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Application of Electrochemical Remediation Technology in Land Engineering

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Abstract

This paper summarized the basic principle of electric remediation technology, the research progress in soil salinization and heavy metal remediation, discussed the factors that affect the efficiency of soil electric remediation, and analyzed that it is an important research direction to study the ion removal effect of different texture soil on heavy metal contaminated soil and saline soil under different electric field conditions.

Keywords

Electric Repair Technology; Soil Salinization; Heavy Metal Remediation; Efficiency of Soil Electrokinetic Remediation; Soil Texture.

1. Significance of Electric Repair Technology

With the development of social economy, the problem of soil heavy metal pollution caused by mining, industrial production and other activities is becoming more and more serious. According to the National Soil Pollution Survey Bulletin, the overall soil environmental situation in China is not optimistic. The rate of exceeding the standard is 19.4%, and the proportion of slightly, slightly, moderately and severely polluted sites is 13.7%, 2.8%, 1.8% and 1.1% respectively. Among them, 82.8% of the soil environmental pollution is heavy metal pollution, and most of them are complex heavy metal pollution, of which Cd, Pb and Cu are more common [1-3]. The traditional remediation of heavy metal contaminated soil mainly refers to the removal of heavy metals in the soil through physical methods, chemical methods, biotechnology and other measures, or fixing them in the soil to limit their migration, so as to achieve the purpose of soil remediation [4]. However, the electric remediation technology can achieve good remediation effect on organic, inorganic and compound contaminated soil [5], and the technology has good removal effect on low permeability contaminated soil. The remediation technology has wide application scope, low cost and fast remediation efficiency, especially for point source pollution and pollution emergencies [6]. Therefore, the research on electrokinetic remediation of heavy metal contaminated soil is of great significance.

2. Principle of Electric Repair Technology

Electroremediation is a new technology. Its basic principle is to use the electrodynamic effect caused by the applied electric field to drive the pollutants in the soil to migrate in the direction of the electric field. The concentrated pollutants can be centrally treated or separated in the electrode area. Electroremediation can be used to extract heavy metal ions from soil, and also remove ions from saline soil [7]. Advanced electrokinetic remediation processes for heavy metal contaminated soil at home and abroad, such as Lasagna process, cathodic zone conductive solution injection process, cation selective permeation membrane, CEHIXM process, Electro Klean TM electric separation technology, electrochemical natural oxidation technology, electrochemical ion exchange technology, electrochemical adsorption technology, etc.[8]. Electric power repair technology has attracted more

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and more attention due to its advantages of low cost, wide application range, less exposure to harmful substances, strong controllability, fast and thorough treatment, and no damage to the original natural ecological environment. And because the generation of electrodynamic effect is less affected by soil permeability, the electroremediation technology is very suitable for multi-directional soil and has technical advantages that other remediation technologies cannot replace[7]. There are many factors affecting the efficiency of soil electrokinetic remediation, including soil type, pollutant property, voltage and current, composition and property of eluent, electrode material and structure, etc. The research shows that this technology can be applied to a variety of soil types from layered clay to fine sand. The soil properties basically do not affect the application of this technology, but to a certain extent affect its repair speed and efficiency [9]. Li Binxu et al.[10] showed that electrodynamic remediation technology can effectively remove tetracycline antibiotics and other antibiotic pollutants in soil, and is an effective means to control soil antibiotic and drug-resistant bacteria pollution. Zhang Mei et al.[11] found that when citric acid and EDTA were used to treat the Pb and Cd contaminated soil in brown soil and red soil, under a voltage gradient of 2 V/cm and a repair time of 4 days, the best electrolyte for brown soil was EDTA, with an average removal rate of 13.2% and 17.8% for Pb and Cd, the best electrolyte for red soil was citric acid, with an average removal rate of 20.0% and 33.8% for Pb and Cd; Prolonging the repair time to 10 days can significantly improve the removal rate of Pb and Cd in red soil. The average removal rate of Cd reaches 91.1% when the electrolyte is citric acid, and 63.2% when the electrolyte is EDTA. The soil electrochemical remediation technology based on current electrode capacitive deionization (S-FCDI) proposed by Xu et al. [12] can remove more than 80% of Cd from kaolin (200g) with relatively low power consumption of 22.7kWh/kg Cd and limited Al loss of 0.06wt% after 19 hours of continuous operation. S-FCDI can be used as a soil electrochemical remediation technology to remove heavy metals with less damage to soil.

3. Application of Saline Soil Remediation

In addition to remediation of heavy metal contaminated soil, electrodynamic remediation technology also has a good effect in removing salt ions and repairing saline soil. Bessaim et al.[13] showed that the increase of treatment time for electrochemical remediation of saline soil significantly promoted the removal of monovalent cations (including sodium (Na+) and potassium (K+)), with efficiency of 63% and 83% respectively. However, increasing the treatment time seems to hinder the removal of calcium (Ca2+) and magnesium (Mg2+). That is, near the cathode. Monovalent anions can be eliminated better by increasing treatment time. The removal rates of nitrate (NO3-) and chloride (Cl-) are 92% and 63% respectively. But the effect of removing sulfate (SO42-) is not obvious. The removal efficiency is related to the pH value of soil, chemical properties, chemical valence of salt ions and their selectivity to clay particles in the clay water electrolyte system.

4. Effect of Soil Texture on Electroremediation

The surface charges of soils with different textures are different due to their different mineral compositions, which makes a great difference in the removal efficiency of ions in soils. The content of montmorillonite in soil is related to energy consumption and heavy metal removal efficiency [14]. Therefore, it is necessary to study the electrokinetic soil remediation technology for different soil textures. The current research on soil electro remediation technology mainly focuses on the effect of heavy metal removal in soil under the condition of fixed electric field strength or soil texture [15], or the removal of toxic metals in sludge[16], petroleum[17], etc. It is of great practical significance to study the ion removal effect of coupling different texture soil with different electric field strength under multiple ion combination conditions. In conclusion, it has a good research prospect to explore the ion removal effect of different texture soil on heavy metal contaminated soil and saline soil under different electric field conditions.

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