



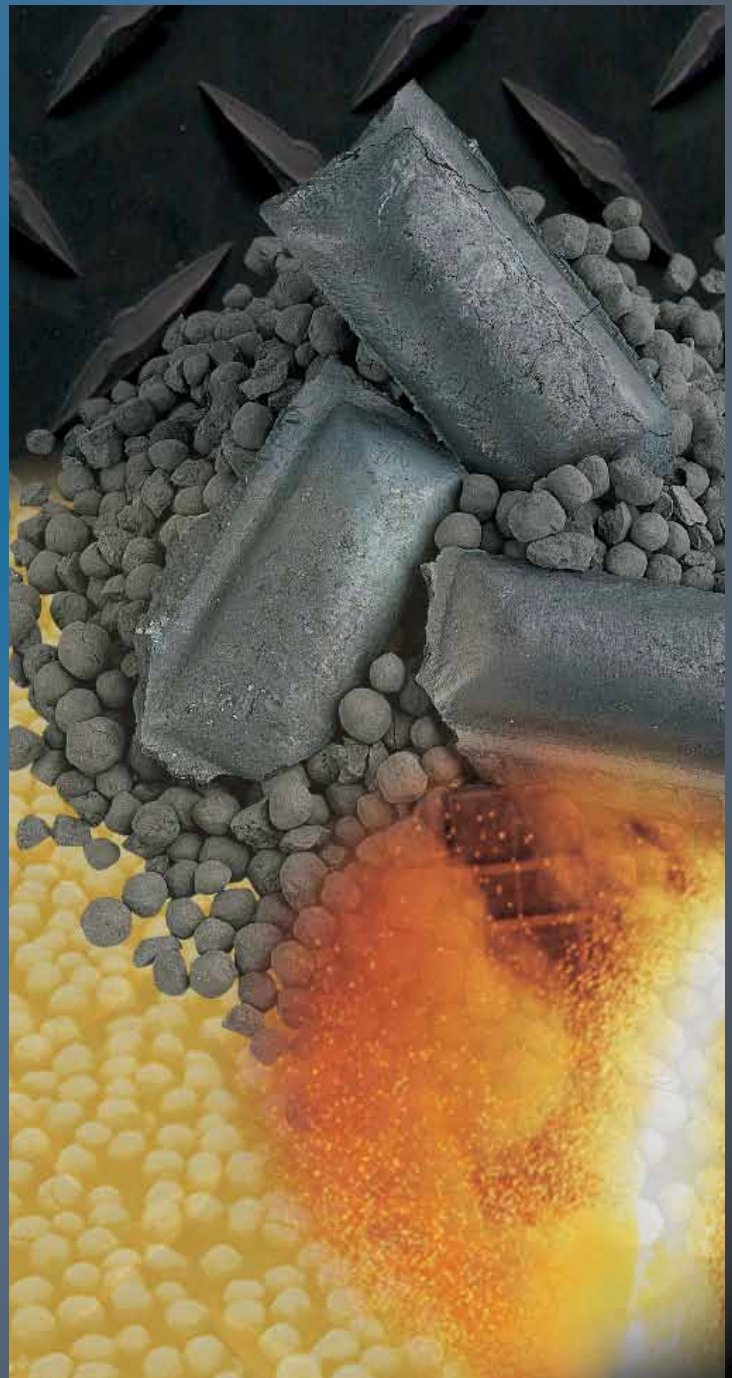
3RD/4TH QUARTER 2009

DIRECT FROM MIDREX

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COMMENTARY

It's Not Easy Being Green

By Christopher Ravenscroft
Marketing Manager



In 1970, a year after the first MIDREX® Plant started up in Portland Oregon, songwriter Joe Raposo penned a timeless tune sung by a children's favorite who crooned simply that "it's not easy being green." How true that sentiment is on many levels, and more still today. Regarding the environment, the difficulty of being green is no excuse for avoiding the issue.

