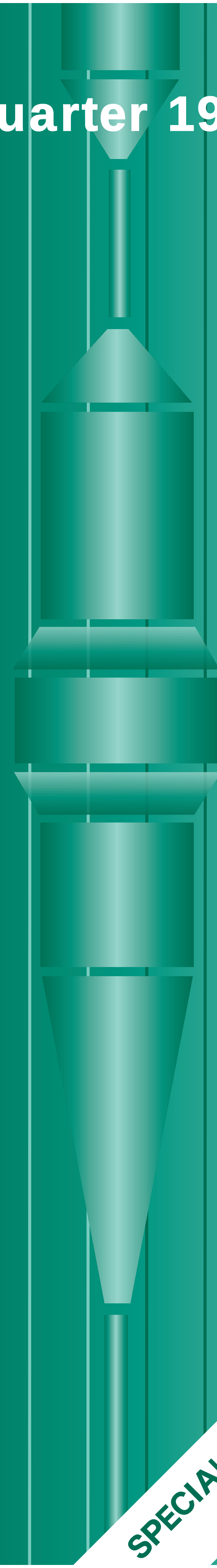
DIRECT FROM MIDREX

4th Quarter 1998



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New Ironmaking Opportunity for Minimills and Integrated Steel Mills

FASTMELT™! —
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SPECIAL FASTMET® ISSUE

DIRECT FROM MIDREX

4th Quarter 1998

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DIRECT FROM MIDREX is published quarterly by Midrex Direct Reduction Corporation, 201 South College Street, Suite 2100, Charlotte, North Carolina 28244 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.

All tons referred to are metric tons (t) or million metric tons (Mt)

Commentary

The Fines They Are A-Changing

Rob Klawonn
Director - Sales & Licensing

In the past year there has been a lot of talk about fines reduction and recycling of steel mill waste materials, and with good reason. Iron ore fines are an inexpensive raw material source, and are typically found in abundance around steel mills. Integrated mills and minimills are facing difficult decisions on how to handle this material. Waste materials such as mill scale, blast furnace flue dust, and filter cake pose similar problems to the steelmaker. Finding a beneficial use of these materials would give a steelmaker a substantial advantage over the competition.

Over the past seven years Midrex and Kobe Steel have been working to give the steelmaker this advantage. By devoting this special issue of *Direct From Midrex* to the FASTMET® and FASTMELT™ Processes, Midrex would like to focus on the progress that has been made by our technical teams. With over seven years of research and development, FASTMET is hardly a new process. Intensive research by Midrex and Kobe Steel has proven the viability of the technology and has brought us to the point of commercialization. This development work has included several phases. First was bench scale testing to characterize iron ore and coals. Since 1992 Midrex has operated a 150 kg/h FASTMET Process Simulator at the Midrex Technical Center near Charlotte, North Carolina. Earlier this year a melter specially designed by EMCI was added to the FASTMET Simulator for testing of the FASTMELT Process. In 1995, Kobe Steel and Midrex began operation of a 2.5 t/h semi-commercial scale demonstration plant at Kobe Steel's Kakogawa Works in Japan. The results from this plant have been very promising. For over two years the FASTMET Demonstration Plant has been running on a 24-hour-per-day schedule, as a full-scale commercial plant would operate. Over 1,000 hours (42 days) of continuous operation was achieved before a maintenance shutdown was performed.

In the past year Midrex and Kobe Steel have been working closely with EMCI International and National Recovery Systems (NRS) on briquetting steel mill wastes and iron ore fines and converting them into liquid FASTIRON™ using the FASTMELT Process. The results have been very encouraging. A test campaign was recently run at the Midrex Technical Center, employing briquetting technology from NRS, the FASTMET Process Simulator, and the EMCI melter. Steel mill wastes were combined with iron ore fines and pulverized coal and briquetted, then fed to the rotary hearth furnace. The hot reduced product was then gravity fed to the EMCI melter and liquid FASTIRON was produced. The resulting product was liquid iron equivalent to blast furnace hot metal with carbon levels of 4.5%, silicon levels of 0.5% and sulfur less than 0.02%.

Currently, we are in discussions with several steelmakers around the world who are interested in FASTMET and FASTMELT. We look forward to providing the world with another successful technology, which meets the steelmaking need to use fines and wastes as feed materials. With FASTMET and FASTMELT, the fines they are a-changing.

MISSION STATEMENT

Midrex Direct Reduction Corporation 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.

FASTMET®

NEW IRONMAKING OPPORTUNITY FOR MINIMILLS AND INTEGRATED STEEL MILLS

By: *Yasuo Kuwata*
Manager FASTMET Projects
Iron Unit Business Plant
& Engineering Group

Even with the onset of the Asian crisis, high quality steel capacity continues to grow. The final product of many of the projects under construction is flat products.

