Proceedings of the International Seminar on Mineral Processing Technology - 2006, Chennai, India. pp. 461 - 463.

Direct Reduced Iron Industry in India – Problems and Prospects

T.R. Ramachandra Rao

Consultant (Mineral Processing, Iron & Steel Technology and Engineering)

Abstract

India is the largest producer of Direct Reduced Iron in the world with annual capacity of nearly 10 Mt comprising coal and gas based DRI plants. India has the largest coal based DRI capacity. The industry is faced with problems relating to raw materials availability and their quality. An important consideration for overcoming this problem will be to install pelletising plants. Despite all odds, the outlook appears to be bright for the DRI industry as the steel production in India is expected to reach about 50 Mt by the year 2010. The paper deals with coal based DRI industry.

INTRODUCTION

India is the largest producer of coal based sponge iron. To-day many of the plants are operating with raw materials of inferior grade and the sponge iron produced by many plants are of inferior quality mainly with regard to gangue content and to some extent metallisation. Such coal based sponge iron is mainly used by induction furnace steel producers leading to technical deficiencies in the steel making process. Further, energy consumption wise, the coal based sponge iron plants are not efficient which can be improved by co-generation using kiln off gas.

CONSIDERATIONS IN SETTING UP COAL BASED SPONGE IRON PLANTS

Coal based rotary kiln sponge iron plants have mushroomed in India mainly in the states of Madhya Pradesh, West Bengal, Orissa, Jharkhand, Goa, Andhra Pradesh , Karnataka and in small numbers in other states mainly due to relatively low investment costs, scarcity and high cost of quality steel scrap and on the assumption that the technology is not sophisticated and could be operated by less experienced personnel. Many of these units have also put up their induction furnaces for steel making and some of them rolling mills mainly to produce construction bars and rods. That is how the use of sponge iron in steel making has become a regular practice mainly by induction furnace steel plants. Majority of the sponge iron units did not have final gas cleaning system to remove fine dust in the gas before letting out to the atmosphere, which are of course installed later/being installed. With the boom in export price of iron ore during last 2-3 years, iron ore suppliers have put up the rotary kilns with the objective of earning higher profits by sponge iron sales.

PROBLEMS OF COAL BASED PLANTS

About 75% of the sponge iron capacity in India is coal based. While setting up the plants, it has been assumed that iron ore and coal are available easily as India has the fourth largest reserves of iron ore and non-coking coal is available in plenty. Contrary to this, the major problems faced by the sponge iron producers relate to raw materials.

Iron Ore

Iron ore of the right quality is the basic input. The sponge iron plants are basically using lump ore. The chief quality requirements are:

i. High Fe content with less gangue and deleterious elements like phosphorous and sulphur – preferably 65% or higher iron content.
ii. Good handling properties - Tumbler and abrasion – preferably +85% tumbler index.

iii. Calibrated to size with less fines – preferably 6-16 mm with less than 3% fines
iv. High reducibility – $(dR/dt)_{40\%}$ about 0.7%/minute or higher. Hematite ores generally meet the requirement
v. Low decrepitation during reduction – less than 5% fines generation
vi. Good compatibility with the reductant coal used.

The ore used in most of the coal based sponge iron plants hardly meet the above requirements. The availability of such ore is difficult as it calls for selective mining and also the extent of such reserves are limited.

Reductant

Coal is the most critical input material for rotary kiln sponge iron production. Non-coking coal is used as reductant. The main quality requirements of coal are:

i. Low ash and high fixed carbon contents
ii. Volatile matter 23-28% desirable
iii. Low sulphur content
iv. Reactivity – desirable 2 (cm^3 CO/gC.sec)
v. Low caking index
vi. High ash fusion temperature – Initial deformation above 1200/1250 °C
vii. Swelling index less than 1.

Although India has huge reserves of non coking coal, only about 15% of such coal is suitable for rotary kiln sponge iron process. Further, in the southern zone, Singareni being the only source, availability of linkage and coal quality are the constraints. The sponge iron plants, therefore, are using any non coking/steam coal available to them. Many of the sponge iron producers have switched over to imported coal usage which has superior properties compared to local coal.

