

DIRECT FROM MIDREX

3RD QUARTER 2003



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Commentary

Proven Technology Pays For Itself

Production of DRI and HBI topped 45 million metric tons in 2002. However, almost 13.5 million metric tons of installed capacity sat idle. Why? For many, it was the financial burden of developing a new process in the midst of a prolonged economic downturn.

Historically, the lack of a well-proven technology has been the major cause of plant failures. The cost of developing a direct reduction process to the point where it can be considered a proven technology could range from \$30-100 million. Development is achieved in stages, beginning in the laboratory and progressing through process simulation, a pilot plant, a demonstration plant, and a prototype commercial plant. The entire process might take 10 years or more to complete.

There is strong temptation to take shortcuts in hopes of cutting dollars from the budget and years from the schedule. This is particularly true at the demonstration plant and prototype commercial plant stages, where the cost is the highest and the goal is the closest. However, it has been demonstrated time and again that first generation plants normally take years to reach acceptable production levels, even if they experienced a relatively smooth start-up. Plants that take a short cut to commercialization usually require substantial additional investment for process and equipment modifications.

The most successful first generation plants cost twice the original capital budget. It is not unusual for these early process plants to cost three or four times their initial budgets. For this reason, it is very difficult to sell a first-of-a-kind plant unless the developer can show dramatic economic benefits over proven process options.

Even subsequent commercial plants can be risky propositions if relevant experiences in the first plant have not been documented, analyzed, and properly applied. Some factors such as equipment designs can take several years of operation to

optimize. Therefore, the process developer should remain involved with the plant once it becomes operational in order to optimize its design and performance.

One thing the tough economic times have taught us is to shop for a bargain, but a purchase at any price is not a bargain if it lacks value. In the case of a direct reduction plant, saving 10-20 percent in initial capital cost most likely would not compensate for the subsequent costs in time, money, and lost production associated with troublesome or delayed start-ups and process and equipment modifications. Proven technology and documented performance have value because they reflect the lessons learned from experience, which has cost the developer time and money. Therefore, it would be unrealistic to expect a responsible process supplier to match the price of a competitor who has not invested in the proof of his product.

When a process supplier offers a price that seems too good to be true, be cautious because most likely, it is exactly that ... too good to be true.



*Rob Klawonn
VP of Commercial
Midrex Technologies, Inc.*

MISSION STATEMENT

Midrex Technologies, Inc. will be a leader in design and integration of solids and gas processes. We will meet or exceed performance expectations, execute projects on time, enhance existing product lines, and provide value-added design, procurement, logistics and field services to our clients. We will develop new business opportunities that will challenge our employees and maintain the economic vitality of our company. Our employees are the key to our success, and we are committed to encouraging them to grow professionally and personally.

FASTEEL™

The Hot Metal of FASTMELT® and the Continuous Scrap Feeding of CONSTEEL®

By James C. Simmons and Kyle J. Shoop, Core Furnace Systems
James M. McClelland, Midrex Technologies, Inc.

(Ed. Note: The following Paper was given at the ISS Tech 2003 show in Indianapolis, IN. The article examines the combination of two commercially proven technologies that are being integrated to create a new form of steelmaking. FASTEEL™ combines the hot metal producing benefits of FASTMELT® with the continuous scrap feeding and preheating of Consteel®. Core Furnace Systems is the exclusive North American representative for FASTEEL™, a technology that was the result of a partnership between Midrex Technologies, Inc., Kobe Steel, Ltd., and Techint Technologies, Inc. The article discusses the major components of the FASTEEL™ system and how they combine to benefit the steel producer.)

FASTEEL represents a new way of making steel, making use of low cost raw materials for the economical production of high grade steels, while at the same time providing the steel maker an environmentally friendly plant by recycling most steel plant wastes

and reducing the amount of greenhouse gases compared to more traditional methods of making steel.

Developed by Midrex Technologies, Inc., Kobe Steel, Ltd., and Techint Technologies, Inc., FASTEEL™ provides a new alternative to traditional methods of steel production through the intergration of FASTMELT® with CONSTEEL®.

By combining hot metal from FASTMELT with continuously fed, preheated scrap in the CONSTEEL Electric Arc Furnace, FASTEEL provides several key benefits for either new steel installations or converting existing facilities. These benefits include improved productivity, decreased operating costs, and reduced overall solid and gaseous emissions of the steelmill.

FASTEEL Process Description

The FASTEEL process can be divided into four main areas: raw material processing, reduction of iron oxides, melting of DRI to produce hot metal, and the combination of preheated scrap and hot metal in the EAF to produce steel, (Figure 1).

