Characterization of the PAC Modified Cationic Rosin Size and its Sizing Effect

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ABSTRACT

Cationic rosin sizes are prepared by premixing extremely pure ployaluminum chloride (PAC) and dispersed rosin size (DRS). It turned out that zeta potential and particle size of the sizing agents took a big change by Plus90 analyzer's and FTIR analyzer's analysis. It turned out that -C=O and -COOH of the DRS have both chemical reaction with PAC to form the muti-hydroxyl aluminum rosin acid and that the cationic rosin sizes modified by PAC has dissymmetric and symmetric flexible vibration two absorbing peaks of the groups (its absorbing peaks at1596cm^{-1} and 1425cm^{-1}). By DRS reacting with PAC, zeta potential of the resin size varied from negative to cationic. Al_2O_3/rosin=1:0.3, zeta potential of premixed admixture is tiptop28.8mv, When joined continuously PAC, zeta potential of cationic rosin sizes descend on the contrary.

INTRODUCTION

The purpose of paper sizing is to evenly distribute the hydrophobic substances onto fiber surface, which makes the paper liquid- resistant [1]. The mechanism of rosin sizing is that rosin and cellulose are combined with each other by aluminum ions, resulting in sizing effect [2]. Aluminum ions of traditional rosin sizing is from aluminum sulfate. PAC employed as aluminum resources instead of aluminum sulfate can lead to better sizing effects. Study results showed sizing with rosin and PAC can improve the retention of rosin[3].PAC mainly used as precipitator of rosin sizing, and the stability of PAC/DRS (dispersed rosin size) sizing isn't solved yet. In recent years, the price of rosin increased rapidly, which challenges the future of this technique. In the current paper, we tried to improve the stability of PAC/DRS sizing and decrease sizing cost by studying the characteristics of PAC and DRS admixture, which could help us find the applying feasibility of this technique. In this paper, we studied zeta potential, particle size distribution and IR characteristics of PAC modified cationic dispersed rosin size using particle size equipment and FT-IR, as well as its sizing effects

EXPERIMENTAL

Raw materials

Highly purified PAC was obtained from Nanning Chemical Industry Group Corporation; Dispersed rosin size was from Wuzhou Rosin Plant, Guangxi; Bleached Bagasse chemical pulp (35°SR) was obtained from Nanning Sugar Corporation, Guangxi.

Methods

Zeta potential and particle size determination [4-5]

Premixing condition:
reaction temperature:30-70℃, stirring speed: 600-900rpm, premixing time:10-30min, PAC: rosin=1:0.1、1:0.2、1:0.3、1:0.4、1:0.5、1:0.6 zeta potential and particle size were determined by 90plus Particle Size Analyzer.

FT-IR measurement [6-7]

FT-IR measurement have been carried out by Germany200*B FT-IR spectrometer. The samples studied were dried and cut into a powder. The powder samples were mixed with KBr and were pressed respectively, to give a pellet to be used as FT-IR analysis sample.

Sizing methods

PAC/DRS sizing: Add 1%PAC(calculated by Al_2O_3 content) into 2% pulp, stirring for 3min, after that 2% DRS was added into, completely mix them and diluted into 0.5%, 1% starch paste and 5% $CaCO_3$ were charged later by, and 0.01% CPAM was dosed at last, and paper sheets were made by Canadian standard sheet former.
PDRS sizing: 2% PDRS was added into 2% pulp, completely mix them and dilute into 0.5%, after that 1% starch paste and 5% $CaCO_3$ were charged, later by 0.01% CPAM was dosed, and paper sheets were made by Canadian standard sheet former.
Sizing condition: CPAM 0.02%, cationic starch 1.0%, $CaCO_3$

20%

RESULTS AND DISCUSSION

Characteristic analysis of PAC modified cationic dispersed rosin size

Zeta potentials and particle sizes of PAC modified cationic dispersed rosin size is shown in figure 1.

Figure1 shows the transformation of zeta potential and particle size of PAC modified cationic rosin size. Normally, more PAC mixing with dispersed rosin size will brought more cationic charge which leads to higher zeta potential of the admixture. But practicality determined results indicate, its determine value is different from anticipation, after dispersed Rosin Size reacted with PAC, electricity charge from negative to positive, Al2O3/rosin=1:0.3, zeta potential of premixed admixture is tiptop28.8mv。 When joined continuously PAC, zeta potential of cationic rosin sizes descend on the contrary. Because PAC is polyhedral, one PAC molecule can aggregate with many rosin particles, more PAC result in more polymerization, which enlarges the particle size of the admixture. So, there will be less rosin particle left in the system, decreasing the surface area of the admixture. The ongoing reaction between rosin particle and PAC increases the size of the admixture, which leads to lower zeta potential of the admixture. So different ratio of PAC to rosin size will result in different characteristics of modified cationic rosin size.

