DIRECT FROM MIDREX

2ND QUARTER 2016

INSIDE THIS ISSUE

COMMENTARY

WITH **STEPHEN MONTAGUE**

Stephen Montague
President & COO, Midrex

EDITOR'S NOTE:
*With the new organization changes within Midrex Technologies, Inc. we are taking this opportunity to give readers the perspective of **Stephen Montague, President and COO of Midrex** on this new paradigm in the Iron and Steel Industry.*

Q: How do you see the steel market today?

A: This is not a typical downturn. Prices of all steel related materials – iron ore, scrap, DRI/HBI, and steel products – have been at very low levels. They dropped about 50 percent from late 2014 until early this year. There was an uptick in the last few months, but that was due to technical factors and prices are slipping again. The fundamental problem, steelmaking overcapacity around the world (especially in China), hasn't changed. China is exporting steel at very low prices, which has become the "new norm." The overcapacity must be reduced, but this will likely take several years.

Interestingly, despite the downturn, the world is continuing to order and build new direct reduction capacity. As a niche player in the industry, we are finding some opportunities we are pursuing aggressively. Four **MIDREX® Plants** with a total capacity of nearly 9 million tons per year are being constructed in Russia, the USA, and Algeria. Steel producers, technology suppliers, and iron ore companies are all suffering, but as always, the strong will adapt, endure, and become stronger. Midrex has chosen to embrace change and adjust our business accordingly.

Q: How is Midrex adapting?

A: We talked about this in two presentations we gave at the Steel Success Strategies Conference in mid-June. The market is demanding that the pace of change be faster than before. Let me briefly review some of the major strategic actions we are taking. The overall theme is "Building on Success and Innovating to Enhance the Future of Steelmaking." Our focus is reliability, flexibility, and partnerships, all supported by relentless innovation. Reliability has been the main factor in the success of the **MIDREX® Process** over the last 45 years. As the plant manager of a **MIDREX® Module** said recently, "Ironmaking isn't about how many tons you can make in an hour, it's about how many hours you can make tons." One exciting development is DRIPAX™, our integrated process optimization system developed in cooperation with our partner Primetals. DRIPAX provides for a highly accurate prediction of DRI metallization and carbon content. It has been implemented at the **MIDREX Plants** at Qatar Steel and ESISCO, and will be used at voestalpine Texas.

MIDREX® Plants are the most flexible in the areas of iron ore feed, metallization and carbon content, product forms and temperature, and energy sources. Some examples: use of up to 70% lump ore at ArcelorMittal South Africa; 9 "combo" plants that are designed to simultaneously produce cold DRI, hot DRI, and/or HBI; and the production of DRI with 96% metallization and 2.8% carbon content at Nu-Iron. We continue to expand our offerings through our technology development program.

COMMENTARY

With regard to partnerships, we are enhancing collaboration with our clients, project partners, and suppliers. Our long term clients have proven to be our most valuable partners – these are relationshps that we work diligently to grow. Our project partners include Kobe Steel, Primetals, Paul Wurth, Aumund, Clariant, Koeppern, Praxair, and SES. They have also been crucial to our success and we are cooperating even more closely to realize the synergies between our collective expertise and innovation. This will enable us to expand the traditional direct reduction market.

Q: How are you expanding the market?

A: Consider the voestalpine Texas plant, which is the first **MIDREX® Plant** built specifically to feed a traditional integrated steelmaking facility. The plant has a capacity of two million tons per year of HBI, about half of which will be shipped to Austria to feed voestalpine's blast furnaces and possibly BOFs in Linz and Donawitz to enable the production of high-quality steel grades. The remainder of the output will be sold on the merchant market. Using HBI made from natural gas will help voestalpine reduce its carbon footprint. The Texas plant is scheduled to start up in third quarter this year.

MXCOL® has allowed us to provide ironmaking solutions in countries like India where the natural gas price is often prohibitively expensive. Midrex has commercialized the only shaft furnace-based direct reduction plants in the world that use coal gas (6 modules total). These include the COREX®/MIDREX® combination, pairing a coal gasifier with a **MIDREX® Plant**, and injecting coke oven gas (COG) directly into a **MIDREX® Shaft Furnace.** We are now commercializing our **Thermal Reactor System® (TRS™)** for the use of large amounts of COG. **MXCOL®** enables the use of domestic iron ore and inexpensive coal or offgas to make high quality DRI.

"MIDREX® Plants are the most flexible in the areas of iron ore feed, metallization and carbon content, product forms and temperature, and energy sources."

We are also successfully expanding the use of direct reduction technology in non-traditional markets. Algeria has been a target for some time but now has two projects underway: Tosyali Algeria and Algerian Qatari Steel. Each plant has a capacity of 2.5 MTPY and is designed to charge hot DRI to the EAF to produce steel products which will service the growing population. Other areas with great long-term potential include sub-Saharan Africa and the former CIS countries. Our sales team is pursuing a number of projects in those areas.

