A New Polyelectrolite Mediator for the Attachment of Anionic Rosin Emulsion onto Cellulose Fibres

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Abstract

A new chemical based on aluminium salt modification was developed to be used as retention and binding mediator for especially paper industry. It was noted that new floculant/coagulant (CFS) showed significant performance on the charge neutralisation of a stock fibre suspension compared to that of polyaluminium chlorite (PAC) and aluminium sulphate (Alum). While CFS pulled down the negative charge of fibre suspension from -175mV to -25mV with 4% as received base addition, PAC and Alum, however, only went down to around -85mV and -115mV respectively as a result of same addition level of each chemical as received basis. Cobb test, furthermore, revealed that significantly less amount of CFS imparted good water resistance to test papers which strongly approved the superior function of CFS on attaching rosin molecules onto fibre surfaces.

Key words: Cellulose fibre, retention, opposite charges, polyelectrolyte, cobb.

1. Introduction

Papers tissues and towels are the thinnest flexible cellulosic sheets made through wet formation where a jet of very diluted fibre slurry is directed between a gap of two running woven mesh wire which is called as gap forming technique. Dry content of such fibre slurry is normally adjusted to be between 0,2 to 0,5% in general which means enormous amount of water needs to be drained. Final end product of an ordinary paper tissues are actually made of combining a couple of extremely thin sheets. Packaging grade papers used in corrugated board manufacturing are made from paper slurries in the range of 0,8 to 1,5% consistency on the basis of dry content. Weights of packaging grade papers vary from 90 to 250 g/m^2 and are mainly made from waste paper recycling. The slurry of such papers, therefore, contains variety of different materials in different proportions compared to a normal photocopy paper that is made only from virgin wood fibres

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and some filler [1]. Depending on the varieties and proportion of pulp ingredients, papermaking may get extremely problematic in terms of meeting target properties of end-products. Papermakers need to balance the charge of pulp slurries to be able to maintain good formation and also high retention. Pulp slurries normally show negative charge which theoretically comes from OH groups over cellulose fibres and fines [Figure 1].

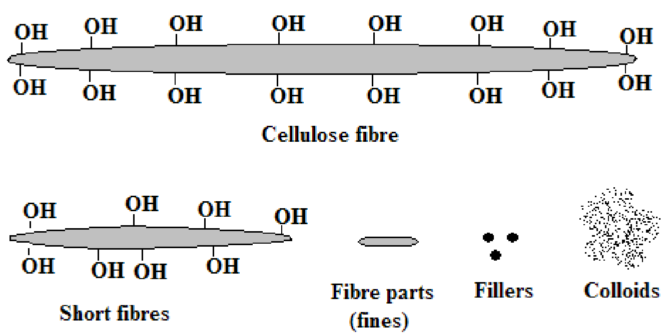

Figure 1: Elements of papermaking slury.

Writing and packaging grade papers are required to show a certain level of resistance to liquids. Rosin emulsion is one of the widely used papermaking chemicals for this purpose where aluminium sulphate is used to attach rosin molecules over fibre surfaces through internal sizing application. Retention of fines and fillers should be also controlled for good performance since practically fines and fillers have higher absorption capacity and surface area than cellulose fibres. In this respect, chemical retention is crucial as it maintains the retention of fines, fibres, colloids and molecules into paper matrix. Therefore, charge neutralisation/adjustment, chemical retention and rosin attachment over cellulose surface are important issues and needs to be carefully handled during papermaking [2, 3].

a) No chemical b) Long polymer c) Short polymer

Picture 2: Effects of coagulants/flocculant on a recyled pulp slury.

Aluminium sulphate have been used in papermaking for long time and named as "papermaker's alum" for ages. Polyaluminiumchlorite (PAC) is also used for retention and charge neutralisation purposes. Length of chemical molecules and electrical charges of molecules determine the size of flocculation/coagulation and strength of such clustering in pulp suspension [Figure 2]. Bigger and longer molecules tend to create coarser flocks which normally damage the formation quality and some properties of papers. Stronger flocks can show great resistance to shear and turbulence in the wet end of paper machine and this may allow higher production speed [2, 4, 5].

2. Materials and Method

Waste corrugated board was teared apart into small pieces, kept into tap water and disintegrated to have a stock pulp slurry at %1 consistency. Chemicals were obtained from Caran Kimya, İzmir. Liguid Coagulant/Flocculant were prepared at 12 and 16% on dry basis by Caran Kimya and named as CFS-1 and CFS-2 respectively. Aluminium sulphate crystals was dissolved in deionised water and prepared at 14 bome concentration and named as Alum in this work. PAC was used as received without any alteration.

