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Evaluation of rheology-modifying and conventional flocculants across various tailings through a dynamic thickening test

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Abstract

Modern mining operations are increasingly challenged by declining ore grades, stricter environmental regulations, and limited access to water resources. At the same time, many plants are operating above their original nameplate capacities, putting additional stress on the existing infrastructures.

In the design phase of mineral processing plants, tailings thickening is often treated as a secondary process – as 'waste' primarily associated with tailings management. It does not always receive the same attention as the money-making parts of the process such as the flotation or leaching stages and rarely sees attention in terms of optimisation. However, poor thickening performance can have a significant negative impact on overall plant efficiency due to low water recovery and poor process water quality.

Improving the flocculant chemistry is a particularly attractive approach for enhancing thickening performance. It can often be implemented rapidly without major capital expenditure (capex) or structural modifications and without impacting operational cost (opex).

In many cases, conventional anionic flocculants (acrylamide-co-sodium acrylate polymer) are unable to ensure optimal performance, especially when plants are pushed above their design limits. In challenging situations with high water recovery requirements, the use of these flocculants may lead to high rake torque, poor underflow density, or unsatisfactory flux rates. Increasing the flocculant dosage is not always effective and can further exasperate the problems.

Rheology-modifying flocculants, particularly those based on Sodium 2-acrylamido-2-methylpropane sulfonate (ATBS) anionic monomer, offer a competitive alternative. These flocculants are more efficient at reducing slurry viscosity. Although their overall charge density may be lower, the sulfonic acid groups in ATBS offer enhanced performance and reliability.

This study compares the performance of conventional anionic flocculants with ATBS-based rheology-modifying flocculants through extensive static and dynamic testing across a variety of ore types and processing conditions. Results clearly demonstrate the potential benefits of selecting the most adapted flocculant chemistry to improve flux rates, underflow characteristics, enhance water recovery, and reduce energy consumption without a costly process redesign.

Keywords: *thickening, rheology-modifying flocculants, settling rate, clarity, dynamic thickening test, yield stress, flux rate, rake torque*

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1 Introduction

Synthetic-polyacrylamide-based flocculants have been successfully used in the mining industry since the 1960s (Merrill & Robert 1959). Since their first use there has been surprisingly little development of the core chemistry and apart from the development of hydroxamate type polymers specific to the Bayer process, the underlying chemistry remained unchanged. Molecular weight, anionic charge density and the physical form of the flocculants are adjusted to match the operation's requirements, but the chemistry remains the same. Most operations still use acrylamide-co-sodium acrylate-based flocculants because of operational experience and attractive cost in comparison with other solutions. In contrast, there has been significant development to the thickeners themselves (high-rate/deep cone/paste, etc.) and improvements in their operation.

One development for the mining industry has been the increasing uses of acrylamide-co-ATBS (or AMPS, Sodium 2-acrylamido-2-methylpropane sulfonate) type flocculants which are often referred to as 'rheology modifiers' (Grabsch et al. 2013). Although a lot of marketing material has concentrated on the effects on the thickener underflow, a potentially more significant benefit is the faster settling rates that these products can give. In an operating thickener the faster settling rates give several benefits:

- Higher throughput: the thickener can run at a higher flux rate (tonnes per m^2 per hour).
- Easier and more stable operation as the interface is minimised and the fast-settling rates keep it under control. For many plants, it removes thickening as a problem area.

The higher throughput is especially important in terms of the reduction in ore grades being mined. We can start to compensate for the lower grades with an increase in the thickeners throughput without investing in extra capital equipment.

If we also consider the difference between conventional, high compression and paste thickening, we see that the improvements in underflow density are more about the tank/rake design than the flocculation and flocculants. To achieve high densities, paste thickeners do not necessarily need to run with rheology/ATBS-type flocculants. Their use may offer benefits, especially in terms of flux rates, but it is not crucial.

We may also look at developments from the Bayer process (alumina) industry. Here, there has been a very distinct shift from large conventional type thickeners to high-rate deep cone type thickeners, with substantial benefits to the operations (Schoenbrunn 2007). This has been achieved by the use of both improved flocculants (hydroxamates and polyacrylates) and the improvement in thickener design. Almost all new plants, or major modifications to existing operations, involve building the smaller deep cone thickeners with very high throughputs for both the primary separations and complete washer trains. Such widespread use indicates that this shift in thickening technology has been highly successful.

Although there are many deep cone/high density thickeners in use outside of the Bayer process, their adoption is not yet universal and most new plants still build the larger conventional type thickeners. This indicates that underflow density may not be the most important factor in selecting equipment for the mining industry, cost (capex and opex) and operability may be more important.

The work in this paper concentrates more on the settling rate/throughput improvements via the comprehensive screening of different flocculant chemistries and the importance of these to actual thickener/plant performance. It goes from simple static cylinder tests, through bench-top dynamic thickening tests and models how this may change thickener performance.

