THE LION GROUP & MIDREX EXPERIENCE:

OPERATIONAL ASPECTS OF LION'S MIDREX HDRI/HBI PLANT

By **Antonio Mouer**: Proposal Manager, Midrex Technologies Inc., Charlotte NC, USA
& **Frederick Mah**: Process Manager, Antara Steel Mills Sdn Bhd, Labuan, Malaysia

INTRODUCTION

This paper discusses operating aspects and technology improvements of the LION GROUP's newest MIDREX plant in Banting, Malaysia. The Plant started up in June 2008 and is rated for 1.54 million tons per year of HDRI/HBI. One of the more unique aspects of the LION DR Plant is that it uses hot transport vessels for transferring hot direct reduced iron (or HDRI) from the direct reduction facility to the adjacent melt shop. LION is one of only two operating MIDREX facilities to utilize hot transport vessels.

LION DRI

The new MIDREX plant in Banting is a part of a new family of dual discharge facilities, capable of producing hot briquetted iron (HBI) and HDRI. The HDRI lines incorporate a proven hot discharge and transport arrangement along with HDRI transport vessels designed specifically to meet the capacity and logistics requirements of LION.

Additional technology improvements specific to the new MIDREX plant which will be discussed in this paper include the use of centrifugal compressors, the use of larger briquetting machines and implementation of a new briquette cooling conveyor. However, before a more detailed discussion of the MIDREX Plant, information on the LION GROUP's steel making capability and product mix is reviewed.

The LION GROUP's steel businesses are involved in iron and steel making, rolling of flat and long products and downstream manufacturing of various steel products.

The LION GROUP operates Megasteel, Malaysia's only integrated flat steel mill producing hot rolled and cold rolled coils. Megasteel uses a state-of-the-art Direct Current Electric Arc Furnace - Compact Strip Production (EAF-CSP) process which incorporates thin slab casting technology.

The manufacture of long products such as bars, wire rods and channels, is undertaken by Amsteel Mills, in Banting and Klang, and Antara Steel Mills, in the southern state of Johore, which are equipped with modern facilities comprising electric arc furnaces, ladle furnaces and 6-strand continuous casting machines. These facilities are designed to produce high quality billets including special grade billets for rolling into specialty bars and higher grade wire rods for stringent applications.

The LION GROUP also operates Antara Steel Mills in Labuan that produces HBI for local consumption and for export within the Asia Pacific region. High quality HBI is used as a substitute for scrap to produce high and stringent quality steel.

LION GROUP'S IRON AND STEEL PRODUCT MIX

Product Category	Annual Capacity (million tons)
Iron Making	
Hot Briquetted Iron (HBI)	0.88
Hot Direct Reduced Iron (HDRI)/ HBI	1.54
TOTAL	2.42
Steel Making	
Billets	3.05
Slabs	3.20
TOTAL	6.25
Rolling	
Hot Rolled Coils	3.20
Plates	0.25
Bar, wire rods, sections	2.35
TOTAL	5.80
Cold Rolled	1.45

HDRI & HBI PRODUCTION CAPABILITY AT LION

The new Direct Reduced Iron Plant was built at the Megasteel Facility in Banting, Selangor, Malaysia as shown in Figure 1. The LION plant is based on the well-proven MEGAMOD® Shaft Furnace with a 6.65 meter inside diameter and a proprietary MIDREX® Reformer. All production is based on the use of imported iron oxide. The existing site has the capability of importing 2.5 Mpy of iron oxide and transporting the HDRI and HBI products within the Megasteel facility.

FIGURE 1 *LION'S MIDREX Plant in Banting, Malaysia*

Key Features

The PLANT can produce up to 1.54 million tons per year of high quality hot metallized iron that can be discharged in two forms:

1) HDRI for transport and direct charging to the EAFs, and
2) HBI for storage and cold charging to the EAFs.

Additional features of the new facility include:

- Up to 192.5 tons/hour HDRI
- Two high capacity briquette machines with nominal briquette capacity up to 140 tons/ hour HBI
- Plant discharge of 100 percent HDRI or a combination of HDRI and HBI up to 100 percent of total production.
- Oxygen Injection for increased furnace productivity and high carbon levels
- 8000 hours/year Plant availability
- Sulfur removal from incoming natural gas

Key Benefits

The increased supply of DRI will help to reduce the dependence on scrap as a raw material for steel making by the Group's various steel mills and enable the production of high quality steel.

On site use of HDRI at high discharge temperature reduces utility and maintenance costs (e.g., electrode and refractory costs) and thus steel production costs. As an example, for a typical case, hot charging at 600° C lowers operating costs $5-10/t liquid steel and enables a 20 percent productivity increase. Figure 2 shows a hot transport vessel.

Production of HBI allows continuous operation of the MIDREX PLANT while other site operations might not be capable of consuming HDRI as it is produced. Also, the HBI may be exported safely, thus adding additional flexibility to the plant operation.