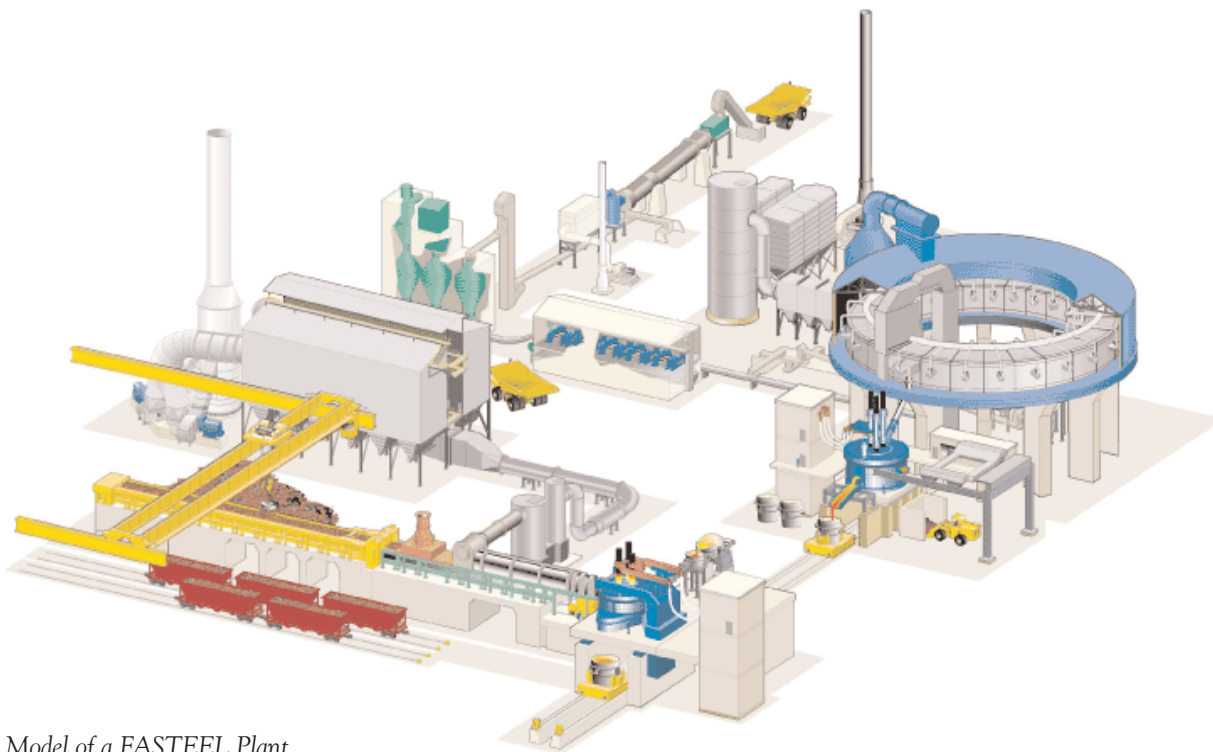


Figure 1 - Model of a FASTEEL Plant

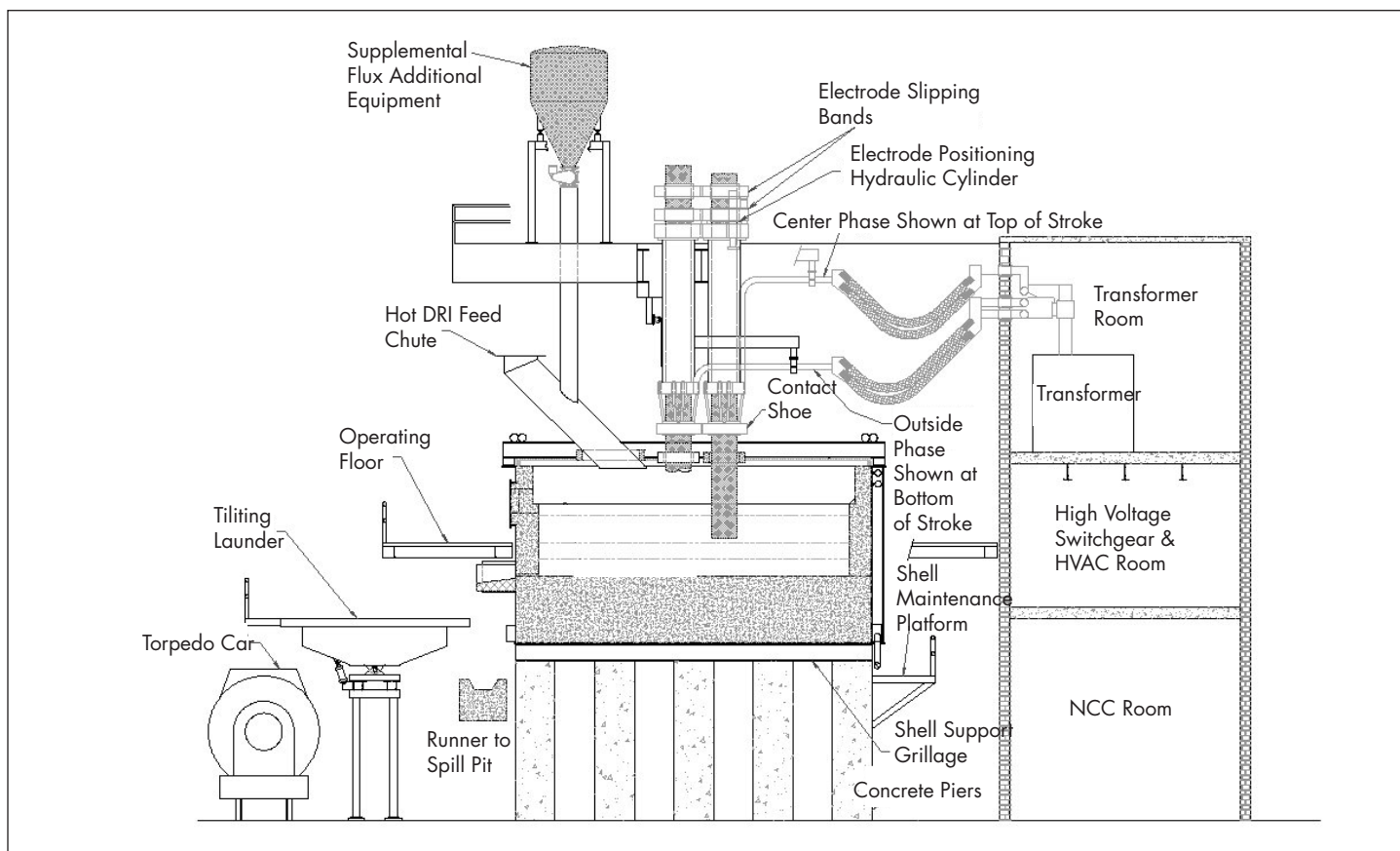


Figure 2 - Cross-sectional view of the EIF

Raw Materials - FASTMELT

Raw materials for the FASTMELT process can be classified into three categories: iron oxides (i.e. virgin materials and / or iron bearing materials), reductants (i.e. carbon source), and additives (i.e. binder, fluxes, etc.). An extensive group of raw material combinations (i.e. iron bearing waste materials and different reductants) has been evaluated in laboratory scale testing and pilot plant work. A partial list of evaluated raw materials follows:

- Blast Furnace Filter Cake
- Iron Ore Concentrates
- BOF Filter Cake
- Blast Furnace Dust and Sludge
- Mill Scale
- Coke Breeze
- EAF Baghouse Dust
- Low/Medium/High Volatile Coals
- Pellet Fines
- Pet Coke

These raw material combinations are tested for many factors: reducibility, green compact strength, DRI strength, gangue content, slag basicity, hot metal chemistry, etc.

