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Technical Progress Report For the Project

NEW CONCEPT FOR COAL WETTABILITY EVALUATION AND MODULATION

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STATEMENT OF OBJECTIVES

This project is concerned concept for coal surface wettability evaluation and modulation.

The objective of the work are to study the fundamental surface chemistry feature about the evaluation of the surface wettability of coal and pyrite and establish a new separation strategy which could contribute to the advanced coal-cleaning for premium fuel application.

SCIENCE AND TECHNICAL PROGRAMS

In this quarter, the capillary rise test results of three coals, mineral pyrite, and coal pyrite samples in methanol, ethanol and propanol have been tested. The test results shown that the kinetic wettability of coals, mineral pyrite, and coal pyrite in the alcohol homolog are dependent on the carbon chain length, as the length of the carbon chain is shorter, the surface wettability is the better.

THE KINETIC CAPILLARY RISE TEST IN METHANOL

The capillary rise test results for Upper Freeport Coal, Pittsburgh No.8 Coal, Illinois No.6 Coal, Colorado Mineral Pyrite, and Coal Pyrite in Methanol are shown at Figure 1 to 5. There are a linear relation between the h^2 and time.

The slope of the square of height of capillary rise vs time, or Hu's indices of kinetic wettability is a measure the speed of capillary rise for three coal, mineral pyrite, and coal pyrite. The value are listed in table 1, the rank of the Hu's indices of kinetic wettability for five samples in methanol are:

Upper Freeport coal > Pittsburgh No.8 Coal > Illinois No.6 Coal > Colorado Mineral

Upper Freeport coal > Pittsburgh No.8 Coal > Illinois No.6 Coal > Colorado Mineral Pyrite > Coal pyrite.

It can be seen the kinetic wettability of coal is more wettable than coal pyrite in methanol. The test results show that Upper Freeport Coal and Pittsburgh No.8 Coal behave most methanol-philicity and Coal pyrite behaves least methanol-philicity.

THE KINETIC CAPILLARY RISE TEST IN ETHANOL

The capillary rise test result for five samples in ethanol are shown at Figure 6 to 10. It can be seen that between the $h_x h$ and time have been good linear relationship.

The Hu's indices of kinetic wettability for five samples in ethanol are listed in table 2.

From table 2, the rank of the Hu's indices of kinetic ethanol-philicity for five samples are:

Upper Freeport Coal > Pittsburgh No.8 Coal > Illinois No.6 Coal > Colorado Mineral Pyrite > Coal Pyrite.

It is shown that the coal behaves ethanol-philicity than coal pyrite, and Upper Freeport Coal behave most ethanol-philicity and the Coal Pyrite behaves least ethanol-philicity.

THE KINETIC CAPILLARY RISE TEST IN PROPANOL

The capillary rise test results for five samples in Propanol are illustrated at Figure 11 to 15. From these figures, it can be seen that there is a good linear relationship between the $h_x h$ and time.

The Hu's indices of kinetic wettability for five samples are shown in table 3.

From table 3, the rank of the Hu's indices of kinetic wettability for five samples are:

Upper Freeport Coal > Pittsburgh No.8 Coal > Illinois No.6 Coal > Colorado Mineral Pyrite > Coal Pyrite.

Pyrite behaves least propanol-philicity.

THE RELATIVE KINETICS OF CAPILLARY RISE TEST AND WETTABILITY EVALUATION

The ratio of kinetics of capillary rise test between different media is a measure of relative wettability. From table 1,2 and 3, the Hu's evaluation of wettability of five samples in the methanol, ethanol and propanol are shown that the kinetic wettability is dependent on the carbon homologous series of alcohol, as shorter the carbon chain of the alcohol, the better surface wettability.

The Hu's evaluation of wettability of $H_{H_2O}/H_{\text{methanol}}$, $H_{H_2O}/H_{\text{ethanol}}$, and $H_{H_2O}/H_{\text{propanol}}$ for five samples are listed respectively in table 4,5 and 6. It indicates that in the water/methanol, water/ethanol, and water/propanol system, Upper Freeport Coal is very little hydrophilicity, or better floatability than Coal Pyrite, it also can be seen that in these system, Pittsburgh No.8 Coal have a little hydrophilicity, or better floatability than Coal pyrite, It mean that if Methanol, Ethanol, and Propanol are used as flotation collector, coal will be selectively separated from coal pyrite. This has been verified by our investigation elsewhere.

The Hu's evaluation of wettability of $H_{\text{methanol}}/H_{\text{kerosene}}$ for five samples are listed in table 7. It is very interesting to note that the five samples have more methanol-philicity than kerosene. This is very useful for flotation reagents evaluation and selection in practice.

The Hu's evaluation of wettability of $H_{\text{ethanol}}/H_{\text{kerosene}}$ for five samples are listed in table 8. It is indicated that ethanol also can be used as flotation collector.

The Hu's evaluation of wettability $H_{\text{propanol}}/H_{\text{kerosene}}$ for five samples are listed in table 9. It shows that the five samples have lower propanol-philicity than kerosene.

FUTURE WORK

In the next quarter , the wettability of five samples in the alcohol of different carbon chain length will be continue tested.

