



The flocculation and coagulation of PGM ore flotation tailings under degrading water qualities

T.I. Koadibane, M.F. Moya, M. Safari, J. Taguta, M.S. Manono, K.C. Corin

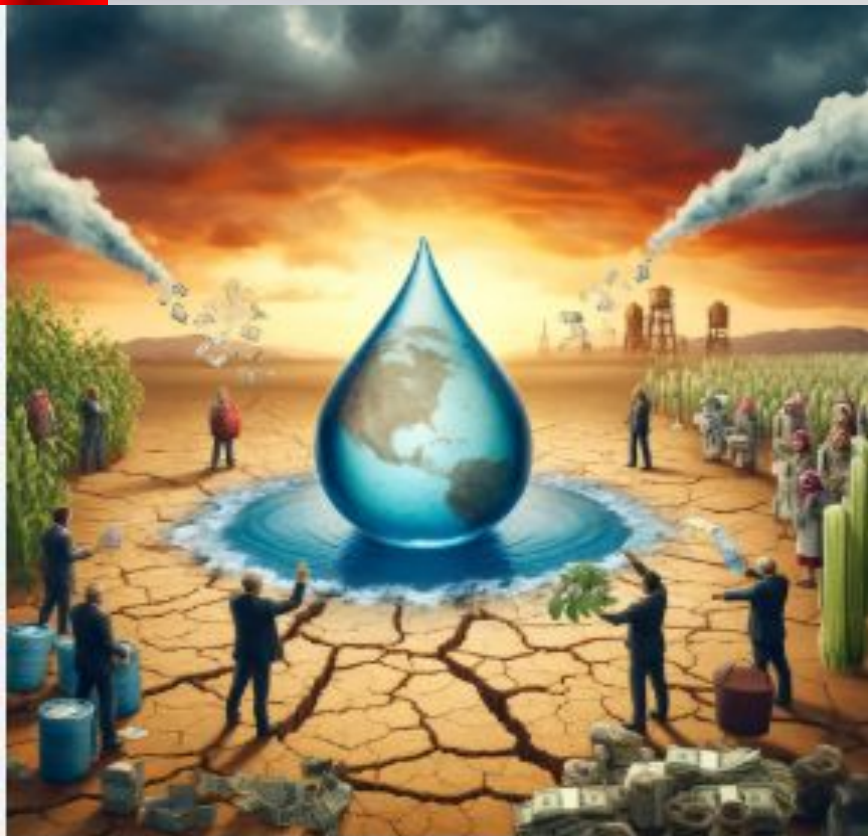
28 October 2025

Background



- Thickeners used for solids and water recovery.
- Recycled process water affects the dewatering processes.
- Process water contains residual ions & polyvalent inorganic electrolytes.

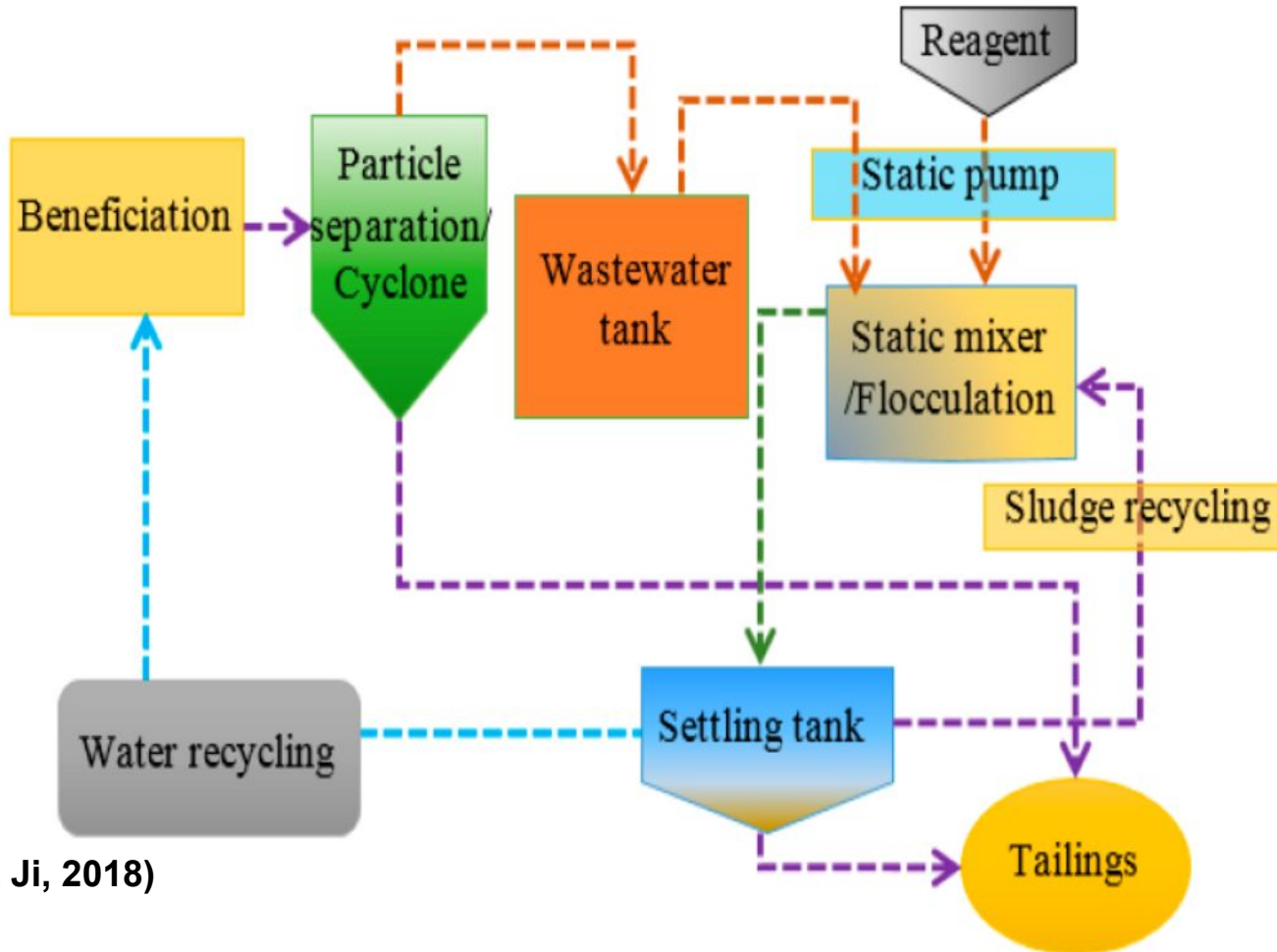
Closing the Water Loops



Powering efficiency with water solutions by:

