CATIONIC POLYELECTROLYTES – ANIONIC SURFACTANT COMPLEXES USED IN THE COAGULATION FLOCCULATION PROCESSES

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S-a studiat experimental îndepărtarea particulelor fine de formazină din apă prin precipitare/coagulare cu complex de polielectrolit şi surfactant şi anume complex poliacrilamidă (produs industrial denumit Praestol 644, obţinut de Degussa) şi laurilsulfat de sodiu (SLS). S-a adăugat oxid de calciu pentru a iniţia precipitarea complexului de polielectrolit împreună cu particulele fine. S-au efectuat experimente cu complecşi având concentraţia de surfactanţi peste concentraţia de agregare critică (cac), cantitatea adăugată corespunzând potenţialului electrocinetic ξ nul pentru amestecul complex de formazină în suspensie. Utilizând metoda microscopiei video şi analizei imaginilor, s-a studiat cinetica procesului de floculare. Rezultatele au indicat durata optimă necesară formării flocoanelor. Au fost determinate viteza de sedimentare a flocoanelor, conţinutul de apă al precipitatului şi volumul de precipitat obţinut, turbiditatea iniţială şi finală a probelor de apă. Turbiditatea finală a apei a fost criteriul principal în determinarea condiţiilor optime de operare. Rezultatele testelor au arătat că, spre deosebire de metoda clasică de coagulare – floculare, în acest caz turbiditatea finală a apei şi durata procesului sunt mult mai mici, sedimentarea flocoanelor are loc mai rapid, dar conţinutul de apă şi volumul nămolului obţinut sunt mult mai ridicate. Utilizând aceste rezultate, au fost determinate condiţiile favorabile de operare.

The removal of formasine fines particles from water by precipitation/coagulation with polyelectrolyte and surfactant complex of Polyacrylamide (industrial product Praestol 644 made by Degussa) and Sodium Lauryl Sulphate (SLS) was experimentally studied. Calcium oxide was added to initiate precipitation of the polyelectrolyte complex together with the fines particles. The experiments have been done with complexes having the surfactants concentration higher then the critical aggregation concentration - cac, the quantity added corresponding to the electrokinetic potential ξ equal to zero for the formasine suspension complex mixture. Using video microscopy and image analysis method the kinetic of the flocculation process has been studied. The results suggested the optimum duration for the flocks to form. The sedimentation velocity of the flocks, the precipitate humidity and volume, as well as the initial and final turbidity of the water samples have been measured. The final turbidity of water was the principal criteria for establishing the optimum operation conditions. Test results showed that unlike the classical method of coagulation – flocculation, in this case the final

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turbidity of water and the duration of the process are much smaller, the sedimentation of the flocks occurs much faster, but the humidity and volume of the sludge obtained are higher. Using these results the favourable conditions of operation have been determined.

Keywords: coagulation – flocculation, flocculation kinetic, polyelectrolyte – surfactant complex

1. Introduction

One of the important problems in contemporary physical and chemical colloid chemistry is searching of simple and effective ways to wide-range controlling the sedimentation stability of real disperse systems. The most promising line in deciding this problem is introducing into the system small portions of various water soluble synthetic polymers able to affect the sedimentation stability of dispersions. Among the broad spectrum of synthetic water soluble polymers, polyacrylamide flocculants (polyelectrolytes) confer high flocculating availabilities, and environmental properties, and moderate price [1]. Polyelectrolyte-surfactant complex forms are more often used in solid-liquid interface processes. This paper studies the use of these complexes in the coagulation/flocculation process.

2. Experimental

The removal of formasine fine particles from tap water colloidal suspension with polyelectrolyte and surfactant complex of polyacrylamide (industrial product Praestol 644 made by Degussa) and Sodium Lauryl Sulphate (SLS) has been experimentally studied. Calcium oxide was added to initiate precipitation of the polyelectrolyte complex together with the fine particles. The experiments have been done with complexes having the surfactants concentration higher then the critical aggregation concentration - *cac*, and the quantity added corresponding to the potential ξ equal with zero. Using optical microscopy and image analysis method the kinetic of the flocculation process has been studied in order to show the optimum duration for the flock's formation. The sedimentation velocity of the flocks, the precipitate humidity and solid phase volume obtained and the initial and final turbidity of water samples have been measured. The final turbidity of water was the main criterion for establishing the optimum operation conditions.

