

Flocculation of chromite ore fines suspension using polysaccharide based graft copolymers

N C KARMAKAR, B S SASTRY[†] and R P SINGH*

Department of Mining Engineering, Indian School of Mines, Dhanbad 826 004, India

[†]Department of Mining Engineering, *Materials Science Centre, Indian Institute of Technology, Kharagpur 721 302, India

Abstract. Graft copolymers are being experimented at the laboratory scale as flocculants. All the four graft copolymers, viz. starch-*g*-polyacrylamide, amylopectin-*g*-polyacrylamide, sodium alginate-*g*-polyacrylamide and carboxymethyl cellulose-*g*-polyacrylamide performed well as flocculants on chromite ore fines suspension. Amylopectin-*g*-polyacrylamide, in particular, performed superior to the rest of the series from the point of view of settling velocity of flocs which is the most important aspect in solid–liquid separation.

Keywords. Flocculation; graft copolymer; mineral industry effluent; chromite ore fines; settling velocity.

1. Introduction

Use of flocculating agents is almost an indispensable practice for the treatment of mineral industry effluent which contains large proportion of fine solids. Unless this effluent is properly treated prior to retaining the solid fraction, it would cause pollution to natural water and silting of river bed reducing its water carrying capacity.

The organic polymeric flocculating agents are now replacing coagulating agents in the form of inorganic salts, as the former possess many advantages over the latter including high performance at lower dosage. In the authors' laboratory, a series of graft copolymers based on polysaccharides and polyacrylamide have been developed that work well as flocculating agent on coal washery effluent, copper and iron ore fines etc (Karmakar *et al* 1998, 1999; Tripathy *et al* 2001). Four grafted copolymers have been used in this study, viz. starch-*g*-polyacrylamide (St-*g*-PAM), amylopectin-*g*-polyacrylamide (Ap-*g*-PAM), sodium alginate-*g*-polyacrylamide (SAG-*g*-PAM) and carboxymethyl cellulose-*g*-polyacrylamide (CMC-*g*-PAM) for flocculation of chromite ore fines suspension.

2. Experimental

Grafting of polyacrylamide chains on polysaccharide backbones was done using redox initiation process involving ceric ion as detailed elsewhere (Karmakar *et al* 1998). Chromite ore was collected from Boula Chromite Mines of FACOR, Orissa. The ore was crushed to – 200 mesh and this size fraction was used for all experimental purposes. Zeta potential of the fines in water suspension was measured using microelectrophoresis technique.

Flocculation jar test was carried out on standard bench type setup following the specifications mostly in the line of Bratby (Bratby 1980; Karmakar *et al* 1999). In 1 l beakers 400 cc of suspension containing 1 wt% of solids was flocculated applying 10–200 ppm of polymer dosages with respect to solids content. Column tests were carried out using glass cylinders of 2 cm inner diameter and 40 cm long (Karmakar *et al* 1999). Settling tests were carried out on 100 cc of 10 wt% suspension for 12.5–200 ppm polymer dosage. Supernatant turbidity after 15 min of settling was noted. Height of the interface was measured over a length of time from which settling velocity was calculated.

3. Results and discussion

Zeta potential of chromite suspension was measured to be – 8.9 mV. This indicates that chromite ore fines acquire negative surface charge in aqueous medium. Results of jar tests are presented in figure 1. The 'blank NTU' i.e. turbidity of supernatant liquid without using any polymer was measured to be 7.8. All the grafted products, in general, performed as good flocculants, bringing down the turbidity value below 0.5 NTU at a dose around 100 ppm. Though the turbidity values were very close to each other, varying only in decimal ranges, it is apparent from the graph that in comparison to St-*g*-PAM the other products performed slightly better.

Results of column settling tests are given in figure 2. In the dosage range of 100–200 ppm, turbidity varied between 1.5 and 3.0 NTU. Hence from turbidity point of view all the polymers performed more or less equally, though St-*g*-PAM had slight edge over the others.