Despite the challenging steel market, we are excited about the future. Our focus on reliability, flexibility, and partnerships, supported by relentless innovation, is designed to create long-term success. We look forward to today's challenges, the opportunities that are created from them, and continuing to find innovative solutions with our partners. ■

DRIPAX™ - MIDREX® PLANT PROCESS OPTIMIZATION SYSTEM

Status Report of the New Generation Technology

Dieter Bettinger, *Primetals Technologies* • Angelika Klinger, *Primetals Technologies*
Brad Cantrell, *Midrex Technologies, Inc.* • Greg Hughes, *Midrex Technologies, Inc.*

EDITOR'S NOTE: *This article details an integrated process optimization system for **MIDREX® Direct Reduction Plants** designed by Primetals Technologies (formerly Siemens VAI) and Midrex Technologies, Inc. to aid in plant state evaluation as well as prediction of product carbon content and metallization. The enhanced system is marketed under the name of **DRIpax™** to new and existing **MIDREX Plants**.*

INTRODUCTION

The goal of DRI plant process optimization is to provide smooth and stable operation plus high performance. One of the challenges is to cope with the delay of several hours between a process change and the resulting actual product analysis available from the laboratory.

DRIpax™ is not just a new name for the DRI modeling system, it is a new and improved method for direct reduction plant process optimization. It offers product quality prediction models based on first principle calculations, while incorporating the lessons learned from the neural networks based predecessor SIMPAX.

The development of DRIpax was a joint effort between Midrex and Primetals Technologies. The capabilities of both partners were brought to bear, including **MIDREX® Direct Reduction Technology**, operational know-how, automation competence, information technology, and physical / mathematical models.

DRIPAX™ ARCHITECTURE

DRIpax™ is structured into three modular system layers: the Process Information & Data Management System, the DRI Plant Process Models, and the DRI Plant Expert System, as shown in ***Figure 1***. The Carbon and Metallization Prediction Models are the key to the benefits of DRIpax. The ability to predict the metallization and carbon levels enables better control of DRI consistency. This is achieved through the ability of DRIpax to take into account the **MIDREX®** Superdata results and inputs from the lab to predict what the met and carbon will be based on the current operation of the plant. DRIpax's predictive ability can help plant operators avoid off-spec DRI by enabling them to diagnose problems earlier. This helps produce a more consistent DRI quality.

MIDREX® SUPERDATA MODEL

The **MIDREX®** Superdata model has been painstakingly developed through the processing of data from various **MIDREX® Plants** over decades of operation in a variety of situations and locations. It runs cyclically and performs mass and energy calculations using online-measurements, feed materials and product analyses. Calculations are carried out to provide further useful information to the operators, especially data concerning the quality of the different gas streams and operation of the **MIDREX® Shaft Furnace** and **MIDREX® Reformer**. It can be used to monitor and assess reduction furnace utilization, bustle gas quality and flows, DRI production rate, reformer performance, combustion air requirements, flue gas flows and analyses, and heat recovery performance.

The Superdata Model is fully integrated into DRIpax, enabling DRIpax to provide:

- Scheduling of the model calculations
- Collection and preparation of the model input data
- Display of model result data integrated in the HMI
- Report viewer to open the model reports
- Display of calculation log data

In contrast to a standalone installation of the **MIDREX®** Superdata Model, the benefits of this full integration include time savings to operating personnel and avoidance of common errors, since no manual input is required to execute the calculations.

METALLIZATION AND CARBON PREDICTION MODELS

The system uses a modular design to predict DRI metallization and carbon content. This benefits the plant by reducing the amount of off-spec product that could be made from the time a process change is made to the time feedback on the DRI is measured by the lab. Having this model installed will provide a benefit across operators, by providing a consistent measure that can help smooth out operations.

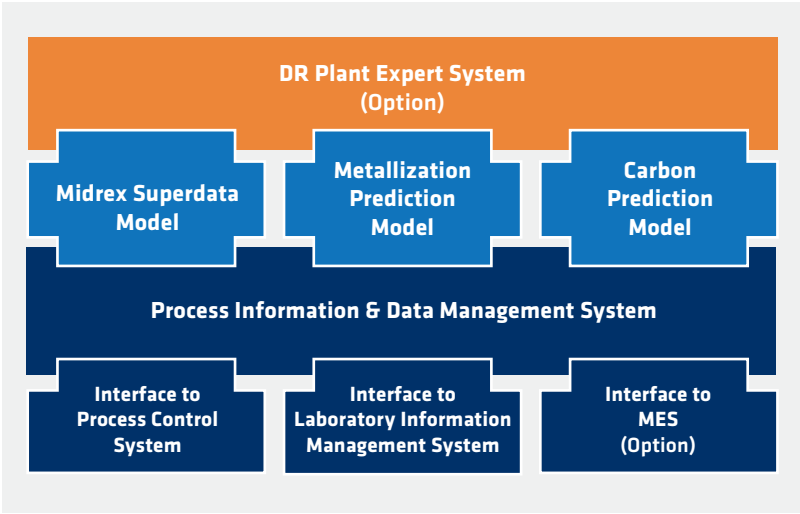


FIGURE 1. *DRIpax™ System Architecture*

Within the **MIDREX® Shaft Furnace**, the retention time in the Reduction Zone depends on the production rate and material bulk density. The DRI then passes through the Transition Zone and the Cooling Zone (CDRI) or hot lower cone (HBI/HDRI) before it leaves the shaft furnace and a product analysis can be taken. After the sample is taken, it is sent to the laboratory to be analyzed. As a consequence of the time lags created by these events, the operator is informed of the DRI analysis several hours after it was discharged (and even longer since it was actually made at the bustle or transition zone of the furnace).