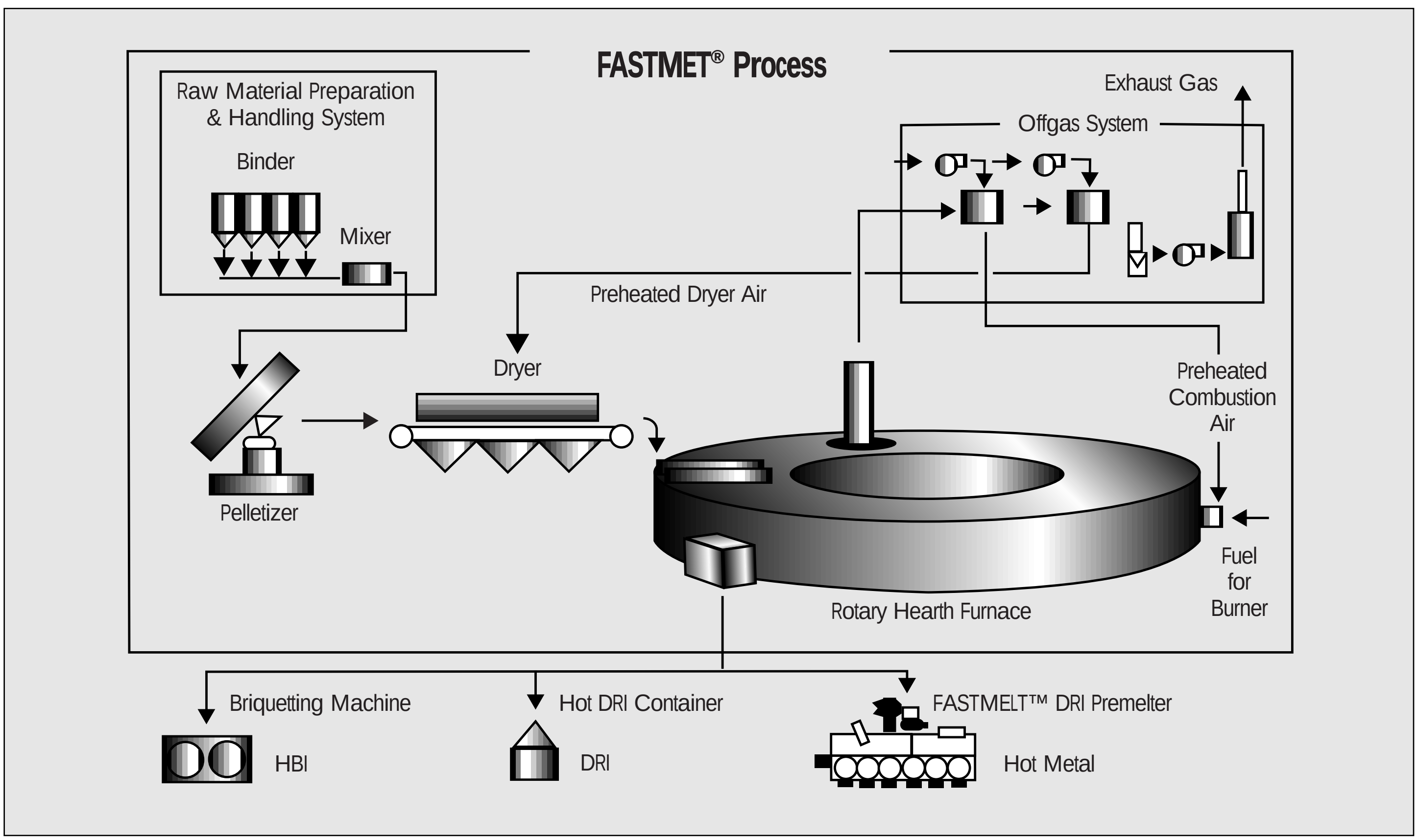
The blast furnace will continue to be the dominant steelmaking route until the first decade of the 21st century. However, as demand has been increasing and diversifying, the steel industry has been growing closer to the markets.

The steel industry is starting to spread more towards the regional mills serving a smaller, adjacent market, rather than huge integrated steel complexes which export much of their products overseas. Today, each steelmaker evaluates their raw materials, clean scrap, merchant pig iron, merchant DRI/HBI, and on-site ironmaking facilities on a long-term and short-term basis. As each steelmaker's demand for iron units becomes more diversified and specific, so must the supply of raw materials. The blast furnace route of steelmaking may not have enough flexibility to keep up with this trend.

One solution for diversifying raw materials availability is gas-based direct reduction, such as the MIDREX® Direct Reduction Process. In 1997, DRI production was over 35 Mt and in 1998 there is over 13 Mt of DR capacity under construction. However, the direct reduction route to ironmaking relies heavily on the availability of an inexpensive natural gas source. For those who do not have this good fortune, the FASTMET® Process offers an alternative.

FASTMET and FASTMELT

The FASTMET Process was developed jointly by Kobe Steel and Midrex Direct Reduction Corporation over the past seven years. FASTMET converts iron ore fines, or any iron oxide fines, into metallic iron using pulverized coal or other solid, carbon-bearing materials as the reductant



in place of natural gas. The raw material and the reductant are mixed, pelletized and dried, and then are transferred to a rotary hearth furnace (RHF) for direct reduction. The FASTMELT™ Process is the combination of the FASTMET Process and a specially designed DRI melter which melts continuously fed DRI and produces hot metal (FASTIRON™) with a controlled carbon content.

The Process

Rotary Hearth Furnace: The pellets are transferred directly to the rotary hearth in a single layer on the solid hearth. Burners and post combustion of evolved carbon monoxide provide the heat required to raise the pellets to the reduction temperature. The burners, located above the hearth, are fired with natural gas, fuel oil, coke oven gas, or pulverized coal. Volatiles are liberated from the reductant as the pellets are heated and are combusted in the furnace.

Reduction: As the rotary hearth furnace rotates, the pellets are heated to 1250 to 1400° C and the iron ore is reduced to metallic iron during one revolution of the hearth. Residence time is typically 6 to 12 minutes.

Offgas Treatment: Offgas from the rotary hearth furnace is first conditioned, then sent to the heat exchangers to preheat the rotary hearth furnace burner combustion air and dryer air. The offgas is treated in a conventional gas cleaning system and exhausted through an ejector stack. A waste heat boiler can be installed in the offgas line to produce steam for heating or power generation.

Product Discharge: FASTMET DRI is continuously discharged from the rotary hearth furnace at approximately 1000° C. It can be loaded into refractory-lined transfer containers for transport and hot charging in an adjacent meltshop. A hot briquetting system can be directly connected to the rotary hearth furnace to produce FASTMET HBI, for easier storage or for sale on the merchant market.

Raw Materials: The FASTMET Process can use a wide variety of raw materials. Any material which contains iron oxide can be reduced. Physical characteristics are preferred to be the size of pellet feed, which is normally described with minimum 67% under 45 microns. Many tests and demonstration plant operations have established that larger materials can also be handled. If the material to be processed is much larger, such as sinter fines and screened fraction of pellets or lump ore, it can be processed after grinding. Fine materials such as steelmaking dust and sludge have been used at the Kakogawa Demonstration Plant with positive results.

