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ANALYSIS OF HEXAVALENT CHROMIUM METAL CONTENT OF RIVER WATER BY FLAME ATOMIC ABSORPTION SPECTROPHOTOMETER

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ABSTRACT

Population growth and intensified human activities have resulted in global environmental conditions experiencing increased risks to water quality. One of the serious threats to water quality is heavy metal contamination, including hexavalent chromium metal (Cr-VI). This study aims to analyze the levels of hexavalent chromium metal (Cr-VI) in river water with an analytical method that is in accordance with SNI 6989.53: 2010, the test method using an atomic absorption spectrometer (SSA)-Nyala. Based on the analysis that has been done on 2 samples (sample A and sample B), the value of hexavalent chromium levels in sample A is 0.035 mg/L and sample B is 0.0127 mg/L. So that the results can be stated that the hexavalent chromium (Cr-VI) levels in the river water are still below the quality standards based on PP RI No. 22 of 2021 concerning the Implementation of Environmental Protection and Management so that it is categorized as safe.

Keywords: *river water, hexavalent chromium, atomic absorption spectrophotometer (SSA)*

ABSTRAK

Pertumbuhan populasi dan aktivitas manusia yang semakin intensif mengakibatkan kondisi lingkungan global mengalami peningkatan risiko terhadap kualitas air. Ancaman serius terhadap kualitas air salah satunya adalah kontaminasi logam berat, termasuk logam kromium heksavalen (Cr-VI). Penelitian ini bertujuan melakukan analisis kadar logam kromium heksavalen (Cr-VI) dalam air sungai dengan metode analisis yang sesuai dengan SNI 6989.53:2010, cara uji menggunakan spektrometer serapan atom (SSA)-Nyala. Berdasarkan analisis yang telah dilakukan terhadap 2 sampel (sampel A dan sampel B) didapatkan hasil nilai kadar kromium heksavalen pada sampel A sebesar 0,035 mg/L dan sampel B sebesar 0,0127 mg/L. Sehingga hasilnya dapat dinyatakan bahwa kadar kromium heksavalen (Cr-VI) pada air sungai tersebut masih dibawah baku mutu yang berdasarkan PP RI No. 22 Tahun 2021 Tentang Penyelenggaraan Perlindungan dan Pengolahan Lingkungan Hidup sehingga dikategorikan aman.

Kata Kunci: Air sungai, Kromium heksavalen, spektrofotometer serapan atom

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INTRODUCTION

Environmental health is essentially an optimum condition or state of the environment that affects optimum health status. The scope of environmental health includes housing, human waste disposal, clean water supply, garbage disposal, dirty water disposal (waste) and so on. One component of the environment that is important for the life of living things is water (Wiriani, 2018). Water is a liquid substance consisting of hydrogen and oxygen molecules which then form the H_2O compound. Water is an essential life source and very important for the life of living things on earth, which is used in various biological, ecological, industrial and environmental processes (Ramdyasari, 2014). Water is used to meet household needs, industrial activities, agriculture, and so on so that, to meet these needs, the existence and availability of clean water is very necessary (Efendy & Syamsul, 2019). Surface water, especially river water, is one of the sources of water that is widely utilized by the community.

Rivers are water sources that have an important role in human life and ecosystems. The utilization of river water is used for various needs such as the provision of clean water sources for drinking, household activities, industry, then for agricultural irrigation, food supply besides that the river is also a habitat for various species of aquatic organisms and biodiversity including fish, amphibians, aquatic insects, and aquatic plants. Rivers are also often used as transportation routes and are popular recreational areas. Water used by humans must meet the requirements in terms of quality and quantity. Water quality must be available in conditions that meet health requirements in terms of physics, chemistry, and biology. Water that can be used for daily purposes must meet the standard water standards for households (Kusnaedi, 2010). Water with poor quality will result in poor environmental conditions that will affect the health and safety conditions of humans and other living things (Sholiha, 2021). With a growing human population and intensifying human activities, current global environmental conditions show an increasing risk to water quality. One serious threat to water quality is heavy metal contamination, including hexavalent chromium metal (Cr-VI).

