tailings disposal

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ABSTRACT
Thickeners are utilised in coal washing for the purpose of solid / liquid separation (dewatering). Thickeners separate an incoming feed slurry (i.e. water with solid particles of either product or tailings material) into two distinct streams; one consisting of clarified water (overflow) and the second stream being a slurry concentrated with solids (underflow).

Thickeners, like most processing technology utilised in CHPPs, are fixed geometry equipment designed for a specific throughput and duty. During the course of the thickeners’ life cycle, they often see the initial design parameters increase and in some cases are utilised for an application that differs from their initial function.

This paper discusses upgrades and modifications to existing thickeners and covers:

• Advances in thickener technology (such as improvements in thickener feed system design and thickener feed dilution, velocity control and de-aeration); its implementation and benefits in upgrades;

• Design modifications to enable higher throughput and / or improved performance; and

• Thickener testwork for the upgrade / modernisation process.

The paper also discusses the upgrade / modernisation of thickeners at three coal preparation plants; two of which are Australian and one which is located overseas. In each case these upgrades were carried out as part of an overall plant upgrade to achieve higher throughput. The modifications to these installed thickeners resulted in an increase in the throughput, as well as further improvements in the thickeners’ process performance.

BACKGROUND
Thickening technology utilises the principle of sedimentation as a cost effective method of solid-liquid separation.

Sedimentation is used to thicken an incoming feed stream to produce two phases, namely ‘overflow’ (a liquid phase containing minimal solids) and ‘underflow’ (a solid/liquid phase containing minimal liquid collected at the base of the thickener tank).
This is accomplished by a number of means:

- settling under the force of gravity;
- addition of reagents such as flocculants which are mixed with incoming feed to enhance gravity settling such that it occurs more effectively and efficiently;
- bed compression due to self weight of material in the settled bed; and
- mechanical raking to release water entrained in the settled bed and assist with transport of settled contents to underflow.

Compared to alternate technologies, sedimentation using thickeners is capable of processing high volumes of slurry at a relatively low cost. In coal preparation thickeners are utilised to:

- densify and minimise the volume of slurry prior to downstream processing (such as filtration);
- densify and minimise the volume of slurry delivered to tailings storage facilities (TSF);
- achieve water recovery; and
- improve processing (such as flotation) through removal of fine solids from process water.

From an environmental, social and economical perspective efficient thickener performance is becoming increasingly important. Environmental requirements are increasingly onerous, particularly regarding utilisation of water resources and the design and usage of tailings storage facilities.

Additionally, processing trends towards finer particle sizes makes thickening more challenging. Consumables such as energy and flocculants are also increasing in cost so truly efficient thickener design is a pre-requisite to most operations nowadays.

Being fixed geometry equipment, thickeners are designed for a specific throughput and duty. Despite this, it is commonly seen that initial design parameters are ‘pushed’ over time and older installed thickeners are repurposed for a different application.

MODIFICATIONS TO THICKENER DESIGN TO ENABLE UPGRADE, DUTY CHANGES AND PROCESS PERFORMANCE IMPROVEMENT

In the following sections the paper discusses aspects of thickener design which can be applied to upgrades and modernisations of existing thickeners to suit increases in thickener throughput, changes in thickener duty or to improve process performance.

FEED SYSTEM DESIGN

Flocculation plays a critical role in thickening through its function of improving the efficiency of gravity settling. Dosing and mixing of flocculants takes place in the feed system so a review of the suitability of the feed system for any change of duty will be critical to ensuring process performance targets are achieved. Aspects of thickener feed system design that can be addressed include:

THICKENER FEEDWELL DESIGN

Feedwell design has seen a number of advances in the past decade. These advances are largely due to the use of computational fluid dynamic (CFD) modelling and plant validation to improve the understanding of the complex and multiphase fluid flow behaviour that occurs in feedwells (Heath and Triglavcanin, 2010).
In feed system design it is important to control the amount of turbulence and fluid shear that occurs in the feedwell, as well as those areas of the feedwell in which it occurs. This is critical to achieving good flocculation, capturing fine and coarse particles in flocculated aggregates without breaking those aggregates which are sensitive to excessive shear energy.

