High Pressure Dewatering Rolls (HPDR) Mk-II: A Step-Change Technology for Sustainable Mineral Tailings Dewatering and Water Recovery

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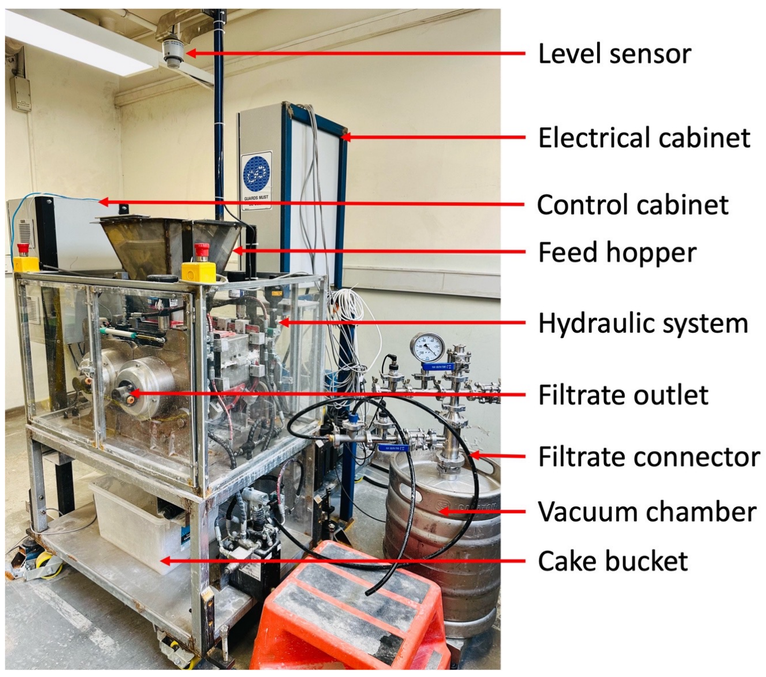
Priority Topic Area: **Materials, Mining and Minerals**

1 – The Problem & Solution

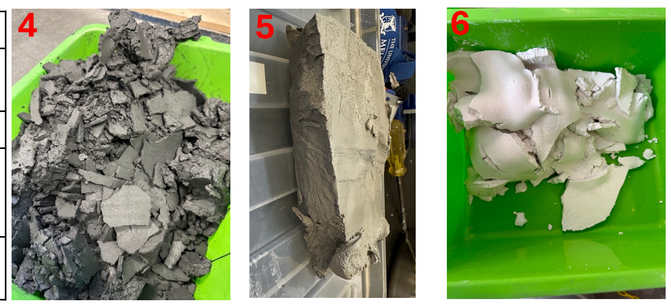
Mining produces billions of tonnes of tailings annually. With ore grade depletion and finer grinding, tailings now contain fine and ultra-fine fractions that are challenging to dewater. Conventional methods struggle to keep up, leaving wet, unstable tailings that increase dam failure risk, environmental damage, operational costs, and water loss.

HPDR Mk-II offers a step-change solution. Unlike conventional filtration or thickening technologies, it integrates high hydraulic pressure, vacuum, and shear in a compact, continuous system to produce high-solids, stackable tailings while capturing water for reuse. At TRL 4, lab-scale trials on diverse tailings show its potential to improve tailings stability and water recovery, enabling safer, more sustainable mining operations.



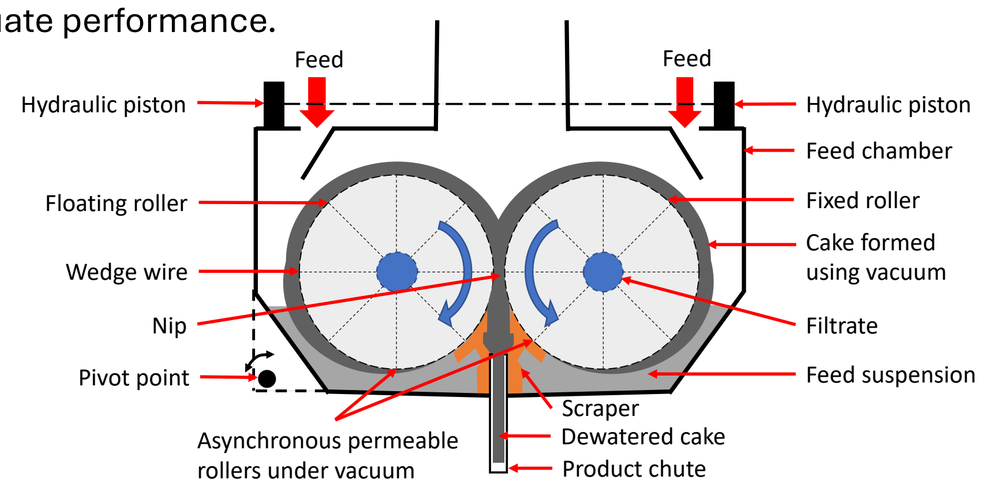
	1	2	3
Material	Red mud	Iron 01	Iron 02
D[3,2] (μm)	4.65	4.24	3.05
Equilibrium conc at 1 MPa (wt%)	59.1	75.2	84.0
HPDR cake conc (wt%)	**71.2**	**74.9**	**84.1**

