고전도도 지료조건에서의 CPAM의 보류특성

Retention Characteristics of CPAM under High Conductivity Stock Condition

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1. Introduction

For the improvement of retention and drainage, cationic polyacrylamide has been widely applied to the paper industry. Recently, anionic trash and conductivity of stock tends to increase because of shortage of water and decreasing quality of recycled pulp. These high anionic trash and high conductivity stock condition lower the activity of cationic polyacrylamide. First of all, anionic trash absorb cationic polyacrylamide and hinder the bonding between cationic polyacrylamide and fibers. And high conductivity stock lower activity of cationic polyacrylamide to induce shrinkage of cationic polyacrylamide. Accordingly, polyamine or polyDADMAC (Diallyl Dimethyl Ammonium Chloride) of high cationic and low molecular weighted polymer treat anionic trash by charge neutralization however, high conductivity problem of stock is rarely researched. First of all, we found amphotreic polyacrylamide improve dissolution stability and better performance at high pH and high conductivity stock condition. In this study, we applied hydrophobically modification of cationic polyacrylamide to improve retention and drainage performance to give shrink resistance from steric effect of hydrophobic functional group.

2. Materials and methods

2.1. Materials

Retention and drainage aid cationic polyacrylamide of P1 to P3 are provided from Eyang chemical co. ltd. white water and machine chest stock of OCC were provided from D-paper.

2.2. Methods

2.2.1 Analysis of Polymers

Solid content was measured by IR dessicator with condition of 160 ℃ during 16 minutes. Viscosity and molecular weight were measured by Brookfield viscometer (LV-2 type) preparing 1% polymer solution.(1) Charge density was measured by PVSK titration method. pH was measured by pH meter preparing 0.5% polymer solution. And dissolution rate was measured by checking insolubles amount preparing 0.2% polymer solution at 10 minutes interval.

2.2.2 Polymer physical characteristics test

2.2.2.1 Polymer viscosity profiling test

After dissolve cationic polyacrylamide to 0.1% consistency using distilled water, conductivities of the solutions were controled using NaCl. Viscosities of the solution were measured using Brookfield viscometer (LV-2 type) to vary polymer solution conductivity.

2.2.2.2 Polymer rheology profiling test

After dissolve cationic polyacrylamide to 1% consistency using distilled water, conductivities were controled using NaCl. Rheology yield values were measured using Brookfield rheomterviscometer (YR-1 type) to vary polymer solution conductivity.

2.2.3. Paper application test

2.2.3.1 Stock

We adjusted final consistency of stock about 1% to adjust consistency diluting thick stock to white water. And the cationic demand of stock was 8.0 ml of 0.001N polyDADMAC titration and pH of the stock was 7.0.

2.2.3.2 Retention, drainage and formation test

Retention and drainage test were performed by the operation of DFA. The consistency of the stock was about 1.0% and the volume of the stock was 500 ml. Retention was determined by measuring FPR by filtering white water using filter paper and let it dry during 8 hours with 105℃. And Ash retention was determined by measuring FPAR by burning filter paper after FPR test under the condition of 24 hours with 525℃. Drainage was compared by drainage curves during DFA test. And Formation was performed by using papers after operation of RDA using Techpap 2D-F sensor. The consistency of the stock was 0.5% 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. And we add 500 ml of tap water on the mesh before forming to improve paper formation. The sequence of chemical contacted time of the stock of DFA and RDA were the same as followings. At first, stock was introduced to the jar and let it stirred at 800 rpm for 5 seconds. And then, CPAM was added and let it stirred at 1,000 rpm for 10 seconds with the dosage of 1,000 ppm per total dried pulp.

2.2.3.3 Stock flocculation rheology profiling test

After control stock conductivity using NaCl, 1,000 ppm (dry pulp base) of cationic polyacrylamide was added. And then stir it under the condition of 1,000 rpm speed during 10 second using paddle type agitator. After that, yield rheology was measure using Brookfield rheometer (YR-1).

