Alfa Laval Australia Pty Ltd
Process Technology

Subject: Slimes sample Y1Q2 Fingerboards Laboratory Spin Test Report – Mineral Sands Slimes Tailings Dewatering test for Decanter Centrifuge	Rev A/ Y1Q2 02/02/2021
Site: Fingerboards/ Kalbar Operations Pty Ltd	
Issued by: Paul Tuckwell/ Alfa Laval Australia (Perth office)	**Class:** Restricted
Keywords: Decanter centrifuge, tailings dewatering	**No. of pages/encl.:9**
Distribute to: Martin van Wyk (Wave International), Paul Tuckwell, Arvin Bangcale (Alfa Laval)	

Summary:

A sample of slimes (labelled Y1Q2) from the proposed Fingerboards mineral sands minesite was tested for its suitability for dewatering in large scale Alfa Laval P3 mining decanter centrifuges.

Laboratory scale testing indicated that the slurry can be dewatered in a decanter centrifuge to form a firm, spadeable, transportable cake of around 65% wt total solids (suspended + any dissolved solids). In full scale operation the moisture level may be lower or higher depending on machine settings, differential speeds, throughput and G forces used.

It is estimated that the centrate clarity will be in the order of 0.2% to 0.8% suspended solids.

The sample supplied was a slurry containing 35% solids. This was too thick for mixing with flocculent for the lab test, so was diluted with potable Perth water for purposes of testing (though the high shear environment of an operating decanter centrifuge would improve floc mixing and viability of undiluted feed). Tests indicated that dilution to 25-30% wt solids would be beneficial for solids recovery and floc dose without impacting on the installed capital price, and this should be considered in any project optimisation.

Lab testing indicated that approximately 340 g active flocculent per tonne of suspended solids is needed to form strong, shear resistant flocs and recover the ultra fine material as part of the cake. Flocculent was not screened and only one type was used in the test (as suggested by Wave International based on thickener test work).

This data is based on laboratory scale measurements and observations only. Results and previous installations/ trials on similar slurries indicate that it is suitable for further development work with decanter centrifuges. The ultra fine nature of the tails solids make it particularly suitable for decanter centrifuges compared to other dewatering technologies.

Feed (at 23% solids), flocculated feed, cake and centrate

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1 - Slurry Type/ Description:

1.1 Source of Sample

The slimes sample tested was labelled Y1Q2. This originated from Fingerboards Project test work at Nagrom. The age and origin of the sample is unknown to Alfa Laval, but was tested within 5 days of receipt. This sample supplied was a thick slurry of 35% wt solids and was diluted to 23% (after targeting 25%) using potable Perth water for testing.

Figure 1: Sample as received at 35% suspended solids

Figure 2: Sample diluted to 23.0% suspended solids

1.2 Suspended Solids

The sample supplied contained fine solids. The particle size distribution of particle size distribution of Y1Q2 was not supplied, but it is assumed to be similar to other samples tested.

There was no evidence of grit or larger solids > 100 micron in the sample.

1.3 Dissolved Solids

For the purposes of lab testing, it has been assumed that the sample contained negligible dissolved solids. Dilution of the slurry was undertaken with Perth tap water, which also contains negligible dissolved solids. The pH was approximately 8.0

1.4 Suspended Solids Density and Components

The homogeneous dry suspended solids density was assumed to be approximately 2790kg/m3 as advised. It has been assumed that is consists of extremely fine quartz solids, along with clay and silt.

1.5 Ease of floc formation

Flocculent dosing was tested after dilution to 23.0% dry solids in the slurry.

It was difficult to mix flocculent into the slurry in the thickened state (35%) supplied with the sample. Strong, shear resistant flocs formed easily in a jar test at 23% wt suspended solids. The optimum dilution value and floc dose can be optimised during a trial and commissioning.

Figure 3: Flocculated solids at 23% wt suspended solids

2 - Testing Aim:

Spin testing at the lab scale is the first practical step in establishing the suitability of dewatering of a slurry with a decanter centrifuge. This enables analysis of the use of centrifugal G forces in dewatering suspended solids. This test aimed to provide an estimate of:

- Cake dryness at typical decanter centrifuge operating conditions
- Suitable feed solids concentration
- Indication of the flocculent dose required under high shear conditions

The results must only be considered as an indication (not a guarantee). In full scale equipment, there are a number of variables available which are not possible to test in a laboratory.

3 - Method:

All suspended solids measurements were undertaken via drying and weighing samples over two days at 110 degC.

A recently prepared sample was delivered by Wave Engineering along with a suggestion of flocculent (Nalco N83384). Flocculent was made up at 0.2% concentration and dosed at this concentration (which is normal for decanter centrifuges). The floc was freshly made at time of testing using potable water, with 2 hrs ageing time.

Slurry was diluted to 23% wt suspended solids using Perth potable tap water. (25% wt was targeted, but later measurement revealed it was 23%)

Flocculent was dosed directly into the diluted slurry with the dose measured. Once strong, shear resistant flocs were obtained, the final dose was recorded.

A spin test using a lab centrifuge was then undertaken using Alfa Laval's high density solid method. This simulates both a range of the G forces the slurry would be exposed to in a full scale tailing decanter centrifuge, and also the shear forces and bowl wall pressure the solids are exposed to. These shear forces are an important mechanism for releasing water from the cake.

Cake dryness and slurry feed concentration were then measured via drying and weighing.

Spin testing without flocculent did not result in good solids recovery due to the ultra fine solids. Hence results reported here are for the flocculated slurry only.

4 - Results:

Figure 4: Cake and centrate

4.1 Polymer Test

The polymer used in centrifuge lab test work was recommended by Wave International (Nalco N83384) at 0.2%, made up in Perth tap water.

The polymer dose required for strong, shear resistant flocs was approximately 340 grams active flocculent powder per tonne of dry solids.

This could be optimised/ improved by a proper screening process in combination with flocculent suppliers, and further testing with various flocculants and slurry dilution during a trial/ commissioning.

4.2 Flocculated sample spin test

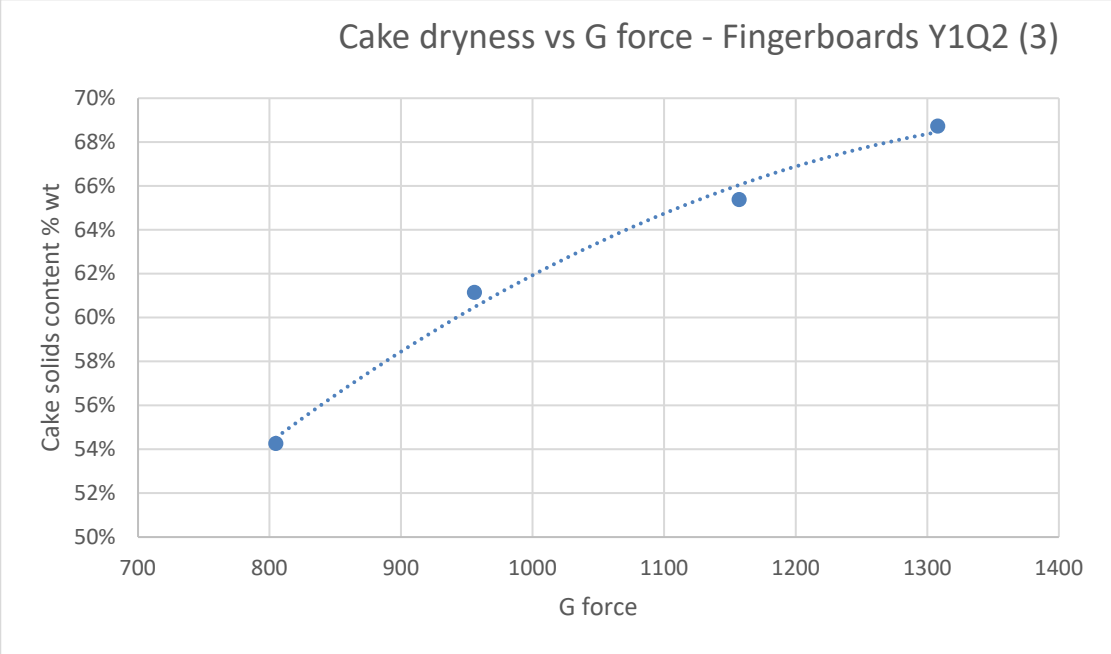

Figure 5 – Cake dryness vs G force

Samples resulting from exposure to different G forces were taken and plotted as shown above. The actual value depends on how the decanter centrifuge is operated, but as a nominal value, 65% wt cake appears to be typical of cake discharged from other decanter centrifuges containing a similar feed and at a similar G force. This was firm, spadeable and appears suitable for stacking, conveying and transport.

