Chemical Oxidation Of Oil Polluted Well In Baruwa Area Of Lagos State By The Use Of Potassium Permanganate

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Abstract: Oil spill in Baruwa was majorly caused by corrosion of pipeline from NNPC that runs through the community. The water sample used for this research was collected from Ajayi's well in Baruwa area of Lagos State. Several litres of oil had already being pumped out of the wells by Geotechnical Staff of the Federal University of Technology, Akure (FUTA). Total Petroleum Hydrocarbon (TPH) was evaluated. $KMnO_4$ solution of different molarities was prepared: 0.010, 0.032, 0.063, 0.158, 0.316 M. It was observed that all the molarities oxidized the water sample but 0.010 M $KMnO_4$ oxidized faster than the rest and gave a better result in the Laboratory.

Keywords: chemical oxidation, oil pollution, potassium permanganate, well.

1. INTRODUCTION

Water from beneath the ground has been exploited for domestic use, livestock and irrigation purposes since the earliest times. Although the precise nature of its occurrence was not necessarily understood, successful methods of bringing the water to the surface have been developed and groundwater use has grown consistently ever since. Groundwater constitutes about two- third of the freshwater resources of the world and, if the polar ice caps and glaciers are not considered, groundwater accounts for nearly all usable freshwater. Even if, consideration is further limited to only the most active and accessible groundwater bodies estimated by Lvovitch (1972) at 4×10^6 km^3, then, they constitute 95 percent of total freshwater. Lakes, swamps, reservoirs and rivers account for 3.5 percent and soil moisture accounts for only 1.5 percent (Freeze and Cherry, 1979). The dominant role of groundwater resources is clear and their use and protection is, therefore, of fundamental importance to human life and economic activity. All over the world, oil spills are recurrent problems with serious consequences both on the living and non-living in the ecosystem. Soil or geological contaminations, owing to spills, are global phenomenon which are eyesores at many sites worldwide. The atmosphere is similarly not spared as volatile and less dense components easily evaporate. Many organic liquids existing as a separate phase are in fact often slightly miscible with water and their solubility can exceed the drinking water standard by orders of magnitude (Van Genuchten, 1980). The dire consequences of these oil spills are, majorly, borne by the host communities where exploration takes place. Also, remote from the exploration sites, the pipe networks for transporting oil to different terminals have further drawn the danger closer to several communities as the cases of ruptured pipes and vandalisation have resulted in casualties from these remote places. Kadafa (2012) reported estimates of 9 to 13 million barrels of spill since the beginning of exploration in 1958. Contamination of groundwater is of great consequence, since, it is the only source of safe drinking water for the local communities and it is often times used untreated. Drinking contaminated groundwater can have serious health effects. Health effects from groundwater pollution depend on the specific pollutants in the water. Ingesting polluted water often causes diarrhea, stomach irritation and others (Nguendo-Tongsi, 2011). Petroleum products contain carcinogenic substances like Benzene, Toluene etc. and exposure to low doses over time can cause cancer amongst the populace in that area. Drinking water contaminated with oil can cause a lot of vomiting. Studies have also shown that oil can affect the skin. There are many diseases that can occur when people are exposed to such water on a long-term. According to World Health Organization (WHO) standard, good water must be colorless, odorless and free from ions and organic matters.

1.1. Statement of the problem

Baruwa Community has been having a running battle with environmental pollution caused by oil spillage from the petroleum pipeline that runs through the community from Mosinmi oil depot and Ejigbo oil facility since 1996. The pipes have become old, rusted and leak in some locations thus polluting the groundwater and wells sunk in the area for the inhabitants' domestic water supply. More than 300 boreholes and wells dug in Baruwa are contaminated with various petroleum products due to the oil leaks. About 500,000 people have been deprived of drinkable water because of this. According to Baale and the community residents, the residents have suffered persistent catarrh, irritation of the airways, wateriness, discoloration of the cornea of the eyes, skin rashes, and dermatitis (Guardian Thursday 25, 2004).

