

Praestospeed 120 Modular Dissolving System: a novel technology to improve the performance of flocculants on tailings management operations

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Abstract

In a time where tailings management operations have gained increased focus within the mineral processing industry, the process of using flocculants to maximise the rate of solid-liquid separation is becoming more common practice across a variety of tailings management operations. This paper describes how important it is for mineral processing operations to achieve optimal flocculant preparation for both flocculated tailings treatment and filtered tailings operations.

For the flocculation of mineral tailings slurries to be cost-effective it is essential to maximise the hydration properties of the flocculant while still achieving the required flocculant performance; whether it is applied directly to the tailings deposition area, into a tailings thickener feed or prior to tailings filtration.

Solenis, through its development of the Praestospeed™ 120 Modular Dissolving System, is able to offer improvements to the flocculant make-up in a manner that is beyond the capabilities of conventional equipment and with a significantly reduced footprint. The use of this unit provides sustainable tailings management for large-scale tailings operations, enabling lower flocculant dose requirements together with a reduction in freshwater requirements.

The main features for this development are described in this paper, together with some recent full-scale examples in tailings operations.

Keywords: *sustainability, flocculants, solid-liquid separation, tailings management, filtered tailings, polymer-treated tailings, Praestospeed 120 Modular Dissolving System*

1 Introduction

Any effective mining operation requires a comprehensive water management strategy. Therefore, tailings management, which involves large volumes of water, can create a wide range of issues and challenges for mine operators that can impact everything from environmental compliance to running a sustainable operation. Water-soluble polyacrylamide-based flocculants (aPAM) are commonly utilised to aid in a faster rate of tailings dewatering, whether applied in a paste thickener or in a polymer-treated tailings application. Such flocculants, however, typically have poor hydration behaviour, especially when they have a high molecular weight.

From an environmental perspective security of tailing dams by effective and rapid dewatering of those solids so that you can have a stable tailing storage dam is very critical.

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Solenis has introduced a patented flocculant make-up equipment for the mining sector that brings further value to the application of flocculants in tailings management as well as in conventional dewatering processes.

The Praestospeed™ 120 can produce up to a 1.5% w/w flocculant solution, reducing freshwater requirements by up to 90% and is capable of processing up to 120 kilograms per hour of flocculant powder. The unit is contained within a relatively small footprint, which enables it to be positioned in remote areas such as those associated with tailings disposal.

As well as a significantly reduced equipment footprint, the method in which the aPAM is prepared enables a more hydrated, fully active flocculant chain which consequently reduces dosage requirement when directly compared with an aPAM prepared in a conventional make-up (MU) system. Generally, the dispersion of the aPAM in water is hindered by its tendency to form lumps upon contact with water due to the fine fractions of the flocculant powder below 200 µm. Furthermore, a hydration time of 1–2 hours is necessary for complete hydration of the flocculant, with continued moderate stirring.

This paper discusses the implementation of a Praestospeed on a tailing operation in Australia and details the benefits of applying an optimally hydrated flocculant to tailings to effect speedier dewatering as well as achieving the desired rheological profile and better control of tailings deposition.

2 Summary of the flocculant dissolution Praestospeed process and equipment

The Praestospeed system shown in Figure 1, developed by Solenis, provides a method for efficiently hydrating water-soluble flocculants, especially high molecular weight flocculants, into gel-free solutions. The primary objective is to create a hydration process that avoids gel formation and minimises molecular weight degradation, ensuring that the flocculants remain fully effective. This is achieved through a two-stage dispersal method involving both high- and low-power levels to prevent flocculant damage.



Figure 1 The Praestospeed 120 system

2.1 Key features of the system

1. Two-stage dispersal:

- **First stage** – flocculant particles are dispersed into water using a high-power dispersing unit. The power level is carefully controlled to optimise dispersion without causing flocculant degradation.

- **Second stage** – the mixture undergoes a second dispersal at a lower power level, which gently dissolves the gel content without further damage to the flocculant’s molecular structure. An overview of the system is shown in Figure 2.

