Optimizing Reverts Addition in PGM Smelting: Strategies for Enhanced Furnace Stability and Efficiency

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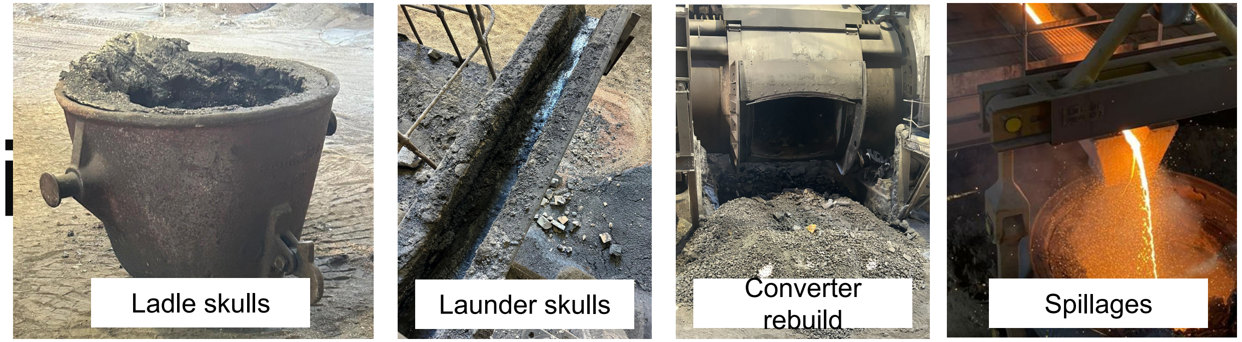
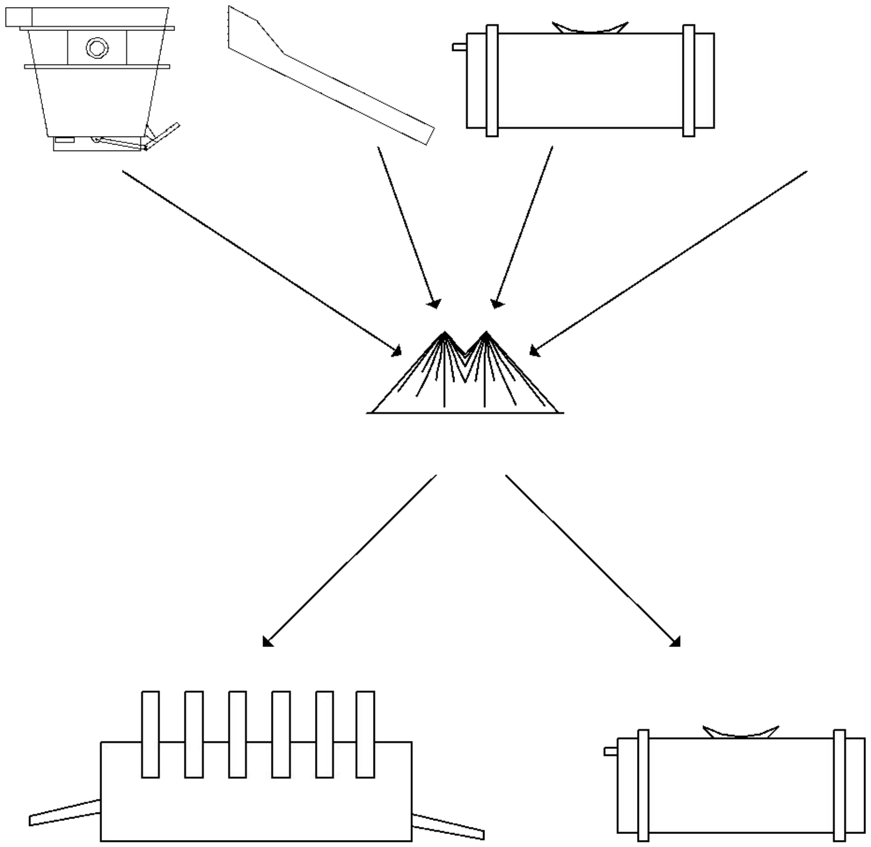
Context: Reverts i
PGM Smelting



- Reverts = process-derived materials (ladle/launder skulls, spillages, converter rebuilds)
- Contain high FeO content and valuable PGMs → recycled to recover metals & control furnace temperature
- Feed method + rate directly influence stability, energy efficiency & refractory life



Objectives & Approach

- Compare batch vs. continuous feed philosophies
- Quantify effect of reverts addition on:
  - Slag properties
  - Electrode behaviour
  - Furnace power, energy consumption, and production
- Develop framework for optimal reverts processing in PGM smelters