Chemicals were gradually added to pulp slurries and charge of pulp filtrates were carefully measured by employing MÜTEK PCD 04 Particle Charge Detector. A number of handsheets at 100 g/m^2 were formed on a British Handsheet Former Machine according to Tappi 205 sp-95 with the addition of 2% rosin emulsion in combination with increasing amount of Alum, PAC, CFS-1 and CFS-2. Water absorption values of handsheets were determined according to Cobb test of Tappi 441.

3. Results

Negative charge value of pulp slurry was noted to be around -175 mV which was getting reduced in line with chemical additions up to -25Mv [3].Compared to constant addition levels of chemicals used in this experiment, CFS-2 was the most effective in charge neutralization of pulp slurry while alum showed poorest performance [Figure 4].

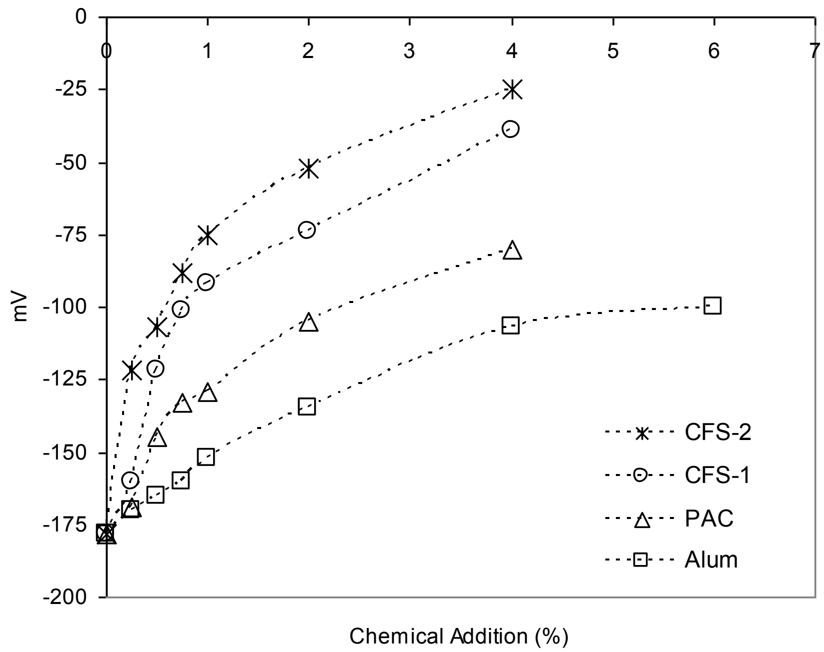

Figure 3: CFS-2 seems to be better in reducing negative charge of pulp slurry.

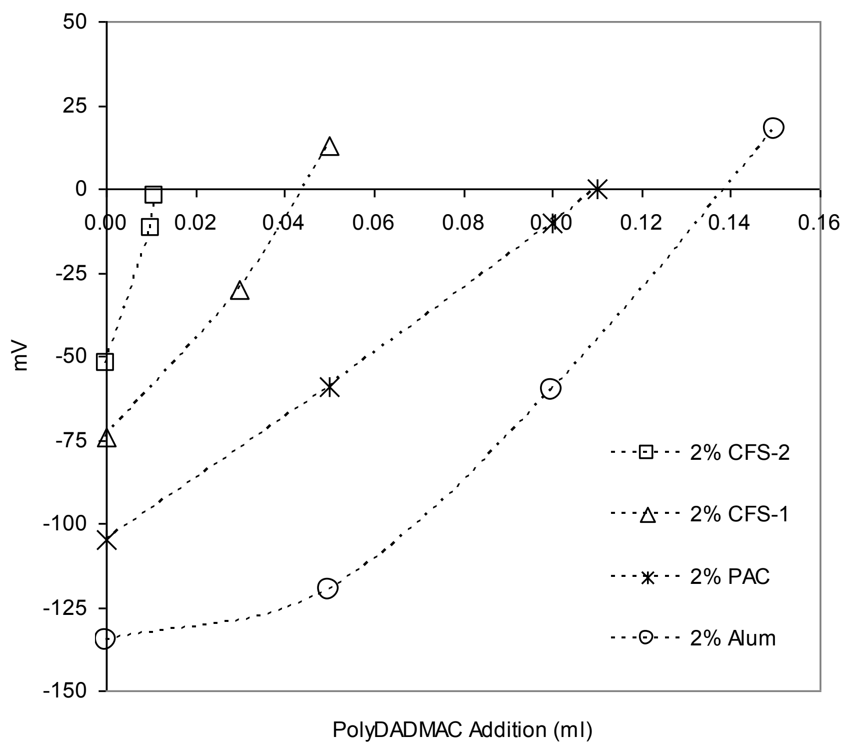

Figure 4: PolyDADMAC used for charge neutralization of pulp slurry.