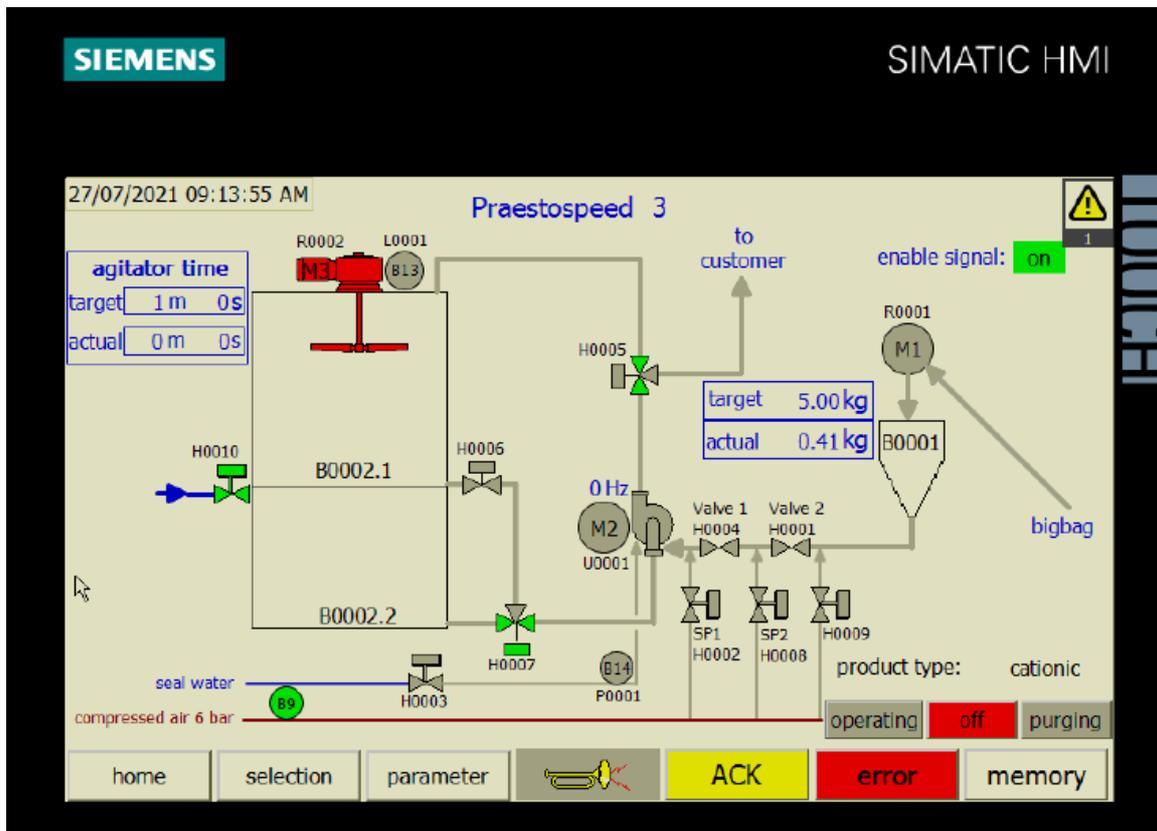


Figure 2 Praestospeed human-machine interface (HMI)

2. Agitated tank for dissolution: after the first dispersal, the flocculant-water mixture is transferred to an agitated tank where it undergoes further mixing and dissolution. The agitation is slow (up to 300 rpm) to avoid shear degradation, with a residence time of one to 15 minutes, depending on the flocculant type.
3. High concentration solutions: the process can produce flocculant solutions with concentrations above 1 wt%, even for high molecular weight flocculants, making it suitable for producing concentrated stock solutions. For low molecular weight flocculants, higher concentrations are achievable.
4. Particle size flexibility: the process handles flocculant powders with fine particles (below 250 μm , ideally below 150 μm) and ensures that even fine particles, which are typically difficult to dissolve, can be fully integrated into the solution without agglomeration.
5. Apparatus: the Praestospeed system includes a dispersing unit, an agitated tank and a storage tank. It can be operated either batchwise or continuously, providing flexibility in production scale. The system is also designed to handle various types of water-soluble synthetic and natural flocculants, particularly polyacrylamides used as flocculants.
6. Applications: the Praestospeed process is particularly useful for:
 - producing gel-free, highly concentrated flocculant solutions
 - applications in waste water treatment, mining, papermaking and petroleum recovery, where large volumes of concentrated flocculant solutions are required quickly.

