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EXTENDED ABSTRACT

Evaluation of Efficiency of SDS and Tween 20 Surfactants on Refining of Diesel Contaminated Clay Using Electrokinetic Process and Determination of Compressive Strength of Clay after Removal of Contaminant

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1. Introduction

In the present era, environmental pollution is a global crisis, increasing population growth and urban development, industrial expansion and unlimited use of natural resources, are among the increasingly important factors of pollutants (Reilley, 1996). Vocciante (2021) found in the study of stability in electrokinetic modification processes that the electrokinetic method is suitable for cleaning inorganic pollutants from clay. Zhou (2021) found that using the electrokinetic method is effective in removing heavy metals zinc, cadmium, and manganese from the soil and leads to the removal of about 72% of the pollutant from the soil sample. Vaishnavi (2021) in the study of bio-electrokinetic modification of diesel-contaminated environment with biosurfactant found that this method is an effective method for cleaning and cleaning soils contaminated with diesel hydrocarbons. Hanaei et al. (2021) found that the direct shear test showed that the adhesion of the soil sample increased and the friction angle decreased after oil contamination, and the permeability test showed that the contamination of the soil sample decreased the permeability of sandy soil and this change It is a function of the amount of oil and the viscosity of oils.

2. Methodology

According to the studies performed in the field of cleaning of soils contaminated with oil, SDS and Tween 20 surfactants were selected. In the present study, an electrokinetic cell in the shape of a soil box made of Plexiglas with dimensions of 50×15×50cm according to Fig. 1 has been used. In this system, the middle chamber Is 30 cm long, where the soil is located and the chambers on the both sides are for pouring electrolyte solutions. The electrolyte chamber and the soil location are separated by plastic mesh plates. The lattice of the plates allows the flow of electro-osmosis to pass during the test. Due to the movement of electrolyte solutions and change in height due to electroosmotic current and prevent reverse electroosmatic current, the electrolyte in the anode and cathode chambers (to prevent the effect of hydraulic gradient on electrical migration and electroosmatic current) is continuously controlled by the pump.

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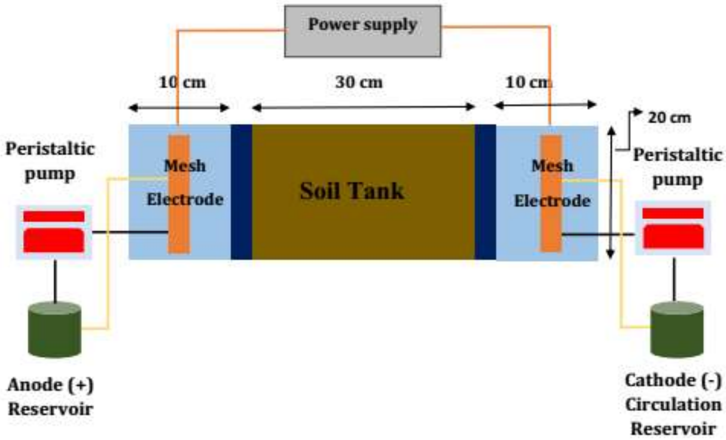

Fig. 1. Electrokinetic process executive system

3. Results and discussion

The electrokinetic process in the absence of pH control shows very significant changes in this parameter in the soil. With increasing concentrations of H^+ and OH^- in the anolite and catholite, respectively, an acidic front moves from the anode side and a base front moves from the cathode side into the soil. Due to the fact that the proton ion mobility is much higher than the hydroxyl ion mobility, so the acidic front will advance faster than the base front along the soil column and in the area near the cathode, these two fronts will meet.

