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Analysis of Cs-137 Radionuclide On The East Jakarta Flood Canal Water Samples Using Gamma Spectrometer

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Abstract: *Radionuclide Cs-137 is a radioactive element that is soluble in water, so its distribution in the environment is influenced by mixing and diffusion, so that Cs-137 radionuclide can cause harmful effects on biotic and abiotic components in the waters. The East Jakarta Flood Canal is a macro drainage system for the city of DKI Jakarta that drains water to Marunda beach, most of the water quality has been polluted with light to heavy levels of pollution. This study aims to determine the water quality of the East Jakarta Flood Canal including in situ and ex situ physical and chemical properties parameters (temperature, pH, salinity and TDS) and Cs-137 radionuclide concentration parameters and the distribution pattern of Cs-137 radionuclides at each sampling point. The samples used were water and kale, the samples were filtered and concentrated from the initial volume of 20 liter of water to 1 liter of water and 10 kilograms to 1 kilogram of Kale plant. The levels of Cs-137 were measured with a gamma spectrometer instrument for 3600 seconds, then data analysis was carried out. The results obtained are the concentration level of Cs-137 in Simplo KBT water ranging from 0-1.571 Bq/L, for duplo 0-0.424 Bq/L while for kale plant 0-3,228 Bq/Kg the overall results are within the quality standard limits set by regulations. the head of BAPETEN Number 7 of 2013 concerning the limit value of environmental radioactivity, which is 2.6×102 Bq/L.*

INTRODUCTION

Environmental quality problems cause air quality to decline, as well as its quantity and must be addressed immediately. The causes of water pollution do not only come from industrial and household waste but can also come from pollution (1). Radioactive pollution can come from three sources, namely, radioactive dust falling from nuclear weapons testing in the atmosphere, around 70-80% falling into the waters, food preservatives, paper and steel industry activities that use radionuclides in the production process, besides that radionuclides are also used in the field of medicine for sterilization and radiography processes (2).

One of the radionuclides that has received attention in the environment is the radionuclide Cesium (Cs-137), radionuclide Cs-137 is a radioactive element that is easily soluble in water, so that its distribution in the aquatic environment is influenced by physical processes in the form of mixing and diffusion. Radionuclide Cs-137 is important to know the distribution, radioactive level, source and processes of its influence in waters. This is because Cs-137 has radiological properties and has a long half-life of 30 years (3). East Flood Canal (KBT) Jakarta is the collecting ducts of air as one way of tackling flooding in Jakarta which was first conceived by Prof. Ir. Hendrik van Breen in 1913. Jakarta KBT across 13 urban villages in North Jakarta 2 villages and 11 urban villages in East Jakarta. The canal into macro-drainage system and controlling the flow of water from upstream to regulate the volume of water coming into town jakarta (4).

Based on these conditions, research on the Cs-137 radionuclide is important in Indonesia, although nuclear activity is still limited. However, the movement of the flow in the waters allows the entry of radionuclide contaminants into Indonesian waters, it is necessary to conduct research on the activity of Cs-137 contained in the waters of the Jakarta KBT using a Gamma spectrometer with 6 sampling points at each downstream river which is the input of the KBT, namely; Kali Cipinang, Sunter, Buaran, Jatikramat, Cakung and Marunda (end of KBT).

EXPERIMENTAL SECTION

Materials

Equipment used glass tools, pH indicators, water checker, thermometer, hot plate, 1 liter Marinelli beaker, funnel, filter paper, glue araldite, label paper, markers, and scales. The materials used East Flood Canal water samples, plant kale and liquid nitrogen. Instruments used tool Gamma Spectrometer

Sample Preparation

The water sample was concentrated until the initial volume of the East Flood Canal was 20 liters to 1 liter. In the sample of kale, the sample is cut or puree the sample until it becomes small or smooth. Dry at 105°C in the oven. The sample was put into a Marinelli 1 Kg beaker.

Sample Measurement

The concentrated canal water sample was then put into a Marinelli 1 liter beaker and then closed with a seal using a tape, then the sample was chopped directly with a gamma spectrometer for 3600 seconds. Analysis of spectral data is done by using the software Maestro.