3 Comparison: traditional flocculant make-down equipment versus Praestospeed 120 Modular Dissolving System

In the context of tailings management, the choice of flocculant make-down equipment is critical to ensuring the efficiency of flocculation processes, as well as optimising costs and environmental impact. Below is a comparison between conventional flocculant make-down equipment and the Praestospeed 120 Modular Dissolving System, developed by Solenis.

3.1 Flocculant dissolution efficiency

- Traditional flocculant make-down equipment:
 - Conventional systems typically involve mechanical mixing or dissolving units that use a slow hydration process where the flocculant powder is added to water and then stirred for a prolonged period (typically 1–2 hours).
 - The mixing is often insufficient to fully hydrate the flocculant, especially for high molecular weight aPAM, leading to incomplete dissolution, the formation of lumps or gels and a suboptimal flocculant performance.
 - Hydration time can be long and may require constant monitoring to prevent flocculant degradation or clumping.
- Praestospeed 120 Modular Dissolving System:
 - The Praestospeed system utilises a two-stage dispersal process with both high- and low-power levels to break down flocculant particles efficiently, ensuring complete hydration and preventing gel formation.
 - The system produces a gel-free solution with minimal molecular weight degradation, ensuring the flocculant retains its flocculant effectiveness.
 - The time required for hydration is significantly reduced, with flocculant dissolution occurring in just a fraction of the time compared to conventional equipment (usually within 15 to 30 minutes).

3.2 Flocculant performance and hydration quality

- Traditional flocculant make-down equipment:
 - Due to inconsistent mixing and slower hydration, conventional equipment may result in poorly hydrated polymer chains, which can affect the flocculation process.
 - Incomplete hydration often requires higher flocculant dosages to achieve the desired solid-liquid separation, leading to inefficiencies and higher costs.
- Praestospeed 120 Modular Dissolving System:
 - The Praestospeed system achieves optimal hydration of the flocculant, ensuring a fully active polymer chain.
 - This leads to better flocculation performance with lower flocculant dosages compared to conventional systems, reducing overall chemical consumption and improving the quality of tailings treatment.

3.3 Operational efficiency and automation

- Praestospeed 120 Modular Dissolving System:
 - The Praestospeed system offers a more automated solution, with precise control over flocculant dispersion and hydration.
 - It incorporates sensors and automated controls to ensure consistent flocculant make-up, reducing the need for manual monitoring.
 - This system also provides scalability and flexibility, with options for continuous or batch processing, and it integrates easily with other systems for real-time monitoring and control.

3.4 Footprint and space requirements

- Traditional flocculant make-down equipment:
 - Traditional equipment often requires larger, more complex set-ups, which take up considerable space in the plant. This can be problematic in remote or confined operational areas. An example of a traditional batching system is shown in Figure 3.
 - The larger equipment also tends to have higher maintenance requirements, which can lead to increased downtime and operational costs.



Figure 3 Make-down system (capacity 80 kg/hr)

- Praestospeed 120 Modular Dissolving System:
 - One of the stand-out features of the Praestospeed system is its compact and modular design, which requires significantly less space compared to conventional make-down units.
 - Its small footprint makes it ideal for placement in remote locations, such as tailings storage facilities, without the need for large, cumbersome infrastructure. System size is shown in Figure 4.