Hexavalent chromium is the oxidized form of the element chromium (Cr) with an oxidation number of +6. It is also known as Cr(VI) and is one of the most toxic and hazardous forms of chromium. Hexavalent chromium is often generated in various industrial processes and human activities, such as metal production, pesticide use, and fossil fuel combustion. Due to its toxic and carcinogenic properties, long-term exposure to hexavalent chromium can cause various health and environmental problems. Adverse effects on human health include skin irritation, respiratory problems, damage to the nervous system, and increased risk of cancer. Hexavalent chromium released into the environment can also contaminate water, soil and ecosystems, threatening organisms and the balance of these ecosystems. Hexavalent chromium that pollutes river water can damage aquatic ecosystems, threaten aquatic organisms, and endanger the health of humans who rely on the water. Hexavalent chromium is a form of chromium that is very harmful to both humans and the environment.

People need to be reminded to preserve the environment considering the potential dangers posed by hexavalent chromium, so there is a need for water quality monitoring or water pollution control. Water quality parameters can be seen from physical, chemical and biological parameters. The value for each parameter has been determined by the threshold or quality standard set by the government. The

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quality standard is the limit of levels allowed for polluting substances or materials to be present in the environment without causing disturbances to living things, plants, or other objects (Herniwati, 2020). The reference quality standard for surface water quality is Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Management and Protection. Analysis of hexavalent chromium metal levels in river water can be done using an atomic absorption spectrophotometer (SSA)-flame.

SSA- Flame can analyze hexavalent chromium levels in river water accurately and sensitively. The spectrophotometer method makes it possible to detect the presence of hexavalent chromium in low concentrations, even below the safe threshold. This study aims to determine the level of hexavalent chromium contamination in river water, so that it can be identified whether the level exceeds the safe limit set by the government. It is also hoped that this research can contribute to efforts to preserve the aquatic environment and encourage awareness of the importance of good water quality monitoring and management.

MATERIALS AND METHOD

This study used an Atomic Absorption Spectrophotometer (SSA)-flame equipped with a hollow cathode lamp (HCL) for the element chrome, volumetric pipettes 1.0 mL; 2.0 mL; 5.0 mL; and 10.0 mL. Measuring pipette 10 mL, volumetric flask 100.0 mL; 200.0 mL; 500.0 mL and 1000.0 mL. 100 mL and 250 mL goblets, 100 mL measuring cup, filter paper with a pore size of 0.45 μm, desiccator and air compressor, mineral-free water, 1000mg/L hexavalent chromium mother liquor, 1 N HNO_3 nitric acid solution, (HNO_3)(1+1), 4% Ammonium Pyrrolidine Ditiocarbamate (APDC) solution, 1 N sodium hydroxide (NaOH) solution, 1N hydrochloric acid (HCl) solution, Methyl Iso Butyl Ketone (MIBK), anhydrous sodium sulfate powder (Na_2SO_4), acetylene gas and compressed air.

The analysis method carried out in accordance with SNI 6989.53: 2010: How to test Hexavalent Chromium (Cr-VI) in water test samples by Atomic Absorption Spectrophotometry (SSA)- extraction. To calculate the hexavalent chromium (Cr-VI) metal content using the following equation:

$$Cr(VI)\ (\mu g/L) = C \times Fp \quad \ldots\ldots(1)$$

Description:
C = Levels obtained from the measurement results (μg / L)
Fp = Dilution factor

RESULTS AND DISCUSSION

Tests have been carried out at the Environmental Laboratory of the Environment and Land Office of South Sumatra Province by analyzing hexavalent chromium metal levels (Cr-VI), the test samples used come from surface water, namely river water. Determination of metal levels is carried out by spectrophotometric method using an atomic absorption spectrophotometer (SSA) - flame and refers to the Indonesian national standard SNI 6989.53: 2010. The determination of hexavalent chromium metal content uses 2 samples, namely sample A and sample B.

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Table 1. Calculation Results of Hexavalent Chromium Metal (Cr-VI) Levels in River Water Using Atomic Absorption Spectrophotometer (SSA) - Flame

No	Sample	Conc (mg/L)	Quality Standards (mg/L)
1.	A	0,035	0,05
2.	B	0,0127	0,05

Determination of hexavalent chromium (Cr-VI) levels is carried out by taking a test sample of 100 mL which has been filtered with a 0.45 µm porous membrane filter and put in a 200 mL volumetric flask, after which adjust the pH of the test sample at 2 to 4 pH by adding 1N HNO_3. Then add 1 mL of 4% APDC solution and homogenize, after that add another 10 mL of methyl iso butyl ketone (MIBK) solution then shake vigorously for 30 seconds and let the solution separate between the water and organic phases. After that, add mineral-free water to the test sample so that the organic layer rises to the neck of the flask and the test sample is ready to be measured using an atomic absorption spectrophotometer (SSA)-flame.

