

Mechanism of Different Passivating Agents on the Solidification of Heavy Metals in Soil

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Abstract

Through the mechanism study, it can be seen that the three kinds of passivating agents can increase the soil pH value and cation exchange capacity, which is beneficial to the transformation of heavy metals from ion exchange state to residue state. The addition of organic fertilizer can increase the activities of urease and acid phosphatase, and montmorillonite is beneficial to activate the activity of catalase in the soil. MO treatment can simultaneously increase the activities of the three enzymes and increase the absorption of soil carbon, nitrogen and organic phosphorus. Electron microscope scanning results showed that MO effectively increased the connectivity between soil particles and increased the specific surface area of soil. Therefore, the synergistic effect of MO treatment on the passivation of heavy metals is obvious, and the passivation effect is the best.

Keywords

Heavy Metals; Minerals; Soil Remediation.

1. Introduction

In the loess area of Shaanxi Province, there are heavy metals exceeding the standard in farmland remediation. The traditional single heavy metal remediation technology has a small application range and high cost, which is not conducive to plant growth. Therefore, it is clear that heavy metals in soil-plant under the action of organic fertilizer and minerals. It is of great significance to carry out heavy metal pollution control to verify the migration law and verify its remediation effect. This project analyzes the influence of minerals and organic fertilizers on the migration law of heavy metals in loess through the soil column dynamic monitoring test, and reveals the internal mechanism of the migration of heavy metal complex pollution in deep soil. Combined with pot experiments, carry out research on the migration of heavy metals in plants, reveal the effect of soil-plant circulatory system on the migration and accumulation of heavy metals under the addition of minerals and organic fertilizers, and monitor soil fertility, soil structure changes and crop growth. The repair mechanism of passivating agents. It provides a theoretical basis for subsequent heavy metal pollution remediation and high-standard farmland construction.

2. Effects of Different Passivating Agents on Soil PH

The form and content of heavy metals in soil are affected by soil pH. In this experiment, because the soil itself is alkaline soil in the north, the pH of the soil is between 8.13 and 8.48, and the pH of the polluted soil and the CK soil is not much different. After adding passivating agent, soil pH increased slightly. Compared with P treatment, soil pH increased by 0.14, 0.31, and 0.35 in O, M, and MO, respectively, and MO soil pH increased the most.

3. Effects of Different Passivator Treatments on Soil Enzyme Activity under Pot Experiment Conditions

Soil enzyme activity refers to the ability of soil enzymes to catalyze the transformation of substances. They participate in the occurrence and development of soil and various biochemical processes such as redox reactions, and are more sensitive to heavy metal pollution in soil. sensitive indicators. In Table 2, the activities of the three enzymes treated with P were the lowest, indicating that high concentrations of heavy metal pollution inhibited the activities of enzymes in the soil. After adding passivator, soil urease activity increased significantly compared with P treatment. O and MO treatments were beneficial to increase the activities of urease and acid phosphatase. Compared with P, the urease activities increased by 0.191 mg/g and 0.162 mg/g, respectively, and the acid phosphatase activities were increased by 28.0 mg/g and 31.2 mg/g compared with P treatment. The concentration values were higher than those of the CK treatment; while the urease activity and acid phosphatase activity of the M treatment increased by 0.094 mg/g and 23.5 mg/g compared with the P treatment, the concentration values were lower than those of the CK treatment, indicating that the organic fertilizer was beneficial to the activation of urease and acidity in the soil. Phosphatase activity increased soil carbon, nitrogen and organic phosphorus absorption, while montmorillonite had little effect on urease and acid phosphatase in soil. Catalase can characterize the microbial activity in soil. In Table 2, the concentration of catalase in O, M and MO treatments increased by 0.07 mg/g, 0.51 mg/g, and 0.27 mg/g compared with P treatment, respectively. M, MO treatments The concentration value of O treatment is higher than that of CK treatment, and the concentration value of O treatment is lower than that of CK treatment, indicating that montmorillonite is beneficial to activate catalase activity.