2 Materials and methodology

The most important application for flocculant is dewatering tailings. For this exercise, three different samples of unflocculated tailings have been selected to evaluate the different flocculants performance. The approach has been divided into 2 phases:

- Phase 1: flocculant screening through static sedimentation tests followed by dose and solids concentration responses. A full range of the non-ionic and anionic flocculants of both conventional (TFA 900 series) and rheology-modifying (TFA 100 series) types were tested to select the best performing flocculants from each group.
- Phase 2: bench-top dynamic thickening and rheological properties for the 2 best performing flocculants (one from conventional and one from ATBS flocculants)
  - Bench-top dynamic thickening tests: solids flux curve and 24-hour mud bed consolidation curve.
  - Thickened mud bed rheology tests: unsheared and sheared vane yield stress.

2.1 Material characterisation

The tailings samples have very different properties in term of particle size, clay activity (methylene blue indicator - MBI) and total ionic strength of the water (conductivity), this allows evaluation of flocculant performance over the large spectrum of applications. The results of the tailings characterisation are presented in Table 1. A laser diffraction particle size analyser has been used for the particle size analysis. MBI has been analyses by common practice described in the literature (ASTM 2024; Hang & Brindley, 1970).

Table 1 Tailings samples characterisation

Physical properties					
Sample	**Particle specific gravity (g/cm³)**	**Particle size (µm)**			**% passing 20 µm (%m)**
		d_{20}	**d_{50}**	**d_{80}**	
Copper tails	2.750	4.9	34.2	248.6	44.4
Tin tails	2.620	4.2	12.3	38.2	64.3
Mineral sands tails	2.434	0.6	8.0	79.2	60.2

Chemical properties							
Sample	**MBI (meq/100 g)**	**Slurry supernatant process water**		**Natural slurry colloidal characteristics Slurry**			
		pH	**Conductivity (mS/cm)**	**pH**	**Conductivity (mS/cm)**	**Process water SAR***	**Natural colloidal behaviour**
Copper tails	1.8	8.00	1.01	7.64	0.47	1.4	Coagulated
Tin tails	8.1	7.97	21.70	7.66	19.43	8.4	Coagulated
Mineral sands tails	13.2	6.36	50.40	6.44	47.70	48	Coagulated

*SAR – sodium adsorption ratio. A ratio between divalent (Ca^{2+} and Mg^{2+}) and monovalent (Na^{+}) cations in the water

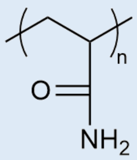
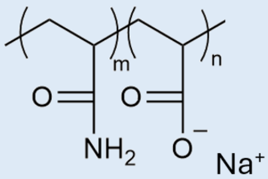
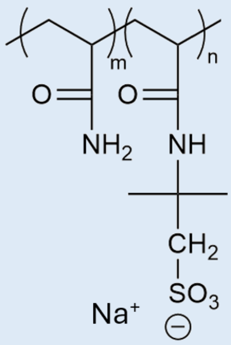
Unflocculated slurries, in which the suspended solids settled out over a 24-hour period leaving a clear supernatant above a settled bed, are typically classified as naturally coagulated. Unflocculated slurries, in which some or all the solids remained in suspension after a 24-hour period leaving a dirty supernatant, are typically classified as naturally dispersive and may require a coagulation step prior to flocculation.

2.2 Flocculants

The main goal of this study is to identify the advantages of the rheology-modifying versus conventional flocculants with quantified values.

SNF produces a broad range flocculants for the different applications. For the mining industry, the most popular flocculants are anionic and non-ionic types with different chemical compositions. The mining range of SNF's non-ionic and anionic flocculants can be divided into three categories as follows shared in Table 2.

Table 2 Tested product and their characteristics

	Non-ionic flocculants TFA 500 series	**Conventional type flocculants TFA 900 series**	**Rheology-modifying type flocculants TFA 100 series**
Structure			

- Non-ionic flocculants TFA 500 series refers to acrylamide homopolymer. Non-ionic flocculants are produced by the polymerisation of acrylamide.
- Conventional type flocculants TFA 900 series refers to acrylamide-co-sodium acrylate polymers. Conventional flocculants can be produced either by copolymerising acrylamide with sodium acrylate or by partially hydrolysing an acrylamide homopolymer along its chain.
- Rheology-modifying type flocculants TFA 100 series refers to acrylamide-co-sodium 2-acrylamido-2-methylpropane sulfonate polymers. Rheology-modifying type flocculant are obtained by copolymerising acrylamide with sodium 2-acrylamido-2-methylpropane sulfonate polymers.

Flocculant solutions were prepared using tap water with an overnight hydration. Procedure was to create a strong vortex in the beaker by stirring at 800 rpm, introduce the flocculant powder into the vortex and after initial wetting, the stirring was reduced to 250 rpm to minimise degradation. The flocculant solutions were made and used at 0.25 g/l concentration.

2.3 Methodology: flocculant screening

2.3.1 Flocculant screening

The flocculant screening tests were carried out by way of standard cylinder settling tests in a 500 mL measuring cylinder by a similar procedure for all samples:

Cylinders were flocculated, as required, using a split additions scheme:

- with a plunger, give the cylinder 3 firm stokes to re-suspend the solids
- add 50 % of the flocculant dose
- mix with 3 medium plungers
- add remaining flocculant

- mix with 3 gentle plungers
- start the timing when the plunger is removed.

For each tailings material, the flocculant screening tests were carried out at a constant slurry solids concentration and constant flocculant dose rate derived from previous test work or current operation with the conventional flocculants (Table 3).