Figure 4 Containerised Praestospeed make-down system with dosing pumps (capacity 120 kg/hr)

3.5 Water usage

- Conventional flocculant make-down equipment:
 - Conventional systems can be water-intensive, particularly when mixing large volumes of flocculant powder, which often results in excess water usage.
 - Water is needed not only for hydrating the flocculant but also for maintaining system cleanliness and dilution of excess flocculant during the process.
- Praestospeed 120 Modular Dissolving System:
 - The Praestospeed system is designed to significantly reduce water usage. It can produce highly concentrated flocculant solutions (up to 1.5% w/w) with much less water compared to traditional systems, cutting down freshwater consumption by up to 90%.
 - This reduction in freshwater usage is especially critical in remote or arid mining operations where water availability is limited and sustainable practices are crucial.

3.6 Environmental and cost benefits

- Traditional flocculant make-down equipment:
 - The inefficiencies in flocculant hydration and higher water consumption associated with traditional systems contribute to higher operational costs and environmental impact, especially in terms of water usage and chemical consumption.
- Praestospeed 120 Modular Dissolving System:
 - By reducing the flocculant dosage through automation and improved flocculant hydration, the Praestospeed system offers substantial cost savings. For example, SIMEC Mining's case study showed a reduction in flocculant usage by 70%, resulting in annual savings of approximately AUD 850,000 (GFG Alliance 2024).
 - The reduction in chemical usage not only cuts operational costs but also reduces the environmental footprint of the mining operation, with a significant decrease in CO₂ emissions and water consumption.

3.7 Scalability and flexibility

- Traditional flocculant make-down equipment:
 - Conventional systems are generally less flexible, especially when scaling up for larger operations or adapting to changing feed conditions. These systems may require significant modifications to meet higher throughput demands.

- Praestospeed 120 Modular Dissolving System:
 - The Praestospeed system is highly scalable and flexible, able to accommodate varying throughput requirements and adapt to different flocculant types and concentrations.
 - Its modular design allows for easy expansion and integration into existing tailings management or processing operations, making it suitable for both small and large-scale applications.

While traditional flocculant make-down systems have been a long-standing solution in tailings management, the Praestospeed 120 Modular Dissolving System offers a more advanced, efficient and sustainable alternative. The Praestospeed system not only provides superior flocculant hydration and flocculant performance but also reduces operational costs, water usage and environmental impact. Its compact design, scalability and automation make it a highly effective choice for modern mining operations looking to optimise their tailings management processes.

4 Case study: Iron Duke, South Australia

SIMEC Mining, a major mining corporation located in South Australia, operates in the Middle Back Ranges, about 60 kilometres from Whyalla as shown in Figure 5. The company manages two hematite mines (Iron Baron and Iron Duke), which include in-pit tailings deposition. Iron Duke uses a perimeter discharge above-ground tailings storage facility (TSF). Iron Duke pumps magnetite slurry 60 kilometres via an underground pipeline to its Liberty OneSteel integrated steel works for local use and export. Both SIMEC Mining and Liberty OneSteel are part of the Gupta Family Group (GFG) Alliance Australia.

Flocculation at the Iron Duke tailings dam began in 2013 when SIMEC transitioned from a conventional dual-discharge TSF to a perimeter discharge, central decant design. This change was implemented to support the Magnetite Expansion Project, as outlined in Golder Associates' feasibility study (Golder Associates 2014).

Once operational, the system demonstrated improved water recovery and a significant reduction in surface water pooling across the TSF. Thanks to the strategic placement of discharge points, water naturally flowed back to the central decant, minimising losses from evaporation and seepage. From 2013 to 2019, SIMEC used emulsion liquid flocculant for this process. However, in 2020 the operation switched to powder flocculant, which has proven to be equally effective while delivering significant cost savings.