Figure 6: Cake at approximately 65% wt suspended solids

5 - Discussion:

5.1 Flocculent Dose

The flocculent tested appeared to result in strong flocs when the slurry was dosed with a sufficient quantity. However, a screening process should be undertaken with the aid of experienced flocculent suppliers to ensure the best flocculent is selection for high shear applications.

5.2 Cake Dryness

Based on previous spin test vs decanter cake dryness comparisons, it is believed that the cake dryness in an operating decanter centrifuge can be adjusted between 61 and 69% wt suspended solids.

The actual dryness in the cake depends on the G force, which can be tested in the lab, but also some other factors which cannot be tested in the lab but can be varied in decanter centrifuge operation. These include the differential speed of the machine, pond height, variations in feed dilution and additive dosing, pH adjustment and throughput.

At the nominal value of 65% suspended solids, the cake is a firm, spadeable cake. This would be suitable for trucking or conveying and did not present as overly sticky. There was no free water draining from the solid cake.

5.3 Centrate

It is difficult to estimate centrate quality in lab scale testing. However, based on previous experience with ultra fine tailings and operating decanter centrifuges, it is believed that a centrate clarity of 0.2 to 0.8% suspended solids is achievable. Pre-dosing with flocculent will be required to achieve centrate with this clarity.

Figure 7: Estimate of centrate quality

6 - Conclusion

The lab based test results indicated that a mining decanter centrifuge can dewater the supplied slurry to a firm, transportable consistency. It is estimated that a cake suspended solids content of approximately 65% wt can be achieved. This preliminary test indicates that this application is suitable for decanter centrifuges and should be pursued further.

The ultra fine nature of the solids also indicate that these are difficult to dewater using filtration technologies, and hence would be an especially interesting duty to investigate further using decanter centrifuges. Alfa Laval have several installations with a small particle size distribution which appear to be similar to the Fingerboard slimes.

Dilution of the centrifuge feed to a level of approx. 25-30% is recommended to provide effective flocculent mixing and floc formation.

Further work on the optimisation for flocculent dose should be undertaken, testing the type of flocculent, dilution of floc and feed and the impact of water chemistry.

Confidentiality

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Figure 8: P3 Decanter (solid bowl) Centrifuges installed on a slimes dewatering duty

Figure 8: Typical cake from a full scale slimes decanter centrifuge

Subject: Slimes sample Y2Q1 Fingerboards Laboratory Spin Test Report – Mineral Sands Slimes Tailings Dewatering test for Decanter Centrifuge	Rev A/ Y2Q1 02/02/2021
Site: Fingerboards/ Kalbar Operations Pty Ltd	
Issued by: Paul Tuckwell/ Alfa Laval Australia (Perth office)	**Class:** Restricted
Keywords: Decanter centrifuge, tailings dewatering	**No. of pages/encl.:9**
Distribute to: Martin van Wyk (Wave International), Paul Tuckwell, Arvin Bangcale (Alfa Laval)	

Summary:

A sample of slimes (labelled Y2Q1) from the proposed Fingerboards mineral sands minesite was tested for its suitability for dewatering in large scale Alfa Laval P3 mining decanter centrifuges.

Laboratory scale testing indicated that the slurry can be dewatered in a decanter centrifuge to form a firm, spadeable, transportable cake of around 66% wt total solids (suspended + any dissolved solids). In full scale operation the moisture level may be lower or higher depending on machine settings, differential speeds, throughput and G forces used.

It is estimated that the centrate clarity will be in the order of 0.2% to 0.8% suspended solids.

The sample supplied was a slurry containing 35% solids. This was too thick for mixing with flocculent for the lab test, so was diluted with potable Perth water for purposes of testing (though the high shear environment of an operating decanter centrifuge would improve floc mixing and viability of undiluted feed). Tests indicated that dilution to 25-30% wt solids would be beneficial for solids recovery and floc dose without impacting on the installed capital price, and this should be considered in any project optimisation.

Lab testing indicated that approximately 400 g active flocculent per tonne of suspended solids is needed to form strong, shear resistant flocs and recover the ultra fine material as part of the cake. Flocculent was not screened and only one type was used in the test (as suggested by Wave International based on thickener test work).

This data is based on laboratory scale measurements and observations only. Results and previous installations/ trials on similar slurries indicate that it is suitable for further development work with decanter centrifuges. The ultra fine nature of the tails solids make it particularly suitable for decanter centrifuges compared to other dewatering technologies.

Feed (at 26% solids), flocculated feed, cake and centrate

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1 - Slurry Type/ Description:

1.1 Source of Sample

The slimes sample tested was labelled Y2Q1. This originated from Fingerboards Project test work at Nagrom. The age and origin of the sample is unknown to Alfa Laval, but was tested within 5 days of receipt. This sample supplied was a thick slurry of 35% wt solids and was diluted to 26% (after targeting 25%) using potable Perth water for testing.

Figure 1: Sample as received at 35% suspended solids

Figure 2: Sample diluted to 26.0% suspended solids

1.2 Suspended Solids

The sample supplied contained fine solids, with a PSD as follows:

Y2Q1 -0.038mm Cyclosize by Assay			
100.00%			
	Size (µm)		
0.81%	38.9		
5.10%	27.2		
7.25%	19.5		
8.68%	13.4		
6.26%	11.1		
71.91%	< 11.1		

There was no evidence of grit or larger solids > 100 micron in the sample.

1.3 Dissolved Solids

For the purposes of lab testing, it has been assumed that the sample contained negligible dissolved solids. Dilution of the slurry was undertaken with Perth tap water, which also contains negligible dissolved solids. The pH was approximately 8.0

1.4 Suspended Solids Density and Components

The homogeneous dry suspended solids density was assumed to be approximately 2790kg/m3 as advised. It has been assumed that is consists of extremely fine quartz solids, along with clay and silt.

1.5 Ease of floc formation

Flocculent dosing was tested after dilution to 26.0% dry solids in the slurry.

It was difficult to mix flocculent into the slurry in the thickened state (35%) supplied with the sample. Strong, shear resistant flocs formed easily in a jar test at 26% wt suspended solids. The optimum dilution value and floc dose can be optimised during a trial and commissioning.

Figure 3: Flocculated solids at 26% wt suspended solids

2 - Testing Aim:

Spin testing at the lab scale is the first practical step in establishing the suitability of dewatering of a slurry with a decanter centrifuge. This enables analysis of the use of centrifugal G forces in dewatering suspended solids. This test aimed to provide an estimate of:

- Cake dryness at typical decanter centrifuge operating conditions
- Suitable feed solids concentration
- Indication of the flocculent dose required under high shear conditions

The results must only be considered as an indication (not a guarantee). In full scale equipment, there are a number of variables available which are not possible to test in a laboratory.

3 - Method:

All suspended solids measurements were undertaken via drying and weighing samples over two days at 110 degC.

A recently prepared sample was delivered by Wave Engineering along with a suggestion of flocculent (Nalco N83384). Flocculent was made up at 0.2% concentration and dosed at this concentration (which is normal for decanter centrifuges). The floc was freshly made at time of testing using potable water, with 2 hrs ageing time.

Slurry was diluted to 26% wt suspended solids using Perth potable tap water. (25% wt was targeted, but later measurement revealed it was 26%)

Flocculent was dosed directly into the diluted slurry with the dose measured. Once strong, shear resistant flocs were obtained, the final dose was recorded.

A spin test using a lab centrifuge was then undertaken using Alfa Laval's high density solid method. This simulates both a range of the G forces the slurry would be exposed to in a full scale tailing decanter centrifuge, and also the shear forces and bowl wall pressure the solids are exposed to. These shear forces are an important mechanism for releasing water from the cake.

Cake dryness and slurry feed concentration were then measured via drying and weighing.

Spin testing without flocculent did not result in good solids recovery due to the ultra fine solids. Hence results reported here are for the flocculated slurry only.

4 - Results:

Figure 4: Cake and centrate

4.1 Polymer Test

The polymer used in centrifuge lab test work was recommended by Wave International (Nalco N83384) at 0.2%, made up in Perth tap water.

The polymer dose required for strong, shear resistant flocs was approximately 400 grams active flocculent powder per tonne of dry solids.

This could be optimised/ improved by a proper screening process in combination with flocculent suppliers, and further testing with various flocculants and slurry dilution during a trial/ commissioning.