3. Results and Discussion

3.1. Analysis of polymers

P-1 is a normal high molecular weight cationic polyacrylamide which is copolymer of acrylamide and ADAM-MC cationic monomer. On the other hand P-2 and P-3 are special cationic polyacrylamide which consist of a few more functional monomers to increase hydro-phobic functions in the polymer. P2 is relatively higher molecular weight and P3 is relatively lower molecular weight however, solid contents and charge density are almost same. Dissolution rate of P-2 is relatively slower than P-1 and P-3 because of relatively high molecular weight and hydrophobic functional group reduce dissolution speed in the water.

Table-1 Analysis of applied CPAM

Items	unit	P-1	P-2	P-3
Solid contents	%	90	90	90
Charge density	meq/g	2.12	2.15	2.11
pH at 1 solution	~	4.1	3.8	3.9
1% sol'n viscosity	cPs	4800	5200	4500
Dissolution rate	min.	20	30	20
Molecular weight	g/mol	13,000,000	14,000,000	12,000,000
Remarks		Normal CPAM	Hydrophobically modified CPAM	

Figure-1 shows viscosity behavior of cationic polyacrylamides according to various conductivity of solution and highest molecular weighted P-2 showed highest viscosity and lowest molecular weighted P-3 resulted lowest viscosity however, there are no specific difference between hydrophobically modified cationic polyacrylamide and normal cationic polyacrylamide. Figure-2 shows the result of rheology yield value by the measurement of Brookfield rheometer (YR-1). The yield point is the point at which a material begins to flow. The associated properties are the yield stress and yield strain. The yield stress is the critical shear stress, applied to the sample, at which the material begins to flow as a liquid. The yield strain is the deformation, resulting from the applied stress, at which the flow start. (1,2) Therefore, we plotted rheology yield to measure stress value vs. apparent strain and both lower molecular weighted and higher molecular weighted hydrophobically modified cationic polyacrylamide resulted stable value by various conductivity conditions. This result shows rheology yield can be applied to characterize hydrophobicity of functional group of cationic polyacrylamide.

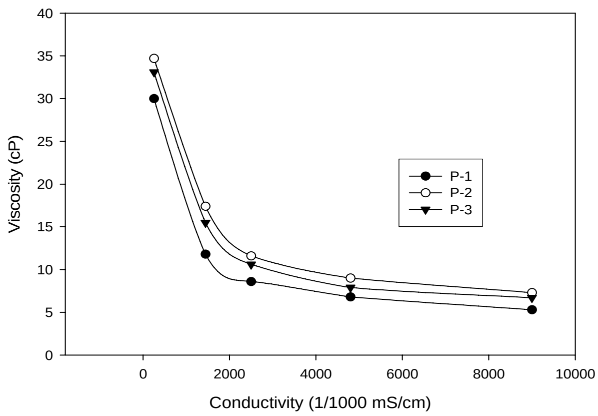

Fig.-1 Viscosity profile of CPAM using dissolving water of various conductivity

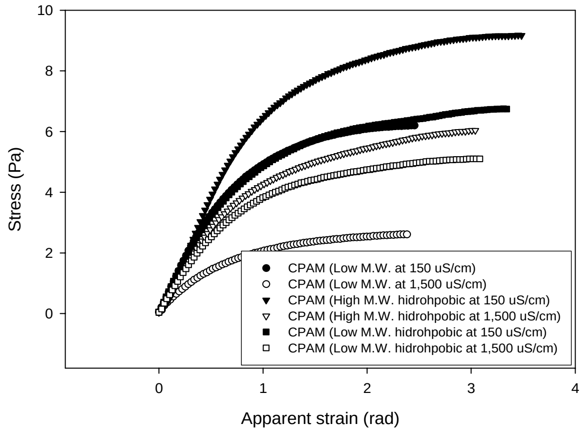

Fig.-2 Rheology yield profile of CPAM using dissolving water of various conductivity