1.2. AIMS OF THE RESEARCH

The research seeks to study the potency of KMnO4 solution in the remediation selected oil polluted well samples and evaluate its kinetics of remediation

2. MATERIALS AND METHODS

2.1. Study Area

Baruwa community is located in the Alimosho Local Government of Lagos State. It lies between latitudes 6"36" 12"and longitude 3"16'. It is drained by Lagos lagoon, Badagry creek and Lekki lagoon which runs into the lagoon. Geographically, the community lies on a poorly sorted coastal sedimentary plain and recent alluvial deposit in Nigeria. The Local Council is richly blessed with arable landmass of about 57.621 km^2 and it is surrounded by rivers Owa and Oponu which are suitable for navigation, fishing and tourism purposes. Groundwater in Baruwa is about 25m below ground surface in wells. The wells are between 0.75 m and 2.00 m in diameter. The wells within the pilot scheme area are about 1.2 m in diameter. There are more than 200 hand dug domestic water supply wells contaminated with floating petroleum product of varying thickness (0.20m to 0.65m) at this site because of oil seepage from leaking underground NNPC (Nigerian National Petroleum Corporation) pipeline. One well was selected for study, Ajayi's well and this represents one of the most polluted wells in Baruwa community.

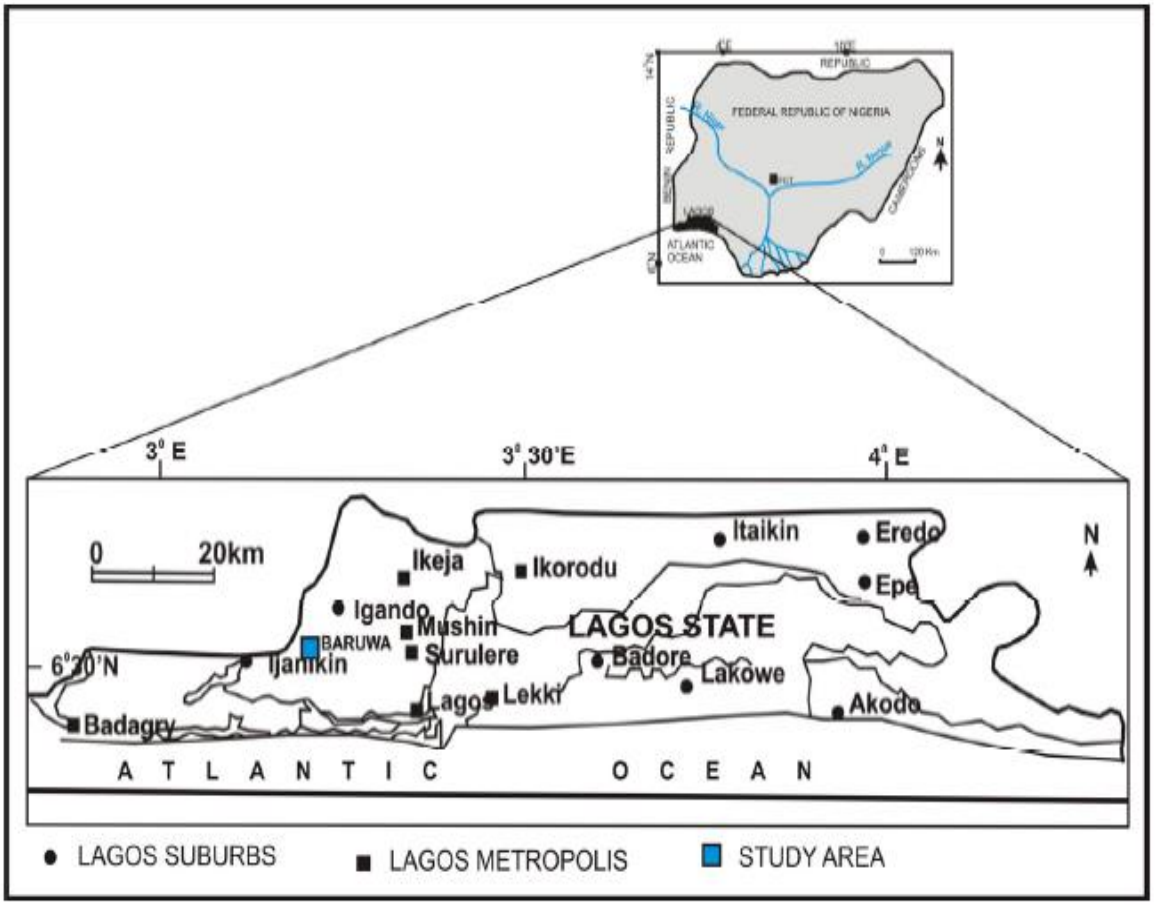

Fig 1: *Location of Baruwa in Lagos from the map of Nigeria*

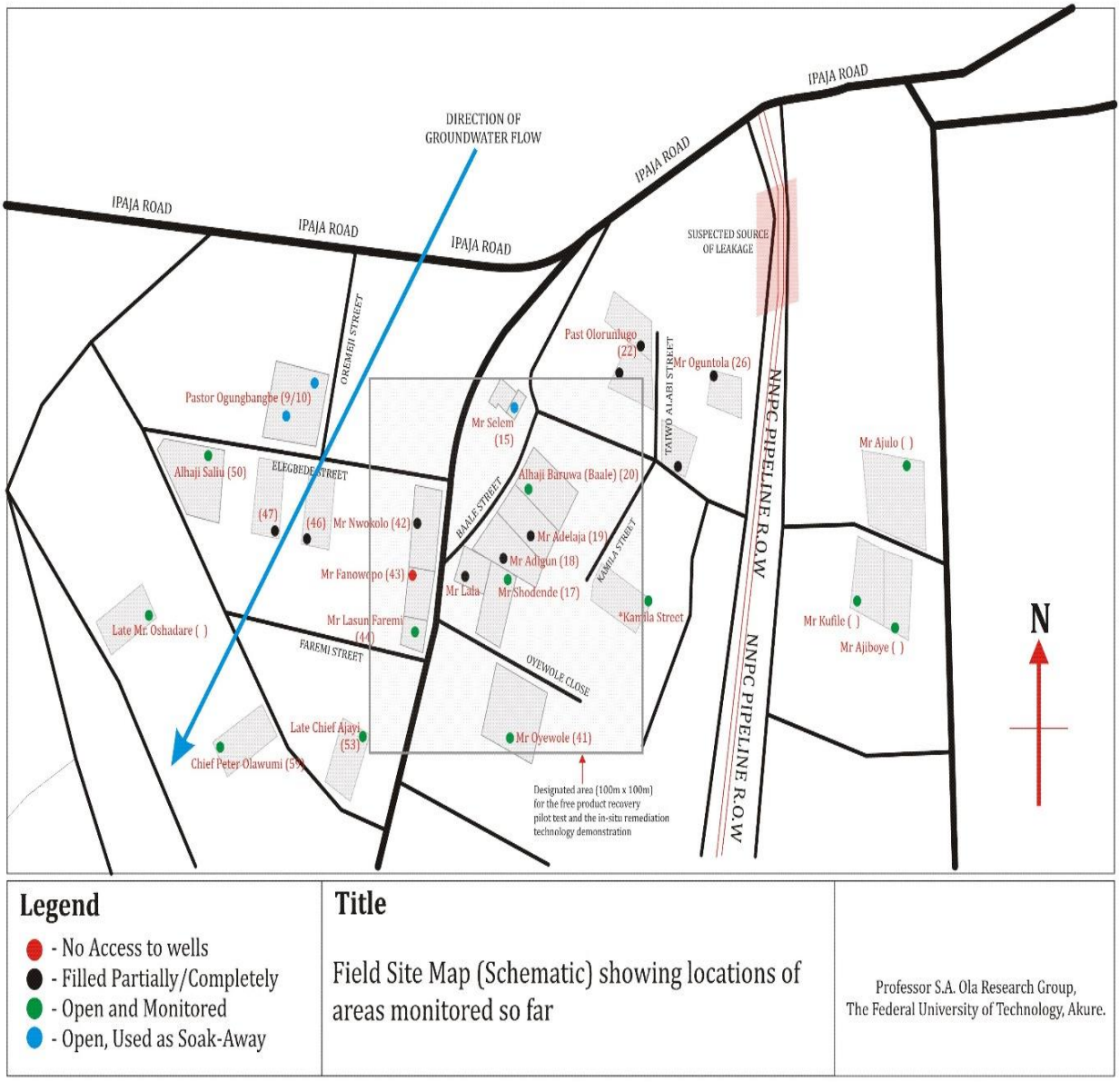

Fig 2: *Location of Late Chief Ajayi's well from the Baruwa's map*

2.2. Sample Collection and Preservation

The water samples for this study were collected from six wells within the pilot scheme and one well outside the pilot scheme as control in Baruwa area of Lagos State. Plastic bottles pretreated with dilute sulfuric acid and thoroughly rinsed with distilled water were used to collect samples for Total Petroleum Hydrocarbon (TPH) and 2 ml of concentrated sulphuric acid was added to each litre of the sample as preservative. The samples were stored in the refrigerator at $4^{o}C$ prior to analysis (APHA, 1985).