4.2 Flocculated sample spin test

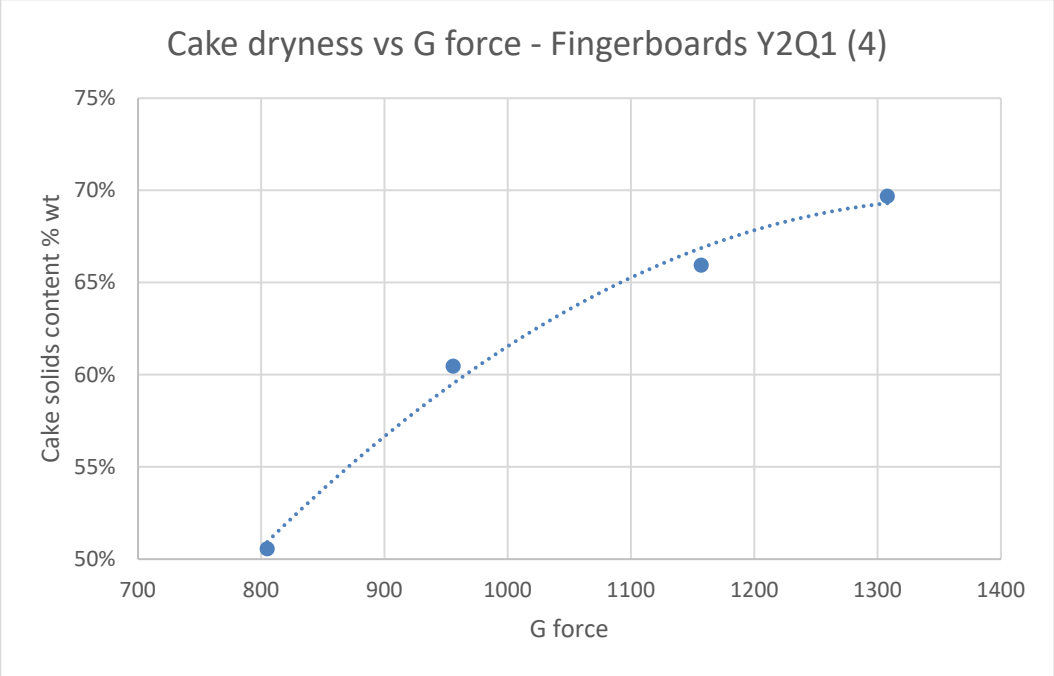

Figure 5 – Cake dryness vs G force

Samples resulting from exposure to different G forces were taken and plotted as shown above. The actual value depends on how the decanter centrifuge is operated, but as a nominal value, 66% wt cake appears to be typical of cake discharged from other decanter centrifuges containing a similar feed and at a similar G force. This was firm, spadeable and appears suitable for stacking, conveying and transport.

Figure 6: Cake at approximately 66% wt suspended solids

5 - Discussion:

5.1 Flocculent Dose

The flocculent tested appeared to result in strong flocs when the slurry was dosed with a sufficient quantity. However, a screening process should be undertaken with the aid of experienced flocculent suppliers to ensure the best flocculent is selection for high shear applications.

5.2 Cake Dryness

Based on previous spin test vs decanter cake dryness comparisons, it is believed that the cake dryness in an operating decanter centrifuge can be adjusted between 60 and 70% wt suspended solids.

The actual dryness in the cake depends on the G force, which can be tested in the lab, but also some other factors which cannot be tested in the lab but can be varied in decanter centrifuge operation. These include the differential speed of the machine, pond height, variations in feed dilution and additive dosing, pH adjustment and throughput.

At the nominal value of 66% suspended solids, the cake is a firm, spadeable cake. This would be suitable for trucking or conveying and did not present as overly sticky. There was no free water draining from the solid cake.

5.3 Centrate

It is difficult to estimate centrate quality in lab scale testing. However, based on previous experience with ultra fine tailings and operating decanter centrifuges, it is believed that a centrate clarity of 0.2 to 0.8% suspended solids is achievable. Pre-dosing with flocculent will be required to achieve centrate with this clarity.

Figure 7: Estimate of centrate quality

6 - Conclusion

The lab based test results indicated that a mining decanter centrifuge can dewater the supplied slurry to a firm, transportable consistency. It is estimated that a cake suspended solids content of approximately 66% wt can be achieved. This preliminary test indicates that this application is suitable for decanter centrifuges and should be pursued further.

The ultra fine nature of the solids also indicate that these are difficult to dewater using filtration technologies, and hence would be an especially interesting duty to investigate further using decanter centrifuges. Alfa Laval have several installations with a small particle size distribution which appear to be similar to the Fingerboard slimes.

Dilution of the centrifuge feed to a level of approx. 25-30% is recommended to provide effective flocculent mixing and floc formation.

Further work on the optimisation for flocculent dose should be undertaken, testing the type of flocculent, dilution of floc and feed and the impact of water chemistry.

Confidentiality

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Figure 8: P3 Decanter (solid bowl) Centrifuges installed on a slimes dewatering duty

Figure 8: Typical cake from a full scale slimes decanter centrifuge

Subject: Slimes sample Y3QB Fingerboards Laboratory Spin Test Report – Mineral Sands Slimes Tailings Dewatering test for Decanter Centrifuge	Rev A/ Y3QB 02/02/2021
Site: Fingerboards/ Kalbar Operations Pty Ltd	
Issued by: Paul Tuckwell/ Alfa Laval Australia (Perth office)	**Class:** Restricted
Keywords: Decanter centrifuge, tailings dewatering	**No. of pages/encl.:9**
Distribute to: Martin van Wyk (Wave International), Paul Tuckwell, Arvin Bangcale (Alfa Laval)	

Summary:

A sample of slimes (labelled Y3QB) from the proposed Fingerboards mineral sands minesite was tested for its suitability for dewatering in large scale Alfa Laval P3 mining decanter centrifuges.

Laboratory scale testing indicated that the slurry can be dewatered in a decanter centrifuge to form a firm, spadeable, transportable cake of around 67% wt total solids (suspended + any dissolved solids). In full scale operation the moisture level may be lower or higher depending on machine settings, differential speeds, throughput and G forces used.

It is estimated that the centrate clarity will be in the order of 0.2% to 0.8% suspended solids.

The sample supplied was a slurry containing 35% solids. This was too thick for mixing with flocculent for the lab test, so was diluted with potable Perth water for purposes of testing (though the high shear environment of an operating decanter centrifuge would improve floc mixing and viability of undiluted feed). Tests indicated that dilution to 25-30% wt solids would be beneficial for solids recovery and floc dose without impacting on the installed capital price, and this should be considered in any project optimisation.

Lab testing indicated that approximately 300 g active flocculent per tonne of suspended solids is needed to form strong, shear resistant flocs and recover the ultra fine material as part of the cake. Flocculent was not screened and only one type was used in the test (as suggested by Wave International based on thickener test work).

This data is based on laboratory scale measurements and observations only. Results and previous installations/ trials on similar slurries indicate that it is suitable for further development work with decanter centrifuges. The ultra fine nature of the tails solids make it particularly suitable for decanter centrifuges compared to other dewatering technologies.

Feed (at 26% solids), flocculated feed, cake and centrate

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1 - Slurry Type/ Description:

1.1 Source of Sample

The slimes sample tested was labelled Y3QB . This originated from Fingerboards Project test work at Nagrom. The age and origin of the sample is unknown to Alfa Laval, but was tested within 5 days of receipt. This sample supplied was a thick slurry of 35% wt solids and was diluted to 26% (after targeting 25%) using potable Perth water for testing.

Figure 1: Sample as received at 35% suspended solids

Figure 2: Sample diluted to 26.0% suspended solids

1.2 Suspended Solids

The sample supplied contained fine solids, with a PSD as follows:

Y3QB -0.038mm Cyclosize by Assay			
100.00%			
	Size (µm)		
2.27%	37.3		
8.33%	26		
9.85%	18.7		
8.84%	12.8		
5.81%	10.6		
64.90%	< 10.6		

There was no evidence of grit or larger solids > 100 micron in the sample.

1.3 Dissolved Solids

For the purposes of lab testing, it has been assumed that the sample contained negligible dissolved solids. Dilution of the slurry was undertaken with Perth tap water, which also contains negligible dissolved solids. The pH was approximately 8.0

1.4 Suspended Solids Density and Components

The homogeneous dry suspended solids density was assumed to be approximately 2790kg/m3 as advised. It has been assumed that is consists of extremely fine quartz solids, along with clay and silt.

1.5 Ease of floc formation

Flocculent dosing was tested after dilution to 26.0% dry solids in the slurry.

It was difficult to mix flocculent into the slurry in the thickened state (35%) supplied with the sample. Strong, shear resistant flocs formed easily in a jar test at 26% wt suspended solids. The optimum dilution value and floc dose can be optimised during a trial and commissioning.

Figure 3: Flocculated solids at 26% wt suspended solids

2 - Testing Aim:

Spin testing at the lab scale is the first practical step in establishing the suitability of dewatering of a slurry with a decanter centrifuge. This enables analysis of the use of centrifugal G forces in dewatering suspended solids. This test aimed to provide an estimate of:

- Cake dryness at typical decanter centrifuge operating conditions
- Suitable feed solids concentration
- Indication of the flocculent dose required under high shear conditions

The results must only be considered as an indication (not a guarantee). In full scale equipment, there are a number of variables available which are not possible to test in a laboratory.

3 - Method:

All suspended solids measurements were undertaken via drying and weighing samples over two days at 110 degC.

