energy in the process was used. This process has a fast rate of pollutant removal, simplicity in operation, low operating and equipment cost (Daneshvar et.al, 2004). This process has been tested successfully to treat many kind of wastewater such as restaurant wastewater, urban wastewater, defluoridation of water and many more. It is expected that this method would be an ideal choice for decolourisation of dye solution. But the performances of this method are not well defined as it is considered to be new method in treating textile wastewater. By doing this study, hopefully it able to give more information about it.

This study investigates the effectiveness of using electricity in treating textile effluent. But this study was focusing in Azo dye, since Azo are the largest class of dye used in textile industry (Zee, 2002) and it's constitute a major class of environmental pollutant (Tan and Gu, 2001). Furthermore, Azo dye can be toxic and potentially carcinogenic (Maarit et.al, 2000). This study were focusing in determined the behaviour of decolourisation of Azo Acid Orange 7 by using electricity under the influence of current density, duration of current flow and concentration of dye.

The entire test was done by using plate steel cathodes and plate iron anode. Anode, withdraw electrons from the electrode material, which result in release of Fe(II)-ions produced iron hydroxide. Then cathode produces H_2 gas from water. Iron hydroxide that remains in aqueous stream as a gelatinous suspensions removed the pollutant by complexation or electrostatic attraction. H_2 gas produced in cathode form bubble and caused the floc produced to be floating on the surface of water. Organic compound from dyes react through a combination of electrochemical reduction, electro-coagulation and electrofloatation reactions (Ching et.al, 2005).

1.3 Objective of study

To determine the behaviour of decolourisation of Azo acid orange 7 by using electricity under the influence of current density, duration of current flow and dye concentration.

1.4 Scope of study

There were some matters to be considered, under the laboratory work which were:

1. The test conducted by using plate steel cathodes and plate iron anode with size 50 mm x 50 mm x 1mm and distance between electrodes is 3 cm.
2. Artificial wastewater was made from Azo acid orange 7 dyes, the concentration was in the range of between 25 mg/l to 200 mg/l.
3. Volumes of artificial wastewater used, 500 ml.
4. The current density used between 40 A/m^2 and 240 A/m^2
5. The duration of current flow for each test were with in 5 to 25 minutes, each duration stage required different sample
6. The laboratory works were focusing in obtaining initial and final colour and absorbance change for each test.

5.2 Recommendation.

Study about the decolourisation of dyes by using electric energy is still in the beginning stage. The study done was insufficient due to time constraint. There are many things need to be done to study the effectiveness of electrocagulation method. As an example this study just focusing in decolourises Azo acid orange 7. While the plate electrode used was made from steel and iron. This study can still be continued in future by:

a) Study different type and arrangement of electrodes

b) Application of the same method for different type of dyes.

c) Study the effect of others factor such as pH, size of plate and temperature

d) Study the characteristics of flocs formed or produced.

e) Flocs form during the process can be studied

f) Application of the process by using textile wastewater from textile factory.

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