FIGURE 2 *Hot Transport Vessel at LION*

Operating Results

Experience to date with the HBI and HDRI systems at LION has been positive with key features of the new design being realized including:

- HDRI discharge temperature from shaft furnace 680° C to 710° C
- Minimal temperature losses from shaft furnace to EAF
- Negligible carbon losses from shaft furnace to EAF.
- Yield improvement
- Power saving approximately 40 kWh/ton (30% to 35% charge of HDRI)
- Improvement in Tap-To-Tap time
- Reduction in copper content in the final product
- Reduction in nitrogen content in the liquid steel

CENTRIFUGAL COMPRESSOR IMPLEMENTATION AT LION

Two single stage centrifugal compressors (see Figure 3) operating in series were selected as the primary choice for the LION plant resulting in:

- A plant layout which is simpler than that required for rotary lobe compressors.
- Lower total installed and operating costs compared to rotary lobe compressors.

Also, process gas flow and pressure rise requirements needed for increased plant designs like LION's are exceeding the capability of the two-stage rotary lobe process gas compressors presently used in older plant designs.

FIGURE 3 *Centrifugal Compressor at LION*

Key Features

Key features of the centrifugal process gas compressors are as follows:

- Two single stage centrifugal compressors, operating in series can deliver the required process gas flow with the required differential pressure.
- Either compressor can be operated alone and deliver more than 60 percent of the process gas flow and pressure rise requirements.
- High efficiency mist eliminators are utilized to remove essentially all water carryover from the top gas scrubber. Most of the dirt in the "dirty" process gas is carried in these water droplets; eliminating the droplets eliminates the dirt.
- Recycle from the compressor discharge to the mist eliminator outlet will ensure no liquid water remains in the gas at the compressor inlet.
- Multiple inlet mist eliminators operating in parallel will allow for online cleaning prior to gas inlet.

Key Benefits

Key benefits of the centrifugal process gas compressors are as follows:

- Total installed cost of the centrifugal system is less than the rotary lobe (e.g., discharge dampeners not required for the centrifugal compressors).
- More efficient operation since the centrifugal compressors require less power than rotary lobes.
- "Dry" compressors do not require water sprays, simplifying the blower area seal leg system and associated sump.
- Simpler foundation design due to two light weight machines as compared to rotary lobes. Also the centrifugal live load is much less than the rotary lobe's inherent rocking motion.
- Centrifugal compressor service parts are much lighter weight than rotary lobe, thus eliminating the need for the compressor maintenance cranes and associated structure.
- Lower maintenance cost for centrifugal compressors as compared to rotary lobe.

LARGER BRIQUETTING MACHINES AT LION

The briquetting system design for LION includes two briquette machines, with briquette strand separators and hot fines recycle systems.

Hot DRI is supplied to each briquette machine by a screw feeder. The briquette machines are roll type machines which produce "pillow" shaped briquettes. Each roll contains dies which form the briquettes as shown in Figure 4. One of the rolls is forced toward the other roll by means of a hydraulic pressure system, which ensures a uniform pressing force. The continuous briquette strand exiting the briquetting machine is fed to the strand separators to break the strands into individual briquettes. The briquettes are passed to the HBI cooling system for slow cooling and discharge to the product handling system. Any smaller chips, fines and dust generated during the strand separation process are recycled via the hot fines recycle system back to the briquetter feed system.

Key Features

The new larger briquetters installed at the LION facility have the following key feature:

- Increased roll diameter of 40 percent compared to the standard briquette machine.

FIGURE 4 *Briquetter Roll at LION at LION*

Key Benefits

Key benefit of the larger briquetters is as follows:

- Production rate of up to 70 t/h per machine

BRIQUETTE COOLING CONVEYOR AT LION

The new briquette cooling conveyor was installed to eliminate operational problems encountered with the standard apron conveyor quench system and improve HBI quality with minimal loss of metallization.

In particular, the system was redesigned to address issues encountered with the standard quench system such as submerged wheels, wheel bearings and seals on the apron conveyor.

Key Features

The new briquette cooling conveyor installed at the LION facility has the following key features:

- The conveyor moves material in a trough type conveyor while slow-quenching the briquettes with water from overflow weirs.
- Material tends to spread out on the trough as it moves down the length of the trough. This spreading helps prevent briquettes on the bottom from being covered by larger sheets of briquettes
- Uses slow horizontal, slow-advance, quick-return motions to advance the material.
- There are no wheels, wheel bearings, or seals on these conveyors.

Key Benefits

Key benefits of the briquette cooling conveyor are as follows:

- The elimination of wheels, wheel bearings, and bearing seals reduces maintenance and increases overall plant availability.
- Most maintenance items on the briquette cooling conveyors are external and accessible for easy inspection and routine service.
- The new conveyor is assembled and tested in the shop. This is then broken down into pieces as large as practical for shipment and re-assembly. This eliminates concerns associated with complex field assemblies.
- The conveyor is supported by a number of pendulum support rods. This system allows free movement of the conveyor and avoids putting horizontal forces into the building's steel structure or foundations.

SUMMARY

LION's new MIDREX Plant provides improved flexibility through its HDRI/HBI dual discharge capability.

Charging HDRI to the EAFs provides major benefits in energy consumption, reduction in EAF maintenance cost, and reduction in tap-to-tap time, while the capability to produce HBI allows continuous operation of the MIDREX Plant while other site operations might not be capable of consuming HDRI as it is produced. HBI may also be exported safely, thus adding flexibility to the plant operation.

Several new features of the MIDREX Plant implemented to improve plant availability include use of centrifugal gas compressors and a new briquette cooling conveyor system.