TR11_178_182

# R. 528

## 31. CORNWALL COAL Co. N.L.: FINGAL WASHERY: HYDRAULIC CYCLONING OF FINE COAL SLURRY

### Introduction

This series of tests was designed to see if an hydraulic cyclone could remove ash from fine coal slurry. This slurry eventually finds its way into the marketable fine coal where because of its higher ash content, it raises the level of ash in the market coal.

Because of the quantity of slurry necessary for the cyclone tests and because the normal plant head of slurry could be sufficient for cycloning the equipment was taken to the washery for the test.

### Method

Tests were made using a Warman 3 inch hydraulic cyclone using the range of vortex finders and nozzles. The slurry was too coarse to allow the ¼ inch nozzle to be used without blocking but an improvised replacement was used. This consisted of a

9 inch length of plastic tube of $\frac{3}{8}$ inch bore clasped in a variable orifice nozzle. The wider bore did not block but the length of tube provided a greater resistance to the nozzle flow than would a normal $\frac{3}{8}$ inch nozzle.

Slurry was bled from a 4 inch line either through a 3 inch hose to the pump feed box or through a one inch hose direct to the cyclone.

Tests N-1 to N-6 were run using a pump to apply pressure to the cyclone. In Tests N-7 to N-10 the available pressure in the pipe line was used for the cyclone head pressure.

**Results**

The test results are given in Table 1.

**Table 1**

| *Test No.* | *Vortex Finder (inch)* | *Nozzle (inch)* | *Product* | *Per Cent* *Weight* | *Ash* | *Distribution Ash* |
|---|---|---|---|---|---|---|
| N-1 .. .... | $\frac{7}{8}$ | $\frac{3}{4}$ | U/F | 98.1 | 25.7 | 97.4 |
| | | | O/F | 1.9 | 35.1 | 2.6 |
| | | | | 100.0 | 25.9 | 100.0 |
| N-2 .. .... | $\frac{7}{8}$ | $\frac{1}{2}$ | U/F | 92.3 | 25.1 | 88.4 |
| | | | O/F | 7.7 | 39.4 | 11.6 |
| | | | | 100.0 | 26.2 | 100.0 |
| N-3 .. .... | $\frac{7}{8}$ | $\frac{3}{8}$* | U/F | 5.8 | 35.1 | 7.7 |
| | | | O/F | 94.2 | 26.0 | 92.3 |
| | | | | 100.0 | 26.5 | 100.0 |
| N-4 .. .... | $\frac{5}{8}$ | $\frac{3}{8}$* | U/F | 33.5 | 36.4 | 40.7 |
| | | | O/F | 66.5 | 26.8 | 59.3 |
| | | | | 100.0 | 30.0 | 100.0 |
| N-5 .. .... | $\frac{5}{8}$ | $\frac{1}{2}$ | U/F | 93.6 | 25.8 | 90.0 |
| | | | O/F | 6.4 | 42.1 | 10.0 |
| | | | | 100.0 | 26.9 | 100.0 |
| N-6 .. .... | $\frac{5}{8}$ | $\frac{3}{4}$ | U/F | 93.7 | 27.0 | 89.6 |
| | | | O/F | 6.3 | 46.5 | 10.4 |
| | | | | 100.0 | 28.2 | 100.0 |
| N-7 .. .... | $\frac{5}{8}$ | $\frac{1}{2}$ | U/F | 87.8 | 26.8 | 82.1 |
| | | | O/F | 12.2 | 42.1 | 17.9 |
| | | | | 100.0 | 28.7 | 100.0 |
| N-8 .. .... | $\frac{5}{8}$ | $\frac{3}{8}$* | U/F | 80.1 | 25.8 | 71.4 |
| | | | O/F | 19.9 | 41.6 | 28.6 |
| | | | | 100.0 | 28.9 | 100.0 |
| N-9 .. .... | $\frac{7}{8}$ | $\frac{3}{8}$* | U/F | 61.5 | 31.3 | 57.9 |
| | | | O/F | 38.5 | 36.3 | 42.1 |
| | | | | 100.0 | 33.2 | 100.0 |
| N-10 ... | $\frac{7}{8}$ | $\frac{1}{2}$ | U/F | 85.3 | 27.7 | 78.8 |
| | | | O/F | 14.7 | 43.1 | 21.2 |
| | | | | 100.0 | 29.9 | 100.0 |

