Influence of C-PAM Characteristics on Retention and Drainage

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1. Introduction

Polyacrylamide (PAM) have been applied for many purpose at the paper mills because of its convenience to modify molecular weight, morphology and ionicity. Aqueous solution, powder, salt dispersion and inverse emulsion types were mainly applied. Aqueous solution type have been applied as a paper strengthening aids because low molecular weight of it was advantageous to prevent agglomeration and give hydrogen bond between pulps. Medium to high molecular weight type of salt dispersion, powder and inverse emulsion have been applied as a retention and drainage aids because high molecular weight of them were advantageous to give a flocculation between pulp and fillers. In this study, we compared physical and chemical characteristics of salt dispersion, powder and inverse emulsion types C-PAM and applied retention and drainage aids for paper. At the result, inverse emulsion type was more suitable as a retention and drainage aids than salt dispersion or powder types because of its convenience to control physical and chemical properties such as solubility, molecular weight and ionicity.

2. Materials and methods

2.1. Pulps and additives

Mixture of 85%(wt) LBKP and 15%(wt) GCC was applied to retention and drainage test as pulp and filler. Salt dispersion, powder and inverse emulsion type of the PAM were applied after polymerization in the lab. Table 1 shows analysis data.

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 Comparison of physical and chemical properties

2.3.1 Analysis of solid contents

Solid content was determined by the evaporation residue method to using I.R. desiccator at the condition of 1g sample with 160℃ during 16 minutes.

2.3.2. Analysis of molecular weight

Molecular weight of the samples were determined to follow rotational viscometer method.[5)]

2.3.3. Analysis of solubility

After dissolve C-PAM with distilled water at the consistency of 0.1%, we checked weight of insoluble particles using 60 mesh standard sieve at 5 minutes intervals.

2.4 Retention and drainage

Retention test was 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, C-PAM was added and let it stirred at 1,500 rpm for 15 seconds of 60 g/m^2 paper forming condition. Retentions were estimated to measure turbidity of white water using SNF multi-channel turbidimeter. Drainage were compared by final CSF drainage amount following TAPPI Standard T227 OM-99 using Britt jar at the same stock and sequence condition with RDA-HSF retention test.

3. Results and Discussion

3.1 Physical and chemical properties of C-PAM

Solid contents of powder type C-PAM was most high as 90% and then inverse emulsion type was 45%, finally salt dispersion type was 40%. Powder type C-PAM had advantages of convenient transportation and storage because of its high solid contents. In terms of molecular weight, manufacturing process of powder type included drying process with hot air after aqueous solution gel polymerization. drying process was very sensitive with temperature and molecular weight to affect external bridging of PAM itself to generate insolubles. therefore we kept moderate drying temperature and suitable molecular weight to prevent insoluble particles. The main manufacturing principal of salt dispersion type was dispersion of PAM polymers by the abundant anionic salts like ammonium sulfate or sodium sulfate and stabilizing polymer. If molecular weight of it was too high, it was very difficult to disperse into the salt and make spherical shape. Inverse emulsion was relatively easy to make higher molecular weight to compare others since it was much stable to make micelle of hydrocarbon oil with surfactants. In terms of dissolution time to determine solubility, salt dispersion type and inverse emulsion was only 5 to 10 minutes to dissolve completely but, powder type needed 60 more minutes to dissolve.

Table 1. Analysis of applied chemicals

Sample name		P-20M	D-20S	E-20S	E-20M	E-20H	E-10M	E-30M	E-40M
Types	unit	Powder	Salt dispersion	Inverse emulsion	Inverse emulsion	Inverse emulsion	Inverse emulsion	Inverse emulsion	Inverse emulsion
Solid Contents	%	90	40	45	45	45	45	45	45
M.W.v	g/mol	$6.0x10^6$	$5.2x10^6$	$5.1x10^6$	$6.5x10^6$	$7.8x10^6$	$6.5x10^6$	$6.5x10^6$	$6.5x10^6$
Dissol. Time	Min.	60	10	10	10	10	10	10	10
pH	~	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Conductivity	μS/Cm	187	2,520	161	157	156	149	158	165
Cationicity	Meq/g	1.42	1.65	1.45	1.42	1.42	1.01	2.2	3.2

3.2 Retention and drainage

3.2.1 Influence of the types of C-PAM

Retention and drainage of inverse emulsion were best and followed by powder and salt dispersion type. This was the same with molecular weight orders. Therefore, molecular weight of the C-PAM considered important quality factor of the retention and drainage. And only salt dispersion type affected conductivity of white water to increase slightly. It was assumed abundant anionic salts to be added to improve dispersing ability. In the laboratory, it was difficult to find out the increase of conductivity of white water however, it will increase conductivity of the white water in the application to the closed white water system of the paper mill. In the high conductivity stock condition of 5,100 uS/ Cm by the addition of ammonium chloride, salt dispersion type showed good resistance to the conductivity but performances of powder and inverse emulsion type were decreased remarkably. This phenomena might be caused the positive functions of the stabilizing cationic polymers in the salt dispersion type polymer. Salt dispersion type has not only negatively influencing components like salts but also positively influencing component like cationic stabilizing functionality.