Oxide reduction and carbon addition are essentially completed when the DRI leaves the Reduction Zone. DRIpax utilizes plant data, previously sampled product analyses, user inputs, and trend analysis to calculate a predicted product quality as oxide enters the process. The result is a predictable and consistent quality DRI product.

In addition, the plant operator will typically not change process set-points based on only one sample result. Often there are requests for additional laboratory samples to provide more data to eliminate or reduce the possibility of laboratory error. This can further delay any corrective action that an operator may wish to take to alleviate any product quality deviations.

DRIpax Metallization and Carbon Prediction Models bridge this delay by calculating the metallization and carbon content based on process measurements and raw material quality parameters. The operators can then adjust process parameters based on metallization/carbon forecasts to achieve a more consistent DRI quality. The product quality prediction is based on model calculations from current information and tracked trends, and has been proven in use at Qatar Steel Module II, a 1.5 million ton per year **MIDREX® Plant**. The plant target metallization and carbon levels

were 94.5% and 2.3% respectively. ***Figure 2*** shows the tight tolerances obtained using DRIpax. The standard deviation of carbon content was reduced 31% and metallization 27%.

MATERIAL TRACKING

Iron oxide and the produced DRI can be tracked through the reduction furnace by using feed material and product properties, feed and discharge rates, technological knowledge about the changes in the material properties during the reduction process, and other data.

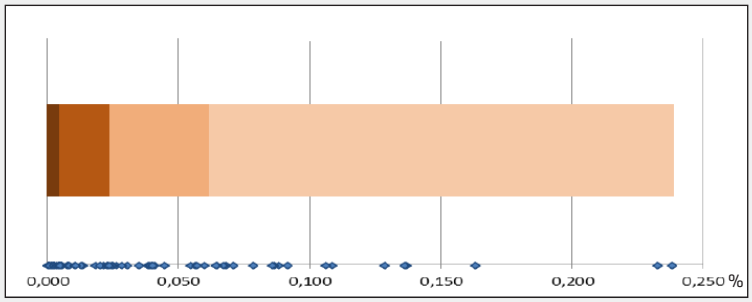
Knowing the position of material in the reduction furnace is essential for the process data in the mass and energy balance equations. For each new product analysis, DRI is back-tracked in order to find out when the reduction was essentially finished. The respective predicted values at this time are displayed together with the measured analysis data. Trends of measured and predicted values indicate the accuracy of both – the models as well as the laboratory results. Deviations in the results are compared with process target values set for plant operation and help operators make better operational decisions.

PROCESS INFORMATION MANAGEMENT SYSTEM

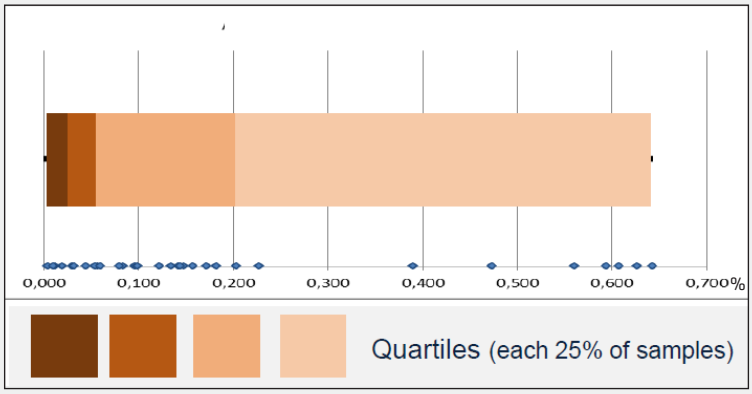
DRIpax is a package unit configured to be easily integrated into an existing or new basic automation system of a **MIDREX® Plant.** The system is configured using state-of-the-art technology with regard to both hardware and software platforms, as well as advanced process modeling technology.

The system consists of a Server-Client Architecture with a link to an arbitrary process control system via the worldwide standardized communication interface. This ability allows the Licensee complete control to provide access to the system in other areas of the plant or remote viewing.

DRIpax provides a communication interface to other platforms such as SAP/MES systems as well as to the laboratory information management system. A link to the laboratory has the benefit that all material



Product carbon content
(absolute difference prediction - actual figures)



Product metallization
(absolute difference prediction - actual figures)

FIGURE 2. *Qatar Steel Prediction Accuracy*

FIGURE 3. *Human Machine Interface*

analyses are read automatically, checked for plausibility and used immediately in the model calculations. In addition, the received analyses are displayed in a Human Machine Interface (HMI) and can be added into certain reports as well. The HMI covers data visualization and data management functions like trending tools, process data visualization, material and analysis management, log/alarm display, user management etc. ***Figure 3*** shows typical screens.

