

# Oil Exploration and Production Waste Management Practices: Comparative Analysis for Reduction in Hazardous E & P Waste Generation in Offshore Oil Platforms in Nigeria

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## Abstract

One way in which oil exploration and production (E & P) has negatively impacted the environment of the host oil bearing communities is by the generation of hazardous E & P wastes and its' unwholesome disposal. The study analyzed oil exploration and production waste generation in offshore platforms and the management procedures and practices in Nigeria. The aim of the study was to determine the quantities of different forms of E & P waste being generated from offshore platforms so as to bring about a reduction in hazardous E & P waste generation in offshore platforms by using technology to recycle it into useful products. The study also assessed the effect of increase in years of usage (aging) of oil production platforms on the quantity of E & P waste produced in the platforms. The case study approach was adopted, in which 6 offshore platforms of Total E & P Nigeria Limited were used as case studies and statistical data on E & P waste generation in the platforms were collected from 2010 – 2013, spanning a 4- year period. The analysis of variance (ANOVA) statistical method was employed in analyzing the data and F – Test was used to test the significance of the null hypotheses. The test showed the acceptance of null hypothesis,  $H_{0A}$  and the rejection of null hypothesis  $H_{0B}$ , and the conclusion that increase in usage years (Aging) of offshore oil platforms does not cause a significant difference in the quantity of E & P waste generation in the platforms. It was recommended among other things that modern waste recycling technology be adopted by stakeholders and continuously improved upon, to convert hazardous and other forms of E & P wastes into useful products.

**Keywords:** oil exploration, production waste, analysis, reduction, hazardous waste, generation, Nigeria.

## INTRODUCTION

Nigeria as a Maritime Nation has abundant deposit of petroleum and natural gas resources offshore. Oil and Gas exploration and production in the country according to Ndukwu (2014), commenced over 5 decades ago. Today, many oil exploration and production (E &P) companies have offshore oil platforms mounted to exploit these natural resources. UNDP (2006) report indicated an increasing trend in Nigerian crude oil production, while noting that there exists more than 7000 kilometers of pipelines and flow lines and 272 flow stations being operated by more than 13 oil exploration and production companies. There exist also numerous offshore oil platforms. Recent statistics indicate that oil production accounts for above 90% of the country's revenue. E & P operations however, produce harmful wastes whose non-conscientious handling and disposal over the years has led to environmental, economic and health problems in the Niger-Delta region of the country, which is host to the oil companies (Aghanifo, 2004). E & P wastes from offshore platforms may constitute atmospheric emissions, drill cuttings, drilling fluids, deck drainage and well treatment fluids, pigging wastes, asbestos, batteries (wet and dry cell), metallic and plastic drums, in addition to oil spills which may result from accidental discharges, deliberate or willful acts of vandalization, maintenance negligence and human error, (Aghanifo, 2004).

Agho, et al (2007), opined that environmental hazard from pollution by E & P wastes in the Niger Delta has multidimensional and multiplier negative impact in the oil bearing communities which may include destruction of aquatic life and sources of economic livelihood, destruction of vegetation and poor yield of farm crops, unemployment, pollution of sources of natural water supply for domestic usage, etc.

Ndukwu (2014) stated that global best practices demand a compulsory conduct of Environmental

Impact Assessment (EIA) in all onshore and offshore oil and gas production projects from the stage of seismic surveys to field development, drilling, production and decommissioning as a first step to proper management of E & P wastes from offshore oil platforms. Sustainable development of oil and gas resource require proper management and disposal of E & P wastes generated in offshore platforms to curb environmental pollution and the related financial liabilities (Ndine,2011).

As opined by Ndine (2011), the IMO issued the MARPOL 73/78 instrument for regulating the discharge of oil and other forms of pollutants into the sea by ships in International Voyage, but did not specifically address E & P waste discharges from oil platforms in any of the annexes. Formal Safety Assessment (FSA) was developed by the IMO, following the piper Alpha disaster of 1988, when an offshore platform exploded in the North sea killing 167 workers (IMO, 2002). Ndine (2011) observed that environmental safety and E & P waste management practices in offshore oil platforms in Nigeria show total negligence of the provision of FSA as, E & P waste are hardly evaluated for risk of hazard, before they are disposed into the host communities. Hazardous E & P wastes can be subjected to risk analysis, evaluated, controlled and be converted to Non-hazardous form or recycled into a useful form by means of technology (Ndine, 2011). The target of E & P safety managers should be to achieve far lower quantum of hazardous wastes by the use of recycling technology to convert all such waste into useful forms.

