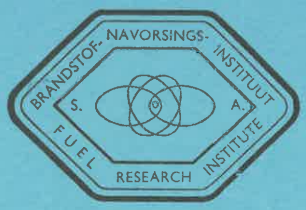

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TEGNIESE MEMORANDUM
TECHNICAL

NO. 30 OF 1968.

REPORT ON CYCLONE TEST ON INDUMENI SLURRY.

OUTEUR:
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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

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REPORT ON CYCLONE TEST ON INDUMENI SLURRY.

This report outlines the reasons for, and the results of, the above tests.

Indumeni Colliery supplies coking smalls to Iscor, the quality being governed by a specification which includes the following:

Ash Content - To be not more than 9.1%
Sulphur Content - To be not more than 1.5%.

The washability of the raw coal has deteriorated, and the sulphur content has tended to increase, resulting in increasing difficulty in meeting the above specification. At Indumeni, two different slurries are produced in the washery, and under normal conditions these are blended with the coking smalls. Both slurries are relatively high in sulphur and ash, and are described as follows:

(a) D.W.P. Slurry.

The fines minus 0.5 mm, wet screened from the raw coal prior to dense medium washing, and thereafter thickened by cycloning.

(b) Norwalt Slurry.

The fines adhering to the raw coal after the wet screening referred to above, eventually appear as non-magnetics from the magnetic separator, and are thickened by cycloning.

When the coking smalls began to increase in ash and sulphur, the first step taken was to withdraw the Norwalt slurry from the saleable product, and as the position continued to worsen the D.W.P. slurry was also withdrawn. The output of Norwalt slurry is considerably lower than that of D.W.P. slurry. It has been stated that the D.W.P. slurry represents 7% of the output, and when it has to be withdrawn the loss in revenue is significant. The position now reached is that the sulphur content of the coking

smalls ...../

smalls is 1.7 - 1.8% without any addition of slurry whatsoever. In order to investigate the possibility of reducing the ash and sulphur levels of the slurry, certain tests were initiated by Anglo American Ltd. These consisted of froth flotation tests, and tests using a concentrating table.

The sulphur content of the raw slurry was of the order of 2.6%, and it was hoped that this could be reduced to approximately 1.7 - 1.8% which would allow of the slurry being admixed with the coking smalls without adversely affecting the overall sulphur percentage. The results of these tests were not encouraging, however, and the use of an autogenous cyclone was then considered. Analysis of the slurry had shown that sulphur was present in approximately the following proportions:

Pyritic - 1.87%
Organic - 0.88%
Sulphate - 0.05%

and it was hoped that the pyritic sulphur would respond to this treatment. Accordingly some tests using a Spargo autogenous cyclone were conducted. The results obtained were very good, a sulphur reduction of 1% and an ash reduction of 5% having been achieved. As no facilities existed for conducting tests in which the ratio of the vortex-finder diameter to the apex diameter could be varied, a request was made to F.R.I. to carry out further tests using a cyclone donated by Spargo Ltd., in which the above ratio could be varied. The Spargo cyclone was fitted into the existing cyclone unit at the Pilot Plant. A sample of Indumeni slurry weighing approximately 800 lbs., and consisting of a correctly proportioned mixture of dried solids from the D.W.P. and Norwalt slurries was provided by Anglo American Corporation of S.A. Ltd.

<u>The tests were carried out as follows</u>:

1. 620 lbs. of the dried slurry was admixed with 560 gallons of water and this mixture constituted the test sample. It should be noted that this is nominal concentration only, and the concentration of the mixture actually passing through the cyclone depends on various factors, and is higher than the nominal figure.

2. ...../

2. As the diameter of the vortex finder was not adjustable, the diameter of the apex had to be varied to give the different ratios tested. The diameters used were $1\frac{1}{4}$", $1\frac{1}{2}$", $1\frac{3}{4}$" and 2", and as the diameter of the vortex finder was 3", the corresponding ratios were 2.4, 2.0, 1.7 and 1.5.

3. The suspension, as described in 1. was allowed to circulate through the plant for a period sufficient to ensure that stable conditions were achieved. During this period the cyclone was being by-passed. The $1\frac{1}{4}$" apex was fitted, and the suspension passed through the cyclone, samples of overflow and underflow being taken. The test was repeated using the remaining apices described above.

Discussion of Results.

The results of these tests did not bear out the results previously quoted for the Spargo cyclone.

The total sulphur content of the raw slurry was 2.7% and this was only reduced to 2.2% in the most favourable test.

The test using the $1\frac{1}{4}$" apex was considered suspect owing to the tendency of the underflow to approach the roping condition, and the result of the test using the 2" apex was also discounted due to the fact that the ash content of the overflow solids rose to 14.8% compared with 12.7% and 12.0% for the $1\frac{1}{2}$" and $1\frac{3}{4}$" apices, respectively. In theory the ash content of the overflow solids should decrease with increasing apex diameter, and the result with the 2" apex was therefore viewed with suspicion.