The results of the coagulation/flocculation experiment, in which Praestol 644 and SLS surfactant were used, are compared with the process in which only Praestol 644 polyelectrolyte was used. This comparison is needed to reveal the

advantages which result when using the complexes solutions in coagulation/flocculation process.

3. Results and discussion

In this research, the polyelectrolyte – surfactant complex doses were considered in order to achieve a ζ potential of approximately zero. The results are presented in figure 1.

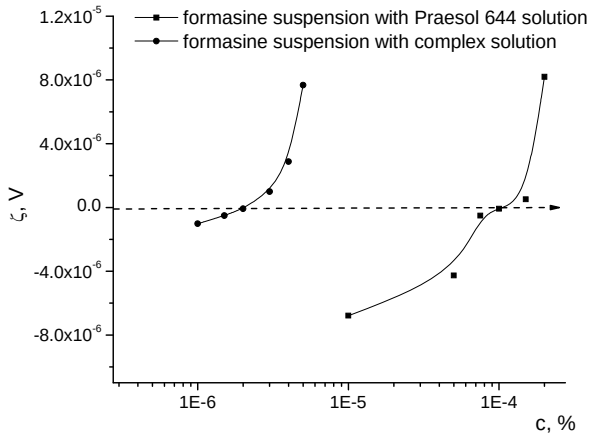

Fig. 1. Dependence of ζ potential of the formasine suspension on the added quantity of Praestol 644 solution / complex solution

The evolution of flocks formation during the experiment is presented in photos 1 – 6 (figure 2). The flock is generated by an electrostatic interaction of the positively charged complex with the negatively charged surface of formasine particles. The complex tends to be adsorbed on the particle surface in a flat conformation due to this attraction and hence, small patches of positive charge may reside on the particles. Flocculation can then occur due to an electrostatic patch type model whereby the positive and negative patches of the particles come into contact, resulting in strong attachment.

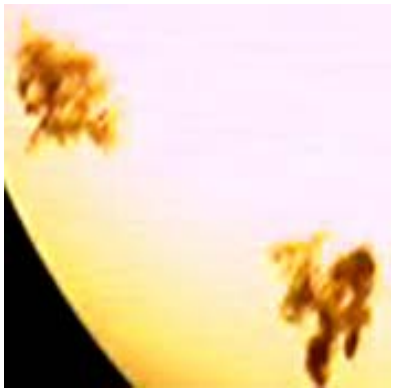

Photo 1. t = 1minutes.

Photo 2. t = 2 minutes.

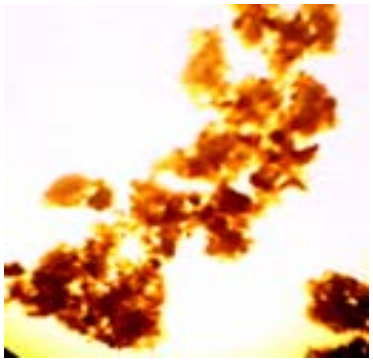

Photo 3. t = 3 minutes.

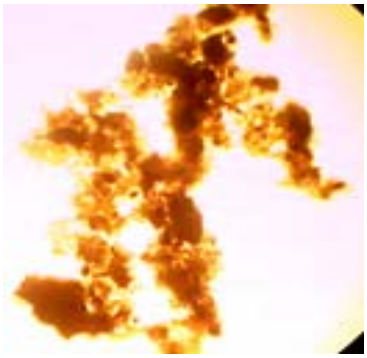

Photo 4. t = 4 minutes.

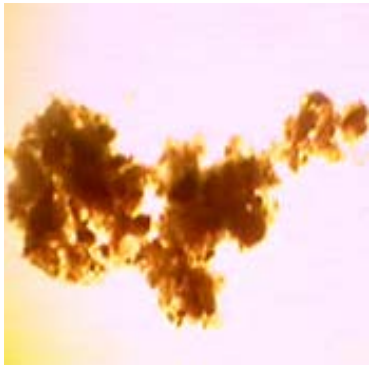

Photo 5. t = 5 minutes.

