CONTROL OF STICKY CONTAMINANTS WITH CATIONIC TALC IN DEINKED PULP

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In this study a cationic talc was applied to deinked pulp for control of sticky contaminants. Effects of the cationic talc on stickies and dissolved and colloid substances were investigated and compared with those of a conventional talc. Characteristics of wet-end chemistry were examined for the pulp with addition of both kinds of talc samples. Furthermore, influences on paper properties were also compared. The results showed that the addition of cationic talc can effectively decrease the content of stickies and DCS, while reducing the cationic demand of the pulp, and the turbidity of the filtrate. Deposition of stickies can be reduced by about 63% with the addition of 2.0% cationic talc into the pulp, and the DCS was reduced from 1989 mg/L to 1927 mg/L. Addition of cationic talc significantly increased the ash content of the paper, but it negatively influenced the paper strength properties.

Keywords: Cationic talc; Deinked pulp; Sticky contaminants; Stickies control; Paper properties

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INTRODUCTION

Stickies remain one of the major obstacles in the manufacture of quality newsprint from recycled fibers. Sources of stickies may include adhesives, hot melts, coating binders, ink residues, deinking chemicals, rosin, and wet strength resin. In mill practices, the contaminants remaining in the pulp furnish can build up within the paper machine headbox, on the forming wire, in the press section, and in the dryer section, causing operation problems and harming product quality (Hubbe et al. 2006; Blanco et al. 2007). Control of sticky contaminants is crucial for papermaking with deinked pulps. Therefore, different measures have been developed and applied in mill practices (Dechandt et al. 2004). Sticky particles, especially micro-stickies, show affinity to talcs, and the ΔG (Gibbs free energy) for adsorptive adhesion between natural talc and sticky substances is in range of -23 to -42 mJ/m^2 (Schweighofer 2010). Adsorption of sticky substances with addition of cationic polymers or cationic talc is one of the reasonable approaches so that they can be retained in the formed paper sheet (Wågberg et al. 1995; Biza 2001).

Talc is a hydrated magnesium silicate with a laminated structure. The mineral has an octahedral brucite layer situated between two tetrahedral sheets of silica. It is presented by the chemical formula of $Mg_3(OH)_2Si_4O_{10}$. Talc is naturally hydrophobic, so that it cannot be wetted in water without the use of surfactant. Hydrophobicity is an apparent property of the planar face, while the exposed particle edges are hydrophilic due to the presence of pH-influenced $MgOH^+$ groups (Charnay et al. 2001; Guera et al. 2005).

Talc can be cationized by adsorbing cationic polymers at the edges of talc platelets, due to a strong interaction that may exist between the polymer and the hydroxyl groups. If enough cationic polymers are added, then the net surface charge of talc can be converted from negative to positive, which is important for attracting sticky particles that usually carry negative charges. Furthermore, talc acts as filler in a paper structure and traps the anionic trash on its mineral particles, so that they can be removed from the pulp suspension. In addition, paper properties can be basically maintained due to the fact that the fiber surface remains available to perform its primary function for fiber-fiber bonding (Biza 2001; Hayakawa et al. 2004; Morris et al. 2002).

The objective of this study is to investigate the effectiveness of cationic talc for the control of sticky contaminants in deinked pulps, and to examine its influences on the wet-end chemistry of pulps and properties of paper handsheets. The investigation also includes a comparison with the results of addition of conventional talc. It is hoped that the preliminary results obtained from this investigation will provide some useful information for the paper mill practice which utilizes recycled fibers.

EXPERIMENTAL

Materials

The deinked pulp was sampled from the machine chest of a commercial deinking puling line, and the conventional talc was obtained from the same mill. Cationic talc was provided by the Rio Tinto Minerals.

Measurement of Sticky Contaminants

The addition levels of both kinds of talcs were varied as 0%, 0.5%, 1.0%, 1.5% and 2.0%. The TAPPI standard procedure was followed to form 120 g/m^2 paper handsheets, except that a sheet of aluminum foil was put on the formed paper sheet for the purpose of measuring gravimetrically sticky substances. The paper sheet was pressed together with the aluminum foil. The paper sheet was dried together with the aluminum foil at 130 °C for 10 min. The aluminum foil was then separated from the paper. Weighing the aluminum foil, the increase in weight is considered as the sticky substances (Delagoutte et al. 2001). The average of 12 measures was taken as the result.