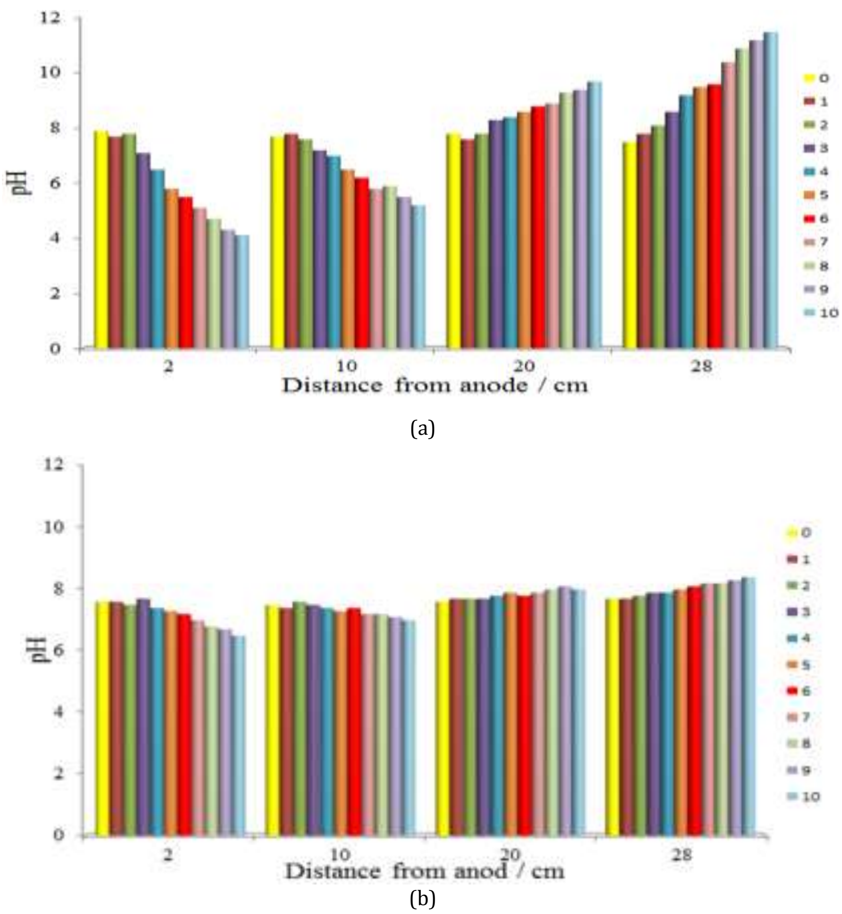

Fig. 2. a) Soil pH changes at different distances from the anode without pH control from the first to the tenth day,
b) Soil pH changes at different distances from the anode along with pH control from the first to the tenth day

In the vicinity of the cathode, the pH value increases sharply and a dense layer is formed by the deposition of metals and other contaminants in this area. This layer reduces the rate of the electro-osmotic current moving towards the cathode, reducing the efficiency of moving the diesel along the soil column (Fig. 2-a).

Also in the vicinity of the anode, due to the sharp decrease in pH, the electroosmatic current occurs in reverse and reduces the efficiency of removing diesel from the soil. But by controlling the pH, pH changes along the soil column are prevented. Therefore, in the anode, the occurrence of reverse electro-osmotic current is largely prevented, and in the cathode, the formation of a dense layer will be delayed, and ultimately the efficiency of diesel removal along the soil column will be higher than the first experiment (Fig. 2-b).

As it turns out, compared to different SDS inhibitors, it shows higher removal efficiency. Surface active substances improve the removal of hydrocarbon compounds from the soil through two main mechanisms: the movement of hydrocarbon particles (oil stimulation) and the dissolution of hydrocarbon compounds in water. In the excitation mechanism, the phenomena of reduction of surface tension and interfacial tension, reduction of capillary force, moisture content and increase of contact angle occur. SDS's greater ability to remove diesel can be attributed to its relatively smaller structure, which is effective in dissolving diesel and has a faster migration rate. Fig. (3) shows the changes in diesel removal efficiency with pH control during 10 days of Electrokinetic with SDS and Tween 20 surfactants. According to this figure, with the increase of time, the amount of diesel removal increases almost linearly. This behavior is the same for different inhibitors and indicates the slow movement and removal of diesel from the soil. Removal efficiency in all the surface active materials used with the increase of the active material shows a significant increase in attention.