Table 3 Static settling tests starting point

Sample	Solids concentration (%m)	Flocculant dose (g/t)	Settling rate (m/h)	Clarity (wedge) from 0 (poor) to 50 (clear)
Copper tailings	10.0	40	16	48
Tin tailings	5.0	80	6.2	49
Mineral sands tailings	3.25	350	25	44

Settling rate and supernatant clarity have been measured to determine the optimum flocculant for each tailings material during the study. For the supernatant clarity measurement in the cylinder tests, the cylinder was allowed to stand for 10 minutes after the final mix before taking the sample. Turbidity (NTU) has been measured by Hach ratio/XR turbidimeter.

Based on the results from the flocculant screening tests, the best 2 flocculants were selected for the optimisation of dosage and slurry solids concentration – one from the conventional range and one from the rheology-modifying range.

2.3.2 Dose and solids concentration responses

The optimum selection of slurry solids concentration in the thickener feedwell and flocculant dose rate was determined through a matrix of 15 cylinder settling tests for each of the 2 selected flocculants across the 3 tailings materials. Each matrix of 15 settling tests consisted of 5 × flocculant dose rates and 3 × slurry solids concentrations (Table 4).

Table 4 Range of parameters for optimisation tests

Sample	Slurry solids concentration (%m)			Flocculant dose rate (g/t)
Copper tailings	7.5	10.0	12.5	30 to 70
Tin tailings	3.25	5.0	7.5	60 to 100
Mineral sands tailings	2.5	3.25	5.0	250 to 450

The settling rate, supernatant clarity and settled bed volume after 10 minutes (to back calculate a bed solids concentration) were measured to determine the optimum flocculation parameters for each tailings material.

2.4 Methodology: bench-top dynamic thickening test

The dynamic thickening tests are designed to determine the underflow solids concentration and overflow clarity as a function of the throughput rate as well as the mud bed accumulation and consolidation properties under dynamic batch operating conditions.

The dynamic thickening tests were conducted in a 100 mm diameter and 440 mm height bench-top test thickener simulating high density/paste thickening conditions (with pickets on rake). Even though the tests are conducted at bench-top level, it provides an accurate assessment of the thickening characteristics of a material under dynamic conditions as would be encountered at full-scale operation. The tests included solids flux tests with the bed level at 120 mm and 24 hour mud bed consolidation tests with the bed level at 200 mm.

Rake geometry includes the vertical pickets on rake and scrapers. Rake speed has been maintained at 1 rpm.

The 2 optimum flocculants per tailings material were evaluated through the bench-top dynamic thickening tests. Representative, undisturbed samples of the thickened mud bed from the bench-top dynamic thickening tests were subjected to the thickened mud bed rheology tests. The thickened mud bed rheology tests are designed to determine:

- The unsheared yield stress of the mud bed which is used to estimate rake drive torque requirements during thickener sizing estimates.
- The fully sheared yield stress versus solids concentration relationship for the material.

The yield stress measurements were conducted using an Anton Paar rotational viscometer with a STIRRET ST22-4V-40/113 vane measuring system (height 40 mm, length 20 mm, rotation rate 0.3 rpm) and assumed that the material presents non-Newtonian flow characteristics. Comparative slump tests were also conducted.

The consolidation profile of the mud bed was determined at bench-top scale over a 24-hour period under high density/paste thickening conditions (pickets on rake) at a starting mud bed level of 200 mm.

3 Results and discussion

3.1 Material characteristics

Experience has shown that the % passing 20 micron and the clay activity, as measured by the MBI method, have a significant impact on the flocculation, settling and overall dewatering behaviour of a mineral slurry (Kaminsky et al. 2024).

Due to the higher ultra-fines content of the tin tailings and the mineral sands tailings, it is expected that higher flocculant dose rates would be required for these materials than the copper tailings.

While the ultra-fines content of the tin tailings and that of the mineral sands tailings is similar, the higher MBI value of the mineral sands tailings indicates a higher clay activity for this material. Higher clay activity indicates an enhanced ability for the clay minerals in the ore to exchange cations with the water environment, which may affect the swelling behaviour of the clay depending on the quality of the process water environment.

The high slurry conductivity for the mineral sands tailings is a result of sea water being used as the process stream at this operation, which would suppress most of the clay swelling behaviour due to the high ionic content of the sea water. The MBI value of the mineral sands tailings is also not particularly high (<15 meq/100 g) and falls within the category of moderate difficulty.

3.2 Static settling test

Static settling tests include the screening stage to define the optimum flocculant for each application and a stage test work to define the starting point for the dynamic tests.

3.2.1 Flocculant screening

To avoid any uncovered area, the full mining range of SNF's non-ionic and anionic flocculants has been tested but excluding the low molecular weight types with a specific application field.

According to the screening results (Figures 1 and 2), the 2 best performers were selected for further evaluation – one each from the conventional and rheology-modifying flocculant ranges.

