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Short Communication

PLC Based Automation System for Proportioning of Raw Mix in Sinter Plant-2 under Modernization and Expansion Project of Bhilai Steel Plant

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Abstract

The main objective of this paper is proportioning of raw material in Sinter Plant-2 (SP-2) to achieve required quality of sinter at blast furnace. The proposed work deals with proportioning and mixing of the raw material by a particular chemical analysis, which is required for sinter making. This is achieved through utilization of belt weighing system using load cells and controllers. In this paper it is envisaged how modernization techniques are used for sinter making. By implementation of the improved PLC based raw material feeding or proportioning system, Sinter Plant II is able to produce Sinter of consistent quality.

Keywords: Agglomeration, Modernization, Production, PLC, Proportion.

Introduction

Bhilai Steel Plant is one of the flagships of SAIL and Sinter Plant-2 is one of the major production shops producing sinter which is the main input of major blast furnaces i.e. BF 5, 6 and 7. The output yield as well as sinter quality and its consistency are measured with respect to $CaO\text{-}SiO_2$. $CaO\text{-}SiO_2$ plays a vital role on the blast furnace performance i.e. production, productivity, cock rate and quality output of the hot metal. Second Sintering Plant was commissioned at 6th BF stage and started on 1st August 1979 with one Sinter Machine of 75 sq. meter sintering area and rated capacity of 0.75 MT/Y. Subsequently three more machines were added to it making the total capacity of Sintering Plant-2 as 3.137 MT/Y. As the sinter being prime material in Blast Furnace burden, its chemical and physical properties play a vital role in hot metal production. In the Metallurgical Technology, the property of sinter is determined by various factors and components present in it. Those are mainly responsible for movement of burden into the furnace as well as physical and chemical properties of hot metal being produced by the blast furnaces. The desired properties of sinter are mainly $CaO\text{-}SiO_2$, MgO, Fe, FeO, strength and Physical size. Out of these the $CaO\text{-}SiO_2$ is the most important component of sinter which is mainly monitored by the blast furnace operators. It is a chemical component which is checked and determined periodically and regularly. The values of the component are maintained in a range as per the norms. The values of $CaO\text{-}SiO_2$ which is within the range of norm are termed as percentage consistency.

The higher consistency of $CaO\text{-}SiO_2$ plays following effects on to the Blast Furnace operation. i. Better thermodynamic behavior of Blast Furnace burden. ii. Improved movement of burden into the Blast Furnace stack will require lesser coke rate for hot metal production. iii. It also improves the easy separation of slag.

The Blast furnace needs various raw materials for manufacturing the hot metal, Sinter is one of the most important inputs for the blast furnace. The utilization of sinter in blast furnace burden facilitates efficient furnace dynamics with reduction in flux and fuel consumption. The sinter plants have the responsibility to manufacture and supply the super fluxed sinter of the required chemical properties to blast furnace. The revamping was based on Schenck weighing controllers[1].

Methodology

The Sinter Making process substantially depends on efficacious functioning of series of operations. All the raw materials are discharged into a conveyor belt in definite proportion and taken to primary mixing drum. The Proper granulation / nucleolus formation is very important. All the raw materials are fed to Secondary Mixing Drum, where the final moisture is maintained. The moisture content in the granulated material is extremely important for quality of sinter which is generally controlled through Feed Water Flow Control and Moisture Measurement. Balling drum rotation input feed rate and spraying water flow or Moisture addition are all interlinked in a cascaded control system with an objective to achieve desired moisture for optimum granulation of Raw Sinter Mix. After balling drum material is charged through roll feeders and hoppers on to continuous horizontally travelling palette of Sinter Machine. The material level control system in the hopper controls the hopper level by adjusting input feed rate of raw material in Balling Drum by an automatic weigh feeder control mechanism. The top layer of bed granulated material on sinter palette is first heated inside an Ignition Furnace. The fuel used in the furnace is a combination of gas emanated from Coke Oven called CO gas. The ignition is maintained at temperature 850-950°C [2].