Modern thickener feedwells are designed to utilise thickener feed momentum for controlled mixing of incoming feed with flocculants and (in many cases) introduce dilution liquor. It is then necessary to dissipate the momentum and energy and gently and evenly distribute the well flocculated feed without breaking up the aggregates, or disturbing the bed inside the thickener when the flocculated slurry exits the feedwell.

Even distribution into the body of the thickener is important to ensure the entire settling area of the thickener is utilised effectively.

Analysis and experience has shown that older conventional feedwells typically suffered short-circuiting (Nguyen et al, 2006), where feed plunges prematurely from the feedwell with poor mixing, flocculation, and energy dissipation. Because the feed stream is not contained in the feedwell and then distributed evenly across the tank it tends to cause high levels of turbulence outside the feedwell and stronger currents in the settling and clarification zones of the thickener.

A modern feed system should achieve one or more of the following benefits, compared to older designs:

- reduced flocculant consumption (which translates to reduced operating costs);
- improved overflow clarity;
- increased underflow density;
- maximised water recovery;
- reduction in required thickener area for a given throughput;
- improved controllability; and
- ability to operate effectively over a range of operating conditions.
In recent years some thickener technology suppliers have developed various new feedwell design concepts to meet the requirement of modern thickener feed system design discussed above. Outotec's Vane Feedwell™ design (Figure 1) was launched during 2008 and has been at the forefront of developments in modern thickener feedwell design. This design incorporates seven globally patented design features and has been utilised in greater than 40 thickener upgrades and over 500 installations of new thickeners globally.

**THICKENER FEED DE-AERATION AND VELOCITY BREAK TANK**

Developments in feed system design such as Vane Feedwell™ have highlighted the importance of feed delivery on thickener performance. Full benefits of feedwell improvements may not be realised if the feed to the thickener is poorly conditioned. Supply of feed to the thickener is often outside of the thickener suppliers' control, particularly in upgrade situations where existing plant layout and available layout space dictate what can and cannot be accommodated.

In particular excessive feed velocity and/or aerated thickener feed are detrimental to thickener performance.

In many cases plants are laid out such that thickeners are gravity fed from an elevated feedbox. Elevated feed tanks tend to result in the thickener feedpipe running part-full, and often over long pipe runs which can have multiple changes in direction and drops in elevation. This can result in the thickener receiving aerated feed at a high velocity.

Aeration can also be present in thickener feeds from various sources, such as the use of flotation frothers in upstream processes.

Highly aerated thickener feed that makes its way into the body of the thickener tends to carry fine particles to the surface of the thickener to form froth. This froth causes issues such as the loss of product to thickener overflow (on product thickeners) and can cause reduction in thickener underflow density due to poor flocculation. Higher maintenance time and costs can
also result due to wear and blockages through accumulation of particles in process water. Where aeration makes its way into thickener underflow, it can also reduce performance in downstream processes such as filtration.

In the past various methods have been utilised to manage thickener surface froth. These include the use of rotating froth collection booms to transport surface froth and the installation of froth knock-down sprays to break down surface froth. While effective to a point, experience shows that it is more effective to remove aeration from the feed and control feed velocity before it reaches the thickener feed well.

![CFD Simulation Results of Thickener Feed Velocity Break/De-aeration Tank](image)

Recognising the importance of receiving thickener feed at the correct velocity and with minimal aeration, Outotec has recently devoted significant R&D resources into thickener feed conditioning designs.

This has lead to the development of a thickener feed velocity break tank / de-aeration tank design that in many cases can be mounted on the thickener bridge or at the tank wall. This system was devised particularly for upgrade / retrofit situations where highly aerated feed (such as flotation concentrates) and / or high feed velocity is experienced.

