

Effect of Hydrogen Peroxide Concentration in Remediation of Oil-contaminated Soils with Use of Fenton Reaction

A. S. Yousefi¹, A. Bostani²

¹Ms student, Department of Soil Sciences, Shahed University, Tehran, Iran

²Assistant Professor, Department of Soil Sciences, Shahed University, Tehran, Iran

Abstract: Refining oil-contaminated soils has a great importance especially in oil producer countries such as Iran. Different methods have been provided to eliminate oil contaminations from soil. The aim of this study was to investigate the effect of Hydrogen peroxide concentration in refining oil-contaminated soils with Fenton chemical method. To do this, a calcareous soil complex sample was collected around the Tehran oil refinery and treated with 10 and 20 percent petroleum in three replications. After reaching to balance conditions, the sample was treated using 0.01, 0.02, 0.12, 0.24, 0.47 and 0.71 equivalent of Hydrogen peroxide. The results indicated that in all level of H₂O₂, the eliminating efficiency in 10 percent was more than 20 percent treatment. Also a significant difference between the levels of hydrogen peroxide used in the removal of oil pollution in both surface concentrations was obtained (P<0.01).

Keywords: oil contamination, Refining, Fenton reaction, Hydrogen peroxide.

INTRODUCTION

Pollution of soil and water to different kinds of contaminants is considered one of the important environmental dangers in urban and industrial areas.

Hydrocarbons is one of contamination kinds that have extensively been scattered in environment. The main source of production and distribution in environment depends on different kinds of oil and industrial activities. Oil and its derivations cause soil contamination by different ways such as bust transmission pipes, waste release of oil industries into grounds and also their leakage from retentive storage [9]. Different methods have been proposed to eliminate oil contaminations from soil that are burning way, soil washing, thermal treatments, Phytoremediation and Bioremediation techniques [10]. Most of above methods aren't especially in scientific broad dimension and from marginal negative effect point of view are considered inefficiency methods. One of ways to eliminate organic contaminations is the using of chemical methods and one of chemical methods is the using of Fenton reaction. Various studies show that using this reaction has a great efficiency in eliminating organic contaminations either in soil [1] or in wastes [4, 2]. The basis of Fenton reaction in eliminating oil combinations is the producing of free radicals kinds such as Hydroxylradicals (OH⁰) based on Hydrogen peroxide reaction (H₂O₂) with bivalenceiron (Fe⁺²) in a homogeneous solution. OH⁰ radical with the power of 2.06 oxidation has been known the second active chemical kind in nature after fluorine. Although in Fenton classic reaction, Hydrogen peroxide concentration has been fixed 0.03(W/V %), in various studies and on the base of soil physical and chemical properties, this concentration has been

Used in the very wide range (0.015 to 27 percent) (W/V) and finally has been proposed [5]. The aim of this study was effect of Hydrogen peroxide concentration on efficiency of oil pollution removal at 10 and 20 percent contamination carried out.

MATERIALS AND METHODS

A complex sample of surface soil (0-20 cm) has been taken around Tehran oil refinery and after transmitting to laboratory and air drying has been passed from sieve two millimeter. Some physical and chemical properties of soil such as soil texture, saturation moisture, organic carbon, equivalent calcium carbonate and the Caution exchangeable capacity were measured with standard methods. To study Fenton reaction effect on oil elimination from soil, an experiment was accomplished in form of a completely randomized design with three replications. Treatments included pollution level (10 and 20 percent), and the equivalent of utilized Hydrogen peroxide (0.71, 0.47, 0.24, 0.12, 0.02 and 0.01). At first, soil sample was contaminated with two concentrations of 10 and 20 percent of petroleum and was kept for two weeks in Incubator to reach a balance conditions (the temperature was 25°C). To do Fenton reaction, 20 g of soil sample was weighted and poured into Meyer flask of 250 ml. Then, for each treatment, 10 ml of iron Sequestrine was used and in four stages (each stage 10 ml in 30- minutes interval) 40 ml of Hydrogen peroxide was added to it and the samples were been shaken for two hours. Finally, remaining of oil amount was measured as weigh [1] and the refining contamination percent of soil was calculated. All of the statistical calculations were done with SAS software.

RESULTS AND DISCUSSION

Table 1 shows some of soil physical and chemical properties. According to this table, the soil has clay texture and its organic carbon is low. Should be noted that the high content of soil organic

carbon leads to a major portion of utilized hydrogen peroxide reacts with organic matter and consequently will reduce efficiency of oil pollution removal.

