# Measurement of Retention and Drainage using Multi-channel turbidimeter with Balance recorder

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## 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[8]. 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 give us just drainage amount information that we could not estimate dynamic information like sectional drainage rates etc[8]. Recently developed retention drainage analyzer-hand sheet former (RDA-HSF) has benefits of convenient measurement of retention, drainage and formation. However, the added water just below the wire part to improve formation and adjust pressure gave bad effect to dilute efficiency of retention and drainage[5~6]. Therefore, we applied multi-channel turbidimeter (MCT) to the BJ to measure realtime retention and flocculation characteristics. 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

85%(wt) of LBKP and 15%(wt) of GCC were used to retention and drainage test

as pulp and filler. P-DADMAC, C-PAM, A-PAM and bentonite were used as retention aids.

## 2.2. Beating

Beating was performed using laboratory valley beater by following TAPPI Standard T200 SP-01. 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 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 estimate realtime retention and flocculation efficiency by analysis of turbidity graph. BR and 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 estimated various dynamic information like sectional drainage rate and final drainage amount etc.
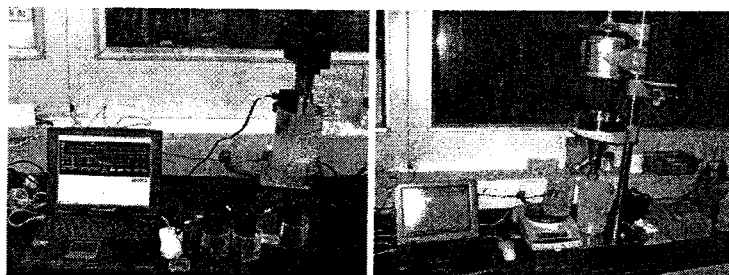


Fig. 1. MCT with BJ and BR with CSF

### 2.3.2. Standard BJ retention and CSF drainage

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 was added and let it stirred at 1,000 rpm for 15 seconds. Retention 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 1, BJ retention measurement resulted just % unit variation and RDA-HSF measurement resulted diluted turbidity efficiency. However, as shown in table 2, 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.

Table 1. Results of BJ, CSF and RDA-HSF method

| 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 2. 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 |

Figure 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 additional C-PAM dosage. Turbidity decreased by increase of C-PAM in the white water tank and this is stands for the

retention. Figure 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.
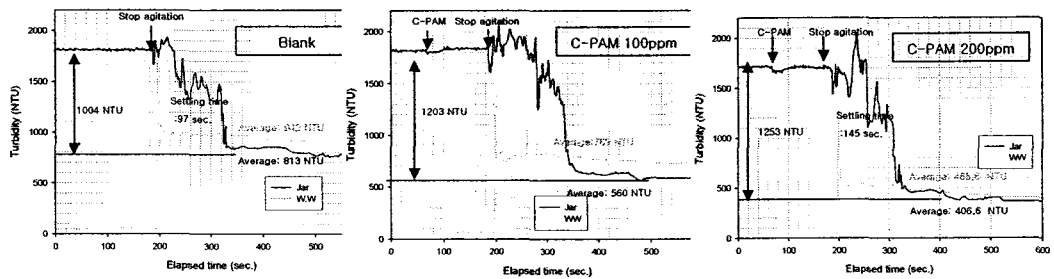


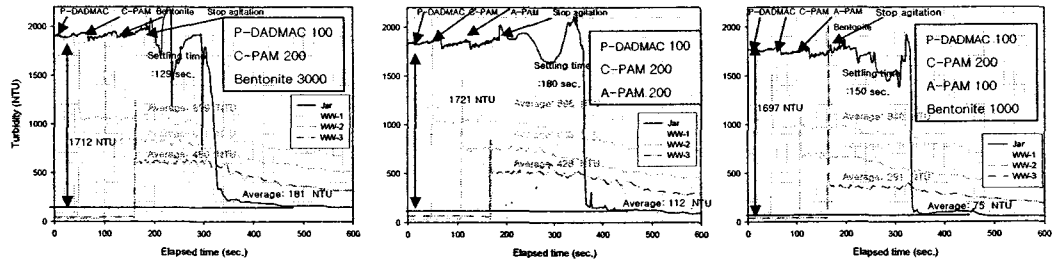Fig. 2. Turbidity profile of single system by MCT methods



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

## 3.2 Comparison of drainage

As shown table 1, the CSF drainage measurement itself was insufficient to determine dynamic information like initial drainage rate etc. Because this method just resulted as a unit of ml CSF. In case of RDA-HSF method of figure 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 figure 1 and we measured sectional drainage rate as well as final drainage amount. We found the multiple retention system using bentonite was effective to improve initial drainage rate compare to other systems.
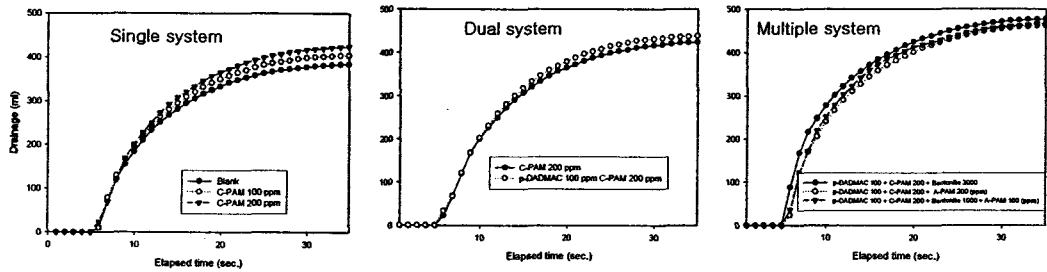


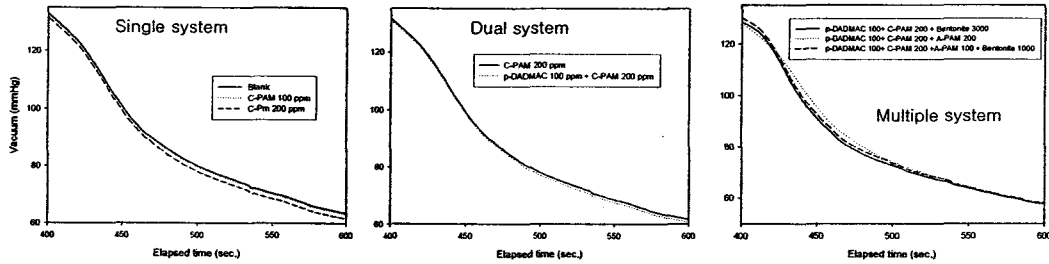Fig. 4. Drainage profile using BR with CSF



Fig. 5. Drainage profile using RDA-HSF

## 4. Conclusions

1. BJ and CSF standard measurement : There were defects of time consuming and difficulty to measure. 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 but, there were difficulty of dilution effects of retention and drainage efficiency by addition of water to the below part of the wire. And

RDA-HSF former formed I-shaped lumps which influence negatively to the next batch.

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. And the method of BR equipped to CSF was useful to measure sectional drainage rate as well as final drainage amount.

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