# Improving PGM recovery through optimised solid liquid separation – Case study

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## Objectives

- Improve PGMs recovery through an optimized solid liquid separation process
- Bench-mark best practice for the operation of the  High-Rate Thickener (HRT) at the Precious Metal Refinery.

## Approach (Divided into 3 parts)

1. Laboratory Test work, by Solenis under Anglo American Technical Solutions guidance.
2. Plant process audit, by Solenis under Valterra Platinum guidance
3. Full scale plant trial, by Valterra Platinum under Solenis and Anglo American Technical Solutions guidance.

## Benefits

- Share learnings and knowledge among product suppliers, technical and operational teams.
- Collaboration- Final product is greater than the sum of individuals
- Share the learnings and benefits of the collaborative approach with other sites and operations

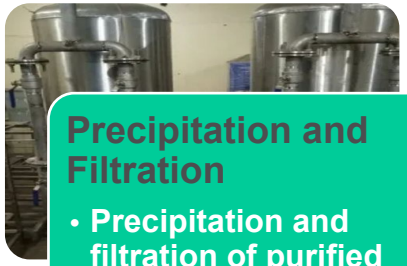
# Defining the problem and impact

**Leaching and Dissolution**

- Chemical leaching to dissolve PGMs

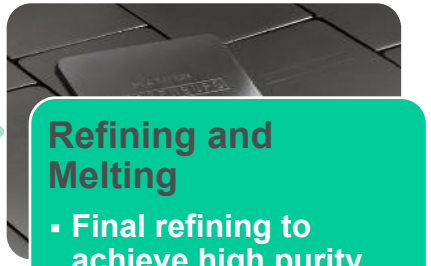
**PGMs Extraction**

- Separation of individual PGMs



**Precipitation and Filtration**

- Precipitation and filtration of purified metals

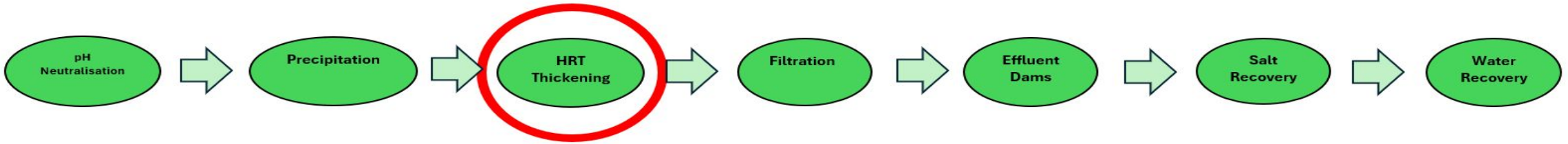


**Refining and Melting**

- Final refining to achieve high purity.

**Liquid Effluent Generating Processes**

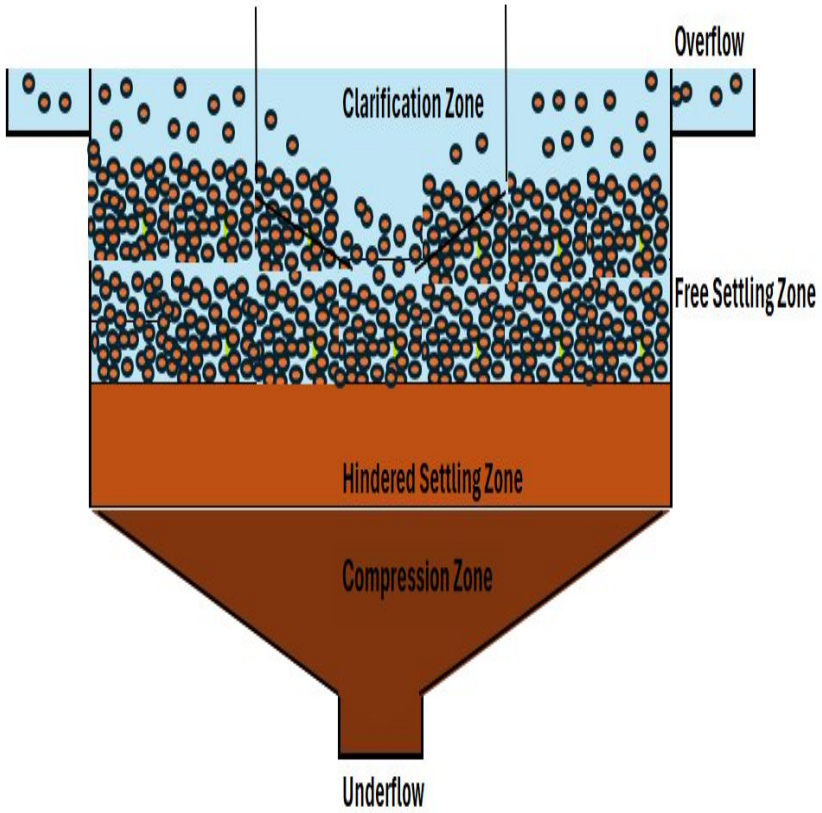
**PMR Effluent Treatment Process Overview**



