



**Bayero Journal of Pure and Applied Sciences, 10(1): 315 – 319**

Received:

Accepted:

ISSN 2006 – 6996

## **ENVIRONMENTAL IMPACTS OF CRUDE OIL SPILLAGES ON WATER IN IBENO LOCAL GOVERNMENT AREA OF AKWA IBOM STATE, NIGERIA**

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### **ABSTRACT**

*Crude oil spillage has been identified to be a regular occurrence in Upenekang village in Ibeno Local Government Area of Akwa Ibom State, Nigeria. This study has been carried out to find out the effect of crude oil spill on stream water and the environmental impact it has on the area. Using water samples obtained at varying distances from the spill site, the effects of the crude oil spill on the surface and underground stream water at the spill site were investigated by testing for the presence as well as the concentrations of toxic heavy metal pollutants. Analyses were also carried out for water conductivity, pH, temperature, hardness, total solids, total dissolved solids, turbidity, suspended solids, dissolved oxygen, carbon dioxide, COD, BOD, THC, sodium, potassium, magnesium, calcium, sulphate, nitrate, iron, copper, lead, chromium and cadmium concentrations using standard methods. The pH of all the samples of both the surface and underground stream water obtained at the spill site were observed to be acidic with very low dissolved oxygen, low COD, low BOD, high hydrocarbon content, high total dissolved solids, high water hardness and high toxic heavy metal concentrations (iron, copper, lead, chromium and cadmium) investigated for, all above admissible concentrations by World Health Organization's standards. A one-way ANOVA showed that there is no significant influence of distance away from spill on the level of heavy metals in the water samples collected in the study area.*

**Keywords:** *Crude oil spill, Upenekang, Water, WHO, ANOVA.*

### **INTRODUCTION**

The threat to human and aquatic lives posed by crude oil spillages cannot be overemphasized. Oil spillage is the release of liquid petroleum hydrocarbon into the environment due to human activities, and is a form of pollution. The term often refers to marine oil spills, where oil is released into the ocean or coastal waters. Oil spills include releases of crude oil from tankers, offshore platforms, drilling rigs and wells, as well as spills of refined petroleum products (such as gasoline, diesel) and their by-products, and heavier fuels used by large ships such as bunker fuel, or the spill of any oily white substance refuse or waste oil. Spills may take months or even years to clean up. Oil also enters the marine environment from natural oil seeps. Public attention and regulation has tended to focus most sharply on seagoing oil tankers. Oil spillage is one of the greatest environmental problems. Oil communities have been at the receiving end of this environmental problem. The problems have generated a lot of concerns within the three tiers of government especially in oil producing states. Oil spillage is one of the contentious issues facing the government, the oil industry and the host communities of the Niger Delta region which Ibeno Local Government Area is one of them. Hydrocarbons are chemical compounds composed of the elements hydrogen and carbon. This includes substances that are commonly thought of as oils, such as crude oil and refined petroleum products,

but it also includes animal fats, vegetable oils, and other non-petroleum oils. Crude oil spills are mainly caused by equipment failure, operational errors, and leaks from obsolete pipes or willful damage. Many of the oil facilities and operations are located within sensitive habitats – including areas vital to fish breeding, sea turtle nesting, mangroves and rainforests. Also drinking water sources are polluted, thus potable water have become very scarce. The presence of oil spillages causes a major impact on the riverine ecosystem and is a likely determinant factor of the poor water quality in oil producing communities like Ibeno (Akoroda, 2000).

Stagnant water bodies cause the oil to remain in the environment for long, resulting in prolonged exposure of the plants and animals (Chindah, 2000). In the case of flowing streams and obtaining potable water, the oil is transported along with the flow of the stream, thereby increasing its area of contamination. Although, there is paucity of research on the effect of hydrocarbon pollution on declining fishery resources, some studies have examined the specific impact of oil activities on aquatic species. One of such studies by Osuntokun (1999) noted that the pollution impact of oil spills affects both water and land. This causes unquantifiable ecological devastation, destruction of marine life and consequently leads to socio-economic paralysis.

