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# R.689. Flotation of coal from washery effluents. Dewatering flotation tailings.

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Previous work (R.651, R.654 and R.665) has dealt with the testing of washery effluents for the recovery of fine coal by froth flotation and the dewatering of both total effluents and flotation tailings by centrifuging.

The purpose of the work has been two-fold. Firstly to demonstrate the feasibility of recovering a significant quantity of high grade coal fines which are presently regarded as a waste product, and secondly to provide data on dewatering of the washery effluents by centrifuging which could be an efficient alternative to the present practice of storing and drying the slurries in a series of settling ponds.

Because of the encouraging results obtained in the laboratory batch work it was decided to instal pilot scale equipment at the washery to extend the experiments to include the continuous flotation of coal from the washery effluents and the continuous clarification of both total effluent and flotation tailings by solid bowl centrifuging.

Some preliminary work of this nature has been undertaken and the results have been reported and discussed in Investigation R.667 and a letter dated 26 July 1974. Some recommendations with regard to modifications to equipment were made in these communications and this report deals with a series of experiments conducted using the modified equipment.

## FLOW CIRCUIT

The pilot plant consisted of a duplex agitair type cell of local manufacture and a Bird solid bowl continuous centrifuge as described in Investigation R.667, with the exception that speed had been increased to 2000 rpm giving a theoretical centrifugal acceleration of 10 000 $m/s^2$.

A bleed from the effluent to be tested was fed to the cell; flotation tailing was fed to the intake pipe of the centrifuge. Control valves were incorporated in the feed lines, with bypass lines, also with valves, to bypass pulp in excess of the capacity of the machines.

Flotation reagents were added to the feed well of the cell. Conditioning time was therefore minimal but this did not apparently affect performance.

An attempt was made to add sulphuric acid to the discharge weir of the cell to flocculate the centrifuge feed but practical difficulties caused this to be abandoned.

The centrifuge feed rate was erratic and frequently not at a low enough rate for optimum performance due to continual blockages of the feed valves by fragments of splintery coal which failed to respond to flotation.

## TEST PROGRAM

Three test runs were conducted:

(1) Bleed from the settling cone underflow with dilution water added at the feed well of the flotation cell.

(2) A composite bleed from the main sump overflow and the basket centrifuge liquid.

(3) Bleed from settling cone underflow without dilution.

In each run when conditions appeared to be steady, all products from the test circuit were sampled at 5 minute intervals over a period of 45 minutes. Feed rate to the cell was determined and reagent consumption measured.

The rougher flotation coal concentrates were subjected to cleaner flotation in batch tests in the laboratory.

Flotation reagents used were Teric 403 and kerosene.

## TEST RESULTS

*Run 1. Cone underflow, diluted*

*A. Pilot circuit*

| *Product* | *% Mass* | *% Ash* | *% Ash distn* |
|---|---|---|---|
| F1C (coal) | 59.5 | 23.9 | 39.8 |
| F1T | 40.5 | 53.1 | 60.2 |
| Centrifuge S/D | 17.6 | 35.5 | 17.4 |
| Centrifuge L | 22.9 | 66.7 | 42.8 |
| Composite F/D | 100.0 | 35.7 | 100.0 |

| | |
|---|---|
| Feed density | 135 g/*l* |
| Feed rate | 13.5 kg/min |
| Centrifuge solids | 19.7% moisture |
| Centrifuge liquid density | 39 g/*l* |

Reagent addition

| | |
|---|---|
| Teric 403 | 1200 g/t |
| Kerosene | 2600 g/t |

*B. Bench cleaner flotation*

| *Product* | *% Mass (overall)* | *% Ash* | *% Ash distn (overall)* |
|---|---|---|---|
| F2C | 52.2 | 17.4 | 26.5 |
| F2T | 7.3 | 61.0 | 13.3 |
| Composite F1C | 59.5 | 22.4 | 39.8 |

No further reagent addition in bench test.

