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The Effect of Potential to Colour and COD Removal from Waste Textile Industry by Electrochemical Method

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The waste textile industry is one of the problems to the human life as well as environment. In this study, the treatment of the waste textile industry by the electrochemical method using stainless steel as anode and cathode was investigated. The effect of potential to color and COD removal were investigated. The research consists of several stages, the electrode composition analysis using Scanning Electron Microscopy-Energy Dispersive X-Ray (SEM-EDX). The electrolysis waste textile industry has been done using various potential. Degradation parameter is Chemical Oxygen Demand (COD) were analysis using spectrometry method. The research results show that stainless steel electrode has composition are iron (72.2 %), chromium (18.9 %), nickel (7.6 %) and silica (1.4 %). After electrolysis at potential constant (3 V) shows percentage degradation of the waste textile industry is 98.56 %. The percentage reduction in COD value of textile waste electrolyzed in optimum condition is 50.38 %. As conclusions are the potential at 3 V and stainless-steel electrode as a good parameter and material for electrochemical degradation of the waste textile industry.

1. Introduction

The textile industry provides a big negative impact on water pollution originating from waste disposal to various places such as ponds, rivers and other public sewers. The main pollutants from the textile industry derived from the wet processes such as scouring, bleaching, and dyeing (Radha et al., 2009). Textile industry waste generated ammonia and organic compounds (Sun et al., 2015). Complex compounds in the form of particles of insoluble solids, salt, dye and heavy metals lead textile waste is very difficult to degrade. A frequent case is the reaction between the dyes with one another so that the waste becomes more complex conditions (Chatzisymeon et al., 2006). Currently, the processing of textile waste containing toxic organic pollutants with traditional methods not fully relies. Based on previous research, biological treatment of the wastewater of textile shows low efficiency due to the degradation of the compounds contained in the dye has a high molecular weight (Malpass et al., 2007). Physical adsorption only effective way to eliminate non-biodegradable pollutants, but quite expensive and difficult to renew the adsorbent used (Mohan and Balasubramanian, 2006). Because of great complexity in the composition of textile wastewater, most of the traditional method becomes inadequate (Nordin et al., 2013).

Some of year, has been used electrochemical techniques (electro-oxidation) for wastewater treatment textiles. In electro-oxidation, the main reagents used are electrons capable of removing organic pollutants in textile wastewater without produce of new pollutants and does not require additional reagents (Mohan et al., 2007). The electrochemical techniques enable excellence to be developed as a cost-effective technology for wastewater treatment textiles. Some of the previous research showed the ability of electrochemical techniques to wastewater treatment. Zinc electrode can be used as an anode (working electrode) to wastewater treatment by electrocoagulation process. The use of the zinc electrode has been able to reduce levels of phenolic compounds and the value of Chemical Oxygen Demand (COD) respectively is 84.2 % and 40.3 % (Fajardo et al., 2015).

Comparison of the use of electrodes of iron (Fe) and aluminium (Al) in the electrocoagulation process orange compound II which is used as a textile dye has also been done. The results showed that the iron electrode better in reducing the color density (decolorization). In terms of sludge produced and operating costs do not

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differ significantly, only aluminium electrodes should use the higher potential for obtaining color density decrease as the use of metal electrodes (Chavi et al., 2011). In this research, textile waste processing is done by electrochemical techniques using stainless steel electrode. In the process do the great variation of potential with a mass of sodium chloride electrolyte and a fixed time. Selection of stainless steel electrode based on the alloy of three metals, namely Cr, Ni, and Mg. The use of three metals at the same time it will be better when compared with the metal. This is because there will be the synergistic effect between the three metals. Additionally, electrode containing two or more metals will have two or more active sites that act as catalysts electrochemical (Riyanto, 2013).

2. Experimental section

2.1 Electrochemical cell set up

Electrolysis textile waste is done with a capacity of 50 mL were collected in a 100 mL glass beaker. Electrolysis process conducted with the help of stirring using a magnetic stirrer and the addition of sodium chloride as an electrolyte. Stainless steel electrodes that are used have size 7.5x2 cm^2. Electrochemical cell and equipment can be seen in Figure 1.