The Nigerian Government through the Department for Petroleum Resources (DPR), implements the Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN). Adedayo (2011), opined that EGASPIN was put in place in 1991 to ensure that oil exploration and production operations do not impact the environment negatively through harmful E & P waste disposal system and management practices. Thus, the performance of environmental regulatory agents on E & P waste management should be hinged on how she achieved the conversion of Hazardous E & P wastes into non- hazardous useful forms (Ufia, 2009).

## LITERATURE REVIEW

Total E & P Nigeria Limited, (2014) explained E & P waste management in offshore platforms as a process involving generation, control, collection storage, transfer and transport, processing and disposal of E & P wastes in a manner that complies with global best practices and best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations.

Veil, (2012) observed that an important and indispensable component of E & P waste management procedure is the need to segregate waste materials into classes or groups according to their various physical and chemical characteristics. This makes it easier to identify which streams of waste are hazardous or non-hazardous, recyclable or non-recyclable, and enables the waste handler to adopt the appropriate disposal techniques for each class, (Veil, 2012). Ndukwu (2014) recognized that E & P waste segregation may create the need for a laboratory analysis of the generated wastes, thus leading to a higher cost of E & P waste disposal.

Reports from total E & P Nigeria Limited (2014) recognized the following procedures and steps adopted by Total Nigeria Limited as best practices in offshore E & P waste management.

**STEP I: Waste identification:** This is the first procedure in E & P waste management as recognized by total E & P Nigeria Limited. This step list all relevant wastes which are outcomes of E & P operations.\

