Separation of fine-grained rutile and zircon by flotation: a study of sensitive flotation chemistry with considerations for operational circuits

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# ABSTRACT

Flotation is extensively used to concentrate various sulphide ores including copper, lead, zinc, gold and nickel. It is not as common for oxide minerals; however, it is used for a range of commodities including rare earths, lithium, and tin. Less common are applications in mineral sands, which are usually processed with physical techniques. Some mineral sand deposits are challenging for the conventional approach and alternative techniques including flotation can provide an advantage. One example is the separation of rutile and zircon at Sierra Rutile with poor performance reported from attempts to use electrostatics on fine grained particles, below 150 µm. To improve the separation, a flotation system was developed, incorporating an amine collector, starch depressant and fluoride activator.

This zircon flotation system has been considered for Australian fine-grained deposits such as the WIM150 resource in Victoria, however little discussion of the underlying flotation chemistry is available. In this work, experimental results are presented to demonstrate the system relies on sensitive surface and solution chemistry. The analysis includes fitting adsorption isotherm models using two computational methods: orthogonal distance regression and by minimising the sum of squared residuals. Curves prepared with both methods are compared, and the limitations discussed. This computational approach provided a significant contribution to characterising the sensitive collector adsorption process, which for zircon is dominated by chemisorption at zirconia sites and enhanced by the addition of NaF and starch, a result of multilayer formation. On rutile, physisorption dominates without significant interactions with fluoride and starch.

This work highlights the benefit oxide flotation can provide and acknowledges the challenge of operating a complex flotation circuit. It demonstrates that successful separation relies on good control over sensitive solution and surface chemistry. Some practical operational considerations are also provided, including water quality, automated reagent preparation and appropriate strategies to monitor reagents in flotation process streams. These considerations are relevant to the flotation of many different oxide minerals and are likely to assist operators to develop strategies for good consistent flotation performance.