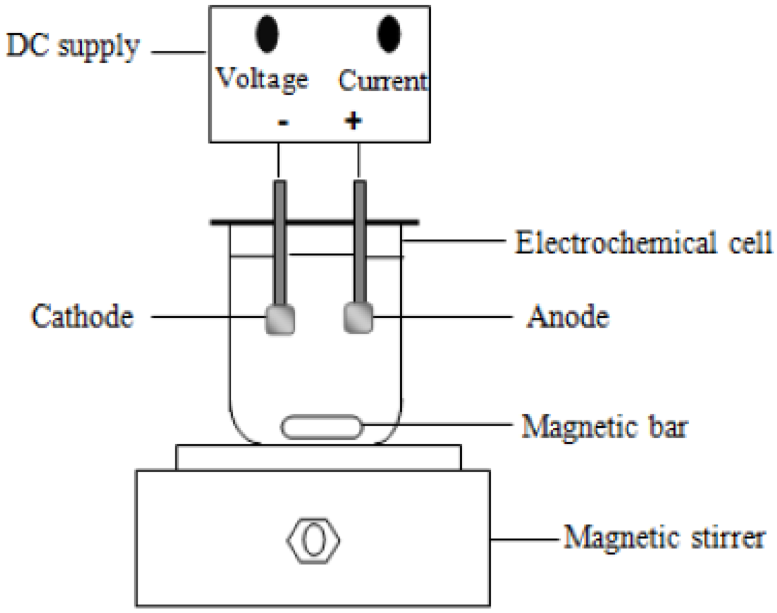


Figure 1: Electrochemical cell and equipment for electrolysis waste textile industry Reagents and Wastewater Sample

Sodium chloride (NaCl), which used a lot of salt is sold in the market which has a purity of 99 %. Textile waste comes from one of the home industry in Yogyakarta, Indonesia.

2.2 Analytical techniques

Morphology structure and composition of stainless steel electrodes were analyzed using Scanning Electron Microscopy-Energy Dispersive X-Ray (PhenomTM). The value of chemical oxygen demand (COD) and the color removal percentage of textile waste before and after electrolysis were analyzed using a UV-Visible spectrophotometer from HITACHI U-2010.

3. Results

3.1 Morphology structure and composition of stainless steel electrode

Morphology structure of stainless steel electrode before use electrolysis of waste textile industry can be seen in Figure 2.

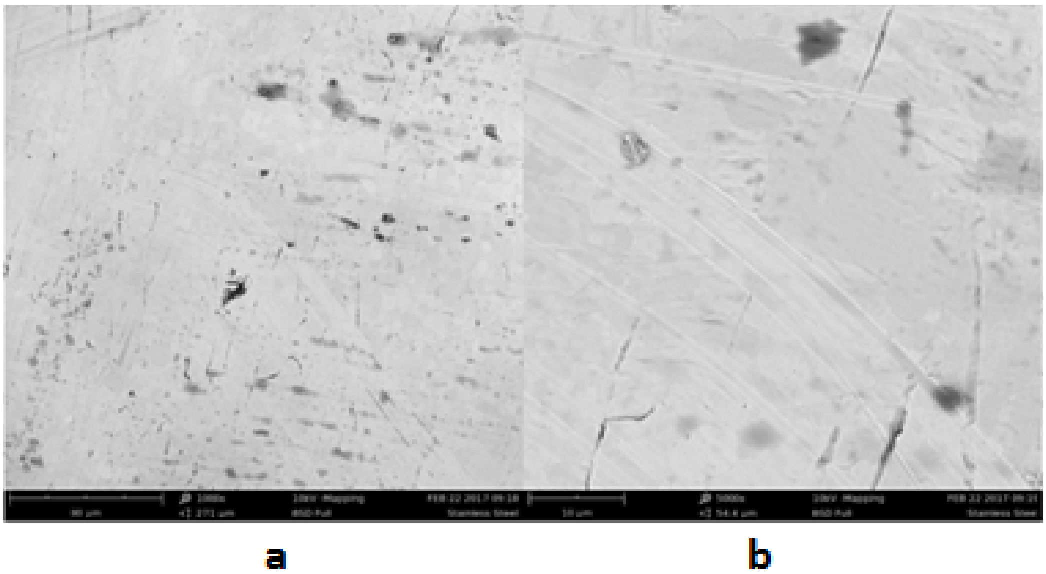


Figure 2: Morphology structure of stainless steel electrode with magnification 1000x and (b) magnification 5000x

