Classification (Atterberg Limits)

TEST IN ACCORDANCE WITH AS 1289

ATC Williams
GROUNDED IN DESIGN

Client: Minemakers Ltd. ..... NATA Report No.: R13513 .....

Address: Level 2, 34 Colin St..... Job No.: 112312.01.....

West Perth .....

Project: Wonarah - BFS ..... Location: NT.....

Register Number	Sample Description	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Sample Curled (CU) / Crumbled (CR)
15913	APH Slimes	60	21	39		
16013	MPH Slimes	45	25	20		

☐ Sampled by ATC Williams Pty Ltd in accordance with AS 1289.1.2.1
☒ Sample provided by the client

The test results relate only to the items tested.

Test Methods:

☐	Liquid Limit	AS 1289.3.1.1 (Standard method)
☒	Liquid Limit	AS 1289.3.1.2 (Subsidiary method)
☒	Plastic Limit	AS 1289.3.2.1
☒	Plasticity Index	AS 1289.3.3.1
☐	Linear Shrinkage	AS 1289.3.4.1
☐	Moisture Content	AS 1289.2.1.1

Sample Preparation:

☐	Natural Moisture	☒	Air Dried	☐	Oven Dried	☐	Unknown
☐	Wet Sieved	☒	Dry Sieved	☐	Unsieved		

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

NATA ACCREDITED LABORATORY NUMBER: 3372
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory ..... Date 29th April, 2013.....

Name of Signatory Peter Lam

ATC Williams Pty Ltd
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ATC Williams unites the companies of Australian Tailings Consultants and MPA Williams & Associates

Determination of the Soil Particle Density of a Soil

TEST IN ACCORDANCE WITH AS 1289.3.5.1

ATC Williams
GROUNDED IN DESIGN

Client: Minemakers Ltd. ..... NATA Report No.: R13613 .....

Address: Level 2, 34 Colin St..... Job No.: 112312.01.....

West Perth .....

Project: Wonarah - BFS ..... Location: NT.....

Register Number	Sample Description	Test Temperature (°C)	% of Sample >2.36 mm	Particle Density (g/cm^3)
15913	APH Slimes	21	0	2.82
16013	MPH Slimes	21	0	2.87

Notes:

☐ Sampled by ATC Williams Pty Ltd in accordance with AS 1289.1.2.1

☒ Sample provided by the client

* = apparent average soil particle density - particle size less than 2.36 mm

X = apparent average soil particle density - particle size greater than 2.36 mm

= soil particle density of the total sample

The test results relate only to the items tested.

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Particle Size Distribution Results

TEST IN ACCORDANCE WITH AS 1289

☑ Method 3.6.1 ☑ Method 3.6.3

☑ Oven Drying Method 2.1.1

ATC Williams
GROUNDED IN DESIGN

Client: Minemakers Ltd.

Address: Level 2, 34 Colin St, West Perth

Project: Wonarah -BFS

NATA Report No.: R13713

Job No.: 112312.01

Register No.: 15913

Location: NT

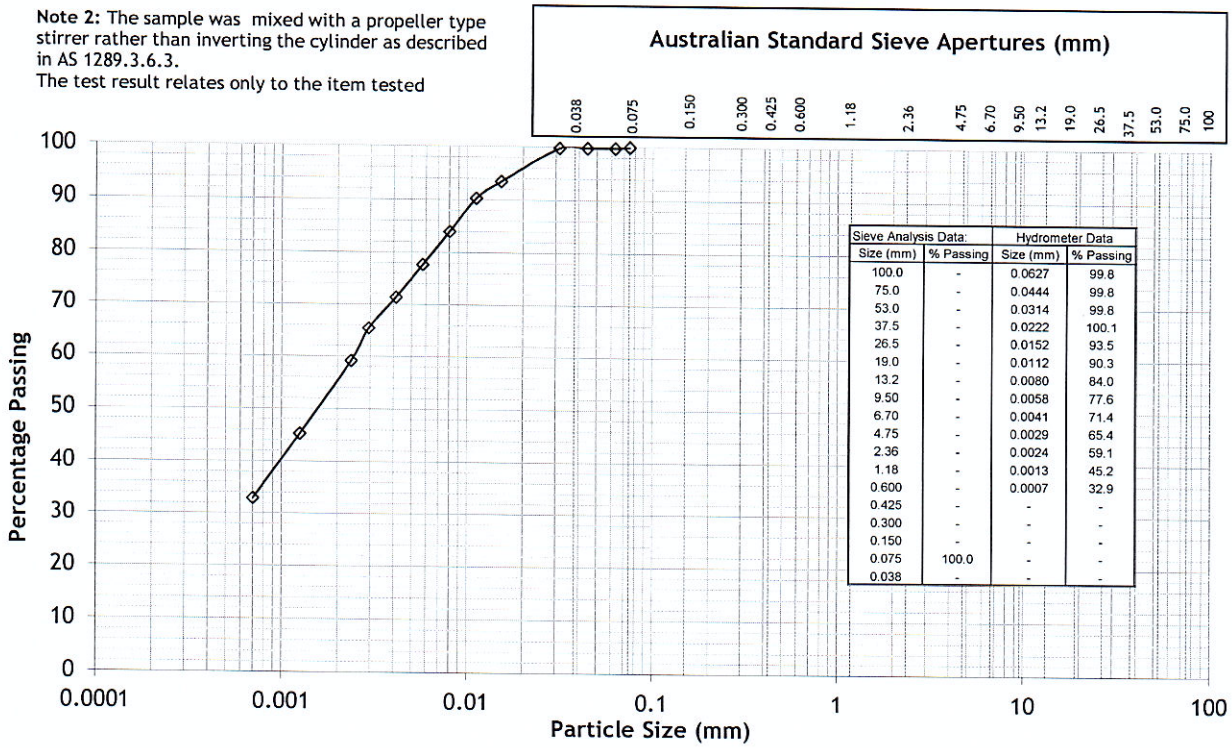
Sample Description: APH Slimes Sample	Borehole ☐ No:	Test Pit ☐ Depth:

Dispersion Method used: Mechanical Stirrer for 1 minute **Hydrometer Type Used:** ASTM 152H

☐ Sampled by ATC Williams Pty Ltd in accordance with AS 1289.1.2.1 Clause 6.5.1 ☑ Sample provided by the Client

Note 1: The sample was oven-dried during sample preparation and not air-dried as stated in AS 1289.3.6.3

Note 2: The sample was mixed with a propeller type stirrer rather than inverting the cylinder as described in AS 1289.3.6.3.
The test result relates only to the item tested



Sieve Analysis Data:		Hydrometer Data	
Size (mm)	% Passing	Size (mm)	% Passing
100.0	-	0.0627	99.8
75.0	-	0.0444	99.8
53.0	-	0.0314	99.8
37.5	-	0.0222	100.1
26.5	-	0.0152	93.5
19.0	-	0.0112	90.3
13.2	-	0.0080	84.0
9.50	-	0.0058	77.6
6.70	-	0.0041	71.4
4.75	-	0.0029	65.4
2.36	-	0.0024	59.1
1.18	-	0.0013	45.2
0.600	-	0.0007	32.9
0.425	-	-	-
0.300	-	-	-
0.150	-	-	-
0.075	100.0	-	-
0.038	-	-	-

CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2	6	20	60	

NATA ACCREDITED LABORATORY NUMBER: 3372

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Date: 29th April. 2013

Name of Signatory: Peter Lam

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Particle Size Distribution Results

TEST IN ACCORDANCE WITH AS 1289

☑ Method 3.6.1 ☑ Method 3.6.3

☑ Oven Drying Method 2.1.1

ATC Williams
GROUNDED IN DESIGN

Client: Minemakers Ltd.

