

The Complexity of Contamination in Power Facility and its Effect on Environmental Pollution

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Abstract

The management of any facility is of importance to the socio-economic activities of the environment concern. This is crucial to not only the development of the area but also for human existence. However, the need to evaluate and determine the extent of environmental issues in a given facility is the main issue of concern. This work is to view the complexities of contamination in a given power facility in Nigeria and explain the effect of environmental pollution of this particular area of interest. While the actual site assessment and investigation of the facility was carried out in September 2013.

Keywords:

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Background to the Study

Muralikrishna (2017), Environmental pollution is one of the most serious problems facing humanity and other life forms on our planet today. Thus, environmental pollution is defined as “the contamination of the physical and biological components of the earth/atmosphere system to such an extent that normal environmental processes are adversely affected.” Though according to Section 2 (c) of the Indian Environment (Protection) Act, 1986, “Environmental Pollution” means the presence in the environment of any environmental pollutant”. This may or may not have been amended in the Indian constitution law. But for academic purpose of this work solely, it is important this is viewed.

Although, environmental pollution is not a modern phenomenon. Clearly, it is not peculiar to man and may indeed have preceded him. However, pollution by man in the twentieth century and beyond is a reflection of development of technology and the resulting increase, in living standards and consumption habits associated with economic growth and diversifications. However, the problem of environmental pollution is global and concerns all counties irrespective of their size, level of development or ideology. Though, notwithstanding political division of the world into national units, oceanic world is interconnected whole, and winds that blow over the countries are also one.

In addition, while the environment is a universal phenomenon pervading the whole world at large. Thus, if nuclear test is carried out in one part of the world the fall out may be carried by winds to any other part of the world and such fall out of irresponsible disposal of radioactive from a remote energy plant in one country may turn out to have greater of full-fledged war and global crisis. According to Japan's experience in Public Health and Medical Systems, Environmental pollution is more than just a health issue; it is a wider social issue in that pollution has the potential to destroy homes and communities. Pollution problems are also closely tied to the mode of development in developing countries. Despite this, many developing countries either have not developed environmental pollution control measures or have not provided adequate implementation structures to ensure that policies are effective.

While the World Health Organization (WHO) estimates that about a quarter of the diseases facing mankind today occur due to prolonged exposure to environmental pollution. Though, Rai (2016), stated that depending on the nature of pollutants and also subsequent pollution of environmental components, the pollution may be categorized as follows:

1. Air Pollution
2. Water Pollution
3. Soil/Land Pollution
4. Noise Pollution
5. Radioactive Pollution
6. Thermal Pollution

Furthermore, the management of facilities not only encourages economic growth but is needed for environmentally friendly interactions. This creates not only thriving business but enhances and promotes good socio-political activities. For an effective productivity and efficiency of operation, facilities are not only guarded properly but they are maintained adequately for good service delivery purposes. The facility to be analyzed in the aspect of environmental pollution and contamination is the Akangba work centre. This is a facility owned and managed by Transmission Company of Nigeria, a subsidiary of Power Holding Company of Nigeria (PHCN). It is classified as a sub-region work centre. It is located at off Adelabu Street in Surulere, Lagos State of Nigeria. The latitude is 6.49517 and the longitude is 3.34702. The work centre name is Akangba 330/132/33KV work centre. It commenced operation in 1972 with four (4) power transformers.

Environmental contamination is one of the parameters to be reviewed in environmental pollution control analysis. This is because of the likelihood of ascertaining the existence of a contaminant in a given environment. Here of interest is land contamination of the area- facility. This was clearly defined and assessed as a site investigation work. The objective of the work was to ascertain the likelihood of potential contamination by persistent organic pollutants (POPs). With emphasis on the potential contaminants of concern are Polychlorinated Biphenyls (PCBs) which are associated with the use of transformer oil at the work centre.

For the purpose of this assessment – site investigation and observation, a radius of between 200m and 500m was chosen for the study to determine the extent of possible contamination. While based on the site assessment and observations there are indications of possible soil and groundwater contamination above international Standards. However, the objective of this work is to, determine if soil and ground water at the site were contaminated with PCBs at all levels, due to the historical use of transformer oils at the station.

