The Characteristics of Cationic Humite Micro-Particle and its Effect as Retention Aid to Paper

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***Abstract* — The paper studies the function of nanometer cationic humite micro-particle and its function as a fluid retention and drainage aid. The results show that the nanometer cationic humite micro-particle had high cationic Zeta potential, which increased while its pH value dropped. With grinding time increasing, the particle diameter and its cationic Zeta potential decreases gradually but noticeably. When it was used in a retention aid system, it performed some retaining effect but was insensitive to shear stress, so it is not an excellent retention system. However, the unit doublet retention composed by Nanometer cationic humite micro-particle and APAM perform excellent retention function. It is an ideal retention system.**

Keywords- cationic humite micro-particle; grinding; retention

I. INTRODUCTION

With the development of Papermaking technology and the increasing requirement for wet end white water canned cycle system, the retention aid system of wet end chemistry receives more and more attention, especially the retention aid technique [1, 2]. In the late 1980s, the retention aid system of CPAM/ bentonite particle developed successfully by Sweden Eak Nobel Paper Chemicals Corporation is regarded as a revolution in paper-making. It can increase the speed of machine, improve the production quality and reduce the production cost [3].

A new micro-particle retention aid system was investigated in this paper. The micro-particulate retentions systems are composed of nanometer cationic humite micro-particle and Anionic PolyacrylAMide (APAM), and it is to be regarded as a new type of retention aid system [4-5].

II. EXPERIMENTAL

A. Materials and Apparatus

Positively charged chrisotile micro-particle: nanometer level, obtained from Haishan leakproof material Co. Ltd., Zhejiang Province. Bleached soft wood pulp and bleached reed pulp and anionic polyacrylamide (APAM): obtained from Sinkiang BoHu Paper group Co. Ltd., Hei Longjiang Province. CaCO3 suspended level, obtained from Sinkiang BoHu Paper group Co. Ltd., Hei Longjiang Province.

Globe mill: QM-3-A, obtained from Tianchuang Chemical Engineering Corporation, Changsha, Hunan Province. Zeta electric potential and granularity survey-meter: Zeta-sizer Nano ZS, produced by Malvern Instruments, England. DDJ dynamic dehydration instruments: Mt2110, Produced by Paper Research Instruments, U.S.A.

B. Experimental Process

Firstly, the concentration of cationic humite micro-particle solution was 40 % and the solution was added into Grinder for grinding within limited time. Secondly, applied experiment of paper stuff CaCO3 suspended liquid (CaCO3 25 % based on the pulp fibers) was added into the mixed pulp suspension in the dynamic drainage jar (2g absolutely dry pulp, ratio of the soft wood pulp to the reed pulp was 3:7). The cationic humite micro-particle was added, and the suspension was mixed for 1min. Then APAM was added. The initial filtrate 100 ml was collected and the turbidity was measured with the spectrophotometer.

III. RESULTS AND DISCUSSION

A. Primary Characteristic of Cationic Humite Micro-particle

The molecular formula of cationic humite micro-particle is Mg7[SiO4]3(F,OH)2. Belong to orthorhombic island shape silicate. However, some Mg2+ in the structure was substituted by Fe3+, Fe2+, Al3+, Cr3+,V5+, etc., therefore, humite micro-particle has high positive charge.

Figure.1 and Figure.2 are the electrification states of non-grinding humite particle. The figures show that the zeta potential of humite micro-particle is +50 mV and the electric density is +0.16 meq/g at pH=7. It is evident that cationic humite micro-particle had high positive charge while zeta potential and electric density increased with the pH value dropped.