Address: Level 2, 34 Colin St, West Perth

Project: Wonarah - BFS

NATA Report No.: R13813

Job No.: 112312.01

Register No.: 16013

Location: NT

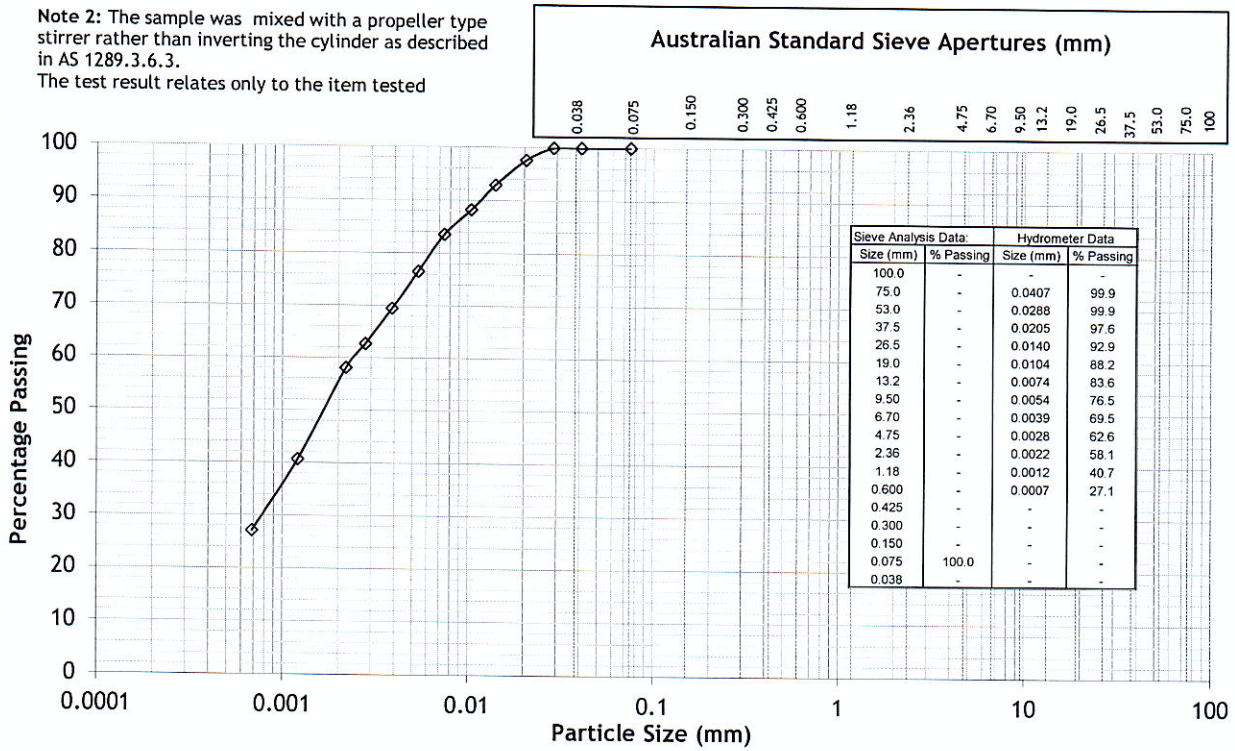
Sample Description: MPH Slimes Sample	Borehole No: ☐	Test Pit Depth: ☐

Dispersion Method used: Mechanical Stirrer for 1 minute **Hydrometer Type Used:** ASTM 152H

☐ Sampled by ATC Williams Pty Ltd in accordance with AS 1289.1.2.1 Clause 6.5.1 ☑ Sample provided by the Client

Note 1: The sample was oven-dried during sample preparation and not air-dried as stated in AS 1289.3.6.3

Note 2: The sample was mixed with a propeller type stirrer rather than inverting the cylinder as described in AS 1289.3.6.3.
The test result relates only to the item tested



Sieve Analysis Data:		Hydrometer Data	
Size (mm)	% Passing	Size (mm)	% Passing
100.0	-	-	-
75.0	-	0.0407	99.9
53.0	-	0.0288	99.9
37.5	-	0.0205	97.6
26.5	-	0.0140	92.9
19.0	-	0.0104	88.2
13.2	-	0.0074	83.6
9.50	-	0.0054	76.5
6.70	-	0.0039	69.5
4.75	-	0.0028	62.6
2.36	-	0.0022	58.1
1.18	-	0.0012	40.7
0.600	-	0.0007	27.1
0.425	-	-	-
0.300	-	-	-
0.150	-	-	-
0.075	100.0	-	-
0.038	-	-	-

CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2	6	20	60	

NATA ACCREDITED LABORATORY NUMBER: 3372

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Approved Signatory: ..... Date: .....

Name of Signatory: Peter Lam

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Customer:	ATC Williams
Contact Person(s):	Quan Nguyen (QuanN@atcwilliams.com.au) John Leavy (johnl@atcwilliams.com.au)
Country:	Australia
Place:	Northern Territory
Application:	Thickening of Clay Fines for TSF
Product of Test:	Wonarah Slimes tailings
Case. No.:	106924TA
Case Manager:	Chris Greenwood
Test Case No.:	106924TA
Test Performed by:	Yefrey Joe
Date of Test:	29, 30- 05 - 2013
Location of Test:	Melbourne, Australia
Test equipment:	99mm Diameter Supaflo High Rate Thickener
Date of Test report:	09-06-2013

CONTENT

1. GENERAL INFORMATION....2
2. OBJECTIVE OF TESTS AND SELECTED TEST EQUIPMENT....3
3. CUSTOMER PROCESS DATA AND SIMPLIFIED FLOWSHEET....5
4. DESCRIPTION OF THICKENING PROCESS....6
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1. GENERAL INFORMATION

Minemakers Limited's (Minemakers) 100% owned Wonarah phosphate project is the largest known phosphate deposit in Australia.

The current estimated mineral resources are set out above. Mineral resources that are not mineral reserves do not have demonstrated economic viability. Inferred resources are considered too speculative geologically to have economic considerations applied to them that would enable them to be classified as mineral reserves. There is no assurance that any part of the Inferred resources will ultimately be converted to mineral reserves.

Minemakers aims to take advantage of Australia's political stability and Wonarah's favourable installed and available infrastructure to develop a major centre for the production of super phosphoric acid (SPA).

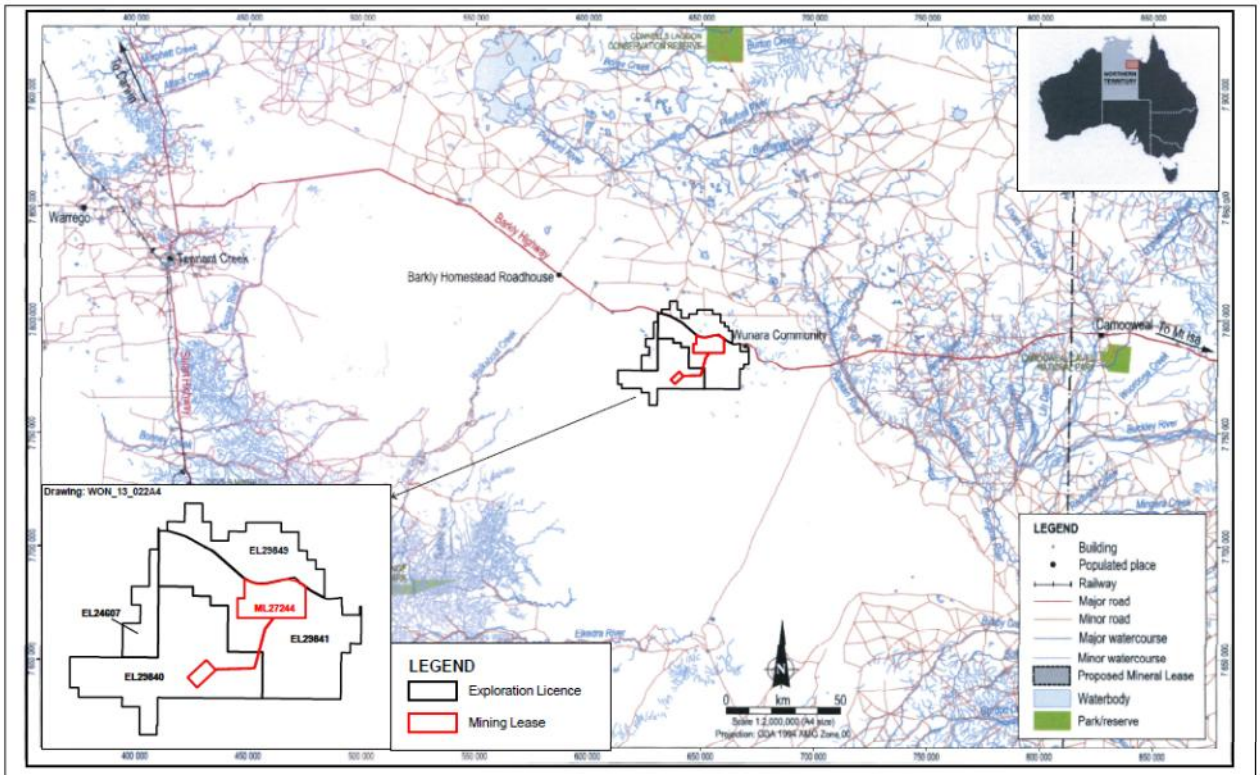


Figure 1: Wonarah Phosphate Project Location

References: http://www.minemakers.com.au

2. OBJECTIVE OF TESTS AND SELECTED TEST EQUIPMENT

The purpose of the testing was to conduct thickener test work on Wonarah Slimes Tailings from MPH and APH ores, with the objectives to determine:

- flocculant type and dose
- overflow clarity
- underflow density
- underflow yield stress

A 99mm Diameter Supaflo High Rate Thickener test rig was used in this test campaign.

