

Production of Pre-Reduction of Iron Ore Nuggets with Lesser Sulphur Intake by Devolatilisation of Boiler Grade Coal

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Abstract : Boiler coals with low fixed carbon and higher ash content have always challenged the metallurgists to develop a suitable method for their utilization. In the present study, an attempt is made to establish an energy effective method for the reduction of iron ore fines in the form of nuggets by using 'Syngas'. By devolatilisation (expulsion of volatile matter by applying heat) of boiler coal, gaseous product (enriched with reducing agents like CO, CO₂, H₂, and CH₄ gases) is generated. Iron ore nuggets are reduced by this syngas. For that reason, there is no direct contact between iron ore nuggets and coal ash. It helps to control the minimization of the sulphur intake of the reduced nuggets. A laboratory scale devolatilisation furnace designed with reduction facility is evaluated after in-depth studies and exhaustive experimentations including thermo-gravimetric (TG-DTA) analysis to find out the volatile fraction present in boiler grade coal, gas chromatography (GC) to find out syngas composition in different temperature and furnace temperature gradient measurements to minimize the furnace cost by applying one heating coil. The nuggets are reduced in the devolatilisation furnace at three different temperatures and three different times. The pre-reduced nuggets are subjected to analytical weight loss calculations to evaluate the extent of reduction. The phase and surface morphology analysis of pre-reduced samples are characterized using X-ray diffractometry (XRD), energy dispersive x-ray spectrometry (EDX), scanning electron microscopy (SEM), carbon sulphur analyzer and chemical analysis method. Degree of metallization of the reduced nuggets is 78.9% by using boiler grade coal. The pre-reduced nuggets with lesser sulphur content could be used in the blast furnace as raw materials or coolant which would reduce the high quality of coke rate of the furnace due to its pre-reduced character. These can be used in Basic Oxygen Furnace (BOF) as coolant also.

Keywords : alternative ironmaking, coal gasification, extent of reduction, nugget making, syngas based DRI, solid state reduction

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