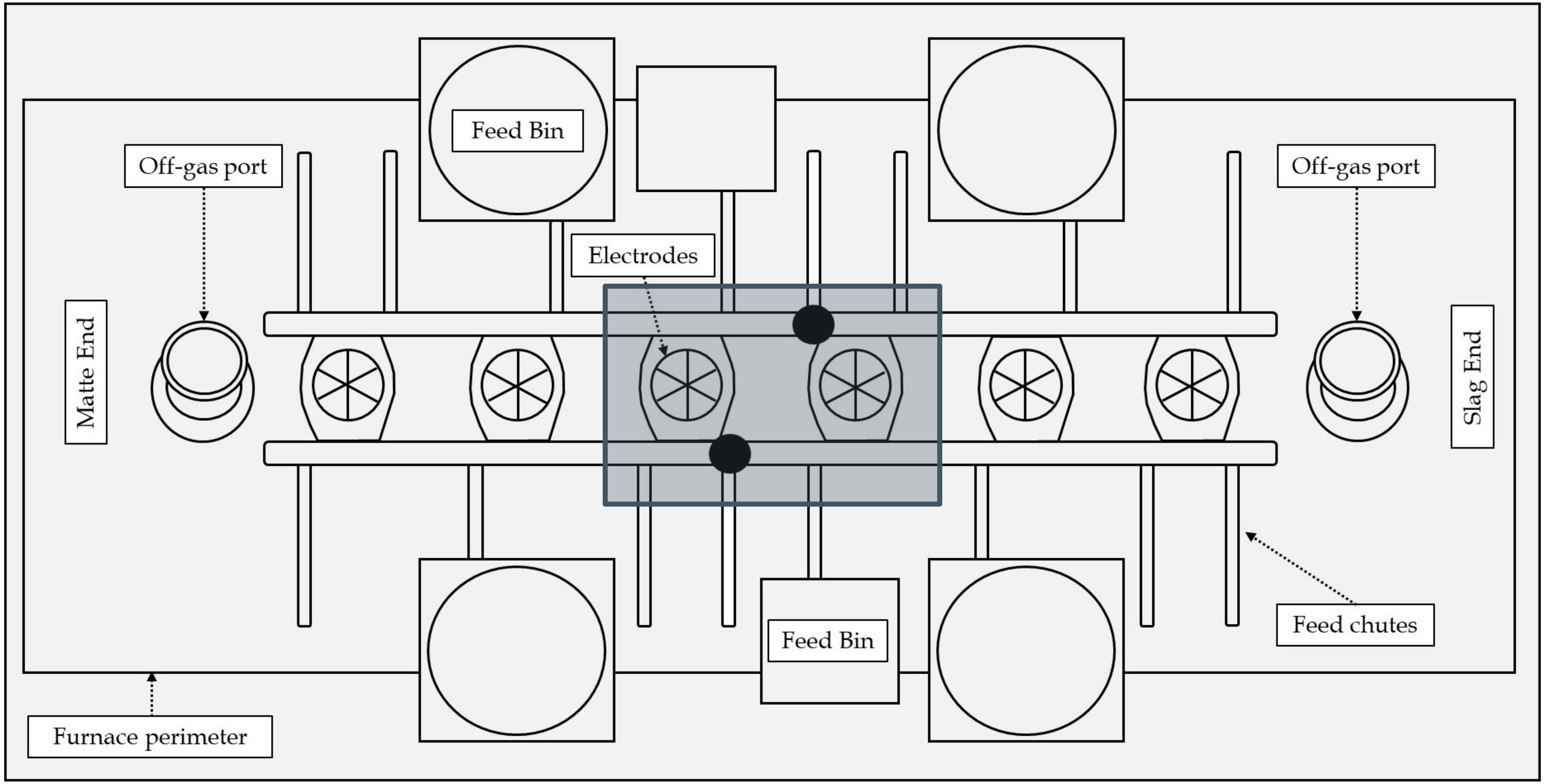
VS Compare

Electrical parameters

Process parameters

Develop

Case Study: Zimplats SMC Furnace 2



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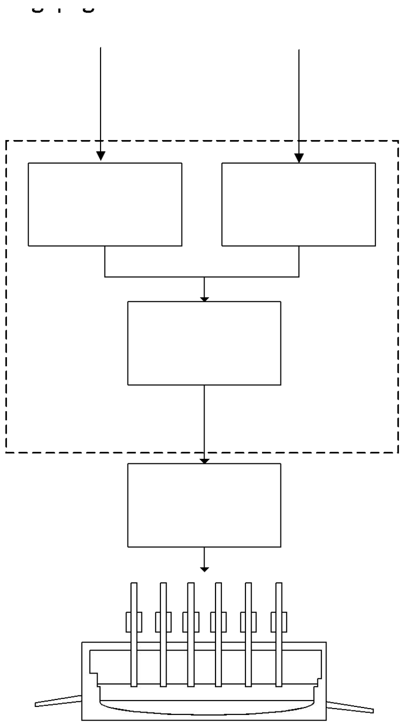