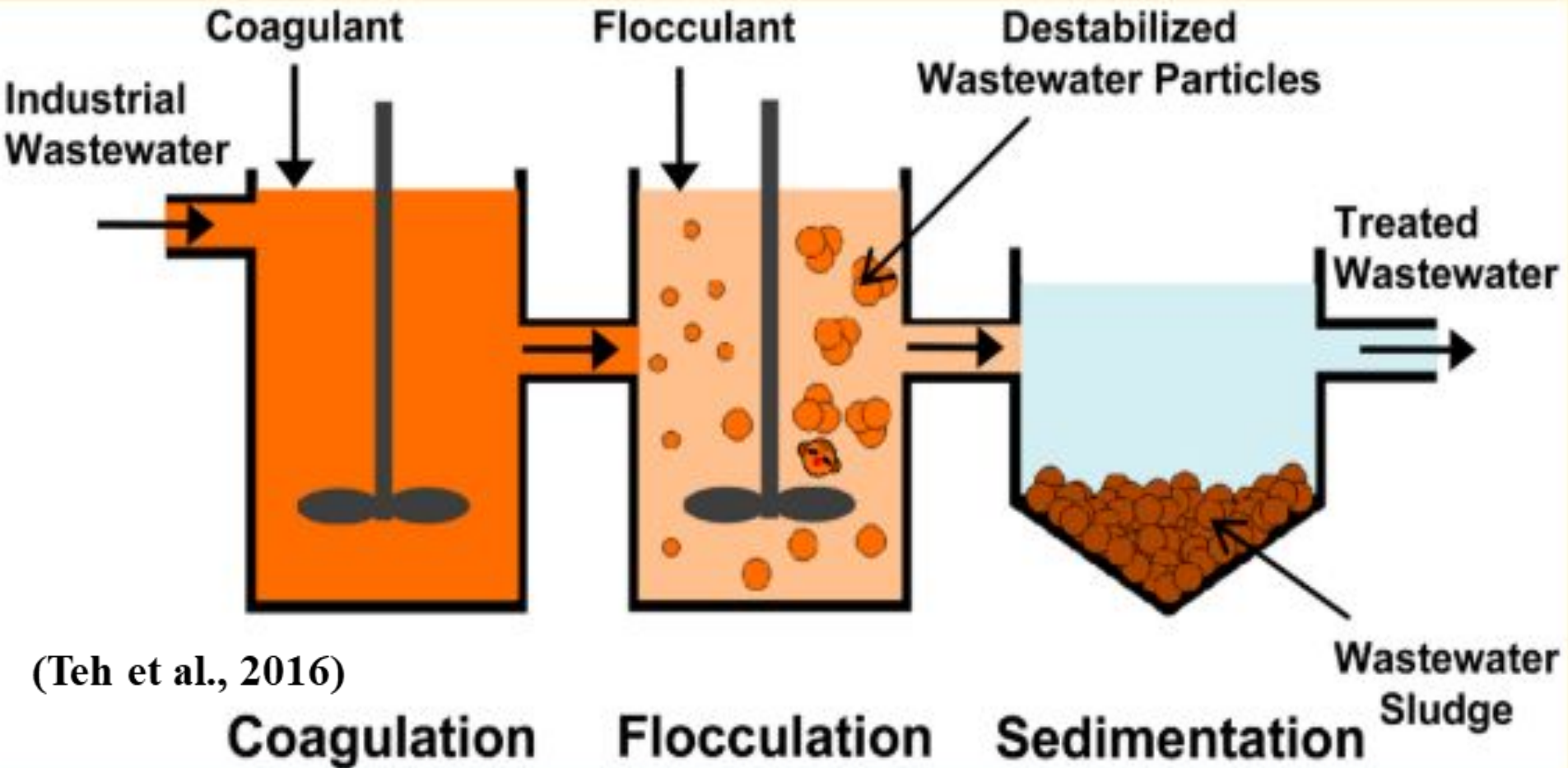
- Saving water.
- Understanding the unit operations.
- Tackling challenges related to water effluents and tailings.
- Developing new methods for water quality control and optimisation.
- Minimising environmental pollution.

Waste Water Treatment Process

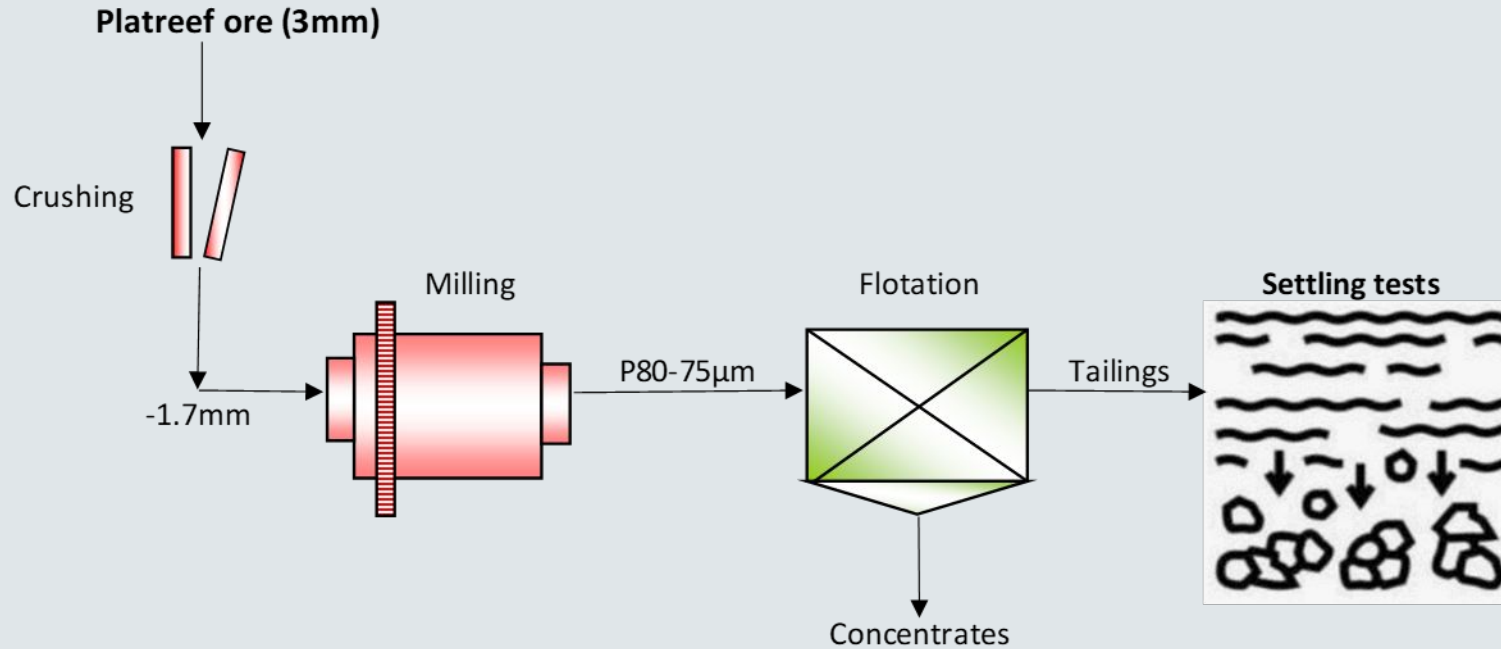


(Park, Han & Ji, 2018)

The Dewatering Process



Experimental Setup



Flotation Tests

Duplicate flotation tests with Tap water, 3SPW, 5SPW & 10SPW.

Feed grind size = P_{80} -75 μ m .

Feed mass = 2kg solids (~35% solids).

5L flotation cell (*About 2L of the tailings slurry is needed for settling tests*).

Flotation residence time of 40minutes.

Flotation reagents and dosages listed below:

Reagent	Type	Dosages (g/t)	Specific gravity (g/ml)	Purity (%)	Conditioning time (min)
Collector	SIBX	120	1.17-1.18	>60	2
Depressant	Sendep 30E	300	0.55-0.67	55-77	3
Frother	Senfroth 522	50	0.83	-	1

Settling Tests

Rougher Tailings

Measure pH & temperature

Measure Settling rates (4 x water types x treatment conditions)

- *No flocculant and Coagulant*
- *Flocculant only*
- *Coagulant only*
- *Flocculant and coagulant*

Conduct turbidity measurements (NTU)

