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Evaluation of the reactivity of anthracites in respect to its chemical and petrographic characteristics in an ilmenite smelting operation

Bagirathi, Nirvashnie

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ABSTRACT

Anthracites are utilised in the reduction of ilmenite in most South African ilmenite processing plants. The smelting mechanism reported by Pistorius (2008) involves the reduction of iron oxide and titanium dioxide, in the ilmenite, using carbon monoxide (generated by the Boudouard reaction) to produce pig iron, titania rich slag and carbon dioxide. The carbon dioxide is converted to carbon monoxide via the Boudouard reaction. The anthracite utilised in the process influences the efficiency of the process. It has been reported that the use of alternative anthracites has affected the smelter operation in the following manner:

- Furnace foaming can occur which results in operational downtime and out of specification product
- Impurities in the reductant can also result in out of specification product
- Smelting reactivity can result in unstable furnace performance and resultant downtime
- Decrepitation of reductant can result in carbon losses and an unstable arc in the furnace with associated resultant downtime

The reasons why different anthracites have a particular effect on the operation have not been determined. The samples evaluated in Jordan (2009) and in the current investigation included a Russian (R), Vietnamese (V), Vietnamese Low Volatile (VLV) and a South African Anthracite (SAA). A representative 5-8mm sample was used for reactivity test in Thermogravimetric Analyser (TGA) at Mintek. Average apparent reactivity was calculated for tests conducted between 850^{o}C and 1600^{o}C (250^{o}C interval). The order of reactivity was that the R most reactive followed by the V, VLV and then the SAA. The Southern hemisphere SAA sample was however comparable to the R and VLV samples at some temperatures. Activation energy was also calculated and it was found that the R anthracite had the highest activation energy followed by the SAA, VLV and V anthracites. Activation energy only indicates the amount of energy required to start the reaction.