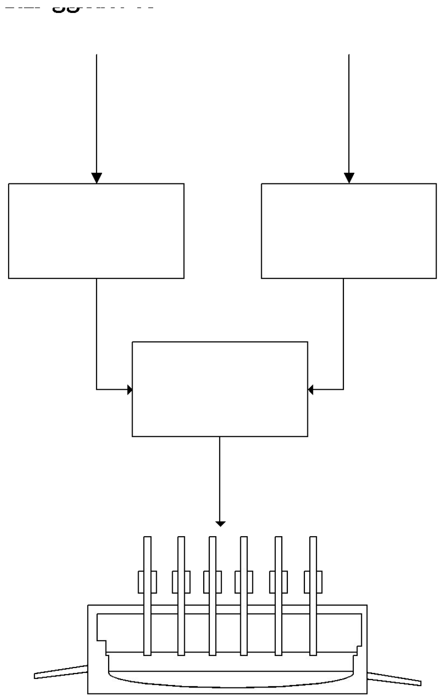
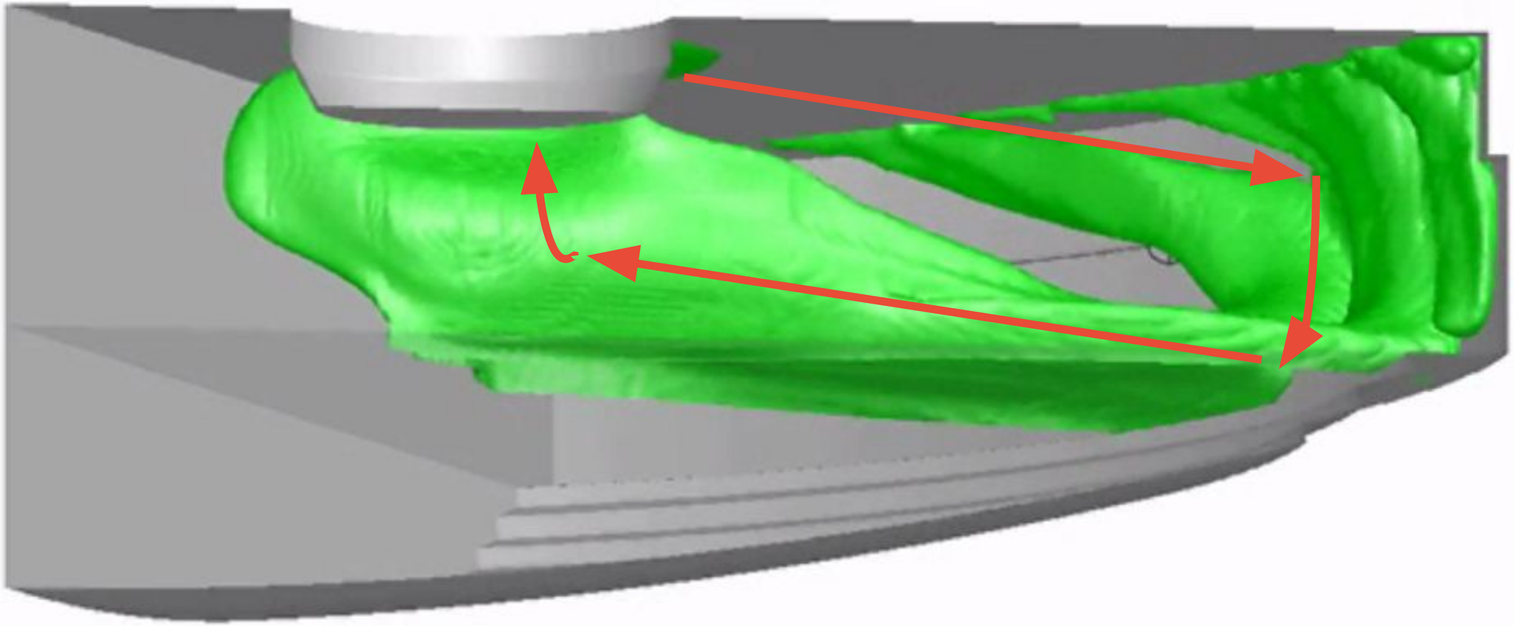
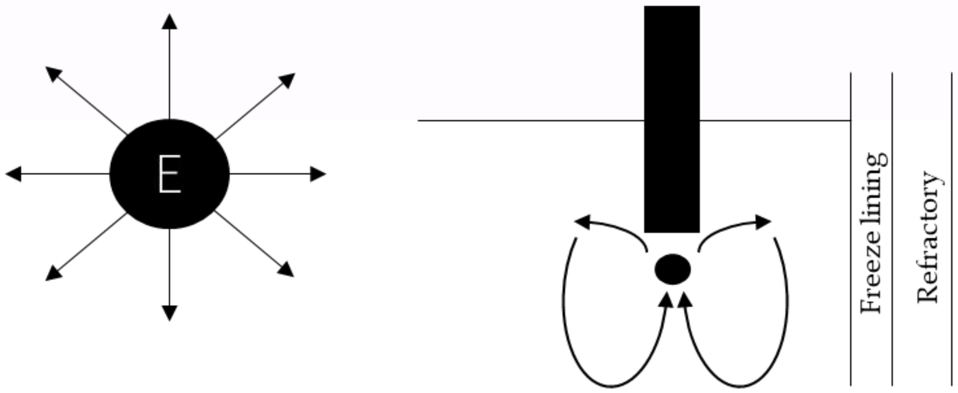
Reverts Handling and Feed Philosophies in the PGM Industry