Picture 1 – 99mm Diameter Supaflo High Rate Thickener

3. CUSTOMER PROCESS DATA AND SIMPLIFIED FLOWSHEET

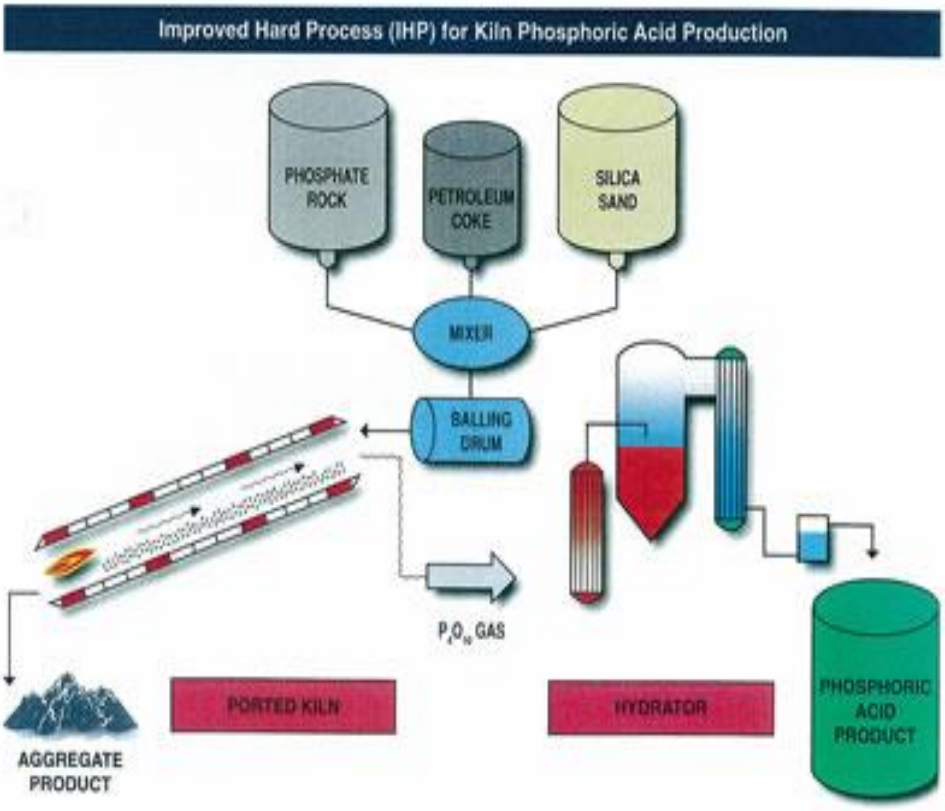


Figure 2: Wonarah Phosphate Phosphoric Acid Production Flowsheet

4. DESCRIPTION OF THICKENING PROCESS

4.1 Sample Characterisation

The solids from the slurry samples and the underflow samples that were generated from each thickening test were dried overnight in an oven at 100 °C.

The suspended solids in the overflow samples collected from each test were determined by filtering 100 mL of overflow liquor through pre-weighed Whatman GF/C filter discs using a vacuum filtration unit. The collected overflow solids were also washed thoroughly with tap water prior to oven drying at approximately 100 °C. The filter discs were then re-weighed to determine the suspended solids content.

Representative samples of the feed slurries were submitted to HRL laboratories Particle Analysis Service for LASER sizing. The results, in graphical form, are shown in Appendices.

4.2 Flocculant Selection

Based on static cylinder tests, the flocculant selected for the dynamic testwork of the samples was Magnafloc 1011.
Results can be seen in Section 6.1.

We used BASF and SNF products for the flocculant selection test work. This should not be viewed as an endorsement of these particular suppliers and other equivalent products may be used.
The flocculants used for the screening were BASF Magnaflocs 10, 1011, Alclar 665, and SNF AN910SH.

Further flocculant screening may achieve better results.

4.3 Feed Dilution Tests

Dilution tests were conducted using Outotec's optimum dilution test method. Outotec's optimum dilution method finds the optimum feed solids concentration for use with Outotec's Vane Feedwell.

Full dilution data for these tests can be found in part B of the report.

4.4 General Batch Dynamic Thickening Test Method

The samples were dynamically thickened in the 99 mm rig.

For each test, stock slurry was drawn from an agitated vessel by a variable speed peristaltic pump, and diluted as required 'on the fly' using a second pump.

Flocculant was added at a set flow rate but at a range of concentrations to deliver the required dosage for each test. Stock flocculant solution was hydrolysed in tap water to 0.25 % w/v (2.5 g/L), and then diluted as required using process water supplied. The diluted flocculant was dosed into the diluent line.

The flocculated solids bed was raked continuously at 2 r/min to de-water, using two rotating picket, in conjunction with two stationary pickets.

The overflow samples were collected at the overflow discharge, located near the top of the wall of the 99mm dynamic thickener rig. This sample was analysed to determine the suspended solids content as described above in Section 4.1.

Underflow samples were taken at bed height of 240mm using a positive displacement pump. The solids concentration was then determined as described above in Section 4.1.

All rheological measurements were carried out using a Thermo Haake VT550 rheometer and an “OK600” 4 blade vane. The method measures shear stress versus time with the peak of this curve equating to the yield stress. A constant shear rate of 0.1 sec-1 was used. For each dynamic test underflow sample, a simple un-sheared vane yield stress was measured.

Note: Due to limited amount, process water was recycled and may contain excess flocculant.

The underflow yield stress is measured to generate data for use in the sizing of the thickener rake drive, it is not intended to be used for any other purpose.

5. TEST – PRODUCT DATA

Two samples were delivered to Outotec's Melbourne laboratory. MPH and APH slimes tailings samples were received as slurry. Some process water was also received and to be used for dilution purposes.

All tests were conducted at ambient temperature.

	APH	**MPH**
Temperature	23	23
Density (t/m³)	1.209	1.203
Solid SG	2.79	2.87
pH	7.7	7.7
Sizing p80 (µm)	12	11
Solid Composition	clay slimes	clay slimes
Liquid Composition	process water	process water
Corossive element	No	No