Measurement of Dissolved and Colloid Substances

The pulp slurry was filtrated with a Dynamic Drainage Jar (DDJ, 100-mesh screen) to remove the fiber fractions. Then 50 mL of filtrate was centrifuged at 2000 rpm. for 20 min. to obtain the supernatant, which containing the dissolved and colloid substances (DCS). The average of three measurements was taken as the result.

Examination of Wet-end Chemistry Characteristics

The cationic demand of the pulp was determined by polyelectrolyte titration with a PCD-03 Mütek Particle Charge Detector from BTG, and poly-diallyl-dimethyl-ammonium chloride (PDADMAC) at 0.001 mmoL/L concentration was used as a standard cationic polyelectrolyte. The turbidity of filtrate was determined with a Hach

2100N Turbidity Meter. The zeta-potential of pulps was determined with a Mütek SZP-04 zeta-potential tester.

Measurement of Paper Properties

The strength and optical properties of handsheets were tested according to the Chinese standard methods of GB/T453-1989, GB/T455.1-1989, and GB/T7974-2002. Ash content was measured according to the method of GB/T463-1989. Images of talc samples were imaged with a FEI Quanta 200 SEM.

RESULTS AND DISCUSSION

Control of Stickies with Addition of Talc

Figure 1 shows that the amount of sticky deposits decreased with addition of both kinds of talcs. It is easy to understand that the sticky substances can be adsorbed or wrapped by talc particles, which reduces their tackiness, and it makes them easier to remain in a paper sheet. Therefore, the free tacky particles, i.e. amount of substances examined by the aluminum foil method was decreased, as shown in Fig. 1.

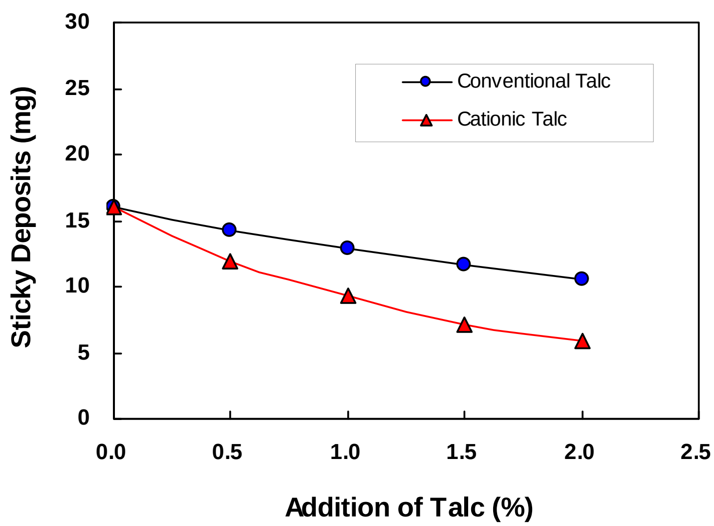

Fig. 1. Addition of talc versus sticky deposit

One can conclude that the cationic talc showed a better performance for reducing sticky deposits than that of conventional talc. At the same addition level of 2.0%, the deposits were reduced from 16.0 mg to 10.6 mg for adding conventional talc, and to 5.9 mg for adding cationic talc, which accounted for 33.8% and 63.1%, respectively. This result is understandable based on the fact that the cationic talc particles had been treated with cationic polymers, which would be expected to remain adsorbed on the edges of talc particles, so that they can be used more effectively to trap sticky substances.

Control of DCS with Addition of Talc

Figure 2 shows the change of dissolved and colloid substances with addition of talcs. It can be seen that the DCS in the filtrate was reduced from 1989 mg/L to 1927 mg/L at an addition level of 2% cationic talc; however the DCS results were not significantly affected by the addition of conventional talc over the varied addition levels up to 2%. A possible explanation is that the charge balance in the pulp system changed with adding of cationic talc, and some DCS thereby lost their stability, so that they were easily agglomerated with each other, and finally trapped by talc particles. Apparently, a decrease of DCS will be beneficial to the recirculation of process water in a papermaking system.