Reductant: A wide variety of reductants are available for use in the FASTMET Process. Coal, coke fines, or any other carbon-bearing material, such as blast furnace dust and sludge, can be used as reductant. Fixed carbon plays a major role by serving as the reductant while volatile content provides additional fuel. If the material is not in the form of fine particles, a pulverizer may be added to handle larger materials.

Product Application: A wide variety of options for product selections are available to meet the specific needs of each steelmaker. FASTMET DRI is used hot to melt in adjacent electric arc furnaces, oxygen steelmaking furnaces or to put into a torpedo car while transporting hot metal from blast furnaces. Cold DRI is used in electric arc furnaces, oxygen steelmaking furnaces, and blast furnaces. FASTMET DRI or HBI can be used as a clean metallic charge material for electric arc furnaces and oxygen steelmaking furnaces. In blast furnaces, FASTMET HBI can be used as a metallic charge or as a coolant to increase production. FASTMELT offers liquid FASTIRON, which is used in an electric arc furnace as a clean metallic charge with numerous advantages such as boosting productivity, consistent, stable and high quality steelmaking, and use of a higher quantity of lower grade scrap. Liquid FASTIRON is also used in oxygen steelmaking just like hot metal produced from a blast furnace.

Cost items	Unit of items	Unit consumption	Approximate cost per t-DRI
Variable items			
Iron ore	Ton	1.2 - 1.35 ton	
Coal	Ton	0.3 - 0.4 ton	
Binder			$3 - 4
Auxiliary fuel	Coal	0.7 Gcal	
Electricity	kWh	100 kWh	
Water	m^3	2 m^3	
Consumables			$1
Fixed items			
Labor	man-hour	0.16 man-hour	
Maintenance			$3
Others			$2

Table I Key process cost parameters for a 500,000 t/y FASTMET DRI Plant

FASTMET Process Features

High productivity and compact furnace: The FASTMET Process is designed to make the most effective reduction reaction in the furnace by maximum use of radiant heat. Reduction time is typically from 6 minutes to 12 minutes. High productivity of 100 kg to 120 kg per square meter per hour is attained by the FASTMET Process. Therefore, the rotary hearth furnace is compact and the space required is minimal.

Uniform and consistent quality: Pellets are placed on the hearth in a single layer. Therefore, each pellet is heated uniformly and has consistent quality and metallization. This allows a wide variety of subsequent use of product.

Adjustable metallization: Easily adjustable metallization between 80% and 93% allows steelmakers to maximize their benefits under specific conditions and locations.

Proven technologies: Nearly three years of successful operation at the Kakogawa Demonstration Plant and seven years of testing at the Midrex Technical Center have proven the success of the process and minimized the risk associated with a new technology. These facilities also provide the opportunity to test raw materials and reductant under real operating conditions.

Flexible operation: With a short reduction time and a small furnace, operational changes can be made quickly and easily. Lost time due to a shutdown is kept to a minimum. If a shutdown is necessary, and the furnace temperature is maintained, production will resume 6 to 12 minutes after the rotary hearth furnace is brought back on-line.

Effective combination of function: Each component of the FASTMET Process is designed to maximize effectiveness in an integrated process. The rotary hearth furnace is the most efficient direct reduction route available today. The dryer removes moisture using heat from the exhaust gas, controlling drying conditions, recycling heat units, and keeping operating costs at a minimum.

Economic Considerations

FASTMET is a flexible ironmaking process. As mentioned above, there are a wide variety of raw materials available for use. Key process parameters vary depending on the chemical characteristics of the raw materials. Major concerns are iron content, form of iron oxide, gangue content in iron-bearing material, and fixed carbon, volatile matter, and moisture content in carbon-bearing material.

Table I shows an example of key process cost parameters for a 500,000 t/y FASTMET DRI Plant. The cost of each item varies by location and operating procedures. Using Table I and plugging in their own costs, each steelmaker should be able to calculate their own production cost. By adding a waste heat boiler, power can be generated from the offgas heat. The generated power can cover most of the electric power required by the plant.

The Opportunity to Become an Environmentally Friendly Steel Mill

Tighter environmental restrictions are a growing concern for steelmakers around the world. Solid wastes contain iron, which is the raw material of the main product of steelmakers, and some wastes contain carbon, which is the main source of reductant.

EAF steelmakers generate EAF dust, continuous caster and steel mill scale, and water treatment sludge. Integrated steelmakers generate blast furnace dust and sludge, basic oxygen furnace dust and sludge, continuous caster and steel mill scale, and water treatment sludge. These iron-bearing materials can be recycled as an inexpensive raw material for ironmaking via the FASTMET Process. Carbon-bearing wastes, such as blast furnace dust and sludge, can also be recycled as an inexpensive reductant. FASTMET will process these wastes with or without the addition of iron ore to produce DRI, while simultaneously removing zinc, lead and alkalis which are not preferred in other iron and steelmaking processes. The exhaust gas from FASTMET is treated by a conventional gas cleaning system designed to comply with local and national environmental standards. The removed zinc and other metal will be collected in a zinc-rich oxide dust — a saleable by-product. And the DRI or HBI or FASTIRON produced will be used as a clean iron source at iron and steelmaking plants. All steelmakers who install a FASTMET or FASTMELT Plant for ironmaking can enjoy the benefits of recycling and cleaning waste oxide, adding clean iron units at the lowest cost, and eliminating increasing waste treatment cost.

Kakogawa Demonstration Plant

Conclusion

FASTMET and FASTMELT can provide an opportunity for ironmaking to both minimill and integrated steelmakers. The nearly three years of operations at the Kakogawa Demonstration Plant, and seven years of tests at the Midrex Technical Center, have proven that a quality product, sustained operation, and reasonable operating and design parameters are achievable and reliable. FASTMET and FASTMELT are economical ironmaking alternatives for steel mills.

This article was excerpted from a paper presented at the Asian Steel Summit, August 24-25, 1998

FASTMELT™!

Your Waste to Profit

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You Think You've Got Problems?

