ABSTRACT

Water-soluble polymers based on grafted polysaccharides have drawn much attention in the recent decades because of their controlled biodegradability, high efficiency as flocculants and shear stability. The graft copolymers show better performance in flocculation than the polysaccharides, which is due to the better approachability of the grafted acrylic chains to the colloidal particles. On further partial alkaline hydrolysis of the graft copolymer its flocculation characteristics increase. The extended chains resulting from anionic repulsion lead to better approachability to contaminants and hence have better flocculation characteristics.

The aim of the present investigation was to synthesize some water-soluble polyacrylamide (PAM) grafted copolymers of carboxymethyl guar gum (CMGG), glycogen (Gly) and xanthan gum (XG), in presence of ceric ammonium nitrate (CAN) as initiator. A series of graft copolymers with variation in the number and length of PAM chains by varying the concentration of acrylamide and CAN were synthesized.

The polysaccharides and the synthesized graft copolymers were characterized by various materials characterization techniques like elemental analysis, fourier transformed infrared spectroscopy (FTIR), scanning electron microscopy (SEM), static light scattering (SLS), thermal analysis (TG/ DTG), viscometry (intrinsic viscosity) and x-ray diffraction (XRD). The flocculation characteristics of graft copolymers were evaluated in two synthetic effluents, namely, iron ore and kaolin suspensions.

While comparing the flocculation efficiency, it was observed that in the series of graft copolymer based on polysaccharides, the graft copolymer with fewer and longer PAM chains was the most effective in all the suspensions. When the flocculation efficiency of the graft copolymers were compared with commercial flocculants, the synthesized graft copolymers were found to be best in performance.

The graft copolymers of polysaccharides and polyacrylamide, carboxymethyl guar gum-gpolyacrylamide, glycogen-g-polyacrylamide and xanthan gum-g-polyacrylamide were partially hydrolysed by the treatment with certain amount of alkali. The series of hydrolysed products of all three graft copolymers were synthesized with varying the experimental conditions in order to establish the flocculation efficiency with expansion and straightening of the grafted flexible PAM chains. The various grades of hydrolysed graft copolymers were characterized by elemental analysis, FTIR spectroscopy, neutralization equivalent, rheological techniques, SEM, SLS, thermal analysis, viscometry (intrinsic viscosity) and XRD.

The flocculation performance of hydrolysed graft copolymers were compared in two suspensions of iron ore and kaolin. The hydrolysed graft copolymers of glycogen and carboxymethyl guar gum showed better flocculation performance than the graft copolymers. In case of xanthan gum however the graft copolymer proved to be the better flocculant when compared to its hydrolysed counterpart due to its pronounced anionocity.

On hydrolysis, the $-CONH_2$ groups of the graft copolymer are converted to $-COO^-$ groups and chain expansion takes place. The negative charges on grafted chains also increase. The former enhances the flocculation and the latter decreases the flocculation due to increasing repulsion between flocculant and negatively charged particles. Optimum hydrolysis in case of CMGG and Gly graft copolymers leads to products with sufficient chain expansion and exhibiting better flocculation performance. In case of xanthan gum, which is an anionic polysaccharide, the effect of chain extension is annulled by anionic repulsion. This leads to decrement of flocculation properties in case of hydrolysed graft copolymer of xanthan gum.

A comparative investigation was also undertaken for the flocculation characteristics of grafted and hydrolysed grafted polysaccharides. Among all water soluble polysaccharides, glycogen has highest level of branching and molecular weight. Its graft copolymers and hydrolysed graft copolymers have been found endowed with characteristics in accordance with Singh's Easy Approachability Model.

Rheological investigations were carried out with the polysaccharides, graft copolymers and hydrolysed graft copolymers. At low shear rate, the shear viscosity of hydrolysed graft copolymers is much more than that of the corresponding graft copolymer and the base polysaccharides. All the aqueous solutions of polysaccharides, grafted polysaccharides and hydrolysed grafted polysaccharides exihibit non-Newtonian pseudoplastic behaviour. This marked shear thinning behaviour of polysaccharide solutions are explained by the conformational states of polymer molecules. The domains of associated polysaccharide chains exist at rest or at low shear and are stabilized by hydrogen bonds. On shearing, the extent of aggregation is reduced resulting in a lower solution viscosity.