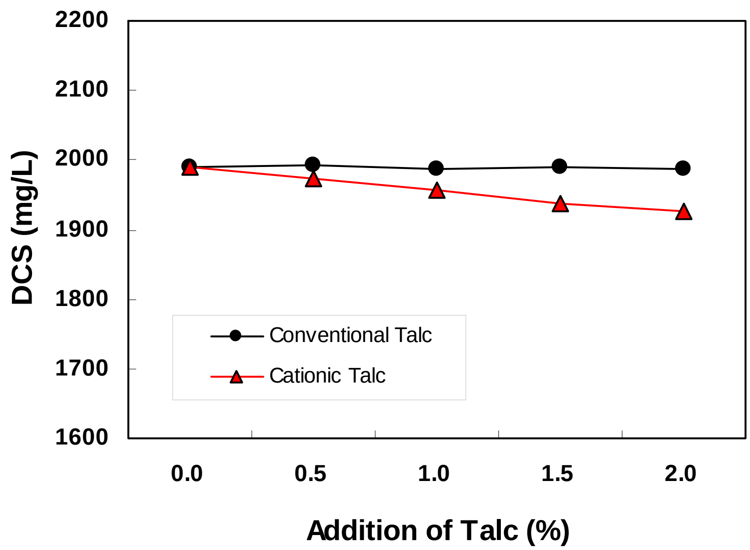

Fig. 2. Addition of talc versus DCS content

Characteristics of Wet-end Chemistry

It is shown in Fig. 3 that the zeta potential of the pulp slightly decreased with the addition of both kinds of talcs, especially in the case of the cationic talc (decreased from minus 28.5 mV to minus 29.9 mV at an addition level of 2.0%). Zeta potential represents the amount of surface charges of pulp fibers. This indicates that the sticky substances were absorbed onto pulp fibers, which can account of the increase of negative charges with increasing addition levels of talc. In addition to absorbing sticky particles, anionic trash can also be trapped by the cationic talc, and this led to further decrease of zeta potential.

It can be seen in Fig. 4 that the cationic demand decreased significantly with the addition of both kinds of talcs. As discussed above, sticky particles can be wrapped by the talc particles, leading to the decrease of negative charges in the pulp suspension. Cationic demand is further decreased with increasing amount of talcs, especially at higher addition levels. The cationic talc showed a higher decrease of cationic demand, which can be explained by the positive charge carried by the cationic talc. This made it attractive not only to stickies but also to anionic dissolved and colloidal substances.