4. Effects of Different Passivators on Cation Exchange Capacity in Heavy Metal Contaminated Soils

Soil is an important place for the migration and transformation of pollutants in the environment. The determination of soil adsorption and ion exchange capacity can effectively understand the purification method of soil pollutants and the allowable degree of pollution load. Cation exchange capacity is the main source of soil buffering performance, and is an important basis for soil improvement and rational fertilization. Soil organic colloid and soil organic fertilizer are important factors affecting the cation exchange capacity in soil. It can be seen that the cation exchange amount of the contaminated soil P treatment was the lowest, which was 3.16 cmol/kg lower than that of CK. The addition of organic fertilizer and montmorillonite passivator significantly increased soil cation exchange capacity. O, M and MO treatments increased the cation exchange capacity by 28.9%, 60.7% and 85.9%, respectively, and were significantly higher than the control (CK). This is mainly because the addition of passivating agent has high adsorption capacity of small pores, which can tightly bind the effective nutrient elements around the lattice of passivating agent by the adsorption force of small pores and the electrostatic attraction of anions and cations. Among the three passivating agents added, montmorillonite + organic fertilizer has the best effect, mainly because montmorillonite is a

layered alkali metal and alkaline earth metal aluminosilicate mineral. A 2:1 layered silicate composed of silicon-oxygen tetrahedron $[\text{SiO}_4]$ and aluminum-water octahedron $[\text{AlO}_2(\text{OH})_4]$. This structure makes montmorillonite have good adsorption and cation exchange properties. In addition, the humus in the organic fertilizer contains oxygen functional groups and has a large adsorption surface, which significantly increases the cation exchange capacity in the soil and enhances the soil fertility.