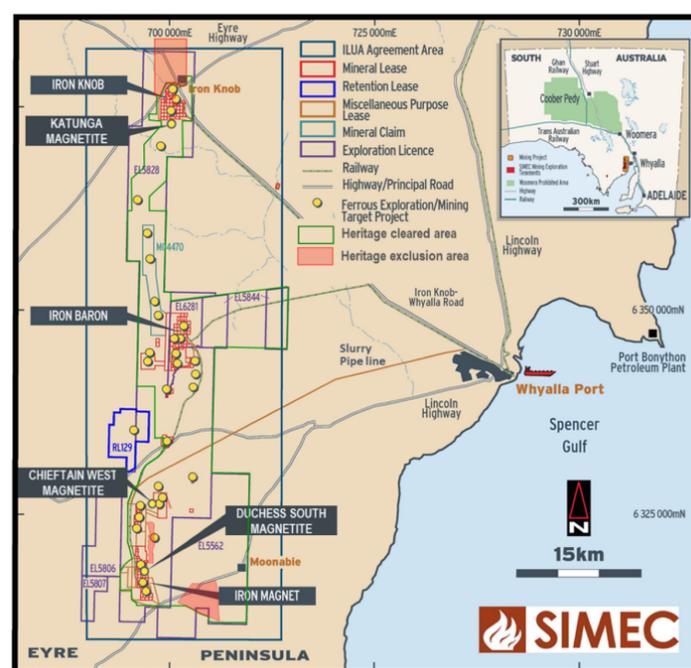


Figure 5 SIMEC Mining overview (Johnson 2022)

The TSF at Iron Duke located in the Magnetite processing area operates as follows:

- Fine magnetite tailings from the tailings thickener is pumped to the magnetite TSF at a density of 1.4 kg/m^3 . The slurry is deposited around the TSF using spigot points located at 100-metre intervals. Solenis Praestol™ 2635DK flocculant is added to the deposition point to accelerate solid-liquid separation and improve water clarity at the decant pond. The deposition point setup is shown in Figure 6.



Figure 6 Tailings dam deposition point configuration (SIMEC WSP 2023)

- Each spigot point includes a ‘mixing chamber’ designed to combine Magnetite tailings, ore beneficiation plant tailings and polymer, as illustrated in Figure 7. The mixing chamber also serves as a protective shield against strong winds, which can interfere with the effective end-of-pipe mixing of the polymer and tailings as shown below in Figure 7.



Figure 7 Flocculant addition point (SIMEC WSP 2023)

- The TSF deposition method aims to form a supernatant pond at the centre of the TSF, called the central decant tower. This water is then pumped back to the processing plant's concentrator raw water tank for re-use. The diesel generated pump at the decant return pond is shown below in Figure 8.



Figure 8 Decant return point (SIMEC WSP 2023)

Slurry is deposited at only one spigot point at a time. After a layer with a maximum thickness of 300 mm has been deposited, the spigot point is transferred to an adjacent spigot point to allow for drying and consolidation of the flocculated tailings. Spigot point layout is shown in Figure 9.



Figure 9 Tailings spigot overview (SIMEC WSP 2023)

With reference to the SIMEC TSF Operating Manual, the basic TSF strategy is summarised below (SIMEC WSP 2023):

- The strategy for deposition on the Magnetite TSF focuses on operating the facility as a perimeter discharge/central decant facility.
- The design assumptions relevant to the deposition strategy are summarised below.
- An average stored in situ dry density of the tailings is 1.6 t/m³.
- A tailings beach slope of 2.8% is used for the first 200 m of beach length, with the remaining 200–500 m beach slope at 0.6%.

In 2023 SIMEC sought assistance from Solenis Australia to explore potential enhancements to the flocculant dosing strategy for the Iron Duke TSF. Without adequate dosing control, excessive flocculant was being dosed, leading to pronounced beaching profiles at or near the slurry deposition area. The effects of this overdosing are marked in orange in the aerial image in Figure 10.