Figure 2 shows morphology structure of stainless steel electrode with magnification 1000x and 5000x. Stainless steel electrodes have surface morphology structure is not different between 1000x and 5000x magnification. Figure 2 showed morphology structure of stainless steel surface materials have homogeneous of metals compositions and smooth surface. The composition of metallic elements in stainless steel electrode can be seen in Figure 3.

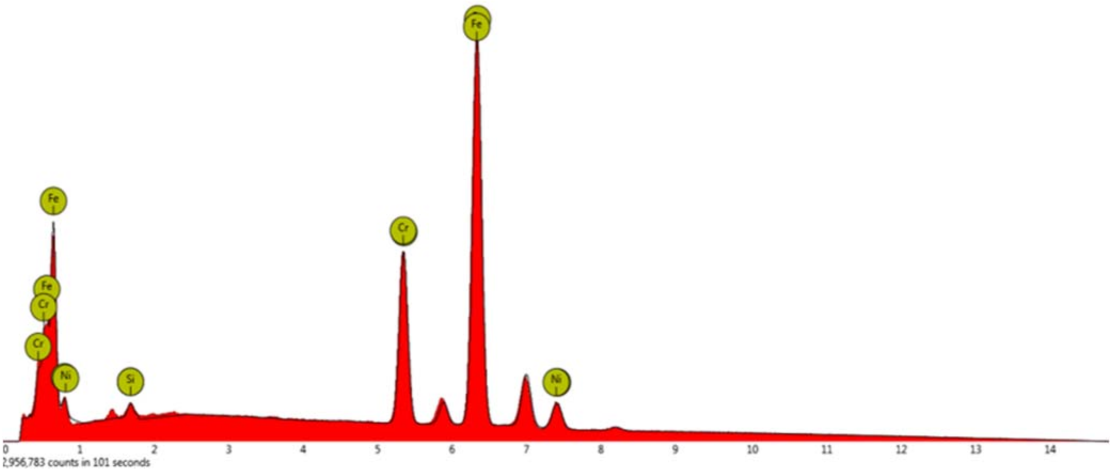


Figure 3: Spectra SEM-EDX analysis results at stainless steel electrode

Table 1: Metal elements in stainless steel electrode analysis using SEM-EDX

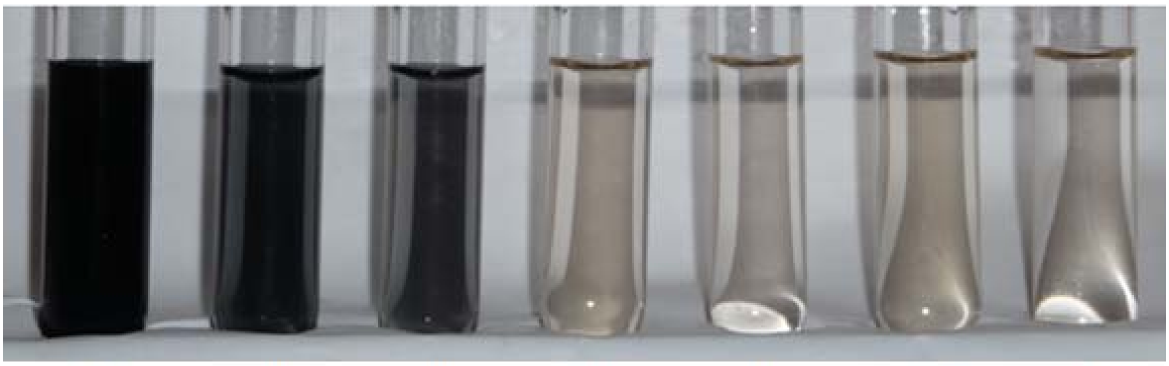
Elements	Percentage (%)
Iron (Fe)	72.2
Chrome (Cr)	18.9
Nickel (Ni)	7.6