After the mix of raw materials is determined for the desired hot metal chemistry, the materials are batched, blended, and mixed. From here they can either be pelletized or briquetted. Typically the

compaction method is selected based on the raw materials comprising the mix and their particle size distribution. Pelletized material is then dried before being fed into the RHF. Briquetted material doesn't need to be dried and is directly fed into the RHF. The key to raw material preparation for the FASTMELT plant is sampling and equipment to make each green ball / briquette as consistent as possible. This will insure consistent DRI production and melting.

Iron Oxide Reduction

The purpose of the RHF is to quickly and efficiently produce a highly metallized DRI uniform in composition and physical properties. This is accomplished by evenly charging and distributing the green compacts on the hearth of the RHF. The green pellet / briquette height on the hearth is one to two layers. This promotes quick and consistent DRI production. Typical retention times for the RHF are 6 to 12 minutes.

The DRI composition can be varied depending on the RHF operating conditions and the blending ratio of the raw materials. The DRI metallization can be controlled from 80 to 95% (metallization = $\text{Metallic Fe} / \text{Total Fe} * 100$). DRI carbon can also be adjusted or optimized for the target or aim hot metal chemistry.

The DRI is typically cooled to 1000 to 1200°C (1830 – 2190°F) prior to being discharged from the RHF. To preserve the sensible heat of the DRI, eliminate any problems associated with hot transfer vessels and to preserve the carbon content of the DRI, it is then directly charged into the EIF.

DRI Melting – EIF (Electric Ironmaking Furnace)

The EIF was designed to satisfy the following objectives: effective melting of FASTMET DRI, removal of gangue, reduction of residual FeO to Fe, desulfurization, and continuous operations. Figure 2 illustrates a cross-sectional view of the EIF.

The main features of the EIF are:

- Stationary (i.e. non-tilting) furnace shell
- Minimal infiltration of ambient air into the furnace interior (sealed furnace)
- Independent iron and slag tap holes or slag skimming in the iron trough similar to blast furnace operations
- Graphite, pre-baked carbon, or self-baking electrodes may be used
- Electrode slipping with the power on
- Offgas handling for dust collection and energy utilization
- Provisions for delivering supplemental additive materials and fluxes into the furnace

In order to test the FASTMELT concept, a pilot scale version of the EIF was designed, built, and commissioned at the Midrex Technical Center. Test work for the FASTMELT program focused on iron ore concentrate and waste iron bearing materials as feed materials. Results using steelmill waste have been previously reported.

Steel Production

FASTEEL combines the hot metal from the EIF and the preheated scrap from the CONSTEEL process to produce liquid steel.

Hot metal from the FASTMELT can be designed to be the most effective for steel production. Typical ranges for hot metal chemistry from the FASTMELT facility are given in Table 1.

Carbon	3.0 – 5.0%	Sulfur	< 0.03%
Silicon	0.1 – 0.6%	Phosphorus	< 0.05%
Manganese	0.4 – 1.2%	Temperature	1450 – 1550°C

Table 1 Range of Hot Metal Chemistry from the FASTMELT Process

The percentage of hot metal added to the EAF can be varied from 0 to 40% depending upon the desired steel chemistry and production rate. Hot metal additions to the CONSTEEL process have already been successfully developed at Shaoguan Iron and Steel.

Raw Materials - FASTEEL

Raw materials for the FASTEEL process can be classified into two categories: cold metallic charge (scrap, HBI and / or pig iron) which is preheated to ~600°C in the CONSTEEL preheater, and hot metal from the FASTMELT facility. General guidelines for the preheated metallic charge are given in Table 2.

The main features of the FASTEEL process are as follows:

- Automatic and continuous charging of preheated scrap into the EAF.
- Scrap enters the preheating section where it is preheated by

Charge Dimensions	Standard EAF charge material and bigger up to 2m
Charge Density	No limits, average density at 0.3 t/m ³ without impact on production
Charge Yield	1 – 2% higher compared to traditional batch charging
Other Charge Materials	HBI, Pig Iron, and Hot Metal

Table 2 Characteristic for FASTEEL Metallic Charge Material

the sensible heat of the off gases and from the combustion of the CO by automatically controlled injection air. This progressive and controlled combustion of CO in the preheater also ensures that the gases leaving the preheater are almost totally free of CO.

- The preheated scrap enters the EAF where it is melted by the liquid steel constituting the furnace hot heel. The electric arc is working on a flat bath covered by foamy slag. The EAF roof remains closed and the primary circuit of the baghouse constantly controls the emissions.
- A slow continuous charging of hot metal through a launder system prevents problems associated with carbon boil.

Economic Evaluation of FASTEEL

The productivity considered for this study is 1,500,000 tons of liquid steel per year (70% Scrap and 30% Hot Metal). Two raw

	Unit Cost
Coal (Delivered)	\$35/Ton
Hot Metal from Blast Furnace	\$130/Ton
Iron Ore (Delivered)	\$30/Ton
Liquid Steel from BOF	\$190/Ton
Alternative Iron Bearing Materials (Delivered)	\$5/Ton
Oxygen for Injection in EAF	\$36/Ton (O ₂)
Electric Energy	\$0.035/kWh
Lime and Dolomite (Delivered)	\$45/Ton
Manpower	\$34/Hr.
Carbon Fines for EAF	\$0.05/lb
Scrap	\$105/Ton
Electrodes	\$1.30/lb
Natural Gas	\$4.00/mmBTU

Table 3 Unit Value Cost for FASTEEL Economic Evaluation

	Scenario No. 1 Virgin Iron Ore	Scenario No. 2 (Virgin Iron Ore & Waste Iron Oxides)
FASTMELT Hot Metal Cost	\$96.4/t	\$87.1/t
FASTEEL Liquid Steel Cost	\$132.4/t	\$128.8/t
Savings compared to BF/BOF	\$57.6/t	\$61.2/t
Annualized Savings (per year)	\$86,400,000	\$91,800,000

Table 4 Economic comparison between FASTEEL and Blast Furnace/BOF Steelmaking

material scenarios were evaluated: the first is the use of virgin iron ores and a high volatile coal; the second is the use of all mill produced iron bearing waste materials as a partial substitute for virgin iron ores. This FASTEEL facility would include the following: one CONSTEEL® EAF capable of producing 1,500,000 tons of steel, and a 500,000 T/Y FASTMELT Plant (One Rotary Hearth Furnace (RHF) and One Electric Ironmaking Furnace (EIF®). The basis for the FASTEEL versus Blast Furnace/BOF economic review is shown in Table 3 on previous page.

