Roasting of spodumene ($LiAlSi_2O_6$) with additives for lithium extraction

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Abstract

The prospective increase in lithium demand drives lithium extraction from mineral sources, predominantly spodumene ($LiAlSi_2O_6$). The current production of lithium from α-spodumene involves calcination at high temperature of 1050 – 1100 ºC and aggressive acid treatment at 250 ºC. Consequently, the current industrial process is associated with high energy consumption during calcination at elevated temperatures and requires strong acid resistant equipment, high amounts of additives to neutralise the acidity and complex purification processes, which produce environmentally undesired waste. Alternatively, we introduce two methods of relatively low-temperature (800 – 900 ºC) roasting with additives (Na_2SO_4 and a flux chemical) for the recovery of lithium from α-spodumene. Roasting of α-spodumene with the flux chemical only, results in the transformation of α-spodumene to both β- and γ-spodumene at lower temperature. The calcine with the mass ratio of α-spodumene/flux chemical of 10:1 showed high lithium extraction of 91 – 92 % after acid treatment. Compared to the typical industrial method, the minimum required energy for transformation of spodumene is lower by about 23 %. This reduction in energy is partly offset by the additional cost of the flux material. This method has the potential to reduce the energy cost of the present industrial

acid process by lowering the energy requirements in the thermal treatment stage to achieve the structural transformation of α-spodumene.

In the second process, roasting of spodumene with both Na_2SO_4 and the flux chemical produces water-soluble $LiNaSO_4$. The extraction of lithium by this approach attained 94 % at a roasting temperature significantly below that used presently in the high-temperature calcine-sulfuric acid leach process, with a α-spodumene/Na_2SO_4/flux mass ratio of 1:0.8:0.01. The roasting of spodumene with the two additives requires 18 % more energy, in comparison with the present technology, but avoids the acid roasting step. Sodium sulfate is readily available, at low cost, from lithium producers using the conventional sulfuric acid leach process. In addition to employing low roasting temperature, the process involves small amount of an inexpensive flux chemical. Furthermore, the calcine materials remain in a powder form with no evidence of the formation of melt or glassy phase at the optimised temperature. Overall, the process has advantages of lower temperature, possibly lower cost and lower environmental footprint, in comparison to refining lithium in the currently practised high temperature calcine-sulfuric acid approach.