Effect of EDTA Chemical Leaching on Remediation of Chromium-contaminated Soil

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Abstract. In this paper, chemical EDTA leaching was carried out to repair chromium-contaminated soil, and 0.005mol/L, 0.01mol/L, 0.05mol/L and 0.1mol/L EDTA solution were used to wash chromium-contaminated soil, respectively, and the removal efficiency of Cr (Ⅵ) in soil under different concentrations of EDTA solution was studied. The results showed that when the concentration of EDTA solution was 0.05mol/L, the highest removal efficiency of Cr (Ⅵ) in the soil was 98.65%, and after reaching the optimal leaching concentration, the leaching concentration continued to increase, and the leaching effect did not increase but decreased.

Keywords: EDTA；Chemical leaching; Chromium-contaminated soil.

1. Introduction

In nature, chromium (Cr) mainly exists in the form of Cr (III), while Cr (VI) usually exists in industrial wastewater and waste residue[1-3]. Heavy metal chromium (Cr) is characterized by strong corrosion resistance and high hardness, and is widely used in leather processing, electroplating surface technology application, textile dyeing treatment and other chemical industries[4-6]. 15% of the existing chemical commodity production in China is closely related to the use of chromium metal. Excessive and disorderly development of chromium minerals, illegal discharge of chromium-containing industrial wastewater, and abuse of agricultural fertilizers and pesticides have weakened the self-purification ability of soil, which can not cope with the increasingly serious soil chromium pollution[7, 8]. At the same time, Cr also has the characteristics of strong concealment, strong accumulation, long residual time, difficult degradation, etc., resulting in the prevention and control of chromium contaminated soil is difficult[9, 10]. Chromium in soil has the characteristics of strong permeability, long residual time, strong accumulation and strong toxicity, which brings potential harm to groundwater and its surrounding environment and human health. At present, the remediation technology of chrome-contaminated soil has become one of the important directions of heavy metal environmental pollution control research[11-13].

In this paper, the leaching effect of heavy metal chromium contaminated soil was studied by chemical leaching method in chemical remediation technology[14-16]. In this study, EDTA-2NA was used as leaching agent for chemical leaching of chromium-contaminated soil, and its leaching effect under different concentration conditions was investigated, and comparative analysis was conducted to determine the concentration of EDTA leaching agent with the best pollution removal effect and economic applicability.

2. Experimental design

2.1 Test soil sample

The soil particle size is mainly 0.25mm-0.5mm medium sand, accounting for more than 98%. Add 200ml deionized water to 100g contaminated soil sample, oscillate with an oscillator 180r/min for 8h, stand for 16h, take a certain amount of supernatant, filter with 0.22μm water filtration membrane, prepare color developing agent using diphenylcarbonic dihydrazine, acetone, concentrated sulfuric acid, phosphoric acid and other reagents according to national standards, and configure standard curve. The content of Cr (VI) in the filtrate was determined, and the content of Cr (VI) in the soil was calculated to be 159.57mg/kg.

2.2 Experimental equipment and drugs

Experimental equipment: visible spectrophotometer, peristaltic pump, rubber hose, funnel, beaker, measuring cylinder, acrylic plexiglass column, sampling bottle, pipette gun, colorimetric tube with stopper, waste liquid barrel.

Experimental drugs: contaminants (potassium bichromate), color developing agents (diphenylcarbamide dihydrazine, acetone solution, sulfuric acid solution, phosphoric acid solution).

2.3 Experimental method

Different concentrations of EDTA chemical leaching experiments were configured with concentrations of 0.005 mol/L, 0.01 mol/L, 0.05 mol/L and 0.1 mol/L EDTA as leaching agents, and the ambient temperature was controlled at 18℃, respectively, to wash contaminated soil. The equipment required for the experiment is shown in Figure 1.