Based on Government Regulation No.22 of 2021 concerning the Implementation of Environmental Protection and Management, the Quality Standard for Lake Water and the like is Class 2, for the hexavalent chromium parameter (Cr-VI) has a quality standard value of 0.05 mg/L. Table 4.2 is the data obtained from the measurement results using an atomic absorption spectrophotometer and compared with river water quality standards based on PP RI No.22 of 2022 concerning the Implementation of Environmental Protection and Management. Sample A has a hexavalent chromium (Cr-VI) value of 0.035 mg/L and sample B has a hexavalent chromium (Cr-VI) value of 0.0127 mg/L. Based on the test results, the value of hexavalent chromium (Cr-VI) levels in river water with sample A and sample B meets the quality standards according to predetermined requirements. This means that the river water can still be used and is safe for the life of living things in these waters. However, monitoring must still be carried out in the water area so that hexavalent chromium (Cr-VI) levels do not increase and disturb the aquatic ecosystem.

The occurrence of hexavalent chromium (Cr-VI) heavy metal pollution in river water comes from human activities such as household waste, industrial waste. In addition to human activities, another thing that affects pollution is the season. The dry season and the rainy season have different effects. In the rainy season, river flow is usually greater which can dilute the concentration of hexavalent chromium. In contrast, during the dry season, the concentration of Cr-VI in the river may be higher (Fadilla, L.N, 2022).

Chromium (Cr) heavy metal is one type of heavy metal that is dangerous. This is because one of its properties is that it will accumulate if the levels exceed the quality standards in the human body. Accumulation of heavy metal Chromium (Cr) can cause lung cancer, chronic festering wounds and also damage to the thin membrane of the nose. Chromium (Cr) is one of the heavy metals that can cause water pollution. Water pollution caused by heavy metal Chromium (Cr) is in the form of a decrease in river water quality and endangers the environment and biota that live in the river. Chromium (Cr) heavy metal is bioaccumulative and toxic so that it can cause the death of biota living

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in the river. The toxic nature of heavy metal Chromium (Cr) can cause acute poisoning and chronic poisoning (Setiyono & Gustaman, 2017). Iron chromium (Cr) polluted in the environment and its amount increases continuously can cause carcinogenic, toxic, bioaccumulative and biomagnification properties.

Excessive Chromium (Cr) heavy metal content in the body can also cause respiratory tract disorders. This disorder is in the form of irritation to the lungs which is the result of long-term inhalation of Chromium (Cr) heavy metals. In addition, it also has an impact on chronic irritation, polyps, tracheobronchitis and chronic pharyngitis. Symptoms resulting from the effects of excessive chromium (Cr) content are nausea, abdominal pain, lack of urine, and coma. If chromium (Cr) comes into direct contact with the skin, it can cause dermatitis (Asmadi et al., 2009). Chromium (Cr) heavy metals most commonly found in waters are Trivalent Chromium and Hexavalent Chromium (Cr-VI). The nature of this hexavalent chromium heavy metal is anionic (very soluble in water) and relatively stable. This heavy metal not only pollutes river water bodies but also the sea. This heavy metal also has toxic properties and is very dangerous (Rahyono et al., 2017). Therefore, alternatives to address this pollution, it is necessary to implement strict regulations for industries and companies that produce toxic waste, make efforts to restore the river ecosystem such as planting vegetation that can absorb heavy metals from soil and water. Regular monitoring of river water quality is needed to identify changes in hexavalent chromium (Cr-VI) pollution levels.

CONCLUSION

Testing the levels of hexavalent chromium metal (Cr-VI) in river water using an atomic absorption spectrophotometer (SSA) - flame at the UPTD Laboratory of the Environmental and Land Service of South Sumatra Province, obtained the value of hexavalent chromium (Cr-VI) levels in sample A of 0.035 mg/L and sample B of 0.0127 mg/L and can be categorized as safe because it is still within the threshold based on Government Regulation of the Republic of Indonesia No.22 of 2021 concerning the Implementation of Environmental Protection and Management.

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