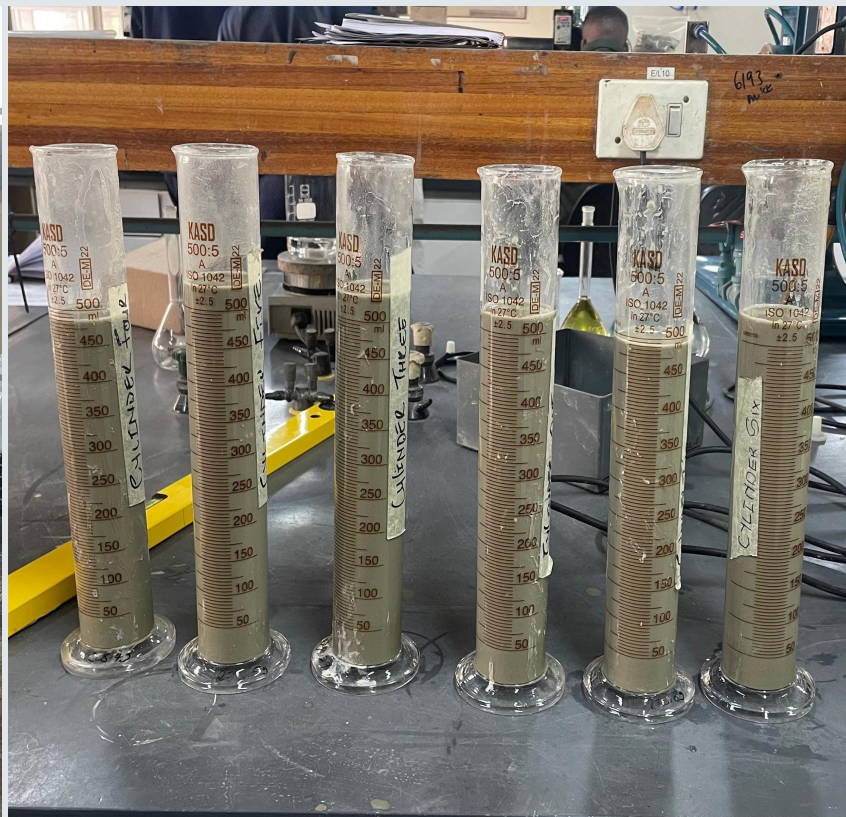
Water Chemistry

Table 1: Cations and Anions in Tap water (Carelse et al., 2022)

Ions	Ag	Al	Ca	Cr	Fe	Mg	Pb	V
Unit (ppm)	<1	<1	26.6	0.05	0.51	7.55	0.061	0.06
Ions	Si	Li	K	NO ₃	Sulphide S	Conductivity	TDS	pH
Unit ()	<0.05 (ppm)	<0.05 (ppm)	1.91 (ppm)	5.14 (ppm)	<0.05 (mg/L)	227 (uS/cm)	113.8 (mg/L)	8.02

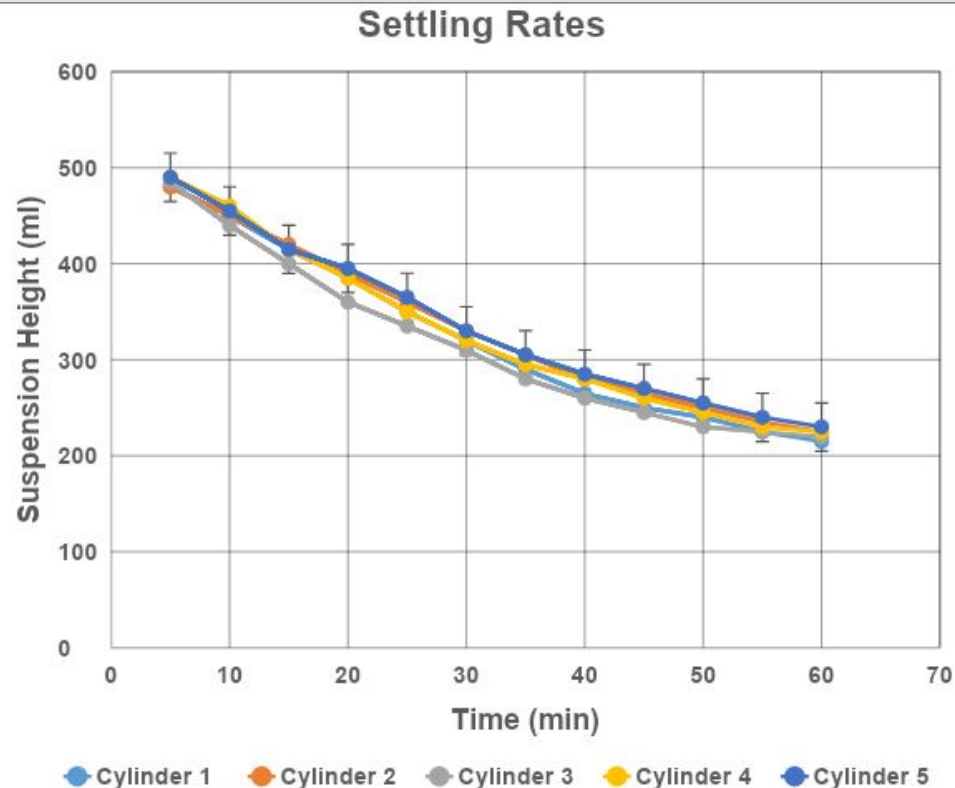
Table 2: Synthetic Plant Waters (SPW) as developed from the University of Cape Town (Manono, M.S., Corin, K.C. & Wiese, J.G. 2018)

Water Type	Ca ²⁺ (ppm)	Mg ²⁺ (ppm)	Na ⁺ (ppm)	Cl ⁻ (ppm)	SO ₄ ²⁻ (ppm)	S ₂ O ₃ ²⁻ (ppm)	NO ₃ ²⁻ (ppm)	CO ₃ ²⁻ (ppm)	TDS (mg/L)	IS [M]
<i>Potable water (RWB)</i>	6.31	2.65	11.25	5.82	<10	-			163.44	
1SPW	80	70	153	287	240	-	176	17	1023	0.0243
3SPW	240	210	459	861	720	-	528	51	3069	0.073
5SPW	400	350	765	1435	1200	-	880	85	5115	0.1212
10SPW	800	700	1530	2870	2400	-	1760	850	10230	0.2426