Materials and Method

Sample Collection, Storage and Preservation

Basically, surface soil samples (topsoil) were collected using a clean stainless steel hand trowel and transferred into aluminum soil that had been previously baked in an oven 150°C for 15 hours after using with organic solvent (pesticide grade acetone). The soil was labeled, sealed, placed in an ice chest cooler and transferred to the laboratory along with chain of custody documentation. Generally, soil samples were collected from the sub-station for laboratory analysis. All the sampling point taken on site was geo-referenced (using GPS: mobile Garmin). Subsequently, the samples were transported to the laboratory in ice chest coolers filled with ice. While the samples were allowed to reach room temperature by taking them out of the coolers, and then allowed to stand under ambient conditions in the laboratory for 30 minutes.

Finally, the extraction of samples started immediately, therefore, followed by gas chromatographic analysis of the samples extracts after sulphuric acid clean up. The identity of the surface soil samples collected with their coordinates is below in table 1.

Table 1: Surface soil samples identity and their coordinates

Sample ID	Height above sea level (m)	Latitude	Longitude
X1	36	06.49573 N	3.34753
X2	31	6.49552	3.34759
X3	30	6.49543	3.34768
X4	21	6.49591	3.34781
X5	20	6.49594	3.34771
X6	18	6.49601	3.34799
X7	17	6.49585	3.3481

Apparatus Pre - treatment

Initially, all glassware used for sample analysis was scrupulously cleaned by soaking it in chromic acid (i.e 10g $K_2Cr_2O_7$ /L of H_2SO_4) overnight, then washed with detergent and copiously rinsed with running tap water followed by distilled water, and then acetone. The glassware transferred into the oven and dried for two hours at 105°C.

Sample Pre - treatment

Basically, foreign objects such as sticks, leaves, stones and metals were handpicked from the soil and oil samples, and then each sample was thoroughly mixed with a glass rod to homogenize.

Sample Extraction

The United State Environmental Protection Agency (USEPA 1996) validated method 3540C was followed for the extraction of samples for PCB analysis. Analytical grade reagent and chromatographic grade solvent and absorbents were used. 30_g of sample weighed into a 250 ml glass beaker and 50ml of the extraction solvent (Hexane + Acetone 1:1) was added. The analyte (PCBs) was extracted into the solvent in an ultrasonic bath for three minutes. The filtered using a grouch crucible and Buckner flask under funnel section. The extract was collected into a 100ml quick - fit glass round bottom flask. The extraction was repeated twice, and the filtered extract were pulled together in the quick - fit round bottom flask. The solvent was then evaporated from the extract in a rotary evaporator until the extract was reduced to approximately 2ml.

Extract Clean-up

The extract was quantitatively transferred into a 15ml glass centrifuge tube, and 2ml of concentrated H_2SO_4 was added carefully in a fume hood. The tube was covered and centrifuged for one minute. The phase was allowed to separate for at least a minute. The aqueous layer (H_2SO_4) was removed with a glass Pasteur pipette and the non - aqueous layer (solvent) was then neutralized with 2ml $KHCO_3$. This mixture was centrifuged for one minute. The aqueous layer was carefully removed with the Pasteur pipette after the separation of the liquid layers. The clean-up Ws repeated until the extract (non - aqueous layer) was colorless. The organic extract was transferred into a calibrator glass centrifuge

tube and made up to the original volume (2ml) with hexane. The cleaned extract was stored in a Vidal with a PTFE – line screwed – cap, labeled approximately and analyzed by Gas Chromatography – Mass Spectrometry (GC - MS). The samples were refrigerated after analysis.

PCB. Determination by Gas Chromatography – Mass Spectrometry

The concentrations of the PCBs as individual PCB congress samples were determined in the extract using a Shimadzu GC –MS Model QP 2010. The gas chromatography was an open – tubular, capillary column with an electron capture detector (ECD), and the mass spectrometer was used to identify the individual PCB congress samples in the extracts.