In December world leaders met in Copenhagen for the United Nations Climate Change Conference (COP 15). Their goal was for "a comprehensive, ambitious and fair international climate change deal" to be agreed upon by world leaders in attendance. How much progress they make remains to be seen; however, it is clear that the global movement is here on a grand scale and the steel industry must continue to be proactive by minimizing its environmental impact.

As a natural gas-based ironmaking process, the MIDREX Process has been very "green" since the beginning. Natural gas is a clean and abundant fuel that allows the MIDREX Process to continue to play an important role in today's environmentally focused steel industry, by producing only one third the CO₂ that a traditional blast furnace/coke oven complex produces.

As the focus on CO₂ emissions increases, alternative solutions and better methodology are working their way in to common practice. Midrex was fortunate to have been ahead of the curve, but as a company and ironmaking

process, we continue to find new ways to improve carbon, nitrogen and sulfur emissions both in terms of technology and operational advancements.

One of our key corporate objectives is environmental responsibility through minimizing emissions from plants and offering recycling options. Along with our project partners, we have designed and supplied facilities that are successfully operating under some of the strictest environmental standards in the world.

In this issue of Direct from Midrex we highlight where we've been and where we're going on both emissions and better quality steelmaking. First, is a paper from ArcelorMittal Lázaro Cardenas Flat Carbon (AMLC-FC), which is a world leader in producing most of its steel grades using 100% DRI. Their technique allows the making of steels with low nitrogen content in an electric arc furnace. Our second article examines just one way the steel industry can lower emissions through use of HBI in the blast furnace. And lastly, we are publishing new emissions numbers based on our latest plants' performances and detailed calculations.

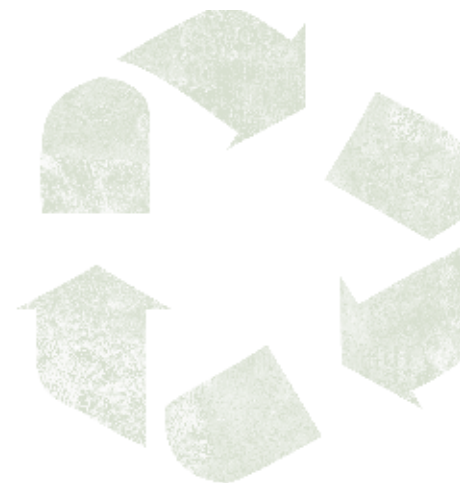
MIDREX® Plants are designed for 100 percent recycling of process gases and water to minimize emissions and maximize energy efficiency and our emission levels are lower than all applicable World Bank standards. Plants can be designed to meet even stricter local regulations.

It's not easy being green, but in our nearly 40 years in the industry we have shown our commitment to it and we continue to be proactive in reducing the environmental impact of our ironmaking processes.

Green is good, and it's the color we like to be.



"As a natural gas-based ironmaking process, the MIDREX Process has been very "green" since the beginning."





THE PRODUCTION OF STEELS APPLYING 100% DRI FOR NITROGEN REMOVAL

The Experience of ArcelorMittal Lázaro Cardenas Flat Carbon

By R. Lule ¹⁾, F.Lopez ²⁾, J. Espinoza ³⁾ R. Torres ⁴⁾ & R.D. Morales ⁵⁾

Editor's Note: This is an abridged paper adapted from the original presentation given at AISTech 2009.

INTRODUCTION

In 1994, the electric steelmaking shop of ArcelorMittal Lázaro Cardenas Flat Carbon began using 100% DRI for some heats. Since then, it has become the normal practice. The main variables of DRI steelmaking, degree of metallization, carbon content, gangue content (especially acid gangue; $\text{SiO}_2 + \text{Al}_2\text{O}_3$) have been studied and evaluated extensively at AMLC-FC through the years. This analysis has allowed AMLC-FC to determine the most cost effective methods throughout the value chain of steel production. Each variable has a special impact in the final cost of the steel produced.