DRIpax™ uses Vaironment as its operating platform for the process optimization system. Vaironment system is also used by Primetals Technologies for other process optimization systems in the field of iron and steelmaking.

The data is visualized graphically using advanced techniques for user machine interfaces. Microsoft Office Products can be connected to the process optimization system to perform studies, evaluations and presentations of the **MIDREX DRI Plant** data. The Primetals's Process Explorer HMI is the backbone of the Human Machine Interface acting as a container for all provided applications of the process optimization system. Reports can be generated cyclically, e.g. every shift, daily, monthly or on demand using a flexible reporting system based on Microsoft Excel.

The full functionality of Microsoft Excel can be exploited to generate and easily modify reports.

DRIPAX APPLICATION AND DOWNSTREAM BENEFITS

DRIpax can be utilized in new or existing **MIDREX Plants** and the system's flexibility enables it to be easily adjusted to various plant configurations.

Meltshops will also benefit from DRIpax. Having a tighter tolerance and more consistent DRI feed, an EAF should expect to see reduced electricity and refractory consumptions, reduced tap-to-tap time and an increase in yield and productivity.

NEXT STEPS

The **MIDREX** Superdata Model and the Quality Prediction Models evaluate the state of the process and the expected product quality. In case of undesired process conditions or product quality it is the operator's duty to perform corrective actions.

Primetals Technologies has many years of experience with closed-loop expert systems for blast furnaces and sinter plants. The basic idea of these expert systems is an evaluation of the

actual state and the generation of corrective actions to alleviate the undesired conditions. The knowledge base of these expert systems consists of operational rules and knowledge of metallurgical experts.

The next step in the development of DRIpax is the implementation of an Expert System for **MIDREX Plants** for the shaft furnace and the reformer areas. Midrex is contributing the process and operation know-how and Primetals Technologies is creating the knowledge base for the existing Expert System shell. The DRIpax Expert System will provide closed-loop and semi-automatic operation mode; in semi-automatic mode, suggestions made by the expert system will be executed only after acceptance by the operator. In closed-loop mode, operator acceptance is not required for the execution of corrective actions – however he can still reject corrective actions, keeping the human factor in the plant. ***Figure 4*** shows the system configuration.

The knowledge base of the DRIpax Expert System is principally defined by **MIDREX** specialists. Nevertheless, special operational rules and control philosophy of the individual customers will also be included in the knowledge base. In this sense, each customer will get a tailored expert system perfectly fitting to his needs.

With the introduction of the DRIpax Expert System a first powerful step will be taken in the direction of fully automated quality control and equipment protection. The application of an expert system helps to foster uniform operator decisions over all shifts and early detection of undesired process conditions resulting in small corrective actions that have a positive impact on the overall plant performance and efficiency.

DRIpax™ Expert will be launched for the first time at the **voestalpine Texas MIDREX Plant** that will start up in the second half of 2016 in Corpus Christi, Texas, USA.

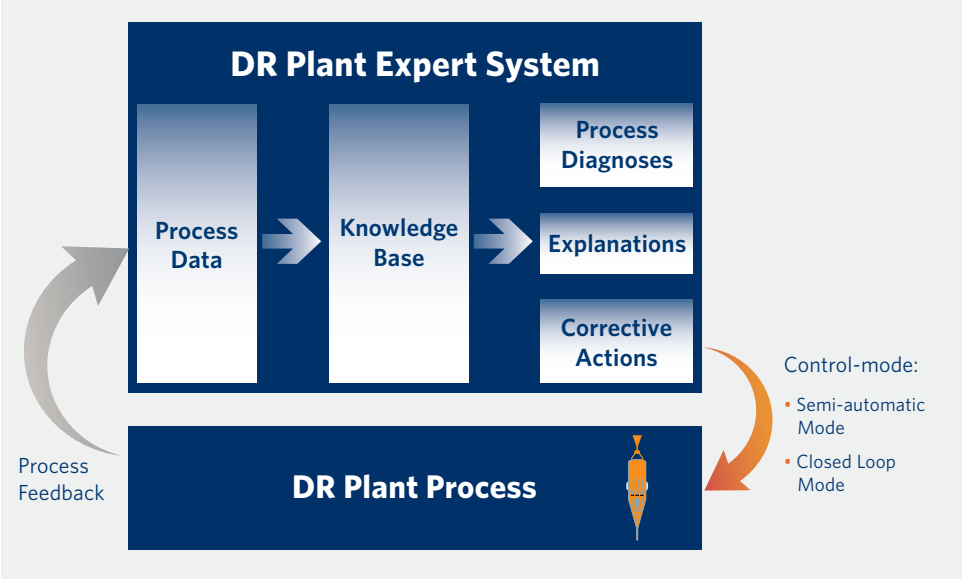
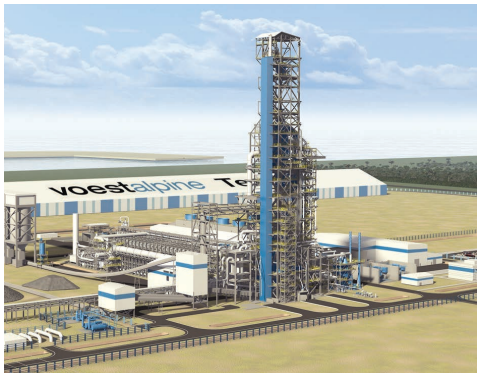


