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MINES BRANCH INVESTIGATION REPORT IR 66-27

RECOVERY OF CARBON AND OTHER PRODUCTS FROM FLY ASH (PROJECT MP-IM-6501)

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

At the request of the Hydro Electric Power Commission of Ontario a study was undertaken of the recovery of carbon and other products from fly ash.

A concentrate material containing 73% carbon (L O I analysis) at 36% recovery was made by grinding and flotation with sodium silicate, kerosene and Frother F-73. Magnetic fractionation of the rougher tails gave a series of products with varying iron content.

The work was of an exploratory nature only. Owing to other arrangements by the supplier the investigation was terminated.

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INTRODUCTION

Early in 1965, personnel of the Hydro Electric Power Commission of Ontario visited Ottawa and discussed the possibilities of beneficiating fly ash, a by-product that accumulated at their fuel-fired generating plants. Two approaches were considered, viz, (1) Recovery of carbon to be returned to their coal pile for reburning, and (2) Recovery of a material that could be used in light-weight aggregate for concrete production.

Previous work on this problem had been carried out at the University of Toronto, the Ontario Research Foundation and in Hydro's own research division.

It was agreed that certain exploratory work would be undertaken to indicate which avenues should be investigated in depth.

During the time of the investigation, the Hydro Electric Power Commission negotiated an agreement with a commercial firm which has taken over a large part of the development work on the utilization of fly ash produced in Hydro's plants. This firm's approach to the problem being different from that previously discussed with the Mines Branch, it was decided to terminate the work and report that done to date.

DESCRIPTION OF SAMPLE

A 200-lb sample was received.

From information* given by the supplier on a similar material, it appears that the carbon is present mainly in the form of coke and, to a minor extent, as coal. The coke particles are highly vesicular and very brittle.

Present also are spherical, glassy particles or beads, fused rock impurities and remnants of rock particles, shale, quartz, etc. These are of relatively high strength compared to the coke occurrences.

ANALYSIS OF SAMPLE

Screen and chemical analyses of the sample received are given in Table 1.

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* Hydro Electric Power Commission of Ontario, Research Division Reports No. MM 64-19; M 64-51, M 65-9.

Loss on Ignition (L O I) determinations were used as a measure of the carbon present*.

Acid-soluble and total iron analyses were run to show the iron distribution.

TABLE 1

Screen and Chemical Analyses of Head Sample

Fraction	Wt	LOI	Fe as Fe_2O_3%	
	%	%	Acid Sol	Total
+ 35 m	0.4	20.11	-	-
-35, + 48 m	0.4	29.71	-	-
-48, + 65 m	1.2	31.59	-	-
-65, +100 m	2.9	38.88	-	-
-100,+150 m	5.4	38.22	-	-
-150,+200 m	4.8	25.66	-	-
-200,+325 m	11.7	20.53	-	-
-325 m	73.2	6.21	-	-
Heads	100.0	12.26	14.14	18.30

TEST WORK

The fly ash was treated 1) as received, and 2) after a preliminary grind in an Abbe mill to break down the vesicular coke particles and free the iron-bearing constituents. Bench scale flotation tests to remove the carbon were followed by magnetic fractionation of the rougher tails.

Rougher flotation was carried out in the 200-gram bowl of a Denver D-1 laboratory cell. The density was kept high by using a 500-gram head sample. Sodium silicate was added as a dispersant. The collector-frother combination was a mixture of kerosene and frother F-73, added in steps with conditioning. The floated material was cleaned three times at a low density.

The rougher tails were separated magnetically in the Jones Wet Magnetic Mineral Separator (1) equipped with salient pole plates. Cuts were made at 0, 5, 10 and 25 amps.

A typical result, obtained with the material as received, is shown in Table 2; one with the material pre-ground 15 minutes in an Abbe Mill is given in Table 3.

* It was found in the analytical work done that a negative LOI result was obtained with some high iron products. This is assumed to be caused by the weight gained by oxidized iron, etc.

