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ASSESSMENT OF RADIUS OF INFLUENCE OF SPARGING WELL AND BIOSPARGING OPERATIONS IN OMUKPBU, IKWERE LGA, RIVERS STATE, NIGERIA

[1]Tijani, S. O., [2]Obafemi, A. A., [3]Babalola, A. E., and [4]Usman, A. O.

[1] Institute of Natural Resources Environment and Sustainable development (INRES), University of Port Harcourt Choba, Rivers state Nigeria; [2]Department of Geoinformation & Environmental Management, University of Port Harcourt Choba, Rivers state Nigeria; 3Institute of Ecology and Environmental studies (IEES) Obafemi Awolowo University Ile Ife, Nigeria; [4] Institute of Natural Resources Environment and Sustainable development (INRES), University of Port Harcourt Choba, Rivers state Nigeria.
Correspondences:[1]sheidutijani@gmail.com; [2]andrew.obafemi@uniport.edu.ng; [3]A.babalola@gmail.com; [4]anibasausman@gmail.com

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ABSTRACT

The capacity to analyse the influence of the operation on the targeted wells is critical to the efficacy of biosparging. Its success varies based on the profile of the targeted region in which the operation is carried out. The Omkpbu investigation was able to establish the impact of the activities as defined by the soil texture, which is clay silt in nature. To establish the ROI inside the research region, a 10m deep sparging well (SW) and 8m deep monitoring wells (MW) were constructed at 1m, 2m, 3m and 5m intervals around the sparging well. The influence of the sparging well became obvious on the 13th, 14th and 15th day of the sparging operations. This resulted in an increase in the dissolve oxygen in the ground water condition across the monitoring wells. In comparism with the baseline data there were massive improvement in the presence of dissolve oxygen in the ground water at an increasing rate as the operations continues. Monitoring well 1, 2, 3 and 4 on the 13th day felt an increased rate of influence at 2.6mg/l, 2.5mg/l, 4.31mg/l and 2.83mg/l as against the base line data of 1.9mg/l, 1.5mg/l, 1.7mg/l and 1.9mg/l respectively. Similarly, there were also an increased influence from data generated on the 13th day as at the 14th day the presence of the dissolve stood at 2.7mg/l, 3.6mg/l, 4.9mg/l, and 3.0mg/l respectively. The 15th day noticed a massive increase in the dissolve oxygen in groundwater as it stood at 4.4mg/l, 6.2mg/l, 6.17mg/l, and 4.78mg/l respectively. Biosparging has a great influence in increasing dissolve oxygen in groundwater which essentially is a major requirement for addressing groundwater contamination.

INTRODUCTION

Establishing the radius of influence (ROI) in a biosparging operations is essential for the performance. Biosparging is an in-situ remediation technology that decreases the rate of contamination by injecting low pressure air into the sparging well (SW). As an in-situ remediation approach, it uses micro-organisms to digest organic components in saturated zones (Citation is required). In biosparging, air in the form of oxygen and nutrients (if necessary) are injected into the zone of saturation to increase the bioavailability of soil microorganisms. Biosparging is efficient in decreasing hydrocarbon component concentrations in groundwater, as well as those found below the water table and within the capillary fringe. Despite the fact that biosparging is effective in remediating unsaturated zone components adsorbing to soils. This method is very similar to bioventing in that air is pushed into the soil's subsurface level to stimulate microbial activity and improve pollution removal from polluted regions. Unlike bioventing, however, air is supplied at the pore space, which may cause volatile organic compounds to migrate higher to the unsaturated zone, increasing microbial destruction.

The proportion of injection wells built to clean up a polluted site is usually influenced by the amount and depth of contamination. The ROI of the drilled wells should be properly recognized for effective remediation of contaminated sites, and the quantity and locations of drill wells necessary for the remediation of matching contaminated regions should be precisely calculated to avoid the passing over of contaminated environment (Fan et al. 2013; Chai and Miura 2004).

