NUT COKE IN A BLAST FURNACE

Low ash content coke that is 10-25mm or 12-30mm [industry definitions vary] in size. The majority of blast furnaces nowadays use nut coke of different grain sizes primarily to reduce costs. Among different ways to reduce the coke consumption in the blast furnace, not so much attention was paid for decreasing the coke losses through finding suitable application of small size coke called “nut coke”. In meantime modern blast furnaces use nut coke with different amount (10–140 kg/t hot metal) and different grain size (10–40 mm) in the sinter layer to reduce the coke losses. The influence of nut coke on the shaft permeability and sinter reducibility under blast furnace simulating conditions is discussed as follows. The effect of various factors such as nut coke rate, gas flow rate, and layer thickness on the shaft permeability was estimated using cold model rig. The influence of nut coke on the isothermal and non-isothermal reduction of sinter can be estimated under different gas compositions and temperatures using muffle reduction furnaces. The isothermal reduction of sinter with 30%CO–70%N2 exhibits reduction retardation at elevated temperatures (>1373 K). The reduction retardation increases by the presence of CO2 gas in the reducing atmosphere while decreased by participation of H2 gas. Mixing nut coke in the sinter bed improves the sinter reducibility and inhibits the reduction retardation phenomenon. Metallurgical coke is produced during the carbonization of coking coal blend in a coke oven battery. This coke is produced normally in three size fractions namely coke breeze (size − 10 mm), nut coke (size +10 mm to − 25 mm) and blast furnace (BF) coke (+ 25 mm to − 80 mm). BF coke is one of the most important factors which affect the economic efficiency of a blast furnace. It also constitutes a great portion of the production costs of the hot metal. The use of nut coke in blast furnace is the essential factor to reduce the costs of iron making. The consumption of the BF coke is strongly related to the CO2 emissions.

Nut coke charging with ore burden :-

Operation of many blast furnaces has demonstrated the possibility of coke saving and increase in productivity when using nut coke mixed with the burden, but the reasons for this phenomenon, and consequently the limit for nut coke consumption, are still not very clear. It was supposed that the decrease in coke consumption while using nut coke is caused by the higher reactivity of nut coke compared with the BF coke and that the nut coke reacts preferably with carbon dioxide and in this way ‘protects’ the charged BF coke from the solution loss reaction in the shaft. However investigations both in the laboratory under simulating solution loss reaction conditions and in industrial blast
furnace using nut coke in the ore burden by adding ZrO2 tracer to the coal blend have not proved this theory. The charging of nut coke in blast furnace is associated with reduction in coke rate and increase in the BF productivity. The replacement ratio of nut coke with BF coke is 1 i.e. nut coke replaces BF coke by equal amounts. The reasons for this replacement are described below.

- Feeding nut coke mixed with iron bearing materials into blast furnace results into improvement of gas permeability in ‘dry zone’ of the blast furnace. Calculations of gas permeability when mixing nut coke in the sinter layer shows that mixing of 10 volume % of nut coke in the sinter layer results in a decrease in the pressure drop in the dry shaft by 5.33 %. With the drop in pressure the gas flow rate increases. This in turn means increased blast volume and increased blast furnace productivity. BF productivity increases by 1.5 % to 2.5 % when using 10 to 20 weight percent of nut coke to BF coke rate.

- Improvement in the reduction conditions of the iron burden. Due to the nut coke charging along with the ore burden, direct reduction is promoted in the cohesive zone and inhibited in the hearth zone. This also improves the hearth heating.

- The isothermal reduction in absence of nut coke in the ore burden shows retardation at the elevated temperature due to the formation of liquid slag which blocks the pores of the sinter pieces and inhibits further diffusion of the reducing gas. Mixing nut coke in the sinter burden improves the sinter reducibility through improvement in the gas permeability.

- Protection of BF coke from the solution loss reaction in the shaft due to higher reactivity of the nut coke
Advantages of nut coke usage in blast furnace

- Reduces BF coke consumption at the blast furnace
- Improves blast furnace productivity
- Reduces production cost of hot metal.
- Use of nut coke in the blast furnace reduces overall emissions of CO2 of the steel plant
- Effective utilization of low value product generated during carbonization of coking coal.