# The Challenge: PGM losses through overflow stream

## Status of the HRT

- Feed rate, 20 $m^3$/h.
- Feed solids, 11.58%
- PGM losses > 30%
- O/F suspended solids > 500 mg/L
- O/F Turbidity > 168 NTU
- Slurry SG, 1.07
- No flocculent dosed




## Impact

- PGMs carry over/losses to the O/F
- Significant ZAR in actual losses.
- Environmental concerns – loading effluent dams with solids.

# Part 1: Laboratory Scale Screening Tests

Base case was compared against 7 different product from Solenis

**Parameters considered**

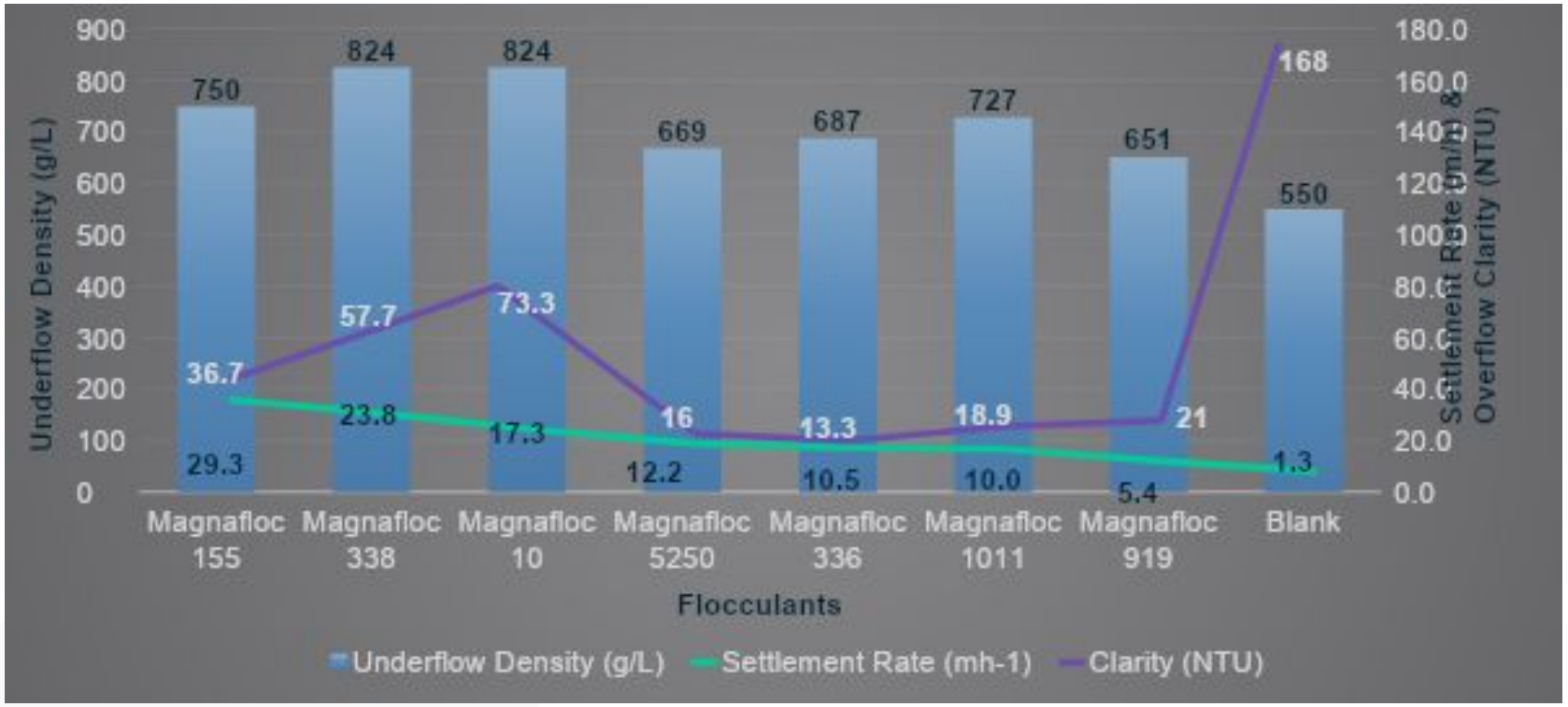
- Overflow clarity
- Underflow density
- Settling rate

