SORBENT STUDIES IN THE REMOVAL OF SELECTED METAL IONS BY HUMIC SUBSTANCES AND HUMIC ACID

Ph.D. DISSERTATION

WIN MA MA, B.Sc. (Hons.); M.Sc.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF YANGON
MYANMAR

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ABSTRACT

Humic acid-based system extracted from an available peat based system has been improvised to use as a novel sorbent material for the removal of metal (II) ions prevalent in an industrial waste water body. In this study, firstly, humic substances from different natural resources (peat, soil, subbituminous, lignite, shale) were extracted with sodium hydroxide and found to show that each sample contained different percentages of humic acid. Peat was found to contain the highest percentage of humic acid i.e., about 70%. Elemental analyses of humic acid, fulvic acid, humin and peat itself show the presence of different percentages of C, H, N, O and S. The peat and extracted humic acid were evaluated for the inherent acidic groups. The pH dependency was shown by peat and extracted humic acid. It also indicates that the cation exchange capacity for peat and humic acid were 6.3 m eq/g and 5.9 m eq/g, respectively.

Characterization of extracted humic acid, fulvic acid and humin indicates the presence of carboxyl and OH groups which can be attributed to phenolic OH, aliphatic OH, aromatic and aliphatic carboxyl and quinone. The presence of C=O, COOH, OH was supported by UV spectra corresponding to 206 and 208 nm. Thermal analysis data for humic acid derived from coal and peat soil were able to reveal different dehydration temperatures, where the amount of absorbed water was accounted to be about 6-8 %. It also indicated that the 42% of volatile material was lost. So that the estimated char was about 58%. Thermal analysis also indicated the nature of thermal stability of humic acids, which also show the same trend in the on set and end temperatures.

The sorption studies of Cu (II), Pb (II), Cd (II), Zn (II) and UO_2^{++} ions with peat and extracted humic acid revealed that each metal ion indicates to possess different binding capacities relevant to pH, initial concentration, contact time,

dosage capacity and relative rate coefficients. Relevant to dosage capacities and relative rate coefficients, it can be concluded that at the working pH (pH 4), the order of binding capacity of the metal (II) ions with peat was Pb > Cu > Zn > Cd, and with humic acid the order was Pb > Zn > Cu > Cd.

On the context of pH variation, initial concentration, dosage capacity and kinetic studies, it is evident that the sorption involved not only adsorption but also, ion exchange and complexation. The chelation of metal (II) ions with humic acid (metal-humates) can also be known from the XRD diffractograms. The presence of metal ions is supported by ED-XRF qualitative analysis.

This study also provides that extracted humic acid is a suitable sorbent material for the uptake of heavy metal ions as well as anions from an industrial waste water sample. The percent removal capacity as determined for a pH 2-3 waste water bodies range from 17-99 % depending on metal ions and anions.

It indicates that extracted humic acids could be used as an effective and efficient sorbent material in waste water bodies containing heavy metal (II) ions, possibly in primary and secondary water treatment systems.