**STEP II:** Waste collection

**STEP III:** Waste segregation

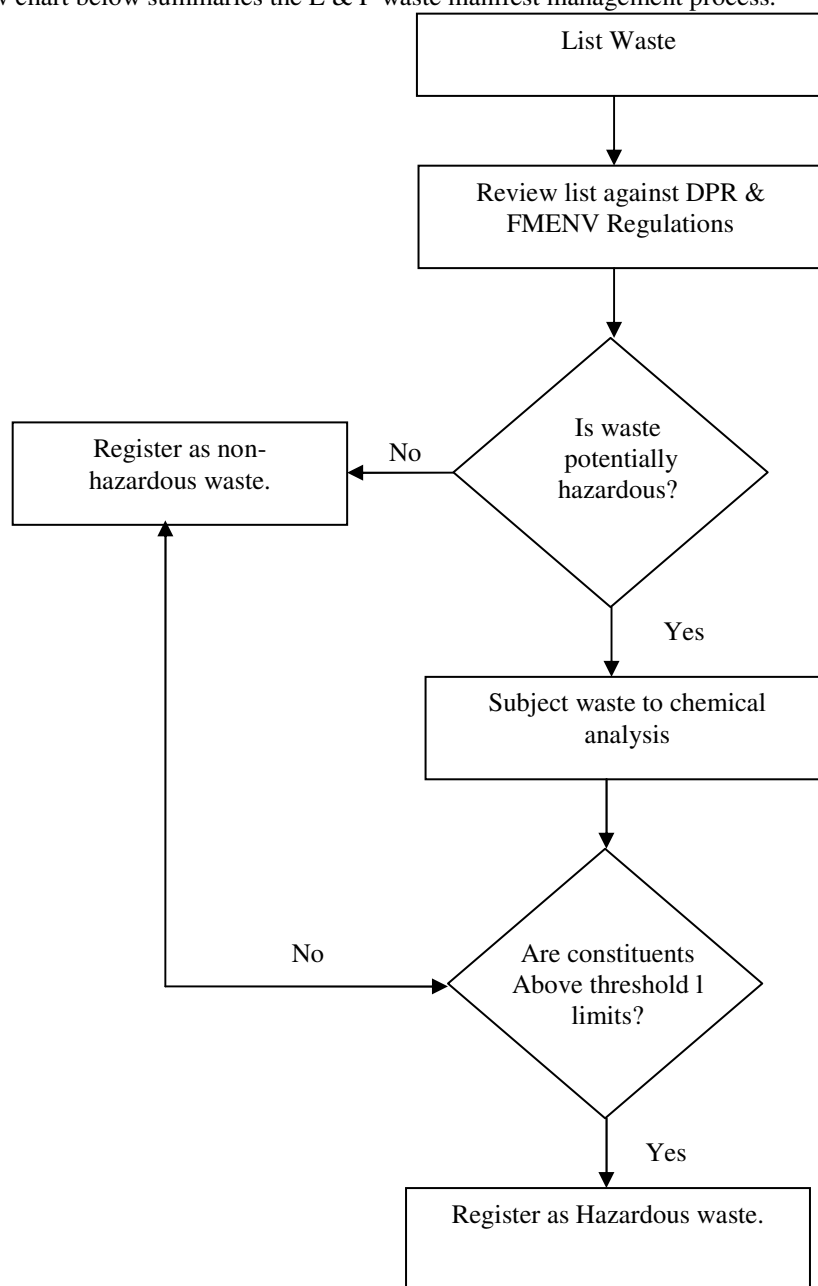
**STEP IV:** Waste transfer

**STEP V:** Waste storage and inventorization

**STEP VI:** Waste treatment and disposal

Ofuani (2011), stated that each procedure/step above is subjected to company's health, safety and environmental rules, regulations and policies. One such rule is the compulsory production, filling and signing by the Cargo handler of a Cargo manifest, for every stream of E & P Cargo handled. The manifest is a record of all E & P streams of wastes generated over the period and signed by designated authorities while copies are appropriately filed, (Ofuani, 2011).

The flow chart below summaries the E & P waste manifest management process.



**Fig. 1: Flowchart for Waste Manifest Management Process at Total E & p Nigeria Limited.**

As reported by total E & P Nigeria Limited (2014), the company classified/grouped E & P wastes generated from its 6 major offshore platforms of Obagi, Obite, Amenam, Unity, odudu and Ofon as summarized in the table below. The table also shows the breakdown of each class of E & P into its' basic components.

**CLASSIFICATION OF E & P WASTES AND THEIR COMPONENTS**

<b>NON-HAZARDOUS RECYCLABLE (NHR)</b>	<b>HAZARDOUS RECYCLABLE (HR)</b>	<b>HAZARDOUS BURNABLES (HB)</b>	<b>NON-HAZARDOUS NON-RECYCLABLE (NHNR)</b>	<b>OTHERS</b>
Recyclable paper, Plastics Recyclable metal scraps Metallic and plastic drum	Spent lube oil Batteries (wet and dry cell) Ink-jet, toner cartridges Fluorescent tube and electric bulbs	Pigging waste Mud/drill cutting Contaminated soil Oily sludge/tank bottom Absorbents Obsolete chemical Air filters/oil filters/fuel filters. Medical waste Combustible trash.	Food/Biodegradable	Sewage Asbestos Wood cuttings Construction debris

Source: Total E & P Nigeria Limited (2014)

Ndine, (2011) observed that in Nigeria, most oil exploration and production companies like Total E & P Limited contract third party incinerators for incineration of Burnable and Combustible E & P wastes. In the opinion of Zabbey (2014), thirty party incinerators in Nigeria are highly unprofessional in their operation as most of them lack furnaces and closed chambers for incineration and incineration of such toxics, as hazardous E & P waste is usually done in the open, in thickly populated Niger Delta residential areas and cities (Zabbey, 2014).

**OBJECTIVES**

The objectives of the research include;

- A. To ascertain the quantum of different forms of E & P wastes generated into the environment from offshore platforms of total E & P Ltd over the period covered by the study from 2010-2013.
- B. To ascertain the effect of increasing production years (aging) of offshore platforms on the quantity of E & P waste generated each year from the platforms over the years covered by the study from 2010-2013.

**HYPOTHESES**

**H<sub>0A</sub>**: There is no significant difference in the total quantity of E & P waste generated per annum from the platforms in each year from 2010 to 2013 as the years of oil production from the offshore platforms increase.

**H<sub>0B</sub>**: There is no significant difference in the quantities of the different forms of E & P wastes generated in the offshore platforms over the years covered by the study from 2010 to 2013.