Energy Consumption

In the rotary kiln process about 6 G Cal of fuel energy is used as compared to less than half the energy required in the gas based direct reduction processes. More than 2 G Cal of energy is let out from the kiln as waste gas. To day some of the plants have incorporated co-generation system to utilize the energy from waste gas and producing cheaper power.

Introduction of co-generation system has improved economics of the rotary kiln /induction furnace operation. However, the higher initial investment has slowed down the adoption of co-generation, especially at the present situation where the sponge iron market is highly depressed.

SPONGE IRON QUALITY

The rotary kiln sponge iron has lower metallisation (about 85 – 88% on the average) and low carbon content (0.1-0.2%) compared to gas based sponge iron (Metallisation of 92 – 94% and carbon content of 1.5 – 2%). The higher metallisation and higher carbon content of gas based sponge iron provide techno-economic advantages in steel making operations.

ALTERNATIVE INPUT RAW MATERIAL

As indicated above, the iron ore lumps used, especially ore of Bellary – Hospet sector, hardly meet the quality requirements for the rotary kiln sponge iron process. The sponge iron fines generation is high and ranges from 15 – 30% depending upon the ore used due to high reduction degradation. This will not only reduce the sales realization of the product but also will lead to accretion formation in the kiln shortening the campaign life. Many plants are using pebbles for this reason which will help to a certain extent but the grade being generally low and contamination being high will lead practically to excess specific fuel consumption apart from quality problems. Moreover, the availability of good pebbles are also limited.

All the above problems on account of ore quality can be overcome with the use of iron ore pellets. The pellets being well sized, high in iron content, having high cold and reduction strength are the ideal input for sponge iron production. The ore fines used for pellet production should be beneficiated to get economic advantage in steel making. The advantages in rotary kiln process with the use of pellets are as under:

i. Higher Fe content and high metallic Fe in sponge iron
ii. Higher tumbler index – above 94%
iii. Higher productivity – 20-25% higher compared to lump ore usage
iv. Lower coal consumption – 20-25% less compared to lump ore usage
v. Higher metallisation – about 90% or higher compared to 85-88% with lump ore
vi. Less sponge iron fines generation – about 5-7% compared to 15-30% with lump ore. Therefore higher sales realization.
vii. Higher strength of sponge iron produced.
viii. Higher campaign life between accretions – about 6-9 months or higher depending on the quality of pellets compared to about 1-3 months with lump ore
ix. Less power consumption in steel making – about 10-15% lower compared to sponge iron from lump ore depending upon its proportion in steel making
x. Higher Proportion of sponge iron can be used in steel making
xi. Higher yield in steel making by 2-3%compared to use of sponge iron from lump ore

If the above advantages are considered, the use of pellets in rotary kiln sponge iron process will become techno-economically advantageous in spite of higher price of pellets compared to lump ore price. . The high cost of beneficiation and pelletisiation plants can be shared by groups of coal based DRI producers as joint venture, as individual plant requirements are generally small, which will ensure availability of quality input at affordable price. Further, as the fines generation during mining and calibration of ore generates about 50-60% fines, use of fines in pellet production would ensure rational utilization of iron ore deposits. In addition, the use of pellets will result in steady growth of DRI industry as quality product can be produced to replace high grade steel scrap which is costly with fluctuating price.

OTHER CONSIDERATIONS

The inputs to the DRI industry such as non-coking coal, natural gas, iron-ore, railway movement and power are virtually controlled by state and central governments who , by their appropriate policy frame work, can contribute to its sustained growth. To develop Indian steel industry and to make basic raw material available at affordable prices, surplus iron ore after meeting domestic needs should only be exported.

CONCLUSION

Despite all odds, with the rational utilization of Indian iron ore and with appropriate policy frame work as indicated above , the outlook appears to be bright for the DRI industry, particularly in view of limited availability and high cost of quality steel scrap and as the steel production in India is expected to reach about 50 million tonnes by the year 2010.