MATERIALS AND METHODS

The study was within an existing oil facility ROW with clay silt as its soil lithology formation. It is an area that house series of oil and gas facilities such as well head, Manifold, flow stations and pipeline of various sizes traversing the area mostly within the multinational acquired area known as the Right of Way (ROW). The study area particularly is located in a community known as Omkpobu in Ikwere LGA Rivers State, Nigeria.

The maximum distance over which air can be injected or extracted via injection or extraction wells is referred to as the ROI. The ROI can vary during the design stage depending on several factors such as soil physico-chemical properties, humidity, and the time required for remediation of corresponding sites (Al-maamari et al. 2011).

To calculate the ROI, two distinct types of wells were installed. The sparging well (SW) is built at a depth of 10m below the earth's surface and well casing diameters of 3 inches. The well screen was meant to cover the first 2 meters of the well casing. Filter packs were utilized to fill the annulus region up to 5m from the well's bottom and 2m above the well screen. The annular gap was sealed with a bentonite pallet seal within 100cm, and the well head was fitted and grouted. The design of the monitoring wells is identical to that of the sparging well, but with a longer well screen and a depth of 8m. Similarly, the monitoring wells were built with a well head, but the sparging well (SW) was grouted above the surface of roughly 0.3m to allow for the installation of sparging equipment. The sparging well acts as the sparging source, and three monitoring wells were built at varying distances of one meter, two meters, 3meter and five meters to calculate the ROI from the sparging operations on the monitoring well.

In order to set up the air injection operation, a compressor driven by an energy source was employed as the air supply. A flow meter was placed within the 1/2 inch line air pipe to allow monitoring of the flow rate from the compressor. The air is sent to the well-head and controlled at 14psi to prevent air stripping and VOC evaporation. The behaviour of the three monitoring wells that were being monitored was occasionally influenced by the operations that were being carried out. At varied intervals, Hana Multiparameter in-situ equipment was utilized to constantly monitor influence behavior in the three monitoring wells.4.

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RESULTS

There were varied behaviours in terms of dissolve oxygen in the monitoring wells after days of sparging operations. The monitoring's behaviour varies as the number of days of operation rises. Prior to the procedures, the dissolve oxygen in the monitoring well was 1.9mg/l for monitoring well 1 (MW), 1.5mg/l for 2, 1.5mg/l for monitoring well 3 (MW), and 1.7mg/l for 4.

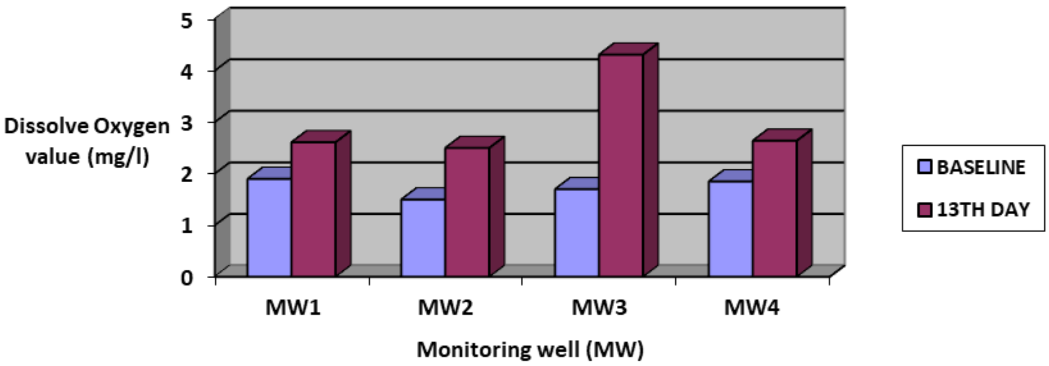

Fig.1: Analysis of baseline of DO compared to the 13th day

Influence in monitoring began to show in the monitoring wells after many days of sparging operation, notably on the 13th day of operation. On the 13th day of the sparging operations, there was an effect of 2.61mg/l as opposed to the baseline of 1.9mg/l in 1, which is 5m distant from the sparging well (SW); 2 also noted an influence of 2.5mg/l as opposed to the baseline of 1.7mg/l from a distance of 2m. 3 which is 1m away from the sparging well (SW) similarly noticed an influence of 4.31mg/l as against the baseline 1.7mg/l; 4 which is 2m away from sparging well (SW) was also influenced by the operation as the DO increased from the baseline of 1.85mg/l to 2.83mg/l;

