

Brett Salisbury, Science Developments, Australia, introduces a step change in the control of coagulant dosing at coal handling and preparation plants.

PLAIN TAILINGS

OptiFlox[®] technology, developed by Australian firm Science Developments, is a control system for the dosing of coagulant in coal handling and preparation plants (CHPPs).

The system was originally developed to control coagulant dosing in coal tailings thickeners in response to the intermittent occurrence of colloid clay particles in the tailings slurry. An OptiFlox system is currently installed at a coal tailings thickener at a large CHPP in New South Wales, Australia. The system is expected to be applicable to coal froth thickeners as well as tailings dewatering units, such as belt press filters.



Inconsistent tailings thickener performance

CHPPs typically have a tailings thickener, which concentrates tailings through sedimentation, coagulation and flocculation. Sedimentation is a gravitational based process while coagulation and flocculation are induced by the addition of chemical reagents to the tailings slurry. The thickener underflow is either further dewatered or disposed of, while the clarified water is returned to the plant for re-use.

In many CHPPs, there are times when tailings thickeners experience poor performance, resulting in turbid water returning to the plant. Sometimes referred to as blackwater, the clarity of the water from the thickener deteriorates to such an unacceptable level that the CHPP is either shut down or production slowed until water clarity can be improved.

These shutdowns typically last from 30 min. through to several hours, depending upon the cause of the problem and the capability of the plant operators to rapidly diagnose and rectify the issue. Such plant stoppages can result in substantial losses in both productivity and revenue.

Opportunity cost of inconsistent thickener performance

Within the Australian coal industry, the value of lost revenue due to productivity losses from inadequate water clarification from tailings thickeners typically ranges from AUS\$1.6 million/yr to almost AUS\$10 million/yr, depending upon the size of the plant (Figure 1).

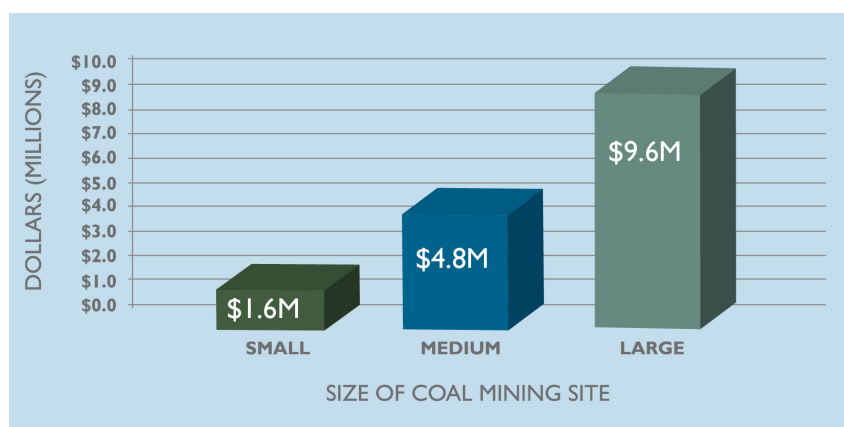


Figure 1. Estimated annual revenue value of production lost per mine site.

Appropriate chemical dosing

While mechanical issues can cause blackwater events to occur, poor chemical dosing in response to constantly changing feed types is a major factor. At many CHPPs, it is well understood that the characteristics, types and concentrations of suspended particles in the feed slurry can change markedly as different seams and coal types are processed. Equally well known is that if the correct coagulant/flocculant dose rate is not applied for the specific slurry characteristics at the time, flocculation will become less effective, leading to turbid water overflowing from the thickener.

It is generally observed that acceptable coal tailings thickener operations are obtained through sedimentation and the application of a low to medium charge density, anionic polyacrylamide flocculant to the tailings slurry. This generally results in good floc formation, which in turn sees fast settling and sufficiently clarified water being returned for re-use.

Importance of coagulant dosing when anionic clays are present

However, at many CHPPs, there is also a requirement to apply a cationic coagulant to address anionic clay particles.