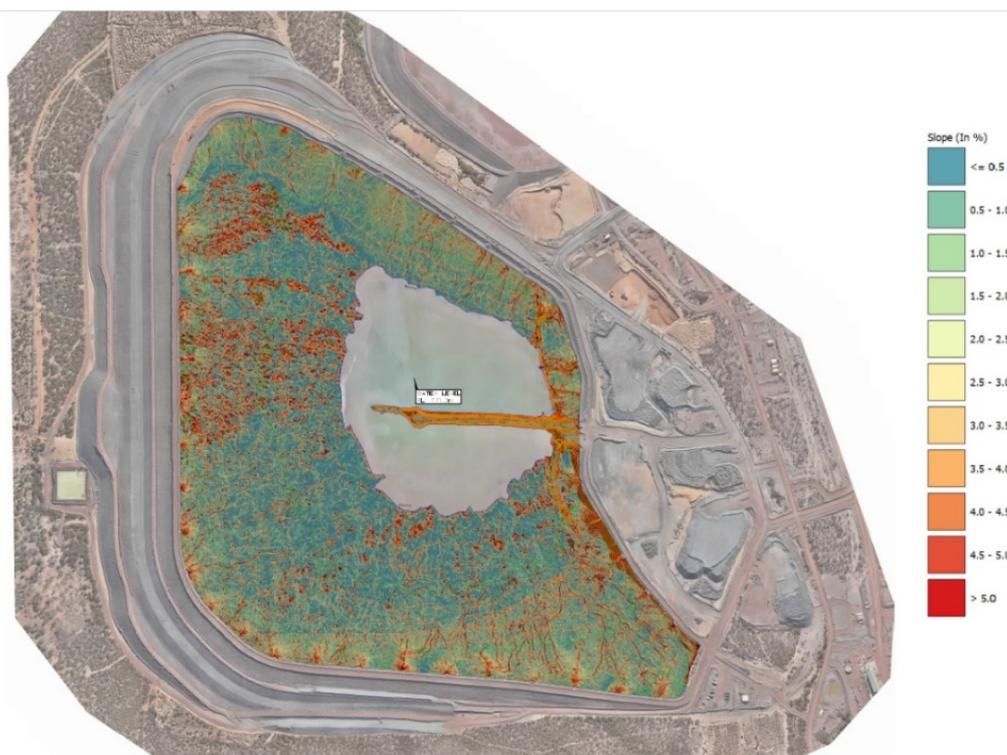


Figure 10 July 2023 slope heatmap (Alexander & Symonds Pty Ltd 2023)

4.1 Proposed process control concept

Solenis, in partnership with SIMEC Mining, explored potential improvements to the current flocculant dosing strategy to minimise instances of overdosing and underdosing.

Optimising the flocculant dose rate is crucial for controlling beaching and water release. One way to enhance this process is by implementing a proportional flocculant dosing control. This system would continuously monitor the thickener's tonnes per hour (tph) underflow and, in real-time – every 30 seconds – adjust the flocculant dosing pump up or down to maintain the target flocculant setpoint.

This approach is commonly known as ratio control. Analysing past trends in tailings underflow density over several months revealed significant fluctuations in thickener underflow, yet the adjustments to flocculant addition rates at the spigot point were not always optimal. Operators were often making dosing decisions based on visual assessments, leaving room for both overdosing and underdosing. There was a clear opportunity to improve dosing accuracy and consistency.

4.2 Key process drivers

Several factors can affect the beaching characteristics of a flocculated tailings slurry. Here are some examples that directly impact flocculation, the rate of water release and the resulting beach angle:

- particle size distribution
- discharge flow rate
- slurry solid content
- slurry rheology (including viscosity and yield stress)
- flocculant dosage (grams per tonne)
- mixing conditions of flocculant and slurry
- variations in tailings mineral composition
- alterations in water chemistry.

4.3 Basic testwork model

The second aspect of developing a more effective flocculant control strategy for TSFs involves correlating the beaching angle with a specific percentage of slurry solids at a given flocculant dose rate. Establishing this correlation enabled automatic flocculant dosage control using a setpoint that corresponds to an indicated beach angle. To evaluate this, testwork was conducted to analyse how beaching profiles change with increasing flocculant dose rates (Kane 2023).