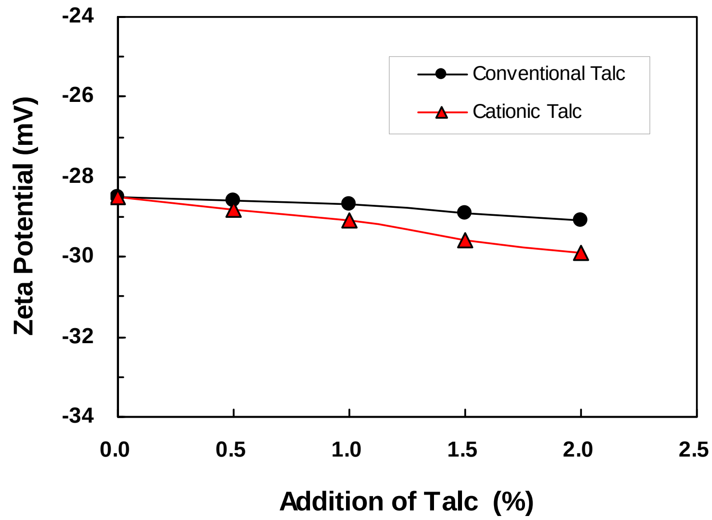

Fig. 3. Addition of talc versus zeta potential

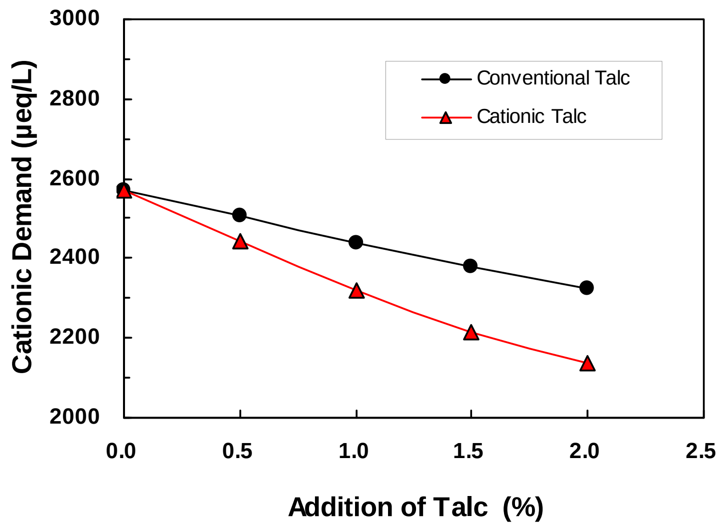

Fig. 4. Addition of talc versus cationic demand

The results shown in Fig. 5 indicate that the turbidity increased slightly with addition of conventional talc, but it decreased noticeably with the addition of cationic talc. This is not unreasonable, since in the case of adding conventional talc, some talc-stickies complexes may pass through the screen of the DDJ apparatus and remain in the filtrate, which results in a higher turbidity. For the case of adding of cationic talc, more sticky substances are attracted, and attached onto pulp fibers. This subsequently leads to less suspended particulates in the filtrate, i.e. showing as a lower turbidity. In addition, the cationic charges carried by talcs can also cause the colloid substances to become aggregated, so that the turbidity is further decreased.

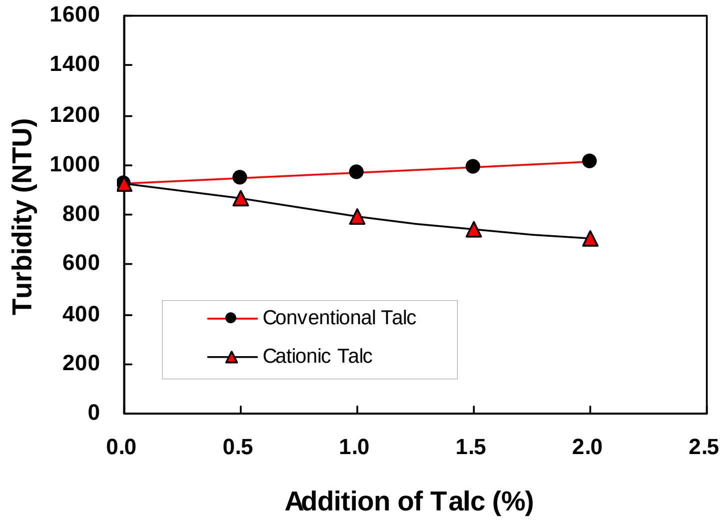

Fig. 5. Addition of talc versus turbidity

SEM Images of Talcs

Retention of talc particles in a paper sheet is related not only to the surface charges but also to the characteristics of the talc. The morphologies of talc samples were observed with a SEM. The images were acquired and as shown in Figs. 6 and 7. It can be seen that the conventional talc exhibited in a laminated structure. As reported in the literature (Charnay et al. 2001), an octahedral brucite layer is situated between two tetrahedral layers of silica; because they are combined mainly by the Van de Waals force, they are more easily separated into lamellae or even smaller pieces The cationic talc showed a scale-like or microcrystalline structure, and with a large specific surface area. Therefore, it demonstrated a higher absorption tendency when interacted with sticky particles and colloid substances.