**METHODOLOGY**

The research adopted a case study approached. It sampled six (6) offshore platforms of Total E & P Nigeria Limited and collected statistical data of E & P waste generated from the platforms from 2010 to 2013. The platforms on which data was collected include; OBAGI, OBITE, AMENAM, UNIT, ODUDU, and OFON offshore platforms. The research used the following symbols to represent the different forms of E & P wastes generated from the platforms as earlier stated.

**NHR**: Non-hazardous recyclable waste

**HR**: hazardous recyclable waste

**NHNR**: Non hazardous non-recyclable waste

**OT**: Others

The Analysis of Variance (ANOVA) statistical method was used to analyze the data while F-test was used to test the two null hypotheses. The data was charted using bar chart to compare the quantity of the different forms of E & P wastes generated in each year covered by study.

## DATA PRESENTATION AND ANALYSIS

**Table 1:** Quality of Different Classes of E & P Waste Generated from Total E & P offshore Platform from 2010-2013 in Tons

S/N	Year	Independent Variable No of Platforms	NHR	HR	HB	NHNR	OT
1	2010	6	59,471	7,097	859,552	82,426	295,872
2	2011	6	65,642	8,402	795,824	795,964	223,751
3	2012	6	78,805	9,299	677,689	279,411	151,630
4	2013	6	84,147	10,607	181,365	343,392	79,509
	<b>Total</b>		<b>2877.65</b>	<b>35405</b>	<b>2514932</b>	<b>903193</b>	<b>750762</b>

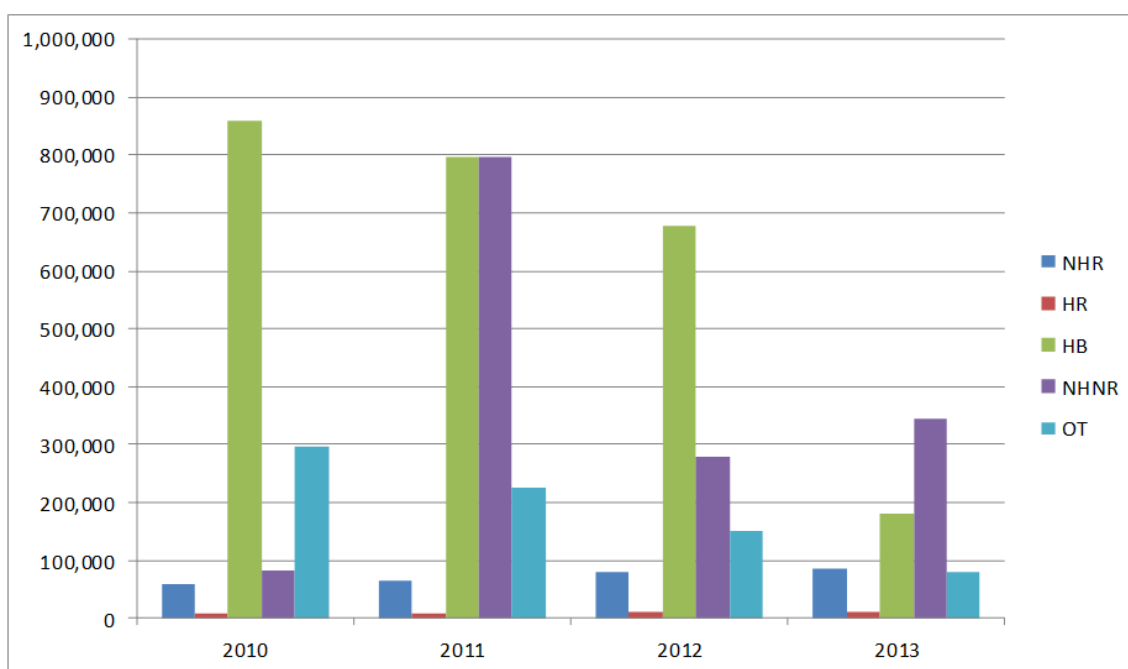
Source: Ndukwu (2014): Statistical Report by Total E & P Nigeria Ltd (2014)

