Effect of Air Flow Profiles and Accretion Rings on Rotary Kiln Operations

BLUESCOPE STEEL LIMITED

Steel Production

Australia/New Zealand

www.bluescopesteel.com

ANSYS®

ANSYS® CFX®
ANSYS® DesignModeler™

Overview

BlueScope Steel Limited operates a division in New Zealand producing 650,000 tons of steel per year from locally sourced iron sand and coal. A key component of the process involves the direct reduction of iron sand by char in four rotary kilns. The primary function of the kilns is to remove oxygen from iron sand to produce a partially reduced material containing the correct amount of carbon for feeding into downstream melters. The reduction process requires energy which is supplied by the combustion of carbon monoxide and char.

The kilns are large structures at about 4.2 meters in diameter with 65 meter-long revolving cylinders. Hot solid char and iron sand enter the kiln at about 600 degrees Celsius. Process air is blown into the kiln via nine burners. Off-gas, which is produced by the reduction reactions, flows counter-current to the solids flow and to the burner air flows.

Accretion layers or rings derived mainly from the impurities occasionally form on the inner face of the kiln shell, limiting the production rate.

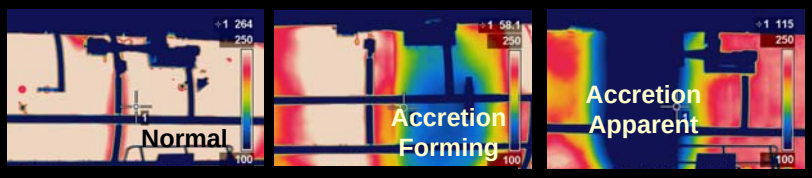
BlueScope Steel was interested in learning about the flow patterns, temperature and concentration contours inside such rotary kilns.

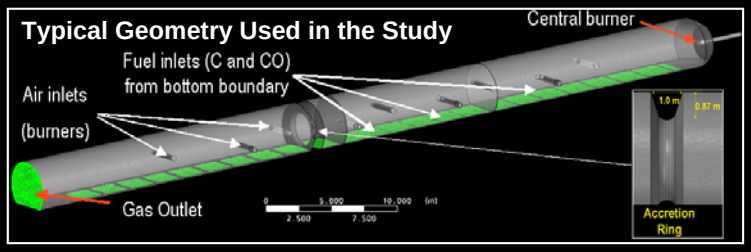
Testimonial

"With the recent developments in software and computer hardware, a very complex CFD problem involving 2.5 million computational cells can be solved in the space of a few hours. This allows for a short turnaround time in providing feedback to the plant personnel."

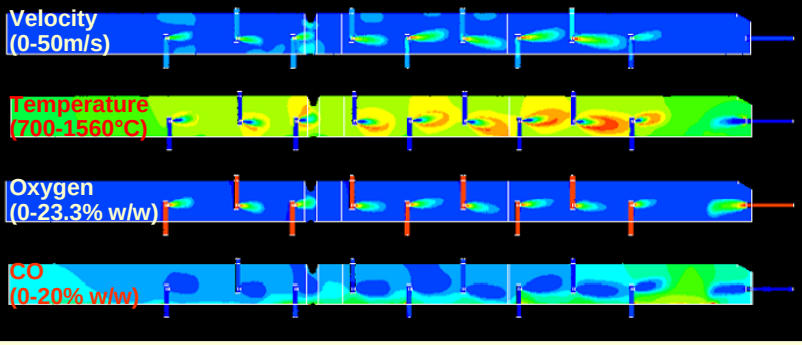
John G. Mathieson
Manager Iron and Steelmaking Research
BlueScope Steel Limited

Thermographic Images of Kiln Shells





Typical Results – Effect of Accretion Ring on Flows



Challenge

- To provide a solution to a complex problem involving highly turbulent flows, chemical reactions, heat transfer and a very large geometry in a reasonable time
- To test a number of geometries and a range of operating conditions in an efficient manner

Solution

ANSYS CFX and ANSYS DesignModeler software successfully provided a solution. A 64-bit workstation was used to carry out the computations. The solution showed good stability and converged in less than 200 iterations. The CFD results were qualitatively validated against available experimental data. The flexibility of both packages meant quick implementation of changes in geometry and/or operating conditions.

Benefits

Feedback comprising full details of the predicted temperature, velocity and concentration contours throughout the kiln was provided in a relatively short time frame to personnel involved in operating the kilns. The effects of air flow rates and other operating parameters also were examined fairly readily. Such information contributes to better understanding of kiln operation and optimization of plant production.

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