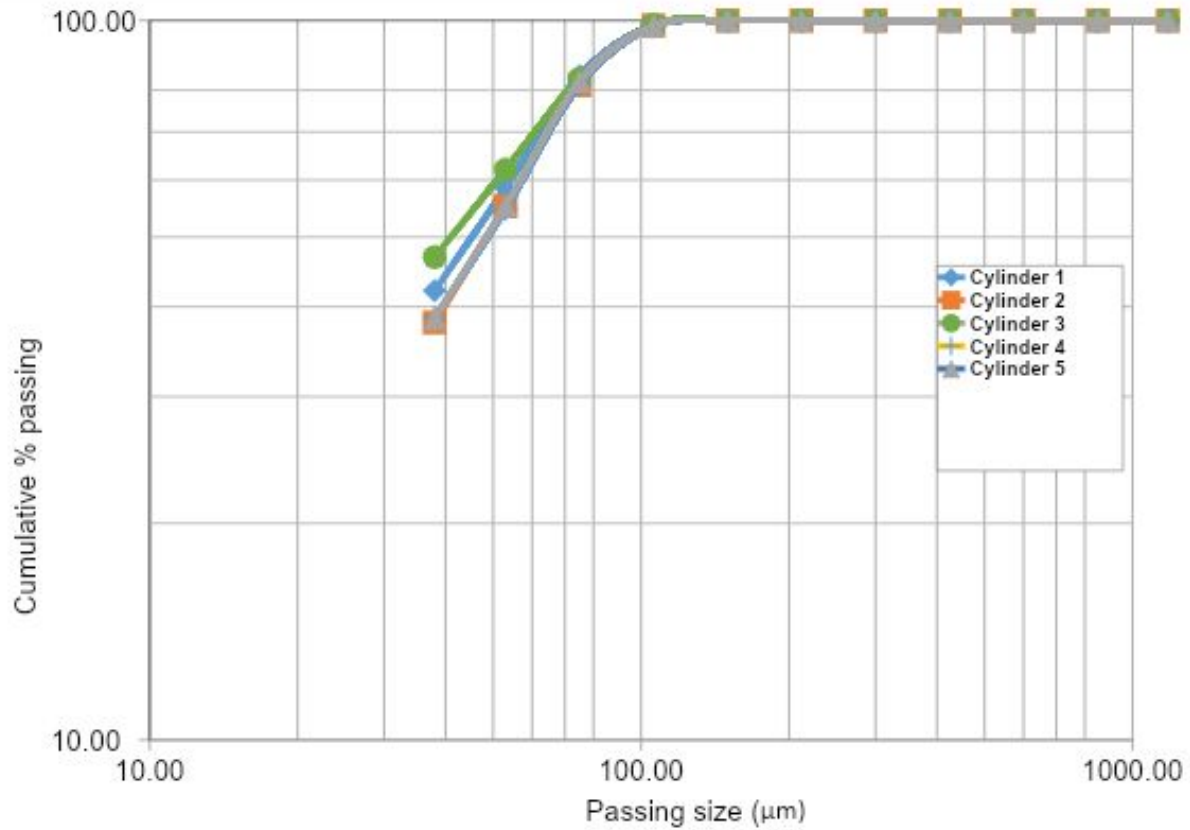


Settling rates

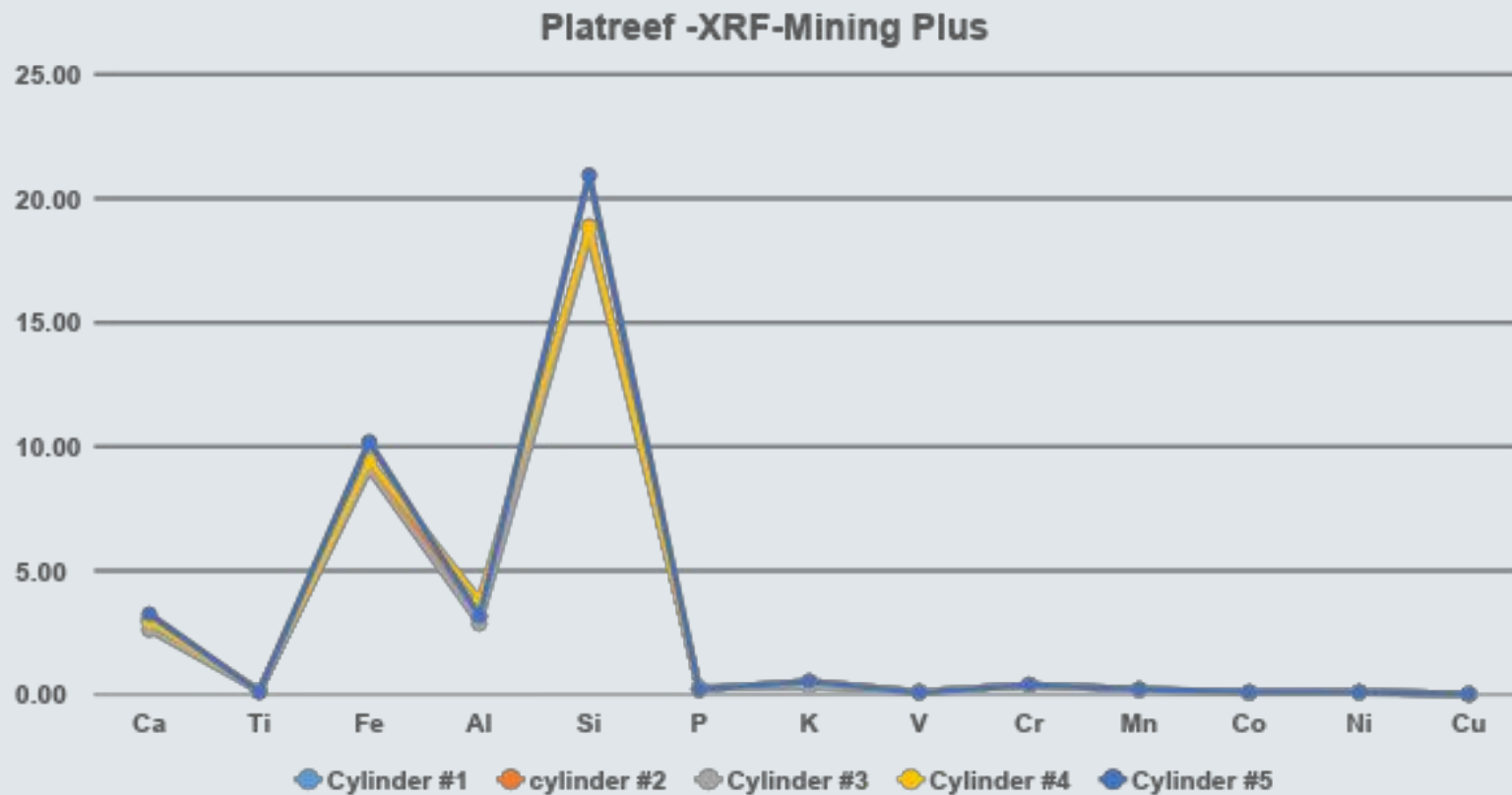
Platreef Flotation Tailings					
Suspension Height(ml)					
Tap Water Treatment Type					
Time (min)	Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4	Cylinder 5
0	500	500	500	500	500
5	490	230	315	245	225
10	385	190	225	210	195
15	325	175	210	205	170
20	270	170	200	205	170
25	225	170	195	205	165
30	200	170	190	205	165
35	185	170	185	205	165
40	180	170	185	205	165
45	175	170	180	205	160
50	175	170	180	205	160
55	170	170	180	205	160
60	170	170	180	205	160
Slurry Mass	878.65	858.64	895.34	836.71	868.58
Cylinder-Mass	274.36	278.40	281.20	276.02	269.16
Slurry Mass	604.29	580.24	614.14	560.69	599.42
Slurry Volume	495	480	500	455	500
Solids density(m/V)	1.22	1.21	1.23	1.23	1.20