**Products considered were the Magnafloc range**

Magnafloc™ 10 Magnafloc™336 Magnafloc™ 919 Magnafloc™ 5250

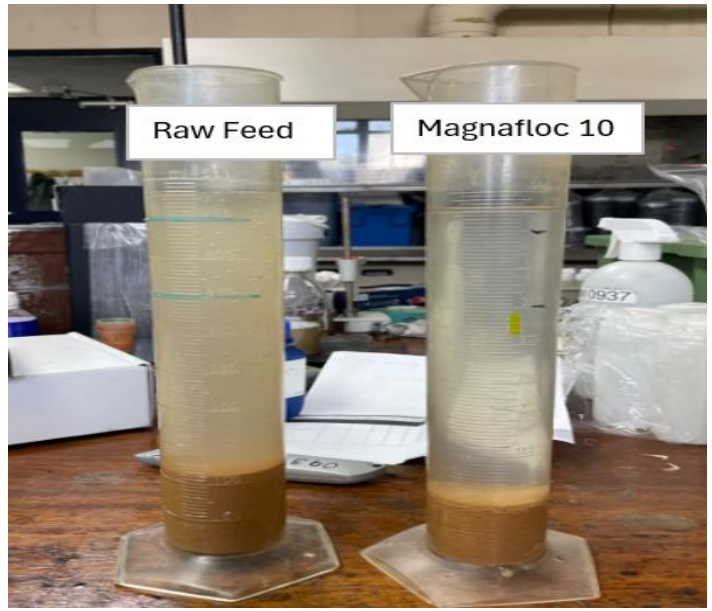
Magnafloc™ 155 Magnafloc™ 338 Magnafloc™ 1011