Based on the analysis results of spectra SEM-EDX at Figure 3 and Table 1 showed that the composition of stainless steel electrode used was iron, chrome, nickel, and silica with percentage are 72.2 %, 18.9 %, 7.6 % and 1.4 %, respectively. The main composition of stainless steel electrode used was iron amounted to 72.2 %.

Iron and nickel have an excellent role for textile waste treatment. Iron can be used for coagulant by electrochemical coagulation process. Nickel is a metal that can be used for catalyst or electrochemical catalyst with the formation of Ni(OH)2. It has never been reported the use of chrome and silica for the degradation textile waste.

3.2 The Effect of Potential to Color and COD

Potential used in the electrolysis process is 0.5; 1.0; 1.5; 2.0; 2.5; and 3.0 V with a mass of electrolyte is 0.5 g NaCl and the optimum time for 60 min. A potentially large variation that is used aims to determine the optimum conditions, with see the maximum absorbance decline of the resulting spectra along with the calculation of the color removal percentage. Figure 4 showed of the color degradation textile waste before to after the electrolysis.



1 2 3 4 5 6 7

Figure 4: Colour degradation result electrolysis of textile waste from left to right: without electrolysis (1) to electrolysis at a potential variation respectively.

Based on Figure 4, colour degradation clearly begins to see when used of potential at 1.5 V. Furthermore, the greater the potential use showed the clearer waste solution. So, from a wide variety of potential used obtained potential use of 3 V is the clearest. The result of the UV-Vis spectra analysis, electrolysis textile waste can be seen in Figure 5.

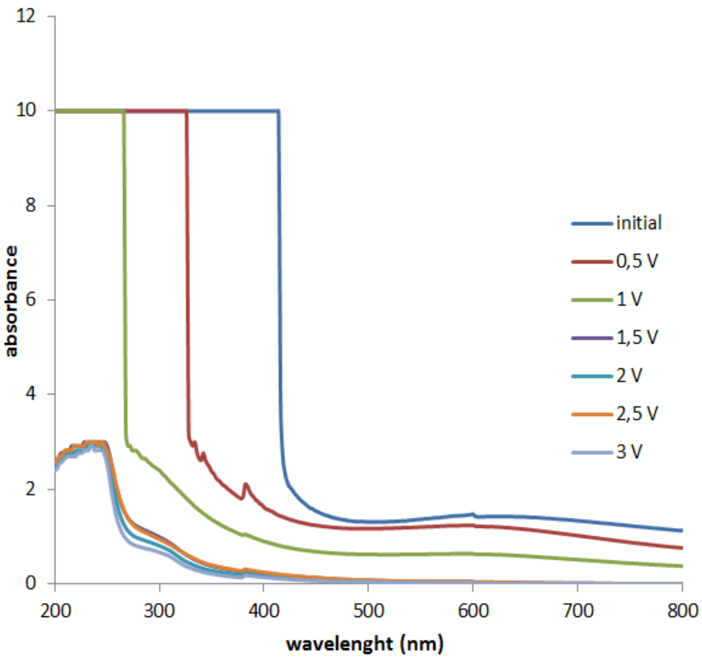


Figure 5: Spectra analysis result of UV-Vis spectrophotometer at various potential

Based on the results of the analysis of the spectra shown in Figure 5 shows that the decrease in absorbance occurs along with the greater potential that is used when the process of electrolysis to textile waste, which found that the maximum absorbance decreases in the potential use of 3 V. Colour removal percentage at potential variation can be seen in Table 2. Colour removal percentage by textile waste electrolysis result calculated using Eq(1).

$$R\% = [100(A0, \lambda – A1, \lambda)]/A0, \lambda \quad (1)$$

Where R% is the removal percentage for colour, A0, λ is the initial absorbance at the selected wavelength (400 nm) and $A_{1,\lambda}$ is the absorbance at the potential selected wavelength (400 nm).