A recently prepared sample was delivered by Wave International along with a suggestion of flocculent (Nalco N83384). Flocculent was made up at 0.2% concentration and dosed at this concentration (which is normal for decanter centrifuges). The floc was freshly made at time of testing using potable water, with 2 hrs ageing time.

Slurry was diluted to 26% wt suspended solids using Perth potable tap water. (25% wt was targeted, but later measurement revealed it was 26%)

Flocculent was dosed directly into the diluted slurry with the dose measured. Once strong, shear resistant flocs were obtained, the final dose was recorded.

A spin test using a lab centrifuge was then undertaken using Alfa Laval's high density solid method. This simulates both a range of the G forces the slurry would be exposed to in a full scale tailing decanter centrifuge, and also the shear forces and bowl wall pressure the solids are exposed to. These shear forces are an important mechanism for releasing water from the cake.

Cake dryness and slurry feed concentration were then measured via drying and weighing.

Spin testing without flocculent did not result in good solids recovery due to the ultra fine solids. Hence results reported here are for the flocculated slurry only.

4 - Results:

Figure 4: Cake and centrate

4.1 Polymer Test

The polymer used in centrifuge lab test work was recommended by Wave International (Nalco N83384) at 0.2%, made up in Perth tap water.

The polymer dose required for strong, shear resistant flocs was approximately 300 grams active flocculent powder per tonne of dry solids.

This could be optimised/ improved by a proper screening process in combination with flocculent suppliers, and further testing with various flocculants and slurry dilution during a trial/ commissioning.

4.2 Flocculated sample spin test

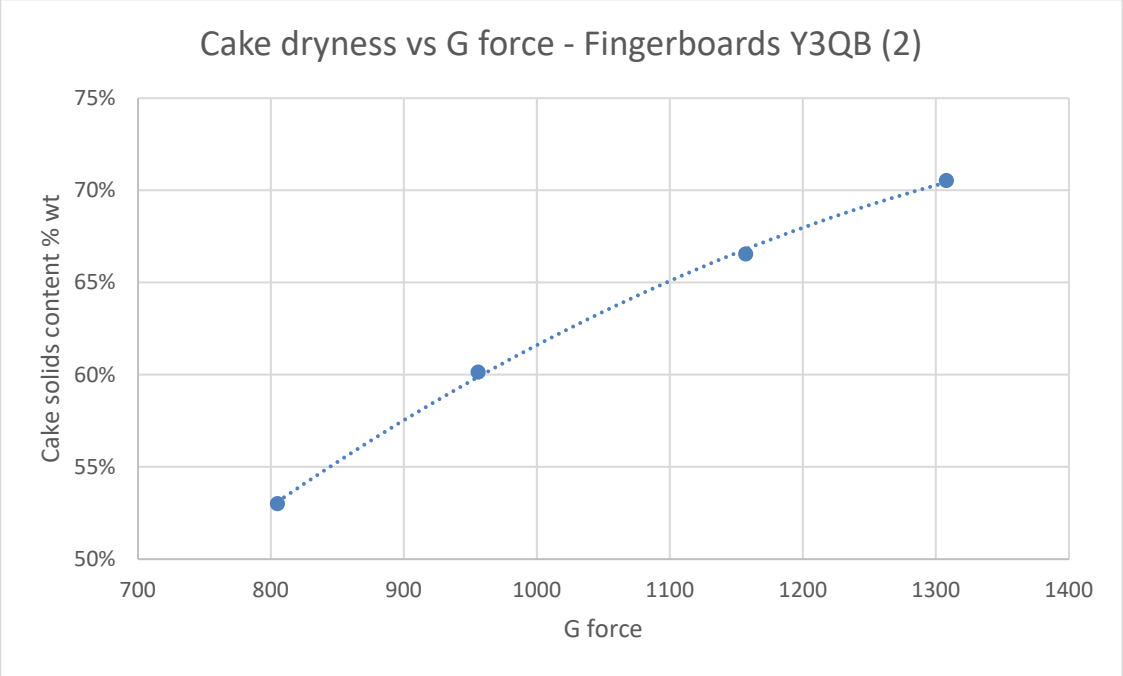

Figure 5 – Cake dryness vs G force

Samples resulting from exposure to different G forces were taken and plotted as shown above. The actual value depends on how the decanter centrifuge is operated, but as a nominal value, 67% wt cake appears to be typical of cake discharged from other decanter centrifuges containing a similar feed and at a similar G force. This was firm, spadeable and appears suitable for stacking, conveying and transport.

Figure 6: Cake at approximately 67% wt suspended solids

5 - Discussion:

5.1 Flocculent Dose

The flocculent tested appeared to result in strong flocs when the slurry was dosed with a sufficient quantity. However, a screening process should be undertaken with the aid of experienced flocculent suppliers to ensure the best flocculent is selection for high shear applications.

5.2 Cake Dryness

Based on previous spin test vs decanter cake dryness comparisons, it is believed that the cake dryness in an operating decanter centrifuge can be adjusted between 60 and 70% wt suspended solids.

The actual dryness in the cake depends on the G force, which can be tested in the lab, but also some other factors which cannot be tested in the lab but can be varied in decanter centrifuge operation. These include the differential speed of the machine, pond height, variations in feed dilution and additive dosing, pH adjustment and throughput.

At the nominal value of 67% suspended solids, the cake is a firm, spadeable cake. This would be suitable for trucking or conveying and did not present as overly sticky. There was no free water draining from the solid cake.

5.3 Centrate

It is difficult to estimate centrate quality in lab scale testing. However, based on previous experience with ultra fine tailings and operating decanter centrifuges, it is believed that a centrate clarity of 0.2 to 0.8% suspended solids is achievable. Pre-dosing with flocculent will be required to achieve centrate with this clarity.

Figure 7: Estimate of centrate quality

6 - Conclusion

The lab based test results indicated that a mining decanter centrifuge can dewater the supplied slurry to a firm, transportable consistency. It is estimated that a cake suspended solids content of approximately 67% wt can be achieved. This preliminary test indicates that this application is suitable for decanter centrifuges and should be pursued further.

The ultra fine nature of the solids also indicate that these are difficult to dewater using filtration technologies, and hence would be an especially interesting duty to investigate further using decanter centrifuges. Alfa Laval have several installations with a small particle size distribution which appear to be similar to the Fingerboard slimes.

Dilution of the centrifuge feed to a level of approx. 25-30% is recommended to provide effective flocculent mixing and floc formation.

Further work on the optimisation for flocculent dose should be undertaken, testing the type of flocculent, dilution of floc and feed and the impact of water chemistry.

Confidentiality

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Figure 8: P3 Decanter (solid bowl) Centrifuges installed on a slimes dewatering duty

Figure 8: Typical cake from a full scale slimes decanter centrifuge

Subject: Slimes sample Y4QC Fingerboards Laboratory Spin Test Report – Mineral Sands Slimes Tailings Dewatering test for Decanter Centrifuge	Rev A/ Y4QC 02/02/2021
Site: Fingerboards/ Kalbar Operations Pty Ltd	
Issued by: Paul Tuckwell/ Alfa Laval Australia (Perth office)	**Class:** Restricted
Keywords: Decanter centrifuge, tailings dewatering	**No. of pages/encl.:9**
Distribute to: Martin van Wyk (Wave International), Paul Tuckwell, Arvin Bangcale (Alfa Laval)	

Summary:

A sample of slimes (labelled Y4QC) from the proposed Fingerboards mineral sands minesite was tested for its suitability for dewatering in large scale Alfa Laval P3 mining decanter centrifuges.

Laboratory scale testing indicated that the slurry can be dewatered in a decanter centrifuge to form a softer cake than other samples tested at around 60% wt total solids (suspended + any dissolved solids). This cake appears transportable (subject to further testing). In full scale operation the moisture level may be lower or higher depending on machine settings, differential speeds, throughput and G forces used.

It is estimated that the centrate clarity will be in the order of 0.2% to 1.0% suspended solids.

The sample supplied was a slurry containing 35% solids. This was too thick for mixing with flocculent for the lab test, so was diluted with potable Perth water for purposes of testing (though the high shear environment of an operating decanter centrifuge would improve floc mixing and viability of undiluted feed). Tests indicated that dilution to 25-30% wt solids would be beneficial for solids recovery and floc dose without impacting on the installed capital price, and this should be considered in any project optimisation.

Lab testing indicated that approximately 500 g active flocculent per tonne of suspended solids is needed to form strong, shear resistant flocs and recover the ultra fine material as part of the cake. Flocculent was not screened and only one type was used in the test (as suggested by Wave International based on thickener test work). Further screening is recommended for this particular tailings type to reduce the dose.

Y4QC appeared to be unique compared to all the other slurries tested, with a higher flocculent dose necessary and a more difficult separation duty. This may influence the capacity of a full scale centrifuge to achieve the required transportable result. Hence it is recommended that particular attention is paid to this tailings slurry in any upcoming piloting and test work in order to predict future capacity and optimise flocculent dose.