Results for these two Scenarios are shown in Table 4. The FASTMELT hot metal cost and the FASTEEL steel cost include personnel, energy cost, consumables, and regular maintenance cost.

As evident from these tables, there is an incredible incentive for integrated mills to adopt the FASTEEL Process as a complement to steel production in their shops.

Besides the above economic incentive, the integrated producer also has to consider the following additional benefits:

- Stop operating and maintaining Blast Furnaces, Sinter Plant, and Coke Ovens.
- Stop operating and maintaining BOF plant.
- Last and most important, increase the overall production flexibility of the shop.

Significant savings in capital expenses planned for the next five years can be achieved by eliminating Rebuild Projects on BOF and Blast Furnace Plants.

Evaluation of the Emissions from FASTEEL

A major source of air emissions from the FASTEEL facility is the RHF off-gas. Off-gases and fumes from the Electric Iron Melting Furnace are collected and consumed as fuel within the RHF. Emissions from the Coal Pulverizer, Revert Dryer, and other ancillaries are negligible or within established BACT limits.

Dioxin and Furans are destroyed, not generated, within the RHF due to high temperature operating conditions. Re-composition of dioxin by *de novo* synthesis is minimized by rapid cooling of the off-gas through the critical temperature range of 450 ~ 250°C in the off-gas treatment system.

The sensible heat of the EAF offgases and the combustion of the

	FASTEEL	BF/BOF
NO _x (kg/ton of liquid steel as NO ₂)	0.33	6.0
SO _x (kg/ton of liquid steel as SO ₂)	0.81	15.6
CO ₂ (kg/ton of liquid steel)	883	1576
PM ₁₀ (kg/ton of liquid steel)	0.025	19.2
Dioxin (Ng-TEQ/Nm ³)	<0.1	No Data

Notes:
 Typical emissions are for 500,000 ton HM/y FASTMELT® Plant
 SO_x is dependent on Sulfur content in Coal
 FASTEEL emissions data is based on no de-SO_x or de-NO_x
 Blast Furnace emissions do not include coke making or sinter plant
 Blast Furnace NO_x, SO_x, and PM10 emissions data from US DOE August 2000 report
 EAF CO₂ emissions data from US DOE March 2000 report

Table 5 Comparison of FASTEEL and BF/BOF Steelmaking Emissions

CO by an automatically controlled air injection system are used to preheat the scrap prior to entering the EAF. This progressive and controlled combustion of CO and the generation and combustion of VOCs in the preheater greatly enhance compliance with EPA regulations. At the end of the preheater, the gases are directed to a fume cleaning system where post-combustion of CO, VOCs, dioxins, and other undesirable gaseous emissions is completed. Comparison for typical emission values for a FASTEEL plant and blast furnace/BOF are given in Table 5.

Conclusion

Based on proven commercial technologies, FASTEEL represents a new way of making steel, making use of low cost raw materials. Offering several key benefits for new steel installations or converting existing facilities, FASTEEL provides economic production of high grade steels while at the same time creating an environmentally friendly plant by recycling most steel plant wastes and reducing the amount of greenhouse gases compared to more traditional methods of making steel. The incentive for integrated mills to adopt the FASTEEL Process as a complement to steel production in their shops is greatly enhanced if the shutdown of sinter plants, coke ovens, and blast furnaces are considered.

WHAT YOU SEE ISN'T ALWAYS WHAT YOU GET

The Reality of Installed Metallic Capacity

By Rob Klawonn, Midrex Technologies, Inc.
Frank Griscom, Consultant

The iron and steel industry is cyclic in nature; however, turnover within the industry often leaves valuable lessons of the past lost in the shuffle. And sometimes these repeating trends can take a long period of time to reveal themselves.

In 1986, Marcus O. Davies, then president & CEO of Midrex Corporation, observed in one of his *Direct From Midrex* commentaries, "Eleven direct reduction processes have reached commercial stage in the past 25 years. Of the 11 first generation plants, none has achieved rated capacity on an annual basis. Less than 50% of the plants were still in operation 10 years after start up." Two years later, Davies, reporting on the state of the direct reduction industry wrote, "Of the 15 or more DR technologies that were considered commercially available in the early 1980s, only a handful have survived."

Davies' successor, Winston L. Tennes, writing in *Direct From Midrex* almost 10 years later, commented, "There is a substantial amount of new direct reduction capacity in commissioning or under construction. However, much of that capacity is based on unproven technology or faces financial or political constraints."

Did history repeat itself in the mid 1990s? Are we on the verge of it happening again? In order to answer these questions, we need to understand what set the cycle in motion more than 30 years ago.

First Wave of Interest

Steel production increased at a robust rate of seven percent per year from 1946-1973. Emerging economies viewed having a steel industry as essential in gaining industrial independence. Visionary steel industry figures, such as the late Willy Korf, saw the potential for market-sized mills that would use electric arc furnaces (EAFs) to melt scrap steel and direct reduced iron (DRI) for making steel. Following the success of a number of these early "mini-mills," particularly in natural gas-rich countries in South America and the Middle East, interest in direct reduction technology ran high in the 1970s. Process options sprang up and were thought to be the next technological breakthrough. Many mil-

lions of dollars and extensive industry attention were focused on the direct reduction industry.

Then came the oil price spike in the early 1980s, which triggered the highest US inflation level in 33 years ... and the steel industry went into a deep recession. With the world's largest consumer economy reeling, the global steel industry also suffered serious downturns. The combination of higher natural gas prices and reduced steel production stranded many of the fledgling direct reduction technologies in the midst of expensive development programs, which ultimately led to their demise.



"Those who cannot remember the past are condemned to repeat it."

George Santayana (1863-1952), a Spanish-born philosopher, poet, and humanist

However, this period provided the catalyst for strong growth of the EAF and introduced the concept of continuous casting (CC). The EAF/CC combination began replacing outdated traditional steelmaking methods in the more cost-sensitive commodity-grade products, but the high quality end of the market remained the exclusive domain of "big steel." The advent of continuous casting brought with it a gradual but persistent decrease in the amount of high quality home scrap, and without a source of low residual iron units, the more sophisticated long products and most flat products would continue to be beyond the reach of EAF operators.