Usage of 100% DRI has been a very important tool for the production of clean steels, with very low tramp elements ($\text{Cu}+\text{Ni}+\text{Cr}+\text{Sn} = 0.05\%$), as well as the production of steel with low nitrogen content (< 25 ppm at meltdown and 40 ppm in final product) for the API X steel grades. Table I shows the nitrogen requirements for some steel grades.

TABLE I *Nitrogen Requirements for Steel Applications*

Application	Nitrogen Requirement (ppm)
Reinforcing Bar	120
Forging Grades	80
Cold Heading Quality	80
Low Carbon Wire	60
SBQ Wire	50
Hot Band (Commercial)	60
Hot Band (High Quality)	40
Deep Drawing for Automotive Parts	20
API X Steel Grades for Sour Gas Application	45

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Nitrogen control of steel grades produced in BOFs and in EAFs has been extensively studied, establishing a better understanding of the metallurgical basis. Table II indicates typical levels of nitrogen content, according to steelmaking method. In recent years, high carbon levels in DRI have been studied as a means of to CO evolution to remove nitrogen from the steel.

Since 2000, several trials were conducted melting DRI with differing %C (2.00- 2.20-2.40- 2.60 and 2.90%). These trials provided evidence that the high carbon in the DRI could decrease the nitrogen content in the steel. As these trials were carried out, the main goal

TABLE II Nitrogen content for several technological routes for steel production.

Process	Nitrogen Content at Steel Tap
EAF (Scrap Processed)	60-100 ppm
BOF	30 ppm
EAF with 100% DRI and 2.40% C	25 ppm
EAF with 100% DRI and 2.70% C	15 ppm

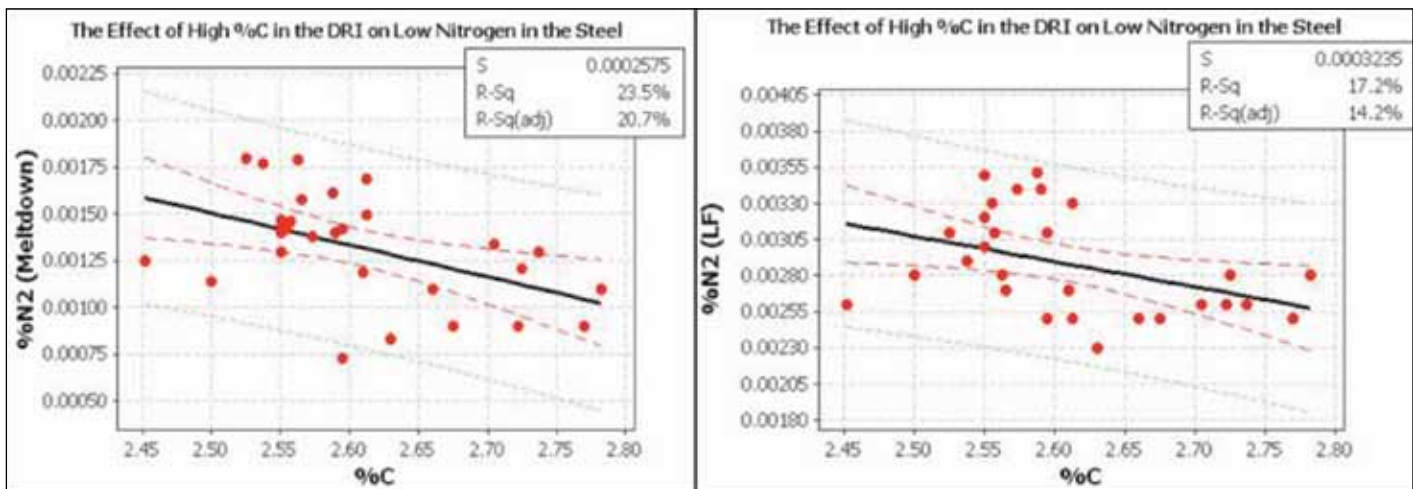


FIGURE 1 Effect of High %C on the Nitrogen content at meltdown and at the Ladle Furnace.

was to increase the %C in the DRI in order to decrease the energy consumption in the EAF. The results obtained were in excellent agreement with the calculated expectations. Besides the benefit of decreasing the energy consumption, another important improvement was observed, namely the fact that the nitrogen content at meltdown was lower as the %C increased in the DRI. At that time, the main idea was to prove that the high %C in the DRI can be important to decrease the energy consumption of the EAF by means of increasing oxygen injection (the oxidation of carbon representing an important energy contribution). However, during these trials, the final nitrogen was very low when DRI with 2.90 %C was applied. The results showed the final nitrogen content at meltdown with this carbon content in the DRI was 7-12 ppm. The next charts show these results.

