Cr(VI) in ferrochrome smelter dusts from pilot-scale DC arc furnace

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An extensive literature review by Beukes et. al (2017) [1] established that all currently employed ferrochrome smelting techniques lead to the formation of a small amount of Cr(VI). Dust has been identified as having the highest concentration of Cr(VI) of all wastes associated with ferrochrome production [2]. An understanding of Cr(VI) formation within ferrochrome smelter dust is therefore fundamental to helping the ferrochrome industry mitigate its environmental impact by minimizing Cr(VI) formation and ensuring its capture. Additionally, this knowledge will inform policy and environmental regulations for the burgeoning ferrochrome industry in Canada.

To understand the formation of Cr(VI) within ferrochrome smelter dust along the off-gas stream, we investigated dusts formed during pilot-scale smelting in a DC arc furnace. Samples of high-grade Black Thor chromite from the Ring of Fire deposits were smelted under basic conditions using varying feed-rates. Dust samples were collected from the furnace freeboard, as well as from dust collectors along the off-gas handling system. Our study focuses on Cr oxidation and speciation, but also includes a thorough characterization of the major and trace element composition, mineralogy, and texture of the dusts at the bulk and microscopic scale.

The dusts largely comprise a mixture of unreacted feed material and glassy spherules, interpreted as aerosolized oxide melt droplets or condensates quenched in the off-gas stream. The spherules are highly hetereogeneous in composition, but are generally rich in SiO_2, MgO, Al_2O_3, and CaO. Individual dust samples contain a variety of Cr oxidation states, as determined by X-ray photoelectron spectroscopy and X-ray absorption near edge structure (XANES). Major findings to date include the identification of Cr(VI) in dust from all parts of the off-gas stream, including the freeboard samples. In addition, our micro-scale results provide strong evidence correlating Cr(VI) occurrence with the glassy spherules.

[1] Beukes et al. (2017) *Journal of Cleaner Production* **165**, 874-889.

[2] Du Preez et al. (2017) *Water SA* **43**, 298-309.