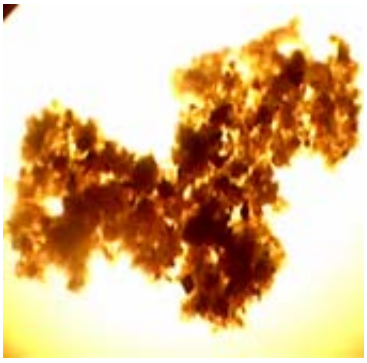

Photo 6. t = 6 minutes.

Fig. 2. Flocks kinetic formation from formasine suspension with complex solution

Usually there is a dynamic equilibrium between flock formation and flock breakage and figure 3 reveals this equilibrium.

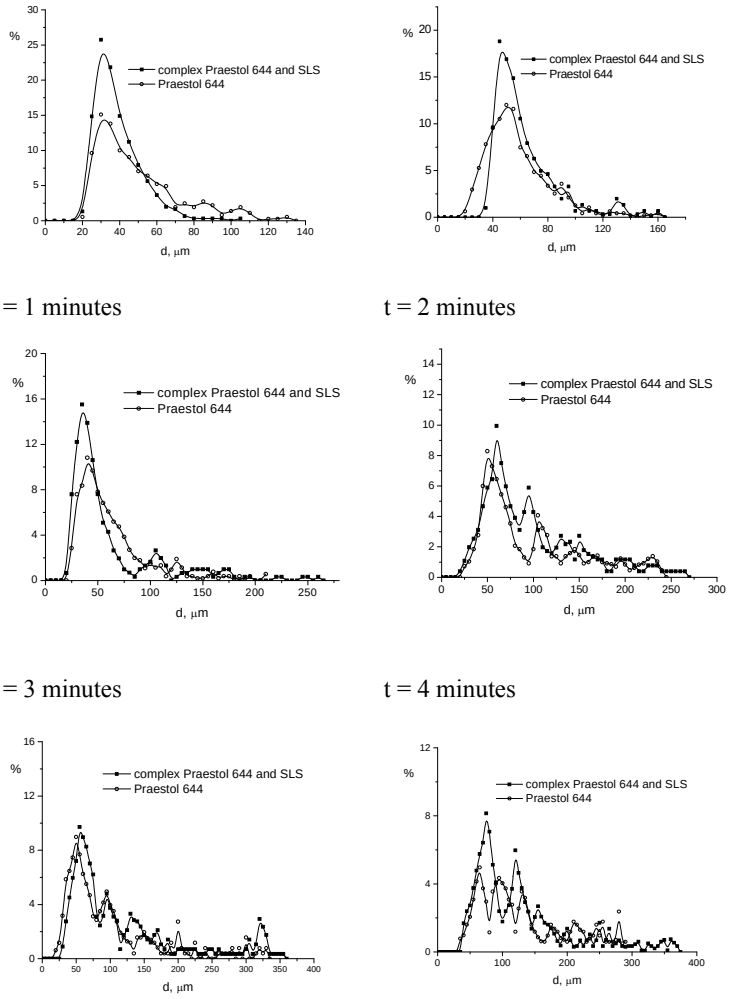

Fig. 3. Histograms of flocks formation

Using the complex solution in the coagulation/flocculation process the agglomeration of the flocks is higher than using only Praestol 644 solution. As the photos taken during the process show (figure 2), the agglomeration occurs between flocks of different sizes and this fact explains the particular shape of the histograms presented in figure 3.

In coagulation - flocculation reactor of high energy input the rate of breakage and erosion of flocks increases with time and so smaller flocks were found after 4 minutes (figure 3)

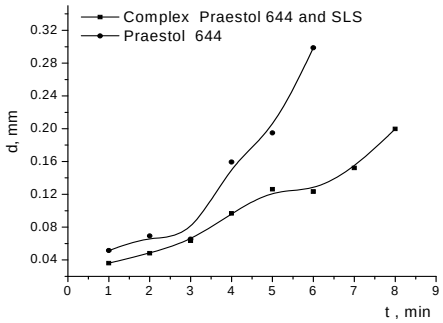

Fig. 4. Evolution in time of flocks medium diameter

The time evolution of the flocks mean diameter presented in figure 4 points out that when using the complex in the coagulation flocculation process there are flocks with mean diameter higher than in the case of using Praestol 644. Because the flocks are bigger, the shape factor has lower values in the case of using only Praestol 644 solution.