In previous research, Goldstein and Fruehan established the mechanism for nitrogen removal by applying large proportions of DRI. They established that nitrogen removal was possible due to the CO evolution by the carbon oxidation, and additionally that by applying big proportions of DRI, low nitrogen levels are possible

via dilution. The observations indicate that the CO from DRI is evolved rapidly while the pellet remains buoyant in the slag phase. The rate of CO evolution from DRI at steelmaking temperatures is fast, controlled by heat transfer, and occurs at relatively low temperatures ranging between 800°C to 1200°C.

In the electric steelmaking shop at ArcelorMittal Lázaro Cardenas Flat Carbon, the normal practice is to feed 100% DRI for the production of steels that require low residual elements and low nitrogen content. A hot heel practice is always used. Prior to Power On, 5000 kg of DRI together with 1,000 kg of coke are fed onto the 50-60 ton of the hot heel that remains from the previous heat. Immediately a vigorous foaming slag formation takes place and allows the pre-deoxidation of the metal bath and decreases the %FeO in the slag. This practice is mandatory because 30 seconds after the Power On, the EAF reaches its highest active power (135 MW). The CO formation continues through all the heat because the DRI is fed to the EAF by continuous charging at a rate of 4500-5000 kg/minute. The %C in the DRI is 2.70%, therefore the carbon contribution by the DRI per minute is 135 kg.

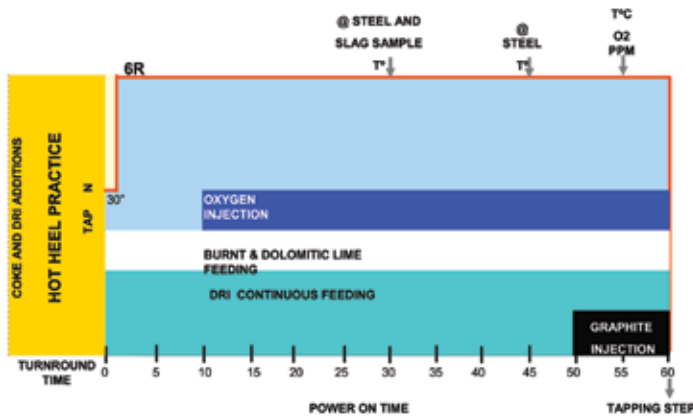
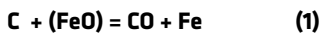


FIGURE 2 Melting pattern used for 100% DRI melting.

With this technology, there are several reactions responsible for the CO formation through the heat. They were explained by R. Morales in a previous document.

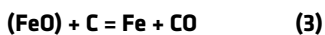
The first reaction takes place at the slag-metal interface during the addition of DRI and coke onto the hot heel in order to carry out the metal bath pre-deoxidation.



When the oxygen injection begins, there is a direct reaction between the gaseous oxygen and the carbon in the metal bath, taking place at the gas-metal interface.



The decarburization of the metallic charge promotes FeO formation. Lowering carbon level in the bath raises oxygen levels and vice versa. The next reaction is generated by the reduction of iron oxide by the carbon in the slag at the carbon-slag interface.



And, there are two reactions which consume CO. The first is reduction of iron oxide at the surface of a CO bubble, shown as Reaction (4). This can be controlled by an intermediate reaction which is shown as Reaction (5). Reactions (4) and (5) occur at the slag-gas and carbon-gas interfaces, respectively.

