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Levels of Heavy Metals in the Effluents of Forcados Terminal from Delta State

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Abstract

Levels of heavy metals in the effluent samples from Forcados Terminal in Warri, Delta State were studied from May 2008 to June 2009. Effluent samples were collected from the two Barge Jetties A and B and Two Saver Pits 1 and 2 inside the tank farm. A total of 96 effluent samples were collected throughout the study period. The levels of heavy metals of the effluent samples were determined using Hach methods as recommended by the American Public Health Association (APHA) and American Society for Testing and Material (ASTM). The results of the heavy metals tested showed that most of the parameters tested complied with their respective DPR and FEMENV Limits for nearshore environments. There was statistical difference at $p \leq 0.05$ in the levels of heavy metals analysed. The range of values obtained for heavy metalsanalysedwere, 0.02-3.89 mg/l for Cu, 0.004 – 3.64 mg/l for Fe, 0.001 – 1.44 mg/l for Zn, 0.001 - 0.63mg/l for Ni. Lead, Mercury and Cadmium were present at levels below detectable limit in almost all the samples anaylsed. Most of the parameters tested for complied with their respective DPR limits for near-shore environments. Periodic monitoring should be given to the Forcados Treatment plants in order to maintain their efficiency.

Keywords: Forcados Terminal, Effluents, Water quality, Compliance.

Introduction

Metals with specific gravities greater than 5.0 are referred to as heavy metals[1]. In many freshwater environments most of the dissolved metal inputs to surface water are quickly adsorbed by fine-grained suspended sediment or channel bed sediments. Global population increase and industrial development have led to an increase in the contamination of the marine environment by metals over the last three decades[1]. Industrial effluents and municipal sewage when discharged into the water and soil pollutes the environment. The activities of some industries, the life style of the people and the havoc done on the environment by disposing waste carelessly contribute to accumulation of metals in effluents[1]. Microbial activity reduces with the presence of heavy metals hence treating wastewater by biological means are inhibited. Heavy metals toxicity in wastewater has been linked to factors like metals species, concentration, pH, pollution load, solubility of the metal ions[1].

Metals are grouped into trace (essential) and non essentialelements. Trace metals are essential micronutrients needed by plants and animals in minute amount. Some of the essential trace metals include Cobalt, Copper, Chromium, Iron, Manganese, Nickel, Molybdenum, Selenium, Tin and Zinc. Essential elements are used to stabilize molecules for redox-processes and also used as osmotic pressure regulator as components of various enzymes. Non essential elements such as Lead, Cadmium and Mecury though has no biological role can be toxic at concentrations commonly observed in soils and natural waters. Both essential metals at high levels can damage cell membranes, disrupt cellular functions, alter enzyme specificity and damage the structure of DNA[2].

Industrial effluents that enter an estuary from a variety of natural and anthropogenic sources contain heavy metals and other toxicants that deteriorate the receiving stream[3]. To ensure that pollutants are not accumulated overtime in the sediments and discourage adverse pollution of our water, effort must be made to prevent any sensitive ecosystem from being damaged as a result of industrial wastewater being discharged into surface water bodies.

Our water should be treated with treatment plants to make it clean and to encourage activities such as fishing, recreation, sports, wild life habitatand improve our health[3]. In most developing countries like Nigeria, most industries dispose their effluents without treatment. These industrial effluents have a hazard effect on water quality, habitat quality, and complex effects on flowing water.

Industrial wastes and emission contain toxic and hazardous substances, most of which are detrimental to human health. Whenenvironmental threshold to decompose pollutants is exceeded by accumulation of waste in the environment, they accumulate in living tissue and proceed along the food chain and could result in the death of organisms[4]. The objective of this research is to assess the heavy metals of Forcados Terminal by comparing the levels of the heavy metals obtained with DPR/FMENV standards.

Materials and Methods

Study area: The coordinates of Forcados Terminal are E: 310300m and N: 162090m within the provisional surface in the Western Niger Delta Sedimentary basin. The features of Forcados Terminal are synonymous with that of Benin formation typical of most areas in the Niger Delta. It is located in Warri Town in the Delta Area of Nigeria. Forcados Terminal is surrounded by swamps in the southern bank of Forcados River 47km west of Warri Town in the Delta Area of Nigeria. The activities that go on in the Terminal include storage, crude oil dehydration and export facilities.

Forcados Terminal has two saver pits 1 and 2 located within the core zone, two sewage plants which are located within the core and secondary zones. The sewage plant at the core zone that is biologically treated treats sewage from the offices inside the storage tank while the one located at the secondary zone which is chemically treated treats sewage from the residential quarters. Forcadosriver is the final end point where Saver pits 1 and 2 effluents is discharged before entering the Atlantic Ocean.

Sample collection: A total of 96 effluent samples were collected from the two Barge jetties A and B and two Saver Pits 1 and 2 of Forcados Terminal inside the tank farm. Four effluent samples were collected biweekly from May 2008 to June 2009.

Samples were collected with the aid of clean 1 liter water sampling cans. Sampling, preservation and transportation were carried out in accordance with recommended methods[5]. Barge effluents A and B were collected from the Main Jetty situated at the Secondary Zone where there are lots of ship and vessel settlers moving in and out of the Terminal. The Saver Pits 1 and 2 effluent samples were collected from the storage tank of the Tank Farm situated at the Core Zone. Control surface water samples were collected 500m away from the sampling points, far away from the Terminal, to avoid control sampling areas that may becontaminated by the effluent discharge. Barge jetties and Saver pits effluent samples were collected from the main jetty at the Secondary Zone and storage tank farm of the core zone respectively. Sampling was done with water cans of 1 liter size. Sampling, preservation and transportation were done with reference to recommended methods[5].

