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The State of Analytical Instruments in Some Environmental Pollution Control Laboratories in Nigeria

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ABSTRACT
The state of the environmental laboratories involved in monitoring environmental pollution control in Nigeria has been studied in this research. The research was undertaken by visiting four analytical laboratories involved in environmental pollution control in Nigeria. The analytical laboratories visited are those of Nigerian National Petroleum Corporation (NNPC) Kaduna, Ashaka cement factory, regional laboratory of the Federal Ministry of Water Resources Gombe, and the National Reference laboratory Lagos. In these laboratories results were collected in the laboratories, interviews were carried out and analytical instruments available were documented. It was discovered that, in these laboratories many standard analytical instruments needed for quality environmental pollution control and monitoring are lacking. Comparison of analytical instruments found in these laboratories with those found in literature revealed that many needed analytical instruments are missing. It is the position of this work that the gap between the environmental analytical instruments found in literature and that found in the research laboratories is very large and calls for concern.

Keywords: Environment, Pollution, Monitoring, Laboratories, Analytical Instruments,

I. INTRODUCTION

The first part of this work has been reported, where the NNPC laboratory results were analyzed [I], in the reported work it was seen that many pollutants in the company were not analyzed for lack of analytical equipments. The importance of using good and accurate analytical instruments in environmental pollution control has already been studied and reported by many scientists, such as Burns [II], Gillian [III], Jayaratne [IV] and many others. In advanced countries, environmental quality monitoring is compulsory and there are effective environmental laboratories well equipped for this purpose. Environmental laws hence are followed strictly. Industries make efforts to use good, accurate and reliable analytical methods since there are good monitoring laboratories on ground. The situation is quite different in many developing countries. Although industrial growth and its associated environmental problems are fast increasing in these developing countries; the monitoring of pollution is mostly not taken serious. Nigeria is not an exception, monitoring pollution control by both the industries and the government monitoring organizations are not taken serious. Treated wastes are dumped into rivers or land without proper control, as such the maximum limits of the pollutants are mostly exceeded; therefore this research addresses the need for good, accurate and reliable analytical methods for the purpose of monitoring pollution control.

In this research four environmental laboratories in Nigeria were visited and their analytical instruments studied and compared with what is obtained in standard situations.
The conclusion that this research has arrived at is that generally the research laboratories lack most of the classical analytical instruments as enumerated in the literatures, even some simple instruments were found missing talk less of the high technology instruments being used in developed countries for environmental pollution control. The gap between the analytical instruments given in the theory and what was found in the research laboratories is big and calls for concern.

II. METHODOLOGY

The methods that are used in this research are mainly three: first is theoretical method using secondary sources, here an in-depth literature review is done to establish the state of the art of analytical instruments in environmental pollution control globally and in Nigeria, establish the state of art of analytical instruments used in pollution control and what is obtained in Nigeria in the literature. Second method is field work, which is done by person to person interview in collaboration with the environmental laboratories in the study area. The study areas were Gombe, Ashaka, Kaduna and Lagos; the

laboratories visited are NNPC (KRPC) Kaduna laboratory, Ashaka Cement Factory laboratory, Regional Laboratory Gombe and National Reference Laboratory Lagos**.** The third method is the use of analytical laboratory results obtained from the environmental laboratories in the study area; these results are analysed by comparison with what is obtained in literature in terms of analytical instruments used in environmental pollution control.

III. RESULTS AND DISCUSSION

Table 1 Summary of Analytical Instruments Found in the Research Laboratories

NNPC (KRPC) Kaduna	**Ashaka Cement Factory**	**Regional Laboratory Gombe**	**National Reference Laboratory Lagos**
DO Meter	IR Spectrophotometer	Thermometer	HPLC
PH Meter	X-Ray Fluorescence (XRF)	PH Meter	GC
TDS Meter	viscosity meter,	Conductivity Meter	AAS
Conductivity/COD/PH Meter	rapid moisture analyzer,	Turbidity Meter	Flame photometer
Double Beam Spectrometer	fusion machine	DO Meter	FIR
GC		DR890 Colorimeter	COD reactor
		UV	Conductivity Meter
		Flame Photometer	PH Meter
		BOD Reactor	Turbidity Meter
		COD Reactor	

