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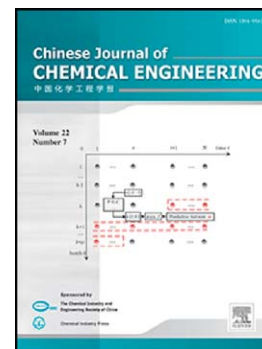
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Energy, Resources and Environmental Technology

Indirect mineral carbonation of titanium-bearing blast furnace slag coupled with recovery of TiO_2 and Al_2O_3 [☆]

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Abstract: Large quantities of CO_2 and blast furnace slag are discharged in the iron and steel industry. Mineral carbonation of blast furnace slag can offer substantial CO_2 emission reduction and comprehensive utilization of the solid waste. This paper describes a novel route for indirect mineral carbonation of titanium-bearing blast furnace (TBBF) slag, in which the TBBF slag is roasted with recyclable $(\text{NH}_4)_2\text{SO}_4$ (AS) at low temperatures and converted into the sulfates of various valuable metals, including calcium, magnesium, aluminium and titanium. High value added Ti- and Al-rich products can be obtained through stepwise precipitation of the leaching solution from the roasted slag. The NH_3 produced during the roasting is used to capture CO_2 from flue gases. The NH_4HCO_3 and $(\text{NH}_4)_2\text{CO}_3$ thus obtained are used to carbonate the CaSO_4 -containing leaching residue and MgSO_4 -rich leaching solution, respectively. In this study, the process parameters and efficiency for the roasting, carbonation and Ti and Al recovery were investigated in detail. The results showed that the sulfation ratios of calcium, magnesium, titanium and aluminium reached 92.6%, 87% and 84.4%, respectively, after roasting at an AS-to-TBBF slag mass ratio of 2:1 and 350 °C for 2 h. The leaching solution was subjected to hydrolysis at 102 °C for 4 h with a Ti hydrolysis ratio of 95.7% and the purity of TiO_2 in the calcined hydrolysate reached 98 wt%. 99.7% of aluminium in the Ti-depleted leaching solution was precipitated by using NH_3 . The carbonation products of Ca and Mg were CaCO_3 and $(\text{NH}_4)_2\text{Mg}(\text{CO}_3)_2 \cdot 4\text{H}_2\text{O}$, respectively. The latter can be decomposed into MgCO_3 at 100-200 °C with simultaneous recovery of the NH_3 for reuse. In this process, approximately 82.1% of Ca and 84.2% of Mg in the TBBF slag were transformed into stable carbonates and the total CO_2 sequestration capacity per ton of TBBF slag reached up to 239.7 kg. The TiO_2 obtained can be used directly as an end product, while the Al-rich precipitate and the two carbonation products can act, respectively, as raw materials for electrolytic aluminium, cement and light magnesium carbonate production for the replacement of natural resources.

Keywords: Mineral carbonation; CO_2 sequestration; Ti-bearing blast furnace slag; Ammonium sulfate; Titanium dioxide; Aluminium oxide

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