Table 1: Product data – APH and MPH Tailings

6. TESTING RESULTS

6.1 Flocculant Screening

APH Tailings

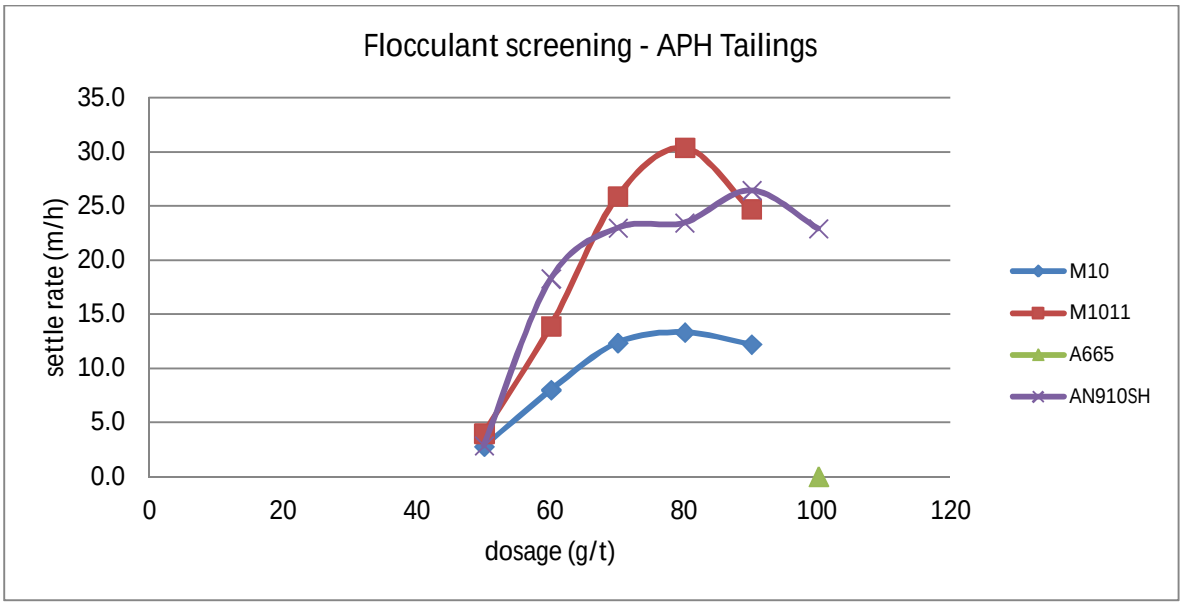


Chart 1: Flocculant screening of APH Tailings

Picture 2: 500ml static cylinder test – APH Tailings

Chart 1, above, show the settling rates of APH Tailings achieved in 500 mL static cylinder tests. As previously discussed in section 4.2, the flocculant selection was conducted on several different types, *see picture 2.*

Fastest settling rates were achieved with Magnafloc 1011. The flocculant was selected, as it gave the fastest settling rates and good supernatant clarity at a dose of 80 g/t. It was started at 80 g/t in the dynamic tests.

MPH Tailings

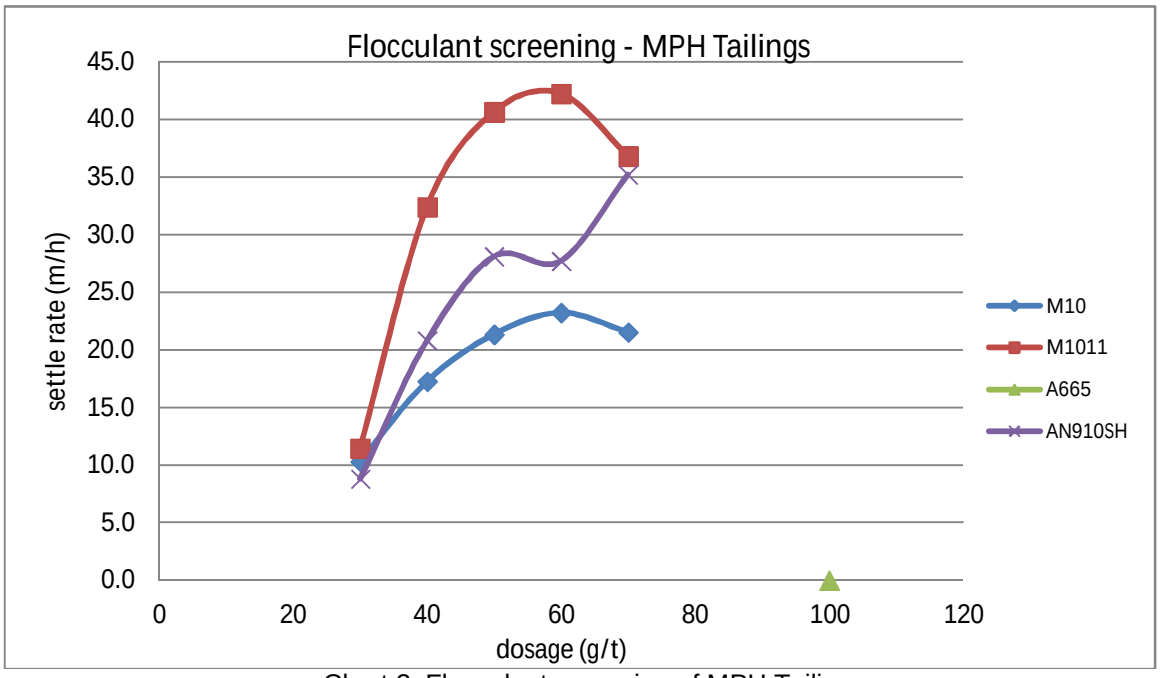
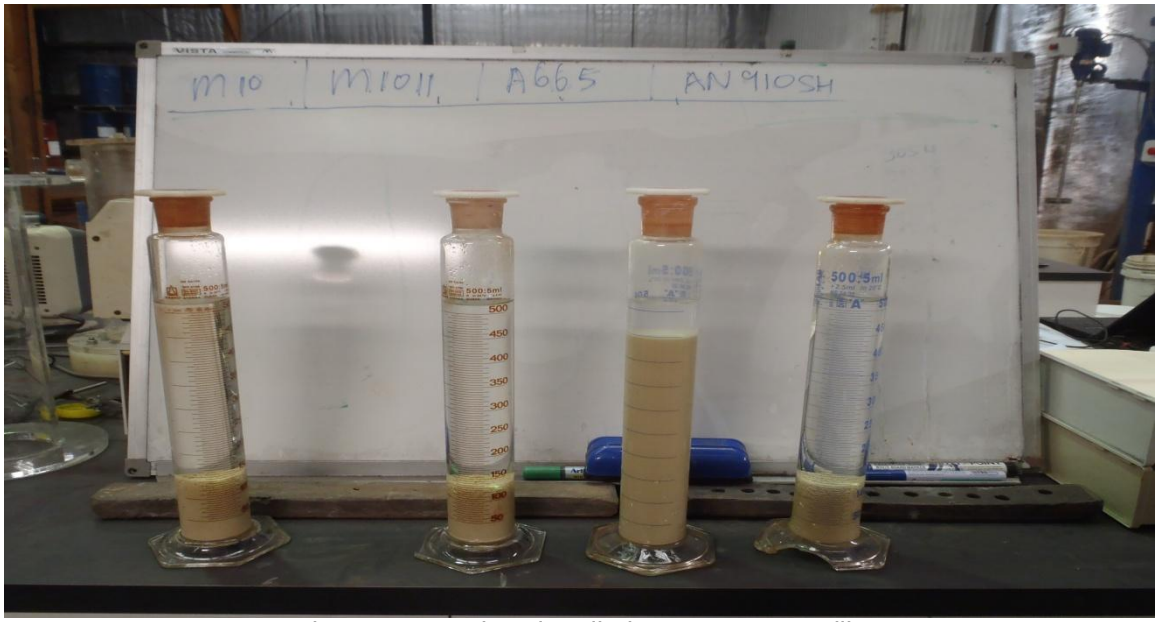


Chart 2: Flocculant screening of MPH Tailings



Picture 3: 500ml static cylinder test – MPH Tailings

Chart 2, above, show the settling rates of MPH Tailings achieved in 500 mL static cylinder tests. As previously discussed in section 4.2, the flocculant selection was conducted on several different types, *see picture 3.*

Fastest settling rates were achieved with Magnafloc 1011. The flocculant was selected, as it gave the fastest settling rates and good supernatant clarity at a dose of 60 g/t. It was started at 60 g/t in the dynamic tests.

6.2 Dynamic Thickening Tests

APH Tailings

	FEED - APH		FLOCCULANT		UNDERFLOW		O' FLOW
Run	Solids	Liquor RR	Type	Dose	Meas.Solids	YS	Clarity
No.	(t/m2h)	(m/h)		(g/t)	(%w/w)	(Pa)	(ppm)
1	0.26	3.8	M1011	80	36.7	74	120
2	0.26	3.8	M1011	100	36.4	74	190
3	0.26	3.8	M1011	60	36.4	66	240
4	0.52	7.6	M1011	80	34.9	53	270
5	0.52	7.6	M1011	100	34.0	43	390
6	0.16	2.4	M1011	80	38.2	105	180
7	0.16	2.4	M1011	60	38.7	120	160
8	"compression"		M1011	60	40.6	142	-

Table 2: Dynamic thickening testwork results of APH Tailings

Table 2, above, shows the dynamic thickening results of APH Tailings

The first run was conducted at a flux rate of 0.26 t/(m^2·h) with flocculant dose of 80g/t. This achieved an underflow density of 36.7 % solids (w/w) with accompanying yield stress measured 74 Pa. The overflow quality was measuring 120 ppm suspended solids.

