Application of zeta potential for retention optimization on bagasse pulp

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ABSTRACT

The presented study reports the interdependence of first pass retention on zeta potential of the furnish. The furnish components were bleached bagasse pulp, starch, rosin, soap-stone-powder and alum. The bagasse pulp exhibit maximum first pass retention at zeta potential level of −5mv or less. The chemical additives change the zeta potential of furnish, depending on their sequence of addition. The best sequence experimentally found was rosin-starch-alum-filler for bagasse pulp.

Zeta Potential and Pulp

Zeta potential measurement technique is well recognised and is reported to give fair idea of the charge variation by the additives used in stock preparation.

The pulp fines are known to exhibit negative charge while in suspension, the reasons for which are identified to be

— Ionization of polar groups
— Adsorption of ions from the surrounding medium including hydrogen or hydroxyl ions from water.
— Partial solution of crystal lattice.

Papermaking pulps exhibit variations in their zeta potential primarily because of variation in their carboxyl content as represented in table 1.

Effect of fines on measurements

One of the most important aspects for zeta potential measurement is the particle size used. Strazdins (2,3) demonstrated that meaningful results are obtained by measuring electrophoretic mobility of fiber fines that remain in their filtrate, assuming that fines represent the same charge as that of fibers. He concluded that zeta potential is primarily determined the surface potential and is less influenced by the composition of underlying material, thus it should be same for fibres and fines. Hinten (4) is of the opinion that fines of

TABLE—1

Pulp	Carboxyl Content m eq /100 gm	Zeta Potential of pulp (mV)
Cotton Linter	0.7	(−) 5.6
Bleached kraft	3.6	(−) 11.2
Bleached Sulphite	4.1	(−) 9.8
Bamboo	5.76	(−) 16.0
Mesta	13.92	(−) 23.0
Grass	12.29	(−) 19.7
Sisal	19.54	(−) 24.8
Eucalyptus	12 0	(−) 14 8
Bagasse	10.37	(−) 17.96

—200 fraction possess three time higher electronegative zeta potential than those of fibers.

Strazdins (5) further presented the experimental support to his earlier assumption based on the fact that

— In most of the pulps, fines represent variety of debris from cell wall
— Surface of fiber is contaminated by electrolytes
— Electrokinetic potential is strictly a surface property and depends upon composition rather than dimensions.

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Experimental approach

The presented studies reports on the interdependence of retention on the zeta potential of bagasse furnish in mill simulated conditions. To confirm the effect of size on zeta potential measurement, the commercial pulps beaten in P.F.I. mill, were fractionated, by dynamic retention jar, to —70 fraction and —150 fraction and the zeta potential of the two fractions was determined. The results are summarized in Fig. 1. The two fractions apparently gave identical results of zeta potential values considering the standard deviation in test values.

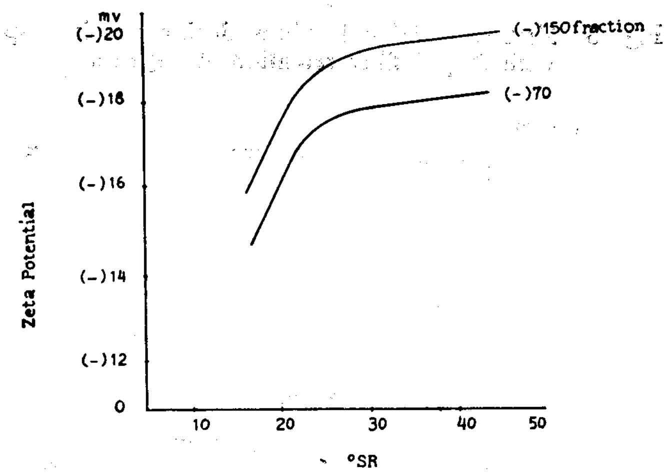

Fig.—1 Zeta Potential of (—) 70 & (—) 150 fractions of Bagasse pulp at different °SR level.

The measurements on—70 fraction is expected to give following advantages :

- The fine fraction thus obtained is nearest to the fine fraction available in paper machine back water.
- The —70 fraction will necessarily contain variety of debris from cell wall as assumed by Strazdins (5).
- The mesh size is nearest to the paper machine wire mesh.
- The solid content of fraction is also found to represent machine back water consistency when headbox conditions of consistency and turbulence were simulated in dynamic retention jar.

Therefore in order to establish the best possible simulation to papermaking conditions, experiments were designed on —70 fraction of the furnish separated on dynamic retention jar.

Zeta Potential and Alum

Paper makers alum is used as a source of aluminium ions meant for controlling pH and promoting fiber additive aggregates to cause wet-end additive retention by promoting the formation of colloidal aggregates, the hydroxides of aluminium probably function by a mechanism which involves both a modification of Zeta potential of interacting surfaces and the formation of a metal hydroxide network structure capable of producing inter particle bridging (6).

