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New Test Methods of Retention and Drainage Using Multi-channel Turbidimeter and Balance Recorder

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ABSTRACT

This study was performed to find effective measuring methods of retention and drainage by comparing traditional measuring methods of Britt jar, Canadian standard freeness tester methods and recently developed RDA-HSF with multi-channel turbidimeter method. At the result, Multi-channel turbidimeter method was useful to measure retention and efficiency of multiple chemical dosing system. A system CSF equipped with the balance recorder was also useful to obtain dynamic drainage information including initial drainage rate and final drainage amount. Therefore, we consider these new measuring systems would be helpful to advance retention and drainage technology.

Keywords : multi-channel turbidimeter, balance recorder, retention and drainage aids

1. Introduction

As the influences of retention and drainage on the productivity and quality of the paper grow higher, the measuring technologies are more sophisticated to improve the accuracy, efficiency and convenience. First of all, most common measuring technologies are Britt jar (BJ) retention and Canadian standard freeness tester (CSF) drainage methods (1-2). However, BJ retention method has defects of time consuming and difficult to filter white water and dry, stabilize and weigh filter paper. CSF drainage method has defects of natural drainage to make fiber pad which is different from mill condition of vacuum de-watering and we can get just drainage amount information that we couldn't estimate drainage speed etc (1-2). Recently developed retention drainage analyzer-hand sheet former (RDA-HSF) has benefits of convenient measurement of retention, drainage and formation (3). This machine is effective to measure drainage with various vacuum conditions (3). However, the added water just below the wire part to improve formation and adjust pressure gave negative effect to dilute efficiency of retention and drainage (3).Therefore,

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we applied multi-channel turbidimeter (MCT) to the BJ for measuring realtime retention and flocculation characteristics (4). At the result we found this application was very effective to observe efficiency of each chemical of multi-chemical retention system. And drainage could be determined by connecting balance recorder (BR) to the computer and CSF to give dynamic information like sectional drainage rate and final drainage amount etc.

2. Materials and methods

2.1 Pulps and additives

LBKP and GCC(17% by dry pulp,wt) were used to retention and drainage test as a stock P-DADMAC, C-PAM, A-PAM and bentonite were used as retention aids. Table 1 shows analysis of applied retention aids.

2.2 Beating

Beating was performed using laboratory valley beater by following TAPPI Standard T200 SP-01 (5). The freeness of stock was 400 ml CSF (±10 ml).

2.3 Measurement of retention and drainage

2.3.1 MCT with BJ retention and BR with CSF drainage

MCT was developed to measure turbidity variation at the different point of water treatment plant. we applied this to BJ to measure retention conveniently. MCT retention measurement followed with modification of TAPPI Standard T 261 CM-00. Sensors of MCT were equipped to BJ and several white water tanks to measure realtime retention and flocculation efficiency by analysis of turbidity graph. BR with CSF drainage measurement followed with modification of TAPPI Standard 227 OM-99. BR connected to the computer was equipped to the CSF to measure drainage and draw graph simultaneously. We can determine dynamic information of drainage rate variation and final drainage amount.

2.3.2 Standard BJ retention and CSF drainage

Table 1. Analysis of applied retention aids

Analysis Items	C-PAM	P-DADMAC	Bentonite	A-PAM
Total solid (%)	42	40	90	41
Charge density (meq/g)	1.36	6.5	<-0.1	-4.0
Viscosity. (cps)	2,200 (0.5%)	250 (bulk)	223 (5%, after 4hrs)	3,200 (0.5%)
pH (0.5%)	4	6	8.5	7.5

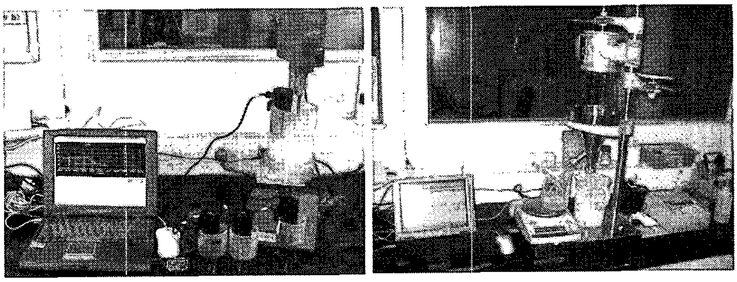

Fig. 1. MCT with BJ and BR with CSF.

Standard BJ retention and CSF drainage measurements followed TAPPI Standard T261 CM-00 and T227 OM-99 respectively. Retention was taken by % values and drainage degrees were taken by ml CSF.