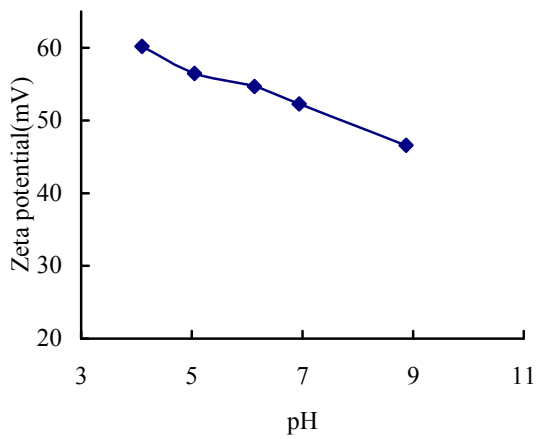

Figure 1. Effect of PH on Zeta potential of humite

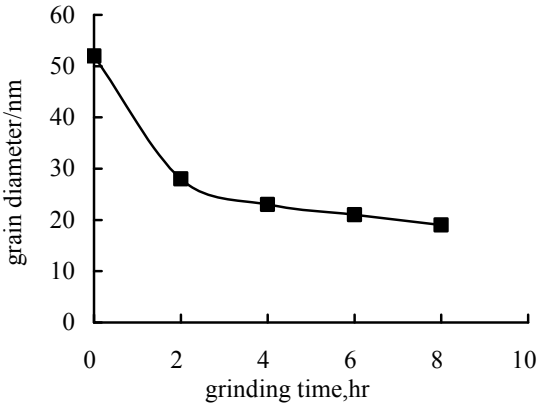

Figure 3. Effect of grinding time on humite grain diameter

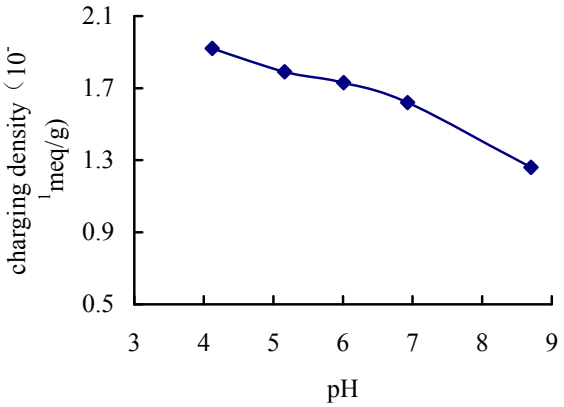

Figure 2. Effect of PH on charging density of humite

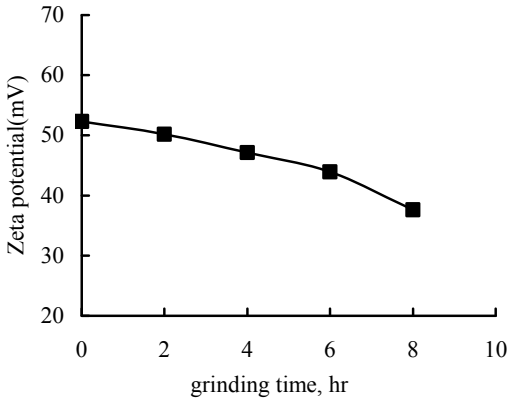

Figure 4. Effect of grinding time on Zeta potential

Figure.3 shows that the particle diameter of cationic humite micro-particle was changed by wet grounding. It is evident that the particle diameter of cationic ungrounded humite micro-particle was 52 nm. The average particle diameter decreased with grounded while the scope of reduces to become slower approximately 3 hours later. The average particle diameter was 19nm at average 3 hours or so later.

What the Figure.4 shows is that the electric potential changing state**.** As shown in figure 4 that the zeta potential of grounded humite micro-particle decreased obviously. The zeta potential of ungrounded humite was quite high but it decreased after grounded, and the scope of decreased obviously especially 8 hours later. So it concluded that the positive electricity ions Fe3+, Fe2+ Al3+, Cr3+ of humite micro-particle was wrapped in the particle and the ions were exposed with grounded, then the zeta potential decreased.

B. Single-component Retention System of Cationic Humite Micro-particle

Figure.5 shows the cationic humite micro-particle retention effect to paper by using dynamic filter. It is evident that the turbidity of the filtrate collected from the dynamic drainage jar was decreased obviously as humite increased. It was probably due to the high cationic zeta potential of humite micro-particle which could adsorb CaCO3 filler and fines with static action. Therefore, cationic humite micro-particle had good retention effect. Before the addition of 20% humite (based on mass

percent of CaCO3), the turbidity reduced slightly. However, the obviously decreased of the turbidity could be observed after amounts of added humite were 20-50%. So it concluded that it had good retention effect of cationic humite micro-particle retention system when the massive humite was added. There is little difference between the ungrounded and grounded humite used alone. Ungrounded humite was relatively better, and it may be due to the zeta potential and the average particle diameter decreased with grounded (Figure 4) while the scope of the zeta potential reduces obviously that had effect on absorption of CaCO3 filler and fines.

