Determination of elements in hospital waste with neutron activation analysis method

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Determination of elements in hospital waste with neutron activation analysis method

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Abstract. The product of the biggest B3 waste is hospital. The waste is from medical and laboratory activities. The purpose of this study is to determine the elements contained in the liquid waste from hospital and calculate the levels of these elements. This research was done by analysis of the neutron activation conducted at BATAN Yogyakarta. The neutron activation analysis is divided into two stages: activation of the samples using neutron sources of reactor Kartini, then chopping by using a set of tools, gamma spectrometer with HPGe detector. Qualitative and quantitative analysis were done by matching the gamma spectrum peak to the Neutron Activation Table. The sample was taken from four points of the liquid waste treatment plant (WWTP) Bhakti Wira Tamtama Semarang hospital. The results showed that the samples containing elements of Cr, Zn, Fe, Co, and Na, with the levels of each element is Cr (0.033 - 0.075) mg /L, Zn (0.090 - 1.048) mg/L, Fe (2.937-37.743) mg/L, Co (0.005-0.023) mg/L, and Na (61.088-116.330) mg/L. Comparing to the standard value, the liquid is safe to the environment.

1. Introduction

Massive development in Indonesia has unwittingly resulted in increased use of Dangerous Toxic Materials (DTM). The pollutant materials generally have toxic nature that are harmful to living organisms. The toxicity of the pollutants is what triggers pollution [1]. Over the last three decades, the use of DTM, such as expired chemical waste in Indonesia has been increasing and widespread in all sectors [2]. The hospital is one of the producers of DTM waste derived from all activities conducted in hospitals and other laboratory activities [3]. Hospital waste contains high organic compounds, harmful chemical compounds, disease-causing microorganisms, and heavy metals that can pollute the environment [4-10]. Heavy metals can also accumulate and endanger humans indirectly, therefore Minister of Environment sets the standard for heavy metal content contained in hospital waste. The quality standards are shown in Table 1.

Table 1 is the hospital waste water quality standard, which is the maximum value allowed for the health facility, such as the hospitals. To know the content of the elements contained in the hospital waste in this study using the method of Neutron Activation Analysis. NAA is one of the techniques of nuclear analysis that has the advantage of identifying elements that do not take long, do not damage the sample, and also has extensive detection limitations. Government General Hospital Klaten in 2006 has previously conducted research by NAA method to identify the elements present in the waste water

[11]. Furthermore, the NAA method has also been used to determine the levels of radio nuclides in samples of waste from the factory galvanized [12].

Table 1. Wastewater Quality Standard for Health Service Facilities According to Minister of Environment Regulation No. 5 of 2014

Parameter	Value (mg/L)
Fe	5
MN	2
Ba	2
Cu	2
Zn	5
Cr	0.5
CD	0.05
Hg	0.002
Pb	0.1
Sn	2
Co	0.4

Neutrons can be differentiated by their energies. In the analysis of neutron activity used a thermal neutron with an energy is about 0.025 eV [13]. When conducting this analysis, samples are exposed to neutrons in nuclear reactors. The stable nucleus in the sample will absorb one neutron so it turns into a radioactive core. The radioactive nucleus will emit gamma rays with certain energies indicating the presence of certain elements. The emitted gamma rays are captured by the HPGe detector contained in the gamma spectrometer device. The gamma spectrometer is defined as a means of measuring and identifying radioactive elements in a sample by observing the characteristic spectrum generated by the interaction of light emitted by these radioactive substances by the detector [14]. On the gamma spectrometer screen will be displayed spectrum of gamma radiation that appears on several different numbers of salur. Qualitative analysis is conducted to determine what elements are contained in the sample, while quantitative analysis is done to determine the level of these elements. This analysis is done interchangeably [15]. The purpose of this study was to determine the elements contained in the Bhakti Wira Tamtama Hospital waste water and calculate the levels of these elements.

2. Methods

In this research the material used is sample of waste water from Bhakti Wira Tamtama Hospital, the sample is taken from 4 points around Wastewater Treatment Plant (WWTP). The sample was concentrated by a heated technique using an electric stove branded masphion S300. Then put it into a sample bottle. Irradiation of the samples were taken at the kartini reactor *Lazy Susan facility,* the sample was irradiated for 12 hours, then it was issued and ready to be enumerated. The sample enumeration uses a set of gamma spectrometer tools with a HPGe detector, the sample is chopped for 8000 seconds. For data analysis, using two analyzes, they are qualitative analysis which aims to determine the elements contained in the sample, and quantitative analysis which aims to calculate the level of each element found in the sample.