2.3. METHODS

2.3.1. Determination of Total Petroleum Hydrocarbon Solvent Extraction

50 ml of samples was collected into 250 ml separating flask. 30 ml of Dichloro methane (DCM) was added into the flask. The flask was shaken and pressure released at intervals. The sample was allowed to stand for few minutes and two layers were formed in the flask. The lower layer (extract) of the sample was collected into a beaker through a filter paper that was filled with anhydrous sodium sulphate (Na_2SO_4). The extraction was done in three batches.

2.3.2. Extracts clean – up and TPH analysis

Column preparation was carried out by inserting glass cotton into the column. Silica gel was dissolved with DCM to form slurry and the slurry was added into the column. Anhydrous Na_2SO_4 was also added and the extract was transferred into the column. The eluted sample was collected in a beaker below the column. This was then concentrated with a Rotary evaporator and then 5 ml of n-hexane was added and the solvent was left to evaporate to dryness. Thus, the TPH was calculated below:

Total Petroleum Hydrocarbon (TPH) mg/L = (A-B x 1000) / Sample Volume (ml)

A = Total gain in weight for experimental sample (mg)

B = Gain in weight for blank (mg)

2.3.3. Laboratory Remediation Procedure

The Total Petroleum Hydrocarbon (TPH) of the water sample was first determined to ascertain the initial concentration. Different molarities of $KMnO_4$ 0.010 M,

0.032 M, 0.063 M 0.158 M and 0.316 M were prepared. Each of these molarities was applied to 250 ml of the the sample (Ajayi) first at 4 ml each for the first and second week, then 2 ml each in the third week and the TPH concentration was evaluated every week using gravimetric analysis.

3. RESULTS AND DISCUSSION

It was observed that the highest molarities – 0.158 and 0.316 M were not fully oxidized. This could be that more time was needed for the full or remarkable oxidation of the sample. Also during the experiment, some of the permanganate solution settled at the bottom of the water sample. Oxidation also took place in 0.063 M, a molarity that was not too high or too low. There was oxidation every week and at the third week, the concentration of TPH was significantly low, 0.027 mg/L. For lowest molarities: 0.01 and 0.0316 M, oxidation was faster and quicker and the TPH reduced the most. Using 0.0316 M, TPH was reduced from 0.466 mg/L to a significant 0.095 mg/L in the 1st week but increased to 0.435 mg/l in the second week. However, in the third week it decreased significantly to 0.009 mg/L. Oxidation was the quickest in the lowest molarity (0.01 M), and at every week, there was a decrease in TPH and the final TPH value was the least compared to others. From this result, it was clear that the least concentration was the best for this study. In regard to this, 0.01 M permanganate was used for the laboratory remediation of the water samples of the oil polluted wells in Baruwa Community and the remediation started from 22nd June, to 31st August 2016.

***Table 1**: Application of different molarities of $KMnO_4$ on Ajayi's well sample*

WK/Molarities	0.01 M	0.032 M	0.063 M	0.158 M	0.316 M
0	0.466	0.466	0.466	0.466	0.466
1	0.095	0.095	0.05	0.149	0.239
2	0.092	0.435	0.044	1.056	0.187
3	0.008	0.009	0.027	1.509	1.026

4. CONCLUSION

This study has clearly established that Ajayi's well is polluted with hydrocarbon by the reason of the TPH value. Though the TPH concentration is not too high because Geoenvironmental Engineering research group in F.U.T.Akure had already pumped and skimmed off a large volume of petroleum hydrocarbon from the well before the sample was collected. It was observed that all the molarities of potassium permanganate solution oxidized the water sample but 0.01 M oxidized better and faster because the TPH concentration present in the water sample was low and required a low molarity of $KMnO_4$.

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