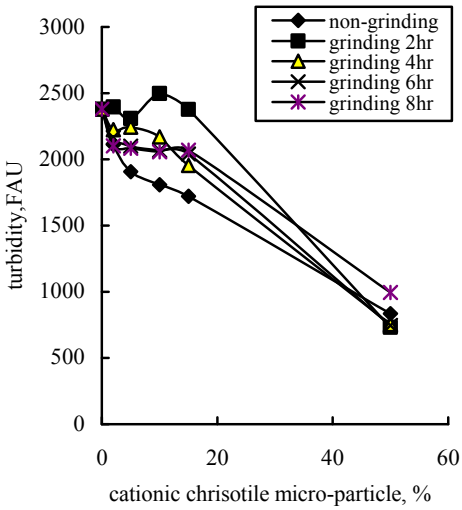

Figure 5. Retention effect of cationic chrisotile

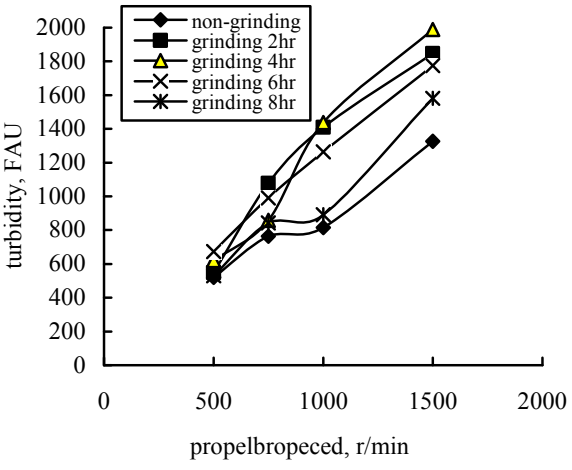

Figure 6. Effect of shear on retention (20% humite)

Figure 6 is about the cationic humite micro-particle effect of shear on retention. The graph shows, no matter in ground or un-ground state, that the turbidity increased rapidly as the shear rate rose. This outcome suggested that flocs formed by cationic chrisotile or APAM were insensitive to the effects of shear, and flocs degraded in size as shear increased. It may be due to the static action between cationic humite micro-particle and CaCO3 filler was quite weak. So it was not ideal retention system of the single component.

C. Cationic Humite Micro-particle/ APAM Retention Aid System

Figure.7 shows the retention effect of the cationic humite micro-particle/APAM retention aid system to the CaCO3 filler and fines. The addition of APAM was 0.5 % (based on mass percent of CaCO3). The turbidity was lowest when the added amount of humite was 2 % (based on mass percent of CaCO3). It is shown that grounded or ungrounded cationic humite micro-particle /APAM retention aid system achieved excellent retention.

