International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 5 May 2022, pp: 1374-1380 www.ijaem.net ISSN: 2395-5252

Assessment of Drilling Waste Management in the Niger Delta Oil and Gas Industry

Opara, Amanda Chigozie [1]&Ogbonna Joel[2]
[1, 2]Centre for Occupational Health, Safety and Environment, University of Port Harcourt, Rivers State.

Submitted: 10-05-2022 Revised: 19-05-2022 Accepted: 22-05-2022

ABSTRACT
When conducting its drilling operations, the oil production industry usually faces excessive wastes. Crude mining and industrial operations create drilling waste. This is significant because it is an unavoidable part of the Niger Delta oil and gas industry. Drilling waste management was defined as ways used to handle drilling and its associated waste effectively to reduce its impact on the environment. This survey offers insight to the management of drilling waste since many approaches were applied in accordance with environmental regulatory directives for managing these wastes. The study aims to analyze different types of wastes generated, to classify the environmental impacts of such wastes and to review various legislation regulating waste management, to identify various forms of waste management, recommend mitigation strategies and sustainable waste management. The conditions for drilling fluids include safety, technology, economy, and environmental considerations. Data from field specialists were collected and analyzed. Drill cuttings wastes were below the Department of Petroleum Resources cap before and after thermal desorption. It was necessary to assess the toxicity level and to treat chemicals in cuttings prior to disposal. The results have been reported and discussed with MS Excel and descriptive statistics. The outcomes after processing saw a significant decrease in value, with limitations of Department of Petroleum Resources maintained to ensure that the ceiling is acceptable before disposal. This also meant that waste burial could damage the atmosphere if it has not been handled correctly before being disposed of. There have been recommendations of safe waste management practices and successful control and management of drill waste.

Keywords: Drilling, Waste Management

I. INTRODUCTION

Drilling run-off is a critical component of all drilling activities. Many of the activities used in oil drilling produce effluents or wastes/run-offs that are harmful to the ecosystem. Before the 1980s, almost no thought was given to cuttings and improper handling of drilling liquids. Typically, these materials were released over the edge when digging underwater or sand-filled-over while drilling on land. The worldwide environmental consciousness from the 1980s to the mid-1990s caused the oil and gas industry and its related regulators to recognize and respect the inherent environmental impact of fracking run-off [14],[8].

Drilling run-offs are generated during drilling operations and are known as used drill-fluids and drill cuttings (DCs). Drilling liquids (muds) grease the drilling bits to allow them to cool in the process; they also assist in dealing with intense pressure and raising the drilling bits, allowing for a significant volume of drilling operation [7].

According to [15], the liquid drilling phase can consist of a combination of gas, natural oils, and air.

The drilling activity is supported by drill mud. The muds lubricate the drilling bit and help transport broken rock bits (drill cuttings) from the depths to the open. Aside from wastewater, drilling run-off is the largest waste ever created by the global industry's exploration and growth [9]. Proper management of run-offs, in particular, should be addressed in locations where their dangerous components will simply contaminate the soil and groundwater. This is exacerbated by relaxation solvents, biocides, diesel, anti-corrosive and drilling chemicals [16].

Drilling run-off control may be a means of managing, capturing, maintaining, transporting, processing, and extracting waste produced during drilling in a very safe and appropriate environment that is following current regulatory requirements.

Numerous control options, such as land application, underground injection, thermal treatment, and biological processes, may be used to fix drilling runoffs [12].

Drilling run-off control often applies to areas in which drilling and related pollution should be properly managed to minimize its effect on the environment. Wastes that are usually associated with drilling operations are: -drill cuttings, polluted drilling liquids and added chemicals, gaseous contaminants from internal combustion engines, generated water as well as heavy metals. The objective of waste handling or control is to ensure that waste does not overburden the environment at such a pace or quantity that is beyond the regular assimilative processes. The elimination or limitation of waste production is crucial, not just in terms of reducing natural liability but also in terms of operating costs [17].