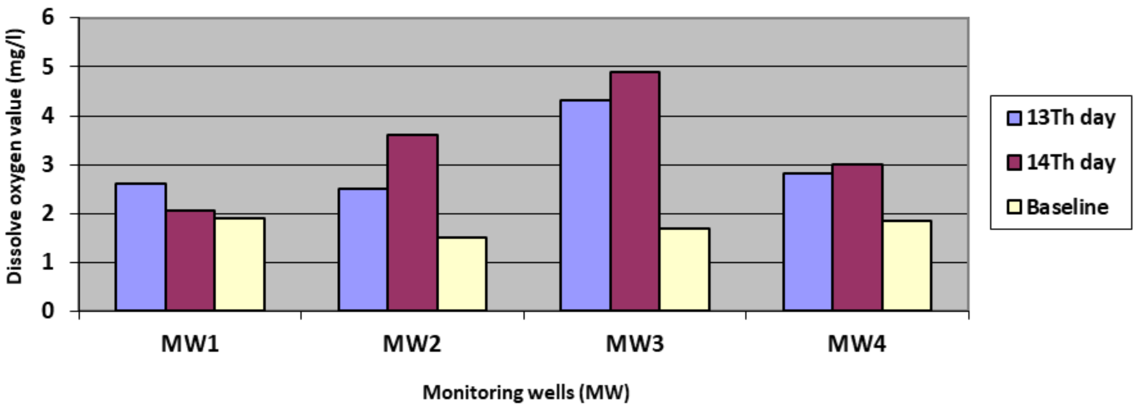

Fig 2. Analysis of baseline of Dissolve Oxygen compared to the 13th/14th day

On the 14th day of the sparging processes they was an influence of 2.7mg/l as against the mg/l of the 13th day which stands at 2.6mg/l in 1 which is 5m away from the sparging well (SW); 2 also noticed an influence of 3.6mg/l as against the mg of the 13th day which stood at 2.5mg/l from distance of 3m; 3 which is 1m away from the sparging well (SW) similarly noticed an influence of 4.9mg/l as against the baseline 4.31mg/l; 4 which is 2m away from sparging well (SW) was also influence by the operation as the DO increased from the mg/l of day 13th which is 2.83 to 3.0mg/l.

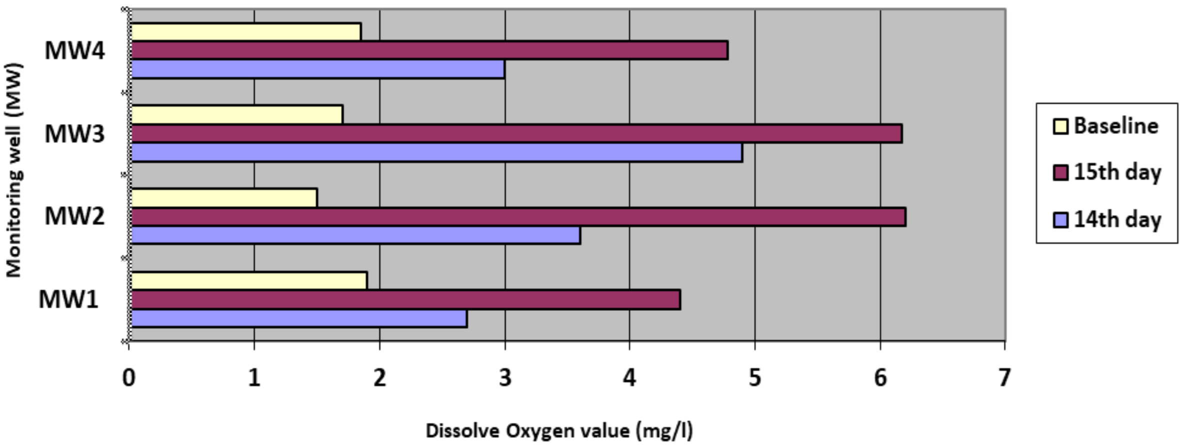

Fig 3: Analysis of baseline of Dissolve Oxygen compared to the 13th/14th/15th day

