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Technical Progress Report For the Project

NEW CONCEPT FOR COAL WETTABILITY EVALUATION AND MODULATION

DOE Project Grant: DE-FG22-92PC92546

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STATEMENT OF OBJECTIVES

This project is concerned with the new concept for coal surface wettability and floatability evaluation and modulation.

The objective of the work is to study the fundamental surface chemistry features about the evaluation of the surface wettability and floatability 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 PROGRESS

During this quarter the Hallimond-tube tests were conducted for the three coals , mineral pyrite, and coal pyrite samples. The kinetic floatability of the five samples have been tested without collector, with kerosene and with benzene as collector. The test results indicate that there are good agreements between the experimental observation and the theoretical assumption hypothesis about the new concept of the surface wettability and floatability of the coal and pyrite. These test results also shown that there are the wettability is incompatibility with floatability.

The Kinetic Floatability Test Without Collector

The Hallimond-tube test results for Upper Freeport coal, Pittsburgh No.8 Coal, Illinois No.6 Coal, Colorado Mineral Pyrite, and Coal Pyrite during no collector(or natural floatability) are listed in the table 1. It shows that the relationship between the yield and times.

The kinetic floatability of the five samples during no collector are illustrated at Figure 1 to 5. From figures, it can be seen that the rank of the kinetic floatability for five samples during no collector or the natural floatability are as:

Upper Freeport Coal > Pittsburgh No.8 Coal > Illinois No.6 Coal > Coal pyrite >

Colorado Mineral Pyrite.

It indicates that the kinetic floatability of coals is more floatable than coal pyrite during no collector. The test results show that Upper Freeport Coal and Pittsburgh No.8 Coal behave most natural floatability and Coal Pyrite and Colorado Mineral Pyrite behaves least natural floatability.

The Kinetic Floatability Test With Kerosene As Collector

The Hallimond-tube test results for the five samples with kerosene collector are listed in the table 2. It indicates the function between the flotation yield and times.

The Kinetic floatability of the five samples with kerosene as collector are shown on Figure 6 to 10. In these test, the kerosene dosage is 170 mg/l. The rank of the floatability for the five samples are:

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

It can be seen that Upper Freeport Coal behaves most floatability and Colorado Mineral Pyrite behaves least floatability on the kerosene-water system.

The Kinetic Floatability Test With Benzene As Collector

The Hallimond-tube test results for the five samples with kerosene as collector are listed in the table 3. The test dosage of the benzene is 170 mg/l. It express the kinetic as the flotation yield and time relationship.

The kinetic floatability of the five samples with benzene as collector are illustrated at Figure 11 to 15.

The rank of the kinetic benzene-philicity for the five samples are:

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

It indicates that the coals behave benzene-philicity than coal pyrite and mineral pyrite in the benzene-water system.

The Kinetics of the Wettability and Floatability Evaluation

The ratio of the kinetic of Hallimond-tube test results between different media is the measure of the relative floatability. The Hu's evaluation of the floatability of the five samples in the system of the water, kerosene-water and benzene-water are shown in table 1, 2 and 3.

The Hu's evaluation of the kinetic wettability and kinetic floatability are summerized in table 1, 2, 3, 4, and 5. It means that Upper Freeport Coal and Pittsburgh No.8 Coal has little water-philicity, much more kerosene-philicity and benzene-philicity, Illinois No.6 Coal has more kerosene-philicity and benzene-philicity, and Coal Pyrite and Colorado Mineral Pyrite have more water-philicity and less kerosene-philicity and benzene-philicity.

From table 2, 3, 4, and 5, the Hu's evaluation of the kinetic wettability (capillary rise test) and kinetic floatability(Hallimond tube test) has been shown that there are different values in the single kerosene and single benzene system and binary kerosene-water and benzene-water system. The kinetic wettability of the benzene is more than the kerosene for the five samples in single kerosene and benzene system, but the kinetic floatability of the kerosene is more than the benzene for the five samples in the binary kerosene-water and benzene-water system. The Hu's evaluation of the kinetics indicates that there are difference between the kinetic wettability and kinetic floatability. It seems due to different molecular structure of the kerosene and benzene. It also shows that the interfacial energy of the solid/liquid, solid/air and liquid/liquid in the binary

kerosene-water and benzene-water system lead to occur difference between the kinetic wettability and kinetic floatability. The studies and evaluation reveal the incompatibility between wettability and floatability.

Future Work

In the next quarter, the kinetic floatability of the five samples with the alcohol of different carbon chain length will be tested.

