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Analysis of Copper (Cu), Chromium (Cr), and Manganese (Mn) Levels from Liquid Waste of The Steel Industry with Atomic Absorption Spectrophotometry (AAS) Method

Syarifah Aini[1], Zul Alfian[2*], and Harry Agusnar[3]

[1,2]Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Jalan Bioteknologi No.1 Kampus USU Medan 20155, Indonesia

Abstract. Liquid waste from the steel industry processing, washing machine, and kitchenware foundry contained the elements of copper (Cu), chromium (Cr), and manganese (Mn). The effluent samples were destructed using concentrated HNO_3. Then determined the concentration of the elements copper (Cu), chromium (Cr), and manganese (Mn) using an Atomic Absorption Spectrophotometer with a calibration curve. The results obtained for the level of copper (Cu) on the sample inlet was 0.9714 mg/L to 0.9719 mg/L, and the sample outlet was 3.9990 mg/L to 4.0002 mg/L. Levels of the element chromium (Cr) on sample inlet was 0.0295 mg/L to 0.0297 mg/L, the sample outlet was 0.0399 mg/L to 0.0400 mg/L. Meanwhile, the level of manganese (Mn) in the sample inlet was 0.1269 mg/L to 0.1271 mg/L in a sample outlet was 2.9699 mg/L to 2.9701 mg/L. Then the steel industry wastewater for elemental copper (Cu) and manganese (Mn) exceeded the limits that have been instituted by the Minister of Environment Decree No. 51, 1995, regarding the Liquid Waste Quality Standard for Industrial Activity.

Keywords: Liquid waste, Cu, Cr, Mn, AAS

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1 Introduction

Indonesia's economic development leads to industrialization. No less than 30,000 industries are operating in Indonesia from year to year showing an increase. This increase in number has an impact on industrialization, namely an increase in pollution resulting from the industrial production process. Pollution of water, air, soil, and disposal of hazardous and toxic waste materials (B3) are problems that must be faced by communities living around industrial areas. (http://ringkasan-hendynura.blogspot.com/2012/10/analysis- environmental-impact-amdal.html)

According to the Decree of the State Minister for the Environment Number: KEP-51/MENLH/10/1995 concerning Quality Standards for Liquid Waste for Industrial Activities.

*Corresponding author at: Department of Chemistry, Faculty of Mathematics and Natural Sciences Universitas Sumatera Utara, Medan, Indonesia.

E-mail address: zul20@usu.ac.id

Journal Homepage: http://jcnar.usu.ac.id

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Article 1 point 3 meant by liquid waste is waste in the form of oozing liquid, produced by industrial activities which are disposed to the environment and are suspected to be able to degrade the quality of the environment.

The metal industry for household use produces a small amount of pickling liquid which cannot be processed at the factory site and requires special processing. The toxic effects of heavy metals can block the work of enzymes so that they disrupt the body's metabolism, cause allergies, and are mutagens, teratogens, or carcinogens for humans and animals. (Widowati, W, 2008)

Analysis using atomic absorption spectrophotometry (AAS) has the advantages of very sensitive analysis results (detection limit is less than 1 ppm), less interference, effective and efficient, selective, specific, relatively inexpensive analysis cost, and can easily create a matrix that fits standard, the analysis time is very fast and easy to do. The work is relatively simple and does not need to be separated from metal elements in its implementation, it is very appropriate for the analysis of substances at low concentrations (Khopkar, SM, 1990). Copper (Cu) is pink in color and is soft and malleable and ductile, copper (Cu) is also needed by humans in small amounts. If the amount exceeds the limit will appear toxicity. (Widowati, W, 2008).

Chromium (Cr) is a gray metal and chromium is an element that is found in everyday life and is an essential element for humans and animals at low concentrations. Chromium (II), chromium (III), and chromium IV) otherwise known as hexavalent chromium, is toxic to humans. (Stoeppler, M. 1992)

Manganese (Mn) and iron (Fe) which are oxidized in water are brownish in color and insoluble, causing limited use of water. Water cannot be used for domestic and industrial purposes. Both of these materials are derived from rock solutions containing Mn and Fe compounds. Water containing dissolved solids has the property of conducting electricity and this accelerates corrosion. http://www.articlebagus.com/2012/01/limbah-metal-berat.html

Based on the description above, the authors are interested to research the analysis of Copper (Cu), Chromium (Cr), and Manganese (Mn) Levels from Liquid Waste in the Steel Industry Using Atomic Absorption Spectrophotometry (AAS) Method.

2 Materials and Methods

2.1 Equipments

In this study, the equipments used were a set of atomic absorption spectrophotometer (AAS), measuring flask, measuring cup, volume pipette, beaker glass, filter paper, pH meter, hot plate, thermometer, distilled water bottle, rubber ball, watch glass, dropper pipette, and funnel.