Steelmakers today face a number of concerns related to in-plant waste materials:

Disposal of iron-bearing wastes: The cost and liability involved can be significant. Non-hazardous wastes from integrated mills can require \$20/net ton (NT) [\$22/metric ton (t)] or more to send to a landfill. Electric furnace baghouse dust, which is listed as an EPA hazardous waste (KO61), costs \$150/NT (\$165/t) or more to be thermally processed or stabilized.

Closure of on-site landfills: For many years, in some cases decades, integrated steel mills throughout the world have stockpiled wastes on site. Theoretically, since the land is "free," this is a low-cost approach. These on-site landfills are filling up and in some cases coming under increasing scrutiny by environmental authorities.

Recovery of valuable iron units: Integrated mills pay \$40-45/gross ton (GT) (\$39-44/t) for iron oxide pellets. With a typical iron content of 65%, this translates to a metallic iron cost of \$60-70/GT (\$59-69/t). For those wastes produced from scrap or hot metal, the cost of each GT of iron can be as much as \$200/GT (\$197/t). Even if these wastes are stockpiled on site, the mill is literally throwing away money.

Controlling steelmaking raw material costs: To be successful, mills must continually reduce costs, perhaps on the order of one percent per year. One very effective way to do this is to reduce raw material costs by processing waste materials and taking a credit for avoided disposal fees.

Conservation of capital: The availability of investment funds is a concern for all steelmakers. Most companies have restricted the amount spent on the costly hot end of the operation, opting instead to focus investment on the more profitable downstream side. A build-own-operate (BOO) plant owned by a third party allows the steelmaker to conserve precious capital funds and avoid the concerns of operating an ancillary facility.

Environmental problems of coke ovens and sinter plants: Production of sinter and coke is a continuing concern for integrated mills. Stricter EPA regulations on steel mill emissions, especially from coke ovens, are a major problem. Most steel companies would prefer to shut down sinter plants and coke ovens if there is a viable alternative.

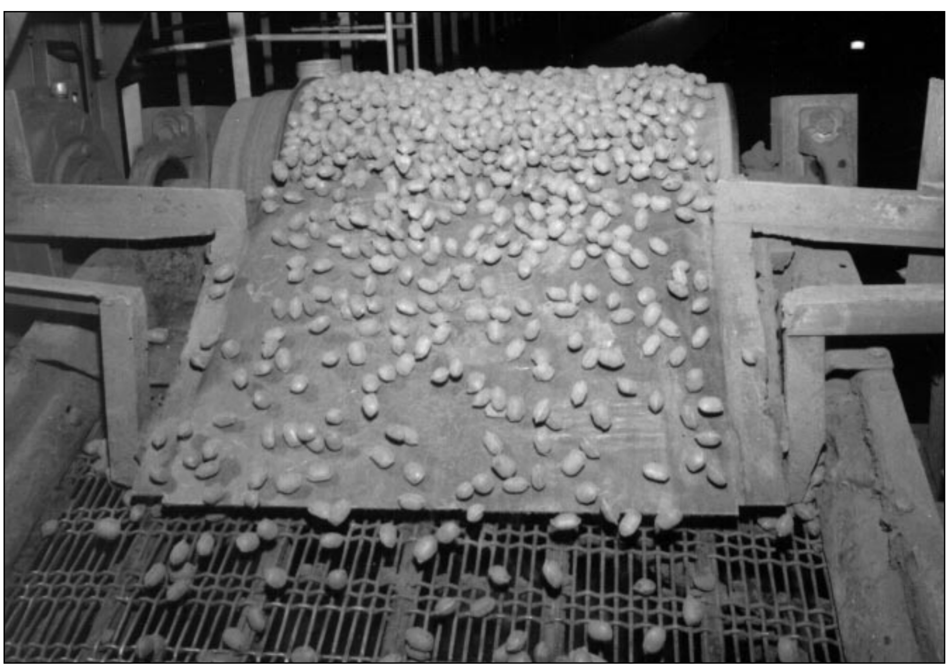


Figure 1 NRS Briquetting Facility

A FAST Solution

The FASTMET® Process, developed by Midrex Direct Reduction Corporation and Kobe Steel, Ltd., can provide a means to address these issues. FASTMET converts steel mill wastes and/or iron ore fines into metallic iron in a rotary hearth furnace using carbon as the reductant. One option is to produce briquettes that can be used in blast furnaces or oxygen converters. Alternately, hot FASTMET DRI can be discharged from the rotary hearth furnace at about 1832˚ F (1000˚ C) and fed to a specially designed electric melter for production of a high quality hot metal known as FASTIRON™. This process is known as FASTMELT™ and is shown in Figure 2.

For FASTMELT waste treatment projects, Midrex and Kobe Steel will team with National Recovery Systems and EMC International, Inc. The capabilities of each company are shown in Table I.

NRS Briquetting System

FASTMET and FASTMELT Plants can be economical in sizes from 150,000 to one million NT per year or more. The FASTMET/FASTMELT Processes for waste treatment use a similar flowsheet as that used for processing 100% virgin iron ore, with two significant differences. First, instead of pelletizing the raw materials, they are briquetted, which provides for more flexibility when using the wide range of chemistries and particle sizes encountered with waste materials. National Recovery Systems operates five waste oxide briquetting facilities at integrated steel mills in the US and Europe, with capacities up to 300,000 NT/y (270,000 t/y). The experience gained in these operations has shown that NRS' binder and briquetting expertise can provide for successful agglomeration of a wide variety of steel mill waste materials.

Zinc Recovery

Second, since steel mill wastes often contain an appreciable amount of zinc and other valuable metals, it is important to

Midrex Direct Reduction Corporation is an international ironmaking technology company, principally known for the MIDREX® Direct Reduction Process, which produced 63.5% of the world's DRI in 1997. Since 1969 Midrex has been the chosen technology for 53 direct reduction facilities. Midrex is also a developer of new ironmaking technologies including the coal-based FASTMET® and FASTMELT™ Processes, and technologies for melting DRI.

