IMPROVING PROCESS CAPABILITY OF THE DESULPHURIZATION STATION IN STEEL MAKING

Can You Predict Output Sulphur of Desulphurization?

THE CASE

On a sultry Friday morning in the month of August Mr Suresh Babu, head of the Steel melting shop in Tata Steel, was glancing through the daily report of his department with a brow of concern on his forehead.

In the last couple of days 6 heats were downgraded due to high Sulphur content. He was now worried about meeting the delivery schedule of a premium order from one of their highly esteemed customers.

He was also concerned that, Sales team will have difficulty in finding an order for the downgraded heats - which will eventually be sold at a lower price - directly affecting the bottom line.

Sulphur content in steel is currently being predicted by a model and the reason for Mr Babu's immediate concern was that despite his team's best efforts his current model only has a 65% accuracy of predicting the Sulphur % in the given specification for few grades. Given his habit of staying abreast of the advances in the field of Predictive analytics, Mr Babu was of the firm belief that an analytics led intervention may act as a panacea for the problem he was currently encountering.

Mr Babu is looking for a team to help him better predict the Output Sulphur % of his Desulphurization process?

DeSULPHURIZATION PROCESS

In order to aid the team Mr Suresh Babu has listed down a brief of the process and the objectives he wanted the Analytical solution to address

1.0 Process Description

To achieve low Sulphur content steel is Desulphurized in a desulphurization(DS) unit.

The Desulphurization unit receives hot metal with high Sulphur level (0.02-0.1 %) from the blast furnaces. The hot metal is then treated to reduce the Sulphur level to 0.002-0.015 % before sending it to LD converter for further processing.

Desulphurization is carried out by the injection process, in which Calcium carbide and Magnesium powder (DS compound) are mixed in a fixed ratio and injected into liquid hot metal through a refractory top lance with an inert carrier gas. The injection time varies from 5 to 20 minutes. After the completion of desulphurization, the slag formed on the top is highly rich in Sulphur and it is skimmed out completely to prevent any Sulphur reversal during primary steel making.

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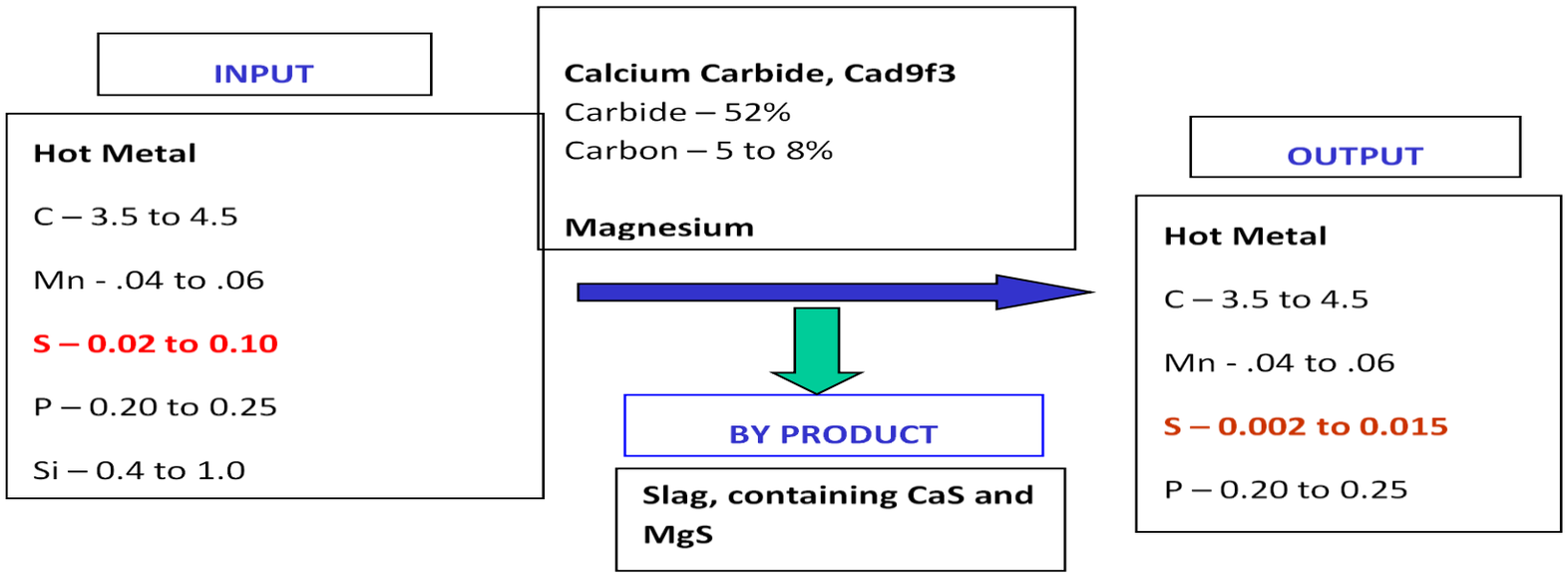

Fig 1 – Process Block diagram of Desulphurization

The CHALLENGE

2.0 Variables Descriptions

Variables	Description
CASTNO	Unique Identification of batch/heat
HM_WT	Size of batch/heat - tons of hot metal being processed at a time
AIM_S	Aim Sulphur for that batch (Normally operator aim to attain 0.003% or 0.008 % or 0.01 % depending on grade of steel)
HM_S	Input Hot Metal Sulphur
HM_C	Input Hot Metal Carbon
HM_SI	Input Hot Metal Silicon
HM_TI	Input Hot Metal Titanium
HM_MN	Input Hot Metal Manganese
CAC2	CaC2 added quantity
MG	Mg added quantity
HM_TEMP	Temperature on incoming hot metal at torpedo station
CAC2_INJ_TIME	Injection time taken for CaC2 to feed in hot metal
MG_INJ_TIME	Injection time taken for Mg to feed in hot metal
DS_S	Output Sulphur achieved after desulphurisation

3.0 Task in hand –

To develop a model, which will predict the Suphur content at DS out (DS_S) based on input variables (HM_WT, AIM_S, HM_S, HM_C, HM_SI, HM_TI, HM_MN, CAC2, MG, HM_TEMP, CAC2_INJ_TIME, MG_INJ_TIME).

Solution Format : A sample code is provided in languages R and python. We would expect you to edit the code as necessary while maintaining the overall framework of the code. You should edit the functions build_model and test_model as per your analysis. Make sure not to change the random seed variable. This is necessary for reproducibility of the code.

Hint – 1) Current model is a linear regression model 2) There are different models for different combination of Input and Output Sulphur 3) DS compound consumption increases exponentialy if you aim lower suphur.

4.0 Award Criteria – Model hit rate

Model hit rate = % data point with (Pred DS_S – Act DS_S) between +- 0.003%,

Model will be tested on a few days of live data of DS (Test Data period - after deadline submission date)

Annexures :-

Input Data, Sample Code in R, Sample Code in Python

ALL THE BEST!

SHIKHAR 25
CHALLENGING THE LIMITS