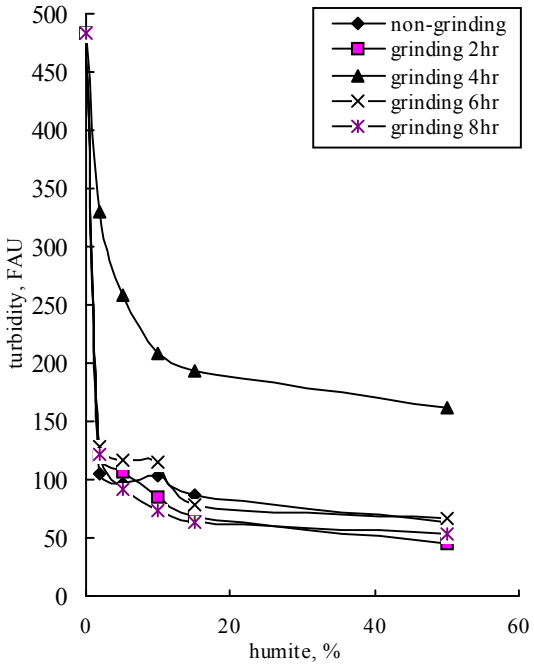

Figure 7. Effect of humite/0.5%APAM double grouping on turbidity

Figure.8 shows the shear of the cationic humite micro-particle/APAM retention aid system. The added amount of humite was 5 % and APAM were 0.5 % (based on filler). Both grounded or ungrounded cationic humite micro-particle and APAM retention aid system were insensitive to the effect of shear. The cationic humite micro-particle grind 2hr or 8hr later was sensitive to the effect of shear and the ungrounded cationic humite micro-particle was more insensitive. It may be due to the positive charge of the ungrounded cationic humite micro-particle was relatively high. There were strong binding between the high cationic charge of the cationic humite

micro-particle and negative charge of APAM that involved excellent resistance to shear.

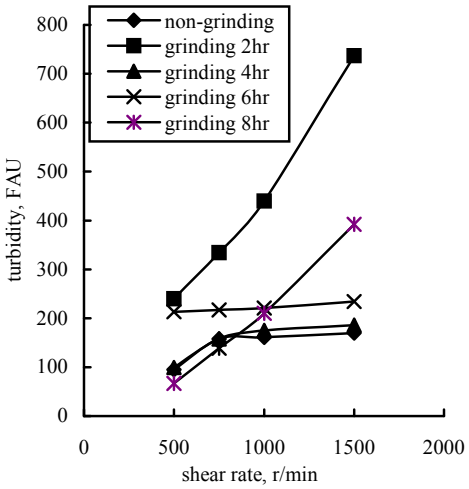

Figure 8. Effect of shear rate on turbidity of humite/APAM double grouping

Figure.9 shows the influence of pH on retention when using grounded or ungrounded cationic humite micro-particle /APAM retention aid system. It is evident that the turbidity increased with increasing pH. The result indicates that the positive charge of the cationic humite micro-particle increased with pH decreasing and then the system had a better retention. The turbidity was lower as pH from 6 to 8.5 then it had had a better retention.

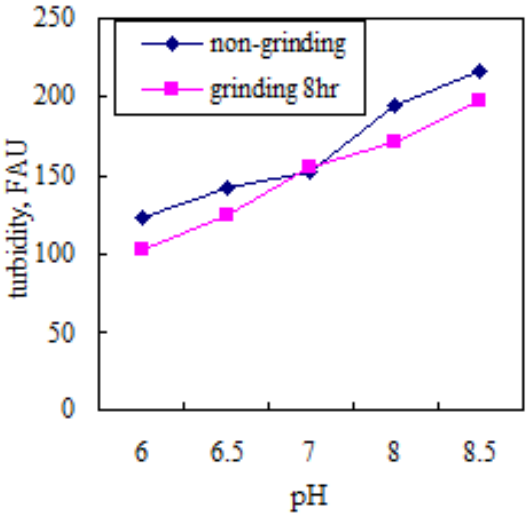

Figure 9. Effect on humite/APAM (humite 5%, APAM 0.5%)

In summary, it had had a better retention both the system of APAM/ grounded and ungrounded cationic humite micro-particle, and then the system of APAM/cationic ungrounded humite micro-particle was insensitive to the effect of shear and pH.

IV. CONCLUSION

1. The nanometer cationic humite micro-particle has high positive charge which increased with the pH value dropped.

2. The average particle diameter and the zeta potential of humite micro-particle decreased with grounding.

3. The cationic humite micro-particle had some retention effect to CaCO3 filler and fines when it was used alone, but with plenty of humite micro-particle had not better retention and it was sensitive to the effect of shear.

4. When nanometer cationic humite was used as retention aid in cationic retention system was insensitive to the effect of shear and pH, especially the ungrounded humite micro-particle had more excellent retention effect. Therefore, the retention aid system of un-ground cationic humite micro-particle/ APAM is an ideal retention aid system.

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