*Run 2. Main sump overflow and basket centrifuge discharge as produced*

*A. Pilot circuit*

| *Product* | *% Mass* | *% Ash* | *% Ash distn* |
|---|---|---|---|
| F1C (coal) | 65.1 | 22.3 | 40.7 |
| F1T | 34.9 | 60.6 | 59.3 |
| Centrifuge S/D | 13.6 | 43.9 | 16.8 |
| Centrifuge L | 21.3 | 71.2 | 42.5 |
| Composite F/D | 100.0 | 35.7 | 100.0 |

| | |
|---|---|
| Feed density | 100 g/l |
| Feed rate | 6.75 kg/min |
| Centrifuge solids | 27.6% moisture |
| Centrifuge liquid density | 32 g/l |

Reagent addition

| | |
|---|---|
| Teric 403 | 2400 g/t |
| Kerosene | 5200 g/t |

*B. Bench cleaner flotation*

| *Product* | *% Mass (overall)* | *% Ash* | *% Ash distn (overall)* |
|---|---|---|---|
| F2C | 57.9 | 13.5 | 23.3 |
| F2T | 7.2 | 80.8 | 17.4 |
| Composite F1C | 100.0 | 20.9 | 40.7 |

No further reagent addition in bench test.

*Run 3. Cone underflow, as produced*

*A. Pilot circuit*

| *Product* | *% Mass* | *% Ash* | *% Ash distn* |
|---|---|---|---|
| F1C (coal) | 48.7 | 25.0 | 41.1 |
| F1T | 51.3 | 34.0 | 58.9 |
| Centrifuge S/D | 47.5 | 31.8 | 51.0 |
| Centrifuge L | 3.8 | 61.8 | 7.9 |
| Composite F/D | 100.0 | 29.6 | 100.0 |

| | |
|---|---|
| Feed density | 241 g/l |
| Feed rate | 26 kg/min |
| Centrifuge solid | 24.5% moisture |
| Centrifuge liquid density | 44 g/l |

Reagent addition

| | |
|---|---|
| Teric 403 | 600 g/t |
| Kerosene | 1350 g/t |

*B. Bench cleaner flotation*

| *Product* | *% Mass (overall)* | *% Ash* | *% Ash distn (overall)* |
|---|---|---|---|
| F2C | 39.0 | 16.4 | 22.3 |
| F2T | 9.7 | 55.4 | 18.8 |
| Composite F1C | 48.7 | 24.1 | 41.1 |

No further reagent addition in bench test.

## SUMMARY AND CONCLUSION

*Flotation*

The results of the pilot plant work with regard to coal flotation are satisfactory and prove that the application of froth flotation methods for the effluents is technically feasible. The results in fact closely parallel those obtained in previous small-scale bench tests.

Reagent usage was excessive in all three runs. Proper control of reagent addition was not possible due to the lack of a proper metering device for feeding them and the quantities used are not indicative of what proper consumption should be. The reagent consumptions reported in R.651 and R.654 are more realistic.

Cleaner flotation in the laboratory resulted in a significant decrease in the ash content of the fine coal concentrate.

*Centrifuging flotation tailings*

This exercise was not very satisfactory under the conditions obtainable in the test programme and no conclusive data was obtained as to the ultimate degree of clarification obtainable.

Practical difficulties prevented the centrifuge from being fed at an even rate and during most of the operating time feed rate was obviously too great for efficient clarification. The lack of a flocculating agent was also a factor, but not perhaps a very significant one.

However, the centrifuge solids, as discharged were in a semi-plastic condition and could quite easily be moved with a hand shovel. No difficulty could be foreseen in the bulk handling of this product with normal earth moving equipment.

In Runs 1, 2 and 3, about 23, 21 and 4% respectively of the pilot plant feed remained in the final effluent. The balance was recovered either as good quality coal concentrate or easily handled centrifuge discharge.

[20 December 1974]