# Part 1: Laboratory Scale Screening Tests Results



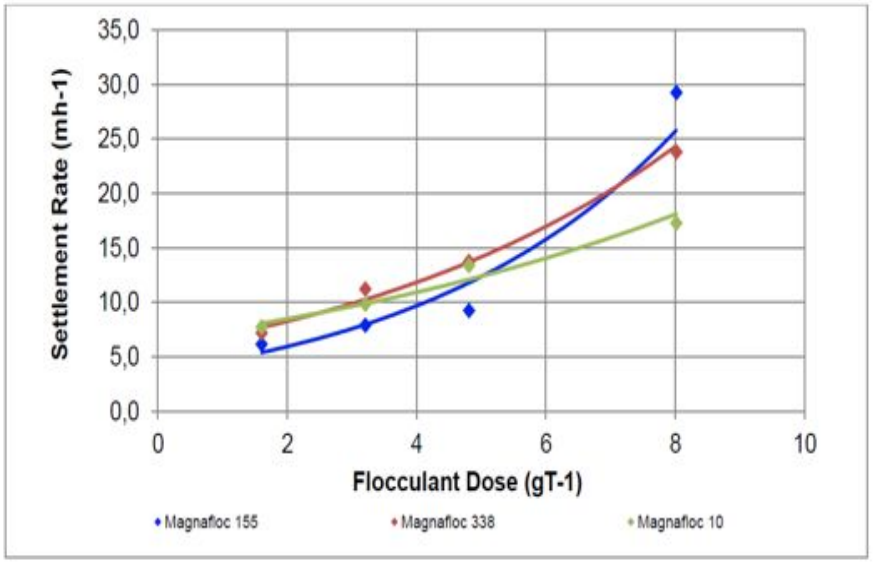

| Parameter | Spec. | Flocculant Ranking | | |
|---|---|---|---|---|
| | | 1st | 2nd | 3rd |
| Underflow density | Not specified | Magnafloc™ 10 | Magnafloc™ 338 | Magnafloc™155 |
| Settlement Rate | 2.5-5 m/h | Magnafloc™155 | Magnafloc™ 338 | Magnafloc™ 10 |
| Clarity | < 300 ppm | Magnafloc™155 | Magnafloc™ 338 | Magnafloc™ 10 |

**Dose profiling was performed on the three flocculants**



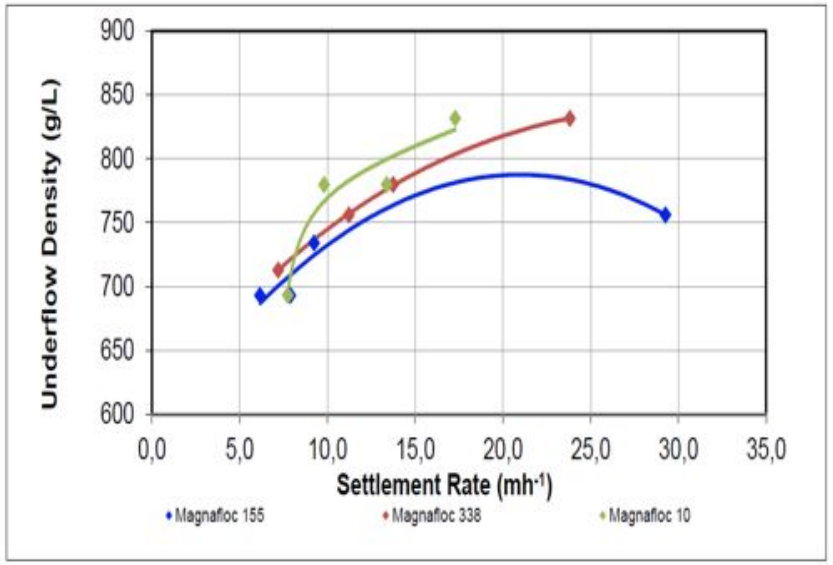

- Magnafloc™ 10, 155 and 338 were the best performers @ 8.2 g/t dose.
- Improved clarity from 168 NTU to 36.7 - 73.3 NTU
- Achieved settling rate of 17.3 m/h to 29.3 m/h vs 1.3 m/h for the base case.
- U/F density range of 750 g/L to

