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Preparation of CWM Using Pulp Waste Liquor

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Abstract

As is known, the presence of chemical additives is very effective for producing high coal loading CWM (Coal Water Mixture). To reduce process cost, natural additive of CWM such as Humic-Acid extracted from low rank coal and lignin obtained by concentrating the pulp waste liquor (black liquor) are noted well now. At the same time, the extraction process and the concentration process deplete a lot of chemical reagent and energy. Further more, the problem of pulp waste liquor disposal or utilization has been attacked from many standpoints. People are still seeking an economical solution. It was once studied to produce CWM using pulp waste liquor directly, but the dispersing effect only by the lignin contained in the black liquor. Corrosion of black liquor due to its high pH is also a difficult problem for the storage transportation and combustion of CWM. This study attempted to extract low rank coal such as lignite using black liquor, and then, prepare CWM using the extraction liquor directly. It was found that the viscosity of CWM prepared by lignite black liquor extraction was lower than that of CWM prepared using black liquor directly. High coal loading CWM (69wt%) can be prepared by the new method and the pH of CWM was under 9, which is lower than black liquor whose pH is 13.

Keywords: lignite, black liquor, extraction, CWM

1 INTRODUCTION

CWM has caught people's more and more attention as a substitutive fuel of oil since the first oil crisis in 1973. High coal concentration and low viscosity value of CWM are desirable for industrial utilization. It is well known that the fluidity of CWM depends on following factors such as the type of coal, the solid content and its size distribution, the temperature, the pH value, the presence of electrolytes and chemical additives [1]. Previous studies mainly revealed that the additives can disperse coal particles effectually in CWM and reduce its viscosity. In order to produce high

consistency CWM with a given or optimum viscosity, a number of effective dispersing agents have been developed [2]. However, the current chemosynthesis dispersing agents are usually expensive and the synthesis technique is complex. So, cheap and facile nature additive are expected to reduce the cost of dispersing agents.

Two kinds of nature materials, Humic Acid (HA) and lignin are pretty abundant on the earth, but so far no one can find any large-scale usage of these two materials. Previous studies indicated that HA and lignin hold surface activeness and were all effective dispersing agent of CWM [3,4,5]. At present, HA is available mostly from low rank coal by alkaline extraction and lignin is from pulp waste liquor (PWL) by concentration and both of them have been

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chemically modified. Preparation process of HA and lignin at present exhibit increasing consumption of chemical and energy, subsequently it will bring heavy environmental problems such as waste water and chemical residue. In order to solve these problems, it is a good choice to use an extracted liquor of low rank coal or PWL directly [6]. In addition, studies showed that the dispersing and adsorbing mechanism of HA and lignin on coal particles in CWM were different. If low rank coal is extracted from hot and alkaline PWL directly, and then the extracted liquor is used to produce CWM, the problems mentioned above can be avoided and the cooperative effect of combined use of HA and lignin is expected.

The object of this study was to experimentally investigate the dispersing effect of HA from lignite and lignin from PWL on CWM, discuss the viscosity of CWM prepared directly by extracting liquor of lignite and by PWL and then develop a new CWM preparation process in which the lignite extraction liquor and PWL can be used immediately.

2 EXPERIMENTAL

Coal and agent: Yongcheng anthracite (YC anthracite) was used for preparation of CWM and Neimenggu lignite (NMG lignite) was used to get HA through extraction. Herby PWL from Xinya paper industry Co. Ltd was used in this study. The characteristics of Yongcheng anthracite are given in Table 1. The total content of solid matter in PWL was 10.6%, the content of lignin in PWL was 4.0 wt% and the pH of PWL was about 12.

Table 1 The proximate, ultimate analysis of coal sample

Sample	Proximate analysis/w%				Ultimate analysis/w%, daf				
	Mad	Ad	Vdaf	C	H	O*	N	S	
YC	8.52	10.91	7.04	91.46	3.78	2.84	1.54	0.38	
NMG	23.91	10.83	45.94	74.94	4.38	18.63	1.03	1.02	

CWM preparation and the measurements of viscosity: The crushed coals were comminuted in the ball mill for 48 h to obtain coal powder and then the coal powder was mixed round slowly in a beaker for 30 min with additive and a quantity of deionised water. The viscosity of CWM was measured by a NDJ-5s viscometer. Measurements condition: number 2 spindle rotated at 30 rpm (10 s) and 3 spindle rotated at 60 rpm (20 s) for 3 min.

