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DEVELOPMENT OF A GAS-PROMOTED OIL AGGLOMERATION PROCESS

Quarterly Technical Progress Report

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T. D. Wheelock, Principal Investigator

ABSTRACT

A number of agglomeration tests were conducted with finely ground Pittsburgh No. 8 coal to study the effects of various parameters on the size and structure of the agglomerates formed, the rate of agglomeration, coal recovery, and ash rejection. In these tests, concentrated suspensions were treated with i-octane and a limited amount of air in a small laboratory mixing unit. Conditions were identified which affected either the rate of agglomeration or the type of product produced. Some conditions led to the formation of unconsolidated flocs while others led to the production of compact agglomerates. Since the product was recovered by screening, the largest recovery of coal and cleanest product were realized when the product was in the form of compact agglomerates rather than in the form of unconsolidated flocs.

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EXECUTIVE SUMMARY

The overall purpose of this research project is to carry out the preliminary laboratory-scale development of a gas-promoted, oil agglomeration process for cleaning coal using model mixing systems. Specific objectives include determining the nature of the gas promotion mechanism, the effects of hydrodynamic factors and key parameters on process performance, and a suitable basis for size scale-up of the mixing system.

During the past quarter a number of oil agglomeration tests were conducted with a small laboratory mixing system to determine the effects of various parameters on process performance. In these tests, suspensions containing 30 v/w% particle concentrations of Pittsburgh No. 8 coal were treated with i-octane at room temperature in the presence of controlled amounts of air. Agitation was supplied by a turbine impeller driven at a controlled speed by a unit which indicated both speed and torque. Depending on treatment time and conditions, the product formed was either unconsolidated flocs or compact agglomerates. The formation of flocs was favored by a low oil concentration and short treatment time. The formation of compact agglomerates was favored by a somewhat larger oil concentration and longer treatment time. Compact agglomerates were readily recovered by screening to provide a large yield of clean coal with a relatively low ash content, whereas flocs were more difficult to recover and separate. The rate of agglomeration was increased by increasing either the oil concentration or agitator speed.

INTRODUCTION

The results of a number of tests were reported previously in which small amounts of air were used to promote the agglomeration of Pittsburgh No. 8 coal with i-octane (ref. 1,2). One series of 35 tests was conducted to determine the effects of various system parameters on the time required to produce spherical agglomerates, and it was found that the time seemed to correlate with the agitator power input per unit volume of particle suspension.

The results of the first few tests of a second series were also reported (ref. 2). The second series is designed to determine the effects of agitation time and various system parameters on coal recovery and grade. A number of tests in this series were completed during the past quarter, and the results are presented below.

RESULTS AND DISCUSSION

The agglomeration tests were conducted with coal from the Pittsburgh No. 8 Seam in Belmont County, Ohio. This coal contained 5.0% sulfur and 28% ash on a dry basis. The preparation of this material and the equipment and procedure used for conducting agglomeration tests were described previously (ref. 1). All of the tests reported below were carried out with a 7.62 cm diameter agitated tank using a 3.65 cm diameter impeller. A solids concentration of 30 w/v% was utilized in each test, and pure i-octane was the agglomerant employed in each test. The particle suspension was first degassed and then dosed with i-octane. After the suspension was conditioned for 5 min. with the agitator running at the desired test speed, a known volume of air was introduced which started the process of agglomeration. As the test continued, agitator speed was held constant while agitator torque

was allowed to vary. The torque was measured and recorded continuously because it had been shown previously that changes in the torque provided an indication of the progress of agglomeration (ref. 1). The mixing tank was cooled with an ice bath to maintain the temperature of the suspension close to room temperature. At the end of a run a sample of the suspension was collected for examination with a microscope. The remaining suspension was then diluted with an equal volume of water and separated with a 250 μm screen. The agglomerated product and the tailings were recovered separately and then dried and weighed. The ash content of the product and tailings was determined subsequently.