2.3.3 RDA-HSF retention and drainage

Retention and drainage were performed by operation of RDA-HSF Paper machine. The consistency of the stock was 0.18% and the volume of the stock was 1,000 ml. Vacuum condition of the drainage part was 200 mmHg at the main and sub tank. The sequence of chemical contacted time of the stock was as followings. At first, stock was introduced to the jar and let it stirred at 1,000 rpm for 15 seconds. and then, cationic polymer was added and let it stirred at 1,000 rpm for 15 seconds. and if needed, anionic polymer or bentonite was added and let it stirred at 1,000 rpm for 15 seconds. Retentions were estimated to measure turbidity of white water using SNF MCT and drainage were compared by the slope of vacuum profile.

3. Results and Discussion

3.1 Comparison of retention

BJ retention measurement had benefit of easy interchange of the data to follow TAPPI standard and wide use in the paper industry however, there were defects of time consuming and difficulty to measure for example, filter white water and dry, stabilize and weigh filter paper to determine retention. Special care must be taken not to expose to the moisture during stabilizing filter paper. This technology was suitable to measure single chemical dosing retention system but, insufficient to measure each chemical's efficiency of multiple chemical dosing retention system. In case of recently developed RDA-HSF measurement, there were benefits of automatic dosing of chemicals by precise sequence and easy determination of retention, drainage and formation. but, there were defects of dilution effect of retention and drainage efficiency by adding about 800 ml (40 wt% of the stock) water to the just below of the wire part to improve formation and adjust pressure. In this case, we might be into the confusions that white water looks clear by dilution effect even though retention was not improved yet. And there were still difficult to estimate retention condition effectively because of reduced measurement range by dilution effect. And RDA-HSF former formed I-shaped lumps which affects bad effects to the next batch because of the strike between propeller type impeller and fibers. As shown in Table 2, BJ retention measurement resulted just % unit variation and RDA-HSF measurement

Table 2. Results of BJ, CSF and RDA-HSF methods

Retention system	Applied chemicals	Dosage (ppm)	BJ and CSF method		RDA method
			Retention (%)	CSF (ml)	Retention (NTU)
Blank		0	70.1	386	515
Single system	C-PAM	100	77.3	404	431
	C-PAM	200	82	422	267
Dual system	p-DADMAC/C-PAM	100/200	85	430	308
Triple system	p-DADMAC/C-PAM/Bentonite	100/200/3000	89	472	254
	p-DADMAC/C-PAM/A-PAM	100/200/200	91	461	190
Multiple system	p-DADMAC/C-PAM/Bentonite/A-PAM	100/200/1000/100	90.4	466	162

Table 3. Results of MCT methods

Retention system	Applied chemicals	Dosage (ppm)	Variation of Turbi. (NTU)	sedimentation time (sec.)	WW-1 (NTU)	WW-2 (NTU)	WW-3 (NTU)
Blank		0	1004	97	N/A	N/A	942
Single system	C-PAM	100	1203	154	N/A	N/A	769
	C-PAM	200	1253	145	N/A	N/A	466
Dual system	p-DADMAC/C-PAM	100/200	1465	159	N/A	651	555
Triple system	p-DADMAC/C-PAM/Bentonite	100/200/3000	1712	129	999	601	480
	p-DADMAC/C-PAM/A-PAM	100/200/200	1721	181	896	623	428
Multiple system	p-DADMAC/C-PAM/Bentonite/A-PAM	100/200/1000/100	1697	152	841	528	291

resulted diluted turbidity efficiency. However, as shown in Table 3, MCT retention measurement equipped to the BJ and white water tanks resulted realtime profile of turbidity of jar and white water. This measurement was effective to compare each chemical's efficiency of multi chemical dosing retention system to find the information like flocculation and retention efficiency from variation of turbidity and settlement rate etc.

Fig. 2 shows turbidity variation graph of BJ and white water tank of single polymer system using MCT. In the jar, turbidity variation and sedimentation time were increased by increase of C-PAM dosage compare to the blank. However, sedimentation time was not increased by

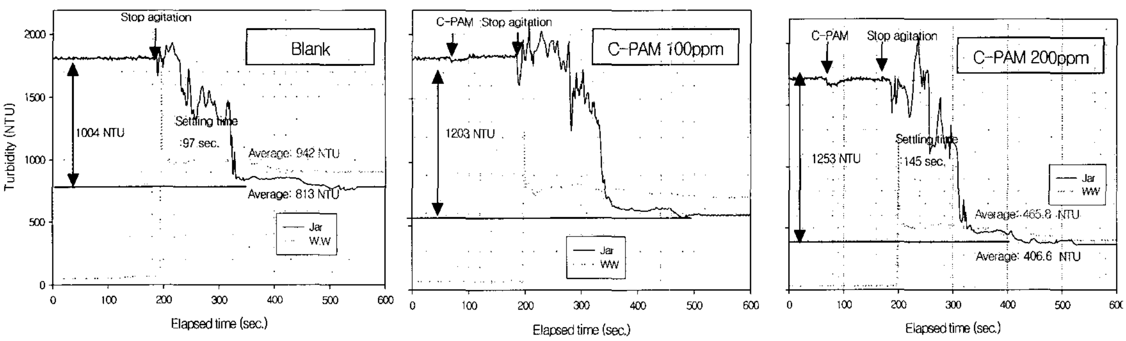

Fig. 2. Turbidity profile of single system by MCT methods.