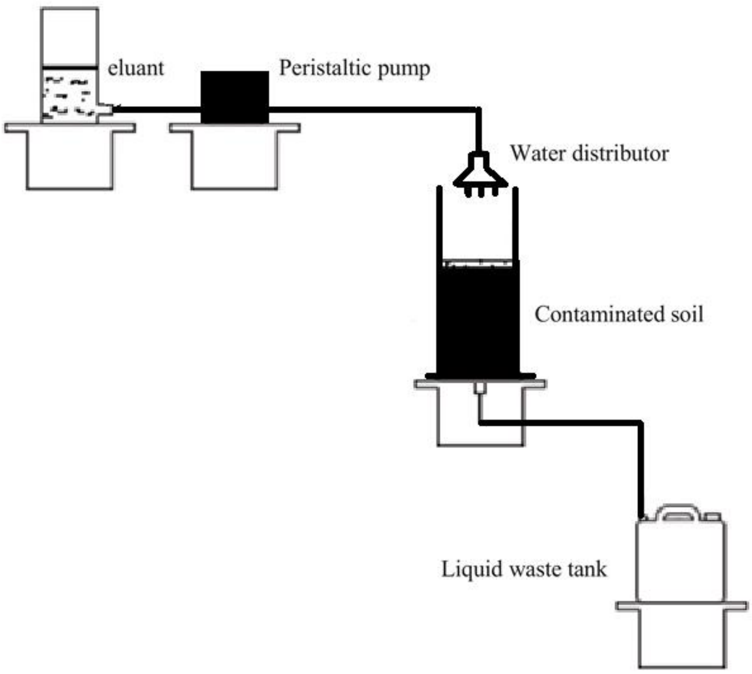

FIG. 1 Experimental equipment

3. Analysis of experimental results

3.1 Differences in chemical leaching time of EDTA with different concentrations

(1) 0.005mol/L EDTA leaching agent: (A) The leaching curve is the leaching curve of 0.005mol/L EDTA leaching agent. The removal effect of Cr (VI) in the soil tends to be gentle when the leaching is accumulated for 60min. Finally, the leaching curve drags when the leaching is completed for 290min. At this time, the concentration of Cr (VI) in the leaching solution is 0.364mg/L, which does not meet the limit value of chromium in the groundwater class III standard.

(2) 0.01mol/L EDTA eluent: (B) curve is the eluent curve of 0.01mol/L EDTA eluent. The removal effect of Cr (VI) in soil tends to be gentle when the eluent is accumulated for 40min. Finally, the leaching curve drags when the leaching is accumulated for 150min. At this time, the concentration of Cr (VI) in the leaching solution is 0.600mg/L, which does not meet the limit value of chromium in the groundwater class III standard.

(3) 0.05mol/L EDTA eluviation: (C) curve is the eluviation curve of 0.05mol/L EDTA eluviation, and the removal effect of Cr (VI) in the soil tends to be gentle when the cumulative eluviation is 20min. Finally, the leaching curve drags when the leaching is accumulated for 100min, and the concentration of Cr (VI) in the leaching solution is 0.042mg/L, which meets the limit of chromium in the groundwater class III standard.

(4) 0.1mol/L EDTA eluent: (D) curve is the eluent curve of 0.1mol/L EDTA eluent, and the removal effect of Cr (VI) in soil tends to be gentle when the cumulative eluent is 40min. Finally, the leaching curve drags after 60 minutes of leaching. At this time, the concentration of Cr (VI) in the leaching solution is 0.111mg/L, which does not meet the limit value of chromium in the groundwater class III standard.

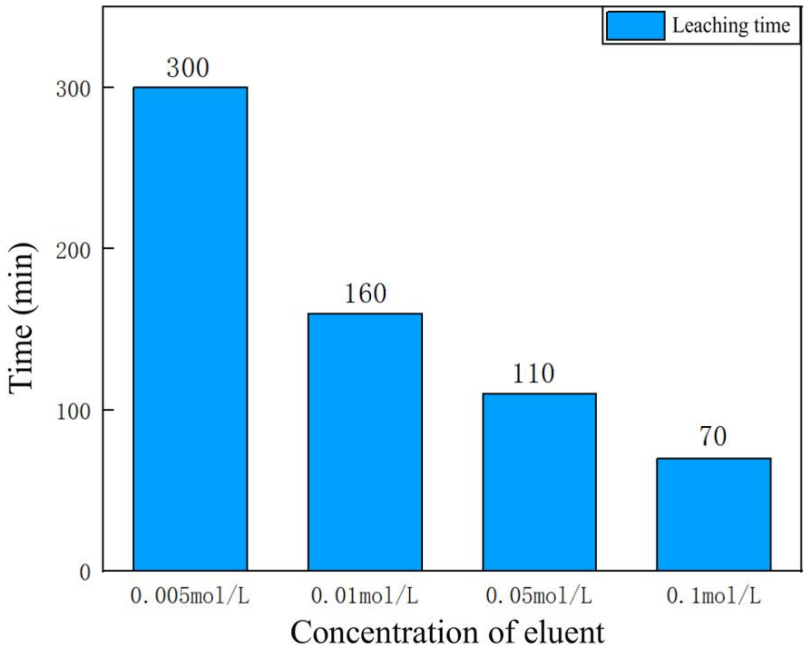

FIG. 2 The leaching time when the concentration of Cr (VI) in the eluent drops below the detection limit

3.2 Chemical leaching effect of EDTA at different concentrations

(1) 0.005mol/L EDTA eluent: The black curve is the eluent curve of 0.005mol/L EDTA eluent. At this concentration, the eluent effect is poor, and 116.909mg of Cr (VI) is still remaining in the soil at the end of eluent.

