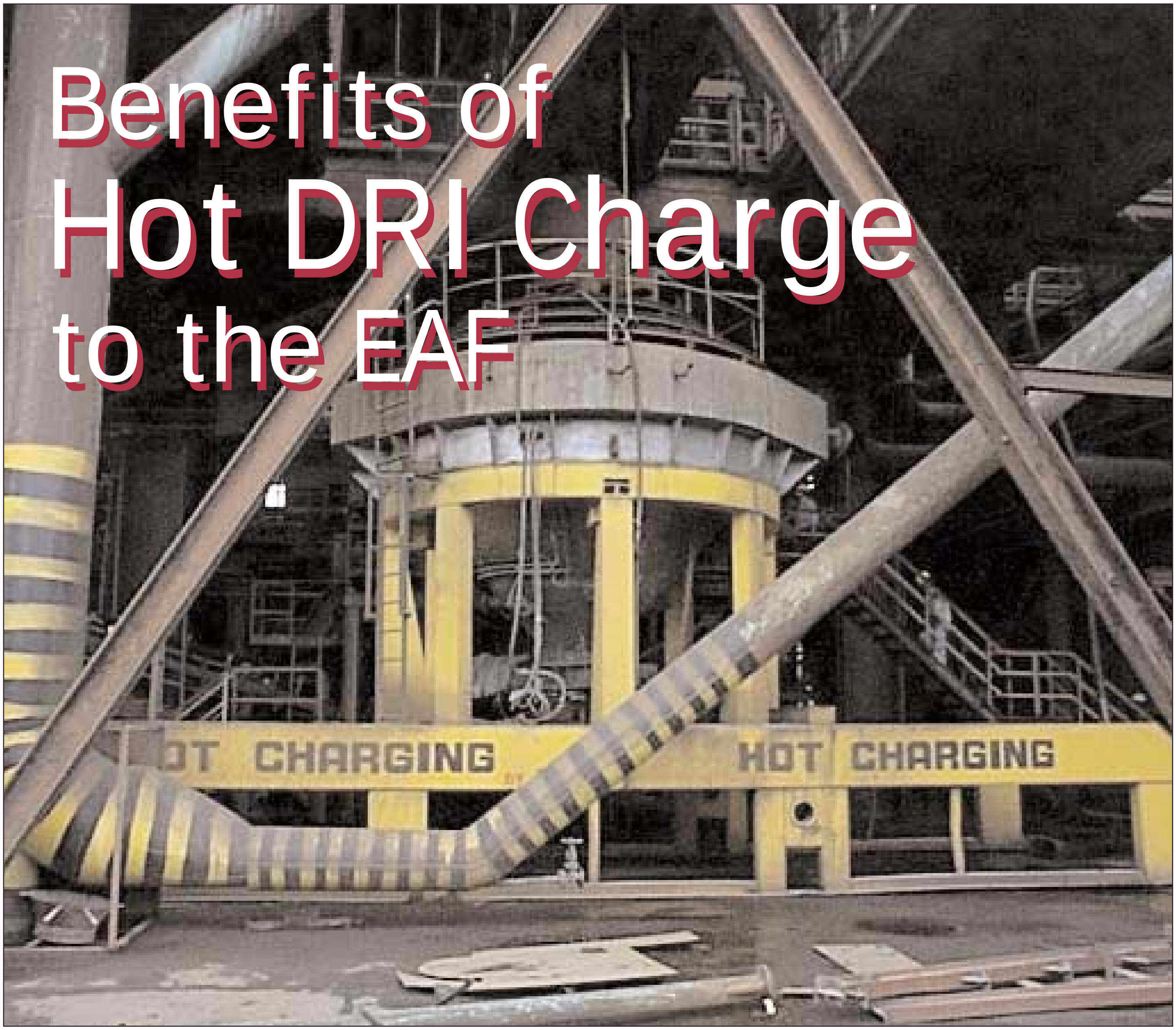

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The benefits of charging hot DRI (HDRI) have been known for many years, however, not until recently have any MIDREX® Direct Reduction Plants seriously pursued the goal of using hot product directly from the MIDREX® Shaft Furnace. Essar Steel began experimenting with hot transport in 1999 on a small scale. Since mid-1999, the production and use of HDRI have increased continuously. Equipment modifications have been undertaken and application of process know-how has shown significant benefits to both operations and cost. Essar Steel has set itself the target of 75 percent HDRI use in the Electric Arc Furnace (EAF) meltshop.

With the high price of electricity in India, the economics certainly provide enough incentive to work out the logistical problems of handling greater than 600°C HDRI.

INTRODUCTION

Essar Steel Ltd. owns and operates a two million ton per year (Mt/y) steelmaking and hot-rolled coil facility in Hazira, Gujarat State, Western India. Compared with energy costs in most parts of the world, those applicable in India are extremely high.

The MIDREX Plant was originally designed as a two-module HBI plant. The plant now has three MIDREX® Series 400 Modules, Module Three being started up in 1992. With the previously completed modifications and those currently in hand, the capacity of all three modules is more than 2.4 Mt/y.