* See under " Method "

These results showed an unexpected ash concentration in most of the overflows. In order to investigate this further, the products from three tests were sized with results as in Table 2.

**Table 2**

TEST N-3—UNDERFLOW SIZING

| Fraction Mesh B.S. | Per Cent | | | Per Cent Distribution | |
|---|---|---|---|---|---|
| | Weight | Cum. Weight | Ash | Ash | Cum. Ash |
| + 14 .. .... .... | 12.2 | 12.2 | 23.8 | 8.2 | 8.2 |
| 25 .. .... .... | 24.0 | 36.2 | 25.4 | 17.3 | 25.5 |
| 52 .. .... .... | 22.0 | 58.2 | 30.3 | 18.9 | 44.4 |
| 100 .. .... .... | 23.0 | 81.2 | 38.3 | 25.0 | 69.4 |
| 200 .. .... .... | 10.5 | 91.7 | 59.6 | 17.8 | 87.2 |
| −200 .. .... .... | 8.3 | 100.0 | 54.3 | 12.8 | 100.0 |
| Composite .... | 100.0 | .... | 35.2 | 100.0 | .... |

TEST N-3—OVERFLOW SIZING

| Fraction Mesh B.S. | Per Cent | | | Per Cent Distribution | |
|---|---|---|---|---|---|
| | Weight | Cum. Weight | Ash | Ash | Cum. Ash |
| + 14 .. .... .... | 12.2 | 12.2 | 15.3 | 7.2 | 7.2 |
| 25 .. .... .... | 29.1 | 41.3 | 17.0 | 19.0 | 26.2 |
| 52 .. .... .... | 23.4 | 64.7 | 24.6 | 22.2 | 48.4 |
| 100 .. .... .... | 17.5 | 82.2 | 34.1 | 23.0 | 71.4 |
| 200 .. .... .... | 6.5 | 88.7 | 43.3 | 10.8 | 82.2 |
| −200 .. .... .... | 11.3 | 100.0 | 40.8 | 17.8 | 100.0 |
| Composite .... | 100.0 | .... | 26.0 | 100.0 | .... |

TEST N-6—UNDERFLOW SIZING

| Fraction Mesh B.S. | Per Cent | | | Per Cent Distribution | |
|---|---|---|---|---|---|
| | Weight | Cum. Weight | Ash | Ash | Cum. Ash |
| + 14 .. .... .... | 10.0 | 10.0 | 19.0 | 7.0 | 7.0 |
| 25 .. .... .... | 24.1 | 34.1 | 18.4 | 16.3 | 23.3 |
| 52 .. .... .... | 23.9 | 58.0 | 22.7 | 19.9 | 43.2 |
| 100 .. .... .... | 21.1 | 79.1 | 29.6 | 22.9 | 66.1 |
| 200 .. .... .... | 8.0 | 87.1 | 42.0 | 12.3 | 88.4 |
| −200 .. .... .... | 12.9 | 100.0 | 45.5 | 21.6 | 100.0 |
| Composite .... | 100.0 | .... | 27.2 | 100.0 | .... |