(2) 0.01mol/L EDTA eluent: The red curve is the eluent curve of 0.01mol/L EDTA eluent. The eluent effect at this concentration is enhanced compared with the previous concentration, but the optimal eluent effect concentration is not reached. The remaining 55.908mg Cr (VI) in the soil is not removed by eluent at the end of eluent.

(3) 0.05mol/L EDTA eluent: The blue curve is the leaching curve of 0.05mol/L EDTA leaching agent. When the concentration of leaching agent is further increased, the leaching effect continues to increase, reaching the optimal concentration expected for the experimental design of leaching effect. At the end of leaching, only 8.073mg of Cr (VI) remains in the soil and is not removed by leaching, with a removal rate as high as 98.65%.

(4) 0.1mol/L EDTA eluent: The green curve shows the leaching curve of 0.1mol/L EDTA leaching agent. After the leaching agent concentration reaches the optimal concentration, the leaching effect does not increase but decreases, but it is still slightly better than the leaching effect of 0.01mol/L concentration. The remaining 53.984mg Cr (VI) in the soil is not removed by leaching at the end of leaching.

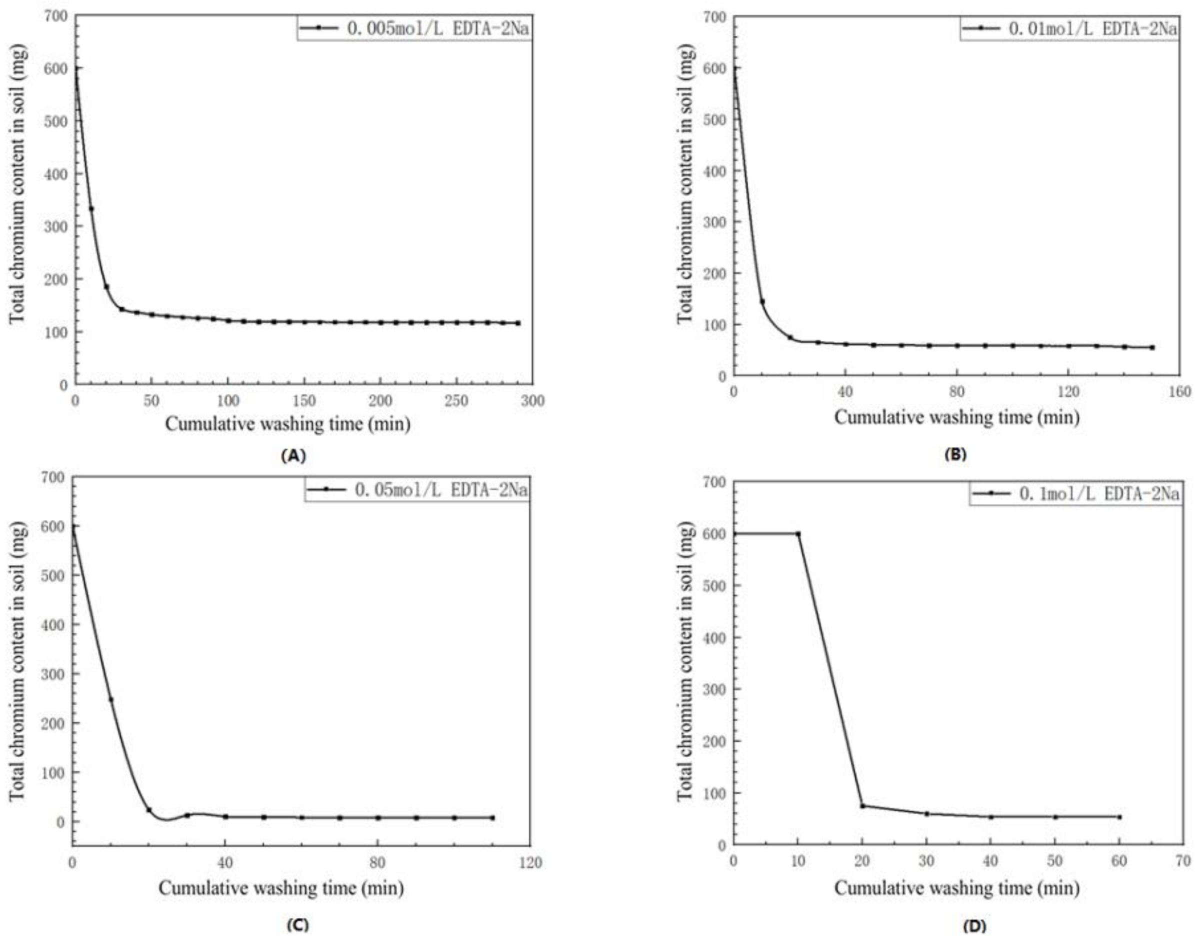

Figure 3. The content of the cr(in the soil in the same concentration of the edta was changed with the time of the wash

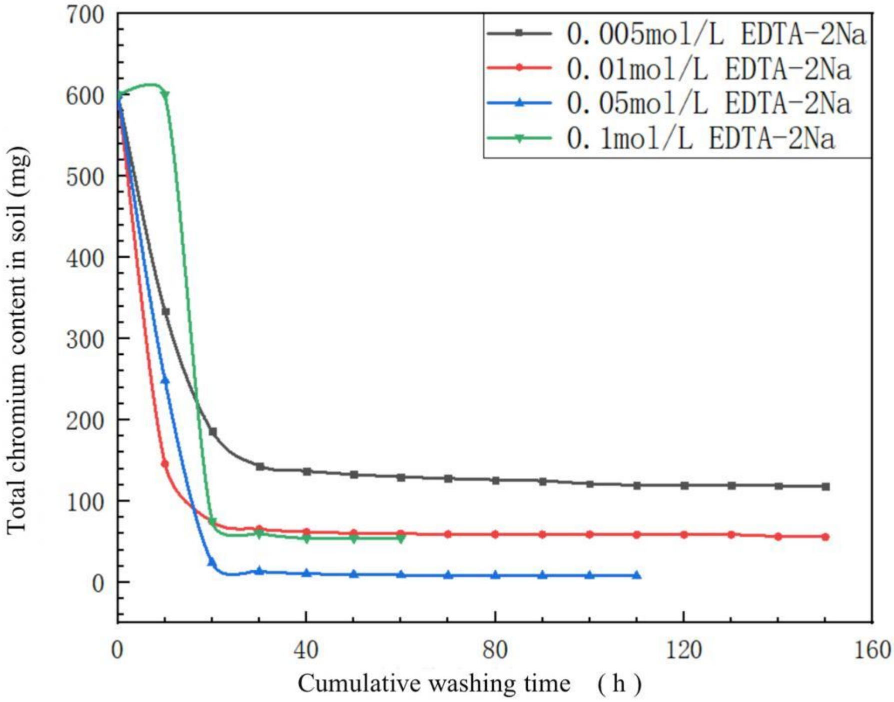

FIG. 4 Changes of Cr (VI) content in soil during leaching with different concentrations of EDTA eluent and leaching time (summary)

4. Summary

(1) Under the neutral conditions of four concentrations of EDTA eluent, 0.05mol/L is the best eluent concentration, with high eluent efficiency.

(2) When EDTA is selected as the eluent, the higher the concentration of the eluent, the better the eluent effect, and the best effect appears at the concentration of 0.05mol/L. After reaching the optimal concentration, the eluent concentration continues to increase, and the eluent effect does not increase but decreases.

(3) The advantages of EDTA leaching are: short leaching time and high leaching efficiency. Although the leaching effect of simulated acid rainfall is acceptable, it needs to maintain a stable acid rainfall for a long time to achieve the experimental effect, which is difficult to achieve the above conditions in real life. EDTA can wash a large amount of contaminated soil in a short time and achieve excellent removal effect.

(4) Chemical leaching of EDTA with different concentrations, four kinds of EDTA solutions with different concentrations are configured as leaching agents. Compared with the first two rounds of experiments, the optimal EDTA concentration is 0.05mol/L, and the removal rate is 98.65%. With the increase of EDTA concentration, the removal rate of Cr (VI) increases rapidly first, and then decreases slightly;

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