KINETIC, RECYCLE AND FIXED-BED COLUMN APPROACH OF HUMIC ACID ADSORPTION BY MONTMORILLONOTE CLAYS

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Abstract

Humic acid is a natural organic matter (NOM) mostly found in water. It gives its characteristic yellowish to brownish color to water making it unaesthetic and has been proposed as factor in the cause of Blackfoot disease (BFD). Many researchers have studied humic acid removal by Montmorillonite clays. The suspended matters in the form of clays provide both an adsorbent for NOM and a nucleating species for precipitating the NOM complex. However, the scope of those works has been restricted to batch adsorption which may be a mean of selecting the best adsorbent for a given application but not necessary how it would be used in practice. This paper, therefore, deals with the kinetics, recycle and fixed-bed column approach of humic acid uptake by Montmorillonite clay and its derivatives namely organo-clays. The organo-clays were prepared by incorporating the cationic surfactant in the form of Quaternary Ammonium Cation (QACs) into the natural Montmorillonite structure. The QACs used in preparation of organo-clays were tetramethylammonium chloride ($C_4H_{12}ClN$), hexadecyltrimethylammonium bromide ($C_{19}H_{42}BrN$), tetradecyltrimethylammonium bromide ($C_{17}H_{38}BrN$) and benzyldimethylhexadecylammonuim chloride ($C_{25}H_{46}ClN$). These QACs are different in their alkyl chain length and size. The precursor and organo-clays were physically characterized in terms of surface area, particle size, carbon content, pore diameter and interlayer spacing. Results indicate that the experimental data fit the non-linear Langmuir Adsorption Isotherm. Some relationships between the physical properties and the humic acid adsorption ability of those clays were observed. Generally, the amount of humic acid adsorbed onto Montmorillonite increased with increasing of QACs size and concentration on clays even the starting Montmorillonite has the higher BET surface area than that of the organo-clay. This means the removing of humic acid by clays cannot be interpreted on the basis of surface area alone. The rates of adsorption were found to conform to pseudo-second order kinetics with good correlation.

Laboratory column experiments were conducted to evaluate the clay performance for humic acid sorption under dynamic flow through conditions. The best adsorbent clay for the

column adsorption of humic acid was selected from the batch results. Mixed sand-clays bed was used for the column experiments due to the fine particle size of clays. The permeability of the mixed sand-clay bed was also studied. The results showed that the permeability the mixed bed was decreased considerably in the presence of even small amount of clays. These column studies were applied to quantify the influence of bed-depth, initial humic acid concentration and sorbent clay quantity on the breakthrough volume of humic acid adsorption. The results show that the breakthrough volume increases with increasing bed depth but decreases inversely with increasing humic acid concentration. The value of breakthrough capacity is about 70% of the batch adsorption capacity.

The spent Montmorillonite can be regenerated easily by heating at 600 ^{o}C to remove humic acid out of the clay structure. The re-used Montmorillonite displayed effective adsorption ability. Hence, Montmorillonite is easily recoverable and reusable such that it is a promising adsorbent for water purification.

Keywords : Montmorillonite, humic acid, fixed-bed column, adsorption, organo-clays

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