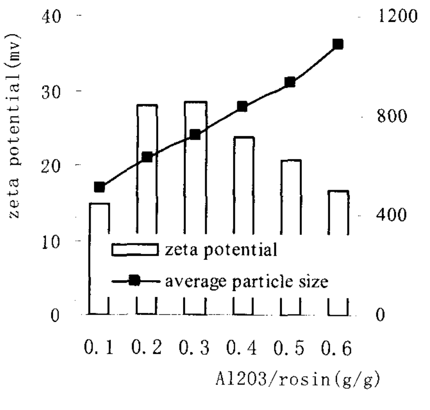

Fig. 1 The transformation of zeta potential and particle size of admixture follows the different ratio of PAC.

FT-IR analysis of PAC modified cationic rosin size

IR spectra of samples [8-9]

IR spectra of different samples were shown in figure 2, figure 3 and figure 4.

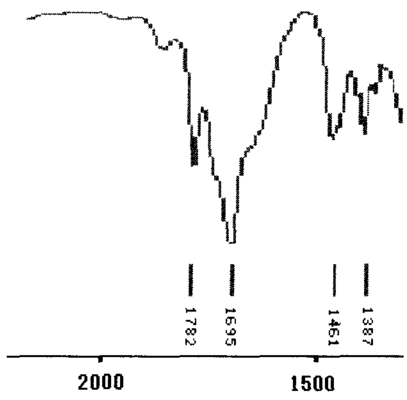

Fig. 2 FT-IR spectrum of dispersed rosin size

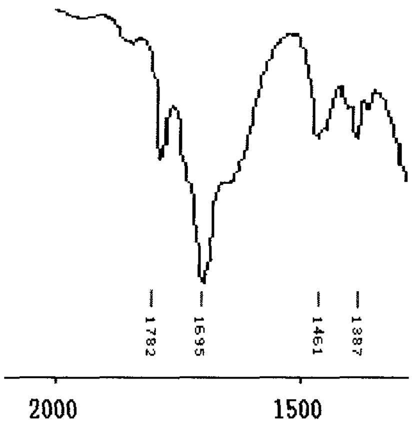

Fig. 3 FT-IR spectrum of the simple mixture (rosin: Al_2O_3=1: 0.6) of rosin size and PAC

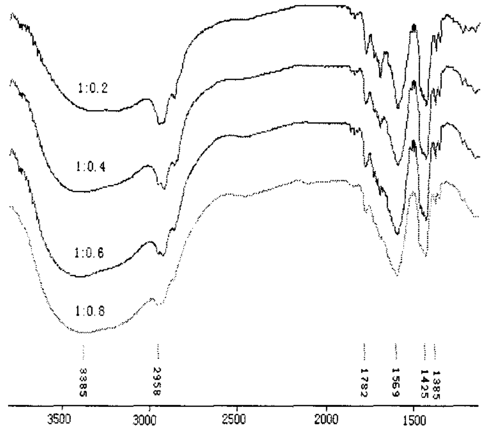

Fig.4 FT-IR spectrum of PAC modified cationic rosin size

FT-IR Spectral Analysis

Fig. 4 FT-IR spectrum of PAC modified cationic rosin size

The FT-IR spectra of rosin and simple mixture of rosin and PAC were shown in figure 2 and figure 3; figure 4 showed the FT-IR spectrum of the admixture of dispersed rosin size and PAC at different ratios. The spectrum analysis was shown in table 1.