The second run was conducted at a flux rate of 0.26 t/(m^2·h) with flocculant dose of 100g/t. This achieved an underflow density of 36.4 % solids (w/w) with accompanying yield stress measured 74 Pa. The overflow quality was measuring 190 ppm suspended solids.

The third run was conducted at a flux rate of 0.26 t/(m^2·h) with flocculant dose of 60g/t. This achieved an underflow density of 36.4 % solids (w/w) with accompanying yield stress measured 240 Pa. The overflow quality was measuring 240 ppm suspended solids.

The fourth run was conducted at a flux rate of 0.52 t/(m^2·h) with flocculant dose of 80g/t. This achieved an underflow density of 34.9 % solids (w/w) with accompanying yield stress measured 53 Pa. The overflow quality was measuring 270 ppm suspended solids.

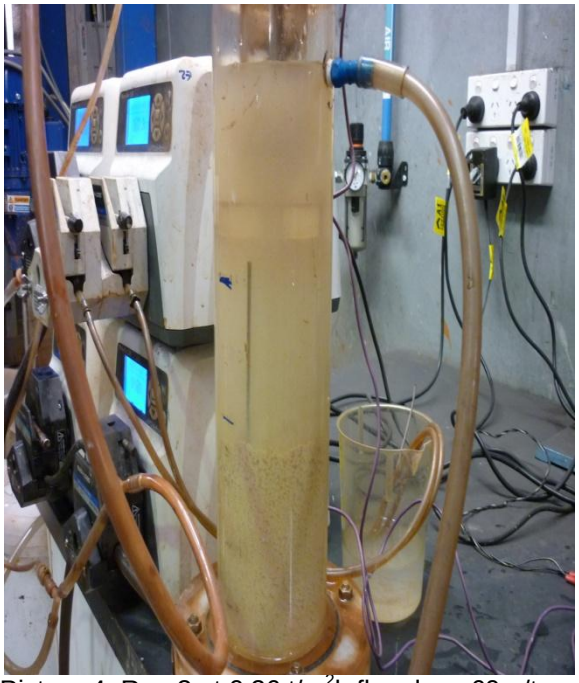
The fifth run was conducted at a flux rate of 0.52 t/(m^2·h) with flocculant dose of 100g/t. This achieved an underflow density of 34.0 % solids (w/w) with

accompanying yield stress measured 43 Pa. The overflow quality was measuring 390 ppm suspended solids.

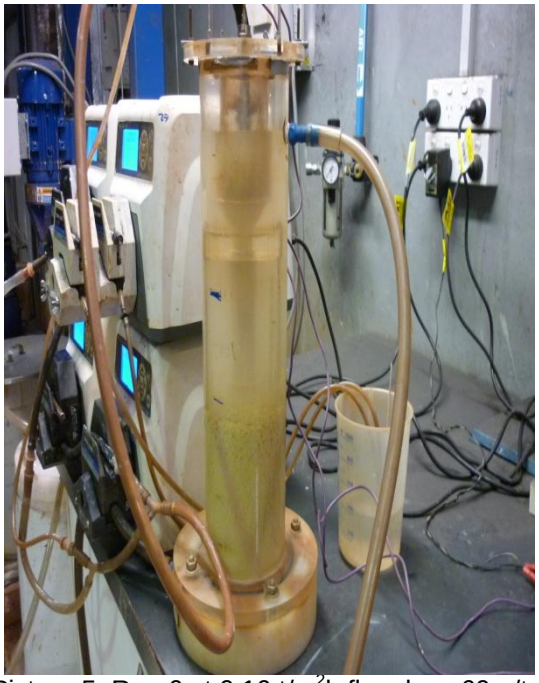
The sixth run was conducted at a flux rate of 0.16 t/(m^2·h) with flocculant dose of 80g/t. This achieved an underflow density of 38.2 % solids (w/w) with accompanying yield stress measured 105 Pa. The overflow quality was measuring 180 ppm suspended solids.

The seventh run was conducted at a flux rate of 0.16 t/(m^2·h) with flocculant dose of 60g/t. This achieved an underflow density of 38.7 % solids (w/w) with accompanying yield stress measured 120 Pa. The overflow quality was measuring 160 ppm suspended solids.

"Compression Test" was conducted on the eighth run. The bed from the 7th run was topped up and raked for an hour. The compression test is run only to observe if further compression is achievable with the sample. The results are only indicative and should not be used for predictive or sizing purposes. This achieved an underflow density of 40.6 % solids (w/w) with accompanying yield stress measured 142 Pa.



Picture 4: Run 3 at 0.26 t/m^2h floc dose 60 g/t O'flow 240 ppm



Picture 5: Run 6 at 0.16 t/m^2h floc dose 60 g/t O'flow 160 ppm

MPH Tailings

	FEED - MPH		FLOCCULANT		UNDERFLOW		O' FLOW
Run	Solids	Liquor RR	Type	Dose	Meas.Solids	YS	Clarity
No.	(t/m²h)	(m/h)		(g/t)	(%w/w)	(Pa)	(ppm)
1	0.25	3.7	M1011	60	42.2	59	140
2	0.25	3.7	M1011	80	42.4	62	150
3	0.25	3.7	M1011	40	41.7	60	130
4	0.46	6.8	M1011	80	39.8	41	220
5	0.46	6.8	M1011	100	39.3	39	170
6	0.16	5.3	M1011	40	43.2	76	150
7	0.16	2.3	M1011	60	43.7	82	150
8	"compression"		M1011	60	46.1	113	-

Table 3: Dynamic thickening testwork results of MPH Tailings

Table 3, above, shows the dynamic thickening results of MPH Tailings

The first run was conducted at a flux rate of 0.25 t/(m^2·h) with flocculant dose of 60g/t. This achieved an underflow density of 42.2 % solids (w/w) with accompanying yield stress measured 59 Pa. The overflow quality was measuring 140 ppm suspended solids.

The second run was conducted at a flux rate of 0.25 t/(m^2·h) with flocculant dose of 80g/t. This achieved an underflow density of 42.4 % solids (w/w) with accompanying yield stress measured 62 Pa. The overflow quality was measuring 150 ppm suspended solids.

The third run was conducted at a flux rate of 0.25 t/(m^2·h) with flocculant dose of 40g/t. This achieved an underflow density of 41.7 % solids (w/w) with accompanying yield stress measured 60 Pa. The overflow quality was measuring 130 ppm suspended solids.

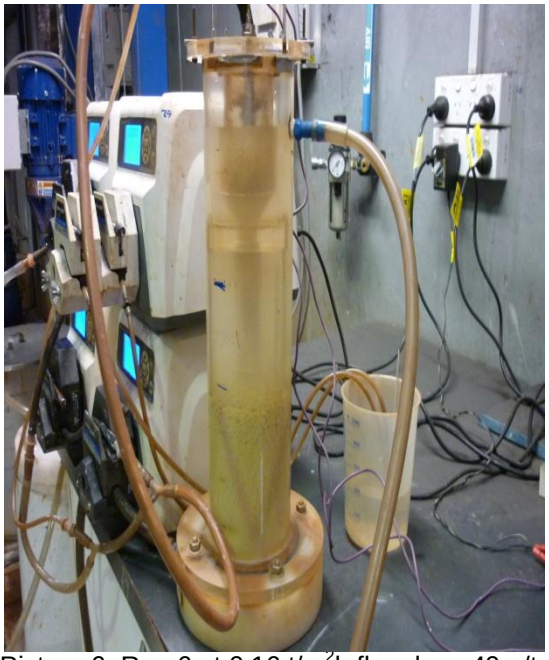
The fourth run was conducted at a flux rate of 0.46 t/(m^2·h) with flocculant dose of 80g/t. This achieved an underflow density of 39.8 % solids (w/w) with accompanying yield stress measured 41 Pa. The overflow quality was measuring 220 ppm suspended solids.

The fifth run was conducted at a flux rate of 0.46 t/(m^2·h) with flocculant dose of 100g/t. This achieved an underflow density of 39.3 % solids (w/w) with accompanying yield stress measured 39 Pa. The overflow quality was measuring 170 ppm suspended solids.

