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Full Length Research Paper

Determination of heavy metal contents in some industrial effluents from Ondo State, Nigeria

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Industrial effluents were collected from JOF Ideal Farm, Owo, an industry producing soya beans vegetable oil; Stanmark Cocoa Processing Company, Ondo; King's Cool, Ondo Plastic Industry Limited (OPIL), Akure; Benkaof Bottling Company, Akure and TISCO Company, Akure, producing disinfectants, dettols and methylated spirit. The effluents collected were kept in polyethylene bottles and labelled as E1, E2, E3, E4 and E5 respectively. Wet digestion of the samples was carried out using concentrated nitric acid. The heavy metal contents of the digests were read using Alpha-4 Flame Atomic Absorption Spectrophotometer. The results were analysed with correlation coefficient, ANOVA and compared with recommended standards of industrial effluents. The result of the analysis obtained showed that effluents from JOF Ideal Farm, Owo and Stanmark Cocoa Processing Company, Ondo had high concentration of nickel than the threshold (recommended) effluents value. Also, the concentration of mercury obtained for JOF Ideal Farm, Owo, Benkaof Bottling Company, Akure and TISCO Company, Akure are higher than the threshold values for mercury in waste water (effluents). Likewise, the concentrations for Arsenic in E1, E3 and E5 were higher than the threshold value for industrial effluents. The concentration of selenium obtained in E1, E2 and E3 were also above the threshold value. Therefore, the effluents generated from these industries are hazardous. Consequently, they could constitute to the level of pollution of both surface and ground water and pose a greater risk to both living and aquatic organisms in the study areas.

Key words: Industrial effluents, disinfectants, heavy metals, pollution, wet digestion.

INTRODUCTION

Industries are to a large extent, a contributing factor to the economic growth of any nation. However, most of these industries have in no small way contributed to the level of pollution of our surface and ground water aquifer. In fact, many aquatic organisms have been brought into extinction as a result of the introduction of certain contaminants and pollutants.

Among these contaminants are heavy metals which belong to the group of elements geochemically described as trace elements. They collectively account for less than 1% of the composition of the earth crust. Heavy metals are metals having density greater than 5 g/cm^3 (Hesse, 1979; Alloway, 1998).

Heavy metals are of serious environmental concern in recent years. This is because of their toxicity, bioaccumulation and bioconcentration in living organisms. Also, their persistence in the environment and non- biodegradable nature has heightened its concern (Yoon et al., 2006). Some of the notorious heavy metals determined in this research are Nickel, Copper, Chromium, Selenium, Arsenic, Mercury, Zinc, Lead and Cadmium. Although, some of these heavy metals are

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Table 1. Concentration of heavy metals in industrial effluents in mg/l and recommended standards.

Metals	E1 (mg/L)	E2 (mg/L)	E3 (mg/L)	E4 (mg/L)	E5 (mg/L)	WHO	US-EPA
Ni	1.0 ± 0.1	1.2 ± 0.1	0.2 ± 0.16	n.d	0.5 ± 0.16	0.02	0.01
Cu	0.044 ± 0.002	0.008 ± 0	0.008 ± 0.001	0.015 ± 0.005	n.d	2.0	0.05
Se	2.471 ± 0.001	1.449 ± 0.002	3.059 ± 0.001	n.d	n.d	0.01	
Hg	1.0 ± 0.1	n.d	n.d	2.0 ± 1.58	3.0 ± 1.0	0.001	
As	0.55 ± 0.08	n.d	0.78 ± 0.11	n.d	1.23 ± 0.04	0.01	
Cr	0.03 ± 0.01	n.d	n.d	0.04 ± 0.02	0.04 ± 0.014	0.05	0.10
Zn	n.d	n.d	n.d	n.d	n.d		
Cd	n.d	n.d	n.d	n.d	n.d		
Pb	n.d	n.d	n.d	n.d	n.d		

n.d: non-detectable.

required at very low concentration, they constitute serious hazard to the environment at high concentration. The hazardous effects of these metals and the regular release of the industrial effluents into the waterways without any assurance of proper treatment and conformity to the acceptable standards formed the basis for selecting five industries among others, whose effluents are released into the environment.