This design is currently an ‘In Development’ product for Outotec and is the result of several years of research and development including CFD modelling, piloting in our labs and prototyping in various applications including iron ore, coal (as discussed later in this paper) and a recent successful installation de-aerating tenacious froth on a flotation concentrate thickener at a NSW Gold / Copper mine. Typical CFD modelling of this design is shown in Figure 2.

### THICKENER FEED DILUTION SYSTEM DESIGN

Where slurry solids concentration is too high flocculant does not effectively mix and contact solid particles in the feedwell. This results in sub-optimal flocculation which in turn results in
poor process performance. That is, poor overflow clarity, reduced underflow density and increased flocculant consumption may be experienced.

Optimum flocculation will occur when the feed in the feedwell is diluted to a point where flocculant can freely disperse and contact the solid particles in the feedwell via transmission paths between those particles. Noting that fine particles will have a higher surface area (per unit mass of solids) than coarser particles a lower solids concentration within the feedwell is generally required for efficient flocculation of a given mass of fine particles compared to the same quantity of coarser particles.

Coal tailings and product thickener applications both have relatively low solids relative density (RD) and fine particle size distribution (PSD). This means coal applications can be challenging compared to other metal and mineral thickening applications. Due to the low solids RD and fine PSD of material being thickened in the coal industry it is often seen that optimal feedwell concentration for flocculation is in the range 2 to 6% solids w/w.

Thus a high level of dilution flow is required for coal applications compared to other applications. In non-coal thickener applications it is commonly seen that material flocculates well at higher concentrations; often as high as 20% solids w/w.

Clarified liquor on the thickener surface can be utilised to dilute the feedwell slurry without introducing additional dilution flow into the circuit. A number of thickener feed dilution systems exist in the market place. One patented Outotec system that can be useful in coal applications where feed concentration is higher than the optimal concentration is the Turbodil® forced feed dilution system.

The Turbodil® system utilises a low head high flow impeller mounted inside a casing which drives the dilution flow into the thickener feed system. Flow is introduced into the upper section of Vane Feedwell™ in a direction complimentary to the flow in the feedwell, assisting the mixing of flocculant with feed slurry in the feedwell.

The Turbodil® forced feed dilution system presents advantages over other fixed geometry feed dilution systems which may not be able to provide the high volume of dilution flow required for optimal flocculation of fine particles present in coal thickening. Furthermore the ability to control the dilution flow delivered by Turbodil® provides additional flexibility over fixed geometry dilution systems.

**ADDITIONAL THICKENER UPGRADE CONSIDERATIONS**

Apart from the feed system, other upgrade considerations are covered below.

**Overflow Collection System (Overflow Launder and Nozzle) Sizing**

Existing overflow launders will have been designed with the original duty in mind. Sizing of the installed launders must be reviewed to ensure that they have capacity to manage any increased flows without flooding.

Many thickener overflow launders have ‘vee’ overflow notches around the periphery of the launder. Considering real world installation accuracies and settling of foundations over time it is not realistic to assume a true level around the launder lip. Without ‘vee’ notches this would result is non-uniform launder flow with associated high localised rise rates. ‘Vee’ notches compensate for the combined manufacturing and installation inaccuracies as well as subsequent uneven settling of the foundations.
Where a new duty has a higher volumetric loading, the existing launder system may not have the capacity to remove the overflow liquor. This can cause the liquor level to back up around the launder resulting in higher localised rise rates which can negatively impact overflow clarity. In extreme cases there is a risk of the tank overflowing.

There are a number of options to remedy this scenario. One option is extending the existing launder height by installing an overflow launder weir plate extension if adequate freeboard is available.

Installing a suitably sized external launder on the outside of the tank is another solution. An upgrade launder mounted on the outside of the tank also increases the available surface area of the thickener; in some cases this can effectively reduce the operating liquor rise rate in the thickener.

In some cases installing a second overflow nozzle at 180 degrees from the existing overflow can resolve the issue by allowing the launder to drain at twice the rate thus lowering the liquor level inside the launder below the ‘vee’ notches.