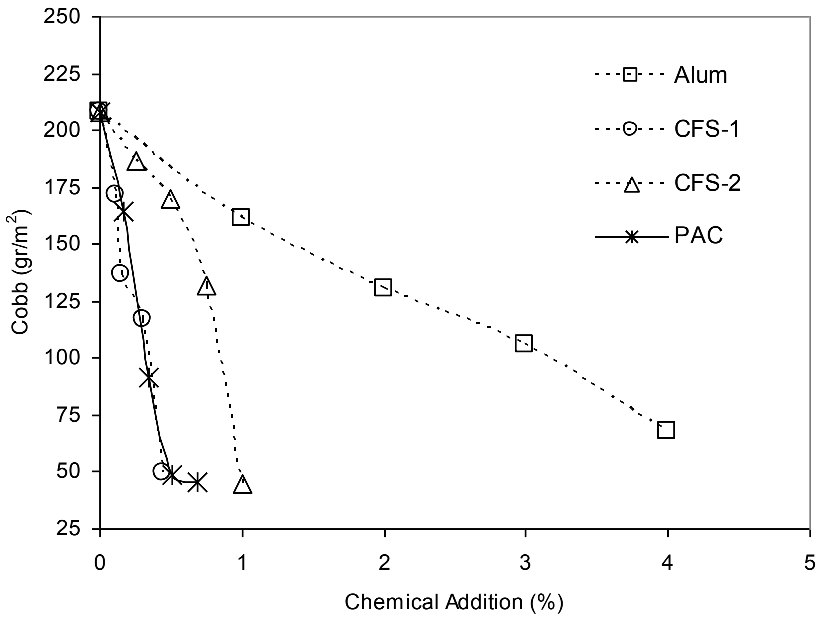

Figure 5: CFS-1 showed good performance in sizing.

Figure 5 indicates that both CFS-1 and CFS-2 showed better performance than Alum on sizing.

4. Discussion

As partly explained in literature, especially pulp suspension made from waste corrugated papers contains quite different ingredients in addition to highly fibrillated and laminated cellulose fibres. Dry and wet strength aid chemicals, surfactants, ink components, adhesives, resins, fillers and dyes can be given as some examples of these elements. These materials are normally called as "anionic trash" and needs to be carefully handled to be able to maintain both better interfiber bonding between cellulose fibres and good internal sizing. Alum, PAC, CFS-1 and CFS-2 were observed to be fighting anionic trash in pulp suspension and reducing negative charges as seen in figure 3. Reason behind the differences between performances of tested chemicals should be questioned in connection with their charge density and molecular chain length. It is well known that small ingredients exhibit larger surface areas and tend to absorb most of the added chemicals in pulp suspension (3, 5, 6). Therefore retention of such small elements during paper formation is deadly important. Chemicals should not only reduce negative charge of suspension, but also promote first past retention. In this respect, CFS-1 and CFS-2 as new polyelectrolytes displayed quite good performance. This is believed to be due to higher charge density and good retention aid function of these chemicals.

Results in figure 4 are in agreement with those in figure 3. Final anionic charge of pulp suspension as a result of %2 chemical addition were tried to be get down to 0, neutral level by gradual addition of PolyDADMAC. It was confirmed that CFS-1 and CFS-2 were quite good in reducing anionic charge of pulp due to both having higher cationic functional groups and good flocculation behaviour.

Cobb result indicates that CFS-1, CFS-2 and PAC worked very well in the attachment of rosin molecules over cellulose surfaces (Figure 5). Alum, however, showed very poor performance due to probably bigger particle sizes. It is known that smaller particle sizes favour the better distribution and the wider spreading of added chemicals which directly reduces the consumption.

Conclusions

It was clearly found that both CFS-1 and CFS-2 could be perfectly used in the rosin sizing system as mediator between cellulose fibres and rosin molecules as well as using as retention aid chemicals. Good performances of CFS-1 and CFS2 are believed to be due to higher cationic charge density, smaller particle sizes and stronger attachment capacity over negatively charged surfaces.

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