PSDs

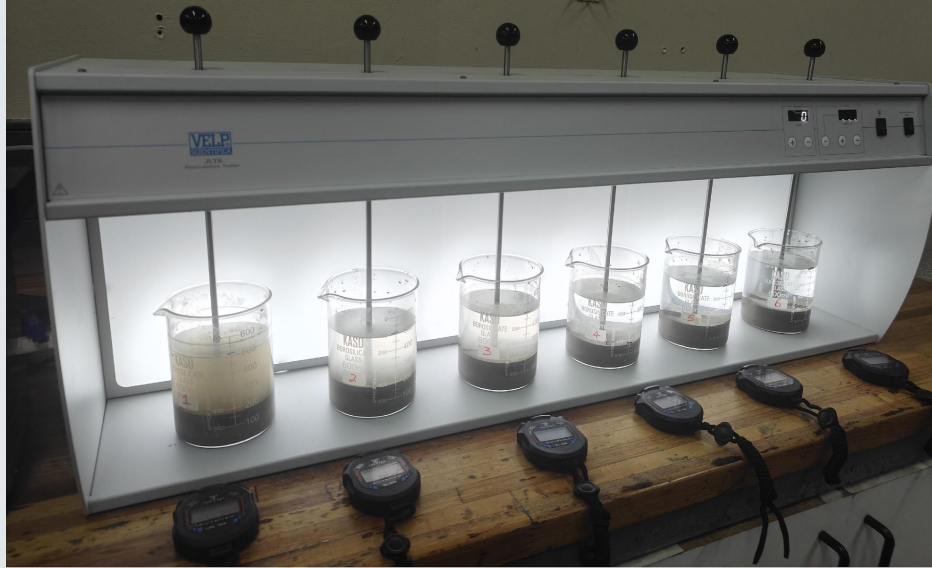


XRF Analysis

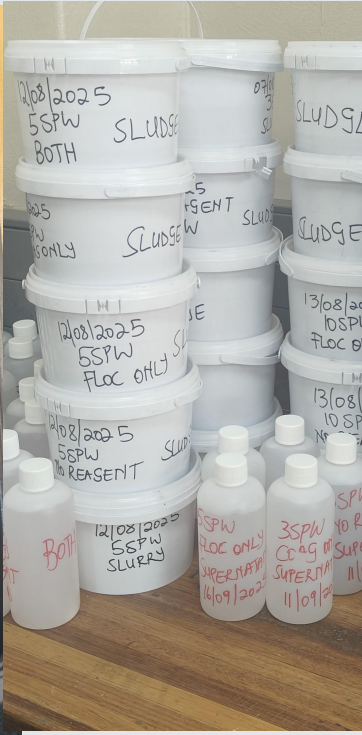


Settling Tests

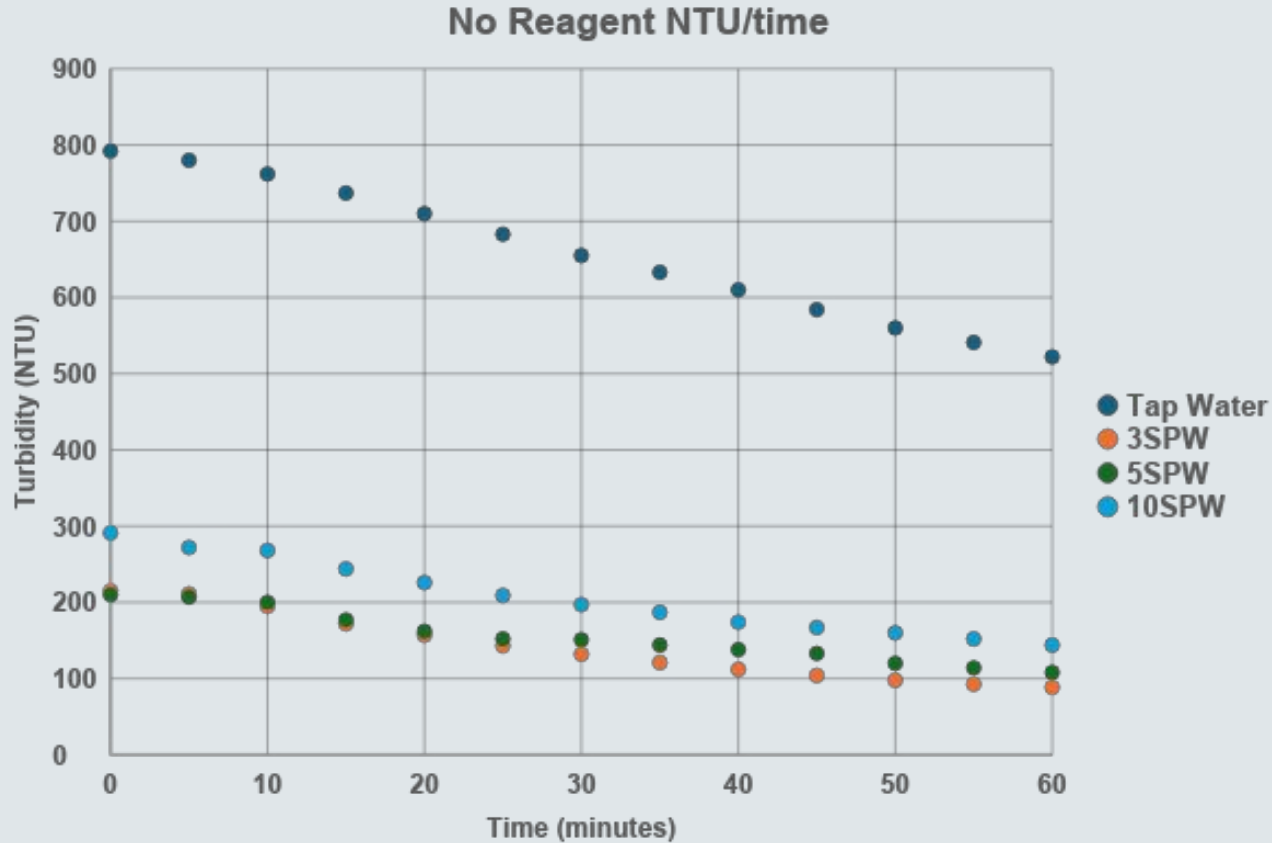
- Addition of a coagulant & flocculant
- Agitate for proper mixing



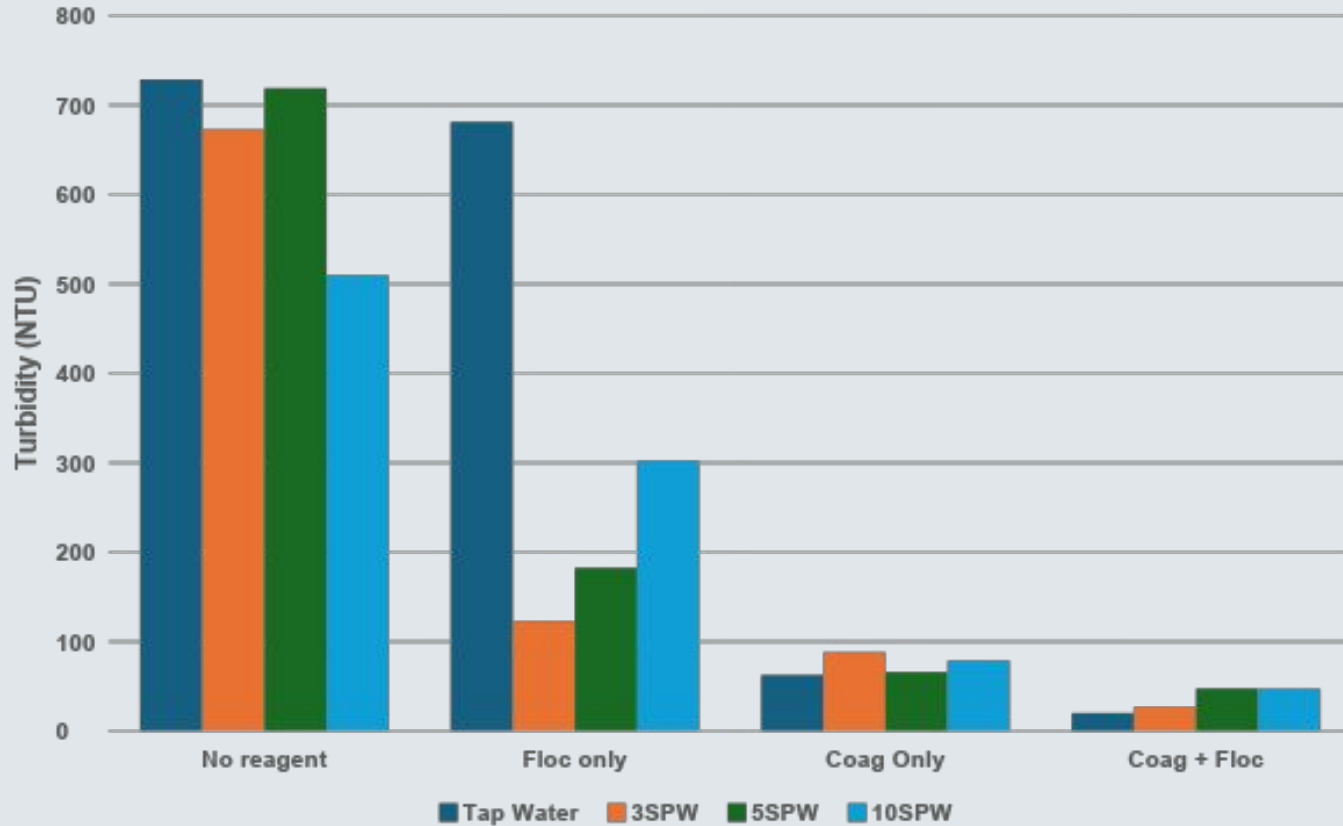
Clarity Testing after Tailings Dewatering