Sibanye Stillwater Marikana Smelter	Sibanye Stillwater Columbus Smelter
	

Reverts Flow Patterns and the Localised Effect



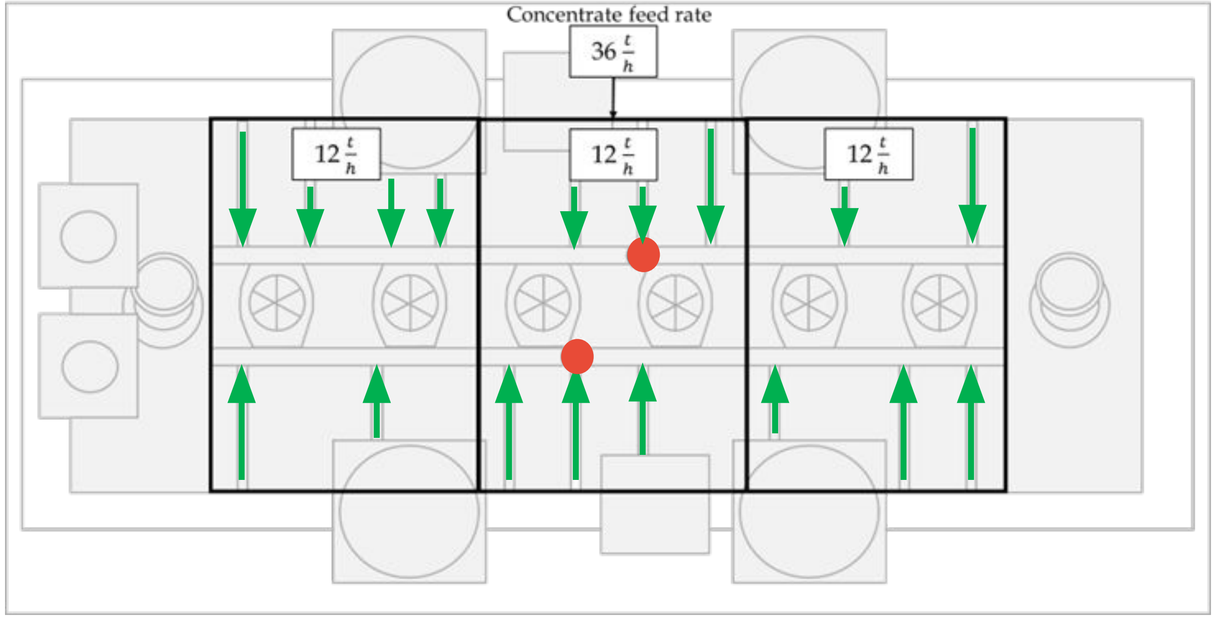
Tracer model developed by Ritchie and Eksteen (2011)