Poor flocculation generally occurs when there is an increase in anionic colloidal and sub-colloidal clay particles relative to other suspended particles in the slurry. This deterioration in tailings thickener performance when using anionic flocculant in the presence of anionic colloidal and sub-colloidal clay particles can be reduced by adding a cationic coagulant before the addition of a flocculant.

In most CHPPs, there is a general awareness of the need for adding a cationic coagulant when treating anionic clays. The problem lies in determining and maintaining the optimal coagulant dose rate.

Where coagulant is used, it is generally applied via fixed rate dosing. However, it is also observed that operators increase coagulant dose rates based on either the notion that 'more is better', or to manage a blackwater event.

As a result, the issue is how to determine and maintain optimal coagulant dose rates to establish:

- When to dose coagulant.
- How much coagulant should be dosed.
- When to stop coagulant dosing.

Existing flocculation control technology will not solve this problem

Automatic control of flocculation in tailings thickeners is currently used at many CHPPs with floc settling rate, floc size and shape interpretation, floc density measurement, sludge blanket characteristics and final turbidity of settled suspension all being measured to different degrees.

A common misconception in the industry is that the existing technology or solutions deliver robust and automated flocculation control. However, the conventional automatic control of flocculation in tailings thickeners will not solve the problem of ineffective flocculation caused by an increase in anionic clay colloids relative to other suspended particles in the water.

Conventional flocculation/optical sensing devices

One of the most common approaches is the use of optical sensing devices to determine the settling rates for flocculated solids introduced to the tailings thickener and then adjust the flocculant dosing rates accordingly. However, these systems are ineffective in distinguishing the deterioration in flocculation performance due to the change in particle surface charge resulting from the presence of anionic clay particles.

As the concentration of anionic clay particles increases, the flocs in the thickener can become smaller. This results in an

increase in settling time and deteriorating overflow clarification/turbidity.

Optical sensing devices respond to a slower settling rate by increasing the flocculant dose rate. However, this can make the situation worse due to the anionic conventional polyacrylamide flocculant having the same charge as the clay particles.

Single turbidity instrument

Another common approach is to measure the turbidity of the water being discharged from the tailings thickener launder and to then use this value to control coagulant dosing. The problem with this method is the inherent delay in sensing a deterioration in flocculation performance as retention time in the tailings thickener can be anywhere from 30 min. to three hours, depending upon thickener size.

The response time is therefore too slow and the coagulant dosing may not be optimal as the slurry characteristics may change during the lag time.

Furthermore, the turbid water means measuring instruments can become blocked with coal tailings relatively quickly, resulting in inaccurate measurements. Frequent cleaning of these instruments is generally impractical.

Combination of conventional flocculation devices and turbidity instrument

Another approach employed is the addition of a turbidity probe within the conventional flocculation control device to provide a measure relating to water clarity (via a NTU or FTU value).

However, as per the conventional flocculation control device, the turbidity probe employed in this manner cannot distinguish between the solids in terms of whether there is a component of anionic clay particles present or if there is an increase or decrease in the anionic clay particles relative to the total suspended particles.

Therefore, the inclusion of turbidity probes in a conventional flocculation control device can neither determine if coagulant is required nor the quantity that should be dosed.

Development

With an increasing demand by CHPP management to drive performance and

cost efficiencies, Science Developments embarked on a R&D programme in 2013 to develop a new technology that could provide a step change in the control and automation of coagulant dosing at CHPPs with an initial focus on coal tailings thickeners.

The technology was developed during a three-year R&D programme. The technology continuously measures in real time certain characteristics of the suspended particles in the tailings slurry in order to maintain optimal flocculation conditions through real-time control of coagulant dosing.

Designed and manufactured in Sydney, Australia, the system has been designed to withstand the harsh conditions of CHPPs. A patent application for the proprietary technology has been lodged in Australia, the US, Europe and other jurisdictions.

