DIRECT FROM MIDREX

1st Quarter 2001

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DIRECT FROM MIDREX

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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: http://www.midrex.com under agreement with Midrex International B.V. The publication is distributed worldwide free-of-charge to persons interested in the direct reduced iron (DRI) market and its growing impact on the iron and steel industry.

Commentary

Positioned for the Future

Winston L. Tennies
President

The steel and DRI markets have been through some interesting times within the past year. As an industry, we saw in 2000 the acknowledgement of DRI and other alternative iron as a necessary charge material in mini-mills producing low residual steel products. In addition, we saw an all-time record world DRI production. We saw the e-mergence (sorry for the pun) of e-business in the steel industry and unfortunately, we also saw the steel market slow worldwide and natural gas prices rise in North America, putting a damper on an otherwise extraordinary year for some MIDREX® Direct Reduction Plants.

Within the Midrex family, several MIDREX Plants set production records. Also, Midrex Enterprises, Inc. successfully completed its corporate headquarters move and we wished a fond farewell to one of the founders of the MIDREX® Direct Reduction Process as he embarked upon a well-earned retirement (see News and Views, page 10).

We spent a lot of time in 2000 further developing and testing new technologies and expanding our scope to better serve the iron and steel industries in the future. Among the new technologies that are in continuous development include a joint venture with Kobe Steel on FASTMET® and FASTMELT®, commercially proven to be suitable for waste recycling from both the economical and environmental aspects. Other developments include: HOTLINK™ for hot charging of DRI using gravity to an adjacent electric arc furnace; high carbon DRI and HBI, which enables a steel mill to increase productivity, reduce energy consumption and enhance steel quality; OXY+™, a partial oxidation system to increase productivity significantly and ITmk3®, a revolutionary ironmaking process (see feature story page 7). With FASTMET and ITmk3 technologies, Midrex now offers alternatives to gas-based direct reduction for North America and other regions. And, we continue to develop the use of chemical energy (carbon) in DRI/HBI as an increasingly viable method to manage energy cost.

January 2001 also marked the official launching of Midrex Solutions™ (see story on page 11), a dedicated group within Midrex to meet our Licensees' needs for value-added project assistance.

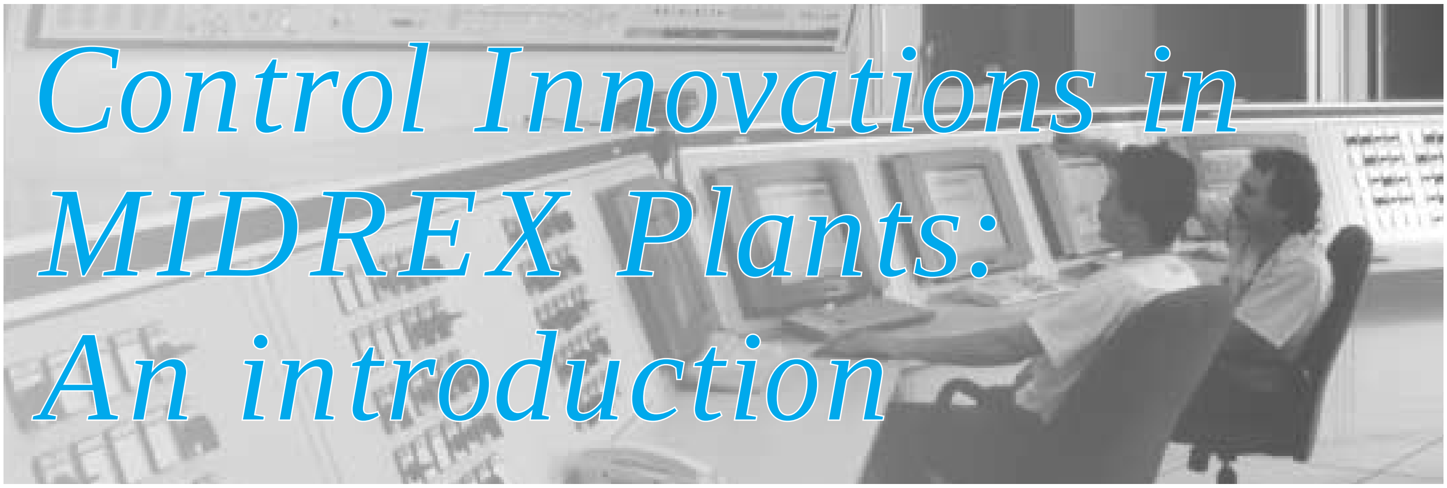
Finally, with the spirit of change and continued growth that Midrex is undergoing, we have changed our name to Midrex Technologies, Inc. This reflects our evolving role in the iron and steel industries and our efforts to utilize our technological strengths in other areas. More details will be forthcoming in the 2nd Quarter 2001 *Direct From Midrex*.