**Underflow Nozzle Sizing**

Installed underflow nozzle/s should be reviewed against the upgrade criteria for adequacy of sizing, flow velocity and compatibility with the inlet diameter of any new underflow pump that may be required for the upgrade duty.

One point worth highlighting is that many coal particles will display a high abrasion index; therefore an increase in velocity at the underflow nozzle may cause wear issues. A suitable wear resistant lining of the underflow cone and nozzles may be required.

If underflow nozzles are undersized, cutting out existing nozzles and replacing with a suitably sized nozzle may be required. In some cases where a stand-by underflow nozzle exists it can be utilised in parallel with the duty nozzle thus halving the flow per underflow nozzle by utilising both the duty and standby nozzles for the new duty flow.

**Torque Ratings (Thickener Bridge, Drive and Raking Mechanism)**

Installed torque should also be reviewed as should the condition of the existing drive and raking mechanism.

As noted above, in many cases new generation thickener feed system designs such as the Vane Feedwell™ will be capable of generating higher density underflow slurries than older technologies. It is therefore important to ensure that any existing thickener mechanism is capable of withstanding the torque load generated by the underflow rheological properties associated with any new duty.

**Tankage, Bridge and Raking Mechanism**

When considering an upgrade or change of duty existing components should be inspected for wear, corrosion, leaks and general condition.

The suitability of the tankage for the new duty should also be reviewed, not least the materials of construction and surface treatment, considering the new duty. If a higher underflow density is expected then the mass of the tank contents will increase. The structural integrity of the tank and support structure should be checked given this increase in mass.

Similarly Bridge and Raking Mechanism materials, surface treatment and capacity to manage the torque requirements of the new duty will require review.
Instrumentation
Installed instrumentation should also be reviewed for suitability for the new process. The general operation and condition of the instrumentation, calibration, cleaning, and correct installation should all be checked. In many cases control of the thickener for a new duty will be improved through installation of newer technology such as an ultrasonic bed level instrument or a settling rate measurement device for control of flocculant dosing.

UPGRADES AND TESTWORK
Testwork on indicative sample(s) of thickener feed material is always recommended whether considering a new thickener or re-using an existing thickener for a new or changed duty.

Testwork permits one to understand the thickening and settling properties of the particular material. This information is valuable to accurately determine thickener loading criteria and other design parameters such as the installed torque required for a particular application. Testing also gives insight into the feed system design requirements such as the optimal solids concentration at which the material flocculates; important for designing the feedwell and dilution system.

Testing also provides information on the process performance that can be expected for the material tested, such as the maximum underflow density or overflow clarity that can be expected for a particular feed material. Satisfactory testwork results are also used as the basis of any process performance guarantees that may be required for the upgraded equipment.

Outotec has developed a method of conducting dynamic thickener testwork for sizing of high rate thickeners using a lab scale thickener. Compared to traditional cylinder settling tests a lab scale thickener is run dynamically on a batch basis and is subject to the effects that will be present in a full scale thickener. This includes the effects of a rotating rake mechanism as well as the continuous up-flow of liquor inside the thickener. It is also possible to withdraw samples of thickened underflow to measure their rheological properties.

This testing can also be carried out on site side by side with an operating thickener. This gives particularly valuable information when a site is looking at auditing or troubleshooting thickener performance. Carrying out the testing on site also presents benefits in applications where aging of material during transport and handling can render the sample unrepresentative, such as seams with high clay content. Site testing can also make it easier to test over a variety of seams as in reality most washeries will receive ROM coal from multiple seams (Bickert, 2012).

UPGRADES – CASE STUDIES
In this section the paper discusses the upgrade and modernisation of thickeners at three coal preparation plants; two of which are Australian and one is located overseas. In each case these upgrades were carried out as part of an overall plant upgrade to achieve higher throughput.

WILPINJONG CHPP UPGRADE
Owner: Peabody Energy Australia Pty Ltd
Location: NSW Western Coalfields

The Wilpinjong CHPP was originally constructed in 2005 with an Outotec 20 m High Rate Thickener installed for the tailings thickener duty.
The original design specification for the thickener was to handle ~115 t/h dry solids and volumetric slurry feed rate of ~1277 m³/h. The original design loadings on the 20 m thickener were a rise rate of approximately 4 m/h and solids loading rate of approximately 0.37 t/m²h.