The ecological impact of pollution by exploration is believed to have an extremely detrimental impact on petrol-carrying populations, including destroying aquatic life and the well-being of financial businesses, vegetation destruction, low yield of homegrown crops, unemployment, and pollution of well-being from the local water source [2].The study is to assess drilling waste management practices in Nigeria with a focus on the Niger Delta.

II. LITERATURE REVIEW

Drilling waste control is a method to monitor, collect, store, transport, handle and remove waste produced during perforation in a safe and satisfying environment, following existing regulatory requirements. Different disposal alternatives should be used for fracking waste restoration, such as land use, underground injection, heat treatment, and natural processes [12].

Two types of waste are involved in the process of drilling oil and gas wells, drilling muds and drill cuttings. The fluid stage may be water, chemical oils or natural oils, air, gas, or a mixture of such segments. The muds also tend to borage the fluid stage. Muds consist of a fluid foundation and multiple solid and fluid additives for high performance in drilling. A portion of the additional ingredients adds conceivably toxic compounds into the liquids that must be taken into account as the following waste is treated. Biocides, tar, fluid segments, corroding agents, stored fluid (unrefined gasoline, salt water), and drilling chemical elements of mud are the principal source of the pollution of the expended fats [1].

Drilling fluids are one of the most significant wastes produced from drilling activities. They're used to grate and cool mechanical drilling equipment, hold surface drilling crates, and seal permeable geological creation [20],[11].

The drilling liquid consists of a fluid foundation (water, fuel or gasoline, or an artificial compound), bentonite clay, lignosulfonate and lignite weighting agents (e.g sulfate), and some specific practical additives. Bentonite mud is used in muds for the digging of cutting and filtering on the walls of the pit to remove cuttings from the well, while lignosulphonates and lignites are used to preserve the mud in liquid form. The drilling fluid is hazardous and thus considered ecologically dangerous [11], [10].

Drill cuttings are created by cutting rocks or stone and soil through drilling pieces. They are made up of a field rock with a drilling fluid layer. Few experiments have influenced soil-plant-water frameworks to remove expended drilling fluids. A few observers find that dull fluids were unfavorable to the soil and growth in high dissolvable salts, weighty metals, and petrol-based compounds. Other drillings have demonstrated favorable and/or no results, as a result of increased pH levels, possible development of micronutrients, and enhanced soil properties, applied at the low rates in field textured soils in bone-dry areas.

The administration of waste-drilling technology and procedures can be assembled into three main categories: waste minimization, waste recovery, and disposal.

In comparison to the regular one or with the use of less-bored fluid approaches that utilize alternate renewable energy (solar, water, and wind) in the performance of drilling operations, for example, the amount of drilling waste delivered into the environment can be reduced utilizing directional slurries [18]. Recycling means changing waste into useful goods and can be used for the production of new products. Alternatively, waste may be used for commercial goods or as feedstock in agricultural processes. Abstraction is the least favored solution to waste disposal from an ecological point of view. Reinjection of cuttings, on-site burial, waste dumps, landfills, land-growing or land-spreading, bio-remediation, composting and vermiculture are examples of removal methods for onshore activities.

Drilling sludge is the second-largest amount of waste generated by the oil and gas exploration and production industry. In the light of the API Survey of Onshore and Coastal Exploration and Production Activities for 1995, approximately 150 million barrels of drilling waste

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 5 May 2022, pp: 1374-1380 www.ijaem.net ISSN: 2395-5252

were produced from onshore wells in the United States alone.

The drilling phase contains two major contaminants, drilling liquid waste and drilling cuttings [15]. Contingent on the depth and diameter of the well, the amount of drilling sludge output from each well is specific. Usually, each well will yield a few thousand barrels of dull waste. Due to the high amount of waste obtained from penetrating operations, proper waste treatment and recycling are needed to avoid pollution and the effects on citizens and the local area. The leakage of drilling waste will also affect the aquatic population. The toxicity of drilling liquids can cause high mortality to the marine community. Contextual analyzes have shown the effect of sludge fracking on the aquatic population [13].