Flow occurs in all directions from electrode

Reverts Flow Patterns and the Localised Effect

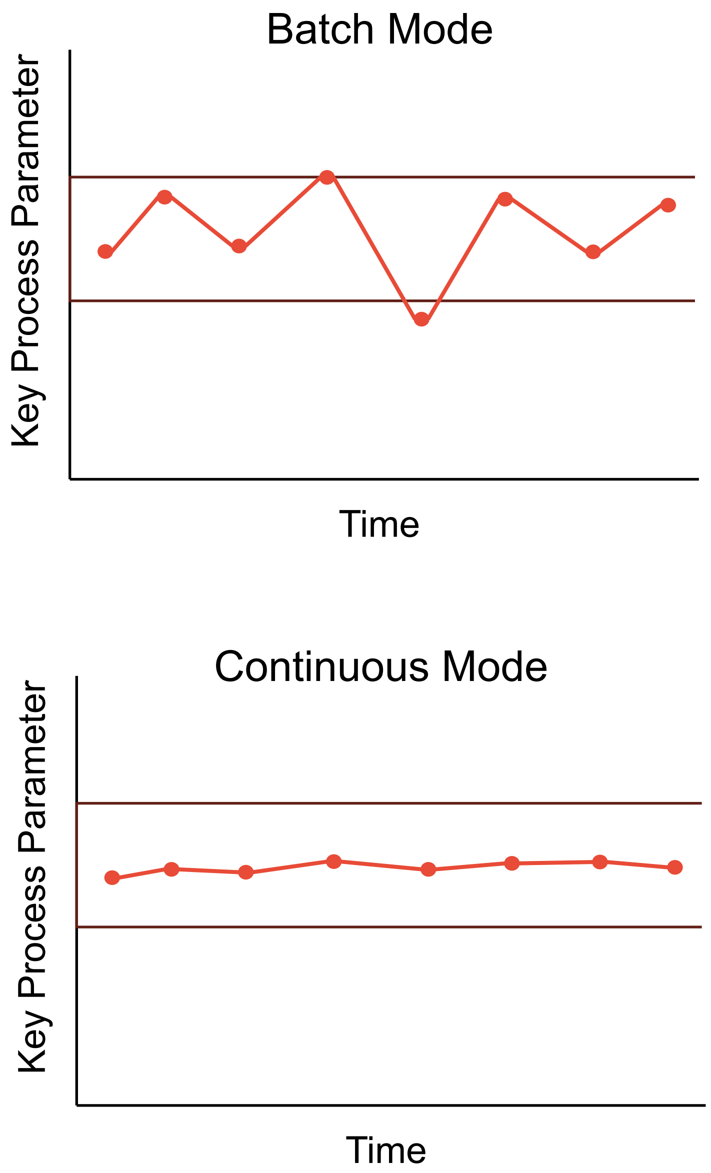
Localized vs. Well-distributed



Description	Unit	Base case	Localised	Well-distributed
Reverts addition	tpd	0 (0% of feed)	26.4 (3% of feed)	26.4 (3% of feed)
	tph	0	3.3	1.1
Reverts feeding time	h	0	8	24
Localised feed rate	tph	0	9.9	1.1

Batch vs. Continuous Feed Comparison

- Batch feeding → operational disruptions + fluctuations in parameters → process instability + difficult process control
- Continuous feeding → maintains steady-state conditions + minimizes parameter fluctuations → stable operation + easier process control



