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Coal : The most critical raw material for sponge iron making

Process requirement

Sponge iron making is a process in which iron ore lumps (typically 5mm-18mm size) are tumbled with a 'select' grade of non-coking coal and little dolomite inside an inclined rotary kiln and control combusted in the presence of air for about 12 hours before the products are air cooled, magnetically separated, screened and stored sizewise (+3mm lumps, -3mm fines) in finished product bunkers prior to dispatch.

The process entails a direct reduction of the iron ore (i.e. removal of oxygen from the ore) in solid state to metalize the ore at a critical' temperature to make this possible and yet at that temperature, the coal ash should not fuse. In the event the coal ash fuses at the temperature required for the iron ore reduction process to take place, then it inevitably results in accretion formation which continues to build in a ring formation along the inner circumference of the kiln which eventually closes the passage and does not allow the materials to travel to the other end. This requires the kiln to be shutdown (periodically) for the accretions to be removed, adversely affecting the efficacy and efficiency of the process and productivity of the kiln. This means that it is essential for the 'select' coal to have a high ash fusion temperature (in excess of 1200 degrees centigrade) to prevent from fusing inside the kiln at normal operating conditions.

Further, the 'select' coal has to have a metallurgical property known as 'reactivity' for it to be suitable for sponge iron manufacture. Coals with high reactivity will facilitate the carbon in reacting with the oxygen (in the iron ore) to form carbon monoxide (CO) whereas coals with a low reactivity will not react sufficiently with the iron ores to facilitate direct reduction and will tend to remain largely inert in the process and exit the kiln as high carbon char/waste product. The resulting sponge iron would be of low metalization unsuitable as an electric furnace charge material. Therefore, for a rotary kiln coal based sponge iron manufacturing process to be successful it is absolutely essential to use non-coking coals having high reactivity characteristics and high ash fusion temperatures. Unfortunately, most Indian non-coking coals do not satisfy the above criteria and are, therefore, not suitable for sponge iron manufacturing. Such non-coking coals having low ash fusion temperature and/or low reactivity can be used as fuels for heating in any cement kiln and/or for firing the boilers of power plants where there is no need for 'metallurgical reduction.' In the sponge iron manufacturing process, the coal acts more than as a reductant and, therefore, as a feedstock than as a fuel for providing heat to the process.

Since, there are only a few 'select' coals in each of Coal India's collieries (for e.g. 'Nimcha' and 'MNM' in the Eastern Coalfield 'Churi' and 'Raybachra' in CCL, 'Bishrampur' in SECL); these need to be reserved for sponge iron manufacturing in a metallurgical process rather than to be wasted as mere heating fuels in cement kilns and power plants. This needs to be taken up as a high priority item by the Coal Ministry, because use of such coals (other than for metallurgical purposes) just for heat would result in a national waste of a non-renewable source of energy highly suited to metallurgical processing to make steel.

It is also essential to establish a 'dynamic equilibrium' in any sponge iron manufacturing kiln which requires that the feedstock (i.e. coal) not to be changed during the continuous process of sponge iron making if indeed that operation has to run efficiently. Frequent changes of coal in sponge iron manufacturing creates untold problems for kiln operators eventually leading to loss of kilns through heavy ash deposits and accretion formation.

Therefore, there is an imperative need for sponge iron plants to source their coals at those collieries which can provide them with a long term supply of 'select' grade coals of high reactivity and high ash fusion temperature. And, such a supply of coal has to be consistent in quantity and quality with the supply uninterrupted and of long term duration.