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FILTRATION OF IRON ORE SLIME USING SYNTHESIZED CO-POLYMER

R.P. BHAGAT[1], G.P. KARMAKAR[2] and R.P. SINGH[3]

[1]National Metallurgical Laboratory, Jamshedpur 831 007
[2]Indian School of Mines, Dhanbad 826 004
[3]Indian Institute of Technology, Kharagpur 721 302

The present paper reports study on filtration of iron ore slimes using the co-polymer synthesized by grafting polyacrylamide chains on starch backbone. The efficacy of the synthesized polymer was tested for the filtration of iron ore slimes following flocculation. The filtration rate increases with increasing flocculant dosage. However, the improvement is marginal at higher flocculant dosage. The filtration rate decreases with increasing pulp density and/or increasing pH. The filtration efficacy of synthesized polymer is comparable with the imported one, Magnafloc 1011 at neutral pH. At the alkaline pH, the initial rate of filtration is higher with Magnafloc 1011 compared to the synthesized polymer. The turbidity of filtrate is, however, more than 500 NTU in the former case. The filtration data fits Kozeny's equation at constant pressure.

INTRODUCTION

Water soluble starch and polycrylamides wth various ionicity play a considerable role in solid-liquid separation related to mineral processing and red mud treatment [1-3]. Flocculation of mineral suspensions using polyacrylamides and polysaccharides has been well investigated [4-6]. It has been established that while starch is bio-degradable, polyacrylamide degrades on shearing [7]. In order to eliminate these drawbacks, various graft copolymers have been synthesized at IIT, Kharagpur by grafting polyacrylamide chains on polysaccharides using redox initiated solution polymerization technique [8]. Previous studies have established that these synthesized graft copolymers are more efficient turbulent force reducers and have better flocculation characteristics than the commercially available flocculants [9].

The efficiency of the synthesized graft polymer has been tested in relation to the flocculation of iron ore slimes followed by filtration. Variables which affect the kinetics such as pH value of suspension, solid concentration of pulp, dose of flocculant [10-11] have been studied in the present work.

EXPERIMENTAL

Soluble potato starch G.R.Grade (Loba Chemie, India) and acrylamide monomer (Merck-Schuchardt, Germany) were used without any recrystallization. Reagent grade ceric ammonium nitrate, (Loba Chemie, India) and Analar Grade nitric acid (BDH, India) were used as received. Magnafloc 1011 was procured from M/s. Allied Colloids, U.K.. Iron ore slimes obtained from a typical Indian mine were used. Its particle size was 80% by weight less than 9.66 microns. Mineralogically, it consists of hematite as a major phase, and quartz, illite and kaolinite in minor amounts. The chemical analysis of the hematite slime corresponds to (wt%): 84.64 Fe_2O_3, 497 SiO_2, 5.92 Al_2O_3 and 4.46 LOI.

The starch solution was prepared in double distilled water and then grafting reaction was performed as per standard procedure reported earlier [8]. The laboratory scale synthesis was scaled upto 10 litres batch reactor level [12]. Ceric ammonium nitrate solution in nitric acid was used as a catalyst. Required amounts of catalyst and acrylamide solution were added to the starch solution. The reaction was allowed to continue for 24 hours at 30°C under N_2 atmosphere and the product was precipitated in excess of acetone. After several washings with acetone, the product was dried at 40°C under vacuum. Dried product, herein referred as SAM-S-II was pulverized and used for further studies. The grafting was confirmed by elemental analysis, IR, XRD, thermal analysis and SEM [13]. The details of the synthesis of SAM-S-II are given in Table.I.

Table I: Details of synthesis of SAM-S-II

Moles in reaction mixture				
Acrylamide	CeIV ion* x 10^3	Yield %	Monomer* Conversion(%)	Intrinsic Viscosity (mlg^{-1}), n
0.14	0.03	89.71	88.69	820

The filtration test was carried out in a batch apparatus of 50ml capacity. The filtration kinetics was followed by noting down the volume of filtrate as a function of time till the end.

RESULTS AND DISCUSSION

The kinetics of filtration is influenced by the addition of the flocculant and its amount. The flocculant dose is reported as ppm (equivalent to g/ton), weight basis for all sets of experiments. Besides the above factors, pH value of the suspension and its initial solid concentration influence the kinetics considerably. These effects are discussed below.