Table 1 Hu's Indices of Kinetic Wettability, H, in Methanol

Sample Name	H_{methanol}
Upper Freeport Coal	0.3661
Pittsburgh No.8 Coal	0.3599
Illinois No.6 Coal	0.2430
Colorado Mineral Pyrite	0.2169
Coal Pyrite	0.2030

Table 2 Hu's Indices of Kinetic Wettability, H, in Ethanol

Sample Name	H_{ethanol}
Upper Freeport Coal	0.1877
Pittsburgh No.8 Coal	0.1814
Illinois No.6 Coal	0.1095
Colorado Mineral Pyrite	0.0946
Coal Pyrite	0.0907

Table 3 Hu's Indices of Kinetic Wettability, H , in Propanol

Sample Name	H_{Propanol}
Upper Freeport Coal	0.1560
Pittsburgh No.8 Coal	0.1296
Illinois No.6 Coal	0.0969
Colorado Mineral Pyrite	0.0801
Coal Pyrite	0.0598

Table 4 The Evaluation of Wettability of Methanol $H_{\text{H}_2\text{O}}/H_{\text{methanol}}$

Sample Name	$H_{\text{H}_2\text{O}}/H_{\text{methanol}}$
Upper Freeport Coal	0.0000
Pittsburgh No.8 Coal	0.0322
Illinois No.6 Coal	0.5967
Coal Pyrite	0.7153
Colorado Mineral Pyrite	1.2766

Table 5 The Evaluation of Wettability of Ethanol $H_{H_2O}/H_{ethanol}$

Sample Name	$H_{H_2O}/H_{ethanol}$
Upper Freeport Coal	0.0000
Pittsburgh No.8 Coal	0.0639
Illinois No.6 Coal	1.3242
Coal Pyrite	1.5496
Colorado Mineral Pyrite	2.9514

Table 6 The Evaluation of Wettability of Propanol $H_{H_2O}/H_{propanol}$

Sample Name	$H_{H_2O}/H_{propanol}$
Upper Freeport Coal	0.0000
Pittsburgh No.8 Coal	0.08951
Illinois No.6 Coal	1.4964
Coal Pyrite	2.4281
Colorado Mineral Pyrite	3.4856

Table 7 The Evaluation of Wettability Between Methanol vs Kerosene $H_{\text{methanol}}/H_{\text{kerosene}}$

Sample Name	$H_{\text{methanol}}/H_{\text{kerosene}}$
Coal Pyrite	2.5062
Colorado Mineral Pyrite	2.4181
Pittsburgh No.8 Coal	2.2134
Upper Freeport Coal	2.1211
Illinois No.6 Coal	1.9676

Table 8 The Evaluation of Wettability Between Ethanol vs Kerosene $H_{\text{ethanol}}/H_{\text{kerosene}}$

Sample Name	$H_{\text{ethanol}}/H_{\text{kerosene}}$
Coal Pyrite	1.1198
Pittsburgh No.8 Coal	1.1156
Upper Freeport Coal	1.0875
Colorado Mineral Pyrite	1.0546
Illinois No.6 Coal	0.8866

Table 9 The Evaluation of Wettability Between Propanol vs Kerosene $H_{\text{propanol}}/H_{\text{kerosene}}$

Sample Name	$H_{\text{propanol}}/H_{\text{kerosene}}$
Upper Freeport Coal	0.9038
Colorado Mineral Pyrite	0.8930
Pittsburgh No.8 Coal	0.7971
Illinois No.6 Coal	0.7846
Coal Pyrite	0.7383

Figure 1 The Kinetics Capillary Rise Test Results Of Upper Freeport Coal in the Methanol

Figure 2 The Kinetics Capillary Rise Test Results of Pittsburgh No.8 Coal in the Methanol

Figure 3 The Kinetics Capillary Rise Test Results of Illinois No.6 Coal in the Methanol

Figure 4 The Kinetics Capillary Rise Test Results of Colorado Mineral Pyrite in the Methanol

Figure 5 The Kinetics Capillary Rise Test Results of Coal Pyrite in the Methanol

Figure 6 The Kinetics Capillary Rise Test Results of Upper Freeport Coal in the Ethanol

Figure 7 The Kinetics Capillary Rise Test Results of Pittsburgh No.8 Coal in the Ethanol

Figure 8 The Kinetics Capillary Rise Test Results of Illinois No.6 Coal in the Ethanol

Figure 9 The Kinetics Capillary Rise Test Results of Colorado Mineral Pyrite in the Ethanol

Figure 10 The Kinetics Capillary Rise Test Results of Coal Pyrite in the Ethanol

Figure 11 The Kinetics Capillary Rise Test Results of Upper Freeport Coal in the Propanol

Figure 12 The Kinetics Capillary Rise Test Results of Pittsburgh No.8 Coal in the Propanol

Figure 13 The Kinetics Capillary Rise Test Results of Illinois No.6 Coal in the Propanol

Figure 14 The Kinetics Capillary Rise Test Results of Colorado Mineral Pyrite in the Propanol

Figure 15 The Kinetics Capillary Rise Test Results of Coal Pyrite in the Propanol

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