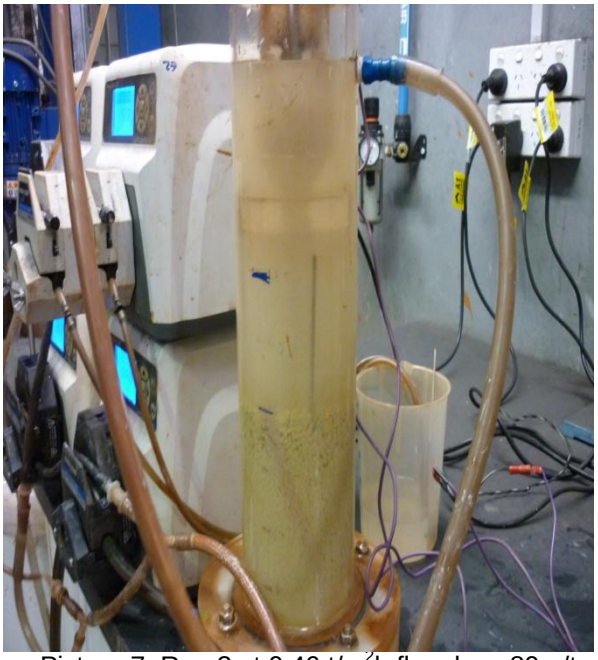
The sixth run was conducted at a flux rate of 0.16 t/(m^2·h) with flocculant dose of 40g/t. This achieved an underflow density of 43.2 % solids (w/w) with accompanying yield stress measured 76 Pa. The overflow quality was measuring 150 ppm suspended solids.

The seventh run was conducted at a flux rate of 0.16 t/(m^2·h) with flocculant dose of 60g/t. This achieved an underflow density of 43.7 % solids (w/w) with accompanying yield stress measured 82 Pa. The overflow quality was measuring 150 ppm suspended solids.

"Compression Test" was conducted on the eighth run. The bed from the 7th run was topped up and raked for an hour. The compression test is run only to observe if further compression is achievable with the sample. The results are only indicative and should not be used for predictive or sizing purposes. This achieved an underflow density of 46.1 % solids (w/w) with accompanying yield stress measured 113 Pa.



Picture 6: Run 6 at 0.16 t/m^2h floc dose 40 g/t O'flow 150 ppm



Picture 7: Run 3 at 0.46 t/m^2h floc dose 80 g/t O'flow 220 ppm

7. CONCLUSION

The test work on Wonarah Tailings samples has shown that the material can be successfully thickened.

All of the results are based on the samples as tested, with conditions specified in section 5 (test product data).

The sole purpose of this report (part A) is to provide the experimental results obtained from the test work performed and the methods used to obtain them. The interpretation of the experimental results obtained and any equipment recommendations made are provided in a separate report (Part B) marked commercial in confidence – property of Outotec (Australia) Pty Ltd.

8. CONTACT INFORMATION

For further questions please contact:

Chris Greenwood
Technology Manager – Thickeners
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END OF REPORT

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9. APPENDIX

Appendix 1	PSD for APH OreTailings
Appendix 2	PSD for MPH Ore Tailings
Appendix 3	Rheological Curve – APH OreTailings
Appendix 4	Rheological Curve – MPH Ore Tailings

APPENDIX 1

PARTICLE SIZE DISTRIBUTION DATA with LASER

APH Ore Tailings

MASTERSIZER 2000

HRL Technology Pty Ltd

Result Analysis Report

Sample Name:
CMM/13/0513 - 01 WONARAH PHOSPHATE - APH - Average

Measured by:
GK

Analysed:
Wednesday, 5 June 2013 6:48:24 PM

Client
Outotec

Particle Name:
Default 1

Particle RI:
1.520

Particle Absorption:
1

Dispersant Name:
Water

Dispersant RI:
1.330

Analysis model:
General purpose

Obscuration:
12.22 %

Concentration:
0.0040 %Vol

Span :
3.311

Weighted Residual:
0.490 %

Result units:
Volume

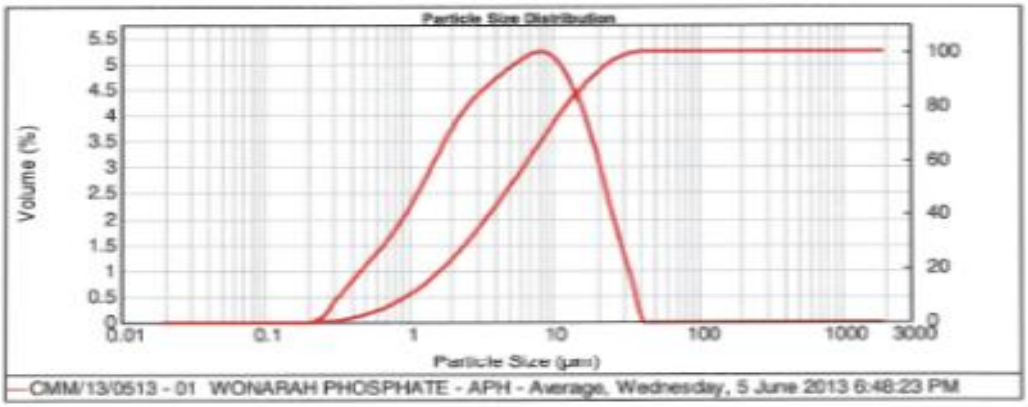
Specific Surface Area:
2.41 m^2/cc

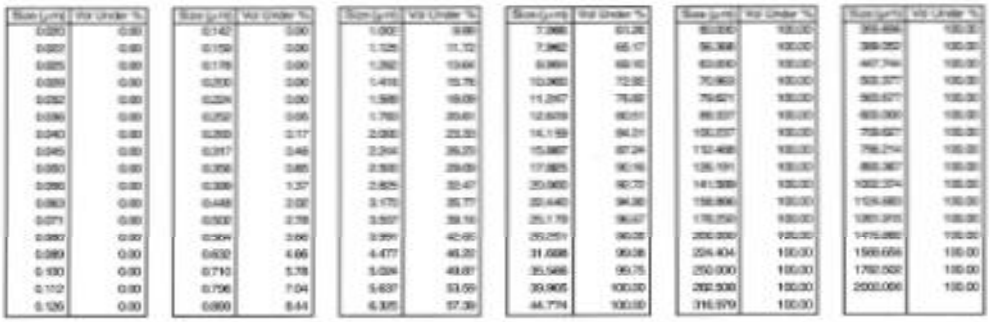
Surface Weighted Mean D[3,2]:
2.489 um

Vol. Weighted Mean D[4,3]:
7.482 um

Mode
8.356 um

d(0.1): 1.003 um d(0.5): 5.045 um d(0.9): 17.706 um





APPENDIX 2

PARTICLE SIZE DISTRIBUTION DATA with LASER

MPH Ore Tailings

MASTERSIZER 2000

HRL Technology Pty Ltd

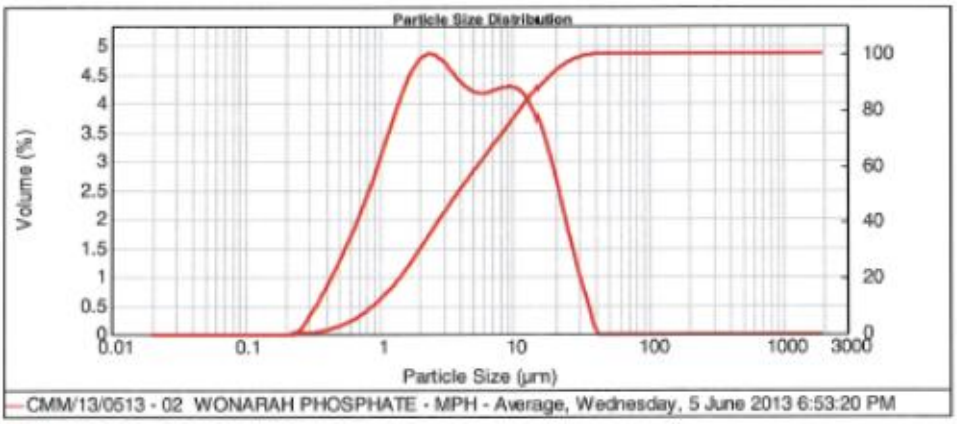
Result Analysis Report

Sample Name: CMM/13/0513 - 02 WONARAH PHOSPHATE - MPH - Average
Measured by: GK
Analysed: Wednesday, 5 June 2013 6:53:21 PM
Client Outotec