Modelling of the filtration kinetics

The filtration data are fitted to the Kozeny equation:

$t/V = (r\ \mu\ v) / (2\ A^2\ \Delta P) * V$, where,

V = volume of liquid flowing in time, t
ΔP = total drop in pressure
r = specific resistance of filter cake
μ = viscosity of fluid
v = volume of cake deposited by the passage of unit volume of filtrate
A = filtration area

Fig.1 shows a typical plot when the initial suspension concentration was 15 percent by weight and the suspension pH was maintained at 6.4. The parameter, t/V, when plotted against V results in straight line thus fitting to the Kozeny's equation. The slope of the straight line represents the resistance.

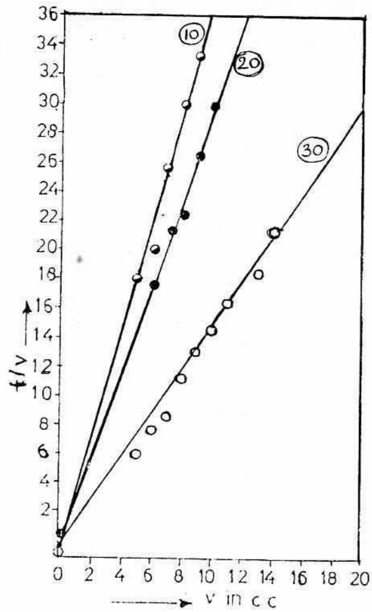

Fig.1 : Ratio, t/V (s/cc) vs. V (cc) in filtration of iron ore slime suspension with 15% pulp density and at 6.4 pH. Figures in the circle show flocculant dose.

Effect of flocculant quantity

It is apparent from Fig.1 that the slope is marginally changed when flocculant dosage is increased from 10ppm to 20ppm. However, a significant decrease in the slope is observed when the amount is increased to 30 ppm. Table II shows the resistance parameters at different pulp densities.

Table II: Summary of results at pH 6.4

Pulp density %	10	10	10	15	15	15	20	20	20
Flocculant dose, ppm	10	20	30	10	20	30	20	30	40
Slope	2.7	1.2	0.9	3.0	2.6	1.3	3.3	2.3	2.2

At 10 percent initial solid concentration, a substantial decrease in slope is observed when the flocculant dosage is increased from 10 ppm to 20 ppm. A further increase in flocculant dosage to 30ppm at this pulp density changes the slope marginally. At 20% pulp density the slope changes significantly when the flocculant dose is increased from 20 ppm to 30 ppm. With further increase in the flocculant dose to 40 ppm the slope decreases marginally (Table I).

The increase in the filtration rate with increasing amount of the flocculant in the suspension is due to the fact that with increasing the flocculant dose, a large number of functional groups are available to be adsorbed on the particles and form bridges with them. Similar trends have been observed by the previous authors [3,14]. An optimum amount is generally recommended which varies from system to system.

Effect to pulp density

It is apparent from the Table I at a particular flocculant dose, the resistance to filtration increases with increase in the pulp density. This can be ascribed to a greater resistance to the flowing water through the particle bed of higher volume.

Effect of suspension pH

For the solid concentration and flocculant dose at 10% and 30ppm respectively on weight basis the change in filtration rate is marginal when the pH value changes from 6.4 to 5.0. The filtration rate decreases considerably for the alkaline suspension. This could be explained in terms of change in zeta potential of the system and degree of ionization of the polymer chain resulting in restabilization of the fines by repulsive forces of the ionized groups in the branches of the polymer chain [15].

The pzc of iron ore slime is 6.8. Therefore, an increase in the pH level increases the interparticle repulsion thus adversely affecting the flocculation. Apparently the filtration rate decreases substantially in the alkaline condition compared to the acidic or neutral pH region.

Effect of flocculant type

Typical filtration results using different types of flocculants when the suspension pH was maintained at 5 and the flocculant dose was 30 ppm showed that the filtration rate is marginally slower with the synthesized flocculant as compared to that when Magnafloc 1011 is used. However, it is significantly higher than that obtained with starch.

At pH 10 the filtration rate increases considerably with the addition of Magnafloc 1011 compared to the synthesized polymer. However, flocculation is difficult and the use of Magnafloc 1011 results in partial flocculation (turbidity higher than 500 NTU).

CONCLUSIONS

1. The synthesized starch-g-polyacrylamide is found to be an efficient flocculant in a small dose at par with Magnafloc 1011.
2. The filtration rate increases with increase in the flocculant dose up to a certain limiting value, after which the improvement is marginal. This phenomenon suggests an optimum level for the filtration following flocculation. The filtration rate decreases with increasing pulp density.
3. pH value of the suspension has a considerable effect on the filtration kinetics. The filtration rate decreases considerably in the alkaline region as compared to acidic or neutral region.

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