Riding The Second Wave

Spurred on by a period of economic expansion reminiscent of the post-World War II boom, global steelmaking rebounded in the late 1980s, led by the EAF-based mini-mill sector. Most analysts of the day forecast that world DRI for EAF use would reach 75 million (M) metric tons (t) by 2005 and at least 100 Mt by 2010. Even more impressive were the gains made by mini-mills in flat products market share, especially in the US market.

With the price of premium quality scrap flirting with the \$150/ton mark and its availability becoming a significant concern, EAF steelmakers started giving direct reduction a second look. Even those industry insiders who once proclaimed that scrap would be able to satisfy all their metallics requirements began to have second thoughts. The result was a surge in direct reduction capacity, with almost a dozen projects either under construction or development by the beginning of the 1990s.

This new wave of interest in alternative sources of metallics brought with it a host of new processes, all promising some advantage over the established direct reduction technologies (MIDREX® and HYL III Processes). Expansion of the direct reduction industry accelerated throughout the early and mid 1990s, and hundreds of millions of dollars were spent on technology development. At the end of 1997, 17 Mt of direct reduction capacity was either under construction or being commissioned, provoking some to speculate that supply could outpace demand and push scrap prices below \$100/ton and drive down DRI prices by \$25-30/ton.

As we now know, scrap prices did fall to historic lows and DRI prices dipped well under \$100/ton. However, the perceived over capacity of the direct reduction industry cannot be "credited" with the deep and protracted decline that characterized the metallics market through the early years of the 21st century.

Déjà Vu, Again?

Looking back at the first two direct reduction waves, we can see some chilling parallels with today. Each time there was a market "boom," companies tried to capitalize by introducing new technologies. Most of these processes came and went, taking with them millions of development dollars and leaving the world littered with idle or under performing installed capacity. On paper, there appeared to be enough direct reduction capacity to meet the projected requirements. As a result, metallics consumers were lulled into a false sense of security, believing these plants would return to the market when increased demand drove up the prices. However, when demand for steel products recovered, EAF operators found themselves scrambling for metallics and paying higher prices ...and idle plants remained closed.

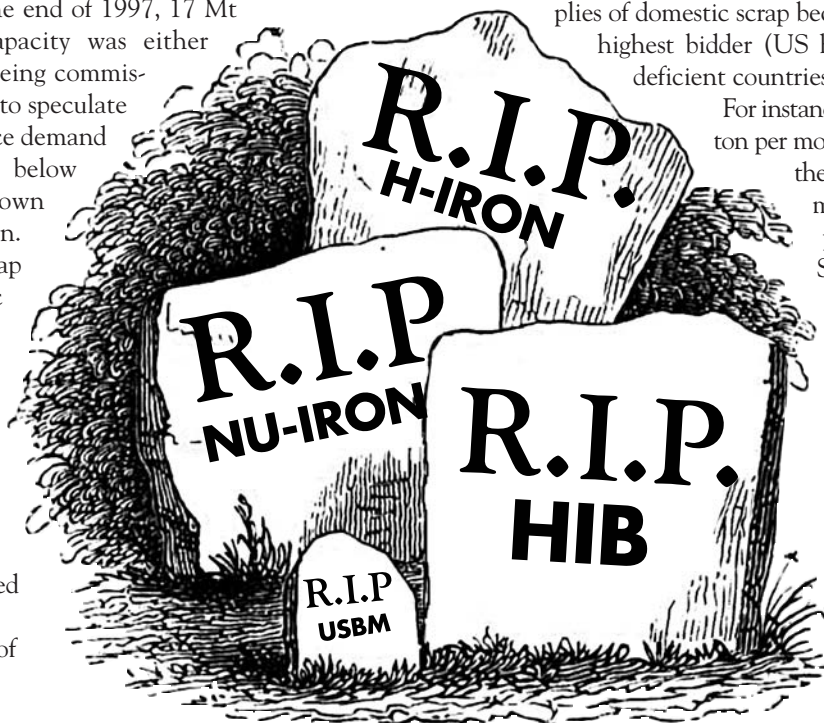
Metallurgic prices around the world are rising once again. Pig iron supplies are tight now that demand is strengthening in Asia and a major source of merchant pig iron is down for a blast furnace reline until later this year. As a result, Brazilian pig iron prices have jumped more than \$50/metric ton and it is trading in New Orleans at more than \$180/metric ton (c&f). Shortages of natural gas in Venezuela have kept HBI production at reduced levels most of the year, which when coupled with increased demand in Asia, has boosted the HBI price to more than \$160/metric ton, (c&f New Orleans).

The metallics scene today is quite similar to the late 1980s when steelmakers believed that increased demand would be satisfied by "hungry scrap traders and idle or under-performing direct reduction capacity." However, these beliefs could be seriously flawed.

The ferrous scrap industry has improved collection, preparation, and classification methods for purchased scrap over the past decade, but the industry has undergone significant structural changes, too. As a result, costs have increased and there are fewer companies in the industry. The US no longer "owns" its supplies of domestic scrap because scrap is typically sold to the highest bidder (US historically pays less than scrap-deficient countries).

For instance, US scrap prices rose \$5 - 12/long ton per month this past summer, primarily on the strength of purchases by overseas mills. Over the past 12 months, the price of No. 1 HMS destined for South Korea vaulted by \$60/metric ton to \$182 - 186/t, and scrap exports to Turkey were up 250 percent in the first four months of 2003.

The average utilization of installed direct reduction capacity in 2002 was only 77%. However, looking at the utilization according to the purpose of the plant gives a different picture. Merchant plants, those that sell their output on the open market, suffered



severely as iron prices reached new lows. Many of them failed and closed, especially those using new and unproven technologies. Average merchant plant utilization was only 45% when all plants, including those that were not successfully commissioned, are included. Economic conditions factored into the lagging performance of many merchant plants, but the costs to bring plants up to performance standards figured into a number of decisions to shut down or operate at less than nameplate capacity. Some industry insiders doubt that a period of higher metallics prices would be enough to encourage additional investment in under performing plants and processes.

Strategic Relationships Rule

Although scrap processors have made significant quality improvements, they cannot remove or lower the residual levels in ferrous scrap. Therefore, pig iron and DRI/HBI are the two principal sources of low residual iron units. The economics of producing pig iron solely as a merchant product are difficult except in Brazil; therefore, pig iron shipments can be somewhat unpredictable and subject to wide price swings.