By all accounts, 2001 will be a very difficult year for the steel industry, and although business will be slow, our goal is to continue developing new technologies and services in anticipation of a market recovery. We all look forward to these new challenges and to a brighter future for all in the 21st century.

MISSION STATEMENT

Midrex Technologies, Inc. will lead in the ironmaking technology industry by supplying superior quality services that provide good value for our clients. We will meet or exceed performance expectations, execute projects on time, enhance existing product lines, and develop or acquire new technologies. Our employees are the key to our success, and we are committed to encouraging them to grow professionally and personally.

Control Innovations in MIDREX Plants: An introduction



By Michael Thompson,
Principal Engineer – Process Systems / Safety
Midrex Technologies, Inc.

In today's market it is critical that a MIDREX® Plant run as efficiently as possible. This can be done by enhancing utilization of resources or maintaining production levels with fewer resources. The first steps are to install a state-of-the-art Distributive Control System (DCS) and keep current PID controllers well tuned. Improved control should then be implemented.

How and Why Improved Control Can Help

"Improved Control" generally means "tighter control than is possible with traditional controllers." This means that the standard deviation of the controlled variable would be less with the improved control loop than with the existing control scheme.

A smaller standard deviation in the controlled variable benefits the plant by:

1. A smaller variation in DRI product quality.
2. Allowing the plant to shift the average value of a controlled variable by half of the decrease in the standard deviation, which will lower costs or increase production. (See Table 1)

Benefits may be quantified by the following equations:

1) improvement (variation reduction) =
standard deviation (old) - standard deviation (new)

2) improvement (average shift possible) =
[standard deviation (old) - standard deviation (new)]/2

Table 1 Benefits of Improved Control

It is desirable to have the ability to shift the average value. For instance, consider temperature control in the reformer. The higher temperatures that increase reformer capacity also shorten the reformer tube life. Because tube life also decreases with each temperature change, the plant must always choose between lost production (lost income) at lower temperatures and shorter tube life (higher cost) at higher or less-stable temperatures.

Improved control allows the ideal solution, which is to increase the average temperature while decreasing temperature variations. While more-stable temperatures result in longer reformer tube life, the plant can also increase the average reformer temperature while reducing the risk that temperature swings will overheat the tubes. Therefore, the reformer capacity and plant production increase.

DRI plant capacity varies by 2-3% for each 1% of required metallization. By reducing the variation in metallization, the plant can increase the average metallization while maintaining production, or it can increase production with the same proportion of on-spec product. Either way, improved control provides higher DRI production and a more-consistent DRI quality.

Each of the various improved control schemes yields similar benefits. Regardless of the choice of method, improved control can result in the following benefits:

- Improved yield
- Increase in product quality
- Reduced operating costs
- Enhanced operating flexibility
- More consistent product quality
- Increased throughput

The 1987 Warren Center project on Advanced Process Control concluded that the economic benefits from the systematic application of this technology were on the order of 2-6% of total operating costs. Other studies since that time have shown that this level of economic benefit may be conservative.

Several of the improved methods not only provide better control, they actually seek optimum control. These two concepts work together, as one needs tighter control to achieve optimum control. Depending upon how the plant chooses to program the system, optimized control may mean maximum production, minimum input cost, or even maximum profit.

Options for Achieving Improved Control

Various methods of improved process control can be applied to almost any control problem. Each method works at a higher level than the standard DCS system.

Advanced process control techniques include a wide variety of methods and software packages such as PID, feed forward, cascade, deadtime compensation, model-based control, constraint control, optimal control, adaptive control, etc.

Advanced Control can be used to directly target certain difficult loops like seal gas oxygen, H_2/CO ratio, and flow measurement errors due to analysis changes. It can calculate unmeasurable items such as excess air to the reformer, cooling zone upflow, feed gas stoichiometric ratios, etc. A simple example is a virtual water analyzer that is used by all MIDREX Plants designed since 1992. This advanced control loop holds constant the water content in the reformer feed gas, resulting in a more-stable H_2/CO ratio.

Level 2 control, *Multivariable Predictive Control*, and *Neural Network Technology* are exciting and beneficial technologies for control improvements. (See sidebar.)

While the Level 1 DCS generates con-

PROCESS CONTROL TERMS

Artificial Intelligence – The simulation of human intelligence processes by computer systems. AI includes learning (the acquisition of information and rules for using the information), reasoning (using the rules to reach approximate or definite conclusions) and self-correction. Applications include expert systems, speech recognition and image recognition.

Expert System – A computer program that simulates the judgment and behavior of a human or an organization that has expert knowledge and experience in a particular field. A form of AI, expert systems typically contain a knowledge base that uses accumulated experience and a set of rules to apply to each situation. Sophisticated expert systems can be enhanced with additions to the knowledge base or to the set of rules.

Fuzzy Logic – A mathematical technique for dealing with non-exact values such as "hot" or "too much" or "slow." Often an integral part of expert systems, fuzzy logic can be successfully applied to areas that have had no control before, especially non-linear, poorly-modeled systems and noisy processes.