Data Analysis

Measurement of Radionuclide Concentration in Sample :

$$C_{avg} = \frac{N_{sp} - N_{BG}}{\varepsilon_y . P_y . W_{sp}}$$

Measurement uncertainty :

$$U_T = C \sqrt{\left(\frac{uNt}{Nsp}\right)^2 + \left(\frac{u\varepsilon}{\varepsilon}\right)^2 + \left(\frac{uP\gamma}{P\gamma}\right)^2 + \left(\frac{uW}{Wsp}\right)^2}$$

Minimum Detectable Concentration (MDC):

$$MDC = \frac{4{,}66 \sqrt{n_B / t_B}}{\varepsilon \; x \; P_\gamma \; x \; F_k \; x \; V}$$

RESULTS AND DISCUSSION

Air quality parameter tests have been carried out to determine the level of polluted air conditions or good conditions in a certain water source and then compare the results with the established water quality standards, this statement is supported by the Regulation of the Minister of Health RI No. 32 of 2017 that factors that affect air include temperature, degree of quality (pH), salinity, and Total Dissolve Solid (TDS) as well as analysis of Cs-137 radionuclides.

Table 1.Temperature

Sample Location	Temperature (C°)		Threshold (C°)
	in situ	ex situ	
Cipinang	36,9	26,7	28-32
Sunter	36,8	26,7	
Jatikramat	36,8	27,0	
Buaran	36,2	27,1	
Cakung	29	27,3	
Marunda	39	27,2	

Temperature conditions in the waters of the canal Jakarta are not included in good condition, this is due to the temperature of the wastewater (sewage) will typically have a higher temperature than the temperature of pure water, resulting in waste water (sewage) a process of biodegradation that can cause a rise in temperature in water.

Table 2. pH

Sample Location	pH		Threshold
	in situ	ex situ	
Cipinang	8	5,58	6,0 – 8,5
Sunter	6	5,96	
Jatikramat	8	6,46	
Buaran	8	6,81	
Cakung	7	6,90	
Marunda	6	6,45	

pH conditions in the waters of KBT Jakarta are still in normal conditions. There was a change in the pH value at the time of in situ measurement due to the length of storage, the duration of storage affected the pH and water holding capacity because the longer the storage the pH and water holding capacity decreased.

Table 3. Salinity

Sample Location	Sal (ppt)	Threshold (ppt)
Cipinang	0,2	<0,5 (air tawar)
Sunter	0,2	
Jatikramat	0,2	
Buaran	0,2	
Cakung	0,1	
Marunda	0,5	0,5-30 (air payau)

Based on the research results jakarta KBT water at the sampling point cipinang, sunter, Jatikramat, Buaran and cakung including freshwater categories while at the sampling point Marunda including brackish water category. This is because the location of the location where the Marunda location near the sea.

Table 4. Total Dissolve Solid (TDS)

Sample Location	TDS (mg/L)	Threshold (mg/L)
Cipinang	291	100-500
Sunter	305	
Jatikramat	395	
Buaran	415	
Cakung	408	
Marunda	454	

TDS content at all sampling points below the threshold first class water quality standard that is equal to 500 mg/liter. Measured TDS value of 100-500 mg/liter was included in fresh water, so the water in the canal jakarta can be classified as clean water (fresh water).

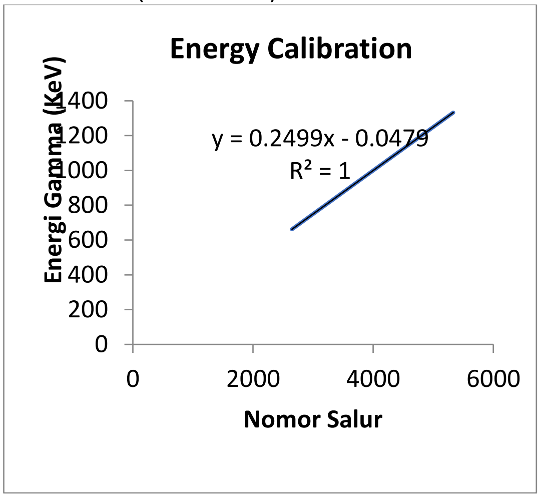

Figure 1. Calibration curves Energy

Figure 1. shows a linear relationship. This is evidenced by the average deviation value of each point on the curve line of R2=1. The energy calibration curve has the equation y=0.2499x - 0.0479 where x= channel number and y=energy in units of keV.