Hot briquetted iron (HBI) was created to be a merchant product, and a number of plants have been built throughout the world to supply the metallic product. The prices of DRI and HBI should be reasonably stable because they are manufactured products. However, because direct reduction products are often sold on a spot basis in competition with scrap, they reflect similar price volatility.

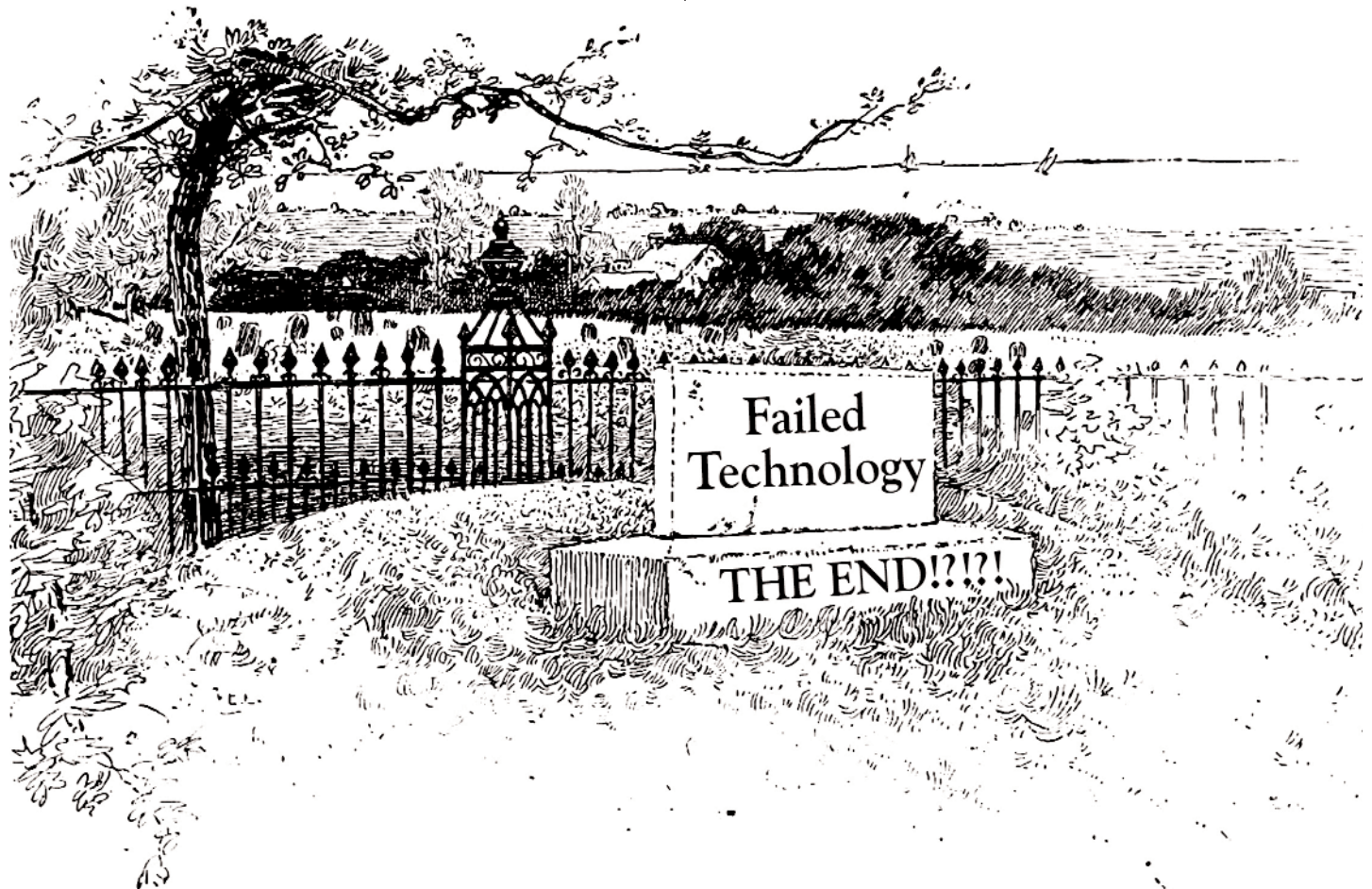
DRI and HBI users can stabilize that portion of their metallics cost by becoming directly involved in the ownership of a plant or by negotiating an off-take agreement with a supplier. In fact, it is unrealistic to think that future merchant capacity will be added without financial assistance or secure product off-take arrangements. Those would-be consumers who assume they will be able to buy sufficient quantities of HBI at an attractive price on a spot basis could find themselves victims of short supply and volatile pricing.

The EAF steel producer of the future will have a broad range of metallics sources from which to choose ... scrap, DRI/HBI, pig iron, hot metal, hot DRI, etc. Why? Because of technological innovations, process improvements, and applications research. The know-how will be there, but will the plants be built to utilize it?

No. Not unless steelmakers begin to look beyond their immediate situations. As long as the focus is on short-term profits, metallics buyers will continue to chase the best spot price. Proponents of this purchasing strategy would cite the law of supply and demand. However, that law would be better served if we also kept in mind survival of the fittest ... and that means replacing installed capacity if it can't survive technologically, operationally, and commercially.

What you see is not always what you get when it comes to installed metallics capacity.

(Note: CRU Monitor, July 2003, source of metallics pricing information. Midrex Technologies, Inc. source of direct reduction market statistics.)



Midrex Celebrates 20 Years With Kobe Steel



QASCO MIDREX® Plant, Qatar

By Christopher M. Ravenscroft
Midrex Technologies, Inc.

This past August marked the 20th anniversary of Kobe Steel Ltd.'s acquisition of Midrex. During these two decades Midrex has enjoyed technological success and continues its innovations for the iron and steel industry. Midrex remains a valuable asset to Kobe Steel as a process technology partner rooted in iron-making and expanding into other process technology areas.

Kobe announced its purchase of Midrex Corporation on August 25, 1983; however, the history of the relationship goes back even further, to the early 1970s with the QASCO project.