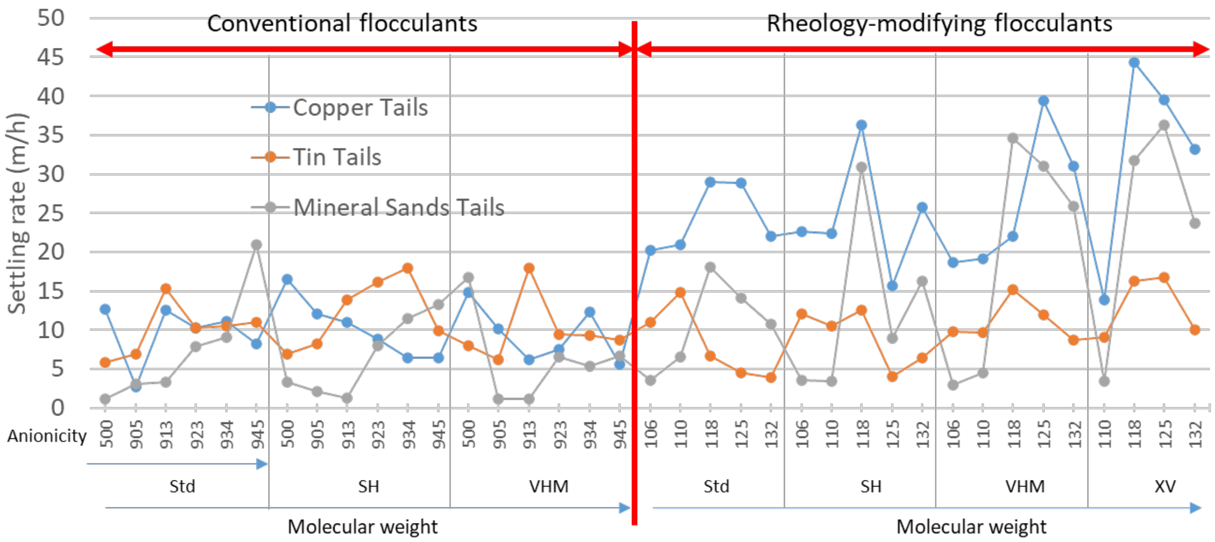


Figure 1 Flocculant screening: settling rate

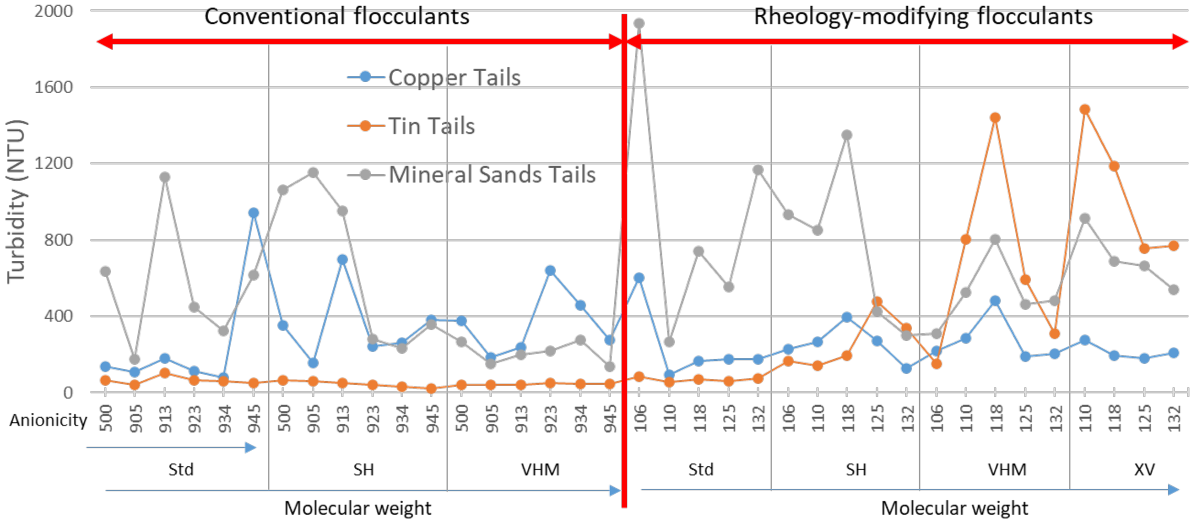


Figure 2 Flocculant screening: turbidity

Based on the results (Figures 1 and 2), the optimum flocculant types listed in Table 5 were selected for the next stage to optimise the flocculant dose rate and slurry solids concentration for each of the tailings materials.

Table 5 Overall flocculant performance ranking

Sample	Optimum flocculant types	
	Conventional flocculants	Rheology-modifying
Copper tailings	TFA 500 SH	TFA 118 XV
Tin tailings	TFA 913 VHM	TFA 125 XV
Mineral sands tailings	TFA 934 SH	TFA 125 XV

3.2.2 Optimisation of flocculant dose and slurry solids concentration

Table 6 presents the final results of the optimisation tests for each tailings material according to the developed matrix (Table 4).

Table 6 Final results of optimisation tests

Flocculant	Slurry solids concentration (%m)	Flocculant dose (g/t)	Settling rate (m/h)	Turbidity (NTU)	Mud bed volume after 10 min (mL)
Copper tailings					
TFA 500 SH	10	60	17	63	95
TFA 118 XV	10	55	22	751	100
Tin tailings					
TFA 913 SH	5	90	10	38	130
TFA 125 XV	5	70	10	534	132
Mineral sands tailings					
TFA 934 SH	3	400	14	240	85
TFA 125 XV	5	300	28	1,099	110

In general, higher or similar settling rates were achieved at a lower flocculant dose rate with the ATBS flocculants than with the conventional flocculant types; however, the supernatant clarity produced was worse for the rheology-modifying series flocculants for all tested samples. For the mineral sands tailings, the ATBS flocculants showed a higher slurry solids concentration (potential increased throughput).