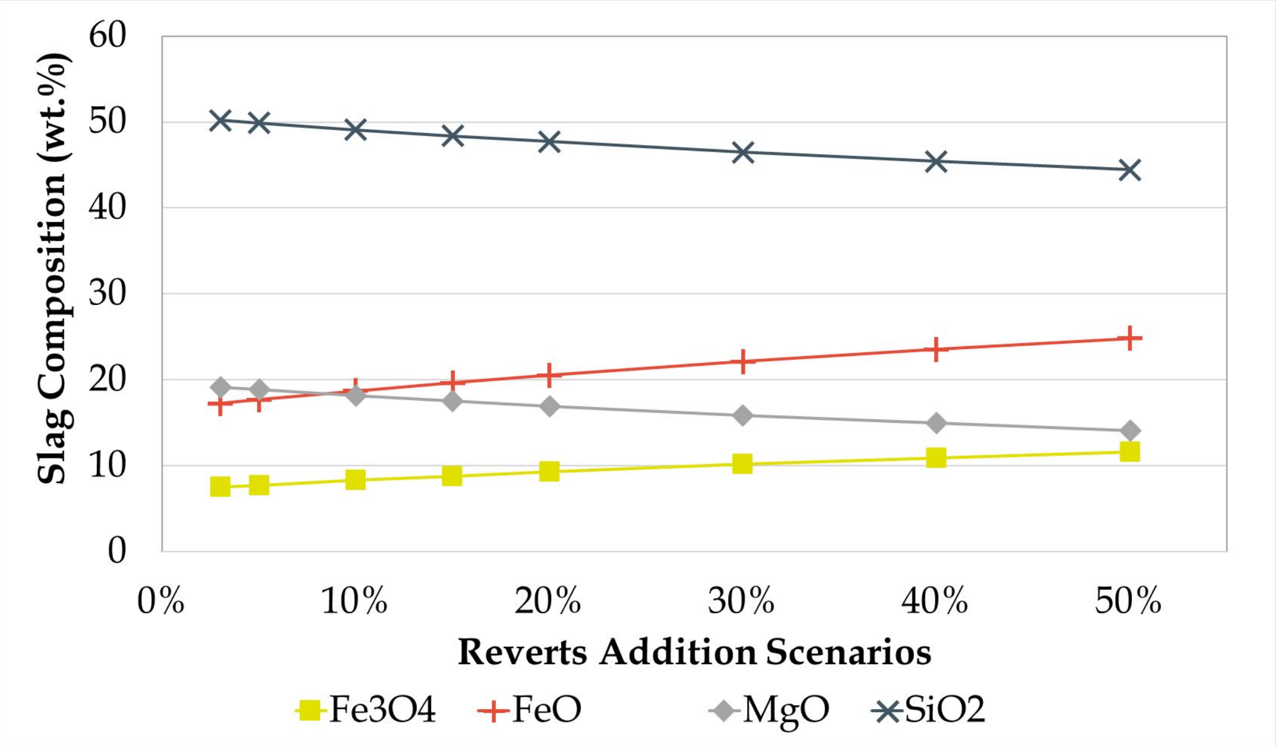
Modelling Approach

- Metsim™: mass & energy balance modelling
- FactSage™: slag phase & liquidus temperature modelling
- Scenarios: 3 % – 50 % reverts (of concentrate feed, simulating batch mode concentration)

Inputs → Metsim™ → Factsage™ → Outputs

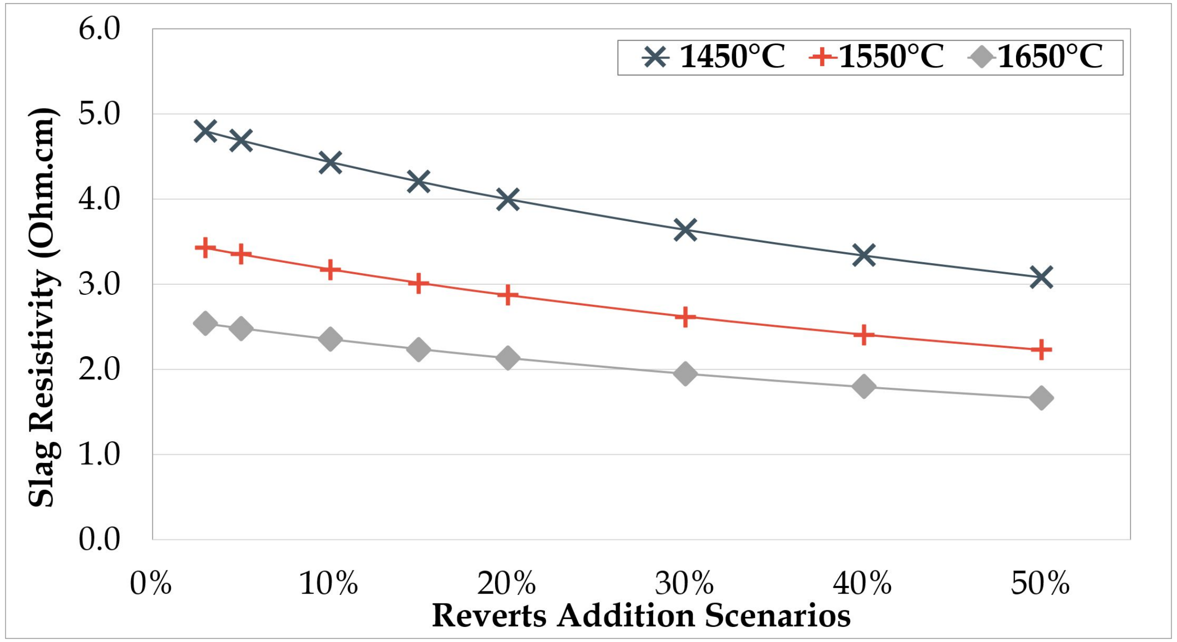
Slag Properties

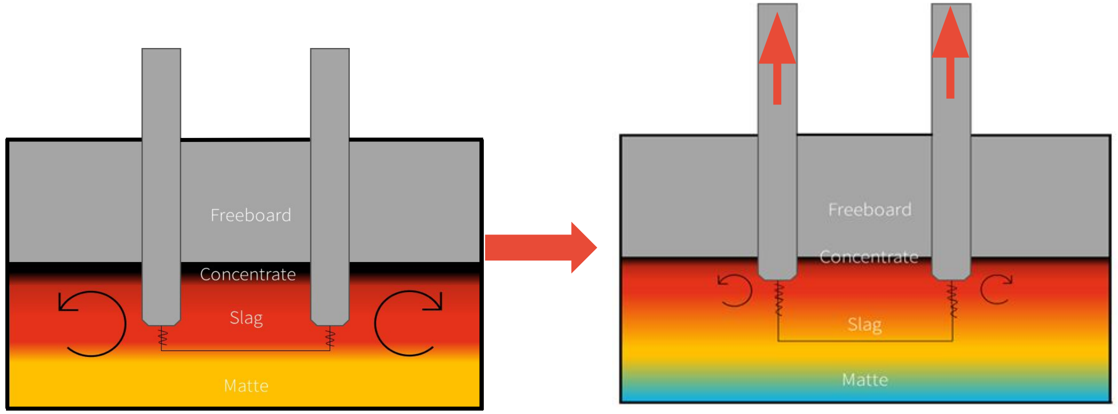
- Increasing FeO due to reverts comprising predominantly of converter slag
- Typically, ~77% converter slag, 21% furnace matte, and a small amount (~2%) converter matte
- Contextualise how these changes influence furnace electrical and process parameters