The surface of the bed is ignited by furnace burners. Air is continuously drawn downwards from top to bottom, bed all along the length of travelling palette grate by suction created through exhauster fans. The carbon present in raw mix material burns with the aid of air. The heat or flame front thus created moves vertically down the material bed layer by layer as the palette travels in forward direction. The hot air is sucked out by exhauster through a series of channels called wind boxes mounted below the palette. The progress of sintering along the length of grate is determined by measuring hot air temperature in different wind boxes by thermocouples. BTP is generally regulated by adjusting the palette speed in such a way that it occurs in the last but one wind box. However it also depends on Bed Height, Moisture and Raw Mix Quality. After leaving the palette the hot sinter is cooled, in the straight line cooler, the hot sinter is dropped on another travelling stand and air is blown from the bottom. The rate of cooling is controlled by adjusting speed of cooler strand and Blower Fans. Under size Sinter is sent to Storage Bins as internal Sinter Return. The cold sinter is finally sent to Blast Furnaces through series of conveyor belts called Sinter Dispatch Route. Process is shown in Figure-1.

Automation Work in Modernization and Expansion Project

Replacement of Belt Weigh Feeders and Belt Weigh Scales: Present Status: There are 24 Bins in the Mixing Bins Building for storage and proportioning of various components of Sinter Mix. These bins are of RCC Construction with volumetric capacity of 100 M3 each. These are arranged in two rows with 12 bins in each row. Belt weigh feeders are mounted at the out let of these bins and also under the Intermediate Raw Mix Storage Bunkers prior to Secondary Mixing Drum in each Sinter Machine circuit in the Sintering Building (Ref Technological Flow Diagram). The condition of existing Belt Weighs Feeders in Mixing Bin Building (Total 24 Nos for 2 rows x 12 bins) and Sintering Building (4 Nos) is reported to be very bad and it has become very difficult to control accuracy of weighing and proportioning of Sinter Mix components with the help of existing Belt Weigh Feeders[3].

Proposed Modifications: Inefficient weighing and proportioning in Mixing Bin Building is making adverse effect on sinter quality and productivity of Sinter Plant. Therefore new Electronic Belt Weigh Feeders with weighing accuracy level of +/- 0.5% (total 28 nos.) have been envisaged in SP-2. Out of 24 nos. in Mixing Bins, 2 nos. of Belt Weigh Feeders will be designed for Lime Dosing.