A research study carried out by Magini (2006), on the effects of oil spillage on water quality/ management in Emadadja, Udu local government area, Delta State, Nigeria showed that the water quality was polluted due to the presence of toxic heavy metals. Other studies by the Niger Delta Environmental Survey have discovered that the toxic properties of hydrocarbon can lead to an immediate death of aquatic life and seabirds, lobsters, fish and crab. Those that survive the spill would have ingested ample oil, which would make them taste oily when eaten. The medium and long term effect is that the means of sustenance of these communities become paralyzed. This implies that the contamination of rivers and creeks that form sources of water to the host communities becomes contaminated and unsuitable for human consumption. From the environmental point of view, the parameters to characterize the soil and sediment will depend on organic contaminants and the metals, especially the heavy metal content and their species in the soil (Miguel and Salvador, 1998).

#### **MATERIALS AND METHODS**

##### **Collection of Samples**

Surface and underground stream water samples were obtained at 100m intervals from each sample point at the spill site. Stream water samples obtained outside the spill site served as the control samples. Borehole water sample was also obtained from the study area. All the water samples obtained were taken for laboratory analysis using standard methods.

##### **Determination of Turbidity**

The electrode of the turbidity meter was introduced into 50ml of each water sample and the turbidity readings were taken (American Water Works Association, 1980).

##### **Determination of Chemical Oxygen Demand (COD)**

A volume of 50ml of each water sample was measured into different conical flasks. 5ml of dilute  $H_2SO_4$  was added and the solution was quickly transferred to a steam bath to boil. Then 15ml of 0.01M  $H_2C_2O_4$  was added followed by the drop-wise addition of  $KMnO_4$  (0.01M) from the burette until the solution turned pink (A.O.A.C, 1984).

##### **Determination of Heavy Metals (iron, copper, lead, chromium and cadmium)**

A volume of 100ml of the water samples were measured into a 250ml beaker. 10ml of HCl were measured into the beakers followed by 30ml of nitric acid and were heated on the hot plate for 10-15 minutes at a temperature between 65-70°C to digest. After the digestion, the samples were allowed to cool and were filtered using funnel and filter paper into a beaker and were made up to 100ml ready for analysis. The digested solutions were analyzed for the presence of iron, copper, lead, chromium and cadmium using atomic absorption spectrophotometer (Unicam 939 AAS) with different lamps in position (Ademoroti, 1996).

##### **Statistical Analysis**

Results were compared by analysis of variance (ANOVA) at 0.05 level of significance as described by Oyeke, (1996).

#### **RESULTS AND DISCUSSION**

The physico-chemical characteristics of the surface stream water samples obtained at 100m, 200, 300, 400, 500 and 600m away from spill are shown in Table 1 and the pH values of the surface water samples obtained at the spill site were observed to be 4.8, 6.2, 5.8, 5.6 and 5.9

respectively indicating acidity of the water samples as compared to 6.5 of World Health Organization's standard while in the control sample (outside the spill site) is 6.6 indicating non-contamination of the water sample. Toxic heavy metals like iron, copper, lead, chromium and cadmium were also tested concentrations were observed to be high when present as compared to the World Health Organization's standard. The sources of these heavy metals are most likely to be the crude oil spills on water bodies especially if one takes into consideration the chemical composition of crude oil. Heavy metals in drinking water samples are related with chronic diseases in humans such as dizziness, nausea, shortness of breath, headaches, fatigue in coordination, as well as irritation of the eyes, which the people of Ibeno LGA have complained of (Magini, 2006).

The results of some vital tests of the water samples in terms of turbidity, conductivity, hardness, total solids, total dissolved solids, calcium, magnesium concentrations, chemical oxygen demand (COD) and biological oxygen demand (BOD) were carried out. The chemical oxygen demand values were observed to be 339, 289, 300, 256, 196 and 194 mg/L at distances 100, 200, 300, 400, 500 and 600m respectively. These values were seen to be worrisome when compared to the World Health Organization's standard. High chemical oxygen demand is an indication of increased biological activities and rate of chemical reaction in the water due to the crude oil spill on the water (Ademoroti, 1986). Higher values of calcium and magnesium beyond W.H.O limit were observed which is an indication of high water hardness in the characterized water samples. Therefore, these polluted waters will not be suitable for consumption by human and aquatic lives (Magini, 2006).

The physico-chemical characteristics of the underground stream water samples obtained at 100, 200, 300, 400, 500 and 600m away from spill are presented on Table 2. The pH values of the underground samples were observed to be 5.4, 5.6, 6.1, 4.9, 5.8 and 6.1 respectively again indicating acidity of the water samples which can be toxic to humans and aquatic lives. Toxic heavy metals like iron, copper, lead, chromium and cadmium were in high concentrations when compared to the World Health Organization's permissible limit. This has rendered underground water in these areas unusable because such water is capable of causing health defects in both plant and animals (Magini, 2006). Oil spill is associated with low dissolved oxygen concentration, increased biochemical oxygen demand, increased water temperature and acidity of the water as reported by Enujiugha and Nwanna, (2004).