3 RESULTS AND DISCUSSION

In order to determine the effect of the concentration of additive on the fluidity of CWM, the apparent viscosity of CWM at different addition concentrations (wt% on dry coal basis) of HA and

lignin was measured, and the coal loading of CWM was 60 wt%. The results were shown in Figure 1, which is revealed that the viscosity of CWM reached minimum at about 0.6 wt% of HA and at about 0.5 wt% of lignin. So the optimum addition concentrations of HA and lignin were determined at 0.6 wt% and 0.5 wt% respectively.

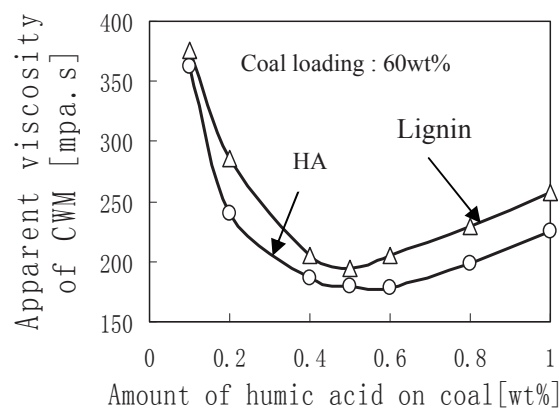


Fig.1 Effect of amount of HA and lignin on apparent Viscosity of CWM

Figure 2 described the apparent viscosity of CWM by different coal loading with the optimum addition concentrations of HA and lignin. The arrived coal loading (ACL) of CWM in which the apparent viscosity of CWM arrive 1000 mpa.s is used to appraise the high loading characteristic of CWM in this paper. As illustrated in Figure 2, the ACL of CWM with addition of HA or lignin was 70.5 wt% or 69 wt% which were both higher than that of without additive.

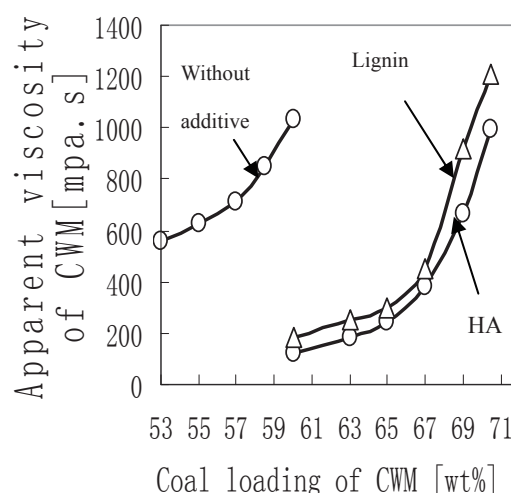


Fig.2 Effect of coal loading on apparent viscosity by addition of HA and lignin

To research the cooperative effect of combined use of HA and lignin, mixture of HA and lignin were added to CWM. According to the above results, the weight proportion of HA and lignin was determined to be 6:5. **Figure3** shows us that optimum addition concentrations of HA-lignin mixture is 0.9wt%, which was more than that of HA or lignin solely, but less than that of the summation of HA and lignin. That is, adsorbed content of HA-lignin was more than that of HA and lignin individually. It can be attributed to that the adsorption mechanism of HA and lignin on coal particles was different, namely, there is no absorption competition between HA and lignin.

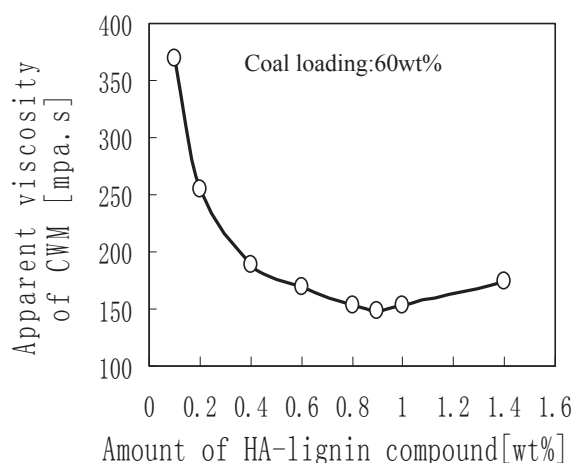


Fig.3 Effect of additive amount of HA-lignin compound on apparent viscosity of CWM

As presents in Figure4, ACL of CWM with addition of HA-lignin mixture could reach 71wt%, which was higher than that of HA and lignin added respectively.

