Flocculation of Suspensions by Polyelectrolyte Mixtures

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Polymers are widely used as flocculants for suspensions in many industrial applications, such as mineral processing, papermaking, water treatment and biotechnology. In recent years there has been considerable interest in the use of multi-component flocculants, especially dual-polymer systems. In the latter case, there can be significant advantages over the use of single polymers.

In order to elucidate the mechanisms of flocculation by polymer mixtures, we have studied the effect of adsorption of cationic and anionic polyelectrolytes (PE) as well as their binary mixtures on the electrokinetic potential, kinetics of aggregation, size and strength of flocs formed from polystyrene, kaolin and bentonite particles as a function of the polymer dose, charge density (CD) of the polyelectrolyte, mixture composition, sequence of the components addition and intensity of stirring the system.

It is shown that maximal aggregation of suspension particles occurs at polymer content of about 0.5-1.5 mg/g that is approximately an order of magnitude less than the concentration corresponding to the plateau value of adsorption for cationic polymers and two-three times less than the maximal adsorption of anionic polymers.

A synergism in the flocculation capacity in mixtures of moderate and weakly charged polyelectrolytes was observed. A mixture of a high charged anionic polyelectrolyte (CD 35 mole%) and a lower charge cationic flocculant (CD 6 mole%) gave optimum flocculation at a 1:1 mass ratio, corresponding to about 6-fold excess of negative over positive charges in the adsorbed layer. Deviation from this optimum composition (1:3 and 3:1 mixtures) gave slower flocculation and significantly smaller floc sizes. An initial intensive short stirring the suspension accelerates the aggregation process and increases the flocs size independently of the sequence of polymers addition. In mixtures of cationic and anionic polyelectrolytes, whatever the sequence of addition, the particles acquire \(\zeta\)-potential that is typical for particles bearing only anionic polyelectrolyte. It may be that the optimum negative/positive ratio gives an optimum conformation of mixed adsorbed layers, as a result of combined effects of charge neutralization (by cationic segments) and bridging between particles (by extended segments of the anionic polymer).

This work was carried out as part of the TÁMOP-4.2.1.B-10/2/KONV-2010-0001 project in the framework of the New Hungarian Development Plan. The realization of this project is supported by the European Union, co-financed by the European Social Fund.