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Rheology of Coal-Water Slurries Prepared by the HP Roll Mill Grinding of Coal

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September 1, 1995 - November 30, 1995

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SUMMARY OF RESEARCH ACCOMPLISHMENTS

The objective of this research is the development of improved technology for the preparation of coal-water slurries that have potential for replacing fuel oil in direct combustion. This should be of major importance to the United States in its efforts to reduce dependence on imported oil and to rely more on its enormous low-cost coal resources.

In accordance with this objective, in the first stage of this project, considerable work was conducted to standardize experimental procedures for sample preparation, coal grinding, and rheological measurements to assure reproducibility of the experimental results. Methods were developed for applying the acoustophoresis technique for studying the electrokinetic behavior of concentrated coal-water suspensions. These measurements were carried out using this technique to identify the potential of chemical additives for functioning as reagents for effective dispersion. Detailed investigations of the effect of solids content and chemical additives on the rheology of coal-water slurries, prepared with fines produced by the ball milling of Pittsburgh No. 8 coal, were conducted during the first phase of our research program. These experiments were to provide a baseline against which the rheological behavior of slurries prepared with fines produced by high-pressure roll milling or hybrid high-pressure roll mill/ball mill grinding could be compared.

Detailed investigation of the effect of high-pressure roll milling on the energetics of fine grinding and the rheology of coal-water slurries prepared with such fines was carried out in the second stage of the project. Our experimental results indicated that a given degree of size reduction could be achieved by hybrid high-pressure roll mill / ball mill grinding with significantly lower energy expenditure as compared to that required for grinding in a ball mill alone. Viscosity measurements showed that the rheological properties of slurries prepared with fine particles

produced by the hybrid grinding of coal are similar to or better than slurries prepared with fines produced by grinding coal in a ball mill only. A commercially available popular reagent used to prepare the slurries, Coal Master A-23-M from Henkel Corporation, proved to be a very efficient dispersant. Studies on the effect of grinding environment in the ball mill on the rheology of slurries showed that wet grinding with dispersants results in improved rheological properties. We also presented a relationship between the packing characteristics of fine particles and the rheology of their slurries. Optimum particle packing corresponding to a minimum in the viscosity was achieved by mixing distributions with different median sizes.

Study of the aging behavior of slurries showed a non-linear increase in their apparent viscosity over time. This increase was found to be partly due to iron released through the oxidation of pyrite contained in the coal. This was confirmed through spectroscopic studies and chemical analysis. Removal of iron by washing coal with iron-complexing reagents significantly lowered the apparent viscosity of freshly prepared coal-water slurries and slowed down the degradation of the rheological properties of the slurries, but only temporarily. Physical cleaning of coal, prior to the preparation of slurries, further improved the long-term rheological behavior of the slurries.

The rheological behavior of slurries is a manifestation of particle-particle and particle-fluid interactions in the slurry. Improvement in the rheology of slurries could be brought about by suitably altering these interactions. The research directed towards investigation of the influence of co-addition of sodium hexametaphosphate and vacuum oil, with CoalMaster as the primary dispersant, showed that co-addition of the reagents significantly improved the rheology of coal-water slurries. Further research conducted in this quarter indicated that co-addition of reagents could substantially lower the total reagents dosage, without adversely affecting the slurry rheology. Besides lowering of the total reagents dosage, we have found that co-addition of reagents also improves the long-term rheological behavior of coal-water slurries.

Our main efforts are being directed towards the preparation of the final report for this project.

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