FIGURE 4. *DRIpax™ Expert*



***voestalpine Texas MIDREX® HBI Plant** will use the DRIpax™ Expert technology.*

THE POSSIBILITIES OF DRIPAX™

The future of efficiency in **MIDREX Plants** is DRIpax. Bringing consistent, controllable product quality to the operation, DRIpax is a tool for operators and managers to improve what they do best, running their **MIDREX Plant**. The benefits of carbon and metallization prediction bring consistency across operators with different experience levels, across shift changes, and the benefits carry throughout the complex and downstream to the meltshop. Qatar Steel, working with Midrex and Primetals Technologies has enhanced the system and is now enjoying its benefits. Available in new plants and as an upgrade to existing plants, DRIpax is advancing the state-of-the-art in process optimization. ■

– 2015 –

MIDREX® Direct Reduction Plants

OPERATIONS SUMMARY

MIDREX® Plants produced 45.75 million tons in 2015, 3.0% less than in 2014. The production for 2015 is estimated from the 31.2 million tons confirmed by **MIDREX® Plants** located outside of Iran and the 14.55 million tons located within Iran reported by the World Steel Association, all by plants based on **MIDREX® Direct Reduction Technology.**

MIDREX® Plants continued to account for approximately 80% of worldwide production of natural gas-based direct reduced iron (DRI) by shaft furnaces. Despite exports of steel from China, which caused steel production in many locations worldwide to slow, at least 11 **MIDREX® Plants** established new annual production records and at least 10 plants established new monthly production records. Four additional **MIDREX® Modules** came within 10% of their record annual production, and at least 7 **MIDREX® Modules** operated in excess of 8,000 hours. Production of DRI/HBI slowed at many plants towards year end (there was a 20% drop in total production from plants outside Iran in the 4th quarter compared to the first three quarters of the year).

Throughout 2015, iron ore prices declined as Chinese ironmaking growth slowed while Australian and Brazilian ore supply simultaneously grew. By December, the price for 62% Fe fines to northeast China had fallen to one-fifth of the price it commanded at the peak in early 2011.

One new **MIDREX® Module** started up in 2015: ESISCO (Egyptian Sponge Iron Steel Co.), a cold/hot DRI **MIDREX® Plant** belonging to Beshay Steel in Sadat City, Egypt.

Cumulative production of DRI products (Cold DRI, CDRI; Hot DRI, HDRI and Hot Briquetted Iron, HBI) by **MIDREX® Plants** has exceeded 875 million tons through the end of 2015.

2015 PLANT HIGHLIGHTS

ACINDAR

After breaking annual production records in 2013 and 2014, **ACINDAR's MIDREX® Plant** started off the year at somewhat reduced capacity but ended the year at maximum capacity after the typical winter natural gas curtailments. The plant averaged more than 131 tons per hour (t/h) for the year. In 37 years of operation, **ACINDAR's MIDREX® Plant** has produced 28.5 million tons, the most by a single **MIDREX® Module** to date.

ANTARA STEEL MILLS

The first **MIDREX® Plant** designed to make HBI produced under annual rated capacity in 2015 due to market constraints.

ARCELORMITTAL HAMBURG

AM Hamburg's MIDREX® Plant, the oldest in operation, which originally started operation in 1971, comfortably exceeded annual rated capacity in 2015, averaging 80 t/h. This was an hourly capacity record for the plant and the plant came within 10% of its record annual production.

ARCELORMITTAL LAZARO CARDENAS

AMLC operated 18% over its rated annual capacity of 1.2 million tons. In 2015, AMLC surpassed the 27.7 million ton production milestone, achieved in 18.5 years since its start-up in August 1997. Production rate averaged more than 188 t/h for the year.

ARCELORMITTAL MONTREAL

After setting annual production records for two consecutive years in 2013 and 2014, Module II's 2015 production was only 0.12% short of its 2014 record production. Module I's 2015 production was well over rated capacity and 12% less than its record annual production. Module II produced over 100,000 tons in July, handily exceeding its previous monthly production record, while Module I fell short of its monthly production record by only 0.4%. Both modules have been operating at full capacity due to competitively priced natural gas and oxide pellets sourced locally.

ARCELORMITTAL POINT LISAS

All three of **AMPL's MIDREX® Modules** operated for most of 2015, producing almost 1.0 million tons of DRI for the adjacent steel shop and for overseas export. Thirty five years after the start-up of Module 1, all three modules were idled in October 2015, having produced over 42 million tons.

