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Valorization of Acid Regeneration Iron Oxide Residues into α-Fe_2O_3 Pigments by Chemical Routes

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In flat steel production, hot-rolled steel surfaces are subjected to acid pickling to remove surface oxide layers. During pickling, the iron concentration in the acid increases over time, and the spent acid is treated and recycled through an acid regeneration process. As a by-product of this process, iron oxide particles composed primarily of hematite and magnetite with an average particle size of approximately 1 mm are generated. However, these by-products are generally utilized in low-value applications despite their high iron content and pigment potential.

This work focuses on converting these iron oxide by-products into nano-sized red iron oxide (α-Fe2O3) pigment, contributing to waste valorization and circular material utilization. A two-step synthesis route was employed, in which ferrous chloride was first obtained via an acid leaching process, followed by controlled oxidation and calcination at temperatures between 500 and 800 ℃ to synthesize nano-sized α-Fe_2O_3.

The influence of calcination temperature on phase formation and particle size was investigated. Hematite formation was confirmed by XRD, while SEM–EDS and particle size analysis were employed to assess microstructural and compositional features. The results demonstrate the feasibility of producing nano-sized α-Fe_2O_3 pigment from steel industry waste through a scalable and environmentally sustainable process. This approach offers a sustainable pathway for the valorization of steel industry by-products, promoting circular material utilization and minimising industrial waste.

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