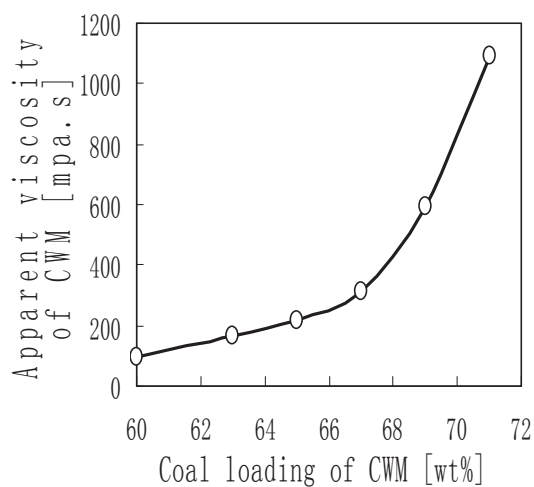


Fig.4 Effect of coal loading on apparent viscosity by addition of HA-lignin compound

To substitute for solid lignin and solid HA, extraction liquor of lignite and PWL were used to produce CWM directly. Because of the high concentration of solid matter and the high pH of liquor, extraction liquor and PWL were diluted with water before producing CWM. **Figure5** shows the apparent viscosity of CWM prepared with extraction liquor and PWL under different diluted multiples. The result indicates that optimum diluted multiples of extraction liquor and PWL are 3 and 7 respectively. In this case, the optimum addition content of HA and lignin should be 0.7wt% and 0.45wt% (on dry coal basis). This result is similar to the data of solid HA and solid lignin shown in **Figure1**.

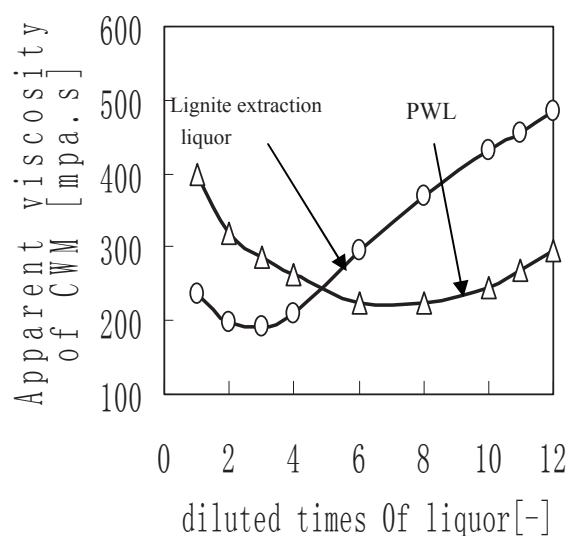


Fig.5 Effect of diluted multiples of lignite extraction liquor and PWL on apparent viscosity

CWM produced by extraction liquor and PWL are plotted in **Figure6**. It is revealed that the ACL of CWM prepared by extraction liquor and PWL directly was

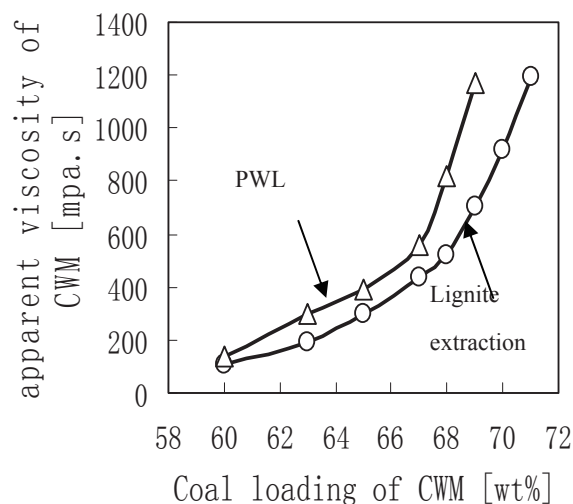


Fig.6 Effect of coal loading on apparent viscosity by lignite extraction liquor and PWL

68.5wt% and 70wt%.

The main objective of this study was to discuss the fluidity of CWM produced by lignite-PWL extraction liquor. The apparent viscosity of CWM (coal loading 65wt%) produced by lignite-PWL extraction liquor diluted by different diluted multiples is shown in **Figure 7**. It is seen that optimum diluted multiples of lignite-PWL extraction liquor is 12. The optimum addition content of HA-lignin compound were calculated to be 0.42wt% (on dry coal).