This data is based on laboratory scale measurements and observations only. Results and previous installations/ trials on similar slurries indicate that it is suitable for further development work with decanter centrifuges. The ultra fine nature of the tails solids make it particularly suitable for decanter centrifuges compared to other dewatering technologies.

Feed (at 27% solids), flocculated feed, cake and centrate

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Contents

1 - Slurry Type/ Description:

1.1 Source of Sample

The slimes sample tested was labelled Y4QC. This originated from Fingerboards Project test work at Nagrom. The age and origin of the sample is unknown to Alfa Laval, but was tested within 5 days of receipt. This sample supplied was a thick slurry of 35% wt solids and was diluted to 27% (after targeting 25%) using potable Perth water for testing.

The slurry had a subtle, but visibly darker appearance compared to other slurries tested.

Figure 1: Sample as received at 35% suspended solids

Figure 2: Sample diluted to 27.0% suspended solids

1.2 Suspended Solids

The sample supplied contained fine solids, with a PSD as follows:

Y4QC -0.038mm Cyclosizing	
100.00%	
	Size (µm)
2.32%	36.5
10.72%	25.5
11.55%	18.3
9.01%	12.5
6.73%	10.4
59.67%	< 10.4

There was no evidence of grit or larger solids > 100 micron in the sample.

1.3 Dissolved Solids

For the purposes of lab testing, it has been assumed that the sample contained negligible dissolved solids. Dilution of the slurry was undertaken with Perth tap water, which also contains negligible dissolved solids. The pH was approximately 8.0

1.4 Suspended Solids Density and Components

The homogeneous dry suspended solids density was assumed to be approximately 2790kg/m3 as advised. It has been assumed that is consists of extremely fine quartz solids, along with clay and silt.

1.5 Ease of floc formation

Flocculent dosing was tested after dilution to 27.0% dry solids in the slurry.

It was difficult to mix flocculent into the slurry in the thickened state (35%) supplied with the sample. Strong, shear resistant flocs formed easily in a jar test at 27% wt suspended solids. The optimum dilution value and floc dose can be optimised during a trial and commissioning.

Figure 3: Flocculated solids at 27% wt suspended solids

2 - Testing Aim:

Spin testing at the lab scale is the first practical step in establishing the suitability of dewatering of a slurry with a decanter centrifuge. This enables analysis of the use of centrifugal G forces in dewatering suspended solids. This test aimed to provide an estimate of:

- Cake dryness at typical decanter centrifuge operating conditions
- Suitable feed solids concentration
- Indication of the flocculent dose required under high shear conditions

The results must only be considered as an indication (not a guarantee). In full scale equipment, there are a number of variables available which are not possible to test in a laboratory.

3 - Method:

All suspended solids measurements were undertaken via drying and weighing samples over two days at 110 degC.

A recently prepared sample was delivered by Wave Engineering along with a suggestion of flocculent (Nalco N83384). Flocculent was made up at 0.2% concentration and dosed at this concentration (which is normal for decanter centrifuges). The floc was freshly made at time of testing using potable water, with 2 hrs ageing time.

Slurry was diluted to 27% wt suspended solids using Perth potable tap water. (25% wt was targeted, but later measurement revealed it was 27%)

Flocculent was dosed directly into the diluted slurry with the dose measured. Once strong, shear resistant flocs were obtained, the final dose was recorded.

A spin test using a lab centrifuge was then undertaken using Alfa Laval's high density solid method. This simulates both a range of the G forces the slurry would be exposed to in a full scale tailing decanter centrifuge, and also the shear forces and bowl wall pressure the solids are exposed to. These shear forces are an important mechanism for releasing water from the cake.

Cake dryness and slurry feed concentration were then measured via drying and weighing.

Spin testing without flocculent did not result in good solids recovery due to the ultra fine solids. Hence results reported here are for the flocculated slurry only.

4 - Results:

Figure 4: Cake and centrate

4.1 Polymer Test

The polymer used in centrifuge lab test work was recommended by Wave International (Nalco N83384) at 0.2%, made up in Perth tap water.

The polymer dose required for strong, shear resistant flocs was approximately 500 grams active flocculent powder per tonne of dry solids.

This could be optimised/ improved by a proper screening process in combination with flocculent suppliers, and further testing with various flocculants and slurry dilution during a trial/ commissioning.

4.2 Flocculated sample spin test

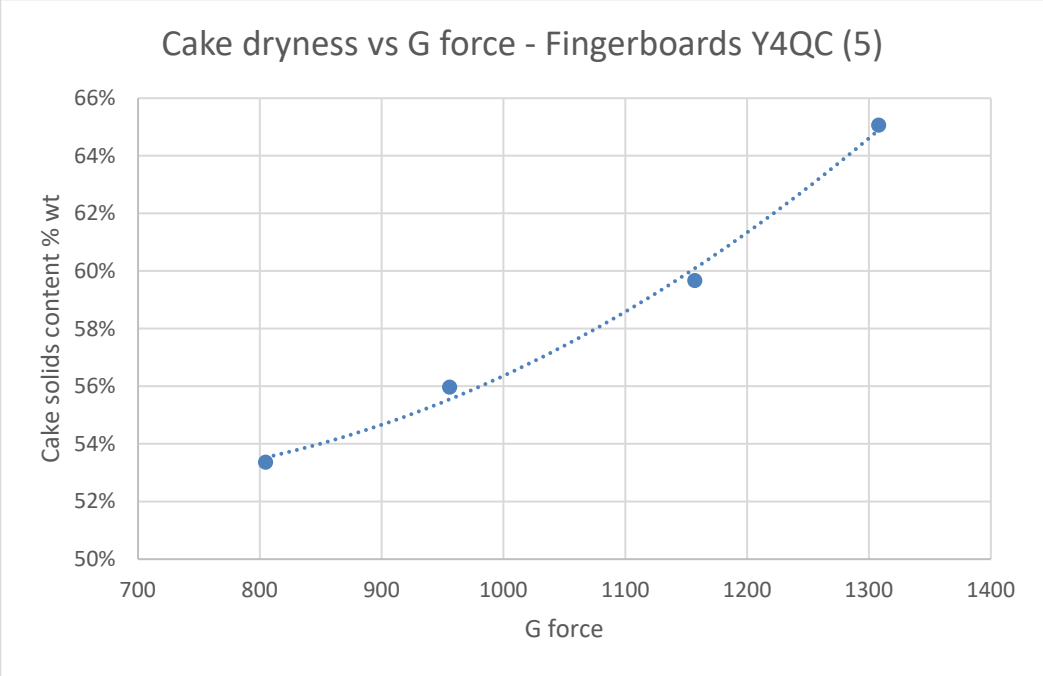

Figure 5 – Cake dryness vs G force

Samples resulting from exposure to different G forces were taken and plotted as shown above. The actual value depends on how the decanter centrifuge is operated, but as a nominal value, 60% wt cake appears to be typical of cake discharged from other decanter centrifuges containing a similar feed and at a similar G force.

While this cake appears suitable for stacking, conveying and transport, it was softer and had a lower shear strength compared to the other 5 samples tested (see separate reports).

Figure 6: Cake at approximately 60% wt suspended solids

5 - Discussion:

5.1 Flocculent Dose

The flocculent tested appeared to result in strong flocs when the slurry was dosed with a sufficient quantity. However, a screening process should be undertaken with the aid of experienced flocculent suppliers to ensure the best flocculent is selection for high shear applications.

5.2 Cake Dryness

Based on previous spin test vs decanter cake dryness comparisons, it is believed that the cake dryness in an operating decanter centrifuge can be adjusted between 56 and 65% wt suspended solids.

The actual dryness in the cake depends on the G force, which can be tested in the lab, but also some other factors which cannot be tested in the lab but can be varied in decanter centrifuge operation. These include the differential speed of the machine, pond height, variations in feed dilution and additive dosing, pH adjustment and throughput.

At the nominal value of 60% suspended solids, the cake is a softer cake than other samples tested. However it did not present as overly sticky and there was no free water draining from the solid cake.

5.3 Centrate

It is difficult to estimate centrate quality in lab scale testing. However, based on previous experience with ultra fine tailings and operating decanter centrifuges, it is believed that a centrate clarity of 0.2 to 1.0% suspended solids is achievable. It is expected that the centrate will contain slightly more solids than the other samples tested unless subjected to a different pre-dosing of coagulant and/ or flocculent. Pre-dosing with flocculent will be required to achieve centrate with this clarity.

Figure 7: Estimate of centrate quality

6 - Conclusion

The lab based test results indicated that a mining decanter centrifuge can dewater the supplied slurry to what appears to be a transportable consistency. The cake is softer than the other samples tested, and the slurry requires a higher flocculant dose.

It is estimated that a cake suspended solids content of approximately 60% wt can be achieved. This preliminary test indicates that this application is suitable for decanter centrifuges and should be pursued further.

