Contribution ID: **354** Type: **Oral Presentation**

Hybrid treatment of Electric Arc Furnace Dust for selective zinc recovery

Tuesday 7 October 2025 15:10 (20 minutes)

Electric Arc Furnace Dust is a hazardous waste of steel recycling, containing iron, zinc and heavy metals such as lead, chromium, cobalt and molybdenum. With an average generation of 15-20 kg dust per ton of produced steel, it requires effective processing to mitigate environmental risks and to recover zinc. The best available recycling technology is the Waelz process, that is based on a high-temperature reduction in the presence of carbon as a reducing agent to recover zinc. Despite its industrial relevance, this method has drawbacks, such as high energy consumption and carbon emissions. Over the past few decades, alternative methods such as the Zincex process and various hydrometallurgical techniques have been explored. However, direct hydrometallurgical leaching is hindered by the insolubility of zinc ferrite and the complexity of high-temperature leaching.

This study investigates a hybrid process that combines hydrogen reduction of zinc ferrite to zinc oxide and magnetite, followed by sulfuric acid leaching of zinc. Pyrometallurgical tests conducted at 450 –550 ℃ confirm effectiveness of hydrogen in reducing zinc ferrite. However, the process requires control of hydrogen concentration in reducing gas to prior magnetite formation, as soluble iron compounds reduce efficiency of following leaching treatment. Sulfuric acid leaching of a synthetic zinc oxide - magnetite mixture at 30 ℃ within a pH range of 3.5 –4.5 identified optimal conditions at pH 4.0 with a duration of 15 –30 minutes. A 30-minute reduction at 550℃ followed by leaching at pH 4 and 4.5 resulted in zinc dissolution of 86% and 71%, with selectivity of 71% and 63% for pure zinc ferrite and EAFD sample, respectively. These results indicate that achieving high zinc extraction with high selectivity remains challenging, requiring further research to minimize iron co-dissolution while maximizing zinc recovery.

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Session Classification: Waste Processing & Byproduct Utilization

Track Classification: Environmental and energy aspects in iron and steelmaking