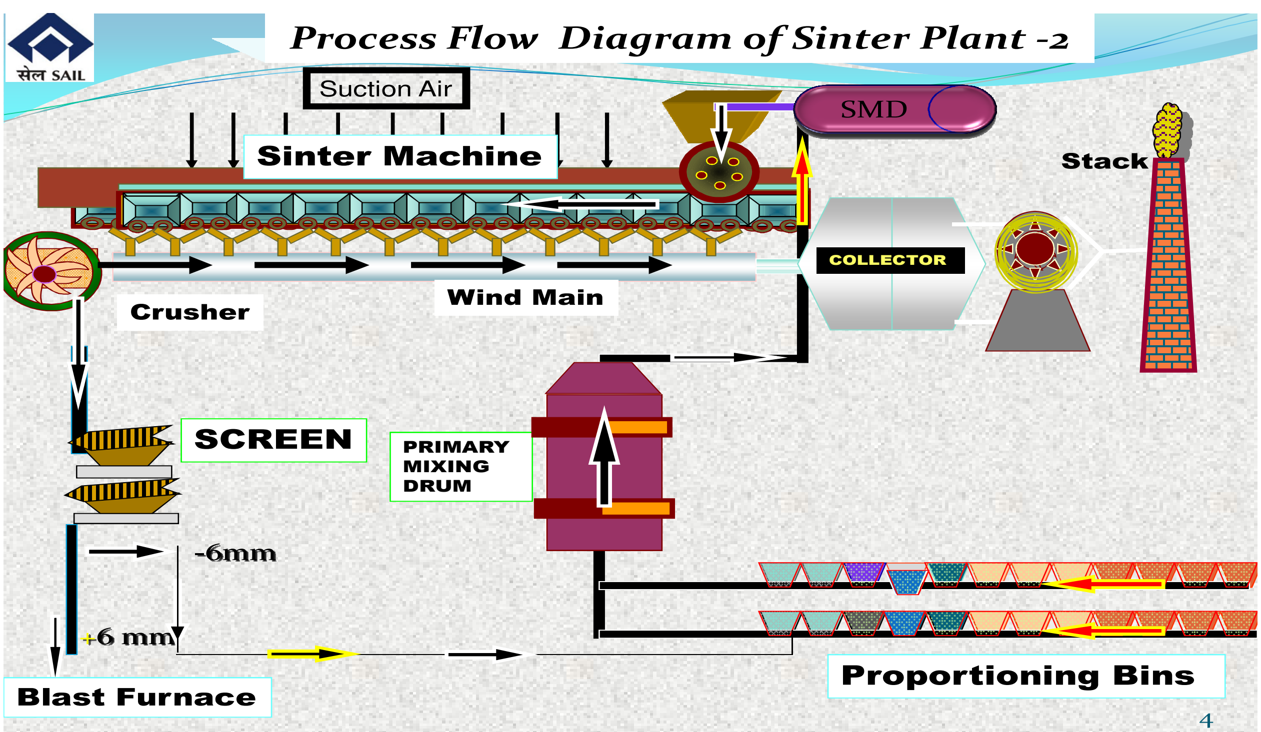

Figure-1
Process flow diagram of sintering plant -2

Design

24 number of Proportioning bins with Weigh Feeders (2 rows each with 12 bunkers). i. 4 Bins for Iron Ore, ii. 1 Bin for Burnt Lime, iii. 3 Bins for Fluxes, iii. 2 Bins for Coke Breeze, v. 2 Bins Sinter Returns.

i. Local / Remote: Each BWF can be controlled from Local Control Box (LCB) as well as Remote (PLC). ii. Auto / Manual: Any number of Bins can be selected from HMI (for example any number of bin/s out of 4 Iron Bins can be selected) either in 'Auto' or in 'Manual' provided its BWF is healthy, ready and remote selected. iii. In auto mode total set point (TPH) for any type of raw material from HMI given by operator will be equally divided among the selected BWF.

Example: Say total set point for Iron Ore is 300 T/Hr, No of Iron Ore Bins selected = 2, Each BWF will carry 300/2 = 150 T/Hr and If 3 Iron Ore Bins are selected than each will carry 300/3 = 100 T/Hr material.

Four Groups in auto mode will be there i. Iron Ore Group, ii. Coke Breeze Group, iii. Burnt Lime Group, iv. Sinter Return Group. Separate 'Group Start/Stop 'command for each group will be there.

Results and Discussion

By implementation of the improved PLC based Raw Material feeding or proportioning system, SP II is able to produce Sinter of consistent quality. This consistency in quality will help in smooth operation of Blast Furnaces with higher productivity in producing Hot Metal (Liquid Iron)[4].

Since Raw Fluxes are consumed from various sources, having different chemistry, during change over duration the control over final Sinter Analysis will be easy.

Conclusion

In view of the benefits being taken from the modernisation steps implemented at Proportioning of Sinter Mix at SP II, we may conclude that similar old plants and processes may also be planned for sustaining production with better quality consistency by PLC based Raw Material feeding or proportioning system. The newly installed PLC systems, modern Belt Weigh Feeders, on line Belt Weighing Scales, VVF drive motors and gas flow controlling instrumentation may shall help in better Sinter Chemistry, product quality control, ease of maintenance, early identification of equipment defects and improved equipment logistics, which in turn ensure consistent quality and production.

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