ARCELORMITTAL SOUTH AFRICA (SALDANHA WORKS)

Operation of the **COREX®** export gas-based **MXCOL® Plant** was limited by the availability of gas from the **COREX® Plant**. The plant averaged using more than 68% South African lump ore for the year.

ACINDAR

Antara Steel Mills

ArcelorMittal Lazaro Cardenas

ArcelorMittal South Africa

COMSIGUA

COMSIGUA operated at reduced capacity three partial months in the year due to the limited supply of locally produced pellets.

DELTA STEEL

The two Delta Steel **MIDREX® Modules** did not operate in 2015.

DRIC

DRIC's two **MIDREX® Modules** in Dammam, Saudi Arabia, kept production steady to satisfy the demand of their neighboring Al-Tuwairqi steel shops. Module 1 set a new annual production record for the sixth consecutive year and both modules set new monthly production records. Module 1 has averaged 8,030 hours of operation per year over the last 4 years.

ESISCO

Due to the high price and reduced availability of natural gas in Egypt during 2015, ESISCO operated intermittently throughout its first year of existence.

ESSAR STEEL

The two largest of Essar Steel's six **MIDREX® Modules** operated at reduced production rates due to a shortage of iron ore and very high natural gas prices in India. Essar was able to use off-gas from its **COREX® Plant** in its **MIDREX® Modules**. The four smaller modules remained shut down for the whole year, while Module 5 operated five partial months and Module 6 operated the whole year.

EZDK

Limited by natural gas availability in Egypt, the three **EZDK MIDREX® Modules** produced just over 1.5 million tons in 2015, about 50% of their maximum capacity. Fifteen years since initial start-up, EZDK's Mod 3, rated for 800,000 t/y, has produced 14 million tons through the end of 2015 despite the slowdown the last couple of years due to the limited availability of natural gas. The three modules have produced 54 million tons of DRI to date.

FERROMINERA ORINOCO

In its 25th anniversary year, **Ferrominera Orinoco's MIDREX® HBI Plant** in Puerto Ordaz, Venezuela, operated at reduced capacity during the entire year; however, it still accounted for over 70% of the 677,000 tons of HBI produced by **MIDREX® Plants** in Venezuela in 2015.

Comsigua

ESISCO

Essar Steel

EZDK

Ferrominera Orinoco

HADEED

Hadeed exceeded rated capacity for the 31st consecutive year in Modules A and B and for the 23rd consecutive year in Module C. Modules A and B each surpassed the 20 million tons milestone in 2015, and the flue gas exhaust systems in both modules were upgraded as part of Hadeed's program to reduce energy consumption. Hadeed's Module E set new monthly production records in April and May, reaching 250 t/h monthly average in April. Hadeed's four **MIDREX® Modules** have produced more than 78 million tons of DRI to date.

JINDAL SHADEED

Jindal Shadeed set a new annual production record in 2015, 0.6% higher than their previous record set in 2013, despite being limited by the availability of natural gas. The plant operated 8,184 hours in 2015. The **MIDREX® Plant** is designed to produce mainly HDRI with HBI as a secondary product stream. A major portion of the production was consumed by Jindal Shadeed's own steel shop.

JSPL (ANGUL)

Jindal Steel and Power Ltd.'s (JSPL) combination HDRI and CDRI plant in Angul, Odisha State, India, set new annual and monthly production records last year. This is the first **MXCOL® DRI plant** using synthesis gas from coal gasifiers to produce HDRI and CDRI for the adjacent steel shop. Operation began in 2014 and the plant continued ramping up production in 2015 with more than 70% of the production supplied hot to the steel shop.

JSW STEEL (DOLVI)

JSW Steel comfortably exceeded rated capacity in 2015. A new system installed at the end of 2014 to reduce natural gas consumption by adding Coke Oven Gas (COG) coming from JSW Steel's coke oven batteries on site to the **MIDREX® Shaft Furnace** operated throughout the year. At the end of the year the plant was shut down temporarily for major maintenance.

JSW STEEL (TORANAGALLU)

JSW Steel's new cold/hot DRI plant using **COREX®** export gas in Toranagallu, India, finalized commissioning and was started up in August 2014, setting a new annual production record in 2015. The plant is designed to produce 1.2 million tons per year of HDRI and CDRI. This is the second plant of its kind; the first one being the **COREX®/MIDREX® Plant** at Saldanha, South Africa.

Hadeed Module E

Jindal Shadeed

JSPL (Angul)

JSW Steel (Dolvi)

JSW (Toranagallu)

LEBEDINSKY GOK

LGOK's MIDREX® HBI Module set a new annual production record of 1,641,000 tons in 2015, 17% over their rated capacity of 1.4 million tons, thanks to record-breaking average hourly production of almost 199 t/h and 8254 hours of operation.

LION DRI

The production of the Lion DRI plant located near Kuala Lumpur, Malaysia, continued to be reduced and intermittent due to reduced steel shop demand. Production in 2015 consisted of 85 percent HDRI and 15 percent HBI.