# Part 1: Laboratory Scale Screening Dose Profiling of the 3 best Performers



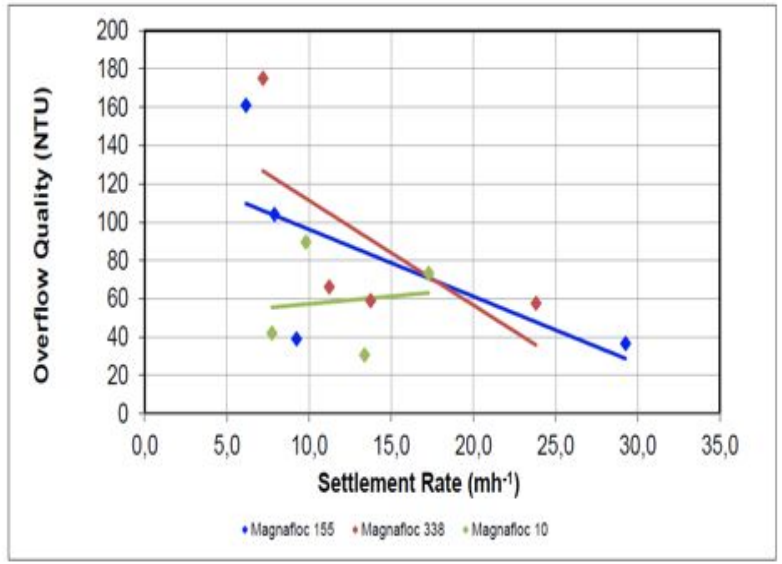

Settlement Rate vs. Flocculant Dose

Magnafloc$^{TM}$155 > magnafloc$^{TM}$338 > magnafloc$^{TM}$10




Underflow density vs. Settlement Rate

Magnafloc$^{TM}$10 > magnafloc$^{TM}$155 > magnafloc$^{TM}$338




Overflow Clarity vs. Settlement Rate

Magnafloc$^{TM}$10 > magnafloc$^{TM}$155 > magnafloc$^{TM}$338

- With advice from the product specialists (Solenis), magnafloc$^{TM}$10 was chosen as best for plant trial

# Part 2 – Plant Process Assessment

- Site has one HRT (~4.5m radius) that treat the effluent after precipitation of PGMs.
- Plant had functional flocculant dosing pumps that can achieve the desired flowrates up to 500 L/hr.
- Flocculent make-up unit on site was for a dry powder flocculent; Magnafloc$^{TM}$ 10 would be suitable to be used with the existing equipment.
- However, the flocculant make-up unit was poorly maintained and had an unknown product that had blocked the screw feeder.
- Screw feeder had no weightometer, hence mass of flocculant had to be measured manually
- After the screw feeder underwent maintenance; it was calibrated to ensure that it was dosing a consistent flocculant mass.
- The flocculant feed rate was set at 0.04% (m/v) concentration of flocculant.

# Part 3 – Full Scale Plant Trial

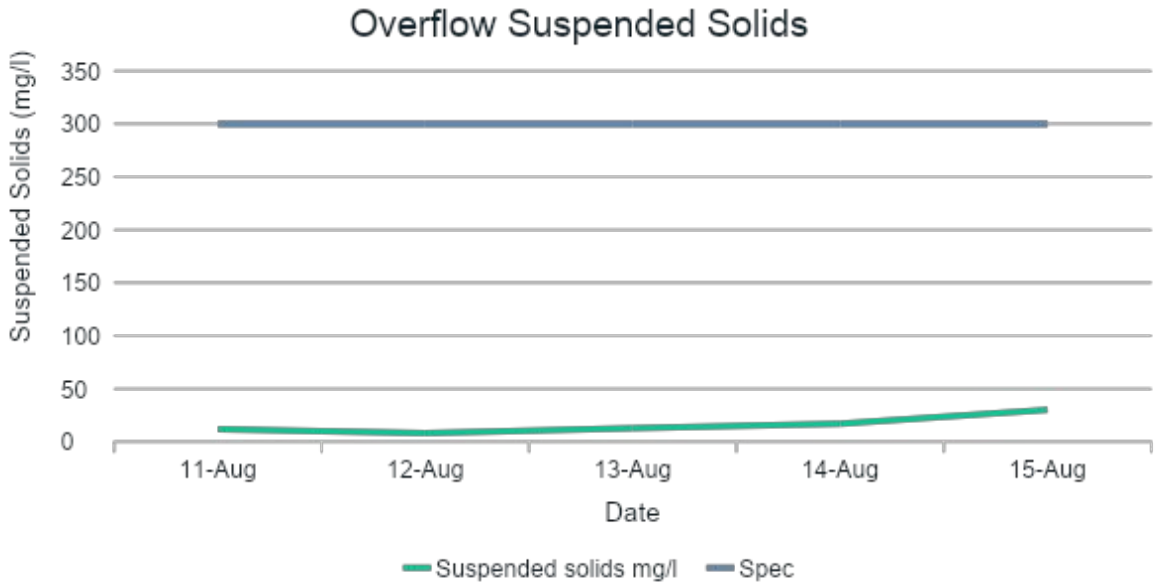
## Plant Conditions

- Screw feeder timer,  30s
- Flocculant concentration, 0.04%
- Flocculant addition, 6.7 g/t