In comparison, the study performed by [19], showed the effect of toxicity due to drill liquid waste. Drilling pollution may also have individual effects on jobs. The main effect of drilling fluid is skin itching, touch dermatitis, coughing, and nausea. Understanding and paying attention to the effects of insufficient control of drilling waste change how operators cope with drill waste. However, in monitoring drilling wastes in various countries, there is success in improving the SBDF's free flow of drill cuttings [6]. With the latest progress in SBDF, dedicated instructions or case-by-case releases should be considered. In certain countries, such as the Netherlands, Norway, and the United Kingdom, the release of SBDF cuttings is allowed [5]. The pre-requisite for the release of WBDF is far less serious. Most of the recommendations consider the direct release of WBDF and drill cuts with authorization and approval by the authority. This gives WBDF the optimal choice of drilling liquid in less drilling testing, given the disposal and waste control of the drilling liquid is more economical. In Egypt, WBDF is commonly used in the light of its negligible effect on the environment [3].

Also, Host Governments are imposing recommendations on fracking liquid control. Other than that, major oil and gas companies, such as Shell, ExxonMobil, and PETRONAS, have laid out their recommendations for the most appropriate way of dealing with such fracking waste.

III. METHODOLOGY

This study adopted a descriptive design, drill cuttings got from a work-over drilling activity with samples obtained at 2,750m depth from a standard well were analyzed to show the physicochemical attributes of the drill cuttings in a laboratory before and after treatment. The study covered Niger Delta region, Nigeria of various mangrove scrub, freshwater, and woodland areas.Data sources were primary data. Primary data were collected from laboratory analysis and relevant experts. The validity of a device refers to a device's capacity to measure what it is intended for. To ensure the validity and reliability of the instrument, validated data were obtained from experts on the ground to lead the analysis to the achievement of the aim of drilling waste (before and after treatment). data collected were evaluated while frequencies and percentages were displayed in tables and maps. Microsoft Excel software was used.

IV. RESULTS

Table 4.1 shows the levels of drill cuttings pollutants in the sample before and after thermal desorption treatment process. From the parameters indicated, the levels of pollutant decreased after treatment apart from pH and electrical conductivity.

Table 1: Concentration of 'Sample A' Drill Cuttings Pollutants Before and After Treatment with Thermal Desorption Unit (TDU).

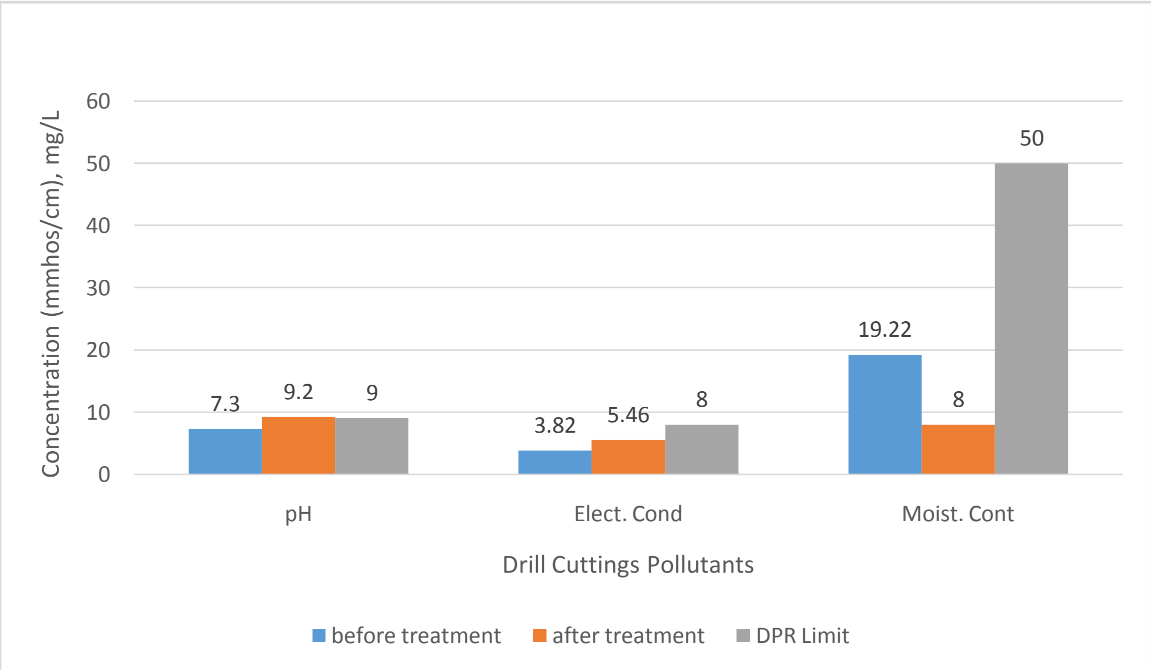
Parameter(s)	Before treatment	After treatment	DPR Limit
Ph	7.3	9.0	6.5-9.0
Electrical Conductivity (mmhos/cm)	3.82	5.46	8
Moisture content (mg/L)	19.22	2.62	50
TPH (mg/kg)	1405.8	87	-
BTEX (mg/kg)	0.7	0.012	-