Particle Name: Default 1
Particle RI: 1.520
Particle Absorption: 1
Dispersant Name: Water
Dispersant RI: 1.330
Analysis model: General purpose
Obscuration: 10.27 %

Concentration: 0.0029 %Vol
Span : 4.110
Weighted Residual: 0.646 %
Result units: Volume
Specific Surface Area: 2.77 m²/cc
Surface Weighted Mean D[3,2]: 2.167 um
Vol. Weighted Mean D[4,3]: 6.548 um
Mode 2.373 um

d(0.1): 0.889 um **d(0.5):** 3.779 um **d(0.9):** 16.421 um



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	12.22	7.056	67.45	50.000	100.00	355.656	100.00
0.022	0.00	0.159	0.00	1.125	14.63	7.962	70.64	56.368	100.00	399.052	100.00
0.025	0.00	0.179	0.00	1.262	17.30	8.934	73.85	63.000	100.00	447.744	100.00
0.028	0.00	0.200	0.00	1.416	20.23	10.000	77.01	70.963	100.00	502.377	100.00
0.032	0.00	0.224	0.00	1.589	23.41	11.247	80.28	79.621	100.00	563.677	100.00
0.036	0.00	0.252	0.02	1.783	26.79	12.619	83.41	89.337	100.00	600.000	100.00
0.040	0.00	0.283	0.10	2.000	30.32	14.159	86.42	100.237	100.00	709.627	100.00
0.045	0.00	0.317	0.34	2.244	33.94	15.887	89.24	112.468	100.00	796.214	100.00
0.050	0.00	0.356	0.71	2.500	37.37	17.825	91.79	126.191	100.00	893.367	100.00
0.056	0.00	0.399	1.25	2.825	41.21	20.000	94.02	141.589	100.00	1002.374	100.00
0.063	0.00	0.448	1.92	3.170	44.77	22.440	95.90	158.886	100.00	1124.663	100.00
0.071	0.00	0.502	2.79	3.557	48.22	25.179	97.40	178.250	100.00	1261.915	100.00
0.080	0.00	0.564	3.84	3.991	51.57	28.251	98.53	200.000	100.00	1415.892	100.00
0.089	0.00	0.632	5.08	4.477	54.83	31.698	99.32	224.404	100.00	1588.906	100.00
0.100	0.00	0.710	6.52	5.024	58.01	35.566	99.83	251.000	100.00	1782.532	100.00
0.112	0.00	0.796	8.16	5.637	61.16	39.905	100.00	282.508	100.00	2000.000	100.00
0.126	0.00	0.893	10.06	6.325	64.30	44.774	100.00	316.979	100.00		

APPENDIX 3

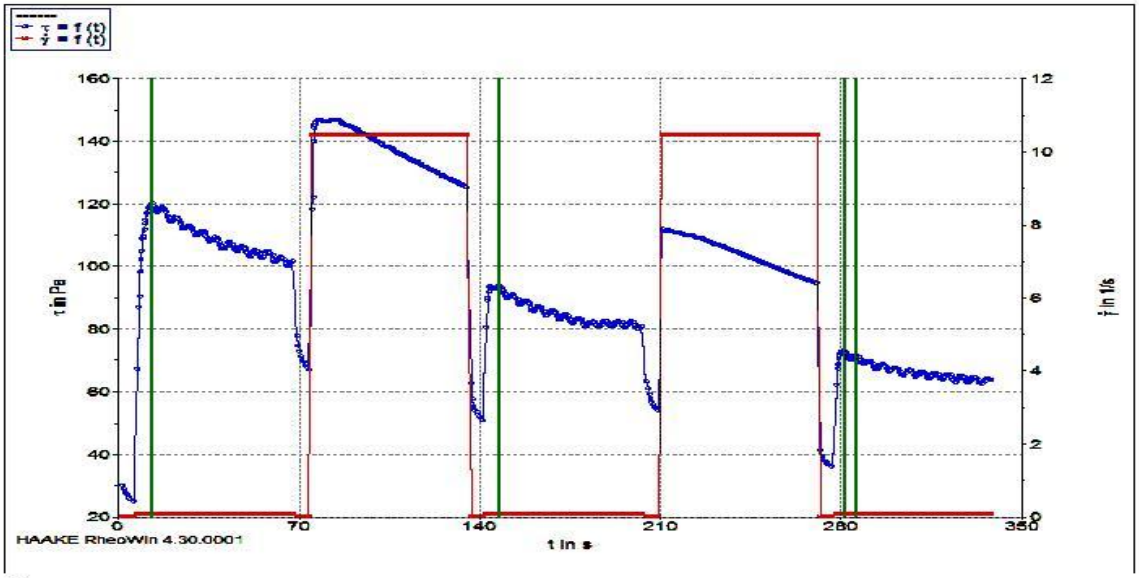
RHEOLOGICAL CURVE – APH Ore Tailings

HAAKE RheoWin 4.30.0001 **Rheological Curve** Page 1

Company	Outokumpu Technology Pty Ltd	**Measuring device**	VT550		
Operator	Outokumpu Technology Pty Ltd	**Temperature device**			
Date/Time	29.05.2013 / 15:49:33 PM	**Measuring geometry**	OK600	**Gap**	1.000 mm
Substance	OK600 SD YS / Shear / YS / Shear / YS Prograi	**A-factor**	21101.551 Pa/Nm		
Sample no	Beaker	**M-factor**	1.996 (1/s)/(rad/s)		
Description					

Comment

Rheology plot



Filename: -----

Job: C:\Users\YefJoe\Documents\Thermo\RheoWin\Jobs\OK600YIELDDOUBLESHEAR2.rwj

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ID 12-2: Curve discussion :

Method	t in s	τ in Pa
Greatest value	13.59	120.3
Maximum	13.15	120.1

ID 13-2: Curve discussion :

Method	t in s	τ in Pa
Greatest value	148.2	93.69
Maximum	147.4	93.73

ID 14-2: Curve discussion :

Method	t in s	τ in Pa
Greatest value	280.9	73.01
Maximum	285.5	71.49

APPENDIX 4

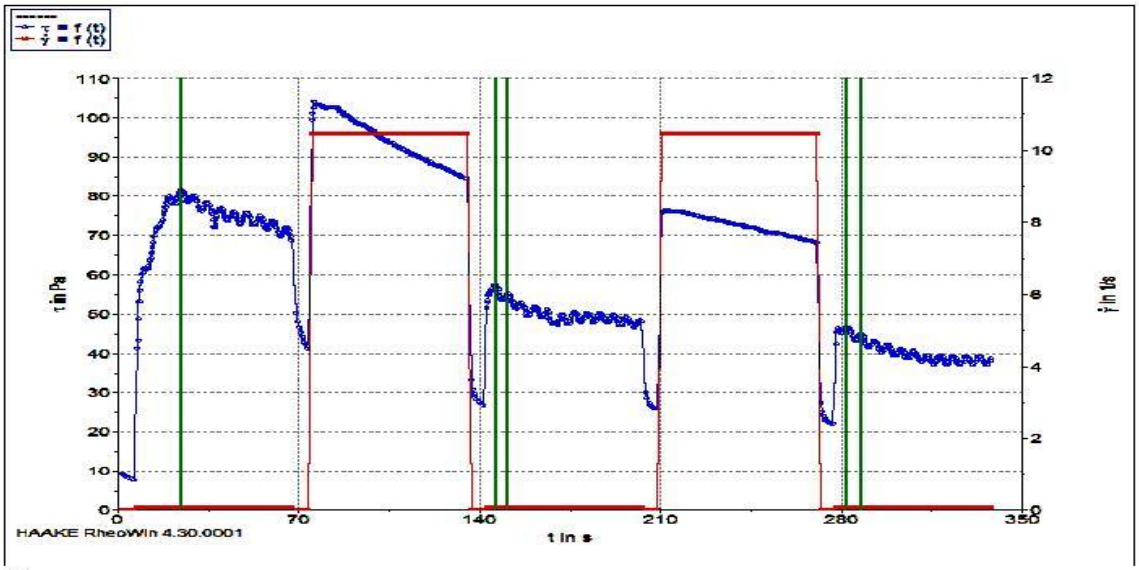
RHEOLOGICAL CURVE – MPH Ore Tailings

HAAKE RheoWin 4.30.0001 — Rheological Curve — Page 1

Company	Outokumpu Technology Pty Ltd	**Measuring device**	VT550		
Operator	Outokumpu Technology Pty Ltd	**Temperature device**			
Date/Time	30.05.2013 / 15:32:37 PM	**Measuring geometry**	OK600	**Gap**	1.000 mm
Substance	OK600 SD YS / Shear / YS / Shear / YS Prograi	**A-factor**	21101.551 Pa/Nm		
Sample no	Beaker	**M-factor**	1.996 (1/s)/(rad/s)		
Description					