Experimentally studies showed that unlike the classic method of coagulation – flocculation, in this case the final turbidity of water (figure 8) and the duration of the process (figure 4) are much smaller, the sedimentation of the flocks occurring much faster (figure 6) and the humidity and volume of the sludge obtained is smaller (figure 7). Using these results the favourable conditions of operation have been determined. In figure 8 c_i and c_f are the initial and final concentrations.

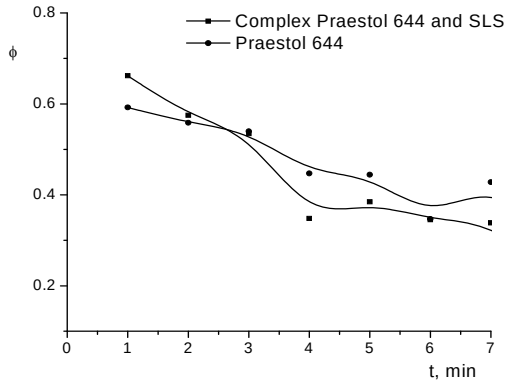

Fig. 5. Time evolution of flocks medium shape factor

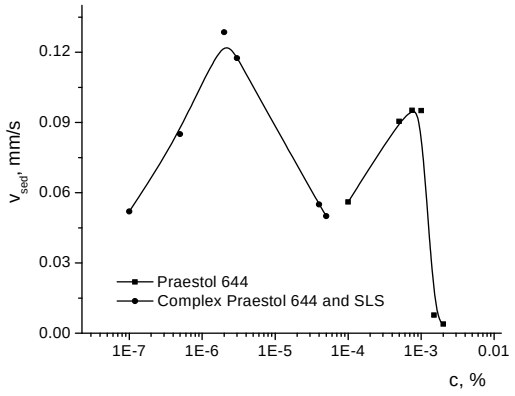

Fig. 6. The sedimentation velocity of flocks resulted in the studied cases

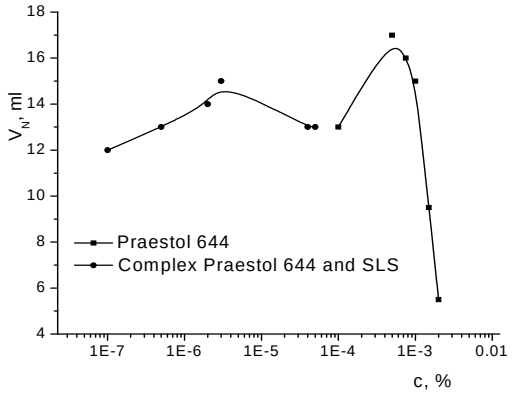

Fig. 7. The sludge volume resulted in the studied cases

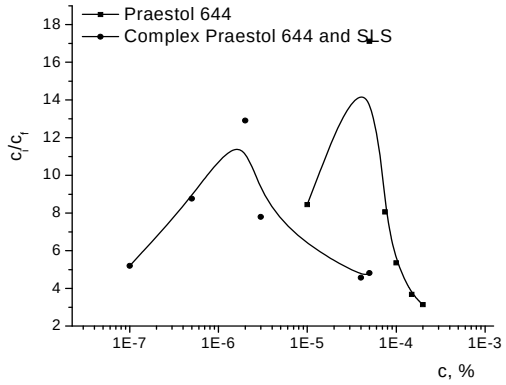

Fig. 8. The separation efficiency in the studied cases

The doze of coagulant is lower using the complex, then in case of using Praestol 644. This fact can be explained through the elongation of the polymer chain caused by the insertion the surfactant micelles and in this way the access of formasine particles at a few electric charges of the polymer chain.

4. Conclusions

The usage of polyelectrolyte surfactant complexes in the process of coagulation flocculation of aqueous formasine suspension leads to very good results. The coagulant doze and the process duration were significantly reduced. The sedimentation velocity of the flocks and the separation efficiency of the formasine from suspension rose in comparison will the case in which only Praestol 644 solution was used and the volume of sludge obtained is smaller. These results recommend the usage of the polyelectrolyte surfactant complexes in industrial applications of coagulation flocculation process. The polymer surfactant complex increases the agglomeration degree of the flocks in comparison with the usage of only Praestol 644 solution.

R E F E R E N C E S

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