Methodology: Iron, Copper was determined using ASTM method as adopted by HACH method[6]. Copper was determined using ASTM method as adopted by HACH method[6]. Chromium was determined using ASTM method as adopted by HACH method[6]. Zinc was determined using ASTM method as adopted by HACH method[6]. Other heavy metals analysis (including Nickel, Lead, Mercury and Cadmium) were carried out using atomic absorption spectrophotometer method.

Statistical Analysis: Statistical methods used to analyse the results of the heavy metals of effluents fromForcados Terminal includes one-way analysis of variance used to determine the significant levels of Cu ,Zn, Cr,Fe, and Ni. The heavy metal properties of the effluents were analysed using SPSS version 17.0 software package. The inequality in means across the sample locations was determined using mean plots with respect to further mean separation. Calculation and comparison of means were also done.

Results and Discussion

Minimal concentrations of heavy metals were recorded throughout the sampling period. Concentrations ranged from 0.001mg/l for Hg, Pb and Cd to 3.76mg/l for Zn while Iron had 3.14mg/l concentration. Other heavy metals analyzed had values less than 1.5mg/l.

Copper: The monthly copper concentrations of the effluents for 12 months are shown in Table-1. The monthly values in all the samples analyzed ranged from 0 to 1.39mg/l with the highest value recorded in June 2008 at Barge Jetty A. Copper was not detected in October 2008 in Barge Jetties A and B and also not detected in September, October and December from Saver Pit 1. Very low values (<0.5mg/l) were observed in most of the months throughout the period of sampling.

Chromium: Chromium concentrations varied between 0.001 and 1.37mg/l (Table-1) with the highest value of 1.37mg/l recorded in April 2009 at Saver Pit 2. Values below 0.5mg/l were recorded in the other months of the year.

Table-1
Descriptive Statistics of Heavy metals of Effluents from Barge Jetties and Saver Pits of Forcados Terminal

Parameter	Minimum	Control	Maximum	Control	Mean (±SE)
Cu (mg/l)	0.00	0.10	1.39	0.6	0.04(±1.0)
Cr (mg/l)	0.00	0.00	1.37	0.2	0.08(±0.09)
Fe (mg/l)	0.00	0.1	3.76	1.4	0.58(±0.14)
Zn (mg/l)	0.00	0.02	3.14	0.31	0.50(±0.03)
NI (mg/l)	0.00	0.00	0.63	0.05	0.03(±0.01)

Iron: Iron concentrations varied between 0.01 and 3.76mg/l (Table-1) with the highest value of 3.76mg/l recorded in June 2008 at Saver Pit 2.

High values were also recorded in October (3.36mg/l), August (2.76mg/l) and December 2008 (2.99mg/l) at Saver Pits 1 and 2. Concentrations of less than 1.0mg/l were recorded throughout the other months of the year.

Zinc: Zinc concentrations varied between 0.001 and 3.14mg/l (Table-1), with the highest value of 3.14mg/l recorded in July 2008 at Saver Pit 1. Lower values of 0.001 – 0.6mg/l were recorded throughout the remaining months of the study.

Nickel: Nickel concentrations varied between 0.01 and 0.63mg/l (Table-1), with the highest concentration recorded in May 2009 at Barge Jetty. Values of less than 0.5mg/l were recorded throughout the remaining months of the sampling period.

Lead, Mercury and Cadmium: Lead, mercury and cadmium were below detectable limit in most of the samples analyzed. Concentrations of 0.001 - 0.002 of the three metals were recorded between June and December 2008 from Barge Jetties A and B and Saver Pits 1 and 2.

The concentrations of chromium, copper, zinc and iron in the Barge Jetties A and B and Saver Pits 1 and 2 were 1.39mg/l, 3.89mg/l, 1.44mg/l and 3.64mg/l respectively. These concentrations of heavy metals were much lower than the 5mg/l DPR threshold which is detrimental to living organism.

Accumulation of heavy metals in soil, water and absorption of such water by plants has resulted to contamination of the environment with respect to concentration of these heavy metals in soil, water and plants.

Environmental hazards derived from heavy metals are linked closely to their concentration and movement in soil profile because even low transport through soil and subsoil materials may eventually increase the content of heavy metals in the ground water[7].

Metals, generally, can be essential nutrients to microorganisms. However, some may be toxic to microorganisms when present at higher concentrations[8].

Dissolved metals in aquatic environments usually form complexes with organic and inorganic ligands. These complexes vary substantially in bioavailability to marine organisms[9].

The heavy metals measured include copper (Cu), chromium (Cr), iron (Fe), zinc (Zn), nickel (Ni), lead (Pb), mercury (Hg), and cadmium (Cd). Nickel, lead, mecury and cadmium were observed to be higher in most of the effluent samples from the Barge Jetties. This is probably due to accumulation of these metals over-time.

Conclusion

The level of compliance of the heavy metals evaluated in this research with regulatory limits were monitored in this research. Forcados Terminal effluent quality was assessed in the course of this study. The following are the conclusions from this research findings. Lead, mecury and cadmium were not detected in Saver pits effluents. They were only detected from Barge jetties effluent samples. This is probably due to accumulation of these metals over-time. The levels of heavy metals measured which complied with their respective DPR limits include copper (Cu), chromium (Cr), iron (Fe) and zinc (Zn).

Recommendation: From the findings of this study, the following recommendations can be made: In other to encourage and maintain efficiency, Forcados Treatment plants should be monitored periodically. Replacement of old biological plants with better and well equipped ones will go a long way in ensuring improved effluent quality. Improved housekeeping around the facility was observed. This should be sustained.

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