The aim of the research is to determine the presence of heavy metals in industrial effluents from these five industries in Ondo State, Nigeria. Also, to determine the possibility of pollution of the ground water and adjoining surface water.

METHODOLOGY

Water samples were collected from five different industries in Ondo State. The industries include: JOF Ideal Farm, Owo; Stanmark Cocoa Processing Company, Ondo; King's Cool, Ondo Plastic Industry Limited (OPIL), Akure; Benkaof Bottling Company, Akure and TISCO Company, Akure. Wet digestion method was used. 50ml of each of the samples were measured into a 250ml beaker. 5ml of concentrated HNO_3 was measured with a syringe and added to the samples. The mixture was evaporated on the hotplate to 20ml. Additional 5ml of HNO_3 was added to the mixture and heated under reflux until a clear solution was obtained which signals the completion of the digestion. 2ml of concentrated HNO_3 was further added to dissolve the precipitates. On cooling, the apparatus was rinsed and the digest poured into a 50ml polyethylene bottle. The bottle was made up to mark and taken for instrumental analysis. Replicate analysis was carried out and blank corrections made.

RESULTS AND DISCUSSION

The concentration of nickel (Table 1) in samples E3 and E5 are less than the concentration at which the liquid wastes could be termed as hazardous; while the concentration of Nickel in samples E1 and E2 could be hazardous when compared with the proposed threshold value of Nickel in liquid wastes (Table 2). Also, all samples contained high concentration of Nickel when compared with W.H.O drinking water quality standard. This agrees with Tariq et al. (2006) in "Characteristics of industrial effluents and their possible impacts on quality of underground water", where the concentration of Ni was above the permissible level. For copper, the concentration in E1, E2, E3, E4 and E5 are less than the recommended value of copper in liquid waste and drinking water by the World Health Organisation (WHO) standard (WHO, 1993). Therefore, they could not be termed as hazardous and are not likely to contaminate surface and ground water.

The concentration of mercury in samples E1, E4 and E5 are higher than the recommended value of mercury in waste water. The values obtained are also extremely high in comparison with the W.H.O drinking water quality standard. This study agrees with the study carried out by Banaras (1994) in which these metals were above the permissible level. Therefore, it exposes the environment to a great risk as that contributes in no small way to the high level of pollution to the water systems. The concentrations of Arsenic in the various samples were also higher than the recommended value by the W.H.O standard for drinking water quality and effluents released from industries. However the concentration of Cr is below the permissible level in all the samples.

Generally, the results obtained from the samples proved that the industrial effluents from most of the industries are contaminated by nickel, selenium, mercury, and arsenic as compared with the permissible level of the W.H.O in industrial effluents. Therefore, the ground water suffers a great risk of being poisoned with these heavy metals.

The analysis result from Table 3 revealed that a positive correlation exists between mercury and chromium, a negative correlation exists between mercury and selenium, while there is no linear relationship between the other metals. From Figure 1, the level of pollution of the five industries studied showed that effluent from E5 showed the highest level of pollution for all the metals. This is closely followed by the pollution

Table 2. Proposed threshold values for identification of liquid wastes and separated liquid phase and solid wastes as hazardous (Horvath, 1987).

Metals	Threshold values (mg/L)
Ni	1.0
Cu	2.0
Se	0.02
Hg	0.01
As	0.2
Cr	0.5
Zn	1.0
Cd	0.02
Pb	1

Table 3. Correlation Coefficient analysis of the heavy metals.