3. Result and Discussion

The results of qualitative analysis on the sample of liquid waste at Bhakti Wira Tamtama Hospital Semarang are Cr, Zn, Fe, Co, and Na. Furthermore, quantitative analysis is done with the aim that is, to know the level of each element that has been known in qualitative analysis. The results of quantitative analysis on liquid samples at Bhakti Wira Tamtama Hospital Semarang are described in the form of bar charts. Cr levels at each location in the wastewater sample are presented in the bar chart in Figure 1.

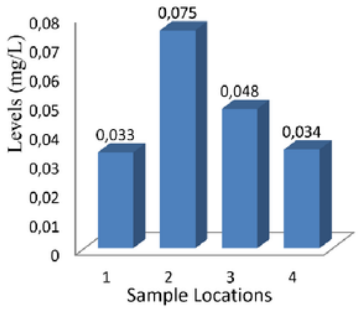

Figure 1. Cr element level on liquid waste samples at Bhakti Wira Tamtama Hospital Semarang. Location description: location 1: container tub 1, location 2: container tub 2, location 3: general container, dan location 4: container after treatment

In Figure 1 it is seen that the highest Cr element level is in location 2 of container 2. The container 2 holds the liquid waste from the laboratory and dental treatment room which is likely to contribute Cr contamination to the wastewater. According to the Regulation of the Minister of Environment on the quality standard of hospital waste that has a maximum Cr content of 0.5 mg/L. From Figure 1 it can be seen that the Cr content contained in the hospital waste water Bhakti Wira Tamtama Semarang still within safe limits, both before and after processing levels [16-17].

Zn content at each location in the liquid waste sample is presented in the form of bar charts in Figure 2.

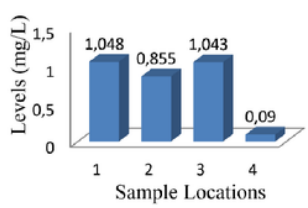

Figure 2. Zn element level on liquid waste samples at Bhakti Wira Tamtama Hospital Semarang

Figure 2 shows that the highest Zn content in location 1 is the container 1. The container 1 contains the waste from the patient's rooms, the various wastes can cause additions to contribute Zn contamination to the sample. When compared with Minister of Environment quality standard, Zn content is still below the quality standard, it is safe if disposed to the environment. Fe content at each location in the liquid waste sample is presented in the form of bar charts in Figure 3.

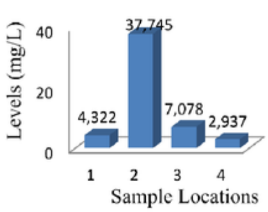

Figure 3. Fe Content Level on Liquid Waste Samples at Bhakti Wira Tamtama Hospital Semarang.

Fe content in liquid waste causes color in water, the color closely related to turbidity. In the sampling process, samples at location 2 were very cloudy when compared to all locations. In Figure 3 it can be seen that the Fe content found in the Bhakti Wira Tamtama Hospital liquid waste after the processing is decreasing, and still within safe limits when compared with the quality standard of the Minister of Environment. Co concentration at each location in the liquid waste sample is presented in the form of bar charts in Figure 4.

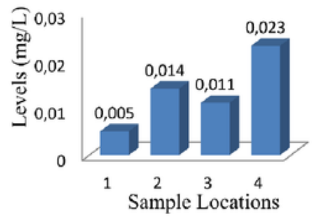

Figure 4. Co content levels on liquid waste samples at Bhakti Wira Tamtama Hospital Semarang.

Co content in hospital effluents usually comes from radiology, physiotherapy, and laboratory rooms. In Figure 5 the highest Co is on location 4, tub after processing. This could happen because at the time of WWTP sampling in the hospital has just finished the repair so it has not been able to work optimally. But if the level is still below the quality standard set by the Minister of Environment, it is safe if thrown into the environment. Na content at each location in the liquid waste sample is presented in the form of bar charts in Figure 5.

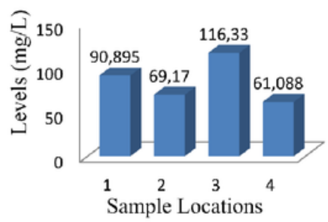

Figure 5. Na content level on liquid waste samples at Bhakti Wira Tamtama Hospital Semarang.

In Figure 5 shows that the highest Na content is in location 3, container 3. Na content one of which can come from the wastewater infus disposal. Based on the levels obtained in the study, the levels after treatment have decreased except for the Co. The levels are still within safe limits, when compared with the Minister of Environment Regulation on waste water quality standards.

4. Conclusion

Based on the research that has been done can be drawn some conclusions; The elements contained in liquid waste are elements of Cr, Zn, Fe, Co, and Na. The levels of each element are Cr (0.033-0.075) mg/L, Zn (0.090-1.048) mg/L, Fe (2.937-37.743) mg/L, Co (0.005 - 0.023) mg/L, and Na 61,088-116, 330) mg/L. The levels are still within safe limits as they fall below the standard set by the Minister of Environment Decree No. 5 of 2014.

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