Kobe Steel, Ltd. is a diversified industrial corporation. In addition to being one of Japan's leading steelmakers, it is a major domestic supplier of aluminum and copper products, industrial and construction machinery, and plant engineering services. The company also has businesses in high technology areas such as electronics, information systems, factory automation, and robotics. Kobe Steel is a developer of new ironmaking technologies, including the coal-based FASTMET and FASTMELT processes and the IT mk 3™ process.

National Recovery Systems brings 30 years of experience in handling and briquetting various sludges, dusts, metallic fines, and mill scales for raw material replacement feed for both iron and steelmaking. NRS owns and operates four facilities in North America and has one licensee in the U.K. These facilities have a total capacity of 1.5 million tons per year.

EMC International, Inc. supplies electric arc furnaces, ladle furnaces, and other steelmaking facilities to minimills and integrated mills throughout the world. EMCI's principals have hundreds of man-years experience in all phases of the steel industry.

Table I MDRC, KSL, NRS, EMCI Capabilities

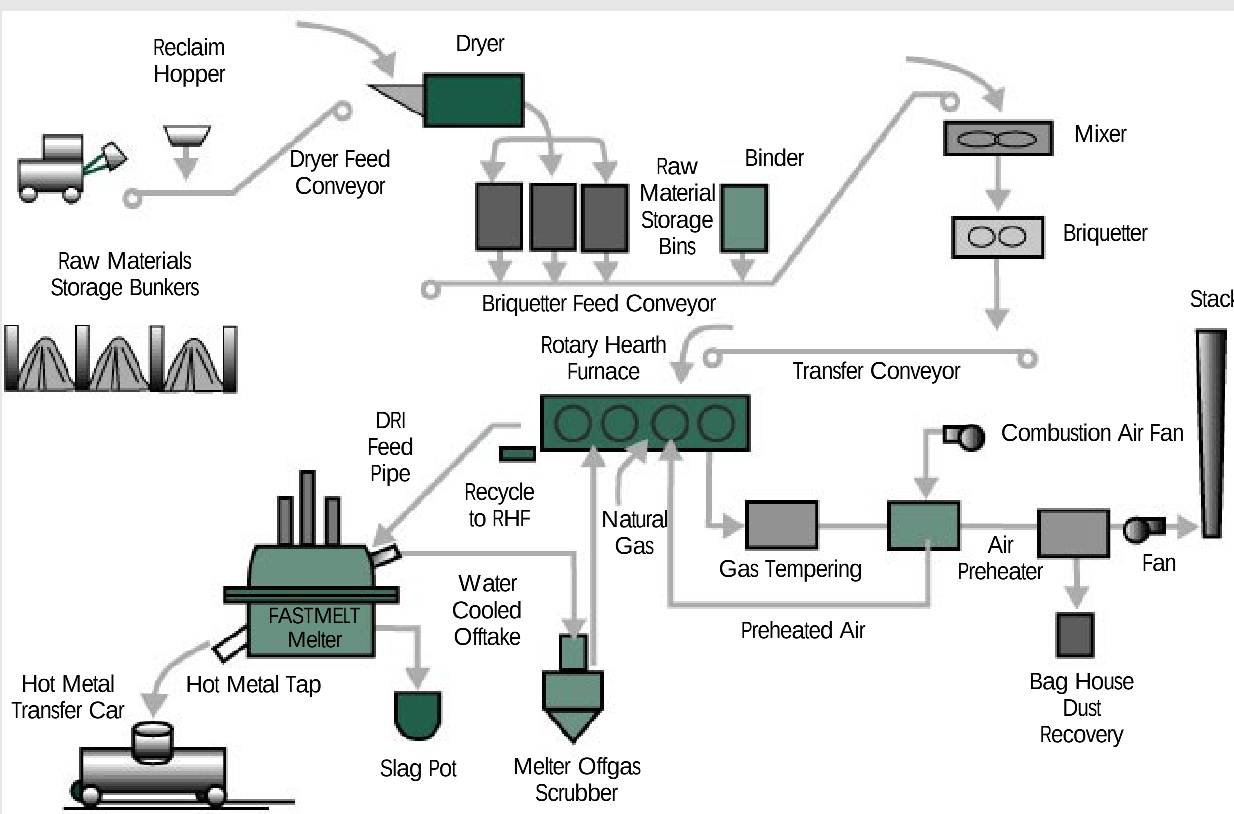


Figure 2 FASTMELT® process flowsheet

C	3.0-5.0%
Si	0.2-0.5%
Mn	0.8-1.2%
S	<0.05%
P	<0.05%
Temperature	2642-2822° F (1450-1550° C)

Table II Typical FASTIRON chemistry using steel mill wastes

provide a means for successful recovery and sale of these by-products.

In the FASTMELT Process, this is accomplished by designing the rotary hearth furnace for minimal iron carryover to the offgas system. The offgas can then be sent through a baghouse and a high zinc content dust (70-90%) produced for sale. One of the key means to achieve minimal iron carryover is use of only one layer of briquettes.

Raw Materials

Steel mill waste materials such as blast furnace dust, blast furnace or BOF filter cake, mill scale, and EAF baghouse dust can be processed. If necessary, virgin iron materials, such as iron oxide pellet fines or purchased iron ore concentrate, can be used to supplement waste feed, thereby increasing plant production and optimizing economy-of-scale.

If blast furnace dust or sludge is used, there may be sufficient carbon in the feed so that additional reductant is not necessary. If not, coke breeze or low volatile bituminous coal can be added.

Product Options

FASTMET waste treatment plants can be designed to produce reduced briquettes for use in blast furnaces to increase hot metal production. Alternately, the briquettes can be charged hot to torpedo ladles or oxygen converters. This product would typically have a metallization level of 85-92% and a carbon content of 2-4%.