Metals	Ni	Cu	Se	Hg	As	Cr
Ni	1					
Cu	0.334988	1				
Se	0.270264	0.420292	1			
Hg	-0.36711	-0.17984	-0.80952	1		
As	-0.15166	-0.22114	0.058233	0.424546	1	
Cr	-0.32888	0.193078	-0.69272	0.916889	0.216913	1

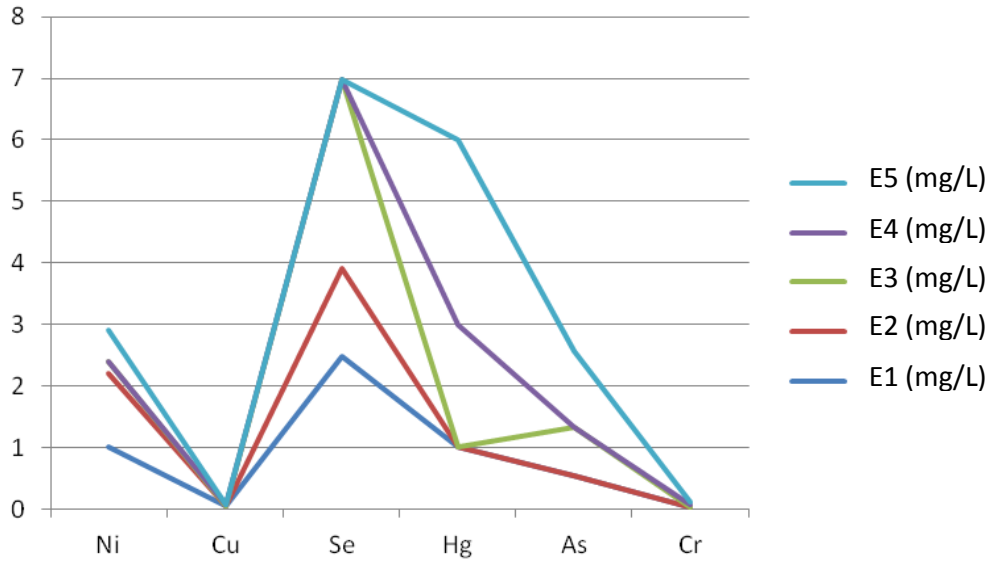

Figure 1. Pollution levels of the five Industries.

level in E4 and E3 while the effluents from the industries tagged E1and E2 are less polluted when compared with the other industries sampled. A critical look at the analysis of variance (ANOVA) of the heavy metals and the samples, showed that no significant difference existed between the pollution levels of the industries as shown in Table 4. The reason could be as a result of the fact that the source of pollution of the industries is the

Table 4. Anova: Two-factor without replication.

Summary	Count	Sum	Average	Variance		
Ni	5	2.9	0.58	0.262		
Cu	5	0.075	0.015	0.000291		
Se	5	6.979	1.3958	1.955409		
Hg	5	6	1.2	1.7		
As	5	2.56	0.512	0.27827		
Cr	5	0.11	0.022	0.00042		
E1	6	5.095	0.849167	0.816935		
E2	6	2.657	0.442833	0.472611		
E3	6	4.047	0.6745	1.455249		
E4	6	2.055	0.3425	0.659598		
E5	6	4.77	0.795	1.39447		
ANOVA						
Source of variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Metals	8.375774	5	1.675155	2.145085	0.101694	2.71089
Samples	1.167022	4	0.291756	0.373602	0.82467	2.866081
Error	15.61854	20	0.780927			
Total	25.16133	29				

same, being heavy metals.

Conclusion

It is obvious that the activities of most industries in Nigeria, calls for serious monitoring. This is necessary because of the outcome of the research conducted. The result of this research showed that some of the harmful heavy metals are present at high concentrations in the effluents produced by the industries. Particularly, the concentration of nickel in E1, E2; mercury in E1, E4, E5; Arsenic in E1, E3, E5; Selenium in E1, E2, E3 are threatening and are at a concentration higher than the permissible limit. Therefore, they could be termed as hazardous and having the potential of polluting the ground water. Also, this high concentration of heavy metals is capable of poisoning living organisms in water.

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