The ultra fine nature of the solids also indicate that these are difficult to dewater using filtration technologies, and hence would be an especially interesting duty to investigate further using decanter centrifuges. Alfa Laval have several installations with a small particle size distribution which appear to be similar to the Fingerboard slimes.

Dilution of the centrifuge feed to a level of approx. 25-30% is recommended to provide effective flocculent mixing and floc formation.

Further work on the optimisation for flocculent dose should be undertaken, testing the type of flocculent, dilution of floc and feed and the impact of water chemistry.

Y4QC should be uniquely investigated as it appears to have different properties compared to all other slurries tested, and may result in a different capacity and result in dewatering equipment.

Confidentiality

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Figure 8: P3 Decanter (solid bowl) Centrifuges installed on a slimes dewatering duty

Figure 8: Typical cake from a full scale slimes decanter centrifuge

Subject: Slimes sample Y6Q2 Fingerboards Laboratory Spin Test Report – Mineral Sands Slimes Tailings Dewatering test for Decanter Centrifuge	Rev A/ Y6Q2 02/02/2021
Site: Fingerboards/ Kalbar Operations Pty Ltd	
Issued by: Paul Tuckwell/ Alfa Laval Australia (Perth office)	**Class:** Restricted
Keywords: Decanter centrifuge, tailings dewatering	**No. of pages/encl.:9**
Distribute to: Martin van Wyk (Wave International), Paul Tuckwell, Arvin Bangcale (Alfa Laval)	

Summary:

A sample of slimes (labelled Y6Q2) from the proposed Fingerboards mineral sands minesite was tested for its suitability for dewatering in large scale Alfa Laval P3 mining decanter centrifuges.

Laboratory scale testing indicated that the slurry can be dewatered in a decanter centrifuge to form a firm, spadeable, transportable cake of around 67% wt total solids (suspended + any dissolved solids). In full scale operation the moisture level may be lower or higher depending on machine settings, differential speeds, throughput and G forces used.

It is estimated that the centrate clarity will be in the order of 0.2% to 0.8% suspended solids.

The sample supplied was a slurry containing 35% solids. This was too thick for mixing with flocculent for the lab test, so was diluted with potable Perth water for purposes of testing (though the high shear environment of an operating decanter centrifuge would improve floc mixing and viability of undiluted feed). Tests indicated that dilution to 25-30% wt solids would be beneficial for solids recovery and floc dose without impacting on the installed capital price, and this should be considered in any project optimisation.

Lab testing indicated that approximately 374 g active flocculent per tonne of suspended solids is needed to form strong, shear resistant flocs and recover the ultra fine material as part of the cake. Flocculent was not screened and only one type was used in the test (as suggested by Wave International based on thickener test work).

This data is based on laboratory scale measurements and observations only. Results and previous installations/ trials on similar slurries indicate that it is suitable for further development work with decanter centrifuges. The ultra fine nature of the tails solids make it particularly suitable for decanter centrifuges compared to other dewatering technologies.

Feed (at 27% solids), flocculated feed, cake and centrate

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Contents

1 - Slurry Type/ Description:

1.1 Source of Sample

The slimes sample tested was labelled Y6Q2. This originated from Fingerboards Project test work at Nagrom. The age and origin of the sample is unknown to Alfa Laval, but was tested within 5 days of receipt. This sample supplied was a thick slurry of 35% wt solids and was diluted to 27% (after targeting 25%) using potable Perth water for testing.

Figure 1: Sample as received at 35% suspended solids

Figure 2: Sample diluted to 26.0% suspended solids

1.2 Suspended Solids

The sample supplied contained fine solids, with a PSD as follows:

Y5QD & Y6Q2 -0.038mm Cyclosizing			
100.00%			
	Size (µm)		
3.13%	36.3		
9.50%	25.3		
10.07%	18.2		
9.21%	12.5		
6.43%	10.3		
61.68%	< 10.3		

There was no evidence of grit or larger solids > 100 micron in the sample.

1.3 Dissolved Solids

For the purposes of lab testing, it has been assumed that the sample contained negligible dissolved solids. Dilution of the slurry was undertaken with Perth tap water, which also contains negligible dissolved solids. The pH was approximately 8.0

1.4 Suspended Solids Density and Components

The homogeneous dry suspended solids density was assumed to be approximately 2790kg/m3 as advised. It has been assumed that is consists of extremely fine quartz solids, along with clay and silt.

1.5 Ease of floc formation

Flocculent dosing was tested after dilution to 27.0% dry solids in the slurry.

It was difficult to mix flocculent into the slurry in the thickened state (35%) supplied with the sample. Strong, shear resistant flocs formed easily in a jar test at 27% wt suspended solids. The optimum dilution value and floc dose can be optimised during a trial and commissioning.

Figure 3: Flocculated solids at 27% wt suspended solids

2 - Testing Aim:

Spin testing at the lab scale is the first practical step in establishing the suitability of dewatering of a slurry with a decanter centrifuge. This enables analysis of the use of centrifugal G forces in dewatering suspended solids. This test aimed to provide an estimate of:

- Cake dryness at typical decanter centrifuge operating conditions
- Suitable feed solids concentration
- Indication of the flocculent dose required under high shear conditions

The results must only be considered as an indication (not a guarantee). In full scale equipment, there are a number of variables available which are not possible to test in a laboratory.

3 - Method:

All suspended solids measurements were undertaken via drying and weighing samples over two days at 110 degC.

A recently prepared sample was delivered by Wave Engineering along with a suggestion of flocculent (Nalco N83384). Flocculent was made up at 0.2% concentration and dosed at this concentration (which is normal for decanter centrifuges). The floc was freshly made at time of testing using potable water, with 2 hrs ageing time.

Slurry was diluted to 27% wt suspended solids using Perth potable tap water. (25% wt was targeted, but later measurement revealed it was 27%)

Flocculent was dosed directly into the diluted slurry with the dose measured. Once strong, shear resistant flocs were obtained, the final dose was recorded.

A spin test using a lab centrifuge was then undertaken using Alfa Laval's high density solid method. This simulates both a range of the G forces the slurry would be exposed to in a full scale tailing decanter centrifuge, and also the shear forces and bowl wall pressure the solids are exposed to. These shear forces are an important mechanism for releasing water from the cake.

Cake dryness and slurry feed concentration were then measured via drying and weighing.

Spin testing without flocculent did not result in good solids recovery due to the ultra fine solids. Hence results reported here are for the flocculated slurry only.

4 - Results:

Figure 4: Cake and centrate

4.1 Polymer Test

The polymer used in centrifuge lab test work was recommended by Wave International (Nalco N83384) at 0.2%, made up in Perth tap water.

The polymer dose required for strong, shear resistant flocs was approximately 374 grams active flocculent powder per tonne of dry solids.

This could be optimised/ improved by a proper screening process in combination with flocculent suppliers, and further testing with various flocculants and slurry dilution during a trial/ commissioning.

4.2 Flocculated sample spin test

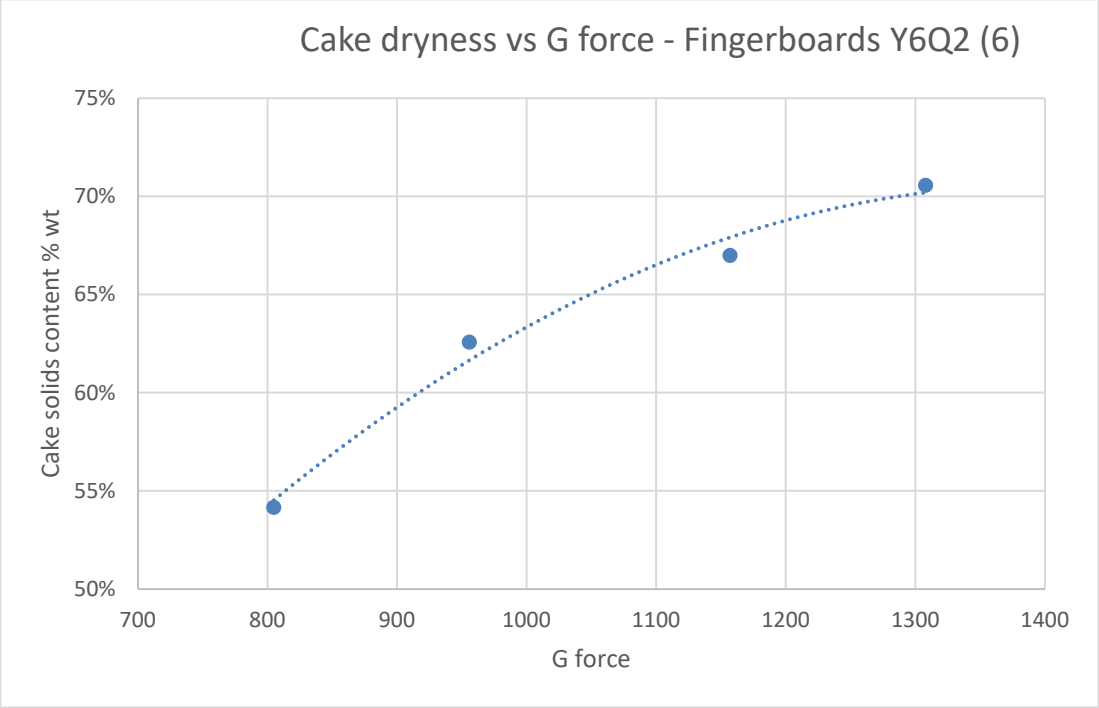

Figure 5 – Cake dryness vs G force

Samples resulting from exposure to different G forces were taken and plotted as shown above. The actual value depends on how the decanter centrifuge is operated, but as a nominal value, 67% wt cake appears to be typical of cake discharged from other decanter centrifuges containing a similar feed and at a similar G force. This was firm, spadeable and appears suitable for stacking, conveying and transport.