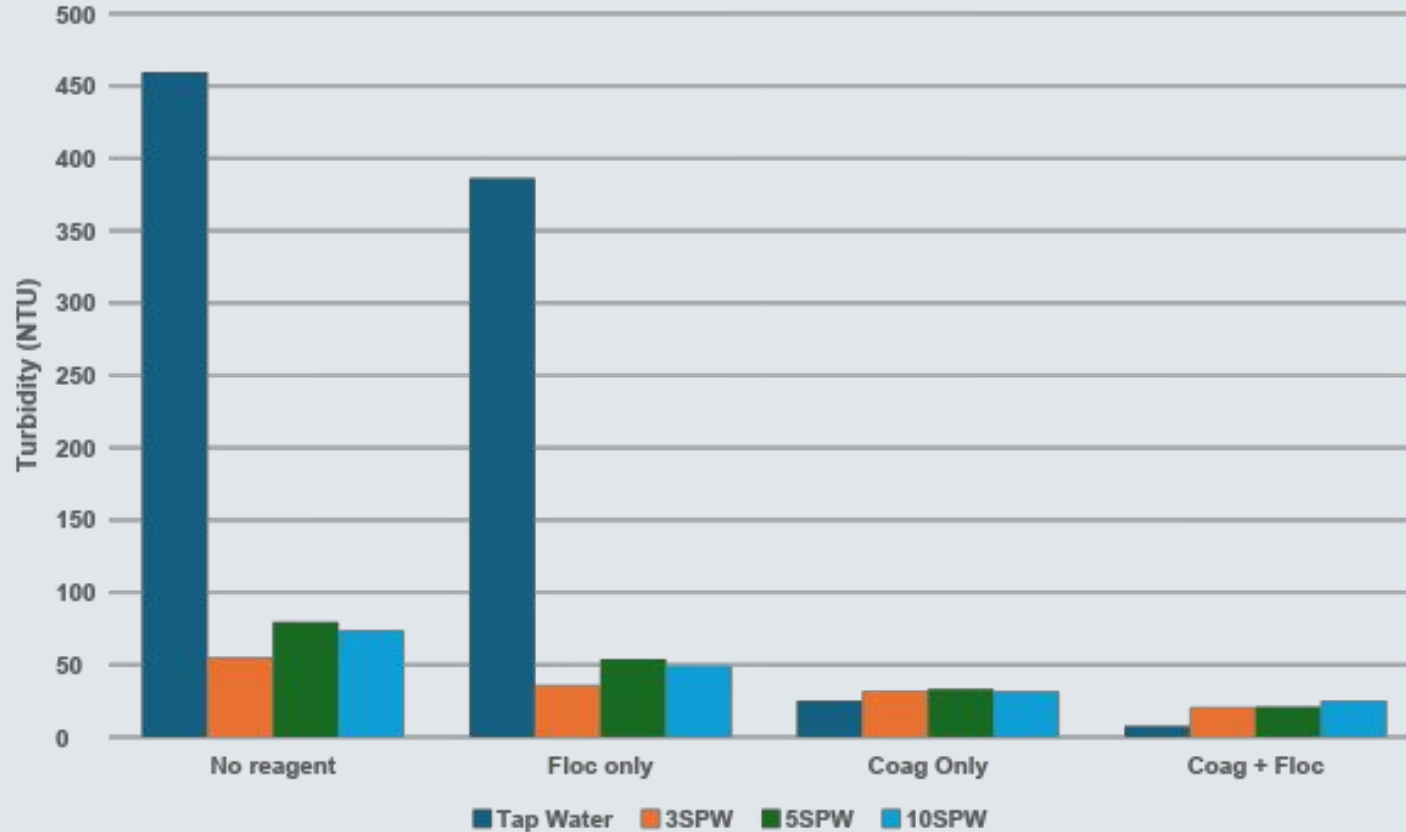
Results & Discussions



Turbidity after 5min of Settling

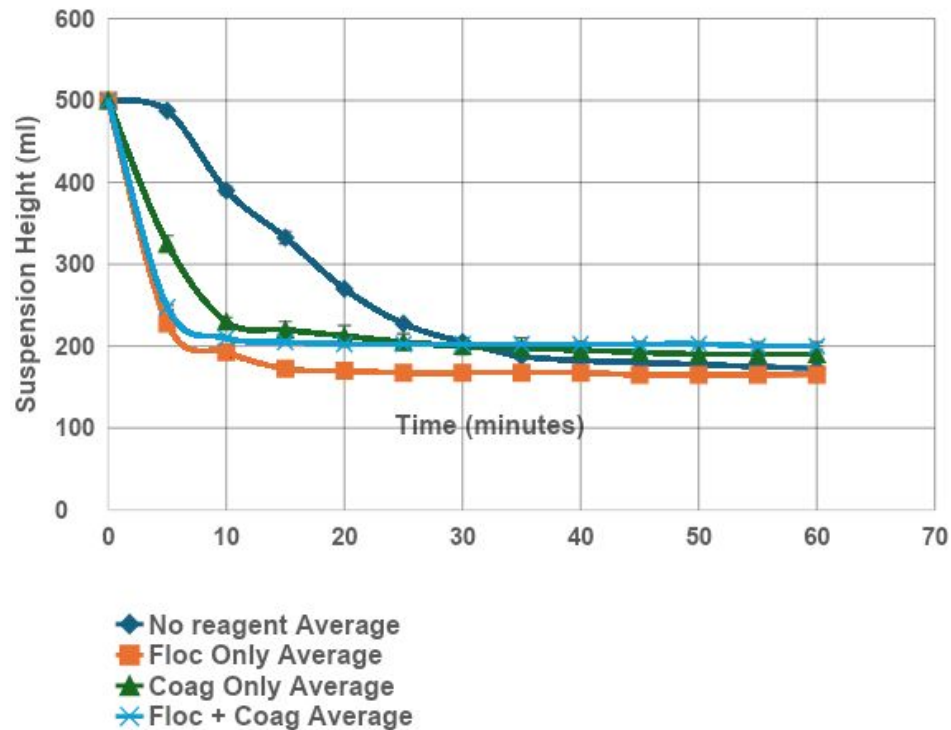


Turbidity after 1 hour of Settling

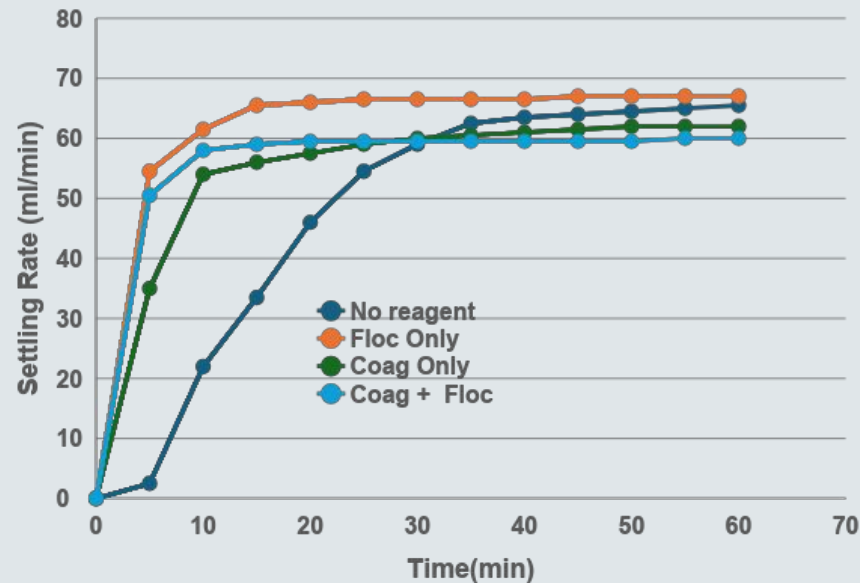


Results & Discussions

tap water Average

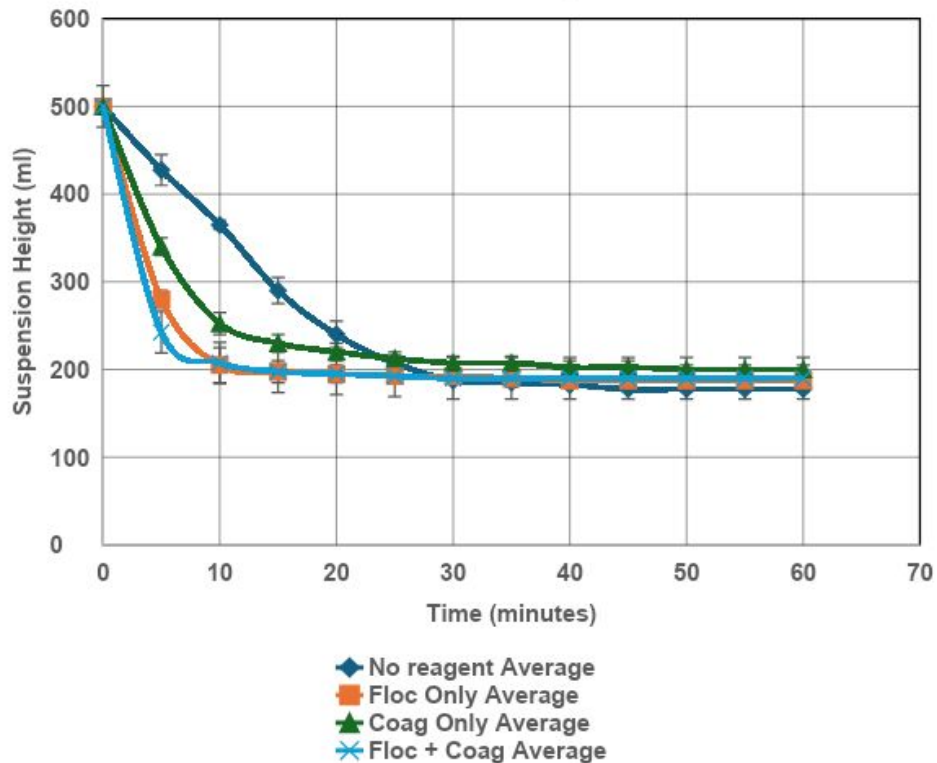


Tap Water

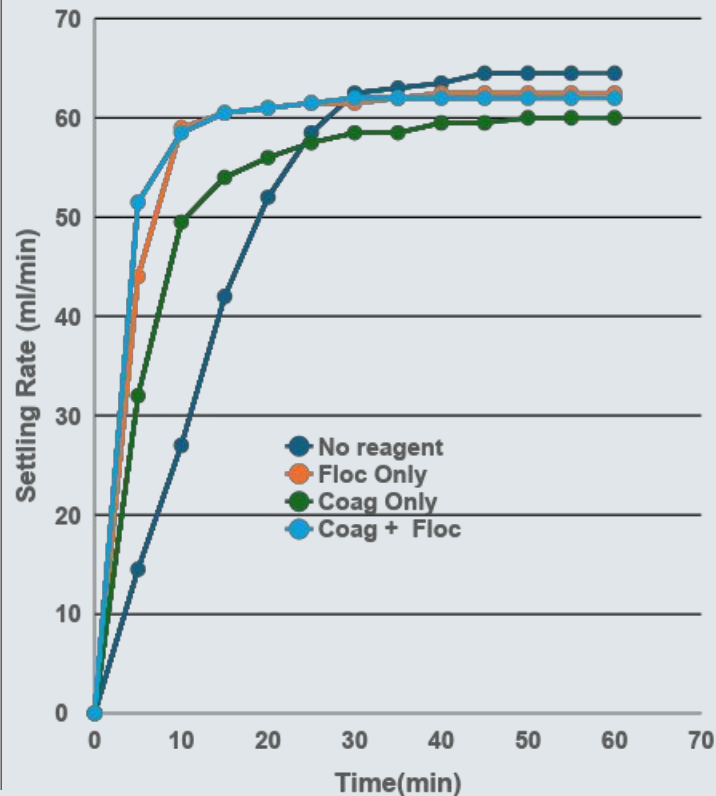


Results & Discussions

3SPW Average

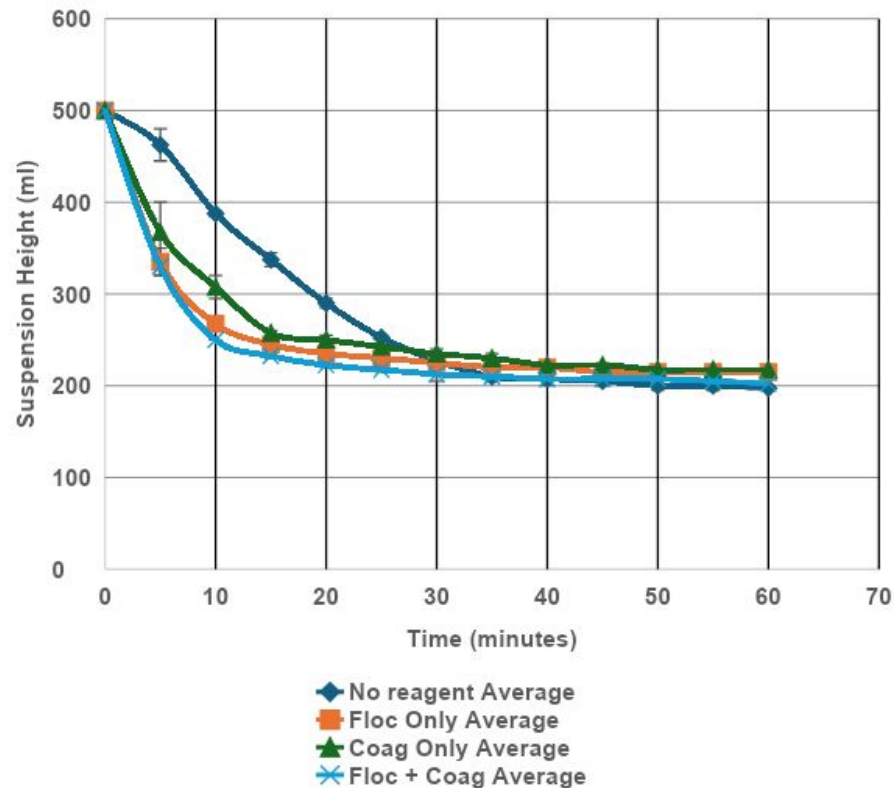


3SPW