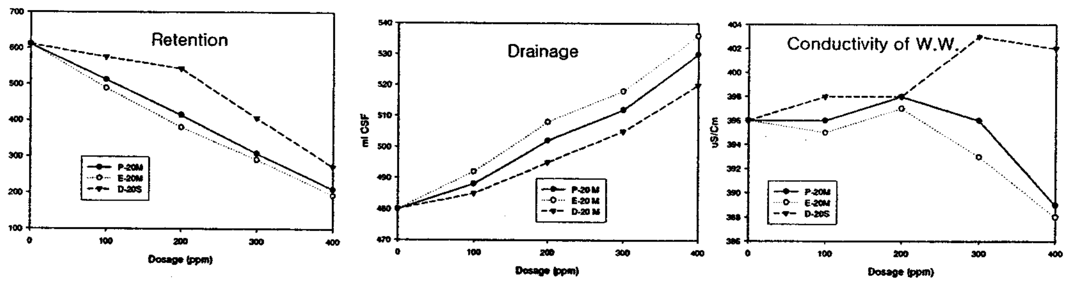

Fig.1 Retention, drainage and conductivity of W.W. with different types of C-PAM at low conductivity (390 uS/Cm) stock condition

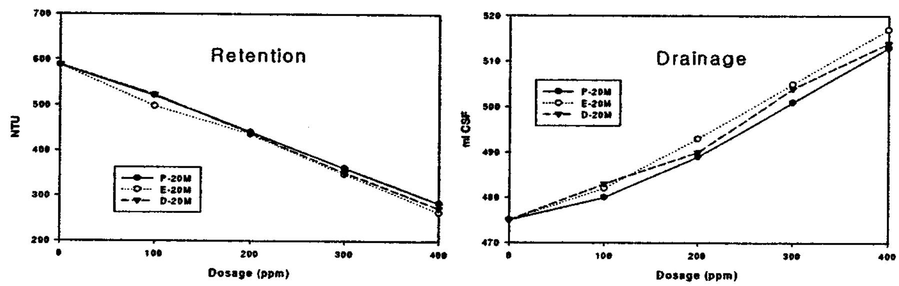

Fig. 2 Retention and drainage with differenct types of C-PAM at high conductivity (5,100 uS/Cm) stock condition

3.2.2 Influence of inverse emulsion type C-PAM

At the result of the retention and drainage characteristics by the different molecular weight of inverse emulsion type C-PAMs, the bigger molecular weight of them showed the better performance of retention and drainage characteristics. This might be assumed that the bigger molecular weight of the C-PAM induced the more chance to make bonding among pulp, filler and C-PAM. In case of retention and drainage characteristics according to the ionicity of the C-PAM, the ionicity around 1.4 Meq/g showed the good performance of retention and drainage characteristics however higher or lower ionicity resulted worse retention and drainage characteristics. This might be considered that cationicity was not enough to bond properly between pulp and fillers in the lower ionic condition and repulsive power was affected to prevent bonding between pulp and fillers in the higher ionic condition.

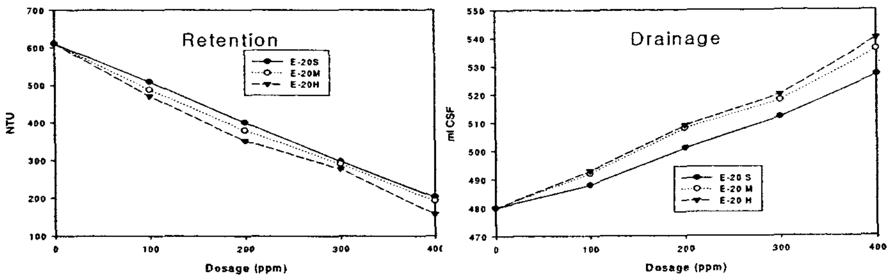

Fig. 3 Retention and drainage with different molecular weight of Inverse emulsion type C-PAM

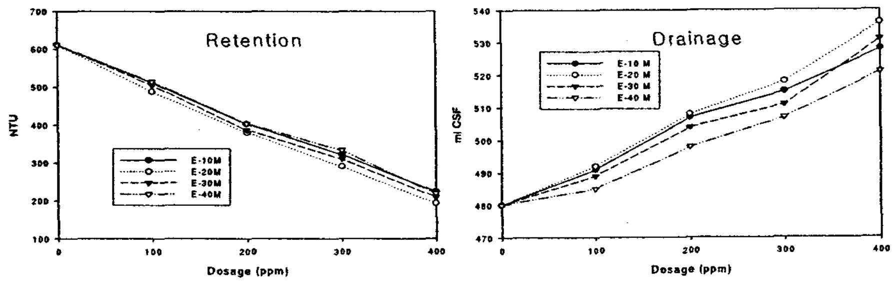

Fig. 4 Retention and drainage with different ionicity of Inverse emulsion type C-PAM

4. Conclusions

1. The inverse emulsion type had not only convenience of increase molecular weight, control ionicity and molecular morphology but also relatively high active polymer contents than salt dispersion type because of its stable micelle condition. Therefore, the most suitable type of the paper retention and drainage among various types of C-PAM was resulted inverse emulsion type.

2. In the low conductivity stock condition, retention and drainage of the inverse emulsion of high molecular weight was the best and salt dispersion type of the low molecular weight was the worst among them. However in case of the high conductivity stock condition by the addition of the ammonium chloride, salt dispersion type showed good resistance to the conductivity but performances of powder and inverse emulsion type were decreased remarkably.

3. With regard to inverse emulsion type C-PAM, retention and drainage were improved by the increase of the molecular weight and on the ionic condition, around 1.4 Meq/g were found best performance ionic condition. To conclude the research, we found the molecular weight and ionicity were important factors to influence retention and drainage and inverse emulsion type C-PAM was the suitable as a retention and drainage aids to improve above characteristics most easily.

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