In many cases, the best option is FASTMELT for production of hot, liquid FASTIRON. The innovative melting furnace is a specially designed unit, drawing on the significant experience of EMCI. The major functions of the melter are:

- Melting of DRI
- Removal of gangue
- Reduction of residual FeO to Fe
- Desulfurization (if necessary)
- Adjustment of carbon and additive content in the molten iron

The furnace is designed primarily as a melter, not a smelter, since FASTMET produces highly metallized DRI. The FASTIRON product can be tailored to match the desired hot metal chemistry. Figure 2 shows the production of FASTIRON at the Midrex Technical Center. Typical specifications are shown in Table II.

For integrated mills, FASTMELT can provide a cost-effective source of hot metal, allowing them to increase hot metal production or shut down a blast furnace. Another possibility is closing sinter plants or coke ovens. For the adjacent EAF user, liquid FASTIRON can provide an economical source of high purity iron that can increase EAF productivity.

The Bottom Line

Based on engineering studies, Midrex and Kobe Steel have estimated the production cost for FASTMELT at a number of sites in North America. Typical operating parameters for briquetting, production of DRI, and melting are shown in Table III.

The estimated turnkey capital cost for a 500,000 NT/y (450,000 t/y) FASTMELT Plant in the US Midwest is $155 million. This cost is dependent on the infrastructure and other project specific requirements.

Using 100% steel mill wastes, the FASTIRON selling price is approximately

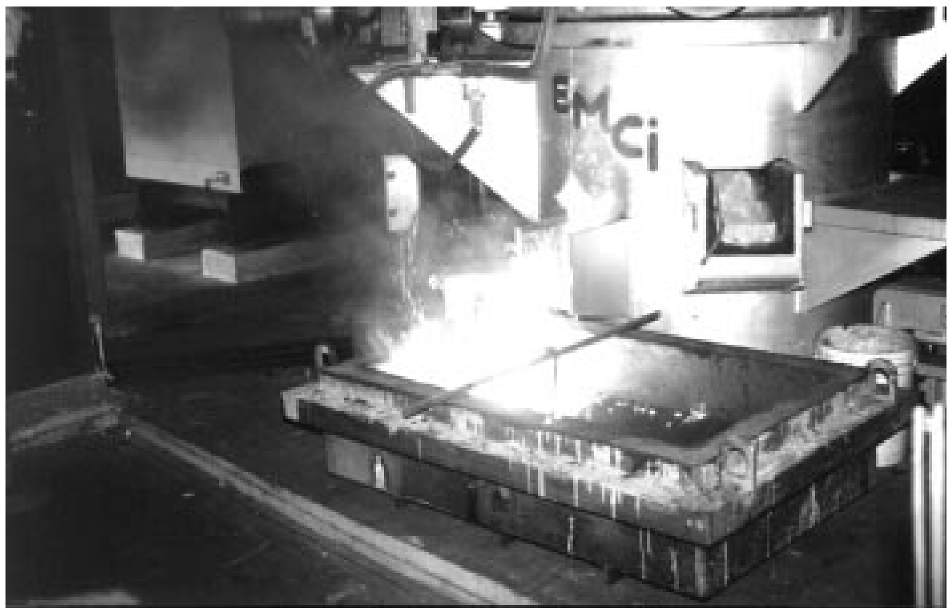


Figure 3 Production of FASTIRON at Midrex Technical Center

Per NT DRI (Per t DRI)	
Mill wastes or iron oxide fines	1.2-1.5 NT (1.2-1.5t) [dry basis]
Coal or coke	0-0.2 NT (0-0.2 t) [dry basis]
Binder	100 lbs. (50 kg)
Natural gas	2.9-3.6 net MM Btu (0.8-1.0 net Gcal)
Electricity	90-108 kWh (100-120 kWh)
Water	475-600 gal. (2-2.5 m3)
Per NT FASTIRON (Per t FASTIRON)	
FASTMET DRI	1.3-1.5 NT (1.3-1.5 t)
Electricity	486-513 kWh (540-570 kWh)
Electrodes	6 lbs. (3 kg)
Lime	0-80 lbs. (0-40 kg)
Refractories	$1.35 ($1.50)
Labor	0.45 man-hour (0.5 man-hour)
Maintenance	$4.50 ($5.00)

Table III Estimated FASTMELT operating parameters

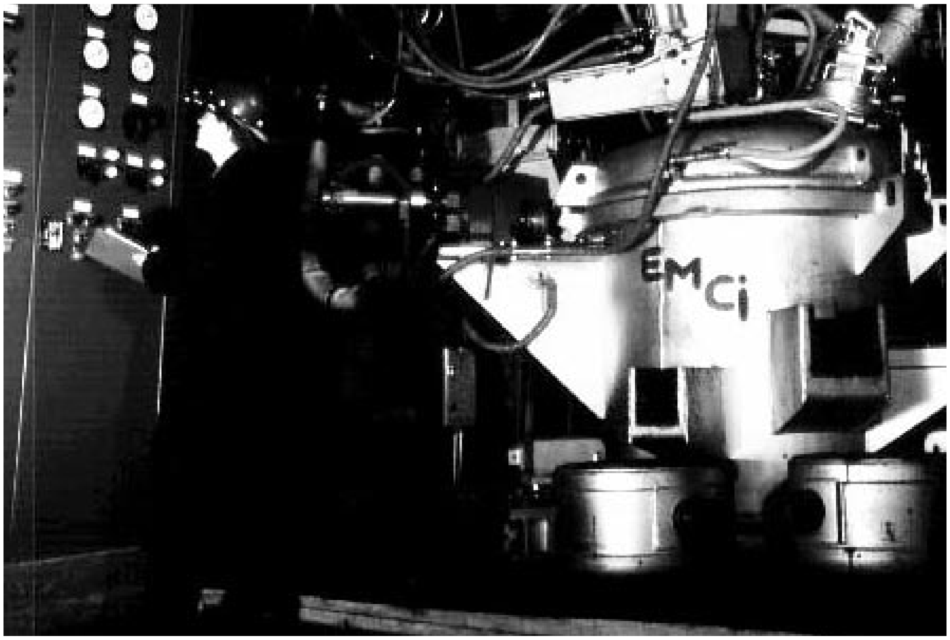


Figure 3 FASTMET Process Simulator and Melter

$135/NT ($150/t). This cost promises to be attractive given the uncertainty of high quality scrap prices, the total cost of producing liquid iron in a blast furnace, and the cost of treating or disposing of waste material.

