EXECUTIVE SUMMARY

1. Sponge Iron is iron ore reduced directly in solid state using coal gas, natrual gas or coal as reductants and is also known as Directly Reduced Iron (DRI). The need for development and commercialisation of sponge iron manufacturing process arose in late 50's when Electric Arc Furnaces (EAFs) engaged in manufacturing steel started facing problems of availability of scrap of desired quality, the traditional source of their iron metallics. The DRI processes soon became popular and since the inception of first DRI plant in 1957 in Mexico, there has been a continuous growth of this industry in last three decades. This is evident from the steep rise in world DRI production during the past three decades. India, entered the sponge iron industry only in 1980, when the coal based DRI plant of Sponge Iron India Limited (SIIL) was commissioned at Kothagudem, in Andhra Pradesh.

2. The reasons for the tremendous growth of the sponge iron industry world over could be attributed to the advantages of using sponge iron in electric arc furnaces, partly substituting scrap, the conventional charge to the furnaces. Further, the use of sponge iron in other steel manufacturing processes has also been well proven. The advantages of sponge iron use in EAFs are summarised below:-

   - Uniform known composition
   - Low levels of residuals/tramp elements
   - Capability to maintain phosphorous level in steel within 0.002%
   - Maintenance of sulphur in steel by its removal in sponge manufacture.
   - Low content of dissolved gases
   - Uniform size and higher bulk density as compared to scrap
   - Capability of forming protective cover of foamy slag in the bath
   - Lower refining requirements of steel produced
   - Potential of sensible heat recovery from waste gases
   - Possibility of producing variety of steels

3. The industry is gaining further importance due to proven utility of sponge iron in other steel manufacturing processes like L.D. Converters, Open Hearth Furnaces (OHFs), Blast Furnaces (BFs) &

- Technologies using carbon monoxide as reductant

- Technologies using mixture of both hydrogen and carbon monoxide as reductant

¤ Static bed technologies using mixed gas as reductant

¤ Moving bed technologies using mixed gas as reductant

The gas based technologies were capable of using either natural gas associated with oil or reducing gas derived from coal.

B. Solid Reducant or Coal Based Technologies

Out of the several technologies developed only a few were proved to be commercially successful; the plants based on the others like Purofer, Armco, Wiberg Sodefors, NSC, Plasma red and Usco were either closed down or dismantled for various reasons. The success of some of the technologies was limited to a few plants of small capacities only. The most successful technologies were the gas based static bed HYL- I technology of Hojalata Y Lamina of S.A. (HYLSA), gas based moving bed technologies of Midrex Corporation of USA and HYL-III process of HYLSA. These contribute over 80% of world sponge iron production today. Out of the coal based technologies SL/RN technology of Lurgi GmbH, West Germany has been the most successful one. Little success has been achieved by other coal based technologies namely CODIR technology of Krupp Industriatechnik now Mannesmann Demag, W.G., DRC technology of Davy Mckee, USA; ACCAR technology of Allis Chalmers now Boliden Allis, USA and the TDR, the only indigenously developed technology of Tata Steel. Recently Jindal Strips have claimed to have developed indigenous coal based technology and that they are installing many sponge iron units based on the new technology. Besides this, Sponge Iron India Limited has absorbed the imported technology and are offering the same to the entrepreneurs.

7. The direct reduction processes available for commercialisation are

A. HYL III Process : The process involves reforming of natural gas, reduction of iron ore by reducing reformed gases and cooling of the product. The gas reforming comprises preheating and desulphurisation of natural gas using zinc oxide, its mixing with steam and passing it over nickel catalyst. Sensible heat of

reformer gas is recovered and used elsewhere in the process. For the reduction, the reducing reformed gas is mixed with lean reformed gas from the reactor after removal of its CO_2 content, preheated and used in shaft kiln reactor for reducing iron oxides. The product sponge iron is cooled by counter current cooling gas in cooling section from where the cooled product is removed continuously.

B. Midrex Process : In Midrex technology reforming is effected by low pressure stoichometric operation which involves formation of reducing gas by passing the mixture of natural gas and recycled top gas from the reactor through the catalyst bed. The reformed reducing gas contains 90% to 92% hydrogen and is used directly in the reduction reactor to reduce iron ore in its upper section. Hot product is continuously discharged from here to lower cooling section where it is cooled by independent cooling circuit. Midrex technology provides for production of specialised product called 'Hot Briquetted Iron'. While producing this, the hot DRI is directly discharged into hot briquetting machine and cooling circuit is eliminated. Hot HBI from briquetting is separated to individual briquettes and cooled.

C. Coal Based Direct Reduction : Coal based direct reduction technologies involve reduction of iron oxides in a rotary kiln by using non-coking coal as reductant. Limestone or dolomite is used as desulphurising agent. The normal operating practice is to feed the kiln with desired proportion of iron oxide, non-coking coal and limestone or dolomite. Some processes use optimum quantity of recycle char in the feed for minimising coal consumption. The charge is preheated in the preheat zone and the reduction of iron ore is effected by reducing gases derived from coal gasification. The heat for the process is provided by burning coal volatiles and excess carbon monoxide emerging from the charge. This is done by introducing controlled quantity of air in the kiln free board along the preheat and reduction zones of the kiln. Part of coal is introduced from the kiln discharge end to supply energy at discharge end, maintaining reducing atmosphere at discharge end to prevent reoxidation of DRI and for controlling degree of metallisation and carbon content of DRI. The separation of the product is more or less similar in all the coal based processes and involves screening and magnetic separation for removal of non magentic ash, char and used desulphuriser. SL/RN, CODIR, DRC, ACCAR, TDR and Jindal's are the available coal based DR processes and the two main operations where different technologies use different techniques are feeding/blowing coal and introduction of air for the process.

based Midrex technology, though commissioned recently, has achieved rated capacity in a short time.

vi) The installed capacity of sponge iron is expected to exceed 6.5 million tonne per year by 1994-95 with about 70% contribution by gas based plants.

vii) SIIL, IPITATA and Jindals have developed capabilities of providing completely indigenous technologies for coal based DRI plants. Indigenous machinery manufacturers are also capable to supply almost 100% equipment indigenously. However, technology for reforming of NG by reactor top gas and certain equipment for gas based plants are not available in the country.

27. The following recommendations are made to ensure the desired growth of the industry:-

i) Adopting indigenously available technologies for settingg up of coal based DRI plants.

ii) For gas based, technology may have to be imported. In that case negotiations may be held for maximum indigenisation of the equipment and time bound arrangements of technology transfer.

iii) Increasing pellatisation capacity of the country based on large iron ore deposits with high proportion of fines/blue dust.

iv) Long term policy in respect of allotment and pricing of natural gas and coal to sponge iron industry.

v) Coal authorities should pay special attention for production of superior grade noncoking coal to cater to the needs of sponge iron industry.

vi) Incentives to new integrated Direct Reduction Electric Furnace (DREF) units and for modernisation of existing steel units.

vii) For testing of raw materials for new projects, facilities of laboratory and pilot and demonstration scale plants available with SAIL, SIIL and other organisations, may be utilized.

viii) Provision of emergency power in new plants and power generation units based on waste heat utilisation in DR process plants.