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 5 May 2022, pp: 1374-1380 www.ijaem.net ISSN: 2395-5252

Arsenic/As (mg/kg)	0.12	0.07	5
Cadmium/Cd (mg/kg)	1.5	0.89	1
Chromium/Cr (mg/kg)	28.93	4.36	5
Copper/Cu (mg/kg)	12.97	7.17	-
Lead/Pb (mg/kg)	58.13	4.09	5s
Mercury/Hg (mg/Kg)	<0.001	<0.001	0.2
Nickel/Ni (mg/kg)	21.59	4.78	-
Vanadium/V (mg/kg)	1.03	0.23	-
Zinc/Z(mg/kg)	46.77	35.33	50
Barium/Ba (mg/kg)	0.42	0.23	100

Source: Nwosu, B. E 2019

Figure 1: Before and after treatment concentration of pH, EC, MC, and DPR limit



International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 5 May 2022, pp: 1374-1380 www.ijaem.net ISSN: 2395-5252

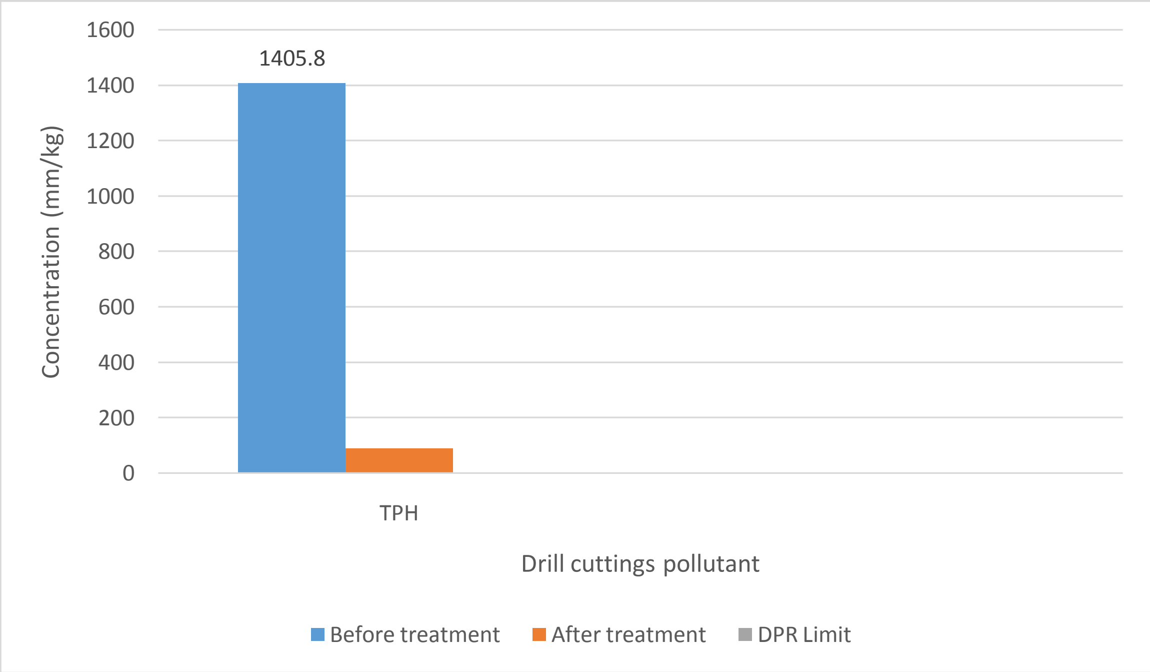


Figure 2: Before and After Treatment Concentration of TPH with DPR Limit.

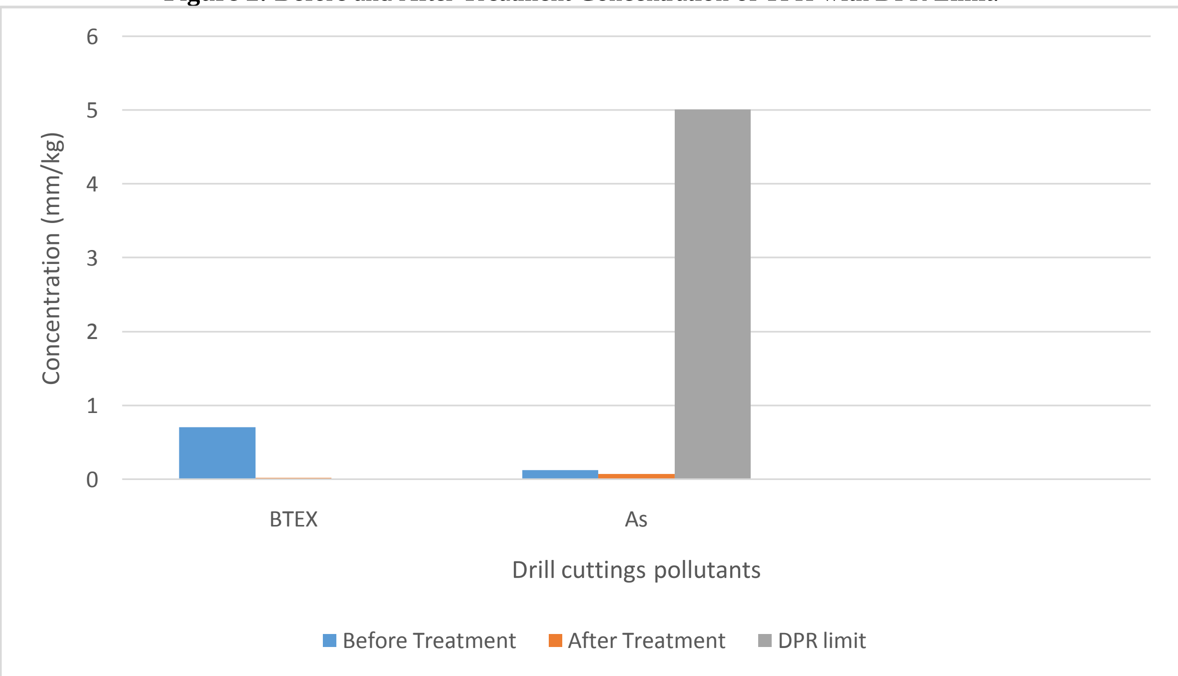


Figure 3: Before and after treatment concentration of BTEX and Arsenic with DPR limit

