TATA STEEL

TATA INNOVISTA
Celebrating Innovation

Soft Sensor for Estimating Hearth Liquid Level

By Tata Steel | Category: Implemented Innovations

Blast furnace is a counter-current chemical reactor, wherein solid raw materials are charged from the top of the furnace while hot blast is blown from the bottom of the furnace. This causes a counter current reaction and finally the raw materials get converted into liquid products. These liquid products are collected from the bottom of the furnace and periodically cast by opening the tap hole. In a day, tap holes are opened and closed around 10-15 times. The tap hole is opened based on the Operator's perception of whether the hearth contains liquid or not. The tap hole is closed assuming that the liquid hot metal and slag have been completely removed from the blast furnace. However, there have been instances where this practice of the Operator's intuition does not work correctly. Therefore, a soft sensor was developed to give the Operator a real-time depiction of hearth condition and drive the casting practice systematically and optimally.

The context

NO EMF SIGNALS

EXTERNAL MEASURING EQUIPMENT DAMAGED

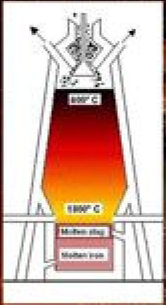
OPERATIONAL PROBLEMS WHEN LIQUID LEVEL EXCEEDS CRITICAL LIMIT

HIGH TEMPERATURE PROBLEMS

There is no direct means to measure the hearth liquid level in the blast furnace, due to high temperature conditions. Operators open the tap hole solely based upon their intuition, and close it based on their experience. These problems triggered the team to develop a system that can show the liquid level remaining in the hearth and share real time predictions to prescribe the course of action to Operators.

The Innovation

This innovation relates to the measurement of hearth liquid level in the blast furnace, without installing any physical sensor. The measurement is made by indirectly calculating the rate at which the liquid hot metal and slag are removed from the blast furnace. The soft sensors are built where physical sensor don't work. When the tap hole is opened, hot metal flows out, and is collected in various torpedoes. Radars are used to monitor the level of hot metal collected in the torpedo. This radar signal is used to calculate the casting rate of hot metal, which when converted into torpedo filling rate gives an estimation of hot metal casting rate. This is a novelty in the present system. Typically, in the EMF probe technology, installation of the probe requires drilling the hearth shell, and precisely installing the probes. Also, there is a need to filter the EMF signals, which does not make it a reliable technology.



Overcoming Challenges

Challenge #1

Determining the casting rate of hot metal since no load cell, sensor or weight measuring system works. This was overcome by using the rate of hot metal filling height.

Challenge #2

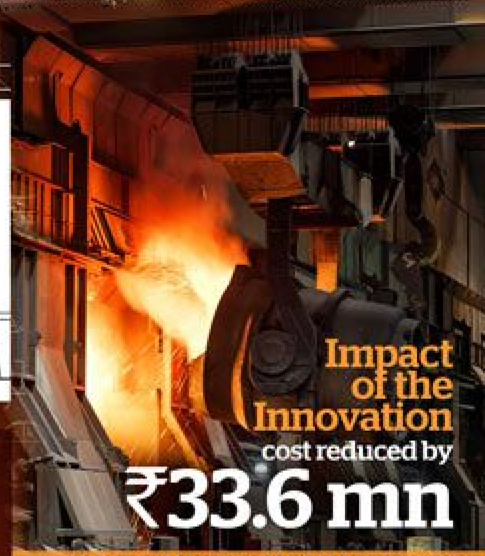
Converting the signals from these changes in hot metal height into casting rate, using solid modelling software in ProE.

Challenge #3

Matching this casting rate with the actual weight of hot metal. This was overcome by encapsulating the system with self-adaptive correction.

Challenge #4

Computing the hearth level on real time, which required number of inputs used in the blast furnace.



Impact of the Innovation

cost reduced by

₹33.6 mn

The system has been useful in reducing the number of casts, number of drill bits, number of drill bars and specific clay consumption.