ABSTRACT

Reductants form a significant portion of the production costs during ferroalloys processing. Consequently, the need arises to cut costs and drive profitability through raw materials optimization, *viz,* reductants. Unconventional reductants are expected to have a high reactivity and fixed carbon content, but their current availabilities are low. Innovation together with substitution has become a necessity to ensure sustainability and competitiveness of processing operations. The main objective of this research was to study and compare the reactivity of commonly used reductants and that of readily available, new sustainable carbon materials as potential reductants for the reduction of natural chromite at steady state. The selected reductants comprise of conventional Reductants A (Market Coke), B and B1 (Trial Market Cokes), C (Industrial Char) and unconventional Reductant D (Charcoal).

This investigation was undertaken by initially characterizing the reductants with the use of advanced analytical techniques including proximate, ultimate, particle size distribution and petrography and then to determine the merits and demerits of each in typical ferrochrome processes. This was followed by reactivity tests in the solid state at temperatures ranging from 1100^{o}C, 1200^{o}C, 1300^{o}C to 1400^{o}C and over a 4 hour period. A thermo-gravimetric analysing (TGA) furnace was used with tests undertaken under inert atmosphere in order to determine the practical performance and application of each reductant. Data collected from a series of TGA furnace campaigns was utilised to determine the reactivity of the selected reductants. Analytical methods of chemical speciation, XRD and SEM-EDS were applied to confirm the extent of chromite reduction.

The outcome of this research project indicated that the best reductants according to overall mass loss were D (122.03%), C (112.97%), A (91.61%), B (90.51%) and B1 (80.72%), consecutively in reducing order. Whilst the unconventional Reductant D was shown to be most reactive and having the highest mass loss at test temperatures 1100^{o}C -1300^{o}C, all conventional reductants performed better than the unconventional

reductant at 1400^oC. At this temperature, Reductant B had the highest mass loss of 51.5% followed by Reductants A (47.7%), B1 (44.1%), C (40.5%) and lastly D with 31.7%. Only Reductants D and C in most instances reached saturation within the test period (4 hours). Substantial reduction of Cr_2O_3 and FeO occurred (%DOR for FeO, 72.03% and Cr_2O_3, 67.96 %) as shown by the analysis of chemical phases present. This had the iron-chrome and chrome-iron phases dominating.