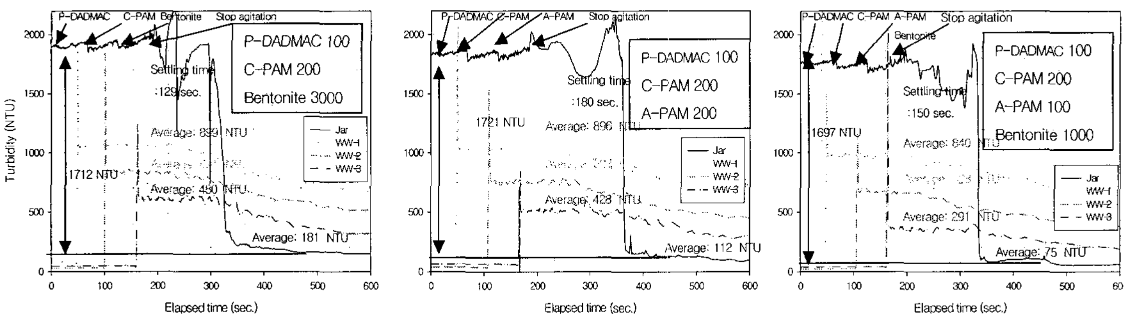

Fig. 3. Turbidity profile of multiple system by MCT methods.

additional C-PAM dosage. Turbidity decreased by increase of C-PAM in the white water tank and this is stands for the retention. Fig. 3 shows turbidity variation graph of BJ and white water tank of multiple polymer system using MCT. The multiple system using bentonite showed characteristics of faster sedimentation time and the multiple system of A-PAM showed best clarification efficiency in the BJ and the multiple system using both of bentonite and A-PAM showed best clarification efficiency in the white water tank. In this result, we found MCT seems very useful to estimate efficiency of each chemicals of the multi chemical dosing systems. However, it seems to get different results by floc size of fines and fillers in the white water tank. Therefore, we must check turbidity vs. retention curve actually and apply turbidity to the retention test.

3.2 Comparison of drainage

As shown Table 2, the CSF drainage measurement itself was insufficient to determine information of initial drainage speed, because this method just gave the result with a unit of ml CSF. In case of RDA-HSF method of Fig. 4, drainage can be estimated by comparison of the vacuum profile at the forming section. Because of the dilution effect by additional water under the wire, changes between curves were too small to classify. We equipped BR to the CSF like Fig. 1 and we measured sectional drainage speed as well as

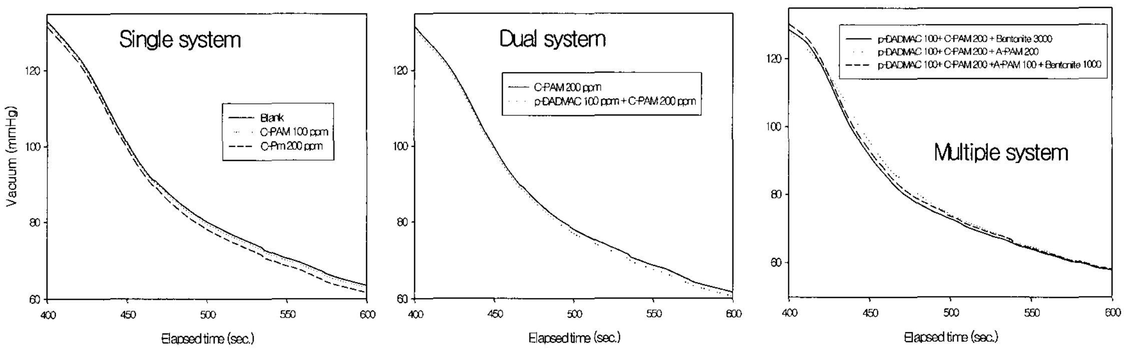

Fig. 4. Drainage profile using RDA-HSF.