Advanced Process Control – Control used to maximize process profitability by reducing off-spec product and increasing yield. It uses logic, predictive algorithms, thermodynamics calculations, fundamental chemical engineering theory, operator experience, real-time control models and other control techniques to achieve economically-related plant operating targets.

DCS – Distributed control systems. The computer and input / output devices at the heart of Level 1 control.

Level 0 Control – Manual control with manual setpoints.

Level 1 Control – Automatic but independent control of loops by computer using manual set points. The DCS computer sees control of each loop as a separate task. This is typical of most plants today.

Level 2 Control – A method of process optimization. Level 2 collects data from the laboratory and the Level 1 DCS, conducts data validation and analysis using on-line process models and may even automatically adjust the Level 1 DCS setpoints to achieve more optimal results. Because a Level 2 system can display recommended setpoint changes or adjust setpoints automatically, loop control becomes one integrated action rather than multiple independent actions.

Level 3 Control – Level 2 control for each plant, plus a financial model designed to optimize the site rather than each plant.

Multivariable Predictive Control – Also called Model Predictive Control (MPC), Model Algorithmic Control (MAC) and Dynamic Matrix Control (DMC). Multivariable Predictive Control uses control algorithms that explicitly include a dynamic model of the process to be controlled. Therefore, based on the knowledge of previous control actions and the current output measurement, the control algorithm can predict the future process outputs.

Neural Networks – Neural networks mimic the way a human brain handles incomplete and confusing sets of data. They learn and recognize patterns using interconnection weighting factors. Neural networks learn by comparing an actual output pattern to a desired output pattern and then adjust these factors to reduce the difference between the two. After a sufficient number of iterations, the network creates an internal model that can be used to predict for new input conditions.

trol data for Level 2 (such as flows), Level 2 generates performance data for Level 3 (such as Gcal/t). A Level 3 system may direct Level 2 to provide a certain metallization. The Level 2 system then directs Level 1 to adjust specific control loops in order to obtain that desired metallization.

Compared with conventional controllers, *Multivariable Predictive Control (MPC)* can handle strong interactions between different process variables, long time delays, and operational constraints on controlled and/or manipulated variables.

Constrained multivariable controls can be applied to push the process operation closer to constraint limits, resulting in increased capacity and more consistent product quality. Constrained multivariable controls also have the ability to perform local optimization functions. Multivariable Statistical Process Control combines features of MPC with Statistical Process Control (SPC) for additional benefits.

Neural networks provide a cost-effective modeling tool and can extend the capabilities of traditional statistics, modeling, and control. They work well in both linear and non-linear systems where first-principles modeling is costly or difficult. Neural networks have the ability to learn the relationships between multiple-input and multiple-output systems. Using a self-generating model, neural networks provide very flexible and powerful techniques for data analysis.

Other uses are dynamic and static process modeling, nonlinear and adaptive control, inferential predictions, fault detection, time series prediction and multivariate pattern recognition.

These abilities make the neural network technology well suited for solving problems in the chemical process industries.

Level 2 systems, MPC systems, and neural networks each optimize a plant using the plant's own constraints. The plant sets the objective function in the model to achieve a specific goal like maximum production, minimum electricity, or minimum natural gas usage. The control method is fundamentally different from a standard control system. A DCS assumes each measured variable has an independent control value. Level 2 integrates and can changes control values to achieve the designated goal.

Midrex Action Plan

Midrex is reviewing several of these technologies to help MIDREX Plants increase productivity, increase quality, and reduce costs. We have already designed a number of individual Advanced Control loops that are critical to quality and production. These provide tighter control of loops such as bustle gas quality, reductant flow per ton of DRI, and burden temperatures. In fact, many of the newer plants built in the last 5 years were designed with and successfully utilize a number of Advanced Control loops. Nearly all of the Advanced Control loops developed by MIDREX can be added to existing DCS systems with minor modifications and no additional hardware.

We have also started development of a Level 2 control system. The Level 2 control system will be used to optimize each plant according to its specific capabilities. Evaluations are now being made for a process model, which is the heart of a Level 2 system. This Level 2 control system can be easily retrofitted into an existing plant and could be in operation by the end of the year. MIDREX intends to complement Level 2 control with an Expert System to aid plant operators with problem diagnosis in order to improve plant availability and reduce maintenance costs.

In future issues of *Direct From Midrex*, we will further examine Optimized Control Systems. For more information regarding the application of Advanced Control or Level 2 control applications for a Midrex plant, contact MIDREX Solutions.

MIDREX® Direct Reduction Plants
2000 Operations Summary

In 2000, many MIDREX Plants set monthly and annual production records. Several more records looked as if they would have been broken, but falling steel, DRI and scrap prices forced many companies to limit their production in the second half of the year.

The following are highlights from selected MIDREX Plants and their performances.