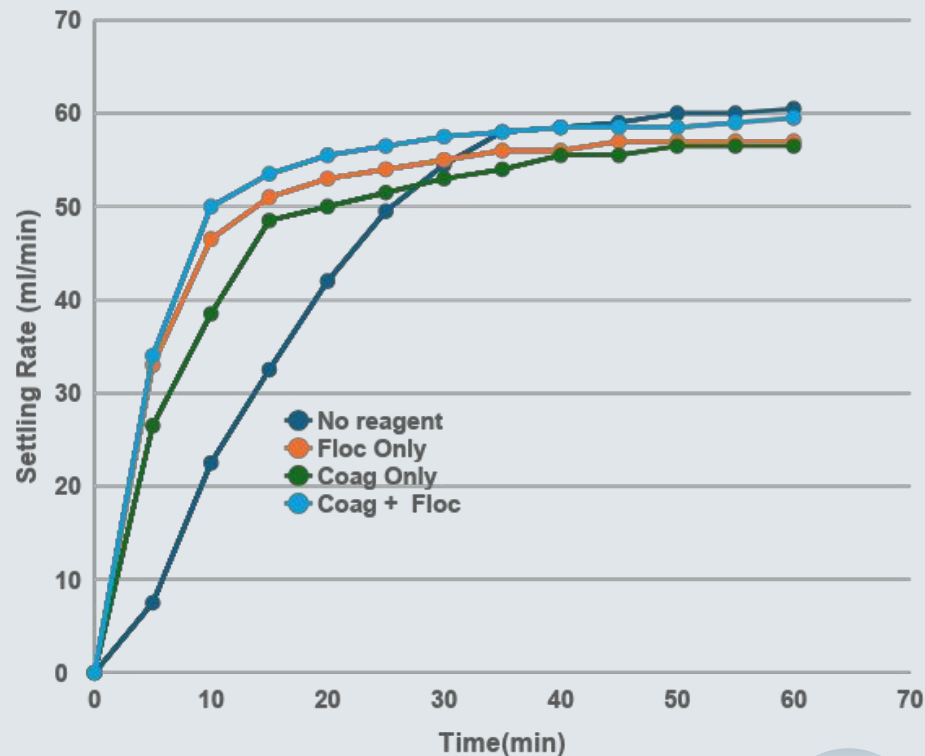


Results & Discussions

5SPW Average

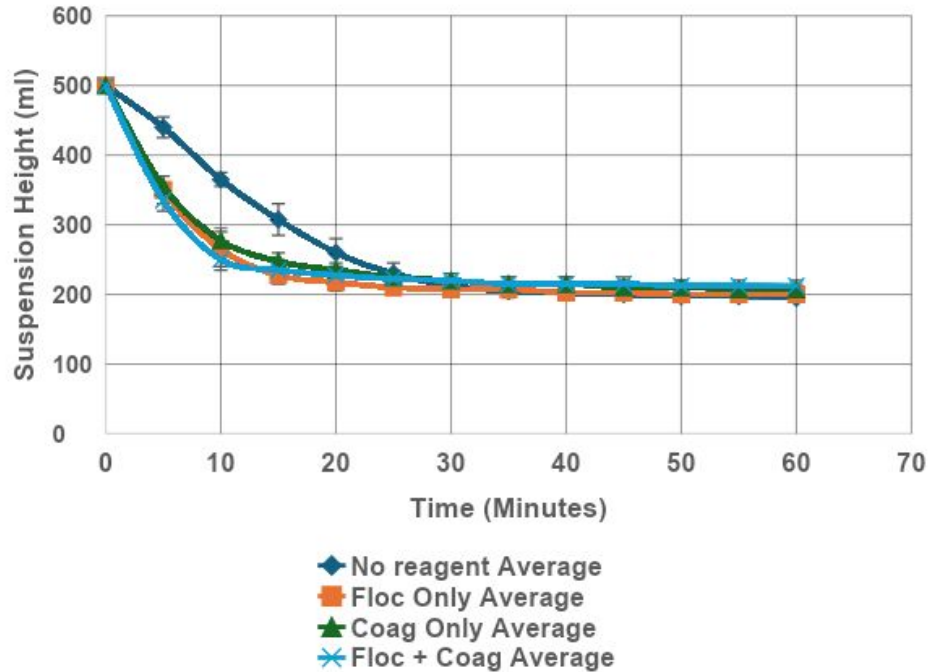


5SPW

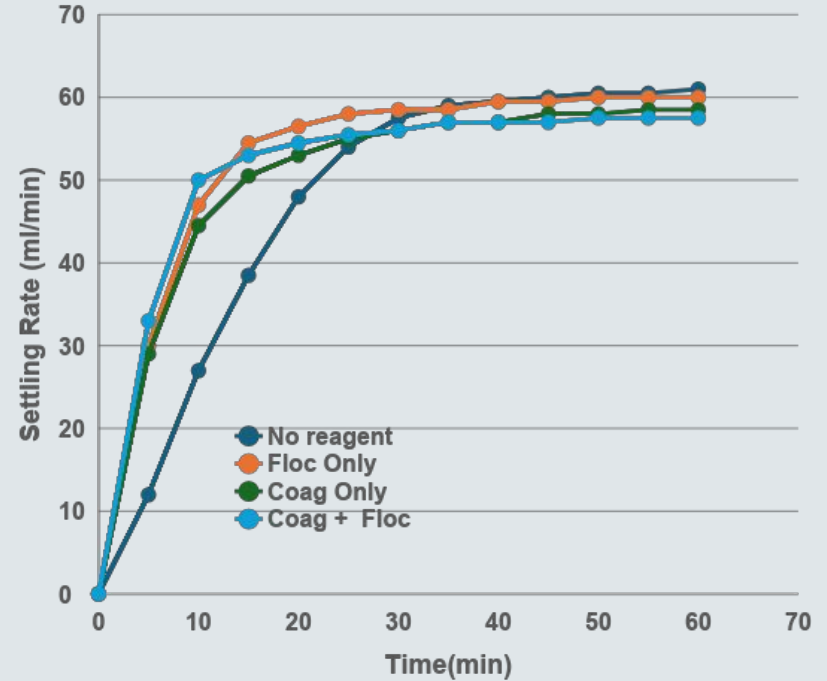


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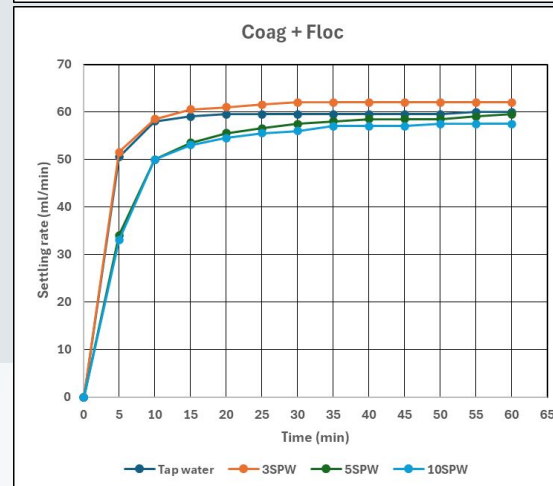
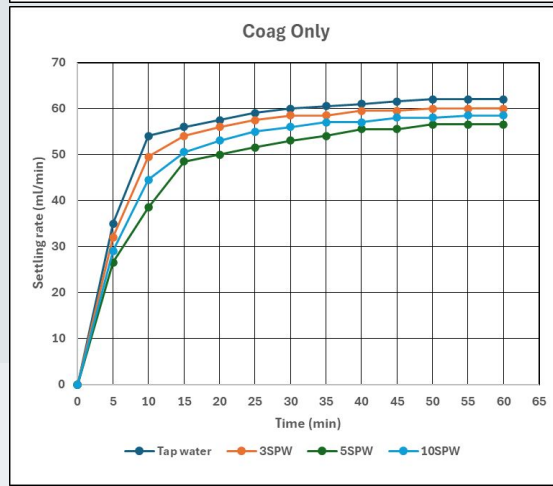
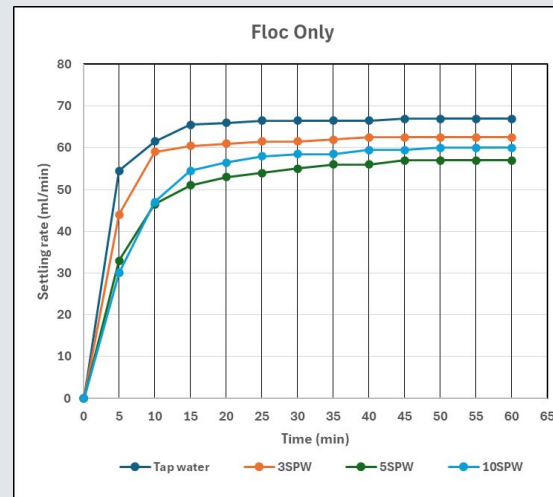
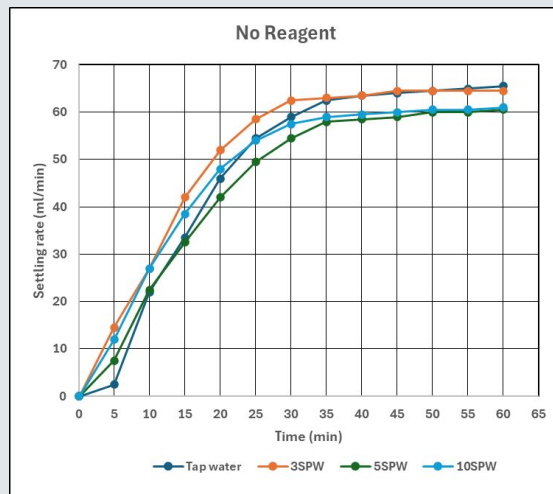
10SPW Average



10SPW



Discussions



Conclusions

- The dewatering unit operation is enhanced by coagulation and flocculation.
- The settling rates & turbidity are affected by process water quality.
- The 3SPW test with floc only reported improved performance.
- 5SPW and 10SPW tests reported poorer performance due higher ionic strengths.
- The mining operators need to optimize the dewatering units for better solid/liquid recovery.

Acknowledgements





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