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An assessment of ceramic filtration for a metallurgical process

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Abstract

Conventional vacuum filtration was previously used for dewatering of iron-ore product, but with changing product quality requirements and declining ore grades, compounded by the complexity of mineralogy and increased energy costs, alternative, more efficient dewatering solutions are being sought. The purpose of this study was to investigate the effectiveness of ceramic filtration for iron-ore dewatering.

Ceramic filtration is a technology best suited to dewatering slurries with high and consistent solids concentration and with particles in a size range between 30 µm and 150 µm. Although the technology is already widely applied to base metal concentrates and ferrochrome products, the introduction of the technology to the iron-ore industry is relatively recent.

Ceramic filter discs are vacuum-disc filters that comprise sintered alumina sector plates with uniform micro-pores. The micro-pores create suction through capillary action and, once wetted, the filter medium allows only liquid to pass through during the filtering process. A filter cake forms on the surface of the disc and is removed by a scraper. Significant energy savings are stated, owing to the lack of air penetrating the ceramic discs. Other stated benefits include continuous operation, low operating costs, high filtration rates, dry filter cakes and high operational availability with an inert ceramic media that is resistant to most chemicals and slurry temperatures.

This technology is used for the final dewatering stage of the concentrate product at the Anglo American Minas-Rio iron-ore operation in Brazil. To produce a concentrate product, a friable itabirite with approximately 40 % haematite in the feed, is processed using crushing, grinding and flotation steps with thickening of the tails, slimes and concentrate product. The concentrate is pumped over 529 km to a port facility where it undergoes further thickening before reporting to ceramic filter units for final dewatering of product.

Assessment of prior testwork programmes performed by the operation showed that the slurry conditions that contributed to highest filtration capacities and lowest cake moistures included a high feed solids concentration, neutral pH and addition of coagulant. Operating conditions that contributed to highest product yield, although with a high cake moisture content, included employment of

maximum vacuum level, maximum disc rotation speed and greatest basin level. The lowest cake moisture content was achieved at minimum vacuum and basin levels and at highest rotation speed. The only factor that was shown to reduce moisture, while increasing productivity, was increased rotational speed of the filter disc. Ultrasonic cleaning, backwashing and use of good quality filter plates also resulted in improvements in filtration efficiencies. Controlled flocculant addition contributed to good product yield, and other factors, notably allocation of sufficient time to facilitate preventative and corrective maintenance and shorter time intervals between acid washing of the plates, plate regeneration and plate replacement, all improved filtration efficiency.

The testwork performed for this programme verified that the highest filtration capacities were achieved at neutral pH, although highest filtration capacities could also be achieved in instances where lime was used to adjust the slurry to higher alkaline pH values. The greatest dry solids capacity, with the required cake moisture content of 8 %, were achieved at neutral slurry conditions, using nitric acid for pH adjustment, along with the addition of small amounts of flocculant. Flocculant addition at more alkaline pH values did not prove to be as successful as the testwork performed at neutral pH, and, despite achieving low cake moisture content, considerably lower filtration capacities were accomplished. Decreased temperatures of ~30 °C resulted in decreased vacuum pressure and reduced plate permeability. Higher slurry temperatures of ~36 °C gave improved filtration capacities that are attributed to decreased slurry viscosities. Testwork showed that improved filtration capacities were generally accompanied by an increase in cake moisture content. Oxalic acid had a negative impact on plate permeability when used for plate regeneration while plate permeability was improved when using either nitric acid, or hydrochloric acids for plate regeneration.

Provided that slurry and operational conditions were optimised and adequate maintenance regimes maintained, the testwork outlines in this thesis demonstrated that sufficient filtration capacities and the required cake moisture content for final concentrate product can be achieved. Thus ceramic filtration is a suitable method for the metallurgical process of dewatering of iron-ore concentrate.