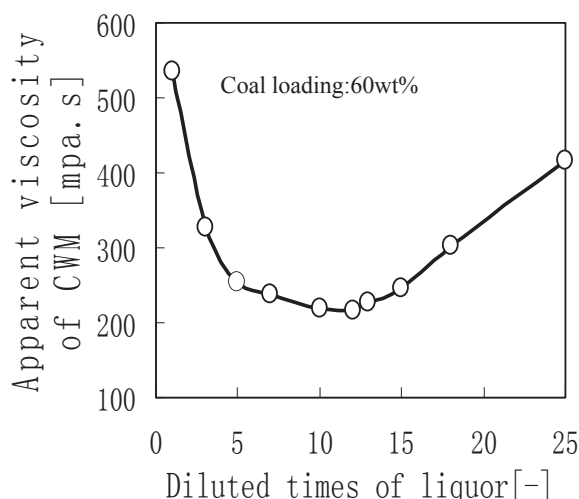


Fig.7 Effect of diluted times of lignite-PWL extraction liquor on apparent viscosity

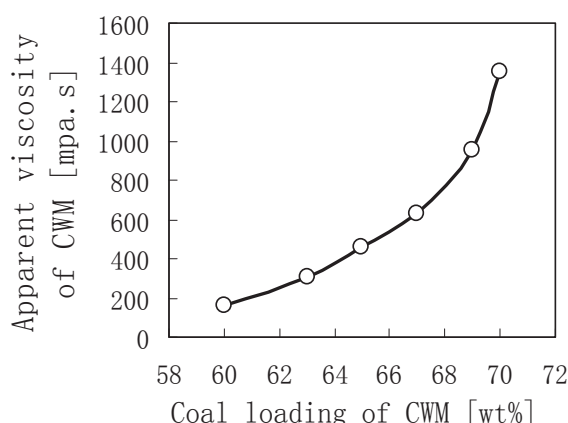


Fig.8 Effect of coal loading of CWM on apparent viscosity using lignite-PWL extraction liquor

Figure 8 presents the apparent viscosity of CWM at different coal loading produced by lignite-PWL extraction liquor at the optimum diluted multiple. It can be indicated that ACL of CWM arrived about 69wt% and agreed with the result of HA-lignin mixture approximately.

4 CONCLUSIONS

Addition of HA from Neimenggu lignite and lignin from PWL can lower viscosity of CWM markedly. Combined use of HA and lignin resulted in more dispersing effect than HA and lignin solely. High coal loading CWM of 69wt% can be produced by lignite-black liquor extraction liquor diluted with water by a high diluted multiple. In this process, the high pH of PWL is utilized to extract lignite and the extraction liquor can be utilized without any treatments, so the burden of treating waste water will be mitigated consumedly and the produce cost of CWM will reduce evidently.

REFERENCES

- (1) Zeki A, E.T W. Effect of Addition of Surface Active Agent on The Viscosity of a High Concentration Slurry of a Low-Rank British Coal in Water. *Fuel Processing Technology*, 2000, 62(1):1-6
- (2) Usui H. Highly Loaded and Stabilized Coal Slurries and Their Additives. *Journal of the Japan Institute of energy*, 1994, 73(6):388-395. (in Japanese)
- (3) Huang D, Tadahi M, Higuchi T, et al. Application of Humic Acid Extracted from Low Rank Coal as CWM Dispersing Agent. *Kagaku Kogaku Ronbunshu*, 2003, 29(1):33-38 (in Japanese)
- (4) Pawlik M, J.S. Laskowski and H. Liu. Effect of Humic acids and Coal Surface Properties on Rheology of Coal-Water Slurries, *Coal Preparation*, 1997, 18:129~149
- (5) Huang D, Tadahi M, Higuchi T et al. Properties of Lignins as CWM Dispersing Agents. *Kagaku Kogaku Ronbunshu*, 2003, 29(6):829-835 (in Japanese)
- (6) Huang D, Tadahi M, Higuchi T, et al. Application of Waste Liquids Containing Lignin from Pulp-Producing Industry to CWM preparation. *CHEM. RES. CHINESE U.*, 2004, 20(2):159-162
- (7) Huang D, Tadahi M, Higuchi T et al. Lignin Properties for Dispersing CWM and Application of Liquid Waste Containing Lignin From Pulp-producing Process to CWM Preparation. *The 13TH International Symposium on Fine Chemistry and Functional Polymer*, 2003, 90-91

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