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2.2 Materials

The materials used were liquid waste from the steel industry, nitric acid (HNO_3), 1000 mg/L of Cu, Cr, and Mn mother liquor, acetylene burner gas, and distilled water.

2.3 Procedure

The sample destruction stage used was in the form of wet digestion. A total of 100 mL of the sample was put into a beaker. Then, as much as 5 mL of HNO_3 was added and then heated until the solution was almost dry. After that, as much as 50 mL of distilled water was added and then put into 100 mL of the volumetric flask through filter paper, then diluted with diluent to the marked line and stirred until homogeneous. Then the levels of copper (Cu), chromium (Cr), and manganese (Mn) were determined using an Atomic Absorption Spectrophotometer. Then, elemental levels of Cu, Cr, and Mn were determined by $\lambda_{specific}$ were 324.8 nm, 357.9 nm, and 279.5 nm, respectively (SNI 6989.16.2009).

3 RESULT AND DISCUSSION

The measurement results of standard series solutions for the absorption of copper (Cu), chromium (Cr), and manganese (Mn) elements shown in Table 1.

Table 1. The results of Copper (Cu), Chromium (Cr), and Manganese Levels from Inlet and outlet samples of steel industry liquid waste

No	Week	Level (mg/L)					
		Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
		Copper (Cu)	Copper (Cu)	Manganese (Mn)	Manganese (Mn)	Chromium (Cr)	Chromium (Cr)
1	I	0.9719	4.0010	0.1271	29701	0.0295	0.0400
2	II	0.9715	3.9993	0.1269	2.9699	0.0297	0.0401
3	III	0.9714	3.9990	01269	2.9700	0.0297	0.0399

Table 1 shows that in the first week the level of copper (Cu) in the inlet sample was 0.9719 mg/L, the second week was 0.9720 mg/L, and the third week was 0.9715 mg/L, while the levels of chromium (Cr) in the inlet sample in the first week was 0.0295 mg/L, the second week was 0.0297 mg/L and the third week was 0.0297 mg/L, and levels of manganese (Mn) in the first-week inlet sample was 0.1270 mg/L, the second week was 0.1269 mg/L and the third week 0.1269 mg/L. The level of copper (Cu) in the first-week outlet sample was 4.0010 mg/L, the second week was 4.0011 mg/L, and the third week was 3.9970 mg/L. The levels of chromium (Cr) in the first-week outlet samples were 0.0403 mg/L, the second week 0.0401 mg/L, and the third week 0.0403 mg/L. Meanwhile, the element manganese (Mn) in the first-week outlet sample was 2.9700 mg/L, the second week was 2.9699 mg/L, and the third week was 2.9702 mg/L.

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Eka Putra (2002) reported that some of the liquid waste of the steel industry in Medan obtained an average content of copper (Cu) 0.01 mg/L to 0.35 mg/L and an average element of chromium (Cr) 0. 16 mg/L to 0.01 mg/L which the levels of copper (Cu) and chromium (Cr) have passed the predetermined threshold while the levels of manganese (Mn) had not passed the threshold value that has been set. This is because some factories do not have a wastewater treatment plant (WWTP).

Based on the observations of the levels of copper (Cu and manganese (Mn) from the first, second, and third weeks from the outlet liquid waste, it was found that the Minister of Environment Decree No. 51 of 1995 concerning the Quality Standard of Liquid Waste for industrial activities was 2 mg. /L for copper (Cu), and 2 mg/L for manganese (Mn), while the outlet sample for chromium (Cr) did not exceed the threshold set by the Decree of the Minister of the Environment No. 51 of 1995 concerning Waste Quality Standards. The liquid is equal to 0.5 mg/L because the chromium element used by the industry is not too much needed in the steel industry production process.

4 Conclusion

Based on the data obtained in this study, it can be concluded that the level of copper (Cu) in the inlet sample was 0.9714 mg/L to 0.9719 mg/L. The level of copper (Cu) in the sample outlet was 3.9990 mg/L to 4.0002 mg/L. The level of chromium (Cr) in the inlet sample was 0.0295 mg/L to 0.0297 mg/L. The level of chromium (Cr) in the outlet sample was 0.0399 mg/L to 0.0401 mg/L, while Manganese (Mn) in the inlet sample was 0.1269 mg/L to 0.1271 mg/L. The level of manganese (Mn) in the sample outlet was 2.9699 mg/L to 2.9699 mg/L. The elemental levels that have been determined by the Minister of the Environment Number: KEP-51/MENLH/10/1995 concerning the Quality Standards of Liquid Waste for Industrial Activities are 2 mg/L for copper (Cu), and 2 mg/L for manganese (Mn).

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