Figure 6: Cake at approximately 67% wt suspended solids

5 - Discussion:

5.1 Flocculent Dose

The flocculent tested appeared to result in strong flocs when the slurry was dosed with a sufficient quantity. However, a screening process should be undertaken with the aid of experienced flocculent suppliers to ensure the best flocculent is selection for high shear applications.

5.2 Cake Dryness

Based on previous spin test vs decanter cake dryness comparisons, it is believed that the cake dryness in an operating decanter centrifuge can be adjusted between 63 and 70% wt suspended solids.

The actual dryness in the cake depends on the G force, which can be tested in the lab, but also some other factors which cannot be tested in the lab but can be varied in decanter centrifuge operation. These include the differential speed of the machine, pond height, variations in feed dilution and additive dosing, pH adjustment and throughput.

At the nominal value of 67% suspended solids, the cake is a firm, spadeable cake. This would be suitable for trucking or conveying and did not present as overly sticky. There was no free water draining from the solid cake.

5.3 Centrate

It is difficult to estimate centrate quality in lab scale testing. However, based on previous experience with ultra fine tailings and operating decanter centrifuges, it is believed that a centrate clarity of 0.2 to 0.8% suspended solids is achievable. Pre-dosing with flocculent will be required to achieve centrate with this clarity.

Figure 7: Estimate of centrate quality

6 - Conclusion

The lab based test results indicated that a mining decanter centrifuge can dewater the supplied slurry to a firm, transportable consistency. It is estimated that a cake suspended solids content of approximately 67% wt can be achieved. This preliminary test indicates that this application is suitable for decanter centrifuges and should be pursued further.

The ultra fine nature of the solids also indicate that these are difficult to dewater using filtration technologies, and hence would be an especially interesting duty to investigate further using decanter centrifuges. Alfa Laval have several installations with a small particle size distribution which appear to be similar to the Fingerboard slimes.

Dilution of the centrifuge feed to a level of approx. 25-30% is recommended to provide effective flocculent mixing and floc formation.

Further work on the optimisation for flocculent dose should be undertaken, testing the type of flocculent, dilution of floc and feed and the impact of water chemistry.

Confidentiality

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Figure 8: P3 Decanter (solid bowl) Centrifuges installed on a slimes dewatering duty

Figure 8: Typical cake from a full scale slimes decanter centrifuge

Subject: Slimes sample Y6Q3 Fingerboards Laboratory Spin Test Report – Mineral Sands Slimes Tailings Dewatering test for Decanter Centrifuge	Rev A/ Y6Q3 02/02/2021
Site: Fingerboards/ Kalbar Operations Pty Ltd	
Issued by: Paul Tuckwell/ Alfa Laval Australia (Perth office)	**Class:** Restricted
Keywords: Decanter centrifuge, tailings dewatering	**No. of pages/encl.:9**
Distribute to: Martin van Wyk (Wave International), Paul Tuckwell, Arvin Bangcale (Alfa Laval)	

Summary:

A sample of slimes (labelled Y6Q3) from the proposed Fingerboards mineral sands minesite was tested for its suitability for dewatering in large scale Alfa Laval P3 mining decanter centrifuges.

Laboratory scale testing indicated that the slurry can be dewatered in a decanter centrifuge to form a firm, spadeable, transportable cake of around 64% wt total solids (suspended + any dissolved solids). In full scale operation the moisture level may be lower or higher depending on machine settings, differential speeds, throughput and G forces used.

It is estimated that the centrate clarity will be in the order of 0.2% to 0.8% suspended solids.

The sample supplied was a slurry containing 35% solids. This was too thick for mixing with flocculent for the lab test, so was diluted with potable Perth water for purposes of testing (though the high shear environment of an operating decanter centrifuge would improve floc mixing and viability of undiluted feed). Tests indicated that dilution to 25-30% wt solids would be beneficial for solids recovery and floc dose without impacting on the installed capital price, and this should be considered in any project optimisation.

Lab testing indicated that approximately 320 g active flocculent per tonne of suspended solids is needed to form strong, shear resistant flocs and recover the ultra fine material as part of the cake. Flocculent was not screened and only one type was used in the test (as suggested by Wave International based on thickener test work).

This data is based on laboratory scale measurements and observations only. Results and previous installations/ trials on similar slurries indicate that it is suitable for further development work with decanter centrifuges. The ultra fine nature of the tails solids make it particularly suitable for decanter centrifuges compared to other dewatering technologies.

Feed (at 26% solids), flocculated feed, cake and centrate

Alfa Laval requests that this Spin Test Report is maintained as confidential and remains within the possession of Wave International, Kalbar Resources and Alfa Laval. Please seek permission from Alfa Laval to share with 3rd parties

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1 - Slurry Type/ Description:

1.1 Source of Sample

The slimes sample tested was labelled Y6Q3 . This originated from Fingerboards Project test work at Nagrom. The age and origin of the sample is unknown to Alfa Laval, but was tested within 5 days of receipt. This sample supplied was a thick slurry of 35% wt solids and was diluted to 26% (after targeting 25%) using potable Perth water for testing.

Figure 1: Sample as received at 35% suspended solids

Figure 2: Sample diluted to 26.0% suspended solids

1.2 Suspended Solids

The sample supplied contained fine solids, with a PSD as follows:

Y6Q3 -0.038mm Cyclosizing		
100.00%		
	Size (µm)	
2.59%	38	
8.33%	26.5	
9.14%	19	
8.02%	13	
5.97%	10.8	
65.94%	< 10.8	

There was no evidence of grit or larger solids > 100 micron in the sample.

1.3 Dissolved Solids

For the purposes of lab testing, it has been assumed that the sample contained negligible dissolved solids. Dilution of the slurry was undertaken with Perth tap water, which also contains negligible dissolved solids. The pH was approximately 8.0

1.4 Suspended Solids Density and Components

The homogeneous dry suspended solids density was assumed to be approximately 2790kg/m3 as advised. It has been assumed that is consists of extremely fine quartz solids, along with clay and silt.

1.5 Ease of floc formation

Flocculent dosing was tested after dilution to 26.0% dry solids in the slurry.

It was difficult to mix flocculent into the slurry in the thickened state (35%) supplied with the sample. Strong, shear resistant flocs formed easily in a jar test at 26% wt suspended solids. The optimum dilution value and floc dose can be optimised during a trial and commissioning.

Figure 3: Flocculated solids at 26% wt suspended solids

2 - Testing Aim:

Spin testing at the lab scale is the first practical step in establishing the suitability of dewatering of a slurry with a decanter centrifuge. This enables analysis of the use of centrifugal G forces in dewatering suspended solids. This test aimed to provide an estimate of:

- Cake dryness at typical decanter centrifuge operating conditions
- Suitable feed solids concentration
- Indication of the flocculent dose required under high shear conditions

The results must only be considered as an indication (not a guarantee). In full scale equipment, there are a number of variables available which are not possible to test in a laboratory.

3 - Method:

All suspended solids measurements were undertaken via drying and weighing samples over two days at 110 degC.

A recently prepared sample was delivered by Wave International along with a suggestion of flocculent (Nalco N83384). Flocculent was made up at 0.2% concentration and dosed at this concentration (which is normal for decanter centrifuges). The floc was freshly made at time of testing using potable water, with 2 hrs ageing time.

Slurry was diluted to 26% wt suspended solids using Perth potable tap water. (25% wt was targeted, but later measurement revealed it was 26%)

Flocculent was dosed directly into the diluted slurry with the dose measured. Once strong, shear resistant flocs were obtained, the final dose was recorded.

A spin test using a lab centrifuge was then undertaken using Alfa Laval's high density solid method. This simulates both a range of the G forces the slurry would be exposed to in a full scale tailing decanter centrifuge, and also the shear forces and bowl wall pressure the solids are exposed to. These shear forces are an important mechanism for releasing water from the cake.