The optimum parameters were undertaken for the dynamic tests as a starting point.

3.3 Bench-top dynamic thickening test

Two best performing flocculants for each sample have been taken for the dynamic tests (Table 6).

3.3.1 Copper tailings

Figures 3 and 4 present the results of the bench to dynamic thickening test – the solids flux tests with underflow solids concentration and overflow turbidity as a function of solids flux rate as well as the results of the bench-top mud bed consolidation tests for the copper tailings.

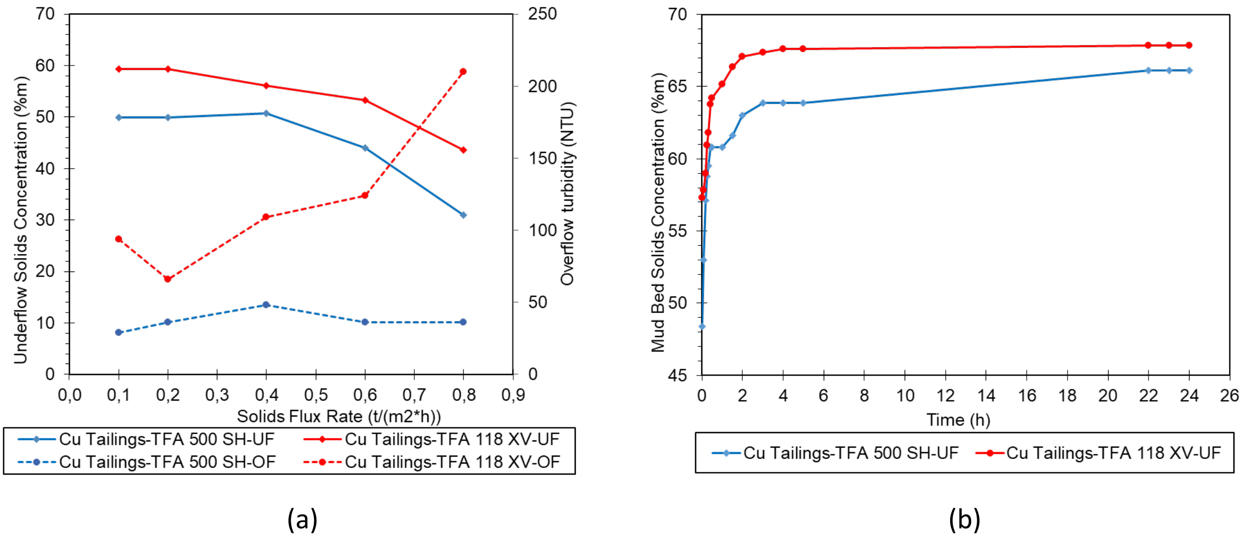
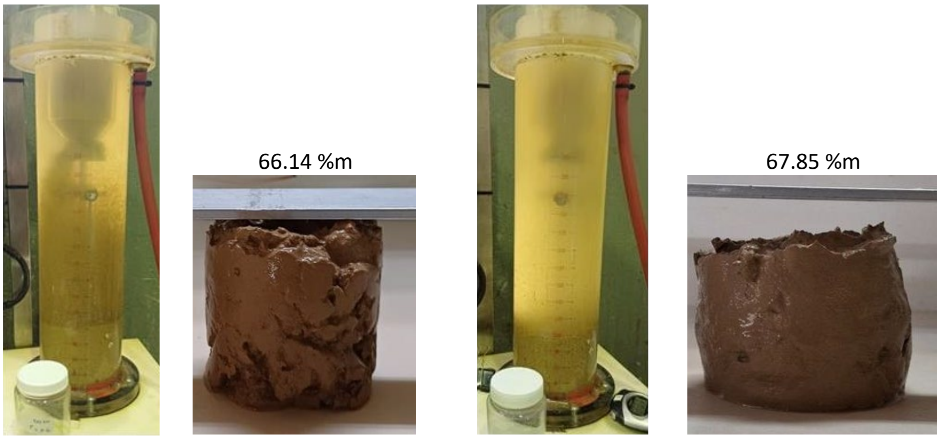


Figure 3 Copper tailings: (a) Solids flux curves; (b) Bench-top mud bed consolidation profile



(a) (b)

Figure 4 Copper tailings: (a) TFA 500 SH; (b) TFA 118 XV

The average consolidation times to achieve 64 %m of solids concentration in the underflow has been estimated via logarithmic interpolation. The sheared and unsheared yield stress has been measured for each sample and the value of 64 %m solids content has been interpolated. The main results are presented in the Table 7.

