CHAPTER 4

Conclusion

The characteristics of leonardite and the adsorption behavior for removal of Cd(II) and Zn(II) from aqueous solutions were studied. The results of characterization revealed that leonardite composed of minerals and organic matters which bear the variety of functional groups. These functional groups play an important role on the adsorption process. The determination of chemical compositions indicated that leonardite mainly comprised SiO_2, Al_2O_3 and Fe_2O_3 whereas the organic matter was less than 36.8%. For adsorption studies, pH value, contact time, initial metal concentration, and temperature were found to have the effects on the adsorption efficiency. Adsorbed amount of Cd(II) and Zn(II) was small at low pH. Both metal ions were best adsorbed at pH 6. The adsorption of metal ions on leonardite was fast and reached equilibrium within 60 min. Pseudo second order can be used to describe the kinetic adsorption of Cd(II) and Zn(II). From the intra-particle diffusion kinetic model, adsorption mechanisms of both metal ions may be controlled by film diffusion and intra-particle diffusion. The temperature has low effect on the adsorption of Cd(II) and Zn(II) on leonardite. The thermodynamic adsorption studies suggested that adsorption of both Cd(II) and Zn(II) on leonardite was spontaneous and endothermic process.

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In the single adsorption systems, adsorption of Cd(II) and Zn(II) was analyzed by the Langmuir and the Freundlich isotherms. The results obtained from the linear and the non-linear regression methods with five error functions were compared. Adsorption of Cd(II) and Zn(II) in the single system was found to be more favored to Freundlich isotherm rather than the Langmuir isotherm. According to the assumption of the Freundlich isotherm, adsorption of the both metals occurred on the heterogeneous surface of leonardite. The adsorption of Cd(II) was more favorable than the adsorption of Zn(II). The maximum adsorbed amount of Cd(II) and Zn(II) from the Langmuir isotherm using MPSD method were 34.03 and 19.78 mg/g, respectively. In binary adsorption systems, the adsorbed amounts of Cd(II) and Zn(II) decreased when compared to the adsorbed amount in the single system. The interaction of Cd(II) and Zn(II) is classified as antagonism. Four multi-component adsorption isotherms including Extended Langmuir, Modified Langmuir, Sheindorf-Rebuhn-Sheintuch (SRS), and Extended Freundlich isotherms were used for predicting the adsorption data. The suitability of the isotherm models was evaluated by the five error analysis. The Extended Freundlich isotherm satisfactorily approximated the equilibrium adsorption in the binary system. The MPSD error functions can give the isotherm parameters for single and binary systems with minimum SNE values.

The results of this research will be helpful in understanding of the adsorption behavior of leonardite and evaluation of leonardite as an alternative adsorbent for the treatment of metal-contaminated water. The advantages of using leonardite as adsorbent are that leonardite is low-cost material and has the good potential for removal of Cd(II) and Zn(II) ions from aqueous solutions. The adsorption process is also effective for the treatment of contaminated water that contained low or medium metal concentrations which are difficult to treat by other processes. The controlling of the temperature of adsorption process is not required since the adsorption capacity is less affected by the temperature. Moreover, the metal-contaminated leonardite can be applied by mixing it with cement.

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