Application of Chemical Oxidants in the Remediation of Petroleum Products Contaminated Ground Water

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Abstract- Ground water is a major source of drinking water and very vital for domestic, industrial and agricultural purposes. Pollution of this important natural resources poses a great danger to life. Groundwater pollution affects useful land site as well as negatively impact the immediate environment. Pollution of ground water associated with health hazard through diet, drinking contaminated water. Although, many remediative techniques are available for the treatment of these organic contamination. The chemical oxidation application is a proven remedial method for achieving effective remediation. The study is focused on the chemical oxidation technique in the remediation of petroleum products in contaminated ground-water. This was an actualised by the use of the most appropriate oxidants and concentrations of three different oxidants. These are Fenton reagent, sodium persulfate the KMnO4. Experiment showed that the optimum oxidative performance was at a concentration above 10% sodium persulphate radical proved best at 30% w/v concentration treatment of diesel and kerosene. The results proved a decision making remedial strategy for site specific field application. A mathematical principle was used to express and vindincate analysis of result of samples obtained.

Index Terms- Ground water contamination, Petroleum product, Chemical Oxidation, Decision Support Tool.

I. INTRODUCTION

Ground water is one of the major sources of portable and domestic water globally. It is also very vital to human, agriculture and industrial purposes. Therefore pollution of this important natural resource poses a great danger and hazards to man and its natural resources. [1, 2] The contamination of ground water as a result of leakage and spills from piles has become a global concern to major players of oil industry. [3] Drinking contaminated water can lead to diseases such as hepatitis, dysentery, cancer, pile, aches and many others. There are other long term effects such as cancer and HBP can also be traced to poisoning and toxins from septic tanks. [2, 1, 5, 4]. Spilled crude oil can exert adverse effect on our environment because of the Polycyclic Aromatic Hydrocarbon (PAH) that comes out from it. Similarly, Total Petroleum Hydrocarbons (TPH) are also pollutants precursors of the environment. [6, 7].

All over the world, especially in developing countries, ground become a source of ground water has become a source of agricultural and drinking water. The high dependence on groundwater due to belief that it is free from pathogens found in surface waters [8, 9]. However, groundwater may contain a wide variety of inorganic and organic dissolved constituents resulting from reactions between water and geological materials [10, 11].

The menace of polluting our ground water with Petroleum hydrocarbons through leakages to the underground needs serious attention since it is most prevalent and ubiquitous water source to most rural and urban dwellers in this country. It is against this background that the chemical oxidation method for groundwater clean-up becomes necessary. Chemical oxidation method is fast and efficient for remedial mass reduction at a lower overall cost because there are no moving parts that could break down. [14, 15]. The treatment involved one-half of a redox reaction in which, there is a loss of electron i.e. oxidised and the other becomes reduced or gain electron.

In-situ Chemical oxidation, involves the introduction of Chemical oxidants into the ground water with an intention to converting inherent hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile and inert. [15] The oxidising agents used in this case are hydrogen peroxide catalysed with Ferrous in Fenton reagent [11, 10] Potassium permanganate and sodium persulfate [13, 16]

II. EXPERIMENTATION

The salts and reagents used in this research work were of Analar grade and were used without further purification. Below is a list of the reagents and sources.
Permanganates appears as $NaMnO_4$ or $KMnO_4$
and comes from …….. BDH chemical Ltd Poole England
Persulphates appears as ammonia and potassium $NH_3.S_2O_8$ or KS_2O_8

and was obtained from …….. Qualikem laboratory, India
Crude Oil ……. Bomu Oil field in Rivers State, Nigeria
Sodium Hydroxide……. BDH Chemical Ltd. Poole England

The persulphate anion reacted with the natural organic matter (NOM) in a simulated type of environment.

The Sodium Persulphate were prepared by dissolving varying weights of 0.34g, 1.98g, 8.57g, 19.7g and 30.68g of the solids in deionised water [16].

The contaminated water samples were prepared by adding the hydrocarbons (diesel motor oil and kerosene) into deionised water container. The mixture was vigorously shaken for 20-30minutes to settle. 5.0ml of the hydrocarbon sample was added to 20ml of the saturated water in a 50ml beaker and was kept for twelve hours degradation period. The solution was shaken vigorously and was sent for the GC-FID for onward chromatographic analysis. Each of the 5 samples of the three (3) types of hydrocarbons were analysed

III. RESULTS

Table 1

Samples	Motor Oil Mg/L	Diesel Mg/L	Kerosene Mg/L
1	15	11	38
2	28	53	73
3	49	25	41
4	21	50	74
5	26	15	54

STATISTICAL INTERPRETATION

The statistical or Mathematical method employed in this analysis is the ANOVA – Analysis of Variance

The null hypothesis as H_o stands for no significant difference in:

i. Chemical oxidation as effective remediative method
ii. The persulphate not effective remediant
iii. Chemical Oxidative is not fast

The alternative hypothesis H_1 holds true for

i. There is a difference to the H_o as in above

Therefore the ANOVA being hypothetical shall serve as a tool for either accepting or rejecting the hypothesis

IV. ANOVA SETTING

Table 2

1	15	11	38
2	28	53	73
3	49	25	41
4	21	50	74
5	26	15	54
	T_1=139	**T_2 = 154**	**T_3 = 280**

$n=n_1+n_2+n_3 = 15$

i. Grand Total $G = \Sigma xij = 573$
ii. Correction factor $C = G^2/n = 328329/15 = 21888.6$
iii. Total sum of square – C = 27653-21888
$\Sigma x^2 - c = 5765$
iv. Treatment Sum of sq. $T_{yy} - C$
24287.4 – 21888.6
$T_{yy} - C = 2398.8$
v. Error sum of sq. $SS_{yy} - T_{yy}$
= 3366

V. ANOVA TABLE

Table 3

Source	D_f	SS	MS	F
Treatment	3-1=2	2399	1199.5	4.8
Error	15-3=12	3366	2166.5	
Total	15-1	5765		

Degree of Freedom t – 1
Fc = $F \infty (2, 12)$
= $F_{0.005}(2, 12)$
Decision Rule
Reject if: F > Fc

F	Fc
4.80	3.80

Since F is greater than Fc, we reject all (H_O) null hypothesis and accept the (H_1) alternative hypothesis which holds true as:

H_1

i. Chemical Oxidation technique is effective for remediative contaminated ground water.
ii. The persulphate oxidant is an effective remediant for ground water pollution.
iii. There exist a significant difference in the remediative methods of ground water polluted by hydrocarbon.
iv. There exist a significant decision report tool for in-situ oxidation remedial technique in treating ground water polluted with petroleum products.

VI. CONCLUSION

Ground water pollution can be remediated using the chemical oxidative technique. The validity was made real using a mathematical check-up called the **ANOVA.** Major users of ground water are advised to sink their materials to the main aquifers level for purity of the ground water. The leakages and spills from piles and oil wells are to be monitored periodical to avoid the hydrocarbon pollutants. The clean ups by regular use of chemical oxidation method is encouraged because all their products are useful environmental inorganic species like Carbon dioxide and water. Chemical oxidation methods are fast, neutralizing and efficient for massive remediation petroleum pollutants. The method is considerably less cost effective and environmentally friendly.

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