Comparison of Flocculation-Spectrophotometry and Streaming Current Detector Method to the Control of Flocculants for the Removal of Humic Acid

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1. Introduction

The charge density for polymeric flocculants, especially in water and wastewater treatment, is often great importance. The optimum dosage of the flocculant is close to that required to neutralize the surface charge carried by the materials. At higher dosages, excess flocculant is adsorbed and the solution becomes restabilized by virtue of acquired charge. Many dissolved organic material(DOM) in natural waters, such as humic substances, is anionic in character and can be effectively removed by cationic additives, such as hydrolyzing metal salts and cationic polymers. In these cases there is a stoichiometric relationship between the anionic charge carried by the DOM and cationic charge of the additive[1-3].

In this study, the optimum dosages of the cationic polymers with different charge density and molecular mass were determined and compared for removing humic acid using flocculation-spectrophotometry and streaming current detector(SCD) method.

2. Experimental

Reagents used in this study were Humic acid(Aldrich Chem. Co.) and Cationic polymers(Allied Colloid Ltd.) which were the copolymers of acryl-amide and dimethylaminoethyl acrylate(DMAEA). The stock solution(5g/L) was prepared by dissolving 2.5g of humic acid in a 500mL of 0.1N sodium hydroxide. The sodium carbonate was used to fix the initial pH of the humic solution.

The properties of the polymers, designated A-F, are given in Table 1. A Camspec UV/Vis spectrophotometer was used for all absorbance measurements. A Charge Analyzer II was used as a streaming current detector for streaming current measurements.

Table 1. Properties of polymers used

Polymer	Charge Density	Approximate Molecular Mass/10^6
A	Low	11-16
B	Medium	11-16
C	High	11-16
D	Low	4-6
E	Medium	4-6
F	High	4-6

3. Results and Discussion

3.1 Flocculation and spectrophotometry

Fig. 1 shows the changes in the absorbance of humic acid with the dosage of each of the polymers. As shown in figure, the absorbance changes very sharply at the optimum dosage which the lowest absorbance of humic acid is shown for polymers of high charge density, while the absorbance changes rather broadly for polymers of low and middle charge density. The results indicate that, in each case, the optimum dosage corresponds with the same amount of cationic charge, pointing out the importance of charge neutralization. The optimum dosages of polymers in Fig. 1 and the removal efficiency at optimum dosage are summarized in Table 2. As shown in Table 2, the lower dosages of cationic polymers were required to neutralize the charge of humic acid and higher removal efficiency were obtained when the polymers of high charge density were used.

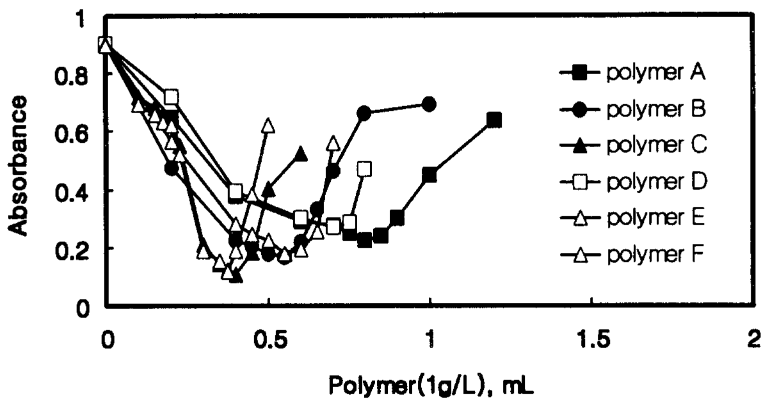

Fig. 1. The charges in the absorbance of humic acid with the dosages of the polymers by centrifugation($C_{Humic\ acid}$ = 50mg/L).

Table 2. The optimum dosage of each of the polymers and removal efficiency at the optimum dosage byflocculation-spectrophotometry.

Polymer(0.1%)	Optimum dosage*(mL)	Removal efficiency(%)
A	0.800	73
B	0.550	80
C	0.400	87
D	0.700	68
E	0.550	79
F	0.375	87

*obtained for 10mL of humic acid(50mg/L, pH 7)

3.2 SCD method

In order to determine the optimum dosage of each of the polymers required to neutralize the charge of humic acid by SCD method, the solution containing 10mL of humic acid(50mg/L, pH 7) was titrated against each of the polymers.

Table 3. The optimum dosage of each of the polymers to neutralize charge of humic acid by SCD method.

Polymer(0.01%)	Optimum dosage*(mL)
A	7.721
B	5.872
C	4.010
D	7.083
E	5.284
F	3.583

*obtained for 10mL of humic acid (50mg/L, pH 7)

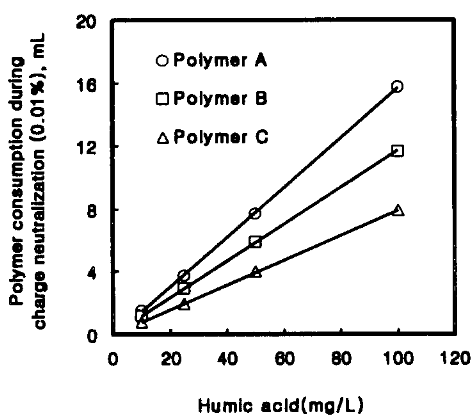

Fig. 2. Stoichiometric consumption of polymer A, B, and C during charge neutralization of different concentration of humic acid by SCD method.

Table 3 shows the polymer consumption during charge neutralization of humic acid. It can be known from Table 2 and 3 that the optimum dosage of each of the polymers are almost identical by both methods. These results illustrate that the optimum dosage of each of the polymers is that required to neutralize the charge of humic acid.

Stoichiometric relationship between the optimum dosage of each of the polymers and different concentration humic acid was investigated by SCD method. Fig. 2 shows the polymer consumption during charge neutralization of different concentration of humic acid. As shown in figure, the neutralization of negatively charged humic acid with each of the polymers appears to proceed stoichiometrically. Also it was found that the optimum dosages of the polymers by SCD method were almost identical to those by flocculation-spectrophotometry for different concentration of humic acid.

4. Conclusions

As the method to determine the optimum dosages of synthetic cationic polymers of different charge density and molecular mass for removing humic acid, flocculation-spectrophotometry and SCD method were investigated. The optimum dosage for each of the polymers obtained by both methods was in good agreement with each other. Also it was found that there is a strong inverse correlation between the optimum dosage and charge density of the polymers, with highly charged polymer giving the lowest optimum dosage. The optimum dosage corresponded with the same amount of cationic charge, pointing out the importance of charge neutralization. A stoichiometric correlation exist between the optimum dosage of each of the cationic polymers and the negatively charged humic acid.

References

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