LISCO

The three **MIDREX® Modules** in Misurata, Libya were severely restricted by natural gas supply in 2015. Module 2 has produced over 10 million tons since its start-up 25 years ago.

NU-IRON

In 2015, Nucor's **MIDREX® Plant** in Trinidad established a new annual production record for a second year in succession due to increased operational availability, and set a new monthly production record in March. Average DRI metallization for the year was the highest of all **MIDREX® Plants** at 96.31 percent, with 2.71 percent carbon in the DRI produced.

OEMK

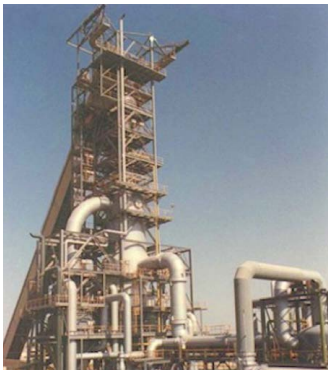
OEMK again produced over 2.8 million tons in 2015, with Modules 1, 2 and 3 setting new annual production records. Modules 1, 3 and 4 also broke their previous monthly production records, with Module 4 breaking it three times at the end of the year after a major maintenance shutdown. The operating hours for OEMK's modules 1, 2 and 3 averaged an exceptional 8453 hours in the year. Module 2 surpassed its 15 million ton milestone in its 30th anniversary year.

QATAR STEEL

In its eighth full year of operation, Qatar Steel's dual product (CDRI and HBI) Module 2 set a new annual production record for the fifth consecutive year, 6.9% above its previous record, due to exceptional plant availability (8487 hours of operation). This **MIDREX® Module** operated 25.8 percent over its rated annual capacity of 1.5 million t/y, totaling 1,887,000 tons for the year, a new record for **MIDREX Modules** with 6.5 meter nominal diameter Shaft Furnaces. Almost the entire production

LGOK II

LION DRI



LISCO

Nu-Iron Trinidad and Tobago

OEMK

from Module 2 was CDRI with metallization averaging 94.8 percent for the year. The production of Module 1 was only 5.6% below its record annual production, and the Module operated 8181 hours.

SIDOR

Production from all four of Sidor's **MIDREX® Modules** was 1.35 million tons in 2015, limited by a lack of oxide pellets. Module 2C remained shut down the whole year.

SULB

SULB's 1.5 million tons/year combo **MIDREX® Plant** (simultaneous CDRI and HDRI production) in Bahrain was limited by market demand in its second full year of operation. Hot DRI accounted for 68% of production and approximately 75% of the CDRI produced was shipped to third parties by sea.

TenarisSiderca

TenarisSiderca operated below maximum capacity throughout 2015 due to limited DRI demand by the steel shop and natural gas curtailments during the winter months. CDRI metallization averaged 95.77 percent for the year. This module surpassed its 20 million ton milestone in December 2015. It has been in operation since October 1976.

TUWAIRQI STEEL MILLS

The Tuwairqi Steel Mills 1.28 million tons/year **MIDREX® Plant** located near Karachi, Pakistan, did not operate in 2015 due to market conditions.

VENPRECAR

In its 25th anniversary year, VENPRECAR's HBI production was severely restricted by the limited availability of iron ore pellets in Venezuela, operating only four partial months in the year.

VENPRECAR

EDITOR'S NOTE:
No DRI production data was received from the following plants located in Iran: *South Kaveh Steel, Mobarakeh Steel, Khouzestan Steel, Khorasan Steel, IMPADCO, IGISCO, Sirjan Jahan, Gol-e-Gohar and Hormozgan Steel.*

Qatar Steel

Sidor II

SULB

Tuwairqi Steel Mills

MIDREX News & Views

Midrex Announces Organizational Changes

By John Kopfle – Director of Corporate Planning

Despite the challenging steel market, Midrex sees good opportunities for MIDREX® Plant sales contracts, Midrex Global Solutions business, and development of new technologies. To position the company for medium and long-term success, the following organizational changes were announced, effective April 1, 2016.

James D. McClaskey
CEO

Stephen Montague
President & COO

Dan Sanford
Executive VP

KC Woody
VP Sales & Marketing

Dave Ahwesh
Director, Procurement & Logistics

Todd Ames
Director, Sales

Chris Hayes
Director, Projects

Geoff Wallwork
Director, Engineering

STEPHEN MONTAGUE has been appointed as the company's President and Chief Operating Officer. He joined Midrex in 1987 as a co-op student and has served in numerous functions, including engineering, operations, technology development, and sales. He was most recently Vice President – Sales & Marketing. Montague replaces **JIM MCCLASKEY**, who served as President and Chief Executive Officer for about 12 years and retains the role of CEO.

DAN SANFORD is now Executive Vice President – Operations. He has worked at Midrex for more than 27 years in roles including project engineering, plant maintenance and operations, equipment fabrication, and design. He was most recently Vice President of Operations.