Oil spill on water increases respiration rates of aquatic organisms leading to increased oxygen consumption and increased decomposition of organic matter which leads to low dissolved oxygen in the water. It was further observed that increased temperature decreases the solubility of gases (especially oxygen) in water which is what has been observed in this study. The lower dissolved oxygen (DO) values in the study area imply that the water is more polluted. DO is essential to all forms of aquatic life including the organisms that break down man-made pollutants. Oxygen is soluble in water. Oxygen tends to be less soluble as temperature increases. In general, the concentration of dissolved oxygen will be the result of biological activity. In natural waters, man-made contamination or natural organic material will be consumed by microorganisms. As this microbial activity increases, oxygen will be consumed out of the water by the organisms to facilitate their digestion

process. The water that is near the sediment will be depleted of oxygen for this reason. The oxygen will be consumed and the water will become anaerobic. The generally accepted indicators of water quality are dissolved oxygen (DO) and the biochemical oxygen demand according to Damaskos and Papadopoulos (1983).

Table 3 shows that the calculated F-value of (0.31) was obtained after testing for significance at 0.05 alpha level with 6 and 150 degrees of freedom. The calculated F-value (0.31) was less than the table F-value (2.09). Hence, the effect of distance on water pollution is not significant.

Again, table 4 shows that the calculated F-value of (0.21) was obtained at 0.05 alpha level of significance with 6 and 149 degrees of freedom. The calculated F-value 0.21 was less than the table F-value 2.09. Therefore, the result was statistically not significant.

**Table 1: Physico- Chemical Characteristics of Surface Water Samples at Different Distances from the Site of Spill.**

S/N	PARAMETER	100m	200m	300m	400m	500m	600m	Control	W.H.O. STANDARD
1	Temperature (°C)	30.4	29.2	28.9	28.7	29.1	27.7	27.2	25
2	pH	4.8	6.2	5.8	5.6	5.6	5.9	6.6	6.5-8.5
3	Turbidity (NTU)	15	13	12	13	10	11	6	<5
4	Conductivity (µs/cm)	32.35	26.86	24.85	33.65	28.61	19.98	9.46	500
5	Hardness (mg/L)	11.83	15.60	9.65	13.75	12.67	10.91	9.76	200
6	Total solids(mg/L)	320	294	309	289	224	218	97.9	500
7	Total dissolve solids(mg/L)	310	285	298	277	215	210	88.7	500
8	Suspended solids(mg/L)	10	9	11	12	9	8	9	20
9	Dissolved oxygen(mg/L)	1.75	1.62	2.04	1.86	2.11	1.58	5.87	3 minimum
10	Carbon dioxide(mg/L)	20.87	14.76	23.60	22.84	18.75	25.76	42.65	50
11	C.O.D(mg/L)	339	289	300	256	196	194	107	125
12	B.O.D(mg/L)	12.65	13.43	15.83	12.55	13.91	12.32	7.82	10
13	T.H.C(mg/L)	1.25	1.12	0.08	0.13	ND	ND	ND	0.05
14	Sodium(mg/L)	16.85	18.77	15.88	12.54	12.65	11.64	7.83	200
15	Potassium (mg/L)	5.48	11.74	8.98	11.56	10.06	7.98	4.75	2
16	Magnesium (mg/L)	45.76	62.54	49.98	45.95	42.54	41.45	28.87	37
17	Calcium (mg/L)	55.78	53.76	58.73	51.45	52.46	50.46	37.24	50
18	Sulphate (mg/L)	26.45	19.76	29.87	24.65	18.87	26.11	10.86	500
19	Nitrate(mg/L)	2.621	1.332	1.129	0.843	1.236	1.464	15.851	1.5
20	Iron(mg/L)	1.652	1.751	1.461	1.413	1.093	2.104	0.921	1.0
21	Copper(mg/L)	1.741	ND	1.413	0.931	1.491	1.536	1.0	1.0
22	Lead(mg/L)	1.419	0.721	ND	0.031	0.941	0.149	0.035	0.05
23	Chromium (mg/L)	0.415	0.541	0.941	ND	0.051	0.432	ND	0.05
24	Cadmium (mg/L)	0.145	0.145	0.143	ND	ND	ND	ND	0.01