Acindar
During 2000, Acindar operated above rated capacity due to very good availability, but steel mill output was constrained by low market demand.

ANSDK III

Caribbean Ispat DR3

Amsteel
Amsteel operated over capacity, producing more than 684,000 tons.

ANSDK
The third module that supplies ANSDK's flat steel products steel mill started up in February and helped the plant to produce more than 1.5 million tons of DRI.

Caribbean Ispat Ltd.
CIL's latest and largest MIDREX MEGAMOD® went on line in July of 1999. In 2000, production at the complex exceeded one million tons despite poor market conditions.

COMSIGUA
COMSIGUA's production for 2000 was an all-time record for an HBI plant, exceeding rated capacity by more than 20 percent in its second full year of operation. An availability level of more than 90 percent was one of the factors contributing to this noteworthy achievement.

Essar

Essar Steel
Module I set a monthly record in December, producing more than 62,900 tons and nearly matched its 1998 annual record. Module II set a new annual record of 619,000 tons.

Module III continues to successfully use a system to transport hot DRI (HDRI) to the meltshop using pallet transporters and charge the material directly to the EAFs.

Georgetown Steel
Georgetown Steel's MIDREX Plant exceeded capacity for the seventh consecutive year and set a record of more than 579,000 tons of DRI produced. This was an 11.5 percent increase over its previous record, with three monthly production records set.

COMSIGUA

IMEXSA

Hadeed

Despite the market downturn Modules A and B broke their annual records by more than 10 percent. This was attributed to very consistent production and high plant availability. DRI products had consistent high carbon levels in the 2.2 to 2.4 percent range.

Ispat Industries, Ltd.

OEMK

IMEXSA

In its third full year of operation, IMEXSA reported very consistent operation, with its MEGAMOD producing nearly 1.7 Mt of DRI and setting a new annual record. This is an all-time high for a single MIDREX Module.

Ispat Industries, Ltd.

Ispat Industries increased its production of DRI to more than 1.2 million tons in 2000, and the MEGAMOD has exceeded capacity every year since beginning operations in 1994.

Khouzestan Steel

The three modules at Khouzestan Steel operated well above capacity. Module II set an annual record with more than 487,000 tons produced due to very good availability. Module III broke a monthly record in December by 10 percent.

LISCO

LISCO's Module IA beat its annual production record by 10 percent, producing more than 550,000 tons in 2000. Module II set an annual record as well as a monthly record.

NISCO

NISCO experienced a good production year with records set by three of its five modules. Module E exceeded its previous annual record by more than 20 percent.

OEMK

Three of OEMK's four Modules set new annual production records, with Module I breaking the record by more than 25 percent. High metallization, up to 97 percent, and good availability were reported for all modules.

OPCO

OPCO again exceeded the one million ton production mark with most of the HBI shipped to the North American market.

QASCO

QASCO experienced another good year, producing over capacity with 95 to 96 percent metallized product.

Saldanha Steel

Saldanha Steel is the world's only direct reduction facility to use the offgas from a COREX ironmaking plant to make DRI. It successfully completed its performance test in early 2001. All of the DRI is consumed in Saldanha Steel's meltshop.

Saldanha Steel

SIDOR

SIDOR's DRI facilities experienced a good year, with all four modules breaking their annual production records and each module setting various monthly records. Of particular note, Module 2C broke its annual record by more than 30 percent due to very good availability. DRI produced was in the 2.2-2.4 carbon range with a metallization of 94-95.5 percent.

VENPRECAR

VENPRECAR set a new annual production record in 2000 of more than 800,000 tons. The HBI produced was mostly sold for export but also used domestically.

ITmk3® – Premium Ironmaking Process for the New Millennium

By Takuya Negami
Executive Advisor
KOBE STEEL, LTD.

Three principal concerns for iron suppliers today are the issues of adding more value to iron ore, providing direct access to the EAF and the environmental impact of steelmaking, including the need to decrease CO_2 emissions.

Kobe Steel and Midrex have arrived at a viable solution for these concerns through a new technology known as IT Mark Three (ITmk3®), based on their coal-based direct reduction technologies that have been in development over the past decade.

History: Kobe Steel / Midrex Coal-Based DR Technology

ITmk3, which stands for "Ironmaking Technology Mark Three," is the latest coal-based direct reduction technology from Kobe Steel and Midrex.

The first coal-based DR technology, called "Heatfast," was developed and tested by National Steel Corp., Hanna Mining, and Midland-Ross Corporation, a forerunner of Midrex Direct Reduction Corporation, in the 1960s. The company suspended the development of the coal-based DR process in order to focus on the natural gas-based MIDREX® Direct Reduction Process.

In the early 1990s Kobe Steel and Midrex renewed their interest in a coal or solid carbon-based direct reduction process, and re-examined application of the Heatfast Process for the production of highly metallized DRI, which was renamed FASTMET®. FASTMET employs a rotary hearth furnace (RHF). A 2.6-meter diameter unit was built at the Midrex Technical Center in Charlotte, North Carolina, and testwork has been successful. The technology was further developed with construction and operation of a commercial-scale, 8.5-meter diameter demonstration plant at Kobe Steel's Kakogawa Works in Japan (see 4th Quarter 2000 *Direct from Midrex* for more information).