TABLE 2

Flotation - Magnetic Separation

Material as received

(Flotation Test No. 8 - Jones Test No. 7)

Reagents:

Sodium Silicate	-2	lb/ton
Kerosene	-5	lb/ton
Frother F-73	-1.8	lb/ton

Conditions:	Density (%S):	Time (Min):
Rougher	30-35	15-16
Cleaner 1	10	4
Cleaner 2	9	3
Cleaner 3	8	3

Fraction	Wt %	LOI		Fe as Fe_2O_3			
				Acid Soluble		Total	
		%	Dist %	%	Dist %	%	Dist %
Concentrate	4.6	72.08	25.7	2.27	0.9	2.67	0.6
Cleaner 3 tails	2.2	46.59	8.0	4.46	0.8	5.51	0.6
Cleaner 2 tails	8.1	24.04	15.1	6.27	4.2	8.58	3.9
Cleaner 1 tails	34.2	13.66	36.1	8.71	24.4	11.56	21.9
Mags 0 amps	14.3	(-)0.97*	0	53.46	62.4	78.45	62.0
Mags 5 amps	5.1	3.81	0.3	8.00	3.3	17.13	4.9
Mags 10 amps	2.7	6.04	0.2	4.11	0.9	8.59	1.3
Mags 25 amps	2.1	5.82	0.2	2.79	0.5	6.24	0.7
Non Mags	26.7	5.46	2.0	1.22	2.6	2.78	4.1
Total	100.0	12.91	100.0	12.22	100.0	18.08	100.0

* Assumed 0 for calculations

TABLE 3

Flotation - Magnetic Separation

Material pre-ground

(Flotation Test No. 7 - Jones Test No. 6)

Reagents:			Conditions:	Density (%S):	Time (Min):
Sodium Silicate	-2	lb/ton	Rougher	30-35	15-16
Kerosene	-5	lb-ton	Cleaner 1	10	5½
Frother F-73	-1.8	lb/ton	Cleaner 2	9	4½
			Cleaner 3	8	3½

Fraction	Wt %	LOI		Fe as Fe_2O_3			
				Acid Soluble		Total	
		%	Dist%	%	Dist%	%	Dist%
Concentrate	6.7	73.22	36.0	1.87	0.9	2.22	0.8
Cleaner 3 tails	3.0	48.71	11.0	4.40	1.0	5.31	0.8
Cleaner 2 tails	7.7	26.99	15.5	6.73	3.8	8.19	3.4
Cleaner 1 tails	34.0	13.60	34.8	10.17	24.8	12.48	22.8
Mags 0 amps	15.6	(-)1.15*	0	56.43	63.9	74.30	62.5
Mags 5 amps	5.5	0.61	0.3	6.12	2.5	15.33	4.5
Mags10 amps	3.1	1.02	0.2	3.02	0.7	6.92	1.1
Mags25 amps	2.5	1.16	0.2	2.22	0.4	5.03	0.7
Non mags	21.9	1.19	2.0	1.23	2.0	2.87	3.4
Total	100.0	13.32	100.0	13.75	100.0	18.60	100.0

* Assumed 0 for calculations

REMARKS

This work was of an exploratory nature only.

In the flotation runs no attempt was made to reduce the quantities of reagents used.

The products of the magnetic fractionation separations were not evaluated as to their suitability for any specific end uses.

Grinding of the fly ash before flotation is beneficial. Comparing the results in Table 2 with those of Table 3 (in which a 500-gram head sample was ground at 50% solids for 15 minutes in a medium size Abbe Mill with a media charge of 3000 grams of ½-inch Burundum pellets) carbon recovery, based on LOI analysis, was increased from 25.7 to 36% in the concentrate. Carbon loss in the rougher tails - combined magnetic and non-magnetic fractions - was reduced from 15.1 to 2.7%.

From Table 3, combining the cleaner 3 tails with the concentrate will give a 65% carbon product at 47% recovery; including the cleaner 2 tails will give a 47.7% carbon product at 62.5% recovery. In a commercial operation, the cleaner tails would be treated as middlings and would be recirculated, resulting in an increase in overall recovery.

The rougher tails separated magnetically into fractions with a distinct gradation in soluble and total iron contents. Other separations could probably be made using different amperage settings. The importance of these fractions would depend on their end use.

CONCLUSIONS

1. A product containing 73% carbon (LOI analysis) at 36% recovery was obtained by grinding and floating fly ash.

2. A product containing 65% carbon at 47% recovery could be obtained.

3. Flotation reagents used were sodium silicate: 2 lb/ton; kerosene: 5 lb/ton; Frother F-73: 1.8 lb/ton.

4. No attempt was made to determine the optimum combination or amounts of reagents required.

5. The rougher tails from flotation were amenable to magnetic separation into products with widely varying iron contents.

6. Evaluation of the results is a matter of economics and end-use products, and is left to the supplier.

7. The test work was of an exploratory nature only.

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REFERENCE

1. R. A. Wyman, W. J. D. Stone, and F. H. Hartman, "Illustrative Applications of the Jones Wet Magnetic Mineral Separator", Mines Branch Technical Bulletin TB 36, Department of Energy, Mines and Resources, Ottawa, Canada.

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