Project Structures

FASTMELT Technology can be applied two ways: 1) a user can purchase a technology package from Midrex and Kobe Steel (including engineering, equipment, and services) and own and operate the plant; or 2) Midrex/Kobe Steel/NRS can supply liquid FASTIRON "over the fence" on a build-own-operate (BOO) basis.

For a BOO project, Midrex, Kobe Steel, and possibly other partners would own and operate the plant. This can provide benefits by conserving scarce capital funds and providing freedom from operating concerns.

Environmental Benefits

Many integrated steelmakers in North America, Europe, and Asia who have been stockpiling wastes on-site for many years are finding that option is no longer available. Sending these wastes off-site for disposal can entail logistical difficulties and considerable cost, on the order of $20-40 per NT ($22-44/t). Disposal of EAF dust is also becoming an issue. The dust is classified as hazardous (KO61) by the US Environmental Protection Agency and thermal processing or vitrification can cost as much as $150/NT ($165/t).

In many cases, there is also a need to recover the wastes that are stored on-site, sometimes as much as one million NT. FASTMET and FASTMELT can provide an excellent means to deal with this problem by processing the waste, thus greatly reducing the volume to be disposed of and producing a cost-effective iron product.

Steelmakers face continuing problems in operating, permitting, and repairing coke ovens and sinter plants. FASTMELT can enable integrated mills to produce sufficient hot metal while shutting down troublesome facilities.

The FASTMET and FASTMELT processes are environmentally compatible, with slag being the only solid waste generated. There are no process water discharges and air emissions are controlled within EPA limits using best available control technology (BACT).

Do Your Homework

Midrex and Kobe Steel have committed significant resources to research and develop FASTMET and FASTMELT. The process improvements developed from this testing have resulted in the only rotary hearth-based process that has demonstrated the ability to consistently produce highly metallized product at good productivities. Extensive characterization and test work on potential raw materials have been conducted in the United States and Japan. Many tests have been run to date on iron ores, steel mill wastes, and reductants. A 330 lbs/h (150 kg/h) FASTMET Process Simulator (shown in Figure 3) has operated at the Midrex Technical Center near Charlotte, NC, since 1992. This unit is used for testing potential raw materials, confirming operating parameters, and gathering environmental data. An electric melting furnace has now been installed for testing the FASTMELT Process, and test campaigns are being conducted.

Midrex and Kobe Steel have operated a semi-commercial scale demonstration plant at Kobe Steel's Kakogawa Steel Works in Japan since December 1995, which was built to assist in development of the FASTMET Process.

Following are some of the plant's major achievements:

- Stable operation with high metallization product
- Optimization of pelletizing process
- High productivity
- High plant availability:
  24 hours continuous operation for up to 42 consecutive days
- Minimized raw material consumptions
- Use of various raw materials (including steel mill wastes)
- Briquetting tests
- Product melting tests

Conclusion

For treating steel mill wastes, FASTMET and FASTMELT provide the following benefits:

- Recycling of iron-bearing wastes
- Elimination of need for disposing of wastes on-site
- Recovery of valuable iron units for steel production
- Recovery of zinc for sale
- Economical source of hot metal to supplement blast furnace production or EAF steelmaking
- Conservation of capital via BOO project
- Possible reduction of coke consumption
- Possible closure of sinter plants and coke ovens

MDRC, Kobe Steel, and NRS are now actively promoting the FASTMET and FASTMELT Processes. A number of budgetary and firm offers have been made to potential clients in North America, Asia, and Europe. The goal is to secure a contract for the first commercial plant in 1999.

Midrex, National Recovery Systems to Develop Waste-to-Hot Metal Project

Blast furnace quality hot metal produced in test campaign

Midrex Direct Reduction Corporation (Midrex) and National Recovery Systems (NRS) have announced plans to jointly promote and develop a project in North America to convert steel mill waste materials into high quality liquid iron. Midrex will supply the plant based on its FASTMELT Process and proprietary oxide briquetting technology supplied by NRS. The plant will be located on the client's property and operated by NRS, who currently operates four waste oxide briquetting facilities in the US and has a licensee in the United Kingdom.

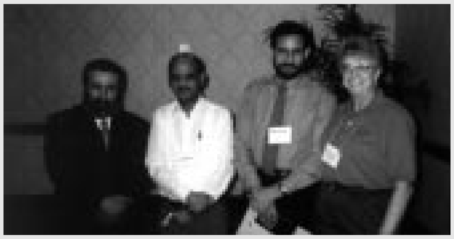
Liquid iron, equivalent to blast furnace quality hot metal, was produced during a test campaign from October 12-14, 1998, at the Midrex Technical Center. Mill scale, blast furnace flue dust, and filter cake were briquetted with oxide fines and fed to the FASTMET™ Rotary Hearth Furnace, where the briquettes were metallized to levels of 85-95 percent. The metallized briquettes were hot charged to a specially designed melting furnace, supplied by EMC International, which produced FASTIRON™, a high quality hot metal. Carbon levels of 4.5 percent were achieved with 0.5 percent silicon and less than 0.02 percent sulfur.

NRS will use its 30 years of experience in handling and briquetting various waste materials to custom design the agglomeration system for the FASTMELT Plant. NRS will combine iron-bearing waste (streams and a solid) carbon source using its proprietary binder briquettes by a gravity-fed roll press. FASTMELT Plants can be supplied through a technology package from Midrex or Kobe Steel to the client, in which case the client owns and operates the facility, or on a build-own-operate (BOO) basis, in which Midrex and Kobe Steel will be involved in the ownership and operation of the facility and the sale of hot metal to the client. The BOO concept can provide considerable benefits for a client by conserving valuable capital funds and providing a cost-effective answer to operational (hot metal shortage) and environmental (waste disposal) concerns.

Discussions about possible FASTMELT Process projects are ongoing with several North American integrated steel mills.

