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Use of blue dust in sintering

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ABSTRACT

Sintering studies were undertaken through a full factorial design of experiment to estimate the quantitative effect of blue dust along with other process variables. Responses from the experiments were then correlated with the process variables through a regression equation. The coefficients of the equation indicated that the coke breeze exerted maximum influence on the strength. It was possible to incorporate blue dust to the extent of 40% with respect to total iron ore fraction without impairing the properties of sinter.

INTRODUCTION

Most of the optimisation studies carried out, on sintering, were on the basis of conventional approach i.e., noting the change in the response by changing one variable at a time. This lacks information regarding interaction among the variables. Keeping this in view and in order to obtain a more complete and quantitative information regarding the process variables and their interaction, this study was carried out in a designed way based on the principle of statistics, wherein the effects on different variables were studied simultaneously.

Blue dust is rich in iron content with low silica and alumina. Yet, it has little use in sintering due to its fine size. A study was undertaken to estimate the quantitative effect of addition of blue dust in the range of 20 – 40% on the strength of sinter. The other variables studied were coke breeze and moisture in the range of 5 – 7% and 6.5 – 7.5% respectively

EXPERIMENTAL

Raw Materials

Raw materials used for this work were -10 mm classifier sand, blue dust, lime stone, dolomite, lime, manganese ore, mill scale, flue dust and coke breeze.

Optimising the Blending Ratio

Ingredients of sintering were mixed in definite proportion so as to meet certain chemical composition of the finished sinter. An optimum blending ratio of the ingredients in the raw mix is required to be evaluated to satisfy all the conditions viz. (i) fixed basicity, MgO% and Mn% in the finished sinter and (ii) consumption of mixed quantities of lime, mill scales and flue dust per tonne of sinter.

Sintering Tests

Sintering studies were conducted in a batch sintering unit. The pot (200 mm x 200 mm x 200 mm) could hold about 30 kg of raw mix. 1000 mm WG suction was created by exhaust fans. LPG was used for igniting the mixture. Proportion of the ingredients for the raw mix was computed through a computer programme. The raw materials were mixed in a concrete mixer in a predetermined way to give maximum granulation.

After sintering, the sinter product was dropped once from a height of 2 m on to a mild steel plate. The broken sinter was sized over 10 mm screen. The +10 mm sinter was tested for tumbler index as per ASTM procedure. The strength of the sinter (tumbler index) was the responses under consideration.

RESULTS AND DISCUSSION

A two level full factorial design of three variables was followed. The variables and their levels in coded and actual values are given in Table 1. Design matrix for the experiments is given in Table 2.

The regression equation including the interaction for tumbler index as response variable (Y) against dependent variables viz.

X_1 = coke breeze content (%), X_2 = moisture (%) and X_3 = blue dust (%) is as follows

$$Y = 63.625 + 1.450 X_1 - 0.025 X_2 - 0.775 X_3 - 0.300 X_1X_2 + 0.400 X_1X_3 + 1.075 X_2X_3 - 0.350 X_1X_2X_3$$

Table 1 : Levels of variables

Variables	LEVELS		
	−1	0	+1
Coke breeze (X_1)	5.0	6.0	7.0
Moisture (X_2)	6.5	7.0	7.5
Blue Dust (X_3)	20.0	30.0	40.0

Technical conditions for sintering studies and physical characteristics of the finished sinter produced under optimum condition are given in Table 3 and Table 4 respectively.

Table 2 : Two levels three factor design matrix

	Factor on Natural scale			Factor on dimensionless scale			Response
Obs'n	Z_1 CB %	Z_2 Moist %	Z_3 BD %	X_1 CB	X_2 Moist	X_3 BD	T.I.(Y) %
1	5	6.5	20	−1	−1	−1	64.5
2	7	6.5	20	+1	−1	−1	66.5
3	5	7.5	20	−1	+1	−1	59.3
4	7	7.5	20	+1	+1	−1	64.3
5	5	6.5	40	−1	−1	+1	62.2
6	7	6.5	40	+1	−1	+1	64.4
7	5	7.5	40	−1	+1	+1	62.7
8	7	7.5	40	+1	+1	+1	65.1
9	6	7.0	30	0	0	0	63.8
10	6	7.0	30	0	0	0	62.6
11	6	7.0	30	0	0	0	63.0

Table 3 : Technical conditions for sintering studies

a) Suction	:	1) 500 mm of WG during ignition
	:	2) 1000 mm of WG during sintering
b) bed height	:	400 mm
c) bed cross section	:	20 cm x 20 cm
d) MgO %	:	2.5%
e) Lime	:	20 kg./t sinter
f) M/SCALE	:	30 kg/t sinter
g) Flue dust	:	15 kg/t sinter
h) Basicity	:	2 $(CaO + MgO/SiO_2 + Al_2O_3)$

Table 4 : Physico-chemical characteristics of the finished sinter produced under optimum condition

Constituents	Fe	FeO	SiO_2	Al_2O_3	CaO	MgO
Assay (%)	46.1	7.66	8.60	2.52	20.6	2.6
Tumbling Index		–	65.2%			
Abrasion Index		–	5.30%			
Productivity		–	2.18 t/hr/m^2			

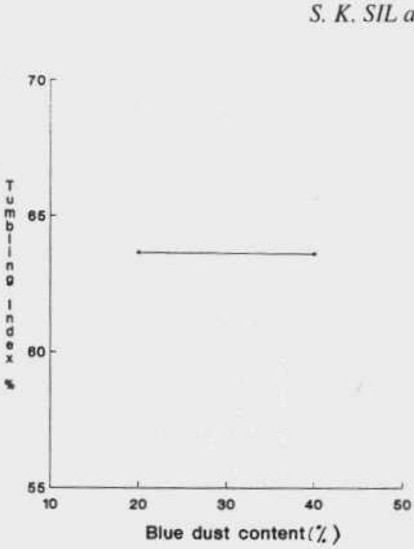

Fig. 1 : Effect of blue dust content on tumbling index of sinter.

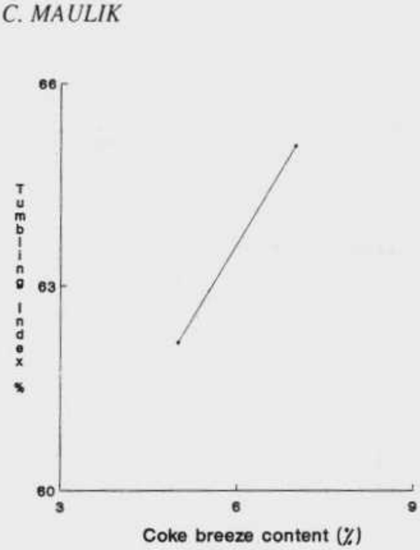

Fig. 2:Effect of coke breeze content on tumbling index of sinter.

CONCLUSIONS

The test results clearly indicated that the quantity of blue dust present in the sinter mix did not effect the strength and its was possible to produce strong sinter with as high as 40% blue dust in the iron ore fraction (as shown in Fig. 1). Most important factor was found to be the quantity of coke breeze. The change in strength was more pronounced at a higher level of coke breeze than that at lower level (Fig. 2).

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