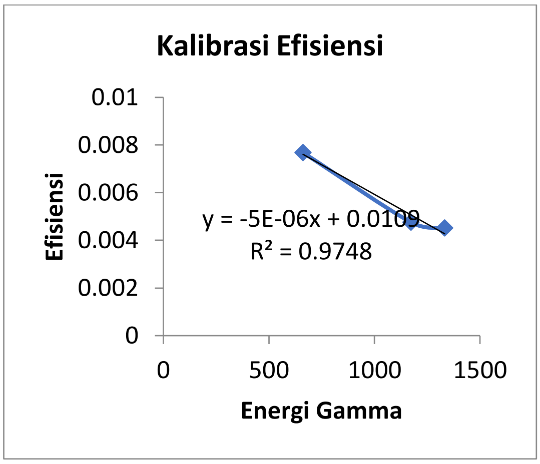

Figure 2. Calibration curves Efficiency

To evaluate the efficiency curve, data from energy calibration results and the value of counting per second (cps) are needed. The cps value is obtained from the division of the net area to the length of the enumeration (in seconds) at each energy level. Then equation with x+y=5x106+0.0109 is etisiensi measurements and X is energy so that efficiency.

Table 5. Concentration of Cs-137 radionuclide sample Water

Lokasi sampling	Konsentrasi (Bq/L) Simplo	Duplo	MDC
Cipinang	-0,72	-0,04	$1{,}04 \times 10^{-2}$
Sunter	-0,33	-0,38	
Jatikramat	0,97	0,08	
Buaran	1,57	0,42	
Cakung	-0,29	-0,25	
Marunda	-0,12	-0,84	

The analysis shows that the value varies with different value ranges far it is due to the location of the research is the open waters with currents konidisi strongly influenced by the canal sluice gates of each of the sampling points. Cs-137 radionuclide content in water KBT jakarta still below the quality standard limits prescribed by the regulations BAPETEN head of No. 7 in 2013 on environmental radioactivity limit values are 2.6 × 102 Bq / L.

Table 6. Concentration of Cs-137 in Kale Plant

Titik Sampling	Konsentrasi (Bq/Kg)	MDC
Cipinang	3,22	$1{,}04 \times 10^{-2}$
Sunter	-0,16	
Jatikramat	0,80	
Buaran	-0,63	
Cakung	1,99	
Marunda	-0,29	

The results were obtained Cs-137 radionuclide content in kale can be caused by the influence of irrigating water sources, water KBT suspected to contain radionuclides Cs-137 can contaminate kale.

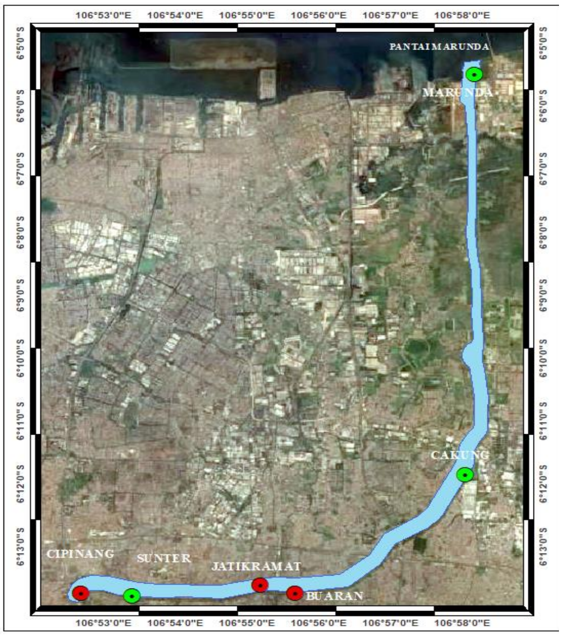

Figure 3. Distribution Pattern of Cs-137 in KBT water simplo

Based on the distribution pattern is visible activity of the radionuclide Cs-137 was detected at the sampling point cipinang, Jatikramat and Buaran.

Figure 4. Distribution Pattern of Cs-137 in KBT water duplo

Based on the distribution pattern is visible activity of the radionuclide Cs-137 Duplo water samples detected at the sampling point cakung and Marunda. Overall not one has any sampling point above the activity threshold means the canal waters are safe from contamination radionuclides Cs-137. However, despite being below the threshold, it turns Cs-137 was detected in the canal waters.

CONCLUSION

^{113}Sn/^{113m}In radioisotope generators for industrial needs is based on this research results provide commercial performance. ^{113}Sn - ^{113m}In generator, meet the requirements regarding the final product specification obtained ^{113m}In radioisotope in chemical form $^{113m}InCl_3$, clear solution, pH at 2, separation yield 95%, radionuclide purity of 95% and radiochemical purity of 95%.

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