**Table 2: Physico- Chemical Characteristics of Underground Water Samples at Different Distances from the Site of Spill.**

S/ N	PARAMETER	100m	200m	300 m	400 m	500 m	600m	Control	W.H.O. STANDARD
1	Temperature (°C)	28.7	28.1	28.5	28.4	28.9	27.5	27.0	25
2	pH	5.4	5.6	6.1	4.9	5.8	6.1	6.7	6.5-8.5
3	Turbidity (NTU)	13	10	14	9	11	9	7	<5
4	Conductivity (µs/cm)	29.72	30.34	27.97	27.32	29.50	24.75	12.65	500
5	Hardness (mg/L)	14.55	11.51	11.87	11.84	10.52	16.12	10.54	200
6	Total solids(mg/L)	248	284	284	266	214	217	102.8	500
7	Total dissolve solids(mg/L)	240	276	275	255	207	208	92.8	500
8	Suspended solids(mg/L)	8	8	9	11	7	9	10	20
9	Dissolved oxygen(mg/L)	2.68	2.08	1.85	2.08	1.83	1.88	8.35	3 minimum
10	Carbon dioxide(mg/L)	16.56	19.78	19.7	26.8	23.3	23.33	38.61	50
11	C.O.D(mg/L)	268	352	259	220	208	199	115	125
12	B.O.D(mg/L)	14.23	11.34	13.34	11.89	11.65	13.68	5.24	10
13	T.H.C(mg/L)	1.08	0.16	ND	ND	ND	ND	ND	0.05
14	Sodium(mg/L)	19.543	19.64	13.75	16.87	16.94	10.12	8.10	200
15	Potassium (mg/L)	9.30	8.84	12.8	13.8	9.982	9.60	5.257	2
16	Magnesium (mg/L)	57.87	58.89	53.12	47.86	47.98	44.87	32.26	37
17	Calcium (mg/L)	61.76	57.97	53.38	56.76	59.12	53.89	43.68	50
18	Sulphate (mg/L)	27.87	22.34	27.66	23.81	24.25	21.25	7.82	500
19	Nitrate(mg/L)	1.881	1.453	1.532	1.452	1.663	0.954	13.734	1.5
20	Iron(mg/L)	1.231	2.091	0.942	0.953	1.431	1.947	0.154	1.0
21	Copper(mg/L)	0.981	1.143	1.003	1.214	0.349	2.015	0.98	1.0
22	Lead(mg/L)	1.234	0.514	0.431	0.143	0.532	1.003	ND	0.05
23	Chromium (mg/L)	ND	0.341	0.010	ND	ND	0.053	ND	0.05
24	Cadmium (mg/L)	0.341	0.213	0.521	0.019	ND	0.090	ND	0.01

**TABLE 3: Anova for Surface Stream Water**

Source of variance	SS	Df	Ms	F
Between groups	13516.20	6	2252.70	0.31
Within groups	1083783.87	150	7225.23	
<b>Total</b>	1097300.07	156		

**TABLE 4: Anova for Underground Stream Water**

Source of variance	SS	Df	Ms	F
Between groups	7860.89	6	1310.15	0.21
Within groups	932440.31	149	6257.99	
<b>Total</b>	940301.19	155		

## CONCLUSION

The physico-chemical characteristics of the surface and underground water samples obtained at the spill area were observed to be acidic with very low dissolved oxygen, high in chemical and biological oxygen demand, high water hardness, high total dissolved solids and high presence of toxic heavy metals like iron, copper, lead, chromium and cadmium. All these observations are indicators that the water samples are polluted and thus, not suitable for humans and aquatic lives. According to Carla, (2002), it was reported that exposure to crude oil spills causes a variety of health problems. It is therefore highly dangerous to drink from the water at Upenekang spilled site. From the analysis of variance (ANOVA), it was observed that there is no significant influence of distance away from spill on the level of

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- heavy metals in surface and underground water samples. This observation portends grievous danger as water bodies contaminated with crude oil spills may go unhindered in polluting very large volumes of both surface and underground water resources.
- CONTRIBUTIONS OF AUTHORS**  
Ndeh, E. S. and Okafor, J. O. carried out the research work and experimental analyses while Akpan, G. U. and Olutoye, M. A. carried out the analysis of variance on the results obtained from the research work.
- CONFLICT OF INTEREST**  
None
- ACKNOWLEDGEMENT**  
We want to acknowledge Petroleum Technology Development Fund (PTDF) for their support all through the course of this research work.
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