Following the development of FASTMET, research and development for ITmk3 began in 1996. The first process candidate was a re-engineered RHF that was tested at the Midrex Technical Center in 1998. In order to further develop the process, a 4-meter diameter ITmk3 pilot plant was built at Kakogawa. Test operations were carried out from October 1999 to March 2000, and again in October through December 2000.

ITmk3 Technology

ITmk3 is the third generation of ironmaking. We define Mark 1, the first generation, as blast furnace ironmaking and Mark 2 as gas-based direct reduction, including the MIDREX® Process.

ITmk3 is a unique process technology since it ventures into a new area in the Fe-C diagram (see Figure 1). In this area, carbon composite pellets are reduced and melted at a relatively low temperature of 1,350°C and the hot metal is easily separated from the slag. The ITmk3 reaction was found in the solid/liquid co-existence phase, which is different from traditional ironmaking processes. Melting occurs after reduction, and residual FeO is less than 2 percent. Therefore, there is no FeO damage to the refractory.

ITmk3 provides a number of benefits versus conventional ironmaking technologies:

- Reduction and slag separation occur within one step
- Super heated temperatures are not needed
- There is no FeO attack to the refractory
- Slag is cleanly separated from the metal
- Fine ore and low grade ore can be used

The final goal of ITmk3 is to produce molten iron directly from fine ore and coal through a one-step process. In the reduction stage, two reactions take place inside the pellet:

(1) $Fe_2O_3 + 3CO = 2Fe + 3CO_2$
(2) $CO_2 + C = 2CO$

Reaction (2) is endothermic, activated at temperatures over 1,000°C. While reduction is most active over 1,000°C, the required reaction heat balances the heating rate from the furnace, so that the pellet temperature is kept constant. When

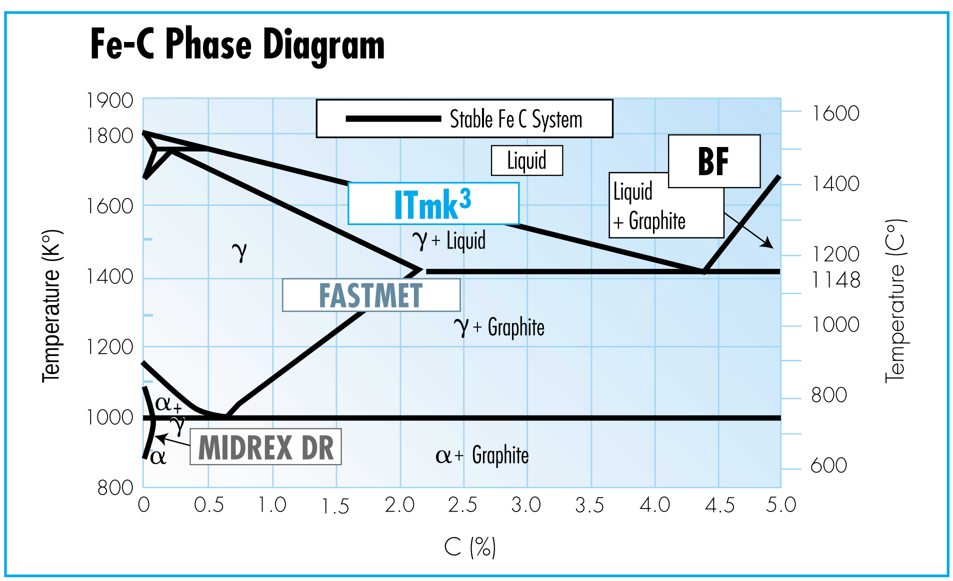


Figure 1 Fe-C Phase Diagram

Item	Cost US$	Notes
Raw material (ore, coal, binder, etc.)	49.0 – 54.0	Ore cost does not include transportation cost
Energy	18.0	Gas + Electricity
Other variable costs	6.0	Consumables
Fixed cost	12.0	Depreciation is not included
Total cash operating cost	85.0 – 90.0	

Table I ITmk3 Production Cost

Iron Nugget Chemical Composition	(Weight %)
Met Fe	96-97
FeO	0
C	2.5-3.5
Si	Depends on raw material specifications
Mn	Depends on raw material specifications
P	Depends on raw material specifications
S	0.05

Table II Iron Nugget Chemical Composition

the reduction degree reaches 95 percent or above, a temperature drop in the iron is observed. This is a good indication that carburization and melting are proceeding. Using this reaction mechanism and a FASTMET-type RHF reactor with a carbon composite iron ore pellet as the raw material, ITmk3 produces an iron nugget product in a solid form which is similar to pig iron.