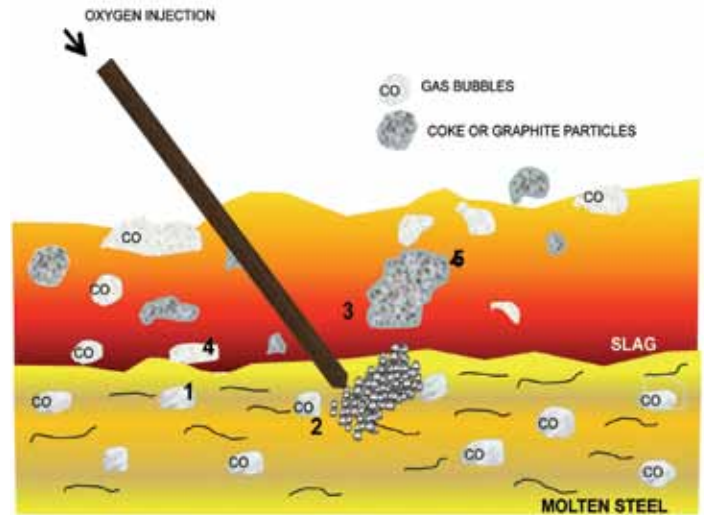
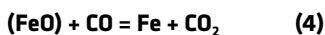


FIGURE 3 Schematic representation of the chemical reactions that take place during slag foaming practice in the EAF. (Numbers in the figure refer to the chemical reactions described in the text.)

All of the reactions promoting CO formation are important. They help avoid nitrogen pick up from the air. By means of continuous slag flushing, the dissolved gases collected in the slag are removed. DRI containing high carbon is the key to maintenance of proper slag foaming by means of CO evolution throughout the heat.

NITROGEN CONTENT IN THE EAF RAW MATERIALS

In steels produced in an EAF, nitrogen comes from two main sources:

- From the scrap (mainly from purchased scraps)
- By air infiltration into the EAF

To assure low nitrogen content of the steel and to avoid sudden changes in nitrogen from the raw materials, all raw material inputs to steelmaking were sampled and analyzed. Results of these analyses are shown in Table III. (following page)

Based upon this analysis, care is taken to minimize addition of any materials that might represent an important nitrogen contribution.





TABLE III *Nitrogen Content in Raw Materials for Steelmaking*

Materials	ppm
Shredded Scrap	100
Internal Scrap	50
DRI	20
Coke	9000
Anthracite	10000
Graphite for Injection	13000
FeSi	320
SiMn	85
FeNb	270
FeMn LC	710
FeMn HC	140
FeMn Electrolytic (flakes)	45
CaF ₂	3060
Fluxes	450

NITROGEN CONTROL DURING EAF STEELMAKING

To assure lowest nitrogen at meltdown, normal melting practice is to use 100% DRI, avoiding usage of purchased scrap. (In the AMLC EAF steelmaking shop only shredded scrap is used.) Also, coke addition at the beginning of the heat is controlled and graphite injection is completely avoided. When DRI with high carbon (>2.5%) is used, the CO formation is sufficient throughout the heat without any need for carbonaceous materials for foaming the slag.

As previously mentioned, a hot heel practice is implemented on 100% of the heats. Vigorous CO formation begins even before Power On of the EAF, minimizing nitrogen absorption of the steel. The CO bubbles adsorb nitrogen as they ascend to the surface, releasing the gases to the atmosphere. This CO formation helps to protect the metal bath from air infiltration, providing a barrier between the steel and the atmosphere.

EAF Closed Door Practice

This practice is very important to avoid nitrogen absorption from the atmosphere. At AMLC the only time the door is opened is after the 'peak' hour. Due to energy restrictions the steel shop works 22 hours per day, Monday-Friday. As stated earlier, never again, for the next 22 hours, is the EAF door opened. After tapping, coke and DRI are added to the hot heel to pre-deoxidize it. Then the DRI addition begins via continuous feed; 250 tons per heat.

Maintenance of the bench of the working door is essential to keep the door closed as much as possible and to retain a sufficient slag volume.