Table 7 Copper tailings: bench-top dynamic thickening results

Parameter	Flocculant	
	TFA 500 SH	TFA 118 XV
Feed solids concentration (%m)	10	10
Flocculant dose (g/t)	60	60
Optimum flux rate within the range 0.1 to 0.8 (t/m^2*h)	0,4	0,4
Mud bed solids concentration (%m) at 1h	61	65
Final mud bed solids concentration (%m) after 24h	66	68
Target underflow solids concentration (%m)	64	64
Required residence time (h)	**5.1**	**0.9**
Unsheared yield stress (pa)	**549**	**306**
Sheared yield stress (pa)	**137**	**79**

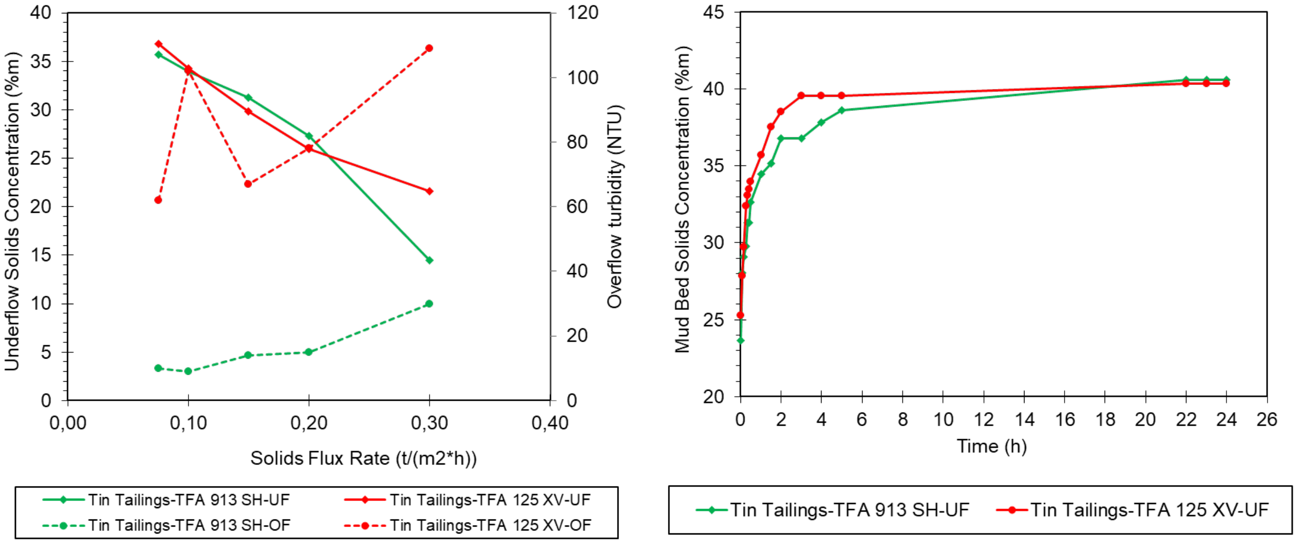
The bench-top dynamic thickening tests confirmed that the thickener overflow clarity is worse for the ATBS flocculants than the standard flocculants at the same flocculant dose rate (109 versus 48 NTU).

The ATBS flocculant improved the mud bed consolidation rate such that higher mud bed solids concentration was achieved at a shorter residence time. In addition, a higher final underflow solids concentration was also achieved with the ATBS flocculant when compared to the standard flocculant (all at the same flocculant dose rate, slurry feed solids concentration and solids flux rate). Table 8 shows that 81.6 % (0.9 versus 5.1 hours) decrease in residence time was achieved with the ATBS flocculant to achieve the baseline target underflow solids concentration for the copper tailings.

For the copper tailings material, the ATBS flocculant produced a lower unsheared and sheared mud bed yield stress, when compared to the standard flocculant, at the baseline target underflow solids concentration (44.3 and 42.4% of decrease).

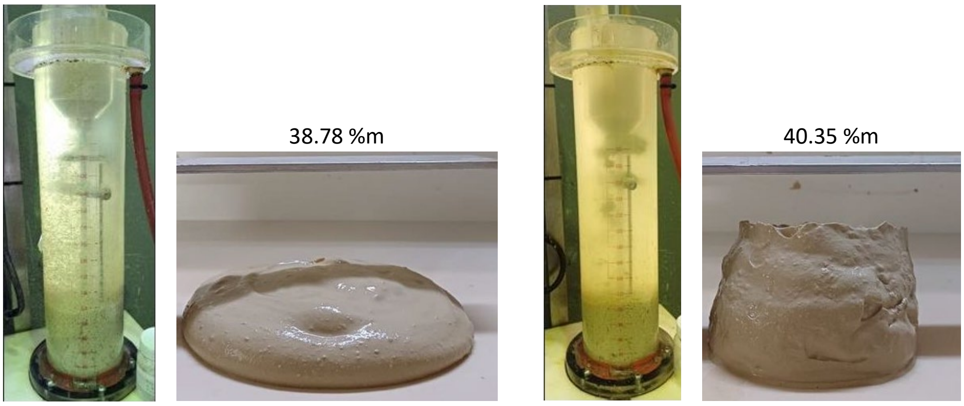
3.3.2 Tin tailings

Figures 5 and 6 present the results of the bench to dynamic thickening test – the solids flux tests with underflow solids concentration and overflow turbidity as a function of solids flux rate as well as the results of the bench-top mud bed consolidation tests for the tin tailings.