Comment

Rheology plot



Filename: -----

Job: C:\Users\YefJoe\Documents\Thermo\RheoWin\Jobs\OK600YIELDDOUBLESHEAR2.rwj

---

ID 12-2: Curve discussion :

Method	t in s	τ in Pa
Greatest value	24.57	81.87
Maximum	24.55	81.54

ID 13-2: Curve discussion :

Method	t in s	τ in Pa
Greatest value	146.3	57.40
Maximum	150.9	54.88

ID 14-2: Curve discussion :

Method	t in s	τ in Pa
Greatest value	282.0	46.63
Maximum	287.4	44.73

Customer:	ATC Williams
Contact Person(s):	Quan Nguyen (QuanN@atcwilliams.com.au) John Leavy (johnl@atcwilliams.com.au)
Country:	Australia
Place:	Northern Territory
Application:	Thickening of Clay Fines for TSF
Product of Test:	Wonarah Slimes tailings
Case. No.:	106924TA
Case Manager:	Chris Greenwood
Test Case No.:	106924TA
Test Performed by:	Yefrey Joe
Date of Test:	29, 30- 05 - 2013
Location of Test:	Melbourne, Australia
Test equipment:	99mm Diameter Supaflo High Rate Thickener
Date of Test report:	09-06-2013

CONTENT

1. PRODUCTION DATA REQUIREMENTS....2
2. FEED DILUTION TESTS....2
3. CONCLUSION....2
4. RECOMMENDATIONS....3
5. CONTACT INFORMATION....4
6. APPENDIX....4

1. PRODUCTION DATA REQUIREMENTS

	APH	MPH	comment
Feed rate (Mtpa)	0.7 to 3.5	0.7 to 3.5	initially 0.7 then increases to 3.5 (max, after 5 years)
Underflow density (%w/w)	50 - 70	50 - 70	*(no specific target)*
Overflow Clarity, ppm	< 250	< 250	*(no specific target)*

2. FEED DILUTION TESTS

Dilution tests were conducted using Outotec's optimum dilution test method. Outotec's optimum dilution method finds the optimum feed solids concentration for use with Outotec's Vane Feedwell.

The optimum feed solids concentrations of the samples were as follows;

	Optimum Feed Density (%w/w)
APH Tailings	6.5
MPH Tailings	6.5

3. CONCLUSION AND INTERPRETATION OF RESULTS

The test work on the Wonarah Clay Slimes Tailings has shown that the material can be successfully thickened.

All of the results are based on the samples as tested, with conditions specified in section 6 (test product data).

APH Tailings sample testwork was conducted at flux rates of between 0.15 t/(m^2·h) and 0.52 t/(m^2·h) produced underflow density 34 – 38.7 %w/w, with flocculant of 60-100g/t and overflow clarity of 120 -390 ppm.

Further "Compression test" was conducted on APH Tailings sample to observe if further compression is achievable with the sample. It achieved an underflow density of 40.6 %w/w solids with accompanying yield stress of 142Pa.

MPH Tailings sample testwork was conducted at flux rates of between 0.16 t/(m^2·h) and 0.46 t/(m^2·h) produced underflow density 39.3 – 43.7 %w/w, with flocculant of 60- 100g/t and overflow clarity of 130 -220 ppm.

Further "Compression test" was conducted on MPH sample to observe if further compression is achievable with the sample. It achieved an underflow density of 46.1 %w/w solids with accompanying yield stress of 113Pa.

The "compression test" result is only indicative and should not be used for predictive or sizing purposes.

4. RECOMMENDATIONS

From the results of the testwork conducted, the following thickener design specifications are recommended. These recommendations should be read in conjunction with the range of test results obtained in Part A of the test report.

The thickener recommendation is for an Outotec High Rate thickener with Outotec Vane feedwell.

Process Stream	APH	MPH
Solids feed rate (Mtpa)	0.7 to 3.5	0.7 to 3.5
Solids feed rate (tph)*	440	440
Solids loading (t/m^2h)	0.16	0.16
Feed slurry density (%w/w solids)	< 30	< 30
Slurry pH	7.7	7.7
Flocculant type	M1011	M1011
Flocculant dosage (g/t)	60	60
Underflow density (%w/w solids)	39 – 41	44 – 46
Overflow clarity (ppm)	< 200	< 200
Required thickener diameter (m)	60	60

**solids feed rate 440tph is equivalent to 3.5Mtpa*

Outotec's experience with testwork and full-scale operation of thickeners allows us to reliably include an estimate of 2 – 3 % increase in thickener underflow density when comparing the testwork to a full-size thickener. This has been taken into account with the above recommendations.

5. CONTACT INFORMATION

For further questions please contact:

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END OF REPORT

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6. APPENDIX

Appendix 1 Questionnaire for Wonarah phosphate

APPENDIX 1 - Questionnaire for Wonarah phosphate

Outotec

THICKENING QUESTIONNAIRE

3.5.2013 1 (1)

CUSTOMER INFORMATION

Project name	Wonarah Phosphate		
Customer	ATC Williams	Invoicing address	ATC Williams
			21 Teddington Road, 6100
Contact person	Quan Nguyen	Telephone/fax	T 8 9355 8700 F8 9355 0711
Title	Senior Engineer	e-mail	QuanN@atcwilliams.com.au

GENERAL INFORMATION ABOUT MATERIAL TO BE THICKENED

Application	Clay fines from pre process wash plant to be stored in a TSF		
Sample name	Wonarah Slimes Tailings (2 x Samples from MPH and APH ores)		
Composition of solids	Clay Slimes	Chem. formula of solids	Tailings from phosphate P_2O_5
Composition of liquid	Ordinary Water	Chem. formula of liquid	H_2O
Corrosive compounds	None		
Other information	Two ore type samples are provided. MPH will be mined first.		

PURPOSE OF TESTWORK

Assessing tailings storage solutions. Tailings would be washing clay fines from the crushed ore and deposition as slurry into a tailings storage facility. It is envisioned that the slurry will be thickened prior to discharge.

THICKENER CONDITIONS

Process Information	Client Information	Example
Process Description	Beneficiation by washing	Concentrate,Float Tail, Pre-leach.
Feed Rate	0.7 to 3.5 Mtpa (5 x 0.7Mtpa Modules)	tph, tpa
Feed % Solids to thickener	<30% w/w	25% w/w
Slurry pH	7 to 9	9 to 10
pH Adjustment	N/A	Lime, H_2SO_4
Feed Temperature	32° C	30°C
Particle Size Distribution	-30µm: (see attached PSD)	p80 ?um, Slimes / Clay ??
Estimated Solids SG	2.82 – 2.87	t/m^3
Estimated Liquor SG	0.80 to 1.00	t/m^3
Target Underflow Density	50-70	50 to 55%, don't just put max pls.
Underflow to ?	CTD/Dam	Detox, Leach, CTD, Dam.
Target Overflow Clarity	Process Water Plant <250ppm	Process water reuse, <250ppm
Coag/Flocculant Description (If any)	Alclar A665 & Magnafloc 1011 trials	Flocculant Type & supplier.
Any restrictions on coag/flocc?	N/A	
Is there a limit on thickener size?	N/A	

PRESENT THICKENING EQUIPMENT √ Does not exist

Type of thickener		Thickener diameter	m
Underflow density	% Solids	Overflow clarity	mg/L
Flocculant used		Flocculant dose	g/t