TEST N-6—OVERFLOW SIZING

| Fraction Mesh B.S. | Per Cent | | |
|---|---|---|---|
| | Weight | Cum. Weight | Ash |
| + 14 .. .... .... | 0.6 | 0.6 | |
| 25 .. .... .... | 0.7 | 1.3 | |
| 52 .. .... .... | 0.7 | 2.0 | |
| 100 .. .... .... | 3.0 | 5.0 | |
| 200 .. .... .... | 4.3 | 9.3 | |
| −200 .. .... .... | 90.7 | 100.0 | |
| Composite .... | 100.0 | .... | 46.5 |

**TEST N-8—UNDERFLOW SIZING**

| Fraction Mesh B.S. | Per Cent Weight | Per Cent Cum. Weight | Per Cent Ash | Per Cent Distribution Ash | Per Cent Distribution Cum. Ash |
|---|---|---|---|---|---|
| + 14 .. .... .... | 8.9 | 8.9 | 17.9 | 6.1 | 6.1 |
| 25 .. .... .... | 19.3 | 28.2 | 17.8 | 13.0 | 19.1 |
| 52 .. .... .... | 23.8 | 52.0 | 21.6 | 19.5 | 38.6 |
| 100 .. .... .... | 27.3 | 79.3 | 26.0 | 27.0 | 65.6 |
| 200 .. .... .... | 11.2 | 90.5 | 38.5 | 16.4 | 82.0 |
| −200 .. .... .... | 9.5 | 100.0 | 49.9 | 18.0 | 100.0 |
| Composite .... | 100.0 | .... | 26.3 | 100.0 | .... |

**TEST N-8—OVERFLOW SIZING**

| Fraction Mesh B.S. | Per Cent Weight | Per Cent Cum. Weight | Per Cent Ash |
|---|---|---|---|
| + 14 .. .... .... | 0.2 | 0.2 | |
| 25 .. .... .... | 0.5 | 0.7 | |
| 52 .. .... .... | 0.5 | 1.2 | |
| 100 .. .... .... | 1.4 | 2.6 | |
| 200 .. .... .... | 2.9 | 5.5 | |
| −200 .. .... .... | 94.5 | 100.0 | |
| Composite .... | 100.0 | .... | 41.6 |

**Discussion**

The above sizings show the following:—

**Table 3**

**UNDERFLOW**

| Test No. | Weight (%) | Size Fraction +52 mesh Weight (%) | +52 mesh Ash Distrib. (%) | −100 mesh Weight (%) | −100 mesh Ash Distrib. (%) | Ash Assay (%) |
|---|---|---|---|---|---|---|
| N-3 .. .... | 6 | 58 | 44 | 19 | 30 | 57 |
| N-6 .. .... | 94 | 58 | 43 | 21 | 34 | 44 |
| N-8 .. .... | 80 | 52 | 39 | 20 | 34 | 43 |

**OVERFLOW**

| Test No. | Size Fraction +52 mesh Weight Per Cent | +52 mesh Ash Distribution Per Cent |
|---|---|---|
| N-3 .... .... .... .... .... | 65 | 48 |
| N-6 .... .... .... .... .... | 91 | 47 |
| N-8 .... .... .... .... .... | 95 | 42 |

This shows that there is no difference between the underflow composition whatever the weight distribution between the cyclone products. It would appear that the hydraulic behaviour of ash and coal in this slurry is similar and hence cycloning will not produce a separation.

In all tests the weight and ash distributions in the cyclone products are similar. This supports the similar hydraulic behaviour of both coal and ash.

The change in cyclone feed pressure shows no alteration to the weight and ash distributions, a further example of hydraulic similarity.

The most marked differences occur when using the pump to feed the cyclone. Here the distribution of weight between the products changes markedly between the $\frac{1}{2}$ inch and nominal $\frac{3}{8}$ inch nozzles. This change is not so marked in the tests using the available pressure although in this case the trend is evident. However it is only a weight distribution change with ash distribution closely following and hence no separation.

**Conclusion**

An hydraulic cyclone is not suitable for reducing the ash content of this slurry.

**Recommendation**

Froth flotation may be worth testing as a means of beneficiating this slurry.