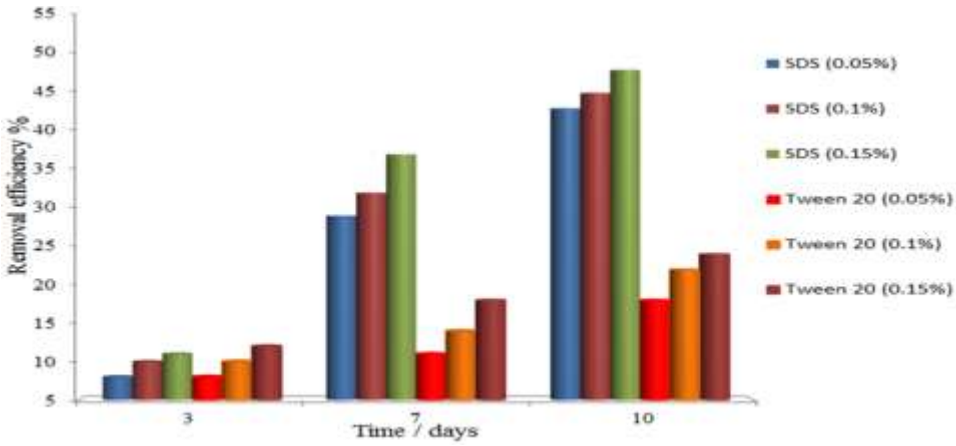

Fig. 3. Changes in diesel removal efficiency in the presence of different concentrations of surfactants in different percentages with pH control at different test times

4. Conclusions

In the present study, the improvement of electrokinetic method using SDS and Tween 20 surfactants for refining diesel contaminated clay has been evaluated. The results show that the highest cleaning efficiency of diesel pollutant is obtained by applying SDS surfactant with 0.15 wt% to 49%, while with application of Tween 20 surfactant with 0.05 wt% the lowest Clearance of 18% is observed. Continuing the research by observing the results of uniaxial experiment to determine geotechnical parameters on clay samples and diesel-contaminated clay samples before electrokinetic process and soil samples after cleaning shows the amount of clay resistance parameters such as unrestricted compressive strength After cleaning, the clay increases by about 12% and reaches about 83% of the unenclosed compressive strength of the soil sample in contaminant-free conditions.

5. References

Hanaei F, Sarmadi MS, Rezaee M, Rahmani A, “Experimental investigation of the effects of gas oil and benzene on the geotechnical properties of sandy soils”, Innovative Infrastructure Solutions, 2021, 6 (2), 1-8. https://doi.org/10.31272/jeasd.27.3.1

Reilley KA, Banks MK, Schwab AP, “Organic chemicals in the environment: dissipation of polycyclic aromatic hydrocarbons in the rhizosphere”, Journal Environmental Quality, 1996, 25, 212-219. https://doi.org/10.2134/jeq1996.00472425002500020002x

Vaishnavi J, “Biosurfactant mediated bioelectrokinetic remediation of diesel contaminated environment”, Chemosphere, 2021, 264 (1), 128377. https://doi.org/10.1016/j.chemosphere.2020.128377

Vocciante M, "Sustainability in ElectroKinetic Remediation Processes: A Critical Analysis", Department of Chemistry and Industrial Chemistry, University of Genova, 16146 Genova, Italy, Sustainability 14 January 2021. https://doi.org/10.3390/su13020770

Zhou JL, "Effective remediation of heavy metals in contaminated soil by electrokinetic technology incorporating reactive filter media", Science of The Total Environment, 2021, 794, 148668. https://doi.org/10.1016/j.scitotenv.2021.148668