

ABSTRACT

Title A study on the removal and recovery system of chromium from the aqueous solution using persimmon gel and microorganism

Doctor Course in Mechanical and biochemical engineering Doctor of Engineering

Student No D13101 Name Tomonobu Hatano

[Abstract] (1,000words, 10points, single space)

Chromium (Cr) is a one of the rare metal and Cr(VI) is a useful resource as oxidizing agent, while it becomes toxic substance when it is released to the natural field. In this thesis, (1) the system of Cr(VI) removal using persimmon gel, removal of Cr(III) which produced during the Cr(VI) removal and desorbed from the Cr(VI) adsorbed on the persimmon gel, and recycle as Cr(III) using microorganism, (2) the system of iron (Fe) removal using microorganism-Cr(VI) removal using persimmon gel-Cr(III) removal using microorganism, and recovery of Fe and Cr(III) by desorption on each step are described. The following present the summary of each chapter of this thesis.

Chapter 1 is described the introduction and brief summary of this thesis.

Chapter 2 is described the adsorbent production, quantitative analysis of metal and the calculation of metal removed and desorbed. Production method of adsorbents, such as persimmon gel and microorganism, analysis methods of metal solutions and interpretation of data were described.

Chapter 3 is described the adsorption of Cr(VI) from the aqueous solution using persimmon gel and desorption as Cr(III) using diluted hydrochloric acid. The effect of the concentration of hydrochloric acid on the Cr desorption adsorbed on persimmon gel at reflux temperature is described. Cr desorbed (%) was increased with increasing the temperature and the most suitable desorbent was 1M hydrochloric acid. Chemical state of chromium after adsorption was determined. All Cr(VI) adsorbed on the persimmon gel was reduced to Cr(III) within 10 min. Because of the Cr(III) wasn't adsorbed at pH 2 on persimmon gel, Cr was adsorbed as the hexavalent and it was rapidly reduced to Cr(III) on the persimmon gel. Effect of Cr(VI) concentration on the Cr(VI) removal using persimmon tannin and that of chemical state of adsorbed Cr were examined. Cr(VI) removed ($\mu\text{mol/g}$ dry wt. of persimmon gel) was increased with increasing the concentration of Cr(VI), whereas Cr(VI) removed (%) was decreased. All of Cr(VI) was reduced to Cr(III) using low concentration of Cr (IV), however, the amount of adsorbed

as Cr(VI) was increased with increasing the concentration of Cr(VI). As all of the adsorbed Cr(VI) was desorbed to Cr(III) after desorption at reflux temperature, reduction was proceeded at desorption, and all of Cr(VI) adsorbed was reduced to Cr(III).

Chapter 4 is described the adsorption and desorption of Cr(III) from the aqueous solution using microorganism. At first, effect of pH on the removal of Cr(III), which could not be removed effectively by persimmon gel, using *Arthrobacter nicotianae*. Cr(III) removal was strongly depended on the pH of the solution. The amount of removed Cr(III) was increased with increasing the pH of the solution and that was maximal at pH 5. As a result of effect of Cr(III) concentration on Cr(III) removal, the amount of removed Cr(III) was calculated 637 μ mol/g dry wt. cells at 1h by Langmuir's adsorption isotherm. *A. nicotianae* can be removed Cr(III) 75 and 90 % within 5min and 2h, respectively. As Cr(III) removal was very rapidly and that was fitted with Langmuir's adsorption isotherm, that was proceeded mainly by adsorption, not by metabolism. The amount of desorbed Cr(III) from that adsorbed microorganism was the highest by hydrochloric acid as a desorbent at reflux temperature. As desorbed Cr(III) using 0.1M and 1M hydrochloric acid at reflux temperature were almost same, 0.1M hydrochloric acid is seemed that the best desorbent because of the environmental reason. The recycling of chromium adsorption at room temperature and desorption at reflux temperature using batch system was examined. The amount of Cr(III) adsorbed was decreased after desorption. Therefore, adsorption was changed by column system which can be effective adsorption. Recycling of Cr(III) adsorption and desorption was proceeded effectively and amount of removed Cr (III) was not decreased by controlling the amount of microorganism and Cr(III). The amount of desorbed Cr(III) was also quantitatively. Selective metal ion removal was also examined from the solution containing 7 kinds of metal ions using *A. nicotianae*. Removal selectivity between Cr(III) and Cu(II) was not observed, but these two metal ions can be removed selectively from the solution containing 7 kinds of metal ions. Removal of Cr(III) using immobilized cells are compared with that using resting cells. As a result, the amount of Cr(III) removed was calculated 417 μ mol/g dry wt. cells in 1h by Langmuir' adsorption isotherm.

Chapter 5 is described adsorption and desorption of metal ions from the Cr plating wastewater containing Cr and Fe using persimmon gel and microorganism. It was examined as the application of Cr removal from the solution containing Cr only. Effect of microorganism amount on Fe removal and that of Persimmon gel amount on Cr(VI) removal from the plating wastewater containing 273ppm of Cr and 24ppm of Fe, and that of microorgasim amount on Cr (III) removal from the solution after Fe and Cr(VI) removed were examined. As a result, almost of Fe and Cr can be removed using two desorbents, such as microorganism and persimmon gel. Fe was removed under effluent

standard at pH 3.0 using microorganism, Cr(VI) was removed perfectly at pH 2.0 using persimmon gel, and Cr(III) was removed near effluent standard at pH 4.3 using microorganism in this removal order. Both Cr and Fe can be desorbed over 85 % of adsorbed amount from the microorganisms removed Fe and Cr(III) and persimmon gel removed Cr(VI) from the Cr plating wastewater containing Cr and Fe.

The chapter 6 is the conclusion of this thesis. The conclusion of the whole of this thesis is described.

Professor (Chairperson)

Takehiko Tsuruta