Electrical Impacts

- Increasing FeO resulting in ↓ resistivity and ↑ conductivity
- ↓ Resistivity → decreased electrode pair resistance
- Fixed setpoints → shallower immersion
- SMC limiting factor → transformer current capacity





Context

Objectives

SMC Case

Industry Benchmarks

Reverts Flow Patterns

Batch vs Continuous

Modelling Approach

Slag Properties

Electrical Impacts

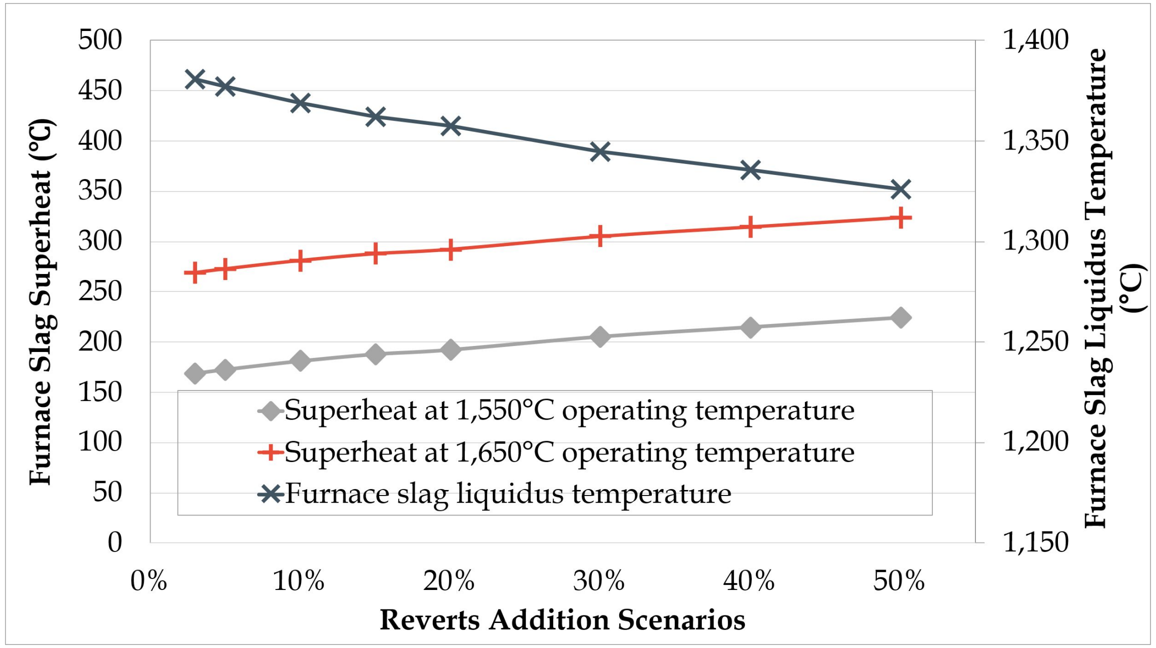
Process Impacts

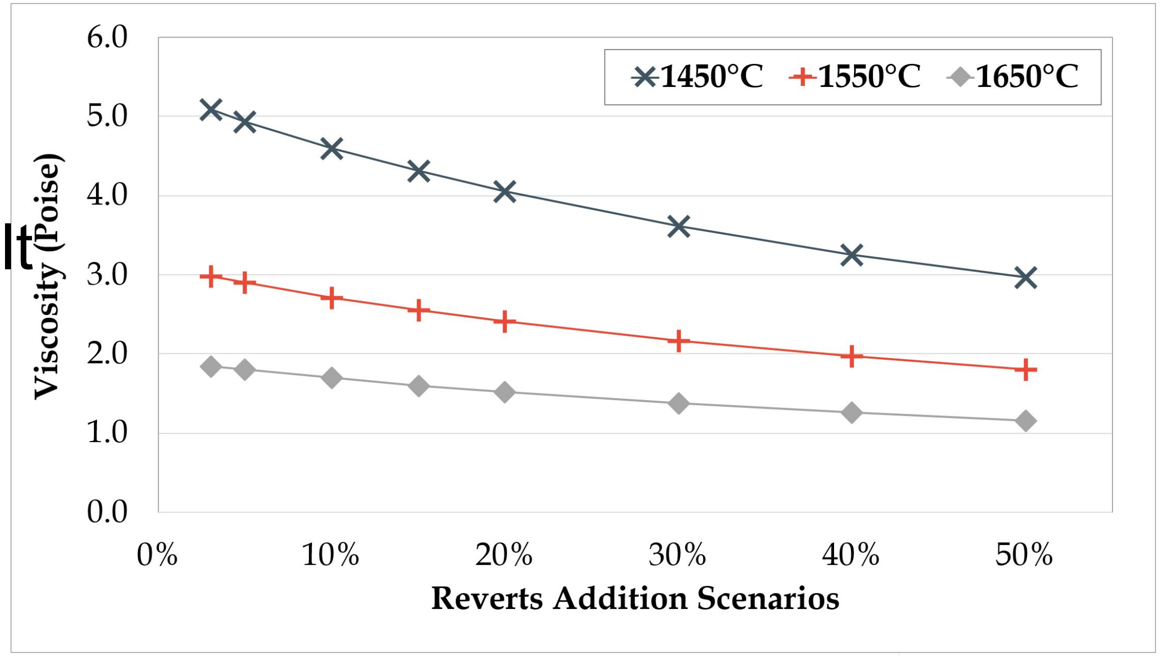
Conclusion

Thank you

Process Impacts

- FeO fluxes slag → lowers liquidus temperature & viscosity
- Benefits: easier tapping, lower PGM losses to slag
- Risks: increased slag velocity → potential mechanical erosion of freeze lining / tapholes
- ↑ Energy requirements to smelt cold material
- Potential converter capacity constraints





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Conclusion

- Feed strategy is as critical as feed chemistry.
- Continuous, well-distributed feeding = greater stability & efficiency.
- Avoid batch feeding if distribution constraints exist.
- Evaluate reverts quantity based on electrical + process impacts.

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References

- Eksteen, J.J., Van Beek, B. and Bezuidenhout, G.A. (2011). Cracking a hard nut: an overview of Lonmin's operations directed at smelting of UG2-rich concentrate blends. Journal of the Southern African Institute of Mining and Metallurgy, 111(10), pp. 705-716.
- Eric, R.H., 2004. Slag properties and design issues pertinent to matte smelting electric furnaces. Journal of the Southern African Institute of Mining and Metallurgy.
- Fallah-Mehrjardi, A., Hayes, P.C. and Jak, E., 2014. Understanding Slag Freeze Linings. JOM, 66, pp.1654–1663.
- Geldenhuys, I., Jones, R.T., McCullough, S. and Fotoyi, Z., 2010. Refractory erosion during reductive PGM matte smelting. Mintek, Randburg, South Africa.