## Results – Underflow

- S.G of 1.2 was achieved vs 1.1-1.3 design specification
- Filter press cake moisture improved by >61%

## Results- overflow




- O/F Suspended solids average  16 mg/L
- Suspended solids removal, > 97%
- Effluent PGM recovery increased by 31%
- Overall plant PGM recovery improved > tenfold.

# Before and After Solution Picture

Thickener Before dosing Magnafloc™ 10

Thickener After dosing Magnafloc™ 10

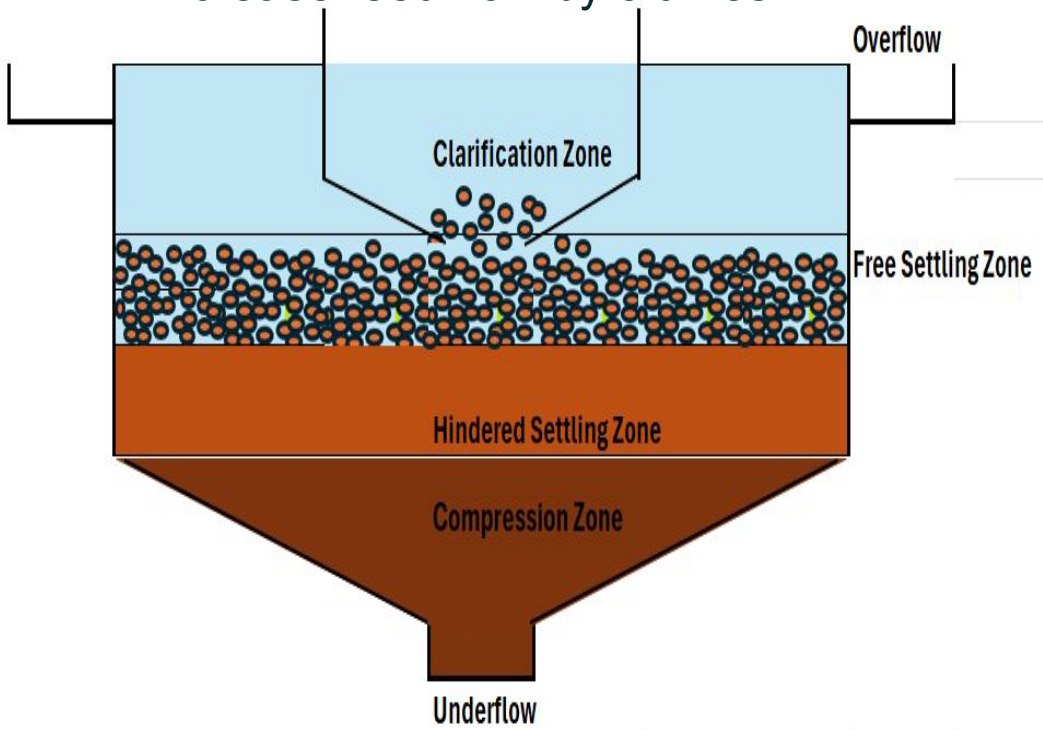
# Benefits of the implemented solution

**Improved PGM recovery.**

- Overflow suspended solids averaging 16 mg/L vs 300 mg/l; > 97% removal from feed slurry.
- Effluent PGM recovery increased by 31%
- Overall plant PGM recovery improved > tenfold.

**Potential to increase throughput**

- High settling rate >15m/l, potential increase feed flow by 3 times.




**Environmental Compliance**

- Reduced solids loading to effluent dam (overflow stream), positive impact on:
  1. Effluent dams structural integrity
  2. Effluent dams operational license.

