Alumina Fines and the Impact on Aluminium Smelting

Client: Outotec

Location: TRIMET Aluminium SE, Essen, Germany

The Project

This fundamental research project was proposed to look at smelter-wide implications of alumina quality (particularly the fines), the link to calciner technology, and to estimate the true 'cost' of each alumina.

LMRC's Role

1. LMRC staff obtained, aided by TRIMET staff, judiciously chosen alumina samples, and performed extensive characterization (XRD/Rietveld refinement, surface area and pore size measurements, thermal analysis, particle size).
2. LMRC scientists developed and implemented multiple regression analysis methods to study a large sample of pot, emissions, weather and materials data to extract the role of alumina quality on plant operations.

Results

Alumina and HF generation

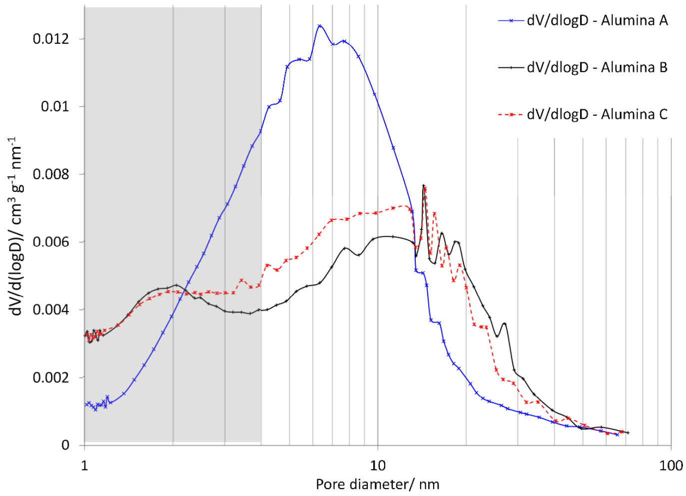
Residual structural hydroxide is widely thought a key source of hydrogen in HF generation. Our models confirm increased Gibbsite (in the fines) increases HF generation, but also reveal that local humidity has a far more pronounced effect than previously expected. We find a strong positive correlation with alumina feeds; having accounted for structural hydroxides already (as Gibbsite) this most likely implicates adsorbed atmospheric moisture as a major HF source.

Alumina and Fluoride Cycle

Bath acidity is associated with fluoride content hence anticipated to depend on alumina Specific Surface Area (SSA, which measured using BET method); high SSA aluminas adsorb, and hence recycle, more fluoride. Unexpectedly, our detailed analysis show that the conventional BET measurement is a poor descriptor; instead, using pore size distribution analysis (BJH-method) with surface area measurement show a clear correlation with bath acidity, but only once pores smaller than ~3 nm are ignored. This, and reconstructions of the pore size distributions (PSDs) of secondary aluminas (Figure 1, top) are in excellent agreement, confirming that porosity below ~3 nm in diameter is inaccessible to HF.

This has major consequences for dry scrubbing as can be seen in Table 1, Figure 1 and Figure 2 – a rise in HF concentration in the scrubber is detected when alumina supply was changed from Alumina A to alumina B (Figure 2), the difference in HF adsorption is due to the significant BJH surface area (Table 1 and Figure 1) rather than the BET surface area (as seen in Table 1).

	Alumina A	Alumina B	Alumina C
BET/$m^2\ g^{-1}$	74.1	65.3	67.9
BJH(3-300)/ $m^2\ g^{-1}$	74.0	52.4	56.2



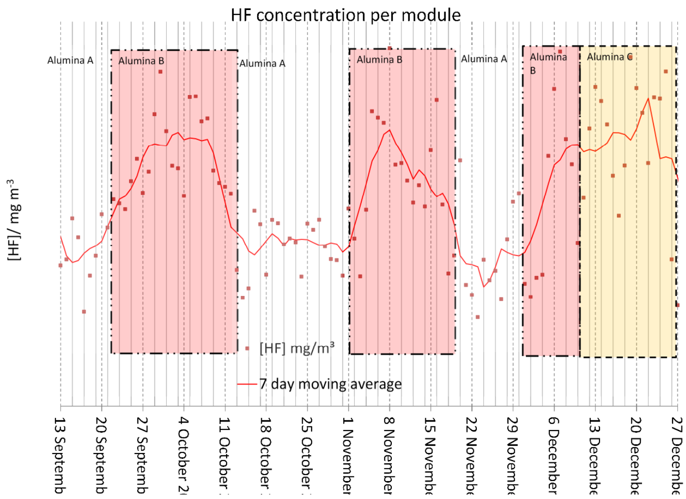


Figure 1: *(top)* Reconstructed PSDs of secondary aluminas based on the models of HF adsorption indicate pores smaller than ~3 nm are inaccessible in dry scrubbing. This has significant and measurable impacts on dry scrubbing ability in the GTC *(bottom)* which persists to the environment, and ultimately impacts the fluoride cycle and pot chemistry.

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