3.2 Paper retention test

Figure-3 shows the result of retention and ash retention characteristics to apply cationic polyacrylamides under the various conductivity stock conditions. First of all, retention to apply P-1 of normal cationic polyacrylamide was decreased by the increase of stock conductivity. On the other hand, retention to apply P-2 and P-3 of hydrophobically modified cationic polyacrylamide showed increase until conductivity to 6 ms/cm. And ash retention to apply P-1 of normal cationic polyacrylamide was not increased but ash retention to apply P-2 and P-3 of hydrophobically modified cationic polyacrylamide increased until conductivity of stock to 6 ms/cm. These characteristics of hydrophobically modified cationic polyacrylamides under the high conductivity stock condition seems very unique because normal catioinic polymer has been known to shrink and lose activity under the high conductivity stock condition.

According to the figure-4 of drainage result, both of normal cationic polyacrylamide and hydrophobically modified cationic polyacrylamide showed good drainage characteristics under the relatively lower stock conductivity condition. As increase stock conductivity, hydrophobically modified cationic polyacrylamide maintained drainage performance but normal cationic polyacrylamide decreased drainage performance drastically. Figure-5 showed formation result of the paper using 2D-F senor, in case of using normal cationic polyacrylamide, formation of the paper improved by the increase of stock conductivity, but, hydrophobically modified cationic polyacrylamide became bad by the increase of stock condition. From the above formation result, we considered hydrophobically modified cationic polyacrylamides make flocs have endurance at high conductivity stock condition. Figure-6 showed yield rheology after flocculation with cationic polyacrylamide by various stock conductivity condition. Normal cationic polyacrylamide resulted considerable decrease of yield value by increase of stock conductivity however, both higher molecular weighted and lower molecular weighted hydrophobically modified cationic polyacrylamides resulted maintenance of rheology yield value by the increase of stock condition.

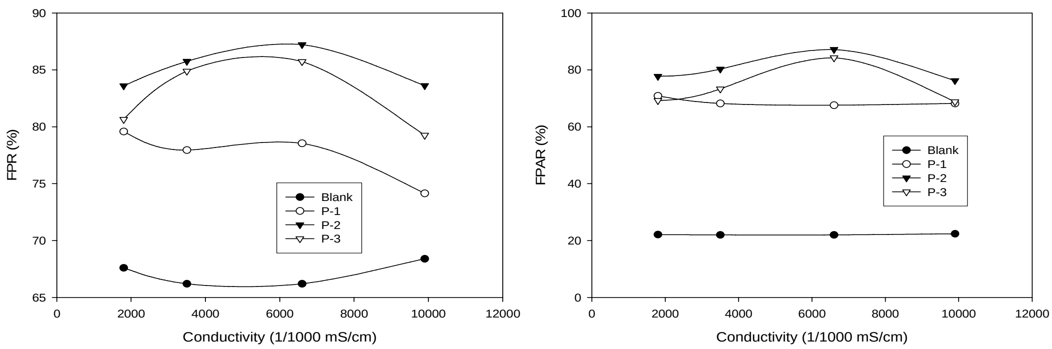

Fig.-3 First pass retention and first pass ash retention profile by CPAM using stock of various conductivity