Table 1- some of soil physical and chemical characteristics

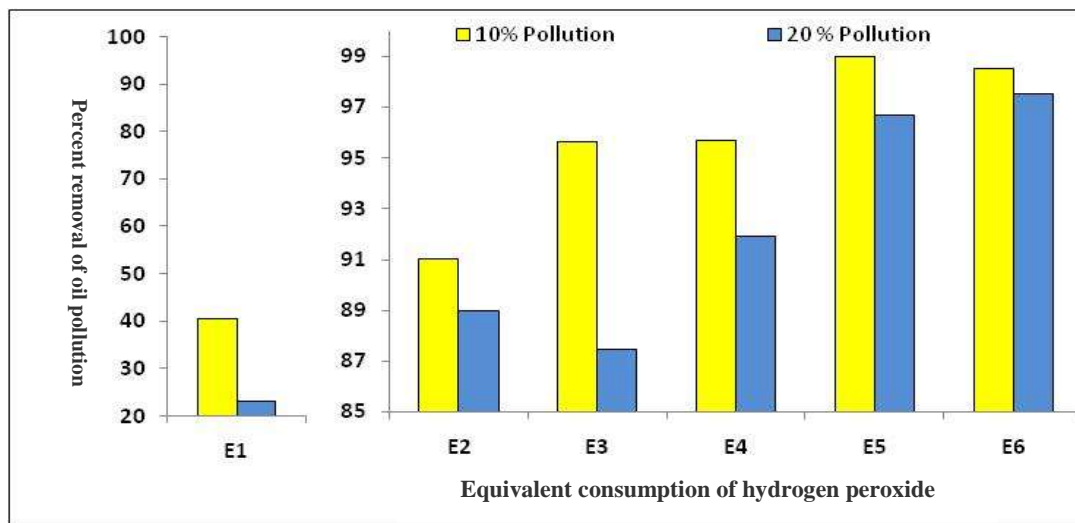
Soil texture	Sand	Silt	Clay	CCE*	OC	CEC	pH
	percent				(Cmol _c kg ⁻¹)		-
clay	19	35	46	15.35	0.39	22.42	7.49

* :equivalent calcium carbonate

Figure 1 shows soil refining contamination percent for various amounts of Hydrogen peroxide and in two concentrations of 10 and 20 percent of oil contamination. As it is obvious, in all treatments of

Hydrogen peroxide, the contamination efficiency in treatments 10 percent was more than 20 percent treatments.

Figure 1 – the comparison of soil contamination refining for various amounts of utilized Hydrogen peroxide in tow concentrations of 10 and 20 percent of oil contamination



The results of variance Analysis and comparison means relating of Hydrogen peroxide concentration on oil eliminating percent have been given in Tables II and III. As it is obvious, there is a significant difference between different levels of utilized Hydrogen peroxide in oil contamination

elimination in two levels of contamination (P<0.01).Also, the results of comparison mean showed that E1 treatment in two levels of contamination has a very low efficiency than other treatments.

Table 2: Analysis of variance for oil contamination elimination percent for various levels of Hydrogen peroxide in two concentrations of 10 and 20 percent of oil contamination

MS		DF	S.O.V
20percent contamination	10percent contamination		
5034.73**	3904.01**	5	EquivalentH ₂ O ₂
3328.01	20.313	42	Experiment error

significant in th

**Significant in P<0.01

Table 3 – Mean comparison of oil removal as effected by utilized Hydrogen peroxide, using Duncans multivariate test.

Petroleum analysis grouped the mean percentage of hydrogen peroxide used in different salt concentrations		
The average percentage of decomposition		
20% Pollution	10% Pollution	Equivalent H ₂ O ₂ utilization
23 a	40.67 ^a	E ₁ (0.5)
87.42 ^b	91.16 ^b	E ₂ (1)
89.17 ^b	95.75 ^{bc}	E ₃ (5)
92.07 ^b	95.83 ^b	E ₄ (10)
97 ^b	96.05 ^{bc}	E ₅ (20)
97.67 ^b	98.50 ^c	E ₆ (30)

CONCLUSION

According to results, it seems that Fenton chemical reaction in refining contaminated soils with oil compounds is a very efficient and successful technique. The results showed, however, that with increasing Equivalent of utilized Hydrogen peroxide number, the efficiency of oil resolution increases, but it seems that from economy point of view, the best treatment of utilized Hydrogen peroxide concentrations is first treatment of Equivalent. Because in this treatment, by decreasing Hydrogen peroxide over 30, oil removed efficiency has been decreased only about 8 percent. Also, the results show that in all Hydrogen peroxide concentrations, the contamination efficiency in treatment is 10 percent was more than 20 percent treatments.

It seems that beside Hydrogen peroxide concentration, other effective irons in refining such as concentrations and the sources of iron compounds in refining efficiency are important, especially in high percents of contamination.

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