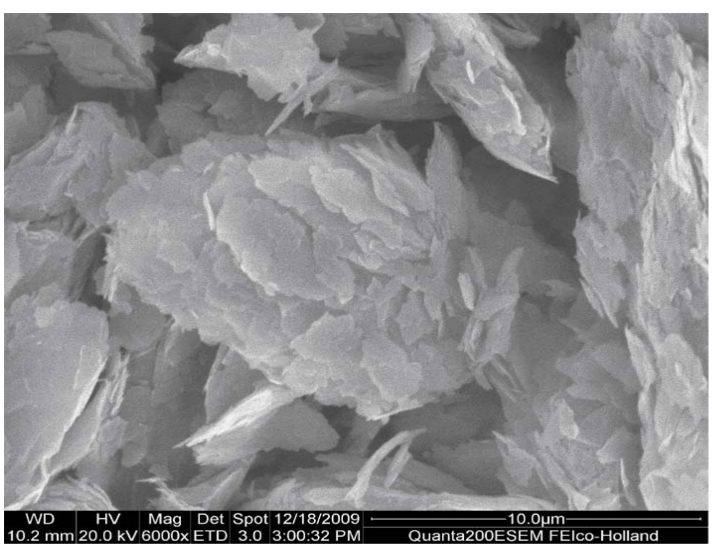

Fig. 6. SEM image of cationic talc

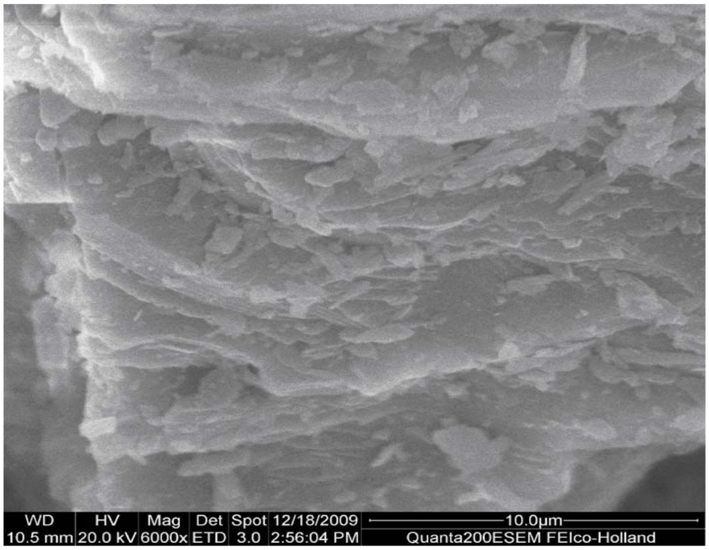

Fig. 7. SEM image of conventional talc

Effect of Adding Talc on Paper Properties

Figures 8 and 9 show that the paper tensile and tear indexes decreased with the addition of both kinds of talc. It is clear that as inorganic materials, addition of talc noticeably affected the fiber-fiber bonding. As shown in the figures, adding cationic talc resulted in a higher decrement of paper strength. As discussed previously, the cationic talc trapped more sticky contaminants than did the conventional talc, so that it affected to a larger extent to the fiber-fiber bonding. This suggests that in a mill practice of adding talc, a combination should be considered to achieve control of sticky contaminants, while also maintaining the desired paper strength properties.

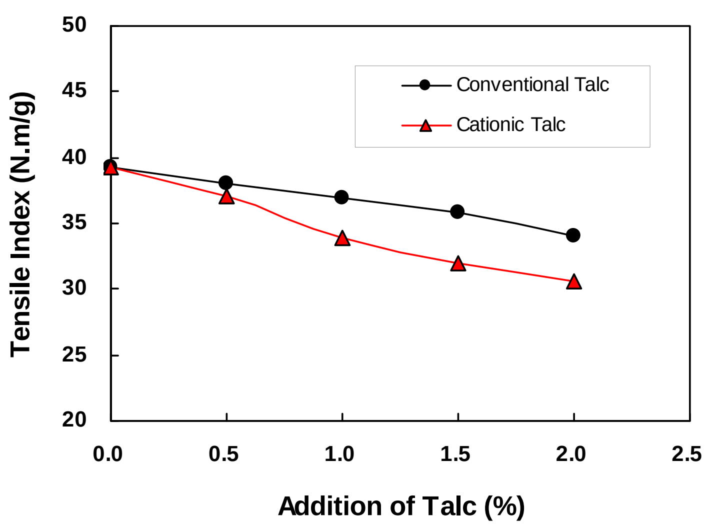

Fig. 8. Addition of talc versus tensile index

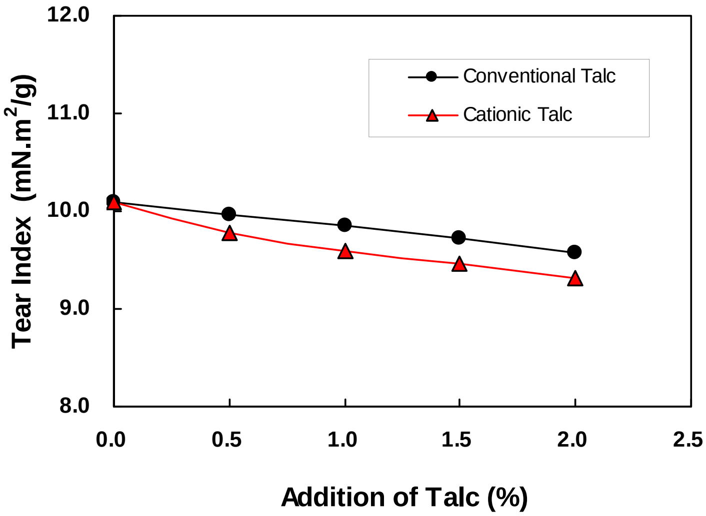

Fig. 9. Addition of talc versus tear index

Figure 10 shows the development of paper brightness with addition of both conventional and cationic talcs. The conventional talc provided the paper handsheets with a higher brightness than the cationic talc. It is easy to understand that the higher brightness resulted from the higher brightness of conventional talc.