To study the role and effect of alum and to determine isoelectric point, pulp samples were disintegrated and a suspension of 0.5% consistency were prepared. Commercial liquid alum having 7.6% alumina was used. The alum was added in varying percentages on oven dry fiber to 500 ml slurry and-70 fraction was taken out after 2 minutes of agitation in dynamic retention jar. The fine content was found to have a consistency in the range of 0.2 ± 0.05% and was used to determine Zeta potential.

The isoelectric point for bagasse pulp was found to occur with the alum quantity of 4% on O.D. fiber, Fig 2.

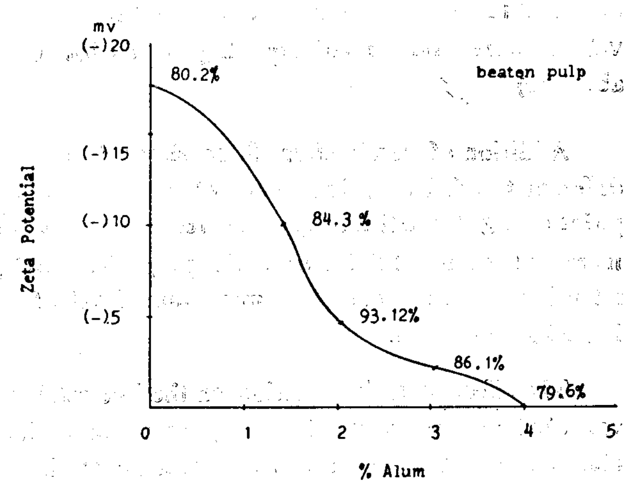

Fig.—2 Zeta potential and Alum dosing relationship with retention of Bagasse pulp.

The amount of fines (—70 fraction) in the beaten pulp were 40.2%.

With the addition of alum the zeta potential value dropped from -17.6 mV to zero and the corresponding increase in fine retention attained maximum first pass retention of 93.12% (82.8% absolute in terms of fine content present) at zeta potential level of -5 mV.

Thus from the point of view of pulp fine retention the optimum zeta potential level was -5 mV or less.

Zeta Potential and Additives

Further to Study the first pass retention of additives on beaten bagasse pulp, common papermakers additives viz. Rosin, Starch and Filler were used.

With the addition of 15% filler (soap stone powder) the maximum first pass retention of 83.1% occurred at -5 mV which on absolute term of fine content (pulp fines and fillers) was 64.8% Fig - 3.

In order to optimize the retention of pulp fines and in organic fines in presence of rosin and starch as wet and additives, it was necessary to understand the influence of these additives on first pass retention with varying zeta potential levels. An option is also available to choose the sequence of addition of starch and rosin with respect to filler and alum.

Addition of starch could have two possibilities-before fillers and after fillers.

Experiments show that addition of starch before filler changes the slope of the curve for isoelectric point. The zero zeta potential is approached faster till -3mV and the maximum first pass retention occur at a level of -3 mV to zeta potential, fig-4. The first pass retention values were also relatively higher 86.8% (72.5% absolute).

Addition of starch after filler showed altogether different trend, Fig-5. The slope of curve to isoelectric point changed drastically and the requirement of alum increased to about 5.2% on O.D. pulp. The first pass retention could achieve the maximum level of 80.4% i.e. 59.2% absolute.

The effect of rosin addition on the isoelectric point was obvious, as shown in Fig-6, apparently due to alum consumed by rosin to from precipitate, however the retention levels were not adversely affected and the first pass retention value remained close to what was observed without starch i.e. 83% overall retention.

Selection of Additive Sequencing

Analyzing the zeta potential for various sequence of addition for optimum level of alum i.e. 4% to attain maximum first pass retention of pulp and inorganic fines, the experiments revealed that.

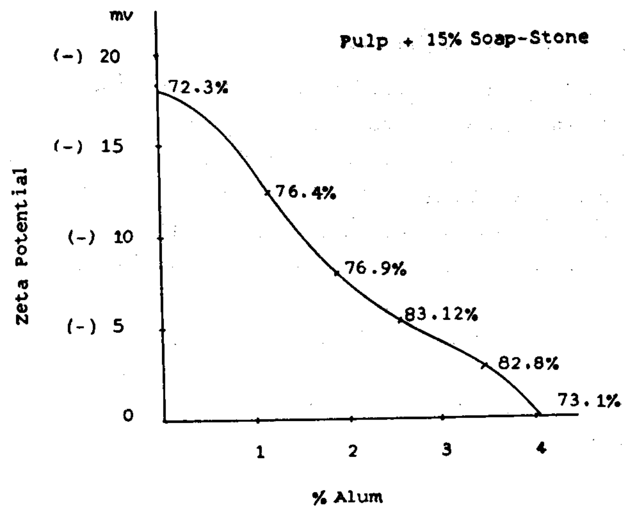

Fig – 3. Zeta Potential and Alum dosing relationship with Pulp & filler retention of Bagasse.