Process Features

From a process standpoint, ITmk3 has many advantages, including simple process, low investment cost, low production cost, flexible iron ore material selection and flexible reducing agent selection.

The process flow, as well as the equipment arrangement, of ITmk3 are quite similar to the FASTMET Process, as shown in Figure 2.

The investment cost for a 500,000 ton/year ITmk3 plant is estimated to range from US$90–$100 million. The production cost at an iron ore mine is estimated at be US$85.0–90.0/ton iron nugget, which assumes an iron ore (pellet feed) price of US$16/ton. Table I shows the details.

ITmk3 can process either magnetite or hematite. During pilot plant testing iron nugget was produced using various types of iron oxide.

Since the process separates metal and slag in one step, it effectively concentrates the iron ore. This opens the possibility of utilizing lower grade iron oxide such as very fine tailings from beneficiation plants; however, energy consumption per ton of iron nugget increases when processing lower grade ore. All the iron contained in the oxide is converted into metallic Fe.

ITmk3 is very flexible regarding carbon sources; the process can use coal, petroleum coke or other carbonaceous material.

Product Features

The nuggets produced in ITmk3 have many beneficial features, including: slag-free pure products, controllable carbon content, no re-oxidization, no fines generation, easy handling and transportation

A representative chemical composition of the iron nugget is shown in Table II.

As seen in Table II, all the iron oxide is reduced and no FeO remains in the iron nugget. The carbon level is controllable by the input of carbon and the heating pattern, with the maximum carbon content 3.5 percent. The contents of silicon, manganese and phosphorus in the product depend on raw material selection. The product sulfur level also depends on the sulfur contained in the coal; however, the process has a good chance to reduce the sulfur level remaining in the nugget to the acceptable range.

The final nugget product does not re-oxidize and does not generate fines. Therefore, it is much easier to handle and transport than DRI and HBI products. The size of the iron nugget is shown in Table III.

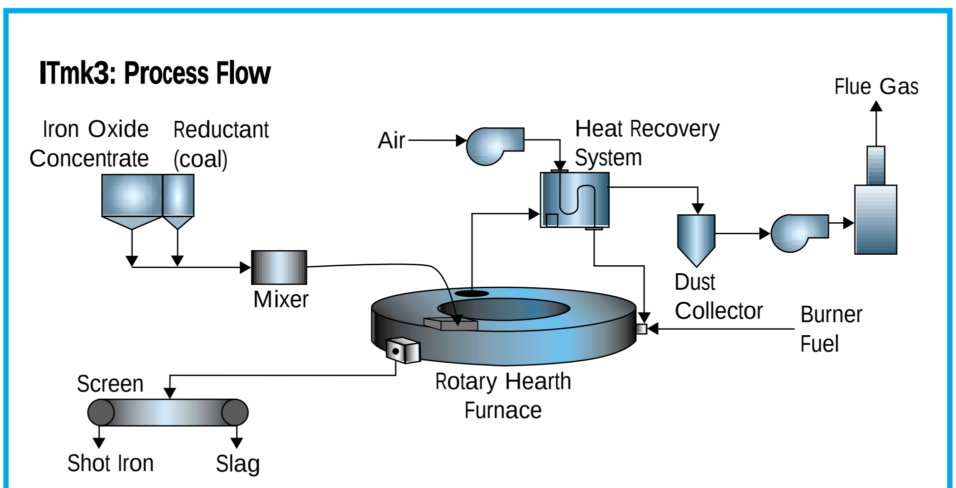


Figure 2 Standard Flowsheet

Mesh	Ratio (%)
+ 3.35mm	100
+ 6.7mm	90

Table III Size of ITmk3 Nugget

Outside diameter of hearth	4 m
Hearth width	0.8 m
Capacity	0.4 ton / hr.

Table IV Pilot Plant Specifications

Pilot Plant Test

A second pilot plant was built at Kobe Steel's Kakogawa Works in 1999, to commercialize the process, and to obtain further engineering data. The first test campaign was in October 1999 and continued for 6 months, and the second test campaign was from October to December 2000. Table IV shows the salient features of the plant.

Figure 3 shows the inside of the furnace. In Zone 1, volatile matter from the coal evolves. In Zone 2, pellets are heated and reduction occurs. In Zone 3, reduction is completed, nuggets are formed and metal is separated from slag. In the last zone, the product is cooled and discharged from the furnace. A magnetic separator can be used to separate the slag and metal nuggets.

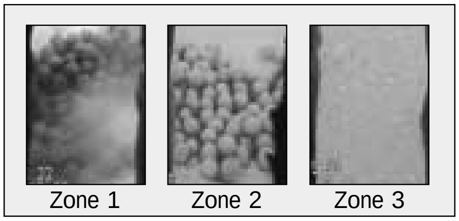


Figure 3 Inside View of the Furnace

Future Business Potential

There are several possibilities for locating an ITmk3 Plant: at a mining site to produce cold iron nuggets, at a port site, or adjacent to an EAF or BOF shop to produce hot iron nuggets for steelmaking.