An upgrade was carried out during 2011 to increase CHPP throughout from 800 t/h to 1200 t/h in line with increase in production from 9.5 Mt/a Run of Mine (ROM) to 14 M/t/a. That upgrade is discussed by Harriman and Brindle (2012).

The owner defined objectives for the CHPP upgrade included the following three objectives, which are related to implementing efficient modern thickener technology:

- improve water recovery;
- achieve high efficiency in flocculant consumption; and
- achieve low overall operating costs.

The thickener design specification for the upgrade duty was maximum 155 dry tonnes per hour feed (t/h) solids and volumetric slurry feed rate of ~2054 cubic metres per hour (m³/h). Resultant loadings on the 20 m thickener were an increased liquor rise rate of approximately 6.5 m/h and solids loading rate of approximately 0.5 t/m²h. (It should be noted that since the upgrade subsequent increases in thickener throughput above the upgrade design specification have occurred).

As part of this upgrade the following modifications were made to the existing thickener:

- Vane Feedwell™ technology was installed to make use of modern feedwell design advancements and the resultant improvements in flocculation and process performance. Also note that due to the approximately 45% increase in volumetric feed rate the geometry of the existing feedwell (which was sized for the original process case) would not have provided adequate residence time for flocculation at the new process conditions.
- An external overflow launder was sized to suit the upgrade process design case. Of interest is the fact that being an external launder allowed the launder to be welded on in-situ while the thickener was operating at the original process design case, minimising the interruption to production. Final process tie-ins were accommodated during the shut-down for the feedwell installation.

Outotec dynamic thickener testwork was carried out for the initial thickener supply in 2005. This provided understanding of how the thickener feed material behaves. This information was utilised in the design of the thickener modifications for the upgrade conditions.

As noted by Harriman and Brindle (2012) ‘these modifications to the existing thickener effectively eliminated the requirement to add a parallel tailings thickener’.

**Further Modifications at Wilpinjong – Velocity Break Tank**

Subsequent to this initial upgrade it was observed that less than optimal flocculation was occurring in the thickener and solid particles attached to bubbles were reporting to the surface of the thickener. This was causing a layer of scum to form on the thickener, impacting on overflow clarity.
A review of the overall installation showed that thickener feed was being presented to the thickener from the washery at a height of some 10 m above the thickener. Further, the increased feed flows from the upgrade were being fed to the thickener through the original plant piping which had been sized for the original flow rates. This resulted in the thickener feed system receiving high velocity feed. As a result the feedwell was excessively turbulent and the high velocity of the feed slurry was causing overflowing of the feedwell (Figure 4, LHS).

Traditionally, to address these issues, one would consider replacing the piping from the washery to the thickener with larger diameter piping to reduce the incoming feed velocity, and look to minimise feed pipe drops in elevation, pipe run lengths and changes in direction where possible. Additionally a large external feed de-aeration tank would be installed, traditionally sized for approx. 45 seconds retention time.

Noting the potentially high costs with the above solutions, an alternate option was put forward to the customer. This was the installation of a prototype of Outotec’s new thickener feed de-aerator / break tank technology (Figure 3).

The design incorporated tangential feed inlet and outlet pipes. The internals of the tank were designed so that the feed is received tangentially in the upper section of the tank and passes through an orifice plate to the lower section before exiting to the feedwell. A dart valve is incorporated to act as a vortex finder such that a cyclone effect is created to dissipate incoming feed energy. This centrifugal force is also utilised to de-aerate the incoming feed.

For this installation a thickener feed velocity break tank was designed to operate at 7.4 seconds residence time (based upon 2050 m³/h feed rate). This residence time is considerably lower than a traditional externally mounted de-aeration tank. Thus it was possible to mount this new tank inside the thickener, supported from the thickener bridge.
Figure 4 (RHS) shows the same view after the install. The overtopping was no longer present, and the feed contained no air. The turbulence levels were also dramatically reduced, improving the flocculation.