Qatar Steel Company (QASCO) was the first integrated steel plant in the Arabian Gulf region, established in 1974 by three shareholders: Government of the State of Qatar; Tokyo Boeki, Ltd.; and Kobe Steel. Kobe's role in the project included turnkey construction of the MIDREX® Plant, meltshop and rolling mill; a management service contract extending eight years; and twenty percent ownership in the complex. In April 1978 QASCO began operation of a 400,000 tons-per-year MIDREX® Direct Reduction Module, 17 months after the start of construction. This was

Mr. Susumu Okushima, President & COO, Infrastructure & Plant Engineering Company, pictured with James D. McClaskey, President of Midrex Technologies, Inc. at Kobe Steel offices in August.

by 1983 Willy Korf's steel empire was in decline, requiring him to sell off his U.S. holdings including Midrex. Due to its successful involvement in QASCO, Kobe Steel had a keen interest in Midrex and purchased the company.

At the time of acquisition, former Vice Chairman Taisuke Mori of Kobe Steel expressed Kobe's intent for Midrex. As quoted in the 1st Quarter 1984 Direct from Midrex, Mori stated:

"The technical excellence of the MIDREX Direct Reduction Process is testimony to the research and development and engineering capabilities of Midrex people. We see Midrex as our marketing and engineering arm and technology base in the United States."

By 1984 Kobe's purchase was quickly rewarded as contracts were signed with Alexandria National Steel Company (ANSDK) and National Iranian Steel Company (NISCO). The Midrex/Kobe partnership facilitated the growth of the direct reduction industry. By 2001, world DRI production leapt to 45.1 million tons with MIDREX Plants producing more than 66.6 percent of the

Midrex's first plant in the Arabian Gulf.

During the 1980s, recession caused a downturn in the metals industries worldwide, and



ITmk3 Nuggets

total. In fact, MIDREX Plants have produced at least 60 percent of the world's DRI each year since 1987.

New Technologies for Direct Reduction: From FASTMET® to ITmk3®

During the early years, Midrex's efforts focused on the patented MIDREX Technology; however, as its relationship with Kobe developed, so too did Midrex by becoming more than a "one" technology company. The two companies have developed several commercially proven coal based rotary hearth technologies including FASTMET®/FASTMELT®, FASTEEL®, FASTOx® and the revolutionary ITmk3®.

In early 1992, Midrex constructed a nominal 0.15 ton per hour FASTMET pilot plant at the Midrex Technical Center in Pineville, NC. Based on the success of the pilot plant operation, Midrex and Kobe Steel built a 2.5 ton per hour FASTMET demonstration plant at Kobe Steel's Kakogawa Steel Works in Kakogawa, Japan in 1995. The Kakogawa Plant was the first rotary hearth reduction plant in the world dedicated to producing highly metallized DRI.

The first FASTMET commercial facility was sold to Nippon Steel Corporation in early 1999 and is located at the Hirohata Works in Himeji, Hyogo Prefecture, Japan. The first DRI from the plant was produced on March 21, 2000. Total time from contract signing to plant start-up was 14 months.



Kakogawa's FASTMET® waste recycling facility

The plant processes 190,000 tons per year of BOF waste materials into 90% plus metallized product using a rotary hearth furnace.

The second commercial plant for steel mill waste processing began operation at Kobe Steel's Kakogawa Works in May, 2001. This facility processes 16,000 tons per year of zinc-bearing steel mill wastes, producing cold DRI and crude zinc oxide.

From the proven FASTMET Process the companies jointly developed FASTMELT and FASTOx. FASTMELT consists of a FASTMET Plant with a Electric Ironmaking Furnace to produce Hot Metal. FASTOx incorporates FASTMELT into a flowsheet for use with a basic oxygen furnace for steelmaking.

FASTEEL is a clean, faster and more flexible way to make steel for significantly less costs than existing technologies. It combines the hot metal produced in the FASTMELT Process in an electric arc furnace (EAF) with scrap that is continuously fed from Techint Technologies' CONSTEEL® system.

ITmk3 is the latest development. A Kobe Steel technology, ITmk3 uses a rotary hearth furnace to convert iron ore fines and pulverized coal into iron nuggets of the same quality as blast furnace pig iron. Kobe Steel and Midrex began research on the ITmk3 Process in 1996.

Currently the technology is being developed at the 25,000-ton-per-year Mesabi Nugget ITmk3 demonstration plant in northeastern Minnesota (USA).

The plant started up quickly and has successfully produced iron nugget product that has been melted in a EAF. Continued successful operation of the demonstration plant will validate the commercial viability of the ITmk3 Process and allow for the construction of a commercial-scale plant in 2005.

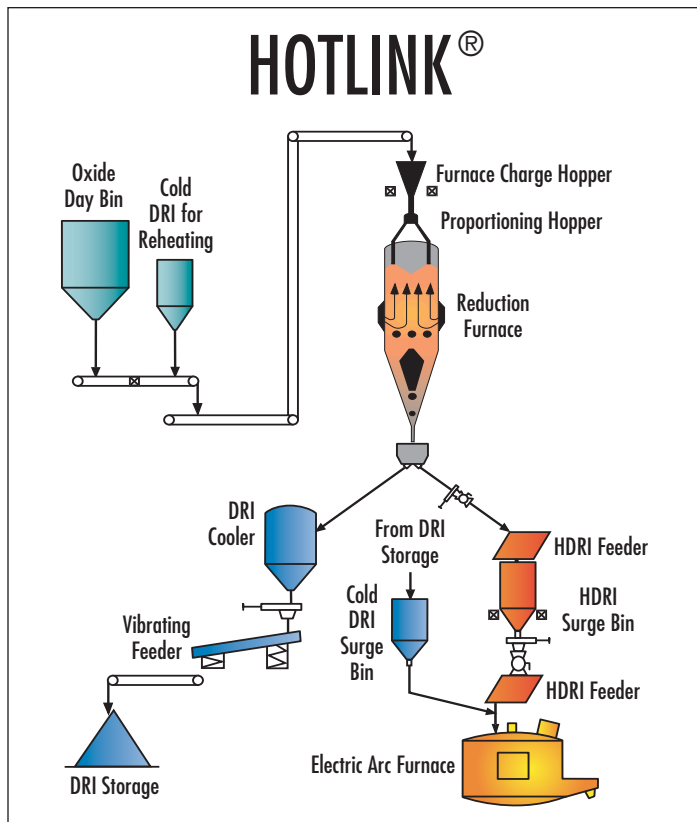
For two decades Midrex and Kobe Steel have been major players in the direct reduction industry. From technology development and project execution to new business diversification efforts, the future looks just as bright.