Table 1 above is the results obtained in the three laboratories visited; this basically shows the types of analytical instruments obtained in these three laboratories. In the laboratories visited, the common analytical instruments found there are the basic ones like $_{p}$H meter, conductivity meter, total solid meter, dissolved solid meter, turbidity meter, etc as seen in Table 1 above. But few of these instruments are fairly advanced ones; example is the HACH DR/890 which is one of HACH Company's well advertised colorimeter. There were few standard instruments found in some laboratories, example are spectrophotometer, gas chromatography, flame photometer, etc. These analytical instruments if well maintained and operated can be of immense help in environmental analysis. A critical component of environmental monitoring is the type of analytical instruments used to analyze samples. Normally the choice of these analytical instruments is dictated by the environment monitored, the parameters of interest and the data quality requirements. And one must select a scientifically sound method, approved by a regulatory agency, for example the Nigerian Federal Ministry for Environment. The laboratories visited just use instruments that are available and not so much dictated by the regulatory agency nor the environment or parameters to be monitored as can be seen from what are obtained in these laboratories. This is an unfortunate situation because analytical measurements are the foundation for determining pollutants and their effects in the environment and to ultimately formulate appropriate risk management policies and laws, because for reporting purposes, the analytical methods used have to be specified.

To understand the importance of analytical instruments in the Nigerian environmental pollution control, let us have a look at some of the pollutants that are found in Nigeria based on the types of industries and activities found in the country. Some common pollution caused by industries in Nigeria are as follows: oil spill, trace minerals, BTEX compounds, PM, VOCs, sulfides, ammonia and suspended solids, OM, PHA, PCB and dioxins, etc. Some of these pollutants can be very hazardous to human health and need sharp control by laboratories. Some air pollutants like SO_2 is typically measured using UV absorption, UV fluorescence or IR absorption spectrophotometer. Carbon monoxide (CO)

and carbon dioxide (CO_2) are usually measured using IR which uses a combination of NDIR and GFC measurement techniques, catalytic sensor is another gas detection technique used in continuous emission monitoring, chemilumescent analyzers are used at times for the measurement of NH_3. GC/MS is used to analyzed samples containing unknown volatile and semi volatile organic compounds, PCBs, etc. There are some portable GC used in many laboratories for characterization of VOCs, PAHs, and PCB, GC/MS is also used for the water analysis. NMR is used in a wide range of samples including waste water, ground water, etc. In the light of the types of pollutions produced by industries in Nigeria and the types of instruments available for environmental pollution control given in literature as enumerated above, one expects to find many of these types of instruments in the research laboratories. Oil company like NNPC in particular should have most of these instruments if not all, but they did not have even a working GC. An instrument like NMR that is use for a lot of measurements was expected in at least the reference laboratory, but none of the research laboratories have this.

Table 2 Appropriate Analytical Instruments for Pollutants Found in Nigeria as found in Literature [VI, VII, VIII and IX]

Pollutants	**Analytical Instruments**
PCBs	GC/MS, Portable GC
SO2	Electrochemical cells, UV absorption, UV Fluorescence, NDIR
NOx	Chemiluminescent, Photomultiplier tube
CO, CO2	IR (NDIR & GFC) techniques, Raman Spectrophotometer
PM	GC/MS, Catalytic Sensor
HCL	NDIR/GFC, UV, FTIR
NH3	NDIR/GFC, UV, FTIR, Chemilumescent analyzers
Hydrocarbons	NDIR/GFC, UV, FTIR
VOCs (air)	GC/MS, Portable GC
Pesticides	GC/MS
PAHs	REMPI-TOF, Portable GC, Two step laser Spectrometry
Oil Spills	GC, EDXRF, GC/PID, NMR, GC-NPD, GC-IRMS
Chlorinated Pollutants	Purge & Trap GC-MS
VOCs (in water)	MI MS
Waste Water	NMR/HPLC, APCI-MS
Sulfur	Inductively Couple Plasma (ICP),
BTEX	Pressurized Liquid extraction (PLE), GCxGCMS, Time of Flight MS
Cement dust, soot, Aerosols	UV/VIS Spectrophotometers
Heavy Metals and metals geberally	^{1}H & ^{3}P NMR, EDXRF, Inductively Couple Plasma (ICP), AAS, AES
Inorganic salts	EDXRF, Ion Chromatography (IC)
Organic compounds,e.g. like proteins	Electrophoresis, TLC
Dioxins	Pressurized Liquid extraction (PLE),GC-IRMS

Generally the research laboratories lack most of the classical analytical instruments as enumerated early, talk less of the high technology instruments found in literature. The gap between the analytical instruments given in the theory and what was found in the research laboratories is big. This can be seen when one compares Table1 above which contains the analytical instruments found in the research laboratories with Table 2 which contains appropriate analytical instruments for the pollutants found in Nigeria from literatures, the gap is big. Figure1 is a comparison of these analytical instruments found in the literature and the ones available in the research laboratories.

