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The flocculation characteristics of humic acid in the presence of kaolin particles by cationic polymers

Sang-Kyu Kam, Byung-Churl Ko*, Min-Gyu Lee[1]
Dept. of Environ. Eng., Cheju National Univ.
[1] Dept. of Chem. Eng., Pukyong National Univ.

1. Introduction

Large proportions of raw water sources are often colored to the extent that they are unacceptable for domestic and even some industrial uses.

The yellowish-brown color of natural surface water comes from humic substances leached from plant and soil organic matter(Vik and Eikebrokk, 1989). Humic substances possess ion-exchange and complex properties that are associated with most constituents of water, including toxic elements and organic micropollutants. They act as a vehicle for transport of toxic, water-insoluble elements and organic micropollutants, thus influencing processes such as dissolution, coagulation and crystal growth(Buffle, 1990; Fairhurst and Warwick, 1998; Vik and Eikebrokk, 1989).

It is commonly observed that natural clay colloids exhibit much higher colloidal stability compared to their pure clay counterparts (Fairhurst and Warwick, 1998). This enhanced stability has been attributed mainly to the presence of adsorbed humic substances on surfaces of natural clays. It has been speculated that a combination of electrostatic and steric stabilization is responsible for the increased colloidal stability of humic-clay complexes(Kretzschmar et al., 1998).

Up to the present, a large number of studies has been conducted on the colloidal behavior of pure clays, clay mixtures and humic substances individually. In fact, however, the binding of ions occured by humic substances influence the soil and water pH and the physicochemical properties of the humic substances themselves (Tipping, 1993).

In this study, the flocculation characteristics of commercial humic acid solution with and without the presence of clays using cationic polymers was monitored continuously by the Photometric Dispersion Analyzer(PDA) and then investigated the effect of the polymer types and the kaolin content on the flocculation of humic acid solution.

2. Experimental materials and methods

5mℓ of humic acid(1g/ℓ) and 2mℓ of 0.1N-Na_2CO_3 were added to the 300mℓ beaker containing about 193mℓ deionized water or kaolin solution and the pH of the solution was regulated by 0.1N and 0.01N-HNO_3. The 300mℓ beaker was placed into a water bath to uniform solution temperature and subsequently tested on. Each of the cationic polymer was added by pippetting a predetermined volume of polymer solution into the suspension and the solution was stirred for a period of 1min at a speed of 150 rpm followed by 60rpm for 15min. MP-3N pump was used because of a continuous re-circulation of the sample. It was placed after the sample had passed through the PDA so as not to disrupt the flocs and their detection. The sampling tube to the PDA monitor was 2.65mm internal diameter and the flow rate was set at 15mℓ/min.

After pouring a portion of the solution from the beaker into the 50mℓ centrifuge tube with 27mm internal diameter and settling the solution for 2 hours, the supernatant liquid was taken and used for UV absorbance(UV254) and turbidity(NTU).

3. Experimental results and discussion

To investigate the influence of the presence of kaolin particles, suspensions containing 25mg/ℓ humic acid and 15 and 35NTU kaolin were prepared.

Using PDA and UV absorbance, the flocculation ranges of cationic polymers of different charge density and molecular mass and the effect of the kaolin content on the flocculation of humic acid solution were investigated. By the index of PDA, it was found that the lag time for the flocculation of humic acid with and without the presence of kaolin particles is shorter for polymers of high charge density(P-C and P-D) than for polymers of low and middle charge density(P-A and P-B).

Fig. 1 shows the total absorbance ratio of humic acid with and without the presence of kaolin particles. As shown in these figures, there is a inverse correlation between the flocculation range and charge density of the polymers, with highly charged polymer giving the shortest flocculation range, indicating the importance of charge neutralization. With the polymers of higher charge density, the lower dosages were required to flocculate the humic acid and higher removal efficiencies were obtained.

The presence of kaolin particles enhanced the flocculation of humic acid by each of the polymers. It is probably thought that the particles provide nucleation sites for floc formation leading to short settling time.

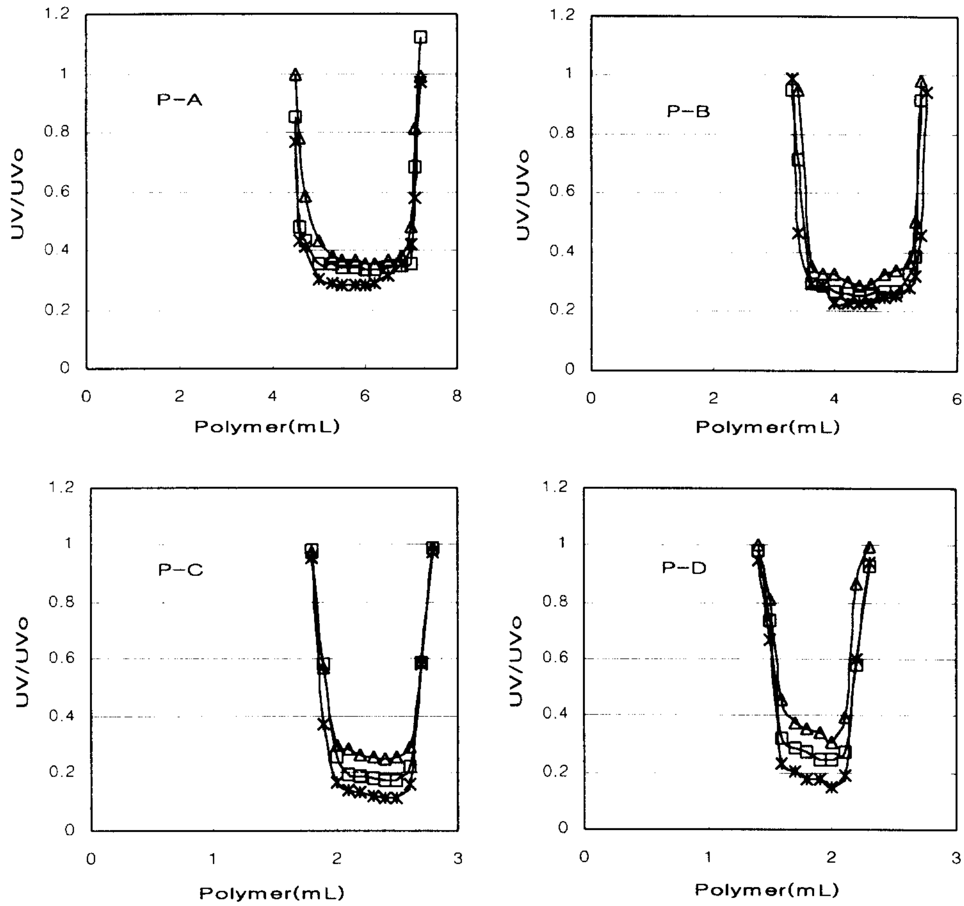

Fig. 1. The total absorbance ratio of humic acid with the dosage of each of the polymers(HA[△], HA+15NTU[□] and HA+35NTU [✱]).

4. References

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