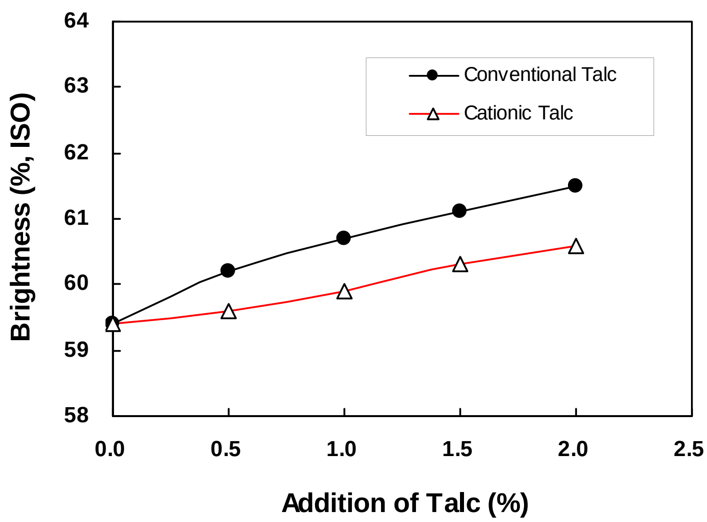

Fig. 10. Addition of talc versus brightness

As expected, the ash content of the paper increased with addition of both kinds of talc, as shown in Fig. 11. Compared with the conventional talc, the paper sheets with addition of cationic talc were observed to have a higher ash content. At addition level of 2.0%, the ash content increased from 3.3% to 6.2% for adding cationic talc, equivalent to an addition level of 5.0% for the conventional talc. This indicated that the cationic talc showed a higher retention efficiency, which will benefit the mill to save costly fine material in the furnish.

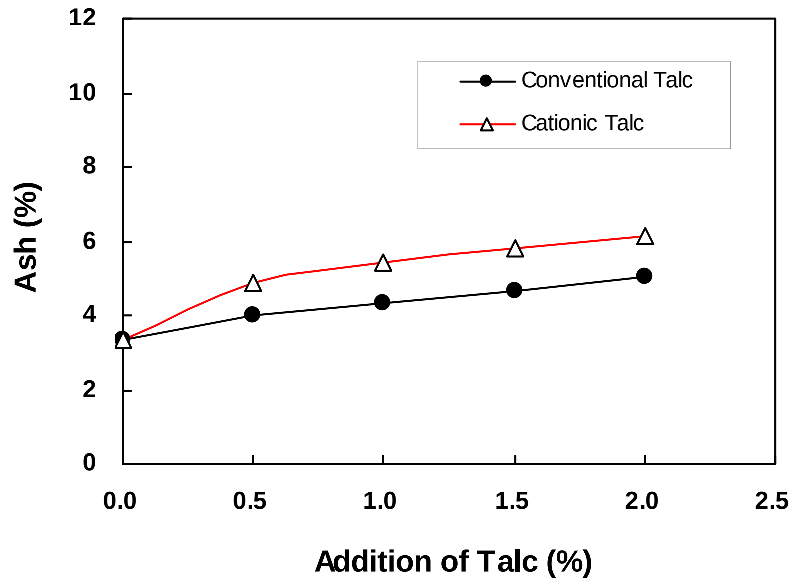

Fig. 11. Addition of talc versus ash content

CONCLUSIONS

1. Addition of cationic talc showed an apparent benefit for the control of stickies and dissolved and colloid substances. Measured by the aluminum foil method, about 63% of sticky contaminants could be removed from the deinked pulp with the addition of 2.0% cationic talc.
2. The turbidity of the filtrate, zeta potential, and cationic demand of the pulp can be significantly decreased by adding cationic talc. Compared to the conventional talc, the cationic talc showed different morphology, which provided a higher specific surface area, in addition to better absorption ability.
3. Adding cationic talc significantly increased the ash content of the paper, but showed negative effect on paper strength properties. The addition level should be considered, combining with the desired paper strength and control of sticky contaminants.

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