From the spectrum analysis in table 1, we concluded that the reaction between PAC and dispersed rosin size happened only after they were premixed together, creating aluminum rosinate. Because once carboxyl group changed into –Coo-, it will combine with aluminum ions. Because of sympathetic vibration of carboxyl group, bond energy of -C=O decreased, decreasing its flexing vibration frequency. Besides, two C=O bond of carboxyl group is the same, theoretically, they has dissymmetric and symmetric flexible vibration two absorbing peaks near and 1420cm^{-1}, respectively[9]. From figure 4 we can see their absorbing peaks were almost the same as where they theoretically are. The absorbing frequency of -C=O in -COOH changed from 1695cm^{-1} into 1596 cm^{-1}. After reacting with PAC two absorbing peaks at 1461 cm^{-1} and 1385 cm^{-1} pile up into 1425 cm^{-1}. Absorbing peaks at 3000-3700 cm^{-1} shown in figure 4 meant aluminum rosinate which was created from reaction was multi hydroxyl aluminum rosinate.

Comparison of PAC modified cationic starch sizing and PAC/DRS sizing

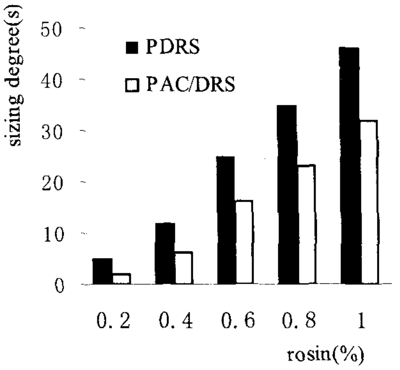

Fig. 5 Rosin: Al_2O_3= 1: 0.8

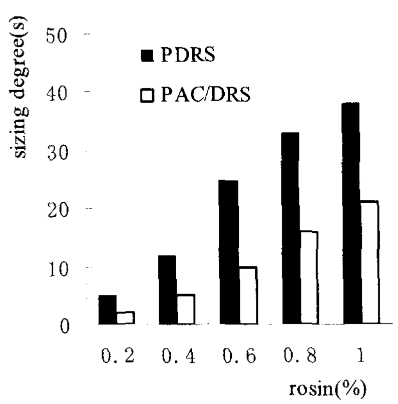

Fig. 6 Rosin: Al_2O_3 = 1: 0.4

It can be seen from comparing figure 5 and figure 6 that sizing effects of PDRS were better than PAC/DRS sizing under the same sizing condition. When PAC content was 50% (Al_2O_3:rosin=0.4:1), the sizing effects of PDRS were still satisfying,however, PAC/DRS sizing effects were remarkably droped. When the same sizing effects were got, PDRS sizing not only can save more than 50% PAC, but rosin dosage also can be decreased evidently. Because in PDRS sizing PAC and rosin reacted with each other and created cationic "multi hydroxyl aluminum rosinate", which is highly charged, and its Zeta potential can be more than 25 mv. The combination of "multi hydroxyl aluminum rosinate" and negatively charged fibers improved the efficiency of PAC and retention of rosin, resulting in better sizing efficiency.

CONCLUSION

When dispersed rosin size and PAC were premixed at the ratio from 1:0.2 to 1:0.8, the particle size of premixed admixture increased following the increasing content of rosin, while its zeta potential decreased, and reached its maximum when the ratio of Al_2O_3 and rosin is 1:0.3.

The FT-IR analysis showed that aggregation reaction happened during the premixing process of dispersed rosin size and PAC. Dispersed rosin size 3000-3700 cm^{-1} proved that aluminum rosinate which was created from reaction was multi hydroxyl aluminum rosinate.

The sizing effects of PDRS were better than that of PAC/DRS sizing at the same dosage of rosin and PAC; more than 50% PAC could be saved and rosin dosage could be evidently decreased by PDRS sizing when the same sizing effects were reached.

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APPENDICE

Table 1 : FT-IR analysis of PAC modified cationic rosin size

Samples	Vibration	Vibration categories	Wave numbers (cm^{-1})	Spectrum analysis
dispersed rosin size	RCO_2—	ν ($CO2^-$, as) ν ($CO2^-$, s)	1695 1461-1387	Functional group of rosin
	C=O	ν (C=O)	1782	The functional group is brought by joined maleic acid anhydride in rosin
Simple mixture of PAC and dispersed rosin size	RCO_2—	ν ($CO2^-$, as) and ($CO2^-$, s)	1695 1461-1387	no reaction took place between PAC and rosin
	C=O	ν (C=O)	1782	
PAC modified cationic rosin size	two combine body with RCO_2—and PAC	ν ($CO2^-$, as) ν ($CO2^-$, s)	1596 1425	Chemical reaction took place between PAC and rosin
		ν (-OH)	3000-3700	This is strong－OH functional group from PAC modification