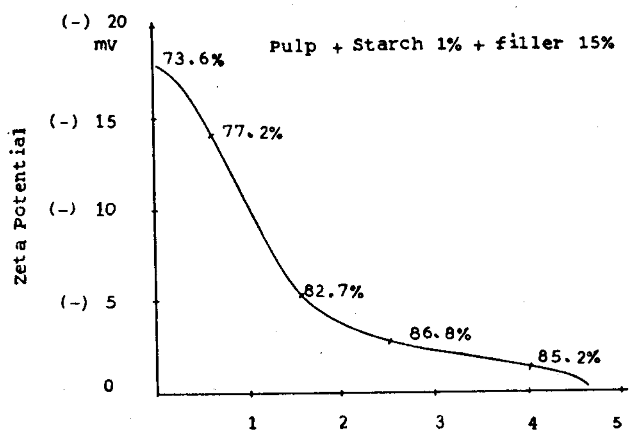

Fig. —4 Zeta Potential and Alum dosing relationship with pulp + 1% Starch + 15% soap-stone on Bagasse Pulp.

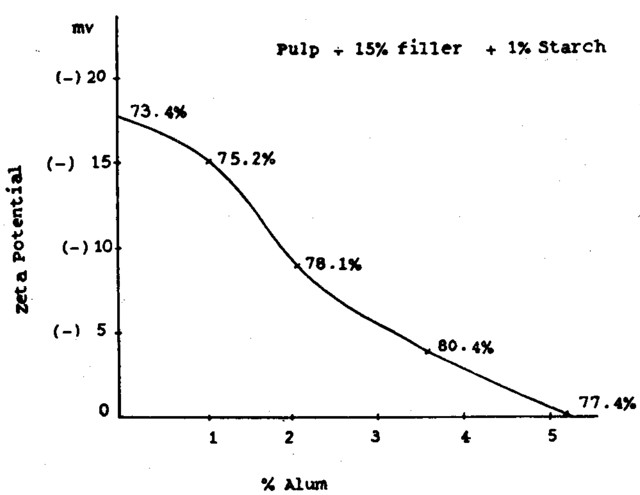

Fig. —5 Zeta Potential and Alum dosing relationship for furnish coating pulp + filler + starch.

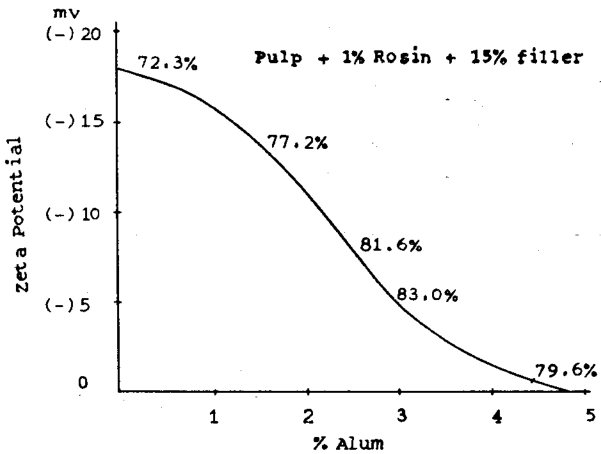

Fig.—6 Zeta Potential and Alum dosing relationship for furnish containing pulp + rosin + filler

The sequence of rosin-starch-filler-alum (4%) attain zeta potential slightly higher i.e. -7 mV and thus extra alum is required to attain levels of -5 mV, yielding maximum retention.

Sequence of starch-rosin-filler-alum could give better retention but the alum consumption is higher, as the level of zeta potential for maximum first pass retention is -3 mV or less.

Sequence of rosin-starch-alum-filler offers maximum retention at -5 mV and the retention level is comparable to the case 2 i.e. starch-rosin-filler-alum.

Sequence of starch -rosin-alum-filler did not give the anticipated results as obtained by addition of starch before fillers and the isoelectric point was reached with 4.5% alum and the maximum retention occurs at zeta potential level of -5 to -3 mV, although the first pass retention was less than that obtained with rosin-starch-alum-filler.

Inference

The above analysis shows that for bagasse bleached pulps, the best sequence for the common additives is rosin-starch-alum-filler and the zeta potential level is -5 mV or less for maximum first pass retention of pulp and filler fines.

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