Cold iron nugget production

In order to increase the value of iron ore, cold iron nugget production at an iron ore mining site or at an export port site promises to be more profitable than production of oxide pellets and/or DRI/HBI. Users of iron nuggets can be both EAF and BOF steelmakers. The ITmk3 product iron nugget is a better feed material than DRI/HBI for EAF operators because of its high carbon content and ease of use. Iron nugget production at a mine site also reduces the transportation cost per unit measure of iron as the gangue material and oxygen contained in the ore is eliminated.

ITmk3 also provides an environmental advantage in that its CO_2 emissions are 20 percent less than traditional ironmaking methods and 30 percent less per ton of iron product shipped.

Hot iron nugget production

If the mini-mill or integrated facility is relatively close to the mine site and transportation charges are reasonable, then the ITmk3 plant can be located in the steel works. The plant could then produce iron nuggets for direct feeding into an EAF or BOF, which increases both the production rate and energy efficiency of the steelmaking process.

Final Research and Development

The ITmk3 process has been developed up to pilot plant scale, which is 0.4 ton/hr. Kobe Steel Ltd. plans to build a 50,000 to 200,000 ton/year semi-commercial scale plant before going to a full-scale commercial facility (i.e., over 500,000 ton/year in one RHF). The plant should have good access to iron oxide (in any form), energy and utilities, which would make brownfield sites especially advantageous. Therefore, Kobe Steel Ltd. would like to build the semi-commercial plant somewhere in North America. It is estimated that plant construction will take approximately 18 months, followed by a 12-month period of R&D operations. It is expected that the final decision will be made in the near future.

Conclusion

- ITmk3 is a new and unique ironmaking technology developed by Kobe Steel, which provides a new business model for iron ore producers.
- It provides a flexible, economical, and environmentally friendly technology for producing a high quality iron product. ITmk3 nuggets can be discharged cold for merchant sale, or hot, for charging to adjacent EAFs or BOFs for high quality steelmaking. ITmk3 plants can be located at mine sites, port facilities or in steelmaking facilities. Considering the importance of sustainable development, ITmk3 presents a great opportunity.
- ITmk3 has been proven through the pilot plant stage, and a semi-commercial scale plant will be started shortly. Tours of the ITmk3 pilot plant, located at Kobe Steel's Kakogawa Works in Japan, are presently being made available to interested iron ore suppliers and steel producers.

Midrex News & Views

OXY+™ Commercial Tests Begin

Midrex began commercial test work on OXY+™ in December of 2000. OXY+ generates a high temperature, high quality reducing gas by partial combustion and reforming of natural gas using oxygen. The use of oxygen as an energy source in the MIDREX® Direct Reduction Process has already proven very beneficial to many MIDREX Plants. Oxygen use significantly increases productivity, and OXY+ provides the ability to use much greater quantities than simple oxygen injection. When combined with the proprietary MIDREX® CO_2 Reformer, OXY+ enhances operational flexibility and productivity.

Initial tests have been successful, and further tests are being planned to optimize its operation. OXY+ can be designed as an addition to existing MIDREX Plants or included with new plants. In the case of new plants, OXY+ will act to lower the specific capital costs and increase the production potential of a specific MIDREX® Shaft Furnace size.

Hadeed Training Seminar Part Two

In late September of last year four plant operators from the Hadeed Midrex® Plant located in Al-Jubail, Saudi Arabia, spent a week at Midrex's corporate offices in Charlotte, NC, for a custom licensee process-training seminar. The success of the first seminar led to a second in January 2001, where six more operators received personal specialized process training addressing some of the latest trends and technology for MIDREX Plant operations. Specialized process-training seminars like these provide MIDREX Plant operators with invaluable instruction and assistance. Topics covered included: new technologies, improved plant operations, methods for improved efficiency, plant safety, trouble shooting and Superdata program training among others.

Hadeed Seminar

Midrex Announces Corporate Promotions

The new year has brought with it new corporate changes within Midrex. Winston Tennies, President of Midrex Enterprises, Inc., is pleased to announce a number of executive staff promotions to better position Midrex for the 21st century. These changes reflect a number of strategic considerations. First, Midrex is globalizing its project execution resources to enhance competitiveness. Concurrently, the company is placing increased emphasis on business development with the goal to identify opportunities in sectors not subject to the same business cycles as the iron and steel industry. Lastly, several people will assume more responsibility for management of the company, thereby helping to ensure a sound succession plan for current senior management.

A few of these organizational changes are as follows:

Frank Griscom has been promoted to Executive Vice President and is responsible for sales, business development, marketing, planning, as well as the new Business Services function. Rob Klawonn assumes the position of Vice President – Sales. Greg Hughes has been promoted to Vice President – Business Development.

Don Lyles assumes the position of Director – Business Services. The Business Services function will be responsible for client and license agreements as well as economic analyses of new business opportunities.