GC – MS Operating Conditions

The following GC-MS conditions were used:

- i. Injector Temperature = 250°c
- ii. Equilibrium Time = 3min
- iii. Initial Oven Temperature = 80°c
- iv. Injection Mode = Splitless
- v. Sampling Time = 1min
- vi. Flow Control Mode = Lower velocity
- vii. Pressure = 72.8k Pa
- viii. Total Flow = 30ml/ min
- ix. Purge Flow = 3ml
- x. Carrier Gas = Helium
- xi. Column Flow = 1.2ml/ min

Table 2: Oven Program

Rate (°c)	Temperature (°c)	Hold Time (min)
-	80	1
10	180	2
10	280	3

Total Run time: 26min

Column used:

HP – IMS (Cross Linked PH ME Siloxane) 1990915 – 933

Film thickness: 0.25mm. Length: Column ID: 0.25mm

IMS Set – up

- i. Ion Source Temperature : 200°c
- ii. Interface Temperature : 250°c
- iii. Solvent Cut Time : 5min
- iv. Detector Gach Mode : Relatives to Time Parameter
- v. Acquisition Mode : Sim (Selected Ion Monitoring)

Calibration Standard

A stock standard containing an equal concentration of Aroclor 1221 and Aroclor 1260 was prepared. There serves of calibration standards were the Prepared, containing equal concentration of both Aroclor 1221 and Aroclor 1260 from the stock standard by diluting with hexane.

Quality Control and Assurance

All glass were thoroughly cleaned and the used of plastic materials was avoided doing sample analysis. A new set of clean glassware was for each sample to prevent cross – concentration. A regent blank was subject to exactly the same analytical procedure as the samples – All reagent used were of an organic – free grade. A mixture of PCB congress samples of known concentration was also analyzed with the GC – MS. The GC – MS has a detection limit 0.002 ppm.

Results and Discussion: The result of the outcome of the above described laboratory analysis is shown below in table 3. This showed that, all the seven (7) identified congress samples collected from the site have a concentration limit range of 0.26ppm – 0.007ppm. Recall that, this analytical work of preliminary site investigation was to be based on the best global practice. Which means that it has the International Standard to be evaluated with. For this type of land contamination, the International Standard for soil sample is 33ppm.

Table 3: PSI Surface Soil Sample results

S/N	Sample ID	Actual Concentration (PPM)
1	X1	0.26
2	X2	0.063
3	X3	0.023
4	X4	0.026
5	X5	0.03
6	X6	0.03
7	X7	0.007

Conclusion

Earlier, the need to evaluate and determine the extent of environmental issues in a given facility was stated as the main concerns for this work. Thus, the work viewed the complexities of contamination of a particular power facility, which is Akangba work centre in Nigeria and explained its effect to environmental pollution. Based on this, the sample results obtained as shown in table 3 above, the following conclusions are drawn.

They are:

- i. The international standard for soil samples that was used is 33ppm.
- ii. None of the soil sample spots is above 1ppm.

- iii. Thus, no need to proceed to Detailed Site Investigation (DSI) Stage.
- iv. Hence, based on the above analytical review, there is no suspected presence of land contamination in Akangba work centre for the period under review.
- v. As that, the time of this site investigation, the level of contamination is not enough for cause of concern.
- vi. Hence, the site facility may be viewed as safe for operational activities in line with global standards of operation.