Table 2: Colour removal percentage at potential variation

Time of electrolysis (min)	Dosage of sodium chloride (%)	Potential (V)	Color Removal		
			Initial (abs)	Final (abs)	% Reduction
		0.5	10	1.622	83.78
		1.0	10	0.904	90.96
60	1	1.5	10	0.238	97.62
		2.0	10	0.181	98.19
		2.5	10	0.250	97.50
		3.0	10	0.144	98.56

Figure 6 shows the effect of potential to the percentage of degradation of textile waste. Based on the Figure 6 results of spectral analysis using Spectrophotometer UV-Vis and calculating of color removal percentage obtained optimum conditions at the potential of 3 V. The percentage decrease of COD value is obtained by comparing the value of COD before and after electrolysis in optimum conditions using Eq(2).

$$\text{COD removal (\%)} = 100(CODo – COD1)/CODo \quad (2)$$

Where CODo is the COD before electrolysis (mg/L) and COD1 is the COD after electrolysis (mg/L).

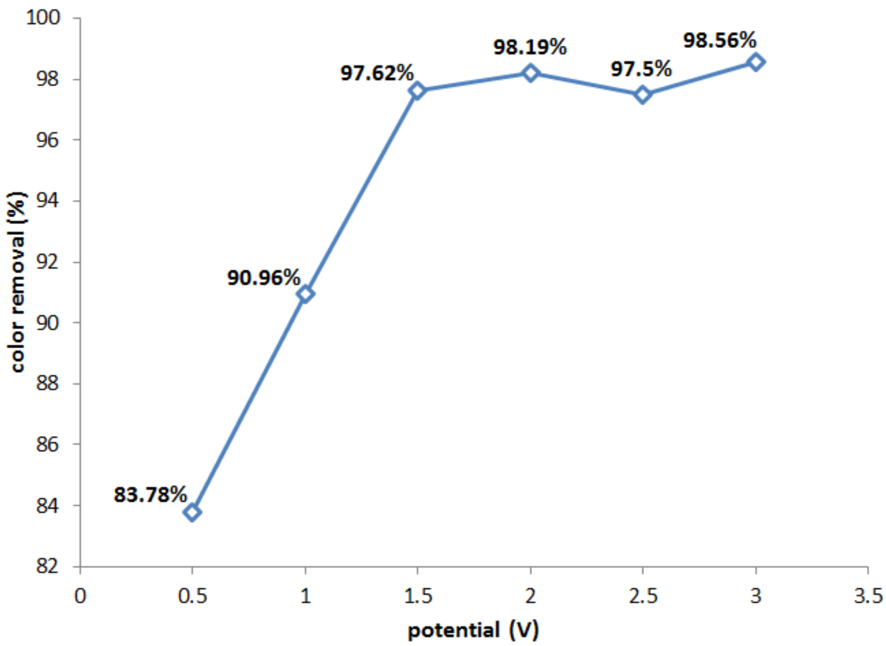


Figure 6: The effect of potential on the percentage of degradation of textile waste

The result of the analysis is COD value before and after electrolysis in the optimum condition shown in Table 3. The percentage reduction in COD value of textile waste electrolyzed in optimum condition is 50.38 %.

Table 3: Analysis result of COD value textile waste

Treatment	COD value (mg/L)	Percentage decrease of COD value (%)	After electrolysis
Before electrolysis	2,086.67	50.38	1,035.33

4. Conclusions

Morphology structure of stainless steel surface materials have homogeneous of metals compositions and smooth surface. Stainless steel electrode has composition are iron (72.2 %), chromium (18.9 %), nickel (7.6 %) and silica (1.4 %). After electrolysis at potential constant (3 V) shows percentage degradation of the waste textile industry is 98.56 %. The percentage reduction in COD value of textile waste electrolyzed in optimum condition is 50.38 %. As a conclusion is stainless steel electrode good for electrochemical degradation of the waste textile industry.

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