It is known that the application of flocculant directly at the point of tailings deposition can positively influence dewatering rate and attainable beach slope (McColl & Scammell 2004).

Referring to Figure 11, a clear trend emerges showing a significant increase in beaching angle as the flocculant dose rate rises above approximately 125 g/t. According to the operating manual, the broad beaching specification range is between 0.6 and 2.8%, depending on requirements. This suggests that the optimal flocculant setpoint, using proportional dosing control, should be between 75 and 125 g/t. For instances where a relatively low beaching angle (around 0.6 to 1.3%) is required, it appears that the flocculant dose setpoint should ideally fall within the range of 75 to 100 g/t.

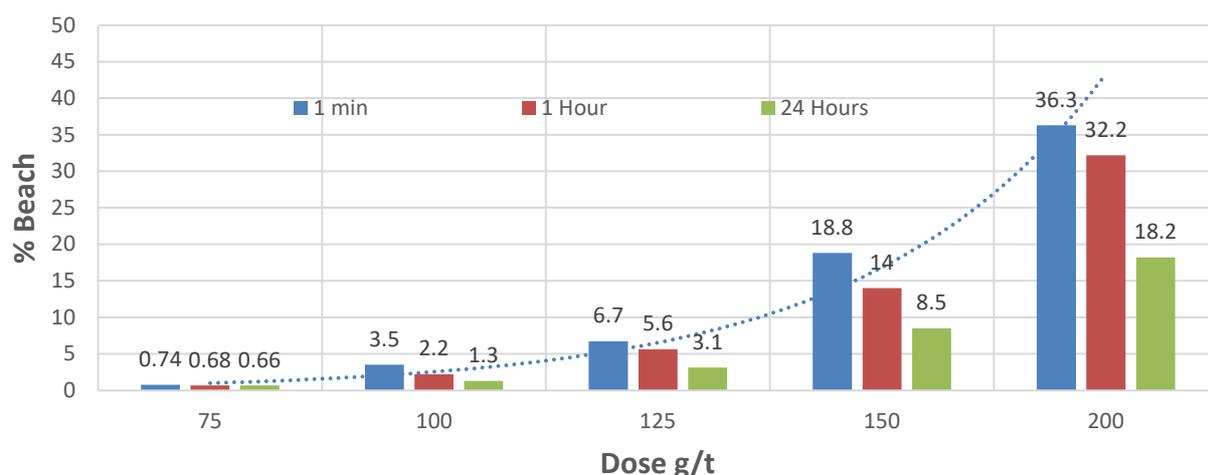


Figure 11 Slope profile (%) versus dose (g/t) feed solids 40%w/v (Kane 2023)

4.4 Process control proposal

Ratio control logic was proposed to SIMCEC through using a test point data range of 75 to 125 g/t to obtain the adequate beach slope. The Praestospeed integrated dosing pump received flow rate and density measurements from the slurry pipeline to accurately control the flocculent dose rate based on mass flow going to the TSF. This data was all managed via the integrated Solenis Cloud Platform shown in Figure 12 . This interface gives operators a clear overview of plant data and dose rates of the flocculent going to the TSF.



Figure 12 SIMCEC Solenis Cloud overview

4.5 Results

With the implementation of the control logic and the use of Praestospeed technology, overdosing events were significantly reduced. Over a 12-month period, the following results were quantified:

- Tailings beach slopes returned to within TSF management operating guidelines. Operator interference was eliminated, and overdosing events were reduced with the automated dosing protocol.