The conditions employed and the results obtained in the present series of agglomeration tests or runs are presented in Table 1. The following conditions were varied among these tests: oil concentration, agitator speed, and total time of agitation. For each of the tests a record was obtained of the variation in agitator torque with time as well as an indication of coal recovery and ash rejection. Typical results are shown in Figure 1 for three runs conducted at different agitator speeds but otherwise similar conditions including an oil concentration of 20 v/w% and air concentration of 9 v/w%. It can be seen that agitator torque depended on impeller speed as well as treatment time following the introduction of air. With an increase in speed the torque would increase and the time taken to reach an identifiable stage in the oil agglomeration process would decrease. For example, the time taken to reach point E decreased as agitator speed increased. Point E seemed to mark the stage when small, compact agglomerates were formed (ref. 1). However, there was some doubt as to whether compact agglomerates were formed at the lowest agitator speed since only flocs and possibly micro-

Table 1. Experimental conditions and results of oil agglomeration runs

Run, No.	Oil, v/w%	Air, v/w%	Speed, rpm	Time, ^a min.	Size, ^b mm	Ash, ^b w/w%	Ash Rej. ^c %	Coal Rec. ^d %
17	30	9	1600	35	0.2	11.87	64.6	95.4
18	30	9	1600	45	0.2	11.68	66.5	94.2
20	30	9	1600	80	2.5	8.19	77.4	96.8
22	30	9	1600	80	2.5	7.82	79.3	96.1
24	30	9	2000	65	2.~3.5	7.95	78.4	95.5
25	30	9	2000	45	0.2-0.3	10.28	71.4	92.2
26	30	9	2000	25	0.15-0.2	11.87	67.0	92.9
27	30	9	2000	10	big flocs	15.90	55.3	88.8
28	20	9	2000	130	0.15-0.22	11.20	68.7	94.2
29	20	9	2200	132	0.08-0.1	12.98	64.9	90.4
30	20	9	1800	130	flocs	19.89	65.5	52.9

^aTreatment time following introduction of air.

^bSize and ash content of agglomerates.

^cAsh rejected to tailings.

^dCoal recovery on a dry, ash-free basis.

agglomerates were found in the mixture at the end of run MS 30. Furthermore, only a slight peak in torque was observed at point E during this run. An analysis of the agglomerated product recovered by screening and of the remaining tailings for each run produced the results shown in Figure 2 for the runs conducted at different agitator speeds. It is apparent that coal recovery was much greater when an agitator speed of 2000 rpm or more was used than when a lower speed was used. The difference was due largely to the size and structure of the aggregates produced at different speeds. At the lowest speed only flocs and possibly microaggregates were produced which were difficult to recover.

Figure 1. Results of three runs conducted with 20 v/w% oil, 9 v/w% air, and different agitator speeds.

Figure 2. Effect of agitator speed on coal recovery, ash rejection, and product ash content for runs made with 20 v/w% oil, 9 v/w% air, and 130 min. treatment time.

A comparison of the results achieved with 20 v/w% oil with those achieved with 30 v/w% oil showed that for a given agitator speed the process of agglomeration was faster at the higher oil concentration. For example, for an agitator speed of 2000 rpm it took 7 min. after air was introduced for the torque to reach the peak at E with the higher oil concentration and 16 min. with the lower oil concentration. Generally, under otherwise similar conditions, larger and more easily recovered agglomerates were produced with 30 v/w% oil than with 20 v/w% oil.

It was shown previously that coal recovery and ash rejection improved when the agglomeration treatment time was extended (ref. 2). This effect is further illustrated by Figure 3 which shows the results of two sets of runs conducted under similar conditions except for agitator speed. One set of runs was conducted with an agitator speed of 1600 rpm and the other set of runs with an agitator speed of 2000 rpm. In both cases coal recovery and ash rejection increased gradually with treatment time. The most notable difference between the two sets of runs was a shift in the ash rejection curve. At the higher agitation speed it required less time to reach the same level of ash rejection.

CONCLUSIONS

A number of agglomeration tests were conducted in which finely ground Pittsburgh No. 8 coal in 30 v/w% concentration was agglomerated with i-octane under various conditions to study the effects of different parameters on the rate of agglomeration, coal recovery, and ash rejection. The results showed that the rate of agglomeration was improved by an increase in either oil concentration or agitator speed. Coal recovery and ash rejection were improved by

Figure 3. Effect of treatment time on coal recovery, ash rejection, and product ash content for two sets of runs conducted at different agitator speeds but with 30 v/w% oil and 9 v/w% air.

changes in operating conditions with produced larger and more easily recovered agglomerates.

Therefore, increases in oil concentration, agitator speed and/or treatment time tended to improve coal recovery and ash rejection.

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