Midrex News & Views

MOU for New MIDREX® Direct Reduction Plant – Proposed project will use HOTLINK®

Midrex Technologies, Inc. (USA) and Al-Ghaith Holdings (UAE) recently announced the signing of a Memorandum of Understanding to establish the world's first Direct Reduction plant to utilize the proprietary Midrex HOTLINK® hot transport system. HOTLINK is a Reliable, Low Maintenance, Gravity-Based System for Hot Charging of DRI to EAFs.

Al-Ghaith and Midrex have signed agreements that should result in commissioning of the new UAE steel producer within 24 months. The 500,000 tonne per year MIDREX® Hot Discharge module will provide hot DRI to a new melt shop. Although Essar Steel of India has three existing MIDREX® Hot Discharge modules



currently delivering hot DRI to the adjacent melt shop, the Al-Ghaith DR plant will be the first to implement all of the benefits of HOTLINK.

Continuous production of hot DRI will allow the Al-Ghaith HOTLINK plant to simultaneously produce HBI for export.



Proposed project site

The mini-integrated steel facility to be constructed by Al-Ghaith and partner will be installed in UAE. With access to a berth of 14 m draft, the facility will be capable of importing iron ore and exporting HBI and semi-finished steel in the form of billets.

The plant implementation will be under the responsibility of Advance Projects Development (Al Ghaith EPC arm) in cooperation with the other partners. Midrex Technologies Inc. will supply a technology package to APD consisting of basic and detailed engineering, proprietary and critical equipment, training and commissioning services.

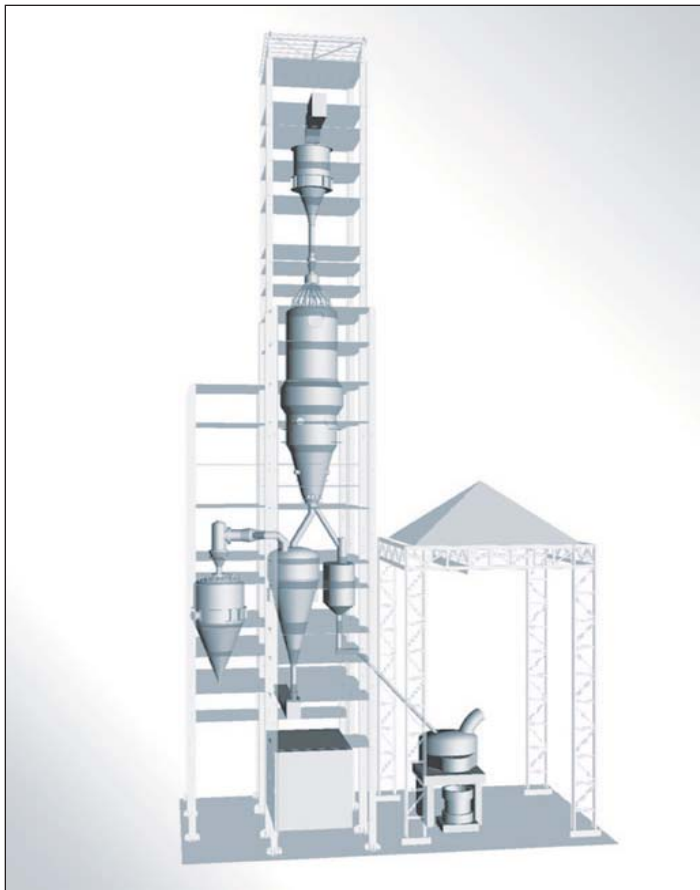
After a DR contracting drought of more than 4 years, the first project to be contracted in the coming wave of new ironmaking projects will utilize the patented HOTLINK system. The last signed contract for a direct reduction plant was contracted in 1998 between Kobe Steel Limited and ANSDK

"HOTLINK" - Details of Hot Charging of DRI to EAFs

Optimization of DR/EAF production and energy efficiency has taken an evolutionary step with the close coupling of a MIDREX Shaft Furnace and an EAF to achieve increased productivity and energy savings in the production of high quality steel. The concept, HOTLINK®, provides a simple, reliable and economical means for hot charging DRI to an adjacent electric arc furnace using gravity to transport hot DRI (HDRI).

HOTLINK is based on proven technology and simple design philosophy. By using gravity transport, HDRI degradation, metalization and temperature losses are minimized. Easy to operate, the HOTLINK system allows no HDRI re-oxidation and has the flexibility to produce any combination of DRI or HDRI based on proven MIDREX® Technology. HOTLINK delivers HDRI to the EAF between 700°C and 750°C.

Midrex News & Views



HOTLINK 3-D Model

Midrex pioneered the continuous gravity-flow direct reduction plant design, as well as the hot discharge furnace feature. HOTLINK places a MIDREX Hot Discharge Furnace just outside and above the exterior wall of the meltshop. This provides the opportunity to discharge directly from the shaft furnace to a hot DRI surge bin and then from the surge bin directly to the EAF by

gravity. This configuration of gravity fed hot DRI has been used on all MIDREX HBI plants to produce more than 50 million tons since 1984.

HOTLINK Modules are equipped to handle any upset conditions via the hot DRI surge bin. The primary goal of the arrangement shown below is to supply hot DRI to the EAF as the demand requires it. However, the plant must also be capable of switching to the production of cold metallics for stockpiling without any interruption in production of hot DRI.

Melting Benefits

- Reduces EAF electrical power required by the EAF.
- Reduces EAF electrode and refractory consumption.
- Increases EAF productivity or allows EAF electrical system to be downsized.

Savings

- Electricity Savings of 120-140 kWh/t liquid steel produced by EAF.
- Electrode Savings of 0.5-0.6 kg/t liquid steel produced by EAF.
- 20% Increase of EAF productivity or downsized EAF electrical system.

Flexibility

- Simultaneously discharge any combination of DRI/HBI/HDRI as demanded by the EAF.
- MIDREX Plant can continue operation when the EAF is off-line.
- EAF can continue operation using stored DRI/HBI when the MIDREX Plant is shut down.
- Implementation of the proprietary SIMPAX™ Process Automation and HDRI quality prediction software will enable the plant operators to optimize plant availability, efficiency and productivity.

Christopher M. Ravenscroft: Editor

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