**Table 2:** Output of Result of Analysis of Table 1 by ANOVA

Summary	Count	Sum	Average	Variance
Row 1	5	1304420	260884	1.24113E+11
Row 2	5	1291583	258316.6	98333057716
Row 3	5	1196534.3	239306.86	70058897842
Row 4	5	699520.6	139904.12	16660612283
Column 1	4	287765	71941.25	129083610.9
Column 2	4	35405	8851.25	2187452.25
Column 3	4	2514932.3	628733.075	94428488352
Column 4	4	903193.6	225798.4	12677701886
Column 5	4	750762	187690.5	8669064402

### ANOVA

Source of Variation	SS	df	MS	F	P-value	F-crit
Rows	49215107790	3	16405035930	0.659489058	0.59254	3.490295
Columns	9.38158E11	4	2.3454E+11	9.428582717	0.001098	3.259167
Error	2.98504E+11	12	24875372443			
<b>Total</b>	<b>1.28588E+12</b>	<b>19</b>				



**Figure II:** Data Analysis by Bar Chart

## DISCUSSION OF RESULT AND FINDINGS

The output of result on the analysis on table II shows four rows with a count of 5, indicating the existence of 5 classes/forms of E & P wastes generated in 6 offshore platforms over the period covered by the study from 2010 to 2013. The results of the analysis from row 1 to row 4 shows that the sum total of E&P waste generated in each year covered by the study amounted to 1304,420 tons, 1291,583 tons, 1196534.3 tons and 699520.6 tons respectively. This represents an average of 260,884 tons, 258316.6 tons, 239,306.9 tons, and 139,904.1 tons of each class/form of E & P waste generated in 2010, 2011, 2012 and 2013 respectively.

Result of the analysis from column 1 to column 3 shows the total sums of the different classes/forms of E & P waste in the platforms over the 4 years period covered by the study. It indicates that total sums of 287765 tons of NHR, 35405 tons of HR, 2514932 tons of HB, 903193 tons of NHNR, and 750762 tons by the study. This represents an average of 71941.25 tons of NHR, 8851.25 tons of HR, 628733.08 tons of HB, 225798.4 tons of NHNR, and 187,970.5 tons of OT forms of E&P waste were generated in offshore platforms in the four years covered by the study. This represent an average of 71941.25 tons of NHR, 8851.25 tons of HR, 628733.08 tons of HB, 225798.4 tons of NHNR, and 187690.5 tons of OT generated per annum from 2011 to 2013 respectively.

The test of hypothesis  $H_{0A}$  by F – test showed and F – statistics of 0.6595 and F – critical value at 0.05 significance level and 3 degree of freedom (df) 3.4903 and P – value of 0.5925. Thus, we accept the null hypothesis that there is no significant difference in the total quantity of E & P waste generated per annum from the offshore platforms in each year from 2010 to 2013 as the years of oil production from the platforms increases.

Test of hypothesis  $H_{0B}$  by F – test showed an F – stat of 9.4286 and F – critical value of 3.2592 at 4 degrees of freedom (df) and P – value of 0.0019. Since F – stat (9.4286) > F – critical (3.2592), we reject the null hypothesis  $H_{0B}$  and accept its alternate. Thus, we conclude that there is a significant difference in the quantities of the different forms of E & P wastes generated in the offshore platforms over the period covered by the study from 2010 to 2013.

The analysis by bar chart compared the quantities of the E & P classes of wastes generated over the period with hazardous burnable wastes ranking highest in the first 2 years of 2010 and 2011, while non-hazardous non-recyclable wastes ranked highest in 2012 and 2013.

## CONCLUSION

It is evident from test of hypotheses that increase in years of usage (age) of offshore oil platform does not lead to significant decrease in the quantity of E & P waste generated in the platforms. This may as a result not significantly decrease E & P waste management cost as the years of usage (age) of the platforms increases.

## RECOMMENDATION

It is recommended that modern recycling technology be adopted and continuously be improved upon to convert hazardous. Burnable- wastes and other forms of E&P wastes into useful products. Thus, regulatory emphasis on offshore E&P waste management should be more on developing appropriate recycling technology, capable of transforming the different classes of E & P wastes into useful products.

Routine auditing of the waste disposal operations of incineration agents (E & P waste incinerators) by regulatory agencies is recommended, with an aim to help train them on global best practices. To this regard, policy should be made that mandate E & P waste incineration agents/companies to have their incineration sites far from city centers and residential areas.

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