Site reported a visual improvement in conditions, particularly overflow clarity, after the installation - although this is a visual observation only. Site also reported a net reduction in downtime associated with the tailings thickener, from ~20 hours per month to ~7 hours per month. The flocculant used in the thickener was changed at the same time as this installation so it is difficult to quantify how much of this improvement can be attributed to the break tank installation alone.

**RAVENSWORTH NORTH CHPP UPGRADE**

Owner: The CHPP is a Joint Venture between Itochu and Glencore and is operated by Glencore

Location: NSW Upper Hunter Valley

The Ravensworth North CHPP upgrade was conducted during 2011 and 2012 and included a two module extension to the existing CHPP as part of an expansion to bring production up to 14 Mt/a ROM. This upgrade is discussed by Walsh, Hunt and Garraway (2014).

Outotec were engaged to upgrade the three existing on ground concrete tank thickeners with new technology to meet the upgrade requirements. The existing thickeners had been built during the early 1980s.

Prior to the upgrade the existing Module 1 Thickener was being utilised to process tailings from the existing CPP module 1. The bridge and mechanism from this thickener had been maintained and was in good condition permitting it to be utilised for the upgrade duty.

The other two thickeners had been decommissioned with bridges, drives and internals removed leaving concrete tank shells only.
In the upgrade all three existing on-ground concrete thickeners were upgraded with new feed systems that had been designed for the upgrade process conditions. The feed systems included:

- new feedpipes;
- Vane Feedwell™ technology; and
- Turbodil™ forced feed dilution systems.

For Modules 2 and 3 thickeners the upgrade scope additionally included:

- New thickener bridges with walkways, maintenance monorails with trolleys; and
- Thickener rake structures with hydraulic rake drive mechanisms and local control panels.

Stainless Steel ‘Vee’ Notch adjustable launder weirs were also designed to suit the upgrade process and provided for mounting to the existing concrete tanks.

New thickener control instrumentation was also provided (rake torque, rake height, bed level, bed pressure) as was a functional description to enable control of the thickeners to meet the process requirements.

As discussed by Walsh, Hunt and Garraway (2014), the plant design had to consider high variability in material properties with 35 different coal seams to be washed. Additionally thickener design had to consider the case where one thickener could be taken off line for maintenance (or similar) with feed diverted to the remaining two thickeners.

Modern thickener feed system design and control principles including Vane Feedwell™ and the flexibility afforded by Turbodil™ forced feed dilution system assist with achieving these operational flexibility requirements. Therefore acceptable process performance can be achieved over varied operating conditions.

The process targets in the upgrade duty specification stipulated an expected underflow density of 35% solids w/w (i.e. underflow RD ~1.22) with minimum acceptable underflow density of 30% solids w/w (equates to underflow RD ~1.18). Targeted average overflow clarity was specified as clarity wedge reading of 30.

Feedback from site is that the upgraded thickeners tend to achieve underflow RD of 1.23 to 1.25 regularly. At times the thickeners do see greater volumetric loadings than the upgrade design criteria and manage to achieve acceptable overflow clarity (although no instrumentation is installed to automatically measure and log overflow clarity readings).

Site reports that overall they are happy with the upgraded thickeners. Also of interest is that since commissioning site have experimented with location of flocculant spargers within the feedwell and have observed improved flocculant performance as a result.

**GROOTGELUK GG2 PLANT – THICKENER MODIFICATIONS**

Owner: Exarro Coal

Location: Limpopo province of South Africa

The two existing 70 m ‘Denver’ coal tailings thickeners at Grootegeluk’s GG2 plant were initially constructed during the 1980’s to accommodate feed from that site at a duty of 225 t/h solids at 7% w/w solids feed concentration.