On the 15th day of the sparging processes there was an influence of 4.4mg/l as against the mg/l of the 14th day which stands at 2.7mg/l in 1 which is 5m away from the sparging well (SW); 2 also noticed an influence of 6.02mg/l as against the mg/l of the 14th day which stood at 3.6mg/l from distance of 3m; 3 which is 1m away from the sparging well (SW) similarly noticed an influence of 6.17mg/l as against the 14th mg/l which is 4.9mg/l; 4 which is 2m away from sparging well (SW) was also influenced by the operation as the DO increased from the mg/l of day 14th which is 3.0 to 4.78mg/l.

DISCUSSION

One of the major findings during the Omkpbu study was an increased significant impact on the dissolve oxygen (DO) in the groundwater monitored through the wells. Oxygen was delivered to resident micro-organisms involved in biological degradation processes during the operations. This supports the previous study of Surendhiran et al. in 2015; Chikere et al. in 2011 and the study of the US Army Corps of Engineers 2002. However, the effect of dissolve oxygen (DO) on monitoring wells is primarily determined by the distribution of the wells.

The radius of oxygen transference is the greatest distance of oxygen transference in air pumped through injection wells for biological pollutant degradation. This was demonstrated by the monitoring wells (MW) 1-4 scenario. According to the findings, as the distance between the well and the sparging well grows, so does its effect in terms of increased soluble oxygen this is however in line with the previous findings of Philp and Atlas 2005 about soil porosity and ROI. In view of (Philp and Atlas 2005) ‘’soil porosity, which impacts

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pollutant bioavailability to microorganisms, and ROI are two important factors that determine biosparging effectiveness''

Low rate air sparged in the research area shows a significant success in the constituent biodegradation rather than volatilization. This is so as only 14psi equivalent to one bar. This however is in line with the view of Philp and Atlas 2005 ''Biosparging, like bioventing and soil vapour extraction (SVE), operates similarly to in situ air sparging (IAS), which employs high airflow rates to accomplish pollutant volatilization, but biosparging encourages biodegradation''. Similarly, neither technique's pollution-removal procedures are mutually hostile. Biosparging has been frequently used to remediate contaminated groundwater using petroleum compounds, notably diesel and kerosene. The complete reduction in BTEX (more than 70%) demonstrates that biosparging may be used to remediate BTEX polluted ground water. The primary limitation is predicting the direction of wind. The biosparging process is comparable to air sparging. However, while air sparging mostly removes components by volatilization, biosparging enhances constituent biodegradation rather than volatilization (generally by using lower flow rates than are used in air sparging). When either air sparging or biosparging is used, some amount of volatilization and microbial degradation occurs.

CONCLUSION

The study demonstrates the useful range of air injection in biosparging activities at Omukpbu. Effective pollutant oxygenation through the sparging well necessitates that the monitoring well be positioned close to the sparging well. Depending on the extent of the region to be oxygenated, a high influence rate is necessary, which necessitates additional sparging wells in parts.

Furthermore, soil lithology plays an important role in the Omukpbu study's effectiveness in understanding the impact of air injection on neighboring wells. The Omukpbu example, which has clay sand lithology, has effectively demonstrated that the operation of biosparging may be successful, particularly if the soil properties are favourable enough to allow air penetration over time. It is evident that correctly constructed sparging systems improve both biodegradation and volatilization. A pilot test to evaluate site characteristics is required to determine the potential viability of sparging at a specific location.

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