1998 Midrex Operations Seminar

The 1998 Midrex Operations Seminar was held in New Orleans, Louisiana, from November 1-6, 1998. The focus of this year's seminar was Reducing Plant Operating Costs. Participants from 14 MIDREX™ Plants from around the world were involved in workshops and presentations prepared by Midrex staff and other MIDREX Plant operators. The seminar also included tours of American Iron Reduction's MIDREX™ Megamod and Tuscaloosa Steel's Mobil DRI facility, both of which began operations earlier this year.



1998 Midrex Operations Seminar

Four New Directors Appointed to Midrex Senior Management

We are pleased to announce the creation of three new director positions. In the expansion of the number of directors from one to four, we are seeking to add depth and strength to our senior management team.

Rob Klawonn is being promoted to the position of Director-Sales & Licensing, reporting to Frank Griscom. Rob joined Midrex in February 1996, as Manager-Sales. He holds a Bachelor of Science in Mechanical Engineering from Bucknell University and a Master of Business Administration from Robert Morris College.

Dan Sanford is being promoted to the position of Director-Engineering, reporting to Bruce Kelley. He joined Midrex in September 1988, and received his Bachelor of Engineering, Science and Mechanics from Georgia Tech.

Greg Hughes is being promoted to the position of Director-Technology, also reporting to Bruce Kelley. He joined the company in May 1986, with a Bachelor of Science in Chemical Engineering from Virginia Tech.

In addition, we are pleased to announce the promotion of Don Lyles to the existing position of Director-Projects, reporting to Win Tennies. Don has been with Midrex since April 1976, and holds Bachelor of Science in Chemical Engineering and Master of Business Administration degrees from North Carolina State University and Queens College, respectively.

Correction - Saldanha Steel

In the previous issue of *Direct From Midrex* (3rd Quarter 1998) there was an error in the caption of the photo of Saldanha Steel's Midrex and Corex Modules. The caption should read "Saldanha Steel's COREX C-2000 (left) and MIDREX Module (right)." We apologize for any confusion.

COMSIGUA HBI Plant, Matanzas, Venezuela

COMSIGUA Heralds Start-up

On October 30, 1998, COMSIGUA held its official inauguration ceremony celebrating the successful start-up of its Midrex HBI Plant in Matanzas, Venezuela. Present for the inauguration were Dr. Rafael Caldera, President of the Republic of Venezuela, Eng. Angel Barreto, President of COMSIGUA, Eng. Efrain Carrera, President of CVG, Mr. Winston Tennies, President of Midrex, and Mr. Takuya Negami, Executive Advisor, Kobe Steel. In late October the 1 million ton/y MIDREX MEGAMOD™ passed the Performance Guarantee Test. The first shipment of Hot Briquetted Iron (HBI) was loaded and shipped around October 22, bound for North America. PSI provided procurement services and Trimark was responsible for design engineering. COMSIGUA is the eighth MIDREX HBI Module and brings the total capacity of MIDREX® HBI Plants to 5.28 million t/y.

Midrex and PSI Sponsor Habitat House

In September, Midrex and PSI joined together to sponsor a house for Habitat for Humanity. Over 100 employees from both companies volunteered their time to build a house for someone less fortunate. This house was one of 14 houses built in a single neighborhood during a Habitat for Humanity "Blitz Week." A special thanks goes to Midrex's Ken Joyner, who served as construction manager.

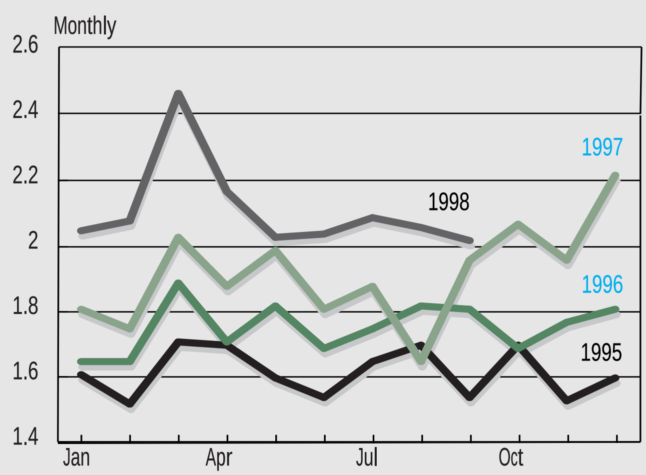
Through volunteer labor and donations of money and materials, Habitat for Humanity builds and rehabilitates simple, decent houses with the help of the homeowner (partner) families. Habitat houses are sold to the partner families at no profit and financed with affordable, no-interest loans. The homeowners' monthly mortgage payments are recycled into a revolving Fund for Humanity that is used to build more houses.

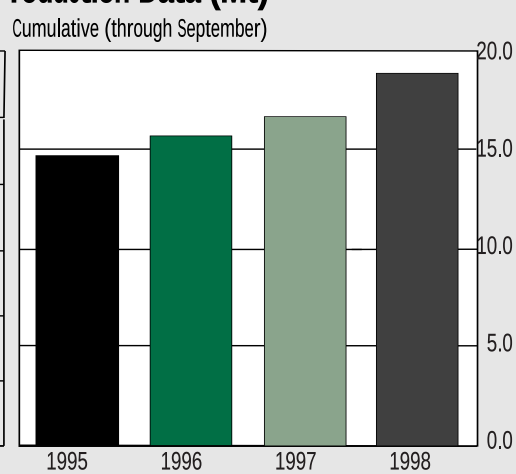
There are more than 250 international affiliates building projects in over 60 countries around the world. To date Habitat for Humanity has built over 70,000 houses and in 1994 was named the 17th largest homebuilder in the US.

For more information on Habitat for Humanity visit their website at www.habitatforhumanity.org.

Midrex and PSI Habitat House, Charlotte, NC, USA

MIDREX™ Plant Production Data (Mt)





Note:
1998 data contains estimates for plants whose data is unavailable at time of publication

DIRECT FROM MIDREX

published by

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