References

- A Preliminary site Investigation Stage 1(PSI 1), (2013). On the Akangba Transmission Sub Region, for contaminated site report conducted by a Joint Team. 25-26,)
- A Preliminary Site Investigation Stage 1(PSI 2), (2013). On the Akangba Transmission Sub Region, for contaminated site report conducted by a Joint Team. 25-26,)
- Barnes, D. (1991). Toxicity equivalency factors for PCBs? *Quality Assurance. Good practice, regulation, and law*, 170–81
- Conservation Foundation. (1987). *State of the environment: A view towards the nineties*.
- Elkins, H. B. & Pagnotto, L. D. (1980). *Industrial health hazards in treatise of analytical Chemistry, Ed. I.M. Kolthoff, P.J. Elving, Part III, 4, Section B, Wiley-Interscience*
- Environmental Protection Agency (E.P.A), (1986). National air quality and emissions trends Report, 198.
- Federal report on acid rain draws criticism (1979). 1404.
- Goldemberg, J. (1987). *Energy for a sustainable world*, World Resources Institute, Washington, D. C.
- Holoubek, I. (2001). *Polychlorinated Biphenyl (PCB) contaminated sites worldwide*, In: Robertson L W, Hansen L G, editors. PCBs – Recent Advances in the Environmental Toxicology and Health Effects of PCBs. Lexington: The University Press of Kentucky, 17–26.
- <http://www.environment.gov.au/settlements/publications/chemicals/scheduledwaste/pcbidentification.html>
- <http://www.chem.unep.ch/pops/pdf/PCBident/pcbident1.pdf>
- International Institute for Environment and Development (I.I.E.D.) & World Resources Institute (W.R.I.). World Resources (1987). Basic Books, New York.

- Irgolic, K. J. & Martell, A. E. (1985). *Environmental inorganic chemistry*, VCH Publishers Inc., USA.
- Jaswal, P. S. & Nishtha, J. (1999). *Environmental law*, 1.
- Lykke, E. (1987). *International mechanisms for the prevention of pollution. Statement at Conference on Constitutional Law*, Laval University, Quebec,
- Management Information Services. (1986). *Economic and employment benefits of investments in environmental protection*,
- Mathews, J. (1987). Global climate change: toward a green-house policy, *Issues in Science and Technology Spring*, 57.
- Marr, I. L. & Cresser, M. S. (1983). *Environmental chemical analysis*, International Textbook Co., New York.
- Muralikrishna, V. & Valli, M. (2017). *In environmental management series*.
- Melosi, M. (1980). *Pollution and Reform in American Cities, 1870-1930*. University of Texas Press, Austin,
- Mehtav, M. C. (1911). *Union of India*, 2 SCC 353, 354.
- Mintzer, I. (1987). *A matter of degrees: The potential for controlling the greenhouse effect*, World Resources Institute, Washington, D. C.
- National Academy of Sciences (N. A.S.). *Science and Technology (1979). A five-year outlook*, W. H. Freeman, San Francisco.
- National Acid Precipitation Assessment Program. *Interim Assessment, (1987). The causes and Effects of Acidic Deposition, 2*. Government Printing Office.
- Ramanathan, V. (1987). *Observed increases in greenhouse gases and predicted climatic changes*, Statement before U. S. Senate Committee on Energy and Natural Resources.
- Reganold, J. (1987). *Long-term effects of organic and conventional farming on soil erosion*, *Nature*: 370.
- Royston, M. (1987). *Pollution prevention pays*, Pergamon New York. Science.
- Sahu, K. C., (1987). *Proceedings of symposium on role of earth sciences in environment* I.I.T. Press.

U.N. Environment Programme (U.N.E.P.). 1987a. State of the Environment. Butterworth, London. 1987b. The Ozone Layer.

1987c. The Greenhouse Gases. U.N. Environmental Programme (U.N.E.P.) & World Health Organisation (W.H.O.). (1987), Global Pollution and Health..

U.N. Environment Programme (U.N.E.P.), World Meteorological Organisation (W.M.O.), & International Council of Scientific Unions (I.C.S.U.), (1985). *The assessment of the role of carbon dioxide and of other green-house gases in climate variations and associated impacts*, Statement at the International Conference, Villach, Austria.

World Commission on Environment and Development (W.C.E.D.), (1987). *Our common future*, Oxford University Press, Oxford.

World Resources Institute (W.R.I.) (1986). *International institute for environment and development (I.I.E.D.)*, World Resources. Basic Books, New York.

www.epa.vic.gov.au.

www.greenfacts.org.