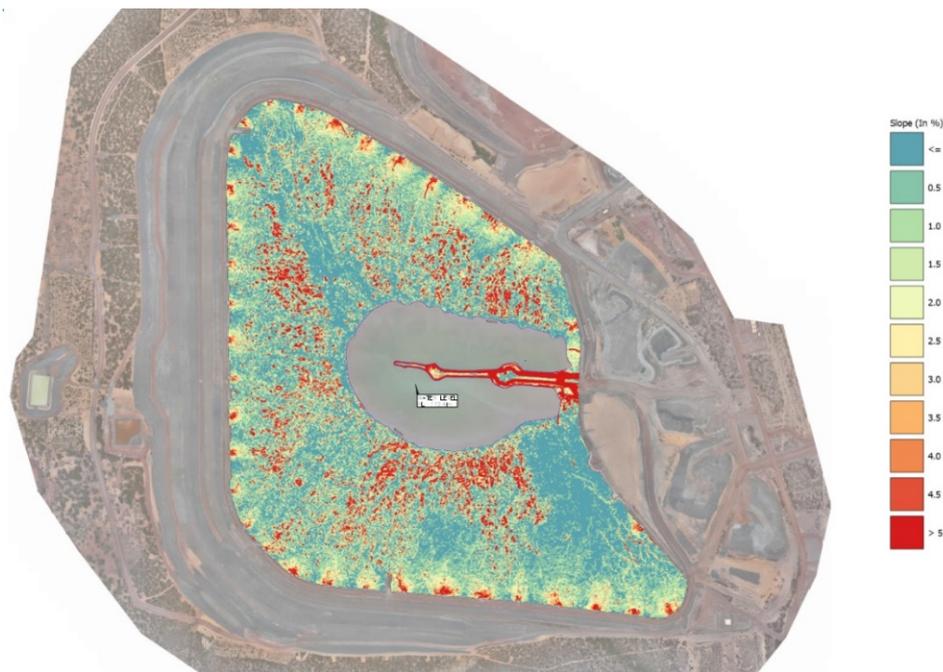


Figure 13 August 2024 slope beach heatmap (Alexander & Symonds Pty Ltd 2023)

- Results indicated dry flocculant usage decreased from 700 to 200 kg per day, which translating to a verified annual cost saving of approximately AUD 850,000 for SIMEC.
- This reduction also provided improved environmental benefits, with CO₂ emissions reduced by 65 tonnes annually.
- Due to the unique features of the Praestospeed, water usage for flocculant make-up decreased by 18,250 cubic metres per year.

5 Conclusion

The implementation of Solenis's Praestospeed 120 Modular Dissolving System has proven to be a transformative advancement in flocculant preparation for tailings management operations, offering both economic and environmental benefits. By enhancing the hydration process of high molecular weight polyacrylamide-based flocculants (aPAM), the system significantly reduces the required flocculant dosage, lowers water consumption and ensures more efficient tailings dewatering. This not only improves the operational efficiency of tailings management but also contributes to a more sustainable mining operation.

The case study at SIMEC Mining's Iron Duke TSF demonstrates the system's ability to optimise flocculant dosing, resulting in reduced overdosing events, improved beaching profiles and more precise control over tailings deposition. Over the span of a year, these improvements led to a dramatic decrease in flocculant consumption (from 700 to 200 kg per day), offering an estimated cost saving of AUD 850,000 annually. Additionally, the reduction in flocculant use contributed to a 65-tonne decrease in CO₂ emissions and saved 18,250 cubic metres of water annually, further underscoring the environmental advantages of this technology.

The Praestospeed system not only enhances the efficiency of tailings management but also aligns with the mining industry's growing emphasis on sustainability and cost-effectiveness. With its compact footprint, scalable design and ability to deliver precise flocculant preparation, it represents a critical innovation in advancing both the technical and environmental aspects of modern mining operations.

Acknowledgement

The successful completion of the SIMEC tailings project was made possible through the dedicated efforts of many team members from both Solenis and SIMEC Mining. This achievement would not have been possible without the onsite support of key Solenis contributors Stephen Darby, John Chadwick and Christo Smit. We would also like to extend our gratitude to David Gerrard from SIMEC Mining, who led the project implementation and effectively facilitated the change management process across various SIMEC groups.

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