5. Effects of Different Passivator Treatments on Soil Morphology

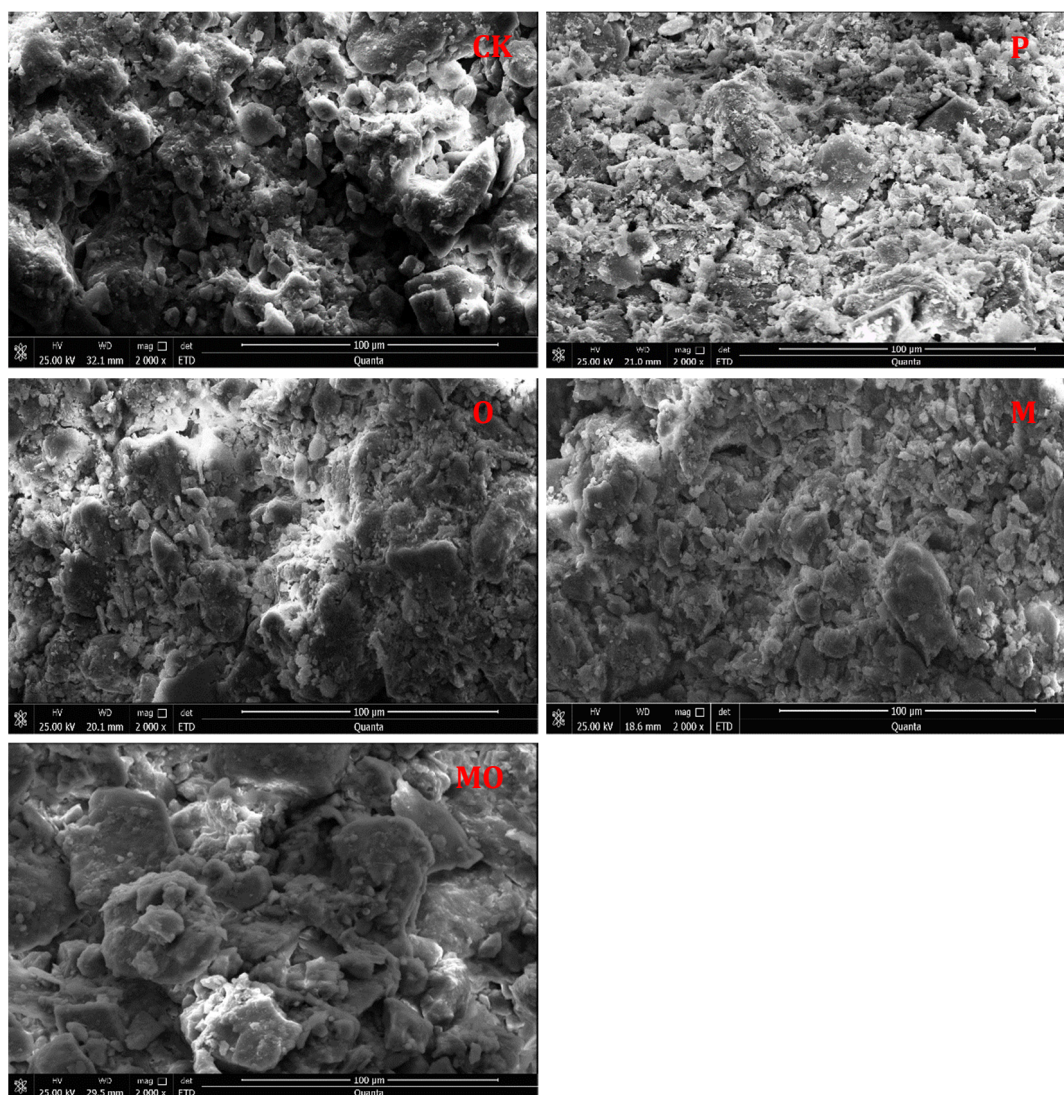


Figure 1. SEM images of soil before and after passivation treatment

In order to further study, the removal mechanism of Cu, Cd, Pb and Zn by passivation agents, the surface morphological characteristics and structures before and after treatment with composite passivators were observed by scanning electron microscope. The results are shown in Figure 1. The surface of normal soil (CK) is relatively flat, less protruding, and the particles are closely connected, with a larger specific surface area. Due to the pollution of heavy metals in the P treatment, after the intrusion of heavy metals, the microscopic morphology of the soil changed more obviously, the interaction between particles was changed, the connection balance between particles was broken, the soil flocculated, and flocculents with larger diameters appeared. In the O treatment, organic fertilizer was added to the heavy metal-contaminated soil, and the heavy metals were wrapped by the organic fertilizer to form

many spherical shapes attached to the soil surface. In the M treatment, a large number of flocculent aggregates formed after the invasion of heavy metals disappeared, forming many block-like structures and covering part of the flocs. These substances adsorbed on the surface of the passivator may be Cu, Cd, Pb and Zn fixed on the surface in the form of precipitates or other complexes. In the MO treatment, the fixation of heavy metals was significantly increased, indicating that the combined use of organic fertilizer and montmorillonite accelerated the passivation effect of the passivation agent in the soil, and effectively increased the connectivity between soil particles and increased the specific surface area of the soil.

6. Conclusion

Through the mechanism study, it can be seen that the three kinds of passivating agents can increase the soil pH value and cation exchange capacity, which is beneficial to the transformation of heavy metals from ion exchange state to residue state. The addition of organic fertilizer can increase the activities of urease and acid phosphatase, and montmorillonite is beneficial to activate the activity of catalase in the soil. MO treatment can simultaneously increase the activities of the three enzymes and increase the absorption of soil carbon, nitrogen and organic phosphorus. Electron microscope scanning results showed that MO effectively increased the connectivity between soil particles and increased the specific surface area of soil. Therefore, the synergistic effect of MO treatment on the passivation of heavy metals is obvious, and the passivation effect is the best.

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