HDRI is discharged from the furnace discharge system upstream of the briquette machines. The HDRI is then fed into hot transport vessels and transported to the meltshop on specially-designed flatbed-trailers. The shaft furnace discharges

HDRI at about 650°C to more than 700°C and measurements show that there is less than a 50°C temperature loss between the charging vessel and use in the meltshop. Measurements have shown that once charged, the temperature loss of the HDRI is less than 5°C per hour.

The meltshop consists of three 160 MVA single electrode DC EAFs that have been in operation since 1995/1996. Each has a tapping weight of 152 t and operates with a hot heel of 80 t.

Originally the EAFs were fitted with consumable pipe oxygen and carbon lances on a common lance manipulator. Water-cooled lances have now been fitted to each furnace to enhance oxygen consumption and yield. A large variety of feed material percentages are charged depending on the metal quality required by the client and raw material availability.

If scrap is in the charge, a bucket charge is made and HBI and slag formers are charged via bins and conveyors through a chute in the roof. The meltshop has a separate baghouse and a 28 MVA ladle furnace for each EAF. The meltshop is located about one kilometer by road from the DR facility.

Additional facilities include an oxygen plant, two lime kilns and a downstream facility including hot skin pass mill, slitting and shearing lines.

HISTORY

To take advantage of the energy in the HDRI fed to the briquetting presses in the three MIDREX HBI Plants, Essar developed a basic concept for "hot transport of DRI" over the years. In August, 1999, the first commercial-scale trials took place where HDRI was discharged from the DR furnace at 650°C, transported by a specially-designed 45 t net weight container to the steel meltshop and charged to the electric arc furnace.

The first trials were a complete success and work immediately started on the second 45 t container. At the same time, design work was taken up on a new 90 t container.

Substantial data collection, studies and work were carried out to ensure that the developed systems were safe and the plant operators were comfortable working with them.

At present, there are two 45 t containers and five 90 t containers in service. Today all three MIDREX Modules are able to discharge HDRI and all three EAFs are able to charge HDRI. Until recently, one module could only accommodate the 45 t containers due to clearance problems with material handling conveyors. The conveyors have been relocated so that now all three HBI modules are now able to discharge to the 90 t containers. The two 45 t containers will be phased out shortly.

Essar has increased the amount of HDRI transported each month with April 2001 achieving 44,671 t. In the 2001-2002 business year, Essar expects to reach a level of 1.2 Mt.

BENEFITS IN THE MELTSHOP

Some of the advantages of using HDRI in the meltshop are increased production, electrical energy and electrode savings, increased yield and decreased moisture in EAF feed.

Essar has found that the production increase in the meltshop can be substantial. Data from last year shows that by hot charging one 45 Mt container of HDRI, the average tap-to-tap time for one heat in the EAF can be reduced from 72 minutes to 69 minutes. If a 90 t container of HDRI is charged, the average tap-to-tap time is reduced to 66.6 minutes. In April, 2001, Essar set a new HDRI transport monthly record of 44,671 t, which translates to about 496 x 90 t containers or a theoretical savings of almost 48 hours production time in the meltshop.

In addition to the increased productivity, savings in electricity and electrode consumption are also considerable. Data shows that EAF heats using one 90 t container of HDRI had an average 60 kWh/t liquid steel (LS) reduction and heats using 135 t of HDRI saw a savings of more than 90 kWh/t. This converts to an average electrical consumption savings in excess of 120 kWh/t LS when operating on 100 percent HDRI charges.

On a daily average basis, electrical consumption in the meltshop has been reduced from 600 kWh/t LS when no HDRI was being used, to 537 kWh/t LS during the best day in April 2001 when 20 heats had HDRI charged in the feed. The additional savings come from improved operation and secondary benefits when using large amounts of HDRI in the charge.

With the reduction in electrical consumption also comes a reduction in electrode consumption. Based on data from last year, an average reduction of 0.3 kg/t in electrode consumption was observed over a period of eight months.

In a typical HBI plant, the briquettes are cooled by quenching them in water either by submersing or spraying. The quenching process has the inherent disadvantage of lowering the metallization of the product and of adding water to the briquettes, which must be evaporated in the EAF.

At Essar, a hot sampling device was recently commissioned to provide reliable data on HDRI quality compared to HBI quality. It was found that due to the quenching of HBI, HDRI has 1.0 – 1.5 percent higher metallization. Also, HDRI is never exposed to water, so no energy is needed in the EAF to evaporate the 0.75 percent moisture normally contained in the briquettes.

As more HDRI is being transported to the meltshop every month, Essar is well on the way to achieving the 75 percent target HDRI use and has seen significant operating cost savings in the meltshop and at the MIDREX Plant. Essar is saving on electrical energy consumption and is simultaneously maximizing meltshop productivity, thus gaining production capacity.

For existing plants with a limitation on steelmaking capacity, hot transport could also be an alternative to a new EAF.

FUTURE

Essar is presently working on a hot screening process and surge bin system to further enhance the tonnage of HDRI available for transport. This will also maximize the yield at both the HBI plants and the meltshop, enabling feeding of minus six mm DRI back into the hot briquetter. This fraction would otherwise be lost into the slag layer and EAF combustion system. Further improvements in process data collection and translation of this data into improved EAF operation are also under development.