ABSTRACT

Anthracites are the preferred reductant for utilization in the ilmenite smelting industry mainly due to the higher fixed carbon units, lower sulphur contents and relatively lower impurities found in the mineral matter content. The primary purpose of the reductant used in the process is to affect reduction of iron oxide forms and titanium oxide forms to yield a product of a low Mn pig iron (LMPI) and a slag containing titanium dioxide and iron oxide.

Industrial test work on various anthracites were undertaken to obtain a better understanding of reductant performance and their effect on process efficiency. The tests were designed to establish reductant efficiency per reductant type as a function of its petrographic characteristics, its influence on a mass and energy balance scale as applied to furnace energy algorithms and its contribution to the smelter Value In Use (VIU) total cost model.

Good correlations were found to exist between the vitrinite content and reductant efficiency. Lower reductant efficiencies are associated with higher vitrinite contents.

The mechanism of reductant loss, expressed as carbon efficiency, seems to be related to the shattering of anthracite when exposed to furnace freeboard conditions at approximately 1600°C in the presence of inherent and surface moisture associated with the reductant.

The d50 particle sizes between the reductants were found to be very similar due to a deliberate size processing step prior to the reductant utilization. Although no good correlation was found between d50 and reductant efficiency, a fair

correlation exists between the -1mm particles and reductant efficiency. A finer size fraction has a higher propensity to escape from the offgas and report to losses.

A reduction in dissolved carbon in the metal for a decrease in TiO_2 percentage in the slag was found to occur in all likelihood as a result of a combination of carbon losses occurring due to decrepitation and reporting to dust losses or insufficient carbon units added initially.

A strong linear dependence exists between reductant ratio percentage and TiO_2 percentages in the slag. A strong linear dependence exists between theoretical energy requirements for varying reductant percentages. It was found that the reductant requirements are strongly dependent on reductant fixed carbon and reductant efficiency.

The carbon percentage in the metal is generally an order of magnitude higher than calculated equilibrium carbon percentage in the metal, indicating that non equilibrium conditions prevail in the metal bath.

Higher carbon content and lower vitrinite content anthracites performed better on overall Value In Use model due to the following reasons:

- **Higher carbon efficiencies** associated with lower vitrinite or rather higher inertinite contents lead to the use of **lower proportions of reductants** to obtain the desired chemistry in the product.
- **Higher carbon efficiencies** were also found to require **less energy** to obtain final product.
- **Lower energy inputs** lead to increasing the overall raw material feed input and ultimately increasing the final product output.
- **Lower treatment costs** of low manganese pig iron occurred due to **lower portions of reductant, less impurities** (sulphur) as a result of lower mineral matter in the reductant and **higher excess carbon** in the low manganese pig iron product.