Oxidation and Emissivity in the Reheat Furnace

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1. Introduction

This project uses research to develop the processes of radiation heat transfer and emissivity in Tata Steel's reheat furnace using topics of oxidation, emissivity and heat transfer.

3. Reheat Furnace

The reheat furnace at TATA Steel is a walking beam furnace which transfers heat via conduction, convection and radiation. (Figure 1)

Figure 1

4. Oxidation

Oxidation in the reheat furnace occurs on the surface of the slabs; this happens when oxygen reacts with the iron on the surface in three stages:

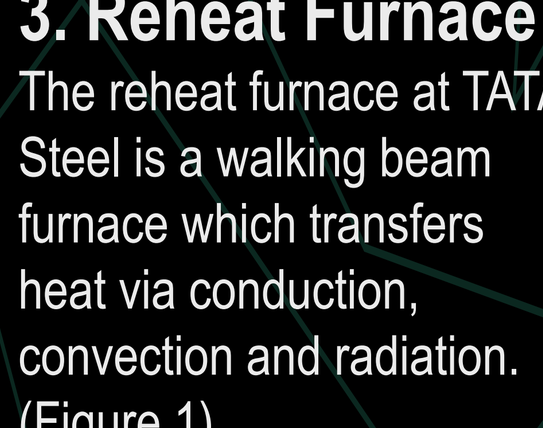

Figure 2

Stage 1 – Wustite Formation
$2Fe + O_2 \rightarrow 2FeO$ (1)
(Figure 2)

Stage 2: - Magnetite Formation and Reduction. (Figure 3)

$6FeO + O_2 \rightarrow 2Fe_3O_4$ (2a),

$Fe_3O_4 + Fe \rightarrow 4FeO$ (2b)

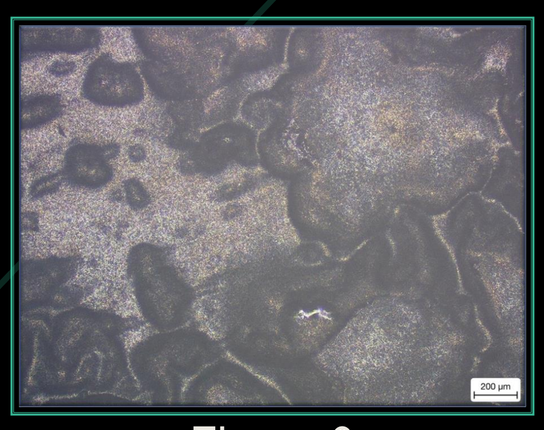

Figure 3

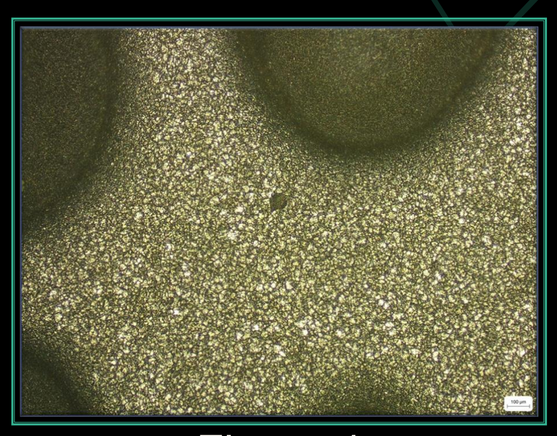

Figure 4

Stage 3 – Hematite Formation
$2Fe^{3+} + 6e^- + \frac{3}{2}O_2 = Fe_2O_3$ (3).
(Figure 4)

Wustite, magnetite and hematite can be found on the surface at a ratio of 95:4:1 respectively.

2. Project Aims

To research oxidation, radiation heat transfer and emissivity. Develop tests to measure the heat transfer and emissivity to find the effects of emissivity in the furnace.

5. Heat Transfer and Emissivity

Heat transfer occurs by three mechanisms – conduction, convection and radiation.

Emissivity can be defined as a number between 0 and 1 that describes the emission/absorption of radiative energy.

Emissivity cannot be directly measured whilst in a furnace over 900^{o}C. Therefore, models to predict emissivity during heating, holding and cooling within a furnace has been developed.

The testing and analysis in this project for the following are underway.

a. Cyclic Test

Figure 5 shows the total heat loss through the walls of the testing furnace during a 0-hour soak.

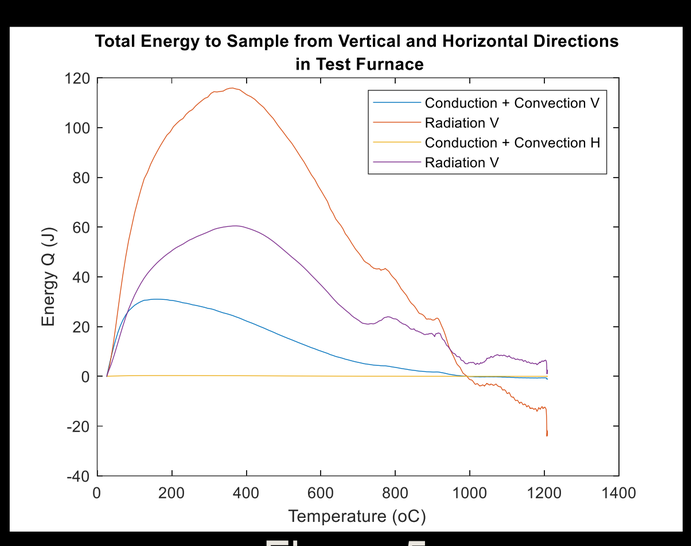

Figure 5

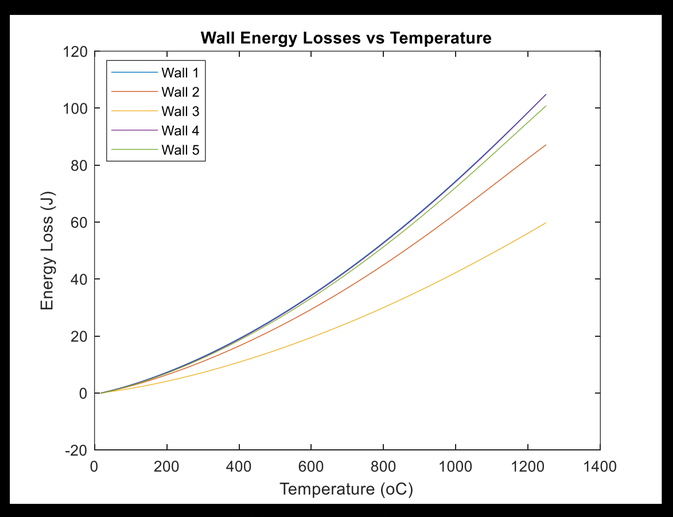

Figure 6

b. Thermal Survey

Figure 6 shows the wall heat loss results of a thermal survey on the test furnace

c. Cooling Tests

Sample will air cooled and temperature measurements recorded whilst cooling to find the emissivity whilst cooling.

6. Future Work

Use the results of the testing above to find the emissivity of the samples and hence how oxide scale effects the emissivity

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