KC WOODY was promoted to Vice President – Sales & Marketing. Woody is a US Army veteran and has been with Midrex for five years. He spearheaded the establishment of Midrex India and subsequently served as Plant Sales Director.

DAVE AHWESH has been promoted to Director - Procurement and Logistics. He oversees all purchasing for major projects and Global Solutions, expediting, vendor controls, and logistics activities. Ahwesh has been with Midrex 20 years as a procurement manager.

TODD AMES is now Director - Sales, responsible for overseeing **MIDREX® Plant and Global Solutions** sales efforts. Ames has been with Midrex for over 10 years, starting in the Engineering Group as a mechanical engineering lead for the Lion **MIDREX® Plant** in Malaysia. He then moved to the Plant Sales Department as a sales manager in 2007. He was instrumental in the signing of the SULB, Tosyali Steel and AQS contracts.

CHRIS HAYES is now Director of Projects, responsible for project management activities, including project controls. He has been with Midrex for over 10 years, beginning as a mechanical engineer working on the Hadeed E project. Hayes spent time in technology development, then moved to Global Solutions as a project manager and engineering lead. Prior to this latest promotion, he was Chief of Mechanical Engineering.

GEOFF WALLWORK has been promoted to Director of Engineering, responsible for providing leadership and direction to the engineering disciplines that are responsible for plant design and operation. Wallwork has 19 years of experience with Midrex, which includes the start-up or optimization of every type of direct reduction plant that Midrex designs, from shaft furnace-based plants utilizing natural gas or syngas to rotary hearth furnace-based plants. He previously worked on many **MIDREX®** Projects as a process engineer and Chief of Process Engineering. ■

MIDREX News & Views

Algerian Qatari Steel to build 2.5 MTPY MIDREX® Plant

MIDREX AND PAUL WURTH AWARDED PROJECT FOR HDRI/ CDRI COMBINATION FACILITY

Algerian Qatari Steel (AQS) has awarded Midrex Technologies, Inc., and its consortium partner Paul Wurth, a contract to supply Equipment, Engineering and Technical Services for one of the world's largest direct reduced ironmaking (DRI) plants. The new natural gas-based **MIDREX NG™ DRI plant** will be located in Bellara, Algeria, 375 km east of Algiers. AQS is a joint venture between Sider Co. and National Investment Fund (51%) and Qatar Steel International (49%). The **MIDREX® Plant** will be part of the overall steel complex that will produce 2.0 million tons of re-bar and wire rod finished products.

AQS's new **MIDREX NG™ DRI Plant** will be designed to produce 2.5 million tons of DRI with the capability to vary its production to produce hot direct reduced iron (HDRI) and/or cold direct reduced iron (CDRI) simultaneously without stoppage of production.

HDRI will be fed via an Aumund hot transport conveyor to a new EAF meltshop located adjacent to the **MIDREX® DRI Plant** allowing for greater EAF productivity and energy savings; CDRI can also be produced for additional onsite use. The new AQS DRI Plant will provide the AQS steelmaking facility with greater production flexibility to produce high quality, low impurity steels as well as decrease their demand for imported scrap. Plants using **MIDREX® DRI technology** transport more HDRI per year and at hotter temperatures than any other commercial technology available. ■

MIDREX
Designed for Today,
Engineered for Tomorrow

PAUL WURTH
SMS group

BENEFITS OF HOT DIRECT REDUCED IRON

There are two main benefits of charging HDRI to the EAF: lower specific electricity consumption and increased productivity. The energy savings occur because less energy is required in the EAF to heat the DRI to melting temperature, resulting in a shorter overall melting cycle.

Additional benefits of charging hot DRI (HDRI) to the EAF are:

- **Less energy required to heat the DRI to melting temperature.**
- **Shorter overall melting cycle**
- **Reduced electrode consumption**
- **Reduced tap-to-tap time up to 20% compared to charging DRI at ambient temperature.**
- **Reduced electricity consumption about 20 kWh/t liquid steel for each 100° C increase in DRI charging temperature.**
- **Lower overall emissions due to lower electricity demand and reduced need for charge carbon.**

DRI Technology is designed by Midrex to work for you.

Christopher M. Ravenscroft: **Editor**

DIRECT FROM MIDREX is published quarterly by Midrex Technologies, Inc., 2725 Water Ridge Parkway, Suite 100, Charlotte, North Carolina 28217 U.S.A., Phone: (704)373-1600 Fax: (704)373-1611, Web Site: **www.midrex.com** under agreement with Midrex Technologies, Inc.

The publication is distributed worldwide by email to persons interested in the direct reduced iron (DRI) market and its growing impact on the iron and steel industry.

To subscribe please register at **www.midrex.com** to receive our email service.

CONTACTING MIDREX

General E-mail:
info@midrex.com

Phone: (704) 373-1600
2725 Water Ridge Parkway
Charlotte, NC 28217 USA

General Press/Media Inquiries
Christopher M. Ravenscroft
cravenscroft@midrex.com
Phone: (704) 378-3380

MIDREX