Over more recent years, additional streams from other plants were added, placing greater demand on the thickeners. The additional streams from plants GG2, 4, 5 and 6 not only increased the operating tonnages, but also contained a significant amount of fines. As a result of
the new feed tonnages and material, a higher flocculant dose was needed, resulting in a reduction in underflow density and an increase of overflow sliming/pulping occurrences. All this lead to poor thickener performance, increased down-time, significant water losses, as well as impacting the slimes dam capacity.

**Grootegeluk Thickener Upgrade**

Outotec were engaged to assist with improving the performance of one of the thickeners. The newly developed Vane Feedwell™ was put forward as part of an option to resolve the issues affecting the GG2 plant. Vane Feedwell™ components were retrofitted to the internals of the existing feedwell and consisted of vanes, a radially sloped shelf and forced dilution.

The thickener upgrade on the first 70 m thickener at the GG2 mine in April 2010 was planned ahead to coincide with an extended plant shut down. In addition to the Vane Feedwell™, a new centre column mounted rake drive mechanism, including a new platform and central column was also retrofitted. A Turbodil™ for feed dilution and flocculant spargers were also installed to improve flocculant addition. A new set of thickener rakes, launder weir plates and local control panel were delivered along with instrumentation including, bed mass, bed level and drive torque. Figure 5 shows the 70 m thickener during the shutdown, with upgrade components installed.

**Figure 5** 70 m Thickener After Installation of Upgrade Components

**Thickener Availability**

Thickener availability was significantly improved upon completion of the retrofit. Prior to the upgrade, the two existing thickeners were equally accountable for the ROM downtime. After the project completion, the newly retrofitted thickener accounted for only 17% of the ROM downtime with the remaining 83% attributed to the existing, unmodified thickener. Prior to the retrofit, the old drive was a major cause of thickener downtime and accounted for 30% of all thickener failures. The new Outotec model SCD multi-pinion column mounted rake drive mechanism has not been the cause of any thickener downtime since installation.
Thickener Underflow Density and Increased Tonnages
Underflow density has shown a major difference following the upgrade. Previously, the underflow density averaged 49.9% w/w at a feed rate of 225 t/h. Post retrofit, a density of 53.3% w/w was averaged at an increased throughput of 245 t/h. This implies that not only a higher underflow density can be achieved, but that it can be achieved at increased operating tonnages of 8.8%. Again, this highlights the Vane Feedwell’s ability to smooth out process variability and hence operate across a wider range. The increase in underflow density enabled the slimes deposition to be maximised – a very important factor for Exxaro Coal in terms of Grootegeluk’s operating costs and sustained operation.

Thickener Overflow Clarity
The overflow clarity showed an improvement from 0.5 to 0.2% w/w, highlighting the new feedwell’s ability to operate with various materials of different liberation (fines) and solid densities, whilst maintaining effective mixing with flocculant and subsequent settling within the thickener.

Flocculant Demand
While flocculant dosage was essentially consistent, averaging 18 g/t both pre and post installation, the thickener overflow clarity, together with the increase in underflow density, indicates the improvement in flocculation efficiency achieved with the new feedwell.

Increased Thickener Availability – More Stable Thickener Operation
The three main areas of client focus were; availability, underflow RD and tonnage. All three areas showed significant improvement. Underflow density increased from 49.9 to 53.3% w/w, despite a throughput increase from 225 to 245 t/h (solids loading from 0.72 t/m²h to 0.78 t/m²h). Overflow clarity improved from 0.5 to 0.2% w/w and availability increased, with no relative density and/or drive related downtimes since the retrofit.

CONCLUSION
The application of modern technology to an existing installation can successfully enable higher throughputs and a change in duty to be achieved, as illustrated in this paper. The cost saving associated with this can be considerable.

There have been a number of recent developments in thickener design to ensure that targeted process performance and effective utilisation of consumables (such as power and flocculant) are realised in thickener upgrades.

There are a number of aspects to be considered in implementing such an upgrade; such as the value in conducting a thorough testwork campaign. Progressing the project in the right manner with experienced parties will ensure ultimate success.

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REFERENCES