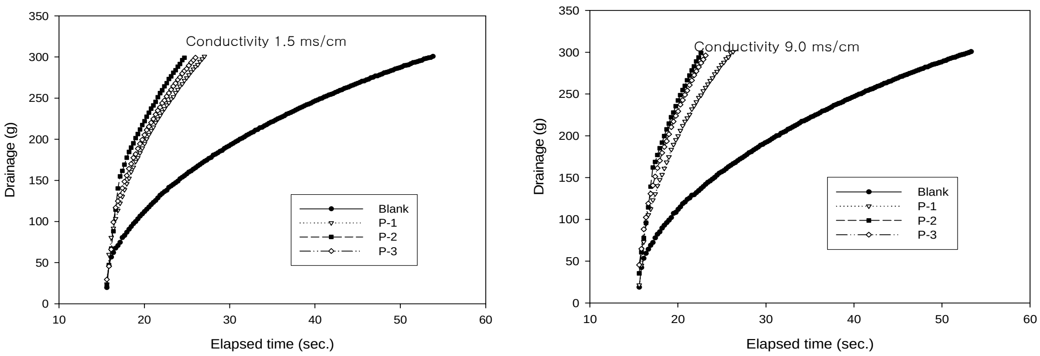

Fig.-4 Drainage profile by CPAM using stock of various conductivity

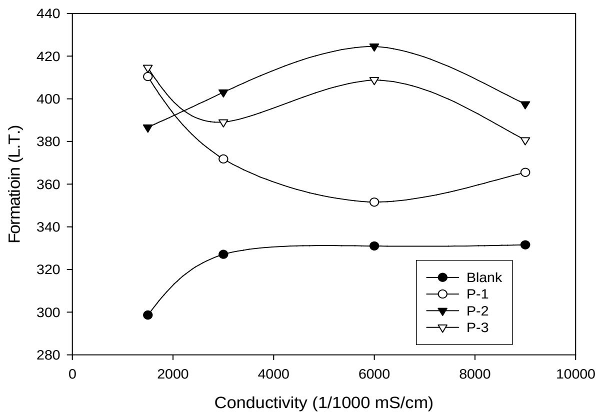

Fig.-5 Formation profile by CPAM using stock of various conductivity

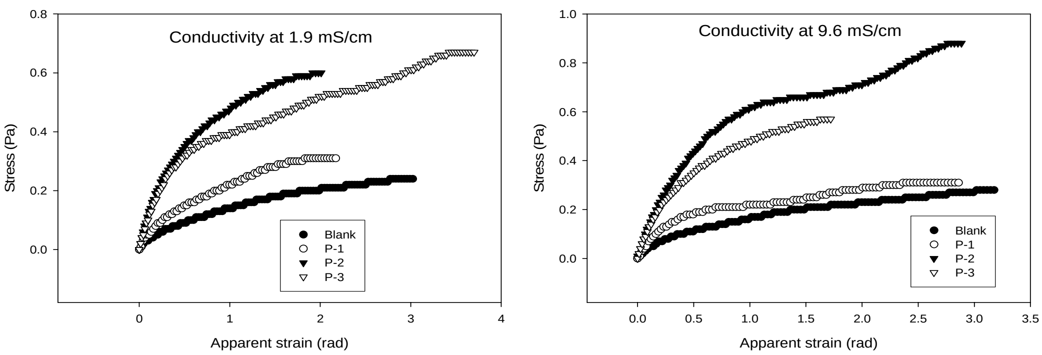

Fig.-6 Rheology profile of flocculated stocks with various conductivity by CPAM

4. Conclusions

1. It was difficult to characterize cationic polyacrylamide and hydrophobically modified cationic polyacrylamide by profiling of viscosity on the stock conductivity. However, hydrophobically modified cationic polyacrylamides resulted better endurance under the high conductivity stock condition than normal cationic polyacrylamide by the measurement of rheology yield value.
2. Normal cationic polyacrylamide resulted worse retention and maintaining ash retention to increase stock conductivity to 6 ms/cm however, hydrophobically modified cationic polyacrylamides showed increase of both retention and ash retention to increase stock conductivity to 6 ms/cm.
3. Normal cationic polyacrylamide showed drastically decrease of drainage characteristics by the increase of stock conductivity however, hydrophobically modified cationic polyacrylamides maintained drainage performance by the increase of stock conductivity.
4. Normal cationic polyacrylamide showed improvement of paper formation by the increase of stock conductivity however, hydrophobically modified cationic polyacrylamide showed opposite result.
5. Normal cationic polyacrylamide showed considerable decreasing of rheology yield value by the increase of stock conductivity however, hydrophobically modified cationic polyacrylamide maintained rheology yield value by the increase of stock conductivity.

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