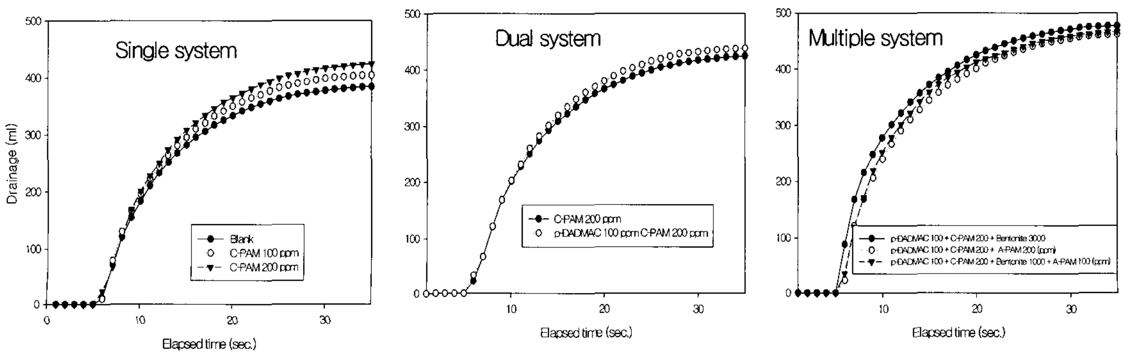

Fig. 5. Drainage profile using BR with CSF.

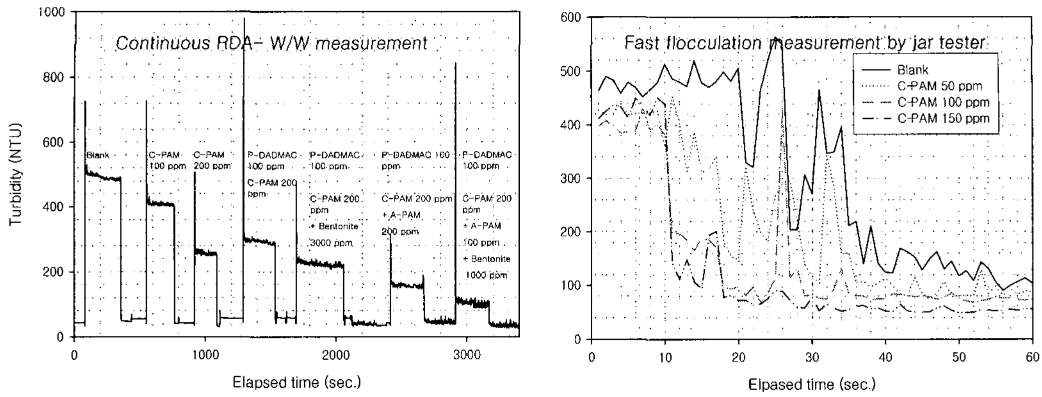

Fig. 6. Various application of MCT (left figure is real time measurement at W. W. tank of RDA-HSF, and right figure is rapid check of flocculation efficiency using jar-tester).

final drainage amount. We found the multiple retention system using bentonite was effective to improve initial drainage rate compare to other systems as Fig. 5

3.3 Various application of MCT

As shown in left graph of Fig. 6, we checked realtime turbidity graph with equipped sensor of the MCT to the white water tank of the RDA-HSF. At the result, we simplified the test sequence and we could see possibility to apply MCT to white water silo of the paper machine to observe retention information. As shown in right graph of Fig. 6, we checked flocculation efficiency conveniently to equipped MCT to the jar-tester. As a result, the efficiency was improved with the increase of the dosage of the C-PAM.

4. Conclusions

1. BJ and CSF standard measurement : There were defects of time consuming and difficulty to measure for example, filter white water and dry, stabilize and weigh filter paper to determine retention. This technology was suitable to measure single chemical dosing retention system but, insufficient to measure each chemical's efficiency of multiple chemical dosing retention system. CSF measurement was not enough to determine sectional drainage rate because it resulted only drainage amount (ml).

2. RDA-HSF method : There were benefits of automatic dosing of chemicals by precise sequence and easy determination of retention, drainage and formation. but, there were difficulty of dilution effects of retention and drainage efficiency by adding about 800 ml (40 wt% of the stock) water to the just below part of the wire to improve formation and adjust pressure. And RDA-HSF former formed I-shaped lumps which influence negatively to the next batch because of the strike between propeller type impeller and fibers.

3. MCT with BJ and BR with CSF method :

After measure to equip MCT to the BJ, it was very easy to determine each chemical's efficiency of the multiple chemical dosing system to see the realtime turbidity variation of the jar and white water tanks and sedimentation time. We applied MCT to the white water tank of the RDA-HSF to simplify the test sequence and we found the possibility to apply MCT to the paper machine to observe retention information. We equipped BR to the CSF to measure sectional drainage rate as well as final drainage amount. We found the multiple retention system using bentonite can improve initial drainage rate compare to other systems.

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