V. CONCLUSION

The pollutant quantities in the principal drill cuttings in the field before and after the thermal phase of desorption. After treating the drill cuttings in TDU, the changes in pH and electrical conductivity as well the amount of the pollutant decrease are indicated in Table 4.1 and Figures 4.1 – 4.6. pH and electrical conductivity increased respectively after treatment as seen in Figure 4.1 from 7.3 - 9.2 mmhos/cm and 3.82 – 5.46 mmhos/cm. The Moisture Content decreased after thermal processing from 19.22 - 9.2 mg/kg. Total Petroleum Hydrocarbon reduced from 1407.8 - 87.73 mg/kg after thermal treatment as shown in

Figure 4.2. This represents 93.81 % TPH removal after thermal treatment. Organics comprising Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) decreased from 0.7 - 0.012 mg/kg and Arsenic from 0.12 to 0.07 mg/kg after treatment as shown in Figure 4.3.

In this study, the Thermal Desorption Unit (TDU) plant was used to manage the box cuttings from an oil drilling process appropriately. In contrast with untreated boiler section, this process greatly decreased the drill cuttings and increased the fine powder share. In this portion, there is a standardized chemical property designed to meet the DPR specifications. Before and after thermal treatment, the chemical characterization of drill cuttings was carried out. The research was carried out for pH, moisture content, conductivity and heavy metals (Cd, Cr, As, Cu, Hg, Ni, Pb, V, Ba, and Zn). In addition, as seen in Table 4.1 the DPR limits were observed in organics, including benzene, resistance, ethybenzenes (BTEX) and total oil hydrocarbons (TOH). Laboratory tests showed a high degree of toxicity before treatment, which exceeded the DPR limit. The reduction of contaminants in the drill cuttings to the safe limit before discharge to the environment is important since it is extremely poisonous and can destroy the ecosystem and human life. For example, the Total petroleum hydrocarbon reduction from around 1405.8 mm/kg before treatment to 87.73 mm/kg after treatment was substantial. The DPR guidelines did not however include any limit for TPH even when these components are also harmful. Thus, treatment of the waste before disposal is always required. After treatment, pH and electrical conductivity increased, concentrations of electric ions increase as acidity reduces thermal treatment. In the thermal treatment, the pH of drill cuttings is within the acceptable limit. The DPR ceiling expected has not however been exceeded. There is a very limited amount of heavy metal, such as arsenic, which was similar before and after treatment and but much less than DPR limit. This could lead to comparatively low toxicity and little or no apparent impact compared to other regions in the country, be it regulated or not.

Untreated drill cuttings contain high amounts of polynucleic aromatic hydrocarbon (PAH) capable of posing a detrimental environmental impact and consistently high health issues. For the drilling components that are returned to the solvent, drill snaps are typically bye products. The drill cuttings from the deep seas ecology of water-based muds have been seen to pose a small risk to the offshore atmosphere, although the degrading environment has effectively prevented those from Oil Based Muds (OBMs).

VI. RECOMMENDATIONS

i. Oil and Gas Companies should expand their capacity to accommodate Interns thus granting access to conduct this and related studies while working with them to provide more valid results.
ii. Records of Laboratory assessments of operations in the Oil and Gas Industries should be made available to researchers in order to aid their research works.
iii. Waste treatment, minimization, and removal should be practiced as much as possible.

