Predict Output Sulphur of Desulphurization Process

On a sultry Friday morning in the month of May Mr Ram Nikumbh, head of the Steel melting shop in XYZ Steel Company, 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 Nikumbh'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 Nikumbh's was of the firm belief that analytics led intervention may act as a panacea for the problem he was currently encountering.

Mr Nikumbh is looking for a candidate to help him better robust model to predict the Output Sulphur % of his Desulphurization process?

Desulphurization Process

In order to aid the team Mr Nikumbh 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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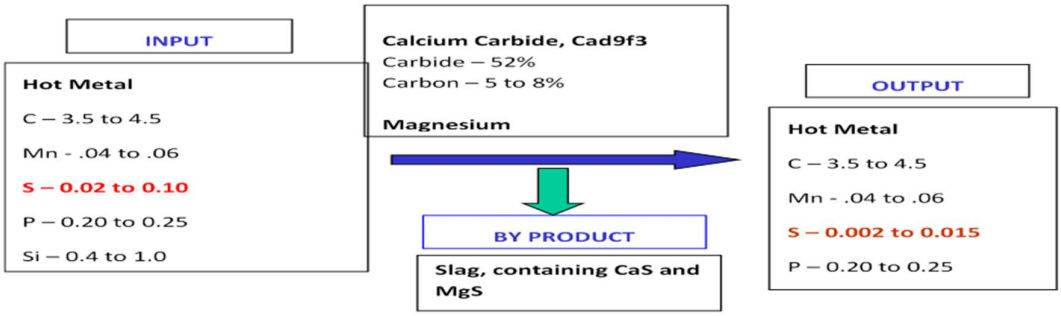

Fig 1 – Process Block diagram of Desulphurization

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
Taregt_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 :

Write a UDF for reading input data named as *read_data*, UDF for EDA named as *data_eda*, UDF for model fitting with multiple algorithms with UDF named as *build_model* and *test_model*. Make sure not to change the random seed variable. This is necessary for reproducibility of the code.

Hint –

1) There could be different models for different combination of Input and Output Sulphur

2) DS compound consumption increases exponentially if you aim lower sulphur.