Dan Sanford has been promoted to Vice President – Operations. He will be responsible for the engineering, technical service, project management and estimating, information management and proposal functions.

Steve Montague has been promoted to Manager – Engineering and will assume responsibility for the entire engineering function.

(Complete organizational changes will be posted soon on the new, updated www.midrex.com website).

Bruce Kelley, Dan Sanford, John Lowe, John Kopfle and Jim McClaskey rafting on the Nantahala River in Western North Carolina

A Founder of the MIDREX Process Retires

At the end of 2000, Midrex Enterprises, Inc. wished a fond farewell to Bruce Kelley, Vice President – Technology and Engineering, who was instrumental in the development of the MIDREX® Direct Reduction Process as well as a friend and colleague to many within the direct reduction industry. Kelley spent his entire 37-year career in the Midrex family, beginning as a co-op student with Midland-Ross in Toledo, Ohio. A graduate of the University of Cincinnati with an MS in Chemical Engineering, he rose steadily through the ranks of Midrex as a key facet of the company's research and development and engineering teams. Kelley was instrumental in developing reforming catalysts for the MIDREX Process, and he is recognized worldwide as an authority on the subject.

On May 17, 1969, Kelley pushed the button to begin reforming operations at the first MIDREX® Direct Reduction Plant at Oregon Steel Mills. [Editor's Note: Kelley was the first to convince Midrex executives to go whitewater rafting during the annual company planning retreat; however, he didn't quite convince them that the water wasn't cold.]

MEI wishes him the best in his retirement. His professionalism and integrity are an inspiration.

Problem Solving 2001: Midrex Solutions™ Brings Resources to Capital and Maintenance Projects

In the last quarter of 2000, Midrex surveyed MIDREX® Direct Reduction Plant licensees about creating a dedicated group focused on value-added project execution assistance. The responses were quick and positive, leading to the establishment of Midrex Solutions™, which officially launched in January 2001. Midrex Solutions concentrates solely on existing plants and their individual commercial needs when executing small capital projects requiring engineering and new equipment designs. Also, Midrex Solutions will aid plants interested in improving performance, reliability, maintenance and enhancing environmental impact.

Currently Midrex Solutions' main focus is on MIDREX Plants and process, but with Midrex's wealth of international experience in project development, engineering, project management, field support and technology transfer, the new group expects to eventually target other steel industry plants and projects.

Drawing upon Midrex Technologies' vast expertise and resources, we are confident that this new group will meet plant needs and requirements.

Midrex Solutions has the ability to support MIDREX Plants with services including:

- Capacity increase studies
- Consulting
- Troubleshooting and problem solving
- Project engineering and coordination
- New equipment designs and supply
- Energy conservation projects
- Process and equipment training
- Field engineering services
- New technology
- Equipment relocations and improvements
- Tender/specification work

For technical issues regarding MIDREX Plant day-to-day operation, Midrex Licensees can continue to expect quality support and attention from Midrex Technical Services and replacement equipment, maintenance and repair parts from P.S.I.

Midrex Solutions is the commercial counterpart to Midrex Technical Services and can provide formal quotations, budgetary estimates and fast-track project executions for a wide array of technical services.

"We understand the equipment installed in each plant and can be a very valuable extension of the plant's staff," said Ross McRoy, Manager of Midrex Solutions. "Our goal is to establish stronger relationships with our plants through the advantages we bring to the market."

For more information regarding Midrex Solutions, please contact Ross McRoy, direct line: (704) 378-3318; telefax (704)-373-1611 or e-mail: solutions@midrex.com.

FASTMET® and FASTMELT® Sales Group Adds New Faces

At the end of 2000, Jim McClelland was appointed Manager – Technical Sales FASTMET® and FASTMELT® with the primary function of providing FASTMET technical sales support. McClelland will retain his duties as Product Manager for FASTMET and will interface with Engineering and Projects as well. Nick Kobayashi has also been assigned to Midrex's corporate offices in Charlotte and together McClelland and Kobayashi will tackle the North American market in an effort to commercialize FASTMET for Midrex with additional successful projects.

The FASTMET® and FASTMELT® Processes developed by Midrex and Kobe Steel, Ltd., convert iron oxide pellet feed, oxide fines and/or steel mill wastes into metallic iron using pulverized coal or other carbon-bearing material as a reductant. The product, direct reduced iron, can be hot briquetted, discharged as hot DRI into transfer containers, or cooled. FASTMET™ DRI is suitable for use in blast furnaces or electric arc furnaces. Alternately, FASTMET DRI can be melted using the FASTMELT Process to produce blast furnace grade hot metal for use in EAFs or oxygen converters, or cast into pigs. By using low-cost iron ore fines and iron-bearing waste materials, the FASTMET and FASTMELT Processes offer a flexible, economical, environmentally friendly approach to ironmaking for the 21st Century.

DIRECT FROM MIDREX

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