The test using the $1\frac{1}{2}$" apex was considered to be the most favourable taking into account the yield of clean coal of 65%, as compared with the yield of only 33% in the case of the $1\frac{3}{4}$" apex. The figures for the $1\frac{1}{2}$" apex test were as follows:

Yield - 65%
Reduction in Ash Content - From 16.7% to 12.7%
Reduction in Sulphur Content - From 2.7% to 2.2%.

The small reduction in the sulphur content was very disappointing, and in order to obtain more information about the

raw ...../

raw slurry certain other tests were carried out. These included:

(a) Microscopic examination of the raw slurry.

(b) Small scale froth flotation test.

(c) Float and sink test at 1.6 specific gravity on the raw slurry plus 200 mesh followed by sizing of the floats and sinks and sulphur determination on the floats and the sinks in 2 sized fractions. It was thought sufficient to determine the sulphur on 2 of the fractions only, as the results would indicate the approximate order of the sulphur in the whole, and would also reduce the amount of analytical work. The percentage of sulphur in the floats provided an indication of the best possible under ideal conditions.

(d) Sizing test of raw slurry with ash and sulphur determination on each size fraction.

The microscopic examination showed that the bulk of the pyrites existed as very fine particles attached to larger particles of coal or shale. This indicated that neither froth flotation nor cycloning would be highly successful. The results obtained in the small scale froth flotation test bore this out.

The sulphur content of the float fractions at 1.6 s.g. shows that even a theoretical separation would be unlikely to give less than 1.80 - 1.85% S in the product, and under practical conditions a figure appreciably higher would be expected. In this case, as the required level is 1.7 - 1.8% to permit of blending with the saleable product, it would appear that success is not possible within the framework of the present investigation.

The results are given in Tables 1 to 5.

(Sgd.) W. GARDINER
RESEARCH OFFICER.

PRETORIA.
24th June, 1968.
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TABLE 1.

SIZING TEST ON RAW SLURRY WITH ANALYSIS OF FRACTIONS.

Fraction	% Weight	% Ash in Fraction	% Sulphur in Fraction
Plus 16 Mesh	9.0	11.5	2.08
16 - 30	25.0	12.2	2.21
30 - 60	26.5	14.6	2.43
60 - 100	14.0	15.7	2.70
100 - 200	12.0	20.4	3.21
Below 200	13.5	30.0	3.40
Total Ash and Sulphur by Calculation		16.65	2.61
Total Ash and Sulphur by Analysis		16.7	2.70

TABLE 2.

FLOAT AND SINK TEST WITH ANALYSIS OF FRACTIONS.

Separating S.G.	% Floats	% Sinks
1.6	87.4	12.6

	Floats			Sinks		
	Sizing	% Ash	% Sulphur	Sizing	% Ash	% Sulphur
Plus 16 Mesh	7.1	8.3	-	5.6	51.4	-
16 - 30	30.8	8.1	1.88	22.2	55.1	5.65
30 - 60	31.7	8.0	-	27.8	59.2	-
60 - 100	17.3	7.9	1.75	22.2	61.6	8.44
100 - 200	13.1	8.5	-	22.2	63.5	-

NOTE: The minus 200 mesh material was removed by screening before this test was carried out.

Table 3...../

TABLE 3.

FROTH FLOTATION TESTS.

Test Number	Product		Residue	
	Ash	Sulphur	Ash	Sulphur
1	9.8	2.19	35.7	3.14
2	9.3	2.19	30.8	3.50
3	8.0	2.12	25.0	3.08

NOTE: Three tests were carried out using normal reagents, i.e. kerosene and MIBC (2 tests) and kerosene and hexylene glycol (1 test). The sulphur and ash were determined on the product and residue in each case.

TABLE 4.

CYCLONE TESTS.

	Test 1 $1\frac{1}{4}$" Apex	Test 2 $1\frac{1}{2}$" Apex	Test 3 $1\frac{3}{4}$" Apex	Test 4 2" Apex
% Ash of Overflow (Product)	15.2	12.7	12.0	14.8
% Ash of Underflow (Discard)	29.6	24.1	19.0	17.6
Calculated Yield of Product	89.6%	65.0%	32.9%	Not Calculated

Table 5...../

TABLE 5.

SULPHUR, SIZING AND ASH CONTENTS OF CYCLONE FRACTIONS.

Test	Fraction	Sulphur	Sizing			Ash in Size Fractions		
			Plus 30 Mesh	30-200 Mesh	Below 200	Plus 30	30-200 Mesh	Below 200
1	Overflow	2.3	49.0	45.3	5.7	9.8	17.8	37.6
1	Underflow	4.2	60.3	38.3	1.4	19.3	37.0	62.1
2	Overflow	2.2	41.0	51.3	7.7	9.0	13.4	32.7
2	Underflow	3.2	50.7	46.0	3.3	15.8	31.7	56.8
3	Overflow	2.1	28.0	59.3	12.7	7.0	11.8	30.3
3	Underflow	2.9	51.3	45.7	3.0	11.5	25.2	53.9
4	Overflow	Not Examined						
4	Underflow	Not Examined						