From this figure the gap can be seen more clearly and shows there is a big room for improvement. With such serious lack of analytical instruments, the monitoring of pollutants by these laboratories cannot be done efficiently. Some of the pollutants enumerated early need very good analytical instruments to control them, because when dealing with certain types of pollutants like BTEX, dioxins, etc, the best means available need to be used to obtained accurate and reliable measurements.

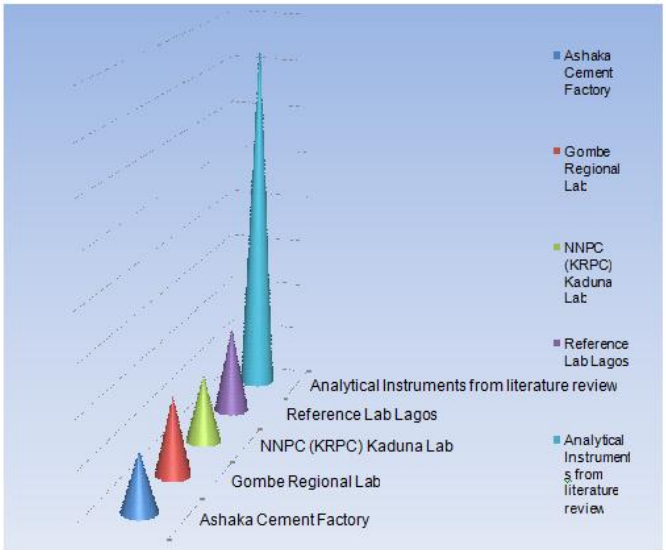

Figure 1: The Number of Analytical Instruments Found in Literature [X, XI, XII, XIII, XIV and XV] Compared with those Found in the Research Laboratories.

The lack of instruments mentioned above can be supported by the analytical results from these laboratories already reported elsewhere [V], [I]. In the Regional Laboratory Gombe the results showed [V] that they were taken using only few from the available instruments, such as PH meter, conductivity meter, turbidity meter, DO meter and DR890. This could mean some of the few analytical instruments seen in the laboratory are not functional or are not yet put in used due to one reason or the other. In NNPC chemical laboratory, the results [I] showed many test were not done because the needed instruments were not available or not in use. In front of many tests is given ND, according to the chemist in the laboratory this means "not determined" due to lack of equipment (instruments) and also faulty equipments. Pollutants like oil, hydrocarbons, phenols, zinc, lead, arsenic, cyanide, cadmium, mercury, etc are not determined in the results collected for lack of instruments. These results reported earlier supports the gap seen between the analytical instruments found in the laboratories and those found in the literatures.

What has been said earlier in this work can be reemphasized here, i.e. the ability of a measurement system to accurately monitor an environmental variable or to detect and analyze a specific pollutant and its concentration over time is crucial if scientists are to successfully measure and control pollutants and preserve the health and safety of the environment. Therefore one can conclude that without good analytical instruments and good new measurement techniques, the Nigerian people would be unaware of some significant environmental problems, hence endangering the health of human beings, animals, plants and the planets at large. This support the Physicist Lord Kelvin as quoted by Matthias [XVI] when he identified the general need for quantification by saying "I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thought, advanced to the stage of science, whatever the matter may be". This is particularly true in environmental pollution monitoring; as such the Nigerian laboratories must be made to play their important role if the environment will be watched over and protected.

To make a complete analysis of the quality of analytical instruments found in the environmental pollution control laboratories in Nigeria, attempt was made to obtained validation data from the research laboratories. Although each claimed to do periodic validations of their equipments, none could make one validation data available for this work. The most reliable method to look at the quality of the laboratory's analytical instruments in the research laboratory would have been to look at the validation data as is known that to be fit for the intended purpose, a method must meet certain validation characteristics, such as selectivity, linearity, range, accuracy, precision, limit of detection and quantization, but validation data were not available in the research laboratories, as such the quality of even the few analytical instruments found in the laboratories could not be checked.

IV. CONCLUSION

From the discussion above, it can be concluded that the gap between needed analytical instruments in literature and what was obtained in the research laboratories is big and calls for concerns, this gap can be seen more clearly in fig 1 and this shows there is a big room for improvement. With such serious lack of analytical instruments, the monitoring of pollutants by these laboratories cannot be done efficiently. The responsible Nigerian government arms need to come to the help of these laboratories so that they can have all the suitable analytical instruments they need for effective environmental pollution control.

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