How the technology works

The purpose of the technology is to continuously measure the change in fine particle quantity and particle surface charge, among other particle characteristics, resulting from either the introduction or an increase in anionic clay particles, relative to other suspended particles in the tailings slurry.

As illustrated in Figure 2, the system obtains a continuous sample of the tailings slurry from the tailings thickener.

Importantly, this continuous sample is filtered and measured (with the appropriate instruments contained in the unit) according to the critical elements or parameters that impact treatment performance.

When the parameters measured drift from the desired values or set points, the system is advised that the tailings slurry requires a change in the treatment regime. Corrective action in the form of coagulant dosing is then undertaken automatically to maintain optimal flocculation. The coagulant dosing is maintained at an appropriate level until the measured particle values return either to, or below, the desired set points.

Performance insights and analytics via cloud

An integral part of this technology is an interactive cloud-based service that tracks and records, in real time, the critical measurements relating to the slurry feed, chemical usage and the health/performance of the OptiFlox system.

The system records these critical measures on a real-time per-minute interval enabling some 1440 data points per day to be recorded across numerous parameters. Remote access to the system also provides immediate insights that can be used to identify and address any system performance and treatment issues.

Concise reporting of the periods of coagulant dosing and chemical consumption levels are also available, as shown in Figure 3. This data can be correlated with coal seam types.

Initial installation at NSW coal mine

An OptiFlox system is operating on a tailings thickener at a large CHPP located in New South Wales, Australia. The

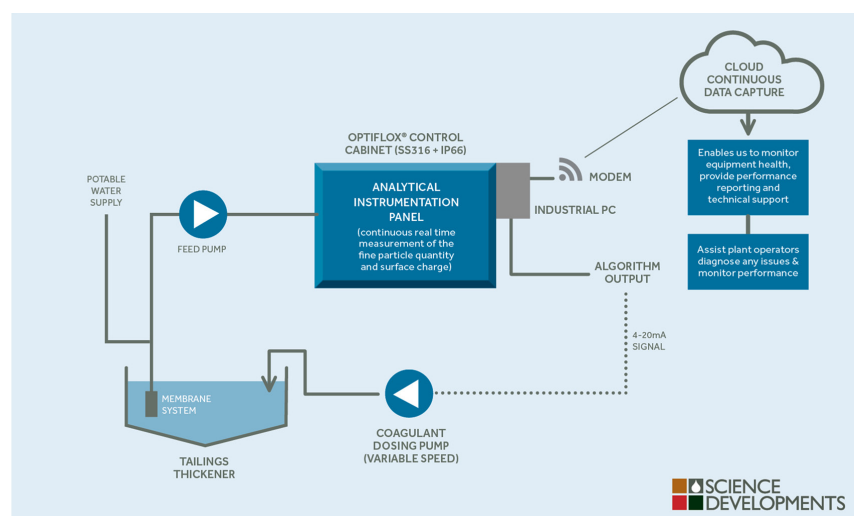


Figure 2. OptiFlox technology process.

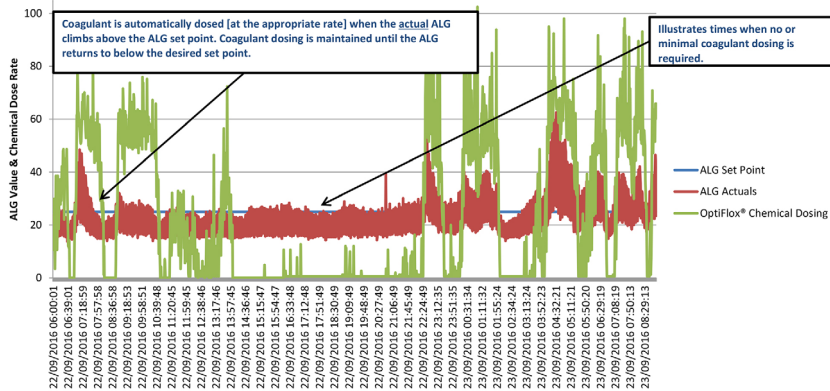


Figure 3. Times and usage of coagulant.