(a) (b)

Figure 5 Tin tailings: (a) Solids flux curves; (b) Bench-top mud bed consolidation profile



(a) (b)

Figure 6 Tin tailings: (a) TFA 913 SH; (b) TFA 125 XV

The average consolidation times to achieve 38 %m of solids concentration in the underflow has been estimated via logarithmic interpolation. The sheared and unsheared yield stress has been measured for each sample and the value for 38 %m solids content has been interpolated. The main results are presented in the Table 8.

Table 8 Tin tailings: bench-top dynamic thickening results

Parameter	Flocculant	
	TFA 913 SH	TFA 125 XV
Feed solids concentration (%m)	5	5
Flocculant dose (g/t)	90	70
Optimum flux rate within the range 0.075 to 0.3 (t/m^2*h)	0.15	0.15
Mud bed solids concentration (%m) at 1h	34	36
Final mud bed solids concentration (%m) after 24h	41	40
Target underflow solids concentration (%m)	38	38
Required residence time (h)	**5,7**	**3,6**
Unsheared yield stress (pa)	**96**	**93**
Sheared yield stress (pa)	**35**	**33**

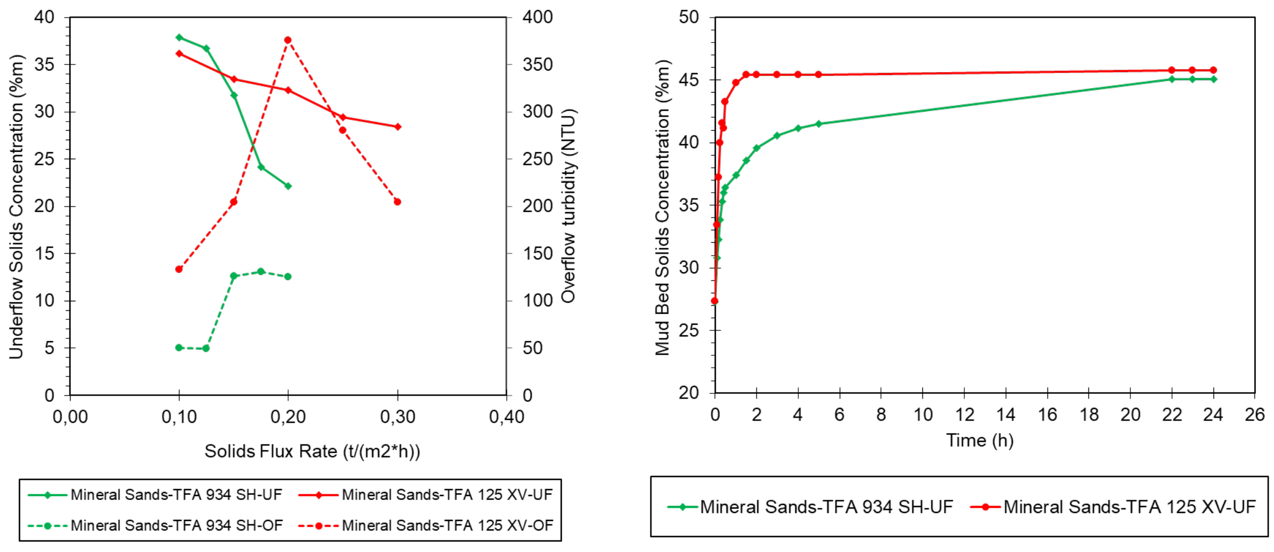
The overflow clarity is worse for the ATBS flocculants than the standard flocculants at the same flocculant dose rate (67 versus 14 NTU).

Fairly similar underflow solids concentrations were achieved at a lower flocculant dose rate for the ATBS flocculant, when compared to the standard flocculant, at the same slurry feed solids concentration and solids flux rate.

The decrease in residence time to achieve the same U/F density is up to 35.5% (3.6 versus 5.7 hours) between best conventional and best rheology-modifying flocculant. The decrease of the unsheared yield stress is about 3.3 and 6.7% for the sheared yield stress.

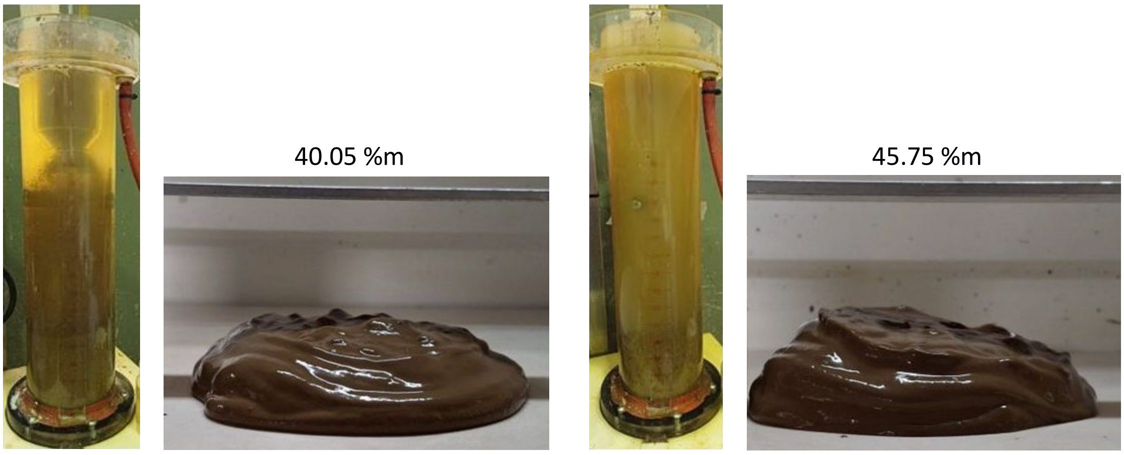
3.3.3 Mineral sands tailings

Figures 7 and 8 present the results of the bench to dynamic thickening test – the solids flux tests with underflow solids concentration and overflow turbidity as a function of solids flux rate as well as the results of the bench-top mud bed consolidation tests for the mineral sands tailings.



