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# Remediation Experimental of Chromium-Contaminated Soft Soil by Temperature-Controlled Electric Combined Leaching

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## Abstract

It is often inefficient and difficult to achieve the ideal remediation effect using a single remediation technology to repair contaminated soil, so the combined remediation technology of temperature-controlled electric combined leaching has aroused people's interest. At present, it is widely used in chromium-contaminated soft soil.

**Keywords:** Chromium-contaminated soft soil; Electrokinetic remediation; Temperature-controlled

## Introduction

Chromium has a series of reactions with soil, such as adsorption, complexation, reduction, oxidation and so on, which makes its existing form in soil different from its input form [1]. According to the continuous extraction method proposed by Tessier et al. [2], the forms of chromium in soil can be divided into the following five forms: exchangeable, carbonate-bound, iron- manganese oxide-bound, organic-bound and residual. The remediation methods of chromium contaminated soil are roughly divided into physical remediation, chemical remediation, bioremediation and combined remediation, among which electrokinetic remediation is a clean and efficient remediation method of contaminated soil, which belongs to the physical and chemical remediation method. The Lasagna technology, which was first used in Kentucky in 1995, and the combined repair technology of Electro-KleanTM and electric adsorption used in Louisiana in the future, the electrochemical oxidation technology used in Germany, and the compound repair technology of EK-solar field used in a site in South Korea [3].

Scholars from all over the world have also carried out extensive experimental studies on the electrokinetic remediation of chromium-contaminated soil. In the 1990s, Ryan et al. [4] put forward the electrokinetic restoration method earlier, and Reddy et al. [5] studied the difference of electrokinetic remediation effect of different types of chromium contaminated soil. Kim et al. [6] conducted an experimental study on the electro remediation of muddy soil polluted by chromium, copper and lead. The results showed that the removal rate of heavy metals depended on their forms in the soil, and the removal rate of exchangeable and carbonate bound chromium reached 70%. Reddy et al. [7] studied the effect of the initial form of chromium in soil on the effect of electrokinetic remediation test.

Al-Hamdan et al. [8] presented a systematic bench-scale laboratory study performed to assess the transient behavior of chromium, nickel, and cadmium in different soils during electrokinetic remediation. It is showed that in kaolin, the extent of Ni (II) and Cd (II) migration towards the cathode increased as the treatment time increased. Peng et al. [9] studied the effect of different electrolytes on electrokinetic remediation of muddy soil polluted by chromium and zinc. Distilled water, SDS solution and citric acid solution were used as electrolytes. After 5 days of electrokinetic remediation, the total removal rates of heavy metals were 20-51%, 26-65% and 34-69%, respectively, and the removal rate of chromium was the highest when citric acid solution was used as electrolyte. Li et al. [10] proposed to use the method close to the anode to enhance the effect of electro remediation of chromium contaminated soil, that is, the anode moves 7cm to the cathode every three days, which is beneficial to the desorption and dissolution of chromium, promote the dissociation of chromium from the soil, strengthen the migration ability of chromium in soil, and improve the removal efficiency of chromium in soil. The effects of acidification time, concentrations of acetic acid and citric acid on removal of chromium from soils were studied by changing the acidification pretreatment conditions, and then speciation analysis of the chromium was conducted to study the regularity of Cr in different speciation's [11]. The total chromium(Cr(T)) and hexavalent chromium(Cr(Ⅵ)) removal rates of the group acidized by citric acid(0.9 mol/L) for five days were up to26.97% and 77.66%, respectively, while the Cr(T) and Cr(Ⅵ) removal rates of the group without acidification were 6.23% and19.01%, respectively. The experiments of Meng et al. [12] proved that acidification pretreatment can significantly improve the removal efficiency of chromium in soil in electrokinetic remediation experiments.

In addition, the citric acid fermentation broth was used to leach and repair the Cr-Cu-Pb contaminated soil, and the chromium removal rate was 43.7%, which was higher than that obtained by using citric acid leaching solution [13]. Accordingly, the authors of this paper improved the temperature-controlled electric combined leaching remediation device based on the development of temperature-controlled electric remediation device. Then, the effects of the concentration of Cr (Ⅵ) and Cr (total), voltage, temperature and the type of leaching solution on the remediation of chromium-contaminated soil are considered and the remediation experiments of chromium-contaminated soil by soil electrokinetic, leaching and electrokinetic leaching were systematically carried out.

The temperature-controlled electric remediation device was used to carry out the remediation experiment on chromium-contaminated soft soil. The factor that had the greatest influence on the removal rate of Cr (VI) in the contaminated soil was voltage, followed by temperature and the initial concentration of Cr (VI) in the soil. Under the applied voltage of 36V, the removal rate of Cr (VI) in each group was more than 96%, and the highest removal rate of Cr (total) in the soil was 76%.

After adopting the improvement measure of increasing the cross-sectional area of the conductive part of the bottom surface of the soil column, the electric combined leaching remediation experiment was carried out on the self-made chromium contaminated soft soil. The study shows that after the experiment, the removal rates of Cr (Ⅵ) and Cr (total) in the soil column are improved correspondingly: the removal rate of Cr (VI) in the soil column of each test group is more than 97%.At low voltage and 15V, the removal rates of Cr (Ⅵ) and Cr (total) in the test group containing oxalic acid, sodium dodecylbenzene sulfonate and citric acid reached 99.6% and 89.4%, 99.2% and 89.6%, 98.1% and 80%, respectively.

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## Conflict of Interest

No conflict of interest.

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