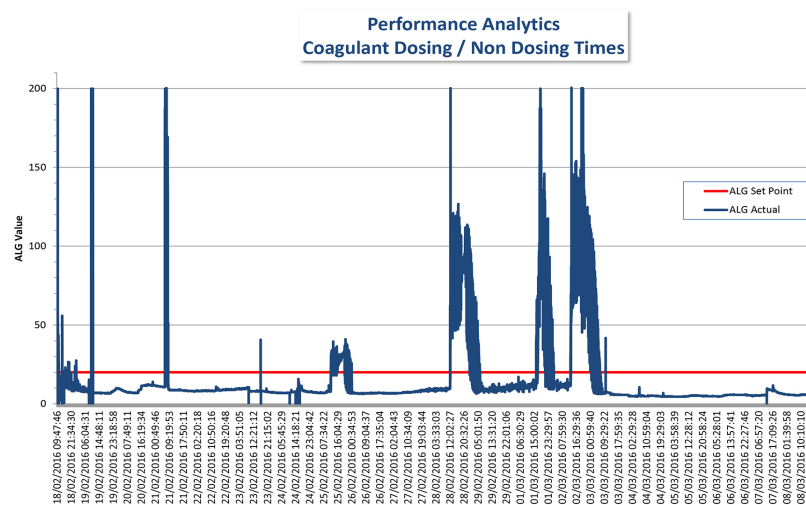


Figure 4. Results when no coagulant is used.



Figure 5. OptiFlox system.

system was not intended to replace the existing conventional flocculation control device, which is still useful in varying flocculant dose rates.

Instead, its role is to measure and automate coagulant dosing to further enhance flocculation control, enabling a

reduction in CHPP shutdowns (caused by blackwater events) and coagulant chemical cost savings as the previous treatment regime used fixed rate dosing of coagulant.

Performance and benefits

The installation of the OptiFlox system has demonstrated that the need for continual coagulant dosing, even at a coal mine characterised with a relatively high clay content, is not required.

The practice in many CHPPs of adhering to fixed rate dosing is inefficient in both thickener performance and chemical costs.

Figure 4 shows an example of performance data across a six-week period and illustrates that, for the majority of this timeframe, coagulant dosing was neither required nor undertaken (i.e. any time when the blue line is below the red 'set point' line). In fact, it is generally typical that there are periods of days when no coagulant is dosed.

The system has delivered material cost savings in terms of total coagulant chemical costs for the coal mine. Another major benefit of the technology has been the material reduction in lost production due to unacceptable water quality.

The success of the first commercial installation has generated significant interest and several other mines are progressing to trials.

Extension of the technology to other applications

Dewatering applications

With mechanical dewatering applications, such as belt press filters, CHPP personnel face similar challenges in achieving ongoing performance improvement and reductions in chemical operating costs associated with dosing coagulants and flocculants.

In most belt press filter operations, the application of coagulant is undertaken after flocculant dosing because of the requirement for charge neutralisation.

Determining coagulant dose rates is done on a largely arbitrary basis by operators, leading to the tendency to overdose. This leads to excessive chemical costs and difficulties in determining and maintaining optimal dose rates, particularly with variation in slurry feed compositions.

A trial of an OptiFlox system at a large belt press operation is planned for this year. As per the system in thickener operations, when the particle parameters measured drift from the desired values or set points, corrective action in the form of coagulant dosing will be automatically implemented.

Coal thickener applications

Initial feasibility work is also underway to apply the OptiFlox technology to coal froth thickeners.

The feasibility programme is focussing on plant yield improvements associated with water quality (stemming from coal thickeners) in flotation circuits.

As recognised in the industry, achieving consistently high water quality serves to reduce the circulating loads, which in turn increases the available flotation froth carrying capacity. ^W