Table 1 Kinetic Floatability of Five Samples No Collector

Yield(%)					
Time (minutes)	Upper Freeport	Pittsburgh No.8	Illinois No.6	Coal Pyrite	Mineral pyrite
0.5	4.16	2.30	1.84	0.24	0.59
2.0	10.12	5.54	3.70	0.91	1.03
5.0	12.72	7.94	5.80	2.00	1.43
10.0	14.75	10.31	8.13	3.34	1.97
15.0	17.36	12.65	8.94	5.02	2.54

Table 2 Kinetic Floatability of Five Samples With Kerosene As Collector

Yield(%)					
Time (minutes)	Upper Freeport	Pittsburgh No.8	Illinois No.6	Coal Pyrite	Mineral Pyrite
0.5	26.34	18.84	10.07	0.73	0.42
2.0	69.13	45.73	20.47	2.27	1.18
5.0	84.13	64.02	28.31	3.6	1.92
10.0	86.94	76.69	36.22	5.84	2.62
15.0	88.47	82.55	41.52	7.54	3.38

Table 3 Kinetic Floatability of Five Samples With Benzene As Collector

Yield(%)					
Time (minutes)	Upper Freeport	Pittsburgh No.8	Illinois No.6	Coal Pyrite	Mineral Pyrite
0.5	13.1	4.84	3.61	0.20	0.43
2.0	22.81	12.92	8.71	0.93	0.79
5.0	32.35	20.92	16.31	1.99	1.2
10.0	41.91	32.86	25.77	3.55	1.83
15.0	48.7	44.1	33.67	4.99	2.54

Table 4 Hu's Indices of Kinetic Wettability, H, in Kerosene

Samples	Kerosene
Upper Freeport Coal	0.1726
Pittsburgh No.8 Coal	0.1626
Illinois No.6 Coal	0.1235
Colorado Mineral Pyrite	0.0897
Coal Pyrite	0.0810

Table 5 Hu's Indices of Kinetic Wettability, H, in Benzene

Samples	Benzene
Upper Freeport Coal	0.4998
Pittsburgh No.8 Coal	0.4611
Illinois No.6 Coal	0.3694
Coal Pyrite	0.3241
Colorado Mineral Pyrite	0.2490

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

Samples	$H_{H_2O}/H_{Kerosene}$
Upper Freeport Coal	0.00
Pittsburgh No.8 Coal	0.99
Illinois No.6 Coal	1.79
Coal Pyrite	1.79
Colorado Mineral Pyrite	3.11

Table 7 The Evaluation of Wettability of Benzene $H_{H_2O}/H_{Benzene}$

Samples	$H_{H_2O}/H_{Benzene}$
Upper Freeport Coal	0.00
Pittsburgh No.8 Coal	0.03
Illinois No.6 Coal	0.39
Coal Pyrite	0.45
Colorado Mineral Pyrite	1.12

Figure 1 The Kinetic Flotation Test Results of Upper Freeport Coal No Collector

Figure 2 The Kinetic Flotation Test Results of Pittsburgh No.8 Coal No Collector

Figure 3 The Kinetic Flotation Test Results of Illinois No. 6 Coal No Collector

Figure 4 The Kinetic Flotation Test Results of Coal Pyrite
No Collector

Figure 5 The Kinetic Flotation Test Results of Colorado Mineral Pyrite No Collector

Figure 6 The Kinetic Flotation Test Results of Upper Freeport Coal With Kerosene As Collector

Figure 7 The Kinetic Flotation Test Results of Pittsburgh No.8 Coal With Kerosene As Collector

Figure 8 The Kinetic Flotation Test Results of Illinois No.6 Coal With Kerosene As Collector

Figure 9 The Kinetic Flotation Test Results of Coal Pyrite With Kerosene As Collector

Figure 10 The Kinetic Flotation Test Results of Colorado Mineral Pyrite With Kerosene As Collector

Figure 11 The Kinetic Flotation Test Results of Upper Freeport Coal With Benzene As Collector

Figure 12 The Kinetic Flotation Test Results of Pittsburgh No.8 Coal With Benzene As Collector

Figure 13 The Kinetic Flotation Test Results of Illinois No.6 Coal With Benzene As Collector

Figure 14 The Kinetic Flotation Test Results of Coal Pyrite With Benzene As collector

Figure 15 The Kinetic Flotation Test Results of Colorado Mineral Pyrite With Benzene As Collector

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