Cake dryness and slurry feed concentration were then measured via drying and weighing.

Spin testing without flocculent did not result in good solids recovery due to the ultra fine solids. Hence results reported here are for the flocculated slurry only.

4 - Results:

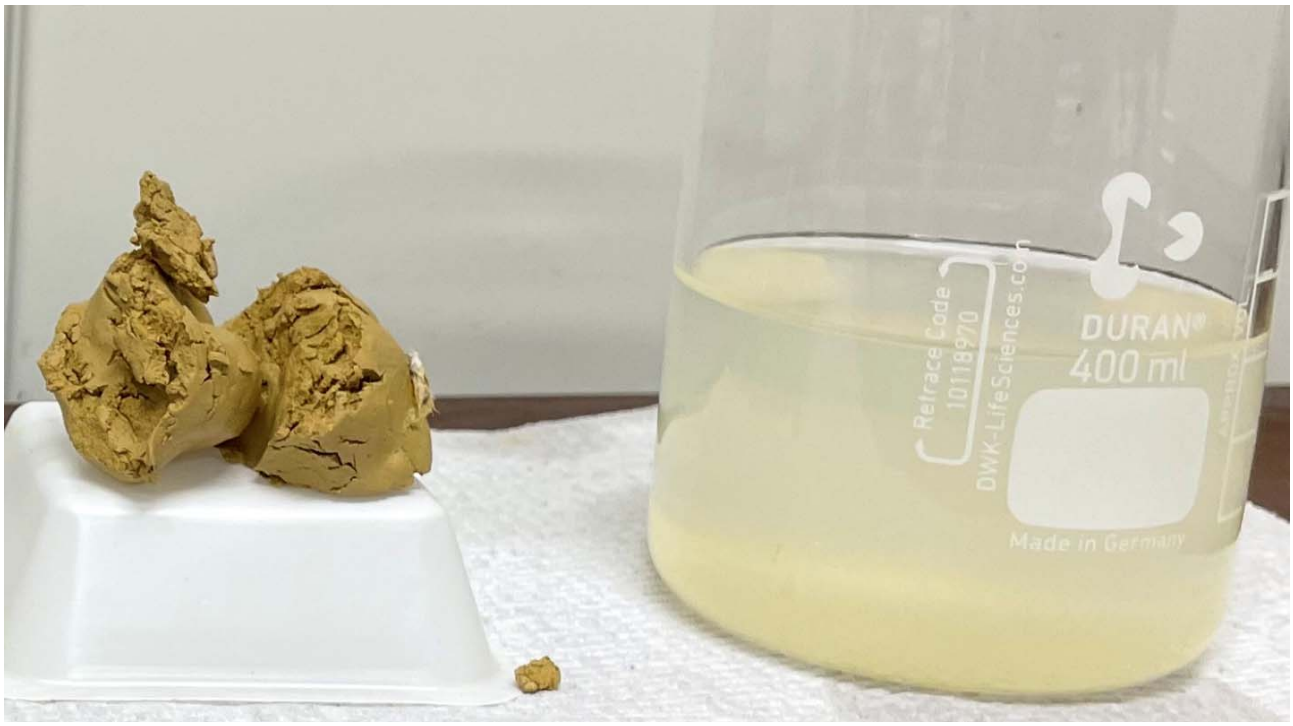

Figure 4: Centrate and cake

4.1 Polymer Test

The polymer used in centrifuge lab test work was recommended by Wave International (Nalco N83384) at 0.2%, made up in Perth tap water.

The polymer dose required for strong, shear resistant flocs was approximately 320 grams active flocculent powder per tonne of dry solids.

This could be optimised/ improved by a proper screening process in combination with flocculent suppliers, and further testing with various flocculants and slurry dilution during a trial/ commissioning.

4.2 Flocculated sample spin test

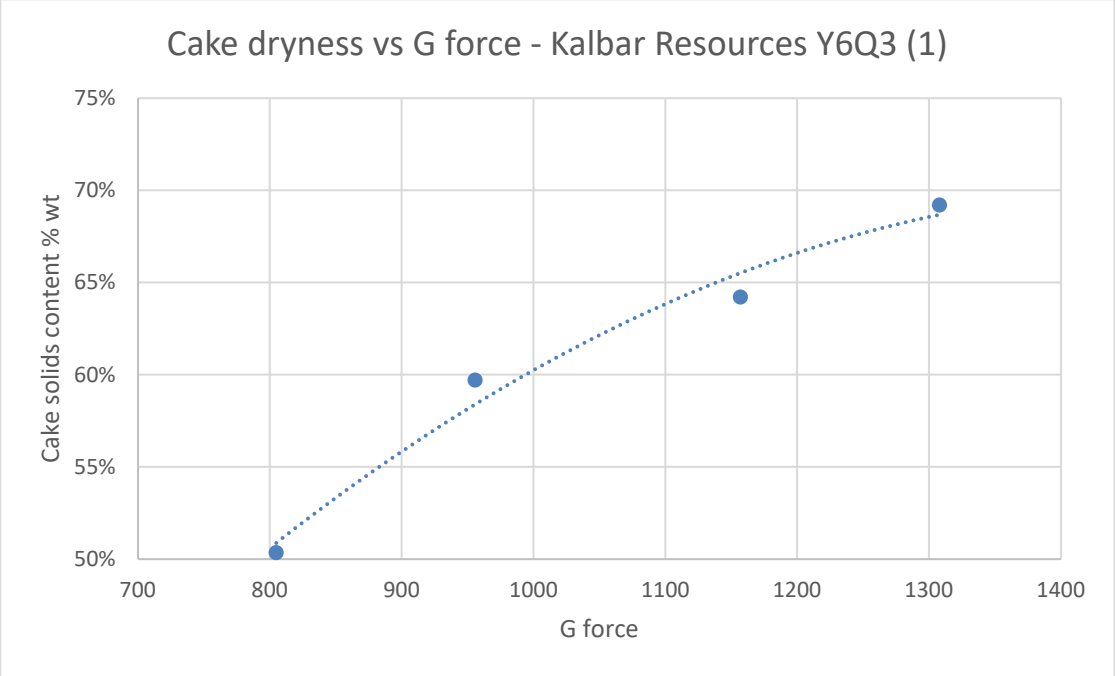

Figure 5 – Cake dryness vs G force

Samples resulting from exposure to different G forces were taken and plotted as shown above. The actual value depends on how the decanter centrifuge is operated, but as a nominal value, 64% wt cake appears to be typical of cake discharged from other decanter centrifuges containing a similar feed and at a similar G force. This was firm, spadeable and appears suitable for stacking, conveying and transport.

Figure 6: Cake at approximately 64% wt suspended solids

5 - Discussion:

5.1 Flocculent Dose

The flocculent tested appeared to result in strong flocs when the slurry was dosed with a sufficient quantity. However, a screening process should be undertaken with the aid of experienced flocculent suppliers to ensure the best flocculent is selection for high shear applications.

5.2 Cake Dryness

Based on previous spin test vs decanter cake dryness comparisons, it is believed that the cake dryness in an operating decanter centrifuge can be adjusted between 60 and 69% wt suspended solids.

The actual dryness in the cake depends on the G force, which can be tested in the lab, but also some other factors which cannot be tested in the lab but can be varied in decanter centrifuge operation. These include the differential speed of the machine, pond height, variations in feed dilution and additive dosing, pH adjustment and throughput.

At the nominal value of 64% suspended solids, the cake is a firm, spadeable cake. This would be suitable for trucking or conveying and did not present as overly sticky. There was no free water draining from the solid cake.

5.3 Centrate

It is difficult to estimate centrate quality in lab scale testing. However, based on previous experience with ultra fine tailings and operating decanter centrifuges, it is believed that a centrate clarity of 0.2 to 0.8% suspended solids is achievable. Pre-dosing with flocculent will be required to achieve centrate with this clarity.

Figure 7: Estimate of centrate quality

6 - Conclusion

The lab based test results indicated that a mining decanter centrifuge can dewater the supplied slurry to a firm, transportable consistency. It is estimated that a cake suspended solids content of approximately 64% wt can be achieved. This preliminary test indicates that this application is suitable for decanter centrifuges and should be pursued further.

The ultra fine nature of the solids also indicate that these are difficult to dewater using filtration technologies, and hence would be an especially interesting duty to investigate further using decanter centrifuges. Alfa Laval have several installations with a small particle size distribution which appear to be similar to the Fingerboard slimes.

Dilution of the centrifuge feed to a level of approx. 25-30% is recommended to provide effective flocculent mixing and floc formation.

Further work on the optimisation for flocculent dose should be undertaken, testing the type of flocculent, dilution of floc and feed and the impact of water chemistry.

Confidentiality

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Figure 8: P3 Decanter (solid bowl) Centrifuges installed on a slimes dewatering duty

Figure 8: Typical cake from a full scale slimes decanter centrifuge