It is also seen from figure 2 that settling velocity increases with polymer dose over the range studied. At

*Author for correspondence

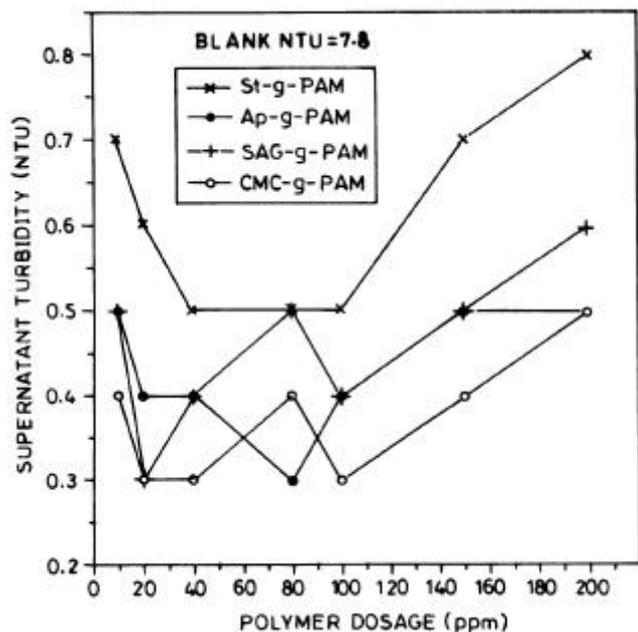


Figure 1. Jar test results.

the dose of 200 ppm, settling velocity for St-g-PAM, SAG-g-PAM and CMC-g-PAM was 11–13 mm/s, whereas at the same dose for Ap-g-PAM it was as high as 24 mm/s. This shows a distinct superiority of Ap-g-PAM over the other products. In solid–liquid separation process, it is the settling velocity that matters more. With the faster settling of flocs, capacity of thickeners, where large scale settling is carried out, also increases. Considering both the parameters together, i.e. supernatant turbidity and settling velocity, Ap-g-PAM performed superior to the other three products. Better performance of Ap-g-PAM is probably due to its high molecular weight and more of branching structure to capture more number of solid particles by a single molecule.

4. Conclusions

The study revealed that grafted copolymers of polysaccharides and polyacrylamide possess good flocculating property. The graft copolymers viz. Ap-g-PAM, St-g-PAM, SAG-g-PAM and CMC-g-PAM have the potential for use in the treatment of effluent emanating from chro-

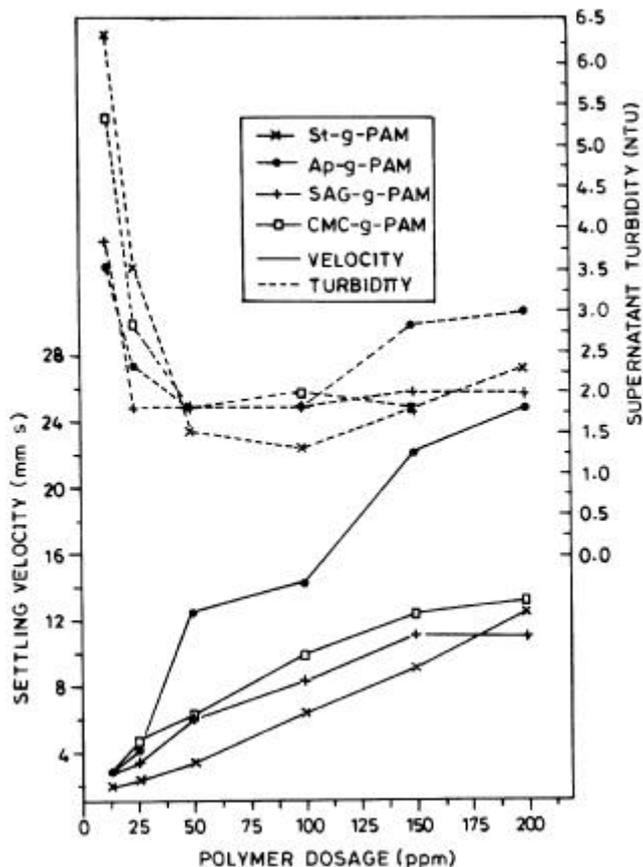


Figure 2. Settling velocity and turbidity for column test.

mite ore processing. Though from supernatant turbidity point of view, all the products performed more or less at the same level, amylopectin-g-polyacrylamide has a clear-cut superiority over the others in respect of settling velocity, which is one of the important criteria in the design of thickeners for solid–liquid separation.

References

- Bratby J 1980 *Flocculation and coagulation* (Crydon, UK: Uplands Press Ltd.) Ch. 8
- Karmakar N C, Rath S K, Sastry B S and Singh R P 1998 *J. Appl. Polym. Sci.* **70** 2619
- Karmakar N C, Sastry B S and Singh R P 1999 *CIM Bull.* **92** 67
- Tripathy T, Karmakar N C and Singh R P 2001 *J. Appl. Polym. Sci.* **82** 375