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Editorial

Synthesis, Characterization and Flocculation Characteristics of Polysaccharide Graft Copolymers

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Editorial

The waste water and industrial effluent treatment may be treated either with inorganic or organic coagulants and flocculants. Efficient flocculants can reduce the total amount of disposed effluent into the atmosphere. Broadly, for coagulation and flocculation, although the basic function remains the same, subtle distinction is made between these two terms. The coagulation means the destabilization of a stabilized system (eg., colloidal system) but flocculation means the floc formation of the destabilized colloidal system, where the addition of flocculent to the destabilized colloidal system results in flocculation. The flocculants may be either inorganic or organic type. Among the inorganic flocculants, the multivalent metallic compounds like aluminum and iron salts are generally used. The organic polymeric flocculants are preferred due their ease in handling, low dosage requirements, less sensitivity to system pH, existence of large cohesive forces between the flocs and the ease in synthesizing the flocculants. Polysaccharides such as starch, amylase, amyl pectin, guar gum, xanthan gum and carboxymethyl cellulose have been used for long as natural flocculants. However, they are less effective flocculating agents when compared with synthetic flocculants. The polyacrylamides have also been used for long as synthetic flocculants. Although their flocculation efficiencies are higher than the natural flocculants, these synthetic polyacrylamide flocculants are easily amenable to shear degradation although they are very efficient drag reducing and flocculating agents even at low ppm concentrations. Whereas, polysaccharides are fairly shear stable but are not very efficient drag reducers and flocculants. Their aqueous solutions are also subjected to rapid biodegradation.

Grafting polyacrylamide branches on rigid backbone of polysaccharides have easy approachability to contaminants in effluents. Recently, copolymers have been synthesized by grafting of flexible polyacrylamide chains on polysaccharide backbones. The graft copolymers have been found to be efficient, shear stable flocculants for industrial effluents. Among grafted guar gum, xanthan gum, carboxymethyl cellulose, starch, amylase and amylopectin, the grafted amylopectin performs the best. These new classes of polymeric materials may be used with a very low dosage for various industry effluent treatments and drag reducing agents.

Many graft copolymers have been synthesized by grafting polyacrylamide chains onto guar gum [1,2], xanthan gum [3,4] carboxy methyl cellulose and starch [5]. Their shear stability and drag reduction efficiency have been extensively studied [3,6]. Most polysaccharides are purified before use [3]. The various graft copolymers have been synthesized by ceric ion initiated solution polymerization technique [4,5]. In this technique, the free radicals are formed exclusively on the polysaccharide molecules, thus minimizing the formation of homopolymers. Later on, the investigations on their flocculation ability yield the same pattern, i.e. the graft copolymers having fewer and longer grafted chains are found to be more effective flocculants [6]. Among the grafted guar gum, xanthan gum, carboxy methyl cellulose, starch, amylase and amylopectin, it has been found that grafted amylopectin is the most efficient flocculant [5-7] Starch consists of linear amylose (molecular weight 10,000-60,000) and branched amylopectin ($Mw = 50{,}000–10^7 g\ mol^{-1}$). Among all the polysaccharides, grafted amylopectin [6-8] has been found to have best flocculation. Graft copolymers are characterized [6] by viscometry, IR, NMR, thermal analysis, morphological study and XRD. Recently the proof of grafting has been given by enzyme hydrolysis [7]. Biodegradation can be followed by monitoring absolute viscosity at certain interval of times over entire period of the test at 30 °C when bacterial activity is maximum. As mentioned earlier, the grafted polysaccharides are less prone to biological attack [8]. The standard jar test and settling tests were followed for measurement of flocculation and settling characteristics [5-7]. First the effectiveness as flocculant was measured in synthetic effluents of kaolin, $PbNO_3$ and coal. Later on industrial effluents from steel, copper, electroplating industries, iron ore mines and coal washeries were treated. In most cases, comparative studies were done with commercial effluents [9].

It may be concluded that by grafting polyacrylamide branches on the backbone of polysaccharide molecule, efficient flocculants with biodegradable as well as shear resistant properties could be developed. When the grafted branches are partially hydrolyzed, the performance increases to a certain level and then decreases. During hydrolysis, the grafted chains are straightened, due to electrostatic repulsion of negatively charged carboxylate anions. As a result, the approachability to the particles in colloidal suspensions increases. There is an optimum degree of hydrolysis where grafted chains get straightened but have some degree of flexibility. Beyond the optimum level, the grafted chains lose their flexibility and behave like a rigid rod. The flocculation efficiency of the above graft copolymers is found to be much higher than that of commercial polyacrylamide-based flocculants because of their greater degree of branching and higher molecular weight [10-13].

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