- Shaw, A., de Villiers, L.P.v.S., Hundermark, R.J., Ndlovu, J., Nelson, L.R., Pieterse, B., Sullivan, R., Voermann, N., Walker, C., Stober, F. and McKenzie, A.D., 2014. Challenges and solutions in PGM furnace operation: high matte temperature and copper cooler corrosion. Journal of the Southern African Institute of Mining and Metallurgy, 113(3), pp.233–242.
- Hundermark, R., 2003. The electrical conductivity of melter type slags. Master's thesis, University of Cape Town.
- Mabiza, L. 2006. An overview of PGM smelting in Zimbabwe – Zimplats operations. South African Institute of Mining and Metallurgy, Johannesburg, 63 - 76.
- Mills, K.C., 2011. The estimation of slag properties. Presented at the Southern African Pyrometallurgy 2011, 7 March 2011. Department of Materials, Imperial College London.
- Munroe, M.M., 1986. Refractory erosion index in electric arc furnaces. JOM, 38, pp.51–52.
- Nell, J. (2004). Melting of Platinum Group Metal Concentrates in South Africa. Journal of the South African Institute of Mining and Metallurgy, 104 (7), 423–428.
- Ritchie, S. and Eksteen, J.J. (2011). Investigating the effect of slag bath conditions on the existence of multiphase emulsion zones in PGM smelting furnaces using computation fluid dynamics. Minerals Engineering.
- Roset, G., McNeill, T.J., Millard, L.M. and Roset, G.K., 1992. Electric furnace operation at the Stillwater Mining Company’s precious metals smelter. Proceedings of the International Symposium on Non-ferrous Metals, Trace Elements, Furnace Practices and Energy Efficiency, pp.279-287
- Sohn, H. 2014. Non-ferrous process principles and production technologies. Treatise on Process Metallurgy, p. 533. Elsevier.
- Warner, A.E.M., Díaz, C.M., Dalvi, A.D., Mackey, P.J., Tarasov, A.V. and Jones, R.T., 2007. JOM World Nonferrous Smelter Survey Part IV: Nickel: Sulfide. JOM, 59(4), pp.58–72.
- Van der Colf, J. and Howat, D.D., 1979. Viscosities, electrical resistivities, and liquidus temperatures of slags in the system CaO-[illegible]utral conditions. Journal of the Southern African Institute of Mining and Metallurgy, 79(9), pp.255–264.