	4	5	6
Material	Nickel	Copper	$CaCO_3$
D[3,2] (μm)	9.33	5.84	12.2
Equilibrium conc at 1 MPa (wt%)	85.0	82.9	83.3
HPDR cake conc (wt%)	**87.9**	**83.1**	**84.3**



2 – Technology Overview

HPDR Mk-II has two semi-permeable rollers: one fixed, one floating on a pivoting frame and pushed inward by hydraulic cylinders. Suspension is fed from the sides and vacuum draws liquid through 30 μm wedge wire screens, forming cakes on both rollers. The floating roller can move outward allowing dynamic adjustment of the nip gap. Cakes meet at the nip, are compressed under hydraulic pressure, and scraped off. Asynchronous roller speeds introduce shear, breaking weak particle networks and opening channels for trapped water to escape, enhancing filtration efficiency. Key metrics such as solids concentration, water recovery, and dewatering rate are monitored continuously to evaluate performance.



3 – Results

HPDR Mk-II has been tested with copper, nickel, red mud, iron ore tailings, and calcium carbonate suspensions. Lab-scale benchmarking was performed against a conventional filter press, the industry-standard technology for high-pressure tailings dewatering, using equilibrium pressures of ~1 MPa. HPDR consistently achieves similar or higher cake solids concentrations, demonstrating its ability to effectively dewater fine and ultra-fine tailings through the combined action of high hydraulic pressure, vacuum, and shear.

HPDR also delivers higher throughput per unit filtration area and operates continuously, avoiding the downtime required for cloth replacement and batch cycling in filter presses. The adjustable filtration path length also allows the system to handle tailings with varying dewatering behaviour.

Some practical considerations remain: while HPDR outperforms other dewatering devices in solids concentration and continuous operation, its throughput per footprint is lower than a large filter press due to the roller design. Scaling to industrial capacities will require optimisation of roller width, nip length, and hydraulic control.

Overall, lab-scale results validate HPDR's potential to improve tailings stability, recover water efficiently, and operate as a feasible, high-performance alternative to conventional dewatering technologies.

4 – Societal Impact

- Produces high-solids, dewatered tailings, reducing dam failure risk and environmental contamination, protecting communities and ecosystems.
- Recovers water for reuse, lowering freshwater demand and supporting water security (SDG 6).
- Minimises operational costs and waste, improving industrial resource efficiency (SDG 12).
- Reduces reliance on conventional tailings dams, lowering long-term environmental liability and land use.
- Mitigates climate impact by decreasing energy-intensive pumping and transport of wet tailings.
- Encourages circular economy practices, improves resource efficiency, and strengthens ESG compliance for mining companies.
- Has the potential to enable safer, more sustainable mining operations with reduced environmental footprints.

5 – Next steps

- Partner with a manufacturer to produce a pilot-scale HPDR (1 tonne/h) and advance the system to TRL 5 (pilot-scale validation).
- Optimise operating parameters for diverse tailings and conduct techno-economic analysis.
- Explore applications to other industrial suspensions beyond mining.
- Prepare for commercial deployment, enabling safer, more efficient, and environmentally sustainable industrial operations globally.

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References

1. Hassan, S., Cavalida, R., Ekanayake, N. I. K., Scales, P. J., Batterham, R. J. & Stickland, A. D. 2025. High pressure dewatering rolls Mark-II: A novel dewatering technology for mineral tailings. *Minerals Engineering,* 232, 109552.
2. Hassan, S., Cavalida, R., Scales, P. J., Batterham, R. J. & Stickland, A. D. 2026. High pressure dewatering rolls: Effect of process variables on cake solids concentration and throughput. *Powder Technology,* 473, 122139.

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