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Production of Pig Iron by Smelting of Blended Pre-Reduced Titaniferous Magnetite Ore and Hematite Ore Using Lean Grade Coal

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Abstract : The rapid depletion of high-grade iron ore (Fe₂O₃) has gained attention on the use of other sources of iron ore. Titaniferous magnetite ore (TMO) is a special type of magnetite ore having high titania content (23.23% TiO₂ present in this case). Due to high TiO₂ content and high density, TMO cannot be treated by the conventional smelting reduction. In this present work, the TMO has been collected from high-grade metamorphic terrain of the Precambrian Chotanagpur gneissic complex situated in the eastern part of India (Shaltora area, Bankura district, West Bengal) and the hematite ore has been collected from Visakhapatnam Steel Plant (VSP), Visakhapatnam. At VSP, iron ore is received from Bailadila mines, Chattisgarh of M/s. National Mineral Development Corporation. The preliminary characterization of TMO and hematite ore (HMO) has been investigated by WDXRF, XRD and FESEM analyses. Similarly, good quality of coal (mainly coking coal) is also getting depleted fast. The basic purpose of this work is to find how lean grade coal can be utilised along with TMO for smelting to produce pig iron. Lean grade coal has been characterised by using TG/DTA, proximate and ultimate analyses. The boiler grade coal has been found to contain 28.08% of fixed carbon and 28.31% of volatile matter. TMO fines (below 75 µm) and HMO fines (below 75 µm) have been separately agglomerated with lean grade coal fines (below 75 µm) in the form of briquettes using binders like bentonite and molasses. These green briquettes are dried first in oven at 423 K for 30 min and then reduced isothermally in tube furnace over the temperature range of 1323 K, 1373 K and 1423 K for 30 min & 60 min. After reduction, the reduced briquettes are characterized by XRD and FESEM analyses. The best reduced TMO and HMO samples are taken and blended in three different weight percentage ratios of 1:4, 1:8 and 1:12 of TMO:HMO. The chemical analysis of three blended samples is carried out and degree of metallisation of iron is found to contain 89.38%, 92.12% and 93.12%, respectively. These three blended samples are briquetted using binder like bentonite and lime. Thereafter these blended briquettes are separately smelted in raising hearth furnace at 1773 K for 30 min. The pig iron formed is characterized using XRD, microscopic analysis. It can be concluded that 90% yield of pig iron can be achieved when the blend ratio of TMO:HMO is 1:4.5. This means for 90% yield, the maximum TMO that could be used in the blend is about 18%.

Keywords : briquetting reduction, lean grade coal, smelting reduction, TMO
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