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SOME COMMENTS ON THE STUDY OF METALLURGICAL COKE AND ITS USE IN THE IRON BLAST FURNACE: UNDERSTANDING PROCESS FUNDAMENTALS THROUGH LABORATORY STUDIES

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Much of the recent experimental work carried out at by the PYROmetallurgical group at the University of Wollongong has focussed on understanding coke behaviour in the lower zone of the blast furnace. This work has had both fundamental and applied elements and has been carried out with a view to improving coke utilization in the blast furnace and ultimately reducing greenhouse gas emissions. Brief details of the some of this research are given below.

**Mineral Layer Effects on Coke dissolution in Iron**

An experimental study of the effect of a mineral layer formation on coke dissolution kinetics in liquid iron has been carried out. The system studied was designed to in part replicate the relatively quiescent conditions in the deadman area of a blast furnace. In this investigation a clear relation between the kinetics of coke dissolution and the morphology of the layer formed on the coke was established [1]. Experimental findings are shown below in Fig. 1 and Fig. 2 for the predominant phases at the coke-iron interface and first order rate plots respectively. The change of slope shown in Fig.2’s first order rate plots represents a slowing of the rate of coke dissolution.

Though not shown in Fig.2, similar results were found for coke dissolution at 1450°C. The change of slope is coincident with the appearance of the more dense CA (CaO.Al\(_2\)O\(_3\)) phase noted in Fig. 1. This finding is considered evidence of a reaction blocking mechanism slowing the dissolution kinetics, where the formation of a dense layer reduces the contact between the coke and liquid iron.
Deadman Coke Fines and Their Sources
There was some ambiguity as to the source of coke fines (generally less than 8mm but 1 to 4 mm in this study) found in deadman area of a blast furnace [2]. To identify the source of these coke fines tuyere probe samples were obtained from both the deadman and raceway areas of the blast furnace (see Fig.3 ). Using measurements of $L_C$, it was established that some of the fines found in the deadman area of a blast furnace were not simply the degradation products of the lump coke in this area. The coke fines had a higher $L_C$ than the coke lump and therefore had experienced a higher temperature than the associated coke lump. Fig. 4 shows typical $L_C$ measurements for the tuyere probe coke samples. This finding has been interpreted as indicating that at least some of the coke fines are being blown into the deadman area (lower temperature region) from the raceway by the high velocity hot blast.

The Development of a Coke Analogue for the Study of Important Coke Reaction Phenomena
Industrial coke is not an ideal laboratory reagent. It has inherent heterogeneity problems with respect to oxide phase composition and phase dispersion not to mention coke porosity variability that often mask or complicate the coke reaction behaviour that is of interest in the metallurgical industries. To overcome this heterogeneity problem an idealised coke analogue material has been developed in which the mineral phase’s composition, morphology and dispersion and the overall porosity can be controlled. Details of the analogue are given and its abilities to represent coke are assessed and discussed. It is envisaged that this coke analogue material will have much to offer in future studies of coke reaction behaviour, particularly in areas where mineralogy of the coke ash is considered to affect coke reactivity. There may also be coal applications of this analogue that are of interest to the power generation industries that have similar heterogeneity problems to coke when trying to understand coal reaction behaviour.

References