REFERENCES

[1]. Adekomaya, S. O. (2014). Development of approximate waste management strategies for drilling waste-Niger Delta (Nigeria) experience. Journal of Environmental and Earth Science, 4(7), 31–33.
[2]. Agho, M., &Uyigue, E. (2007). Coping with Climate Change and Environmental Degradation in theNiger Delta of Southern Nigeria (20073200659 ed.). Benin, Edo State, Nigeria: Community Research and Development Centre (CREDC). Retrieved September 28, 2020, from http://priceofoil.org/content/uploads/2007/06/07.06.11%20-%20Climate_Niger_Delta.pdf
[3]. Agwa, A., Sadiq, R., &Leheta, H. (2012). Offshore Drilling Waste Discharge: Egyptian EnvironmentalRegulations, Society of Petroleum Engineers International Petroleum Exhibition & Conference. Abu Dhabi, United Arab Emirates. doi:10.2118/161446-MS
[4]. NwosuB. E 2019 (Research on Treatment efficiency of Drilling Cuttings using Thermal Desorption Technology)
[5]. Burke, C. J., & Veil, J. A. (1995). Potential Environmental Benefits From Regulatory Consideration of Synthetic Drilling Muds. US Department of Energy, US Department of Energy. Illinois, United States.: US Department of Energy.
[6]. (CAPP), C. A. (2001). Technical Report: Offshore Drilling Waste Management Review, Report 2001-0007,. CAPP (Canadian Association of Petroleum Producers. Alberta, Canada: CAPP (Canadian Association of Petroleum Producers.
[7]. Cordah. (1998). The Present status and effects of drill cuttings piles in the North Sea

(Report No. Cordah/ODCP.004/1998). Aberdeen, UK: Cordah Environmental Consultants.
[8]. Davies, J. M., & Kingston, P. F. (1992). Sources of environmental disturbance associated with offshore oil and gas developments. (In W. J. Cairns (ed.), North sea oil and gasresource, environmental impacts and responses ed.). (N. s. In W. J. Cairns (ed.), Ed.) Edinburgh, UK: Elsevier Science Publishers.
[9]. Department of Energy D.O.E. (1999). Environmental benefits of advanced oil and gas production technology, DOE-FE-0385. Washinton, DC: U.S. Department of Energy, Office of Fossil Energy. Retrieved on 25th September, 2020 from http://www.osti.gov/bridge/product.biblio.jsp?osti_id=771125.
[10]. Drilling Waste Management Information System (2017). Retrieved from http://web.ead.anl.gov/dwm/techdesc/ on 22 September, 2020
[11]. Fink J., & Waltham M. A. (2011) Petroleum Engineer's guide to oil field chemicals and fluids. Gulf Professional Publishing
[12]. Furukawa, Y., Mukai, K., & Ohmura, K. (2017). Improved slant drilling well for in situ remediation of groundwater and soil at contaminated sites. Environmental Science and Pollution Research, 24, 6504–6511.
[13]. Gbadebo A.M.A., Taiwo A.M.A., Eghele U.U., 2010, Environmental Impacts of Drilling Mud and Cutting Wastes from the Igbokoda Onshore Oil Wells, Southwestern Nigeria, Indian Journal of Science and Technology 3 (5), 504-510
[14]. Geehan, T., Alan, G., & Guo, A. (2000). The Cutting Edge in Drilling Waste Management. Houston, Texas, USA: M-I Swaco.
[15]. Onwukwe, S., &Nwakaudu, M. (2012). Drilling Wastes Generation and Management Approach. International Journal of Environmental Science and Development, 3(3), 252-257. Retrieved September 21, 2020
[16]. Patin, S. (2004). Environmental impact of the offshore oil and gas industry. New York, NY :EcoMonitorPublishing East Northport.
[17]. Richard C. Haut, John D. Rogers, McDole, P. W., David Burnett, and Oluwaseun Olatubi, 2007: Minimizing Waste during Drilling Operations, AADE National Technical Conference and Exhibition, Houston, Texas, April 10-12, 2007.
[18]. Sharif, M. D., Nagalakshimi, N. V. R., Srigowri, R. S., Vasanth, G., &Sankar, K. (2017). Drilling waste management and control the effects. Journal Advance Chemical Engineers, 7, 1–9
[19]. Soegianto, A., Irawan, B., & Affandi, M. (2008). Toxicity of Drilling Waste and Its Impact on Gill Structure of Post Larvae of Tiger Prawn (Penaeus monodon). Global Journal of Environmental Research, 2(1), 36-41.
[20]. Yao L., &Naeth M. A. (2015). Soil and plant response to used potassium silicate drilling fluid application. Journal of Ecotoxicology and Environmental Safety. 120, 326–333.