(a) (b)

Figure 7 Mineral sands: (a) Solids flux curves; (b) Bench-top mud bed consolidation profile



(a) (b)

Figure 8 Mineral sands: (a) TFA 934 SH; (b) and TFA 125 XV

The average consolidation times to achieve 40 %m of solids concentration in the underflow has been estimated via logarithmic interpolation. The sheared and unsheared yield stress has been measured for each sample and the value for 40 %m solids content has been interpolated. The main results are presented in the Table 9.

Table 9 Mineral sands tailings: bench-top dynamic thickening results

Parameter	Flocculant	
	TFA 934 SH	**TFA 125 XV**
Feed solids concentration (%m)	3.25	5.00
Flocculant dose (g/t)	325	250
Optimum flux rate within the range 0.075 to 0.3 (t/m^2*h)	0.16	0.225
Mud bed solids concentration (%m) at 1h	37	45
Final mud bed solids concentration (%) after 24h	45	46
Target underflow (U/F) solids concentration (%m)	40	40
Required residence time (h)	2.70	0.25
Target U/F solids concentration (%m) for the rheology	45	45
Unsheared yield stress (pa)	135.4	135.8
Sheared yield stress (pa)	45.2	38.2

The overflow clarity is worse for the ATBS flocculants than the standard flocculants at the same flocculant dose rate (376 versus 126 NTU).

The ATBS flocculant significantly improved the mud bed consolidation rate such that higher mud bed solids concentration was achieved at a shorter residence time. In addition, a higher final underflow solids concentration was also achieved with the ATBS flocculants when compared to the standard flocculants. A further important fact to note is that the mud bed consolidation benefits of the ATBS flocculants were achieved at higher solids flux rates (throughput rates) and lower flocculant dose rates than the standard flocculants. The decrease of the residence time to achieve the same UF density is more than 90% (0.25 versus 2.7 hours) between best conventional and best rheology-modifying flocculant to achieve the baseline target underflow solids concentration. The unsheared yield stress is similar; however, the sheared stress is decreasing by 15.5% with the ATBS flocculant.

4 Discussion

During this study, a full mining range of non-ionic and anionic flocculants covering both conventional (TFA 900 series) and rheology-modifying products (TFA 100 series) has been evaluated on three different tailings materials. The findings highlight the critical influence of polymer chemistry on thickening performance. No single product provides a universal solution. Instead, the optimal choice depends on site-specific operational conditions and constraints, including thickener design, throughput requirements, overflow clarity, installed drive capacity, and underflow pumping.

Rheology-modifying flocculants should be systematically considered during test work as they may offer a very competitive solution for process optimisation. The results also confirm an unavoidable trade-off between overflow clarity and underflow density – a trend consistently observed throughout this investigation.

The final recommendations focus on the overall effect of the rheology-modifying flocculants on the 3 tailings materials:

- For the copper tailings, the TFA 100 series flocculants achieved higher underflow densities in a significantly shorter residence time, which suggests that thickener throughput could be increased. The significant reduction in unsheared yield stress with the ATBS flocculants also suggests that may result by a lower thickener rake torque.
- For the tin tailings, the TFA 100 series flocculants offered little other benefit, apart from a reduction in flocculant dose rate, over the standard flocculants to achieve the same dewatering behaviour.
- For the mineral sands tailings, the TFA 100 series flocculants demonstrated a number of benefits including lower flocculant dose rate, higher slurry feed solids concentration (resulting in increased throughput rate) and higher underflow density in a shorter residence time (again suggesting increased throughput rate). The significant increase in underflow solids concentration for a material with the same ultra-fines (passing 20 µm) content and a higher clay activity than the tin tailings, is very encouraging for the application of TFA 100 series flocculants to the dewatering of clay containing mineral slurries. In general, the unsheared yield stress of the mineral sands tailings increased with the use of the TFA 100 series flocculants, with the exception of TFA 125 XV which achieved a similar unsheared yield stress to the conventional flocculant. It appears that TFA 125 XV is particularly suited to the mineral sands tailings material for this reason.

5 Conclusion

To improve the thickening performance, a broad range of the chemicals should be tested during the feasibility studies and the flocculants performance evaluation. The right choice of the flocculant can significantly improve the operation stability.

Globally, rheology-modifying flocculants offer one more tool to de-bottleneck the existing thickening operations in terms of throughput and torques. Therefore, the rheology-modifying flocculants provide several advantages, but should be tested and considered case by case according to operational targets priority.

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