EAF Tapping

Steel grades produced require high manganese (1.6% Mn). Therefore, addition of FeMn is mandatory. Table III shows the nitrogen composition of different FeMn alloys. Addition of 100 kg of Low Carbon FeMn increases steel nitrogen by about 5 ppm. FeMn electrolytic (flakes), normally used because of their low nitrogen content, increase the cost of the steel. High Carbon FeMn has low nitrogen content, but its addition will often over-carburize the steel. Charge mix selection is crucial to minimize nitrogen content and minimize costs.

Vacuum Degassing

100% of steel grades with nitrogen restrictions receive vacuum degassing treatment to achieve the lowest sulfur and to lower nitrogen. API X steel grades require 0.0024% S max and 45 ppm of nitrogen max. 100% DRI helps to tap the heats with low sulfur content (0.014%).

Vacuum Degassing

Special care must be taken during argon bubbling. An excessive flow rate causes an "eye" to form in the metal bath. This will promote nitrogen absorption from the atmosphere. Additionally, CaF₂ consumption must be minimized due to high nitrogen content. The Power On time must also be adjusted to avoid nitrogen dissociation. Addition of fluxes, carbon and manganese are minimized in order to avoid their nitrogen contributions.

Continuous Casting

Special care must be taken with the mechanism of the slide gate (ladle to tundish) to avoid infiltration of air. Argon bubbling for sealing in the long nozzle and SEN must be proper. An excessive argon flow will promote reoxidation of the steel and nitrogen pick up.

RESULTS

Melting 100% DRI with high %C (>2.5%) has allowed the production of steel grades demanding low nitrogen content. At present AMLC produces 1.4 million tons per year of API X grades, about 35% of its total output. In addition to using 100% DRI with



high carbon, raw material selection is very important to assure low nitrogen content.

Figure 4 shows the results obtained regarding Nitrogen versus the carbon content of the DRI.

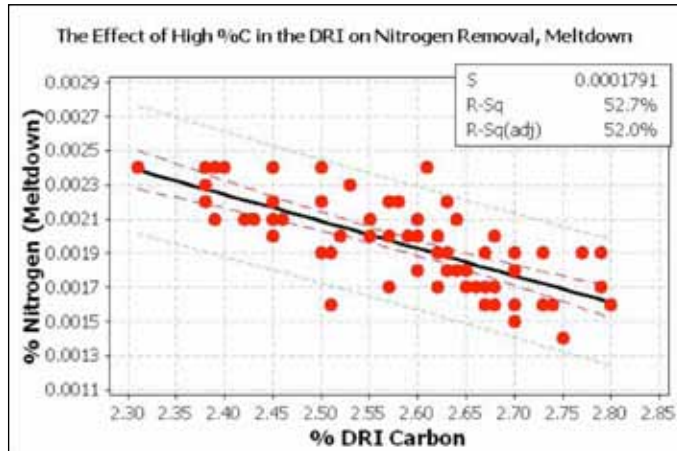


FIGURE 4 The Effect of %C on nitrogen (100% DRI)

API X grades require very low %S (0.0024% max). Usage of 100% DRI and proper selection of raw materials are extremely important, not only to avoid nitrogen content but also to avoid sulfur. All of these steels receive treatment at the vacuum degassing station. The effectiveness of nitrogen removal in the vacuum degasser depends on the sulfur level since sulfur is a surface active element. Once the first stage is concluded successfully, the next stage is to respect the fundamentals described during the vacuum degassing and ladle furnace treatment. Figure 5 shows the sulfur content in the different stages for steelmaking. It is important to see the sulfur removal in each process stage and the final %S in the steel.

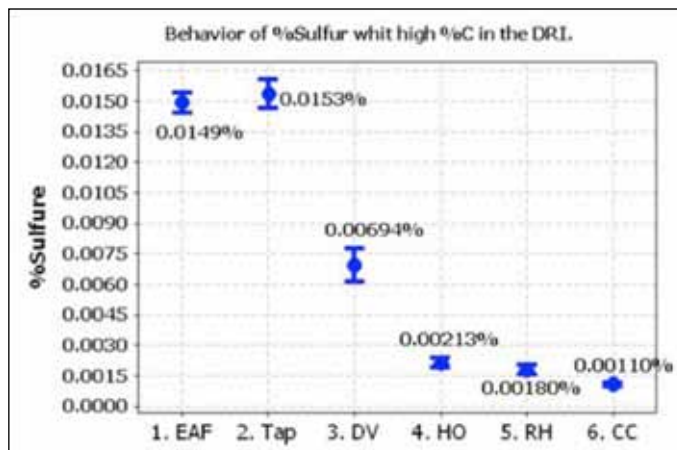


FIGURE 5 Sulfur content in each process stage for steelmaking.

To avoid nitrogen pick up in the ladle furnace, it is important to control the argon flow rate as well as to avoid fluxes (lime and CaF_2) and carbonaceous material additions. Power On time must also be controlled in order to avoid nitrogen dissociation. Figure 6 shows histograms of nitrogen content at EAF meltdown and at the end of the LF process. Figure 7 indicates the %S in the steel relative to the nitrogen obtained.

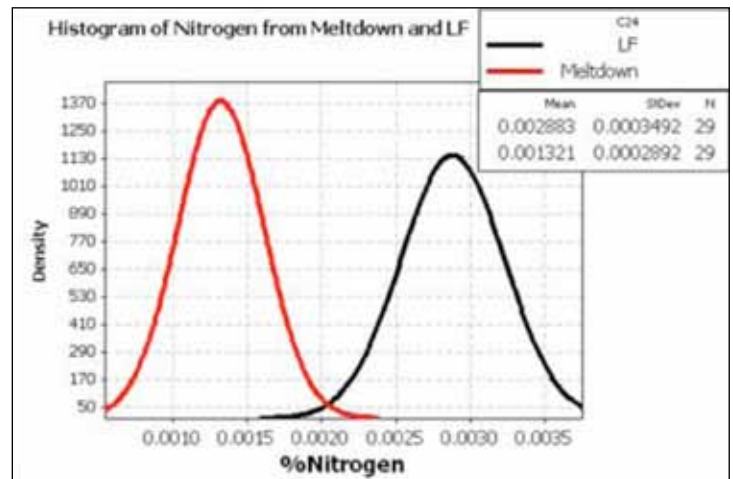


FIGURE 6 Nitrogen content at EAF meltdown and at the end of the Ladle Furnace treatment

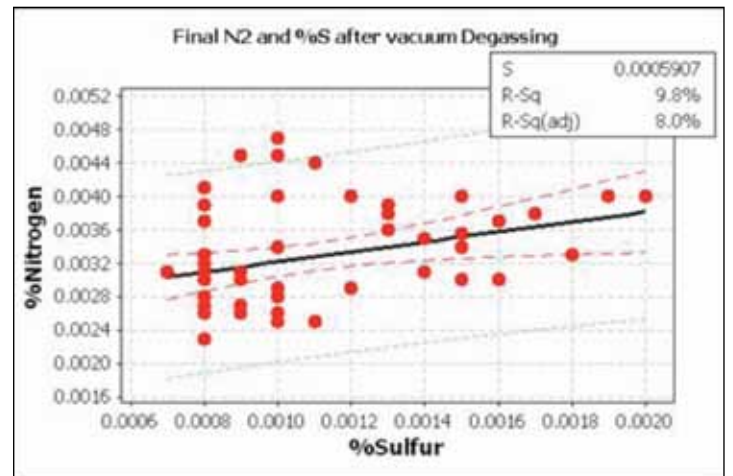


FIGURE 7 Nitrogen and sulfur contents after vacuum degassing treatment using 100% DRI

Nitrogen control for steelmaking is not easy unless the steelmaking shop has the proper equipment installed and the availability of low nitrogen raw materials. These are needed to control nitrogen from the beginning of the EAF process.



Figure 8 shows nitrogen content at each process stage.