**Downstream process improvements.**

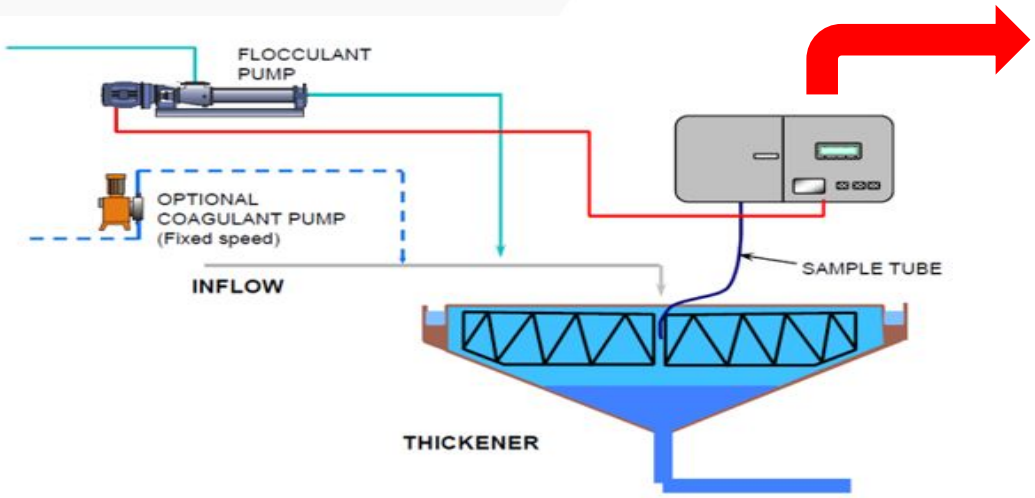
- Improved cake moisture by >61% in filter press due to increased underflow density.
- Reduction in chloride content in filter cake due to low moisture content.
- Reducing working load on filter press.

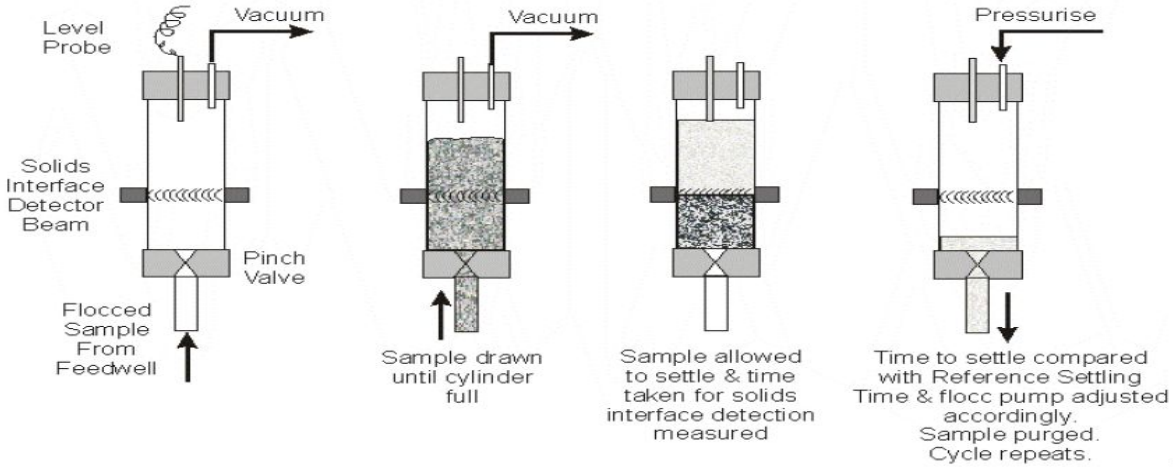
# Learnings and way forward

- Plant obtain basic monitoring equipment such as turbidity and density meters.
- Direct focus at ensuring high plant utilisation, and stable and consistent operation of the plant to prevent any PGM losses.
- Installation of a settling rate controller and bed level measurement equipment that will allow for automation and monitoring within the HRT. Benefits being:

**1. Consistent underflow density.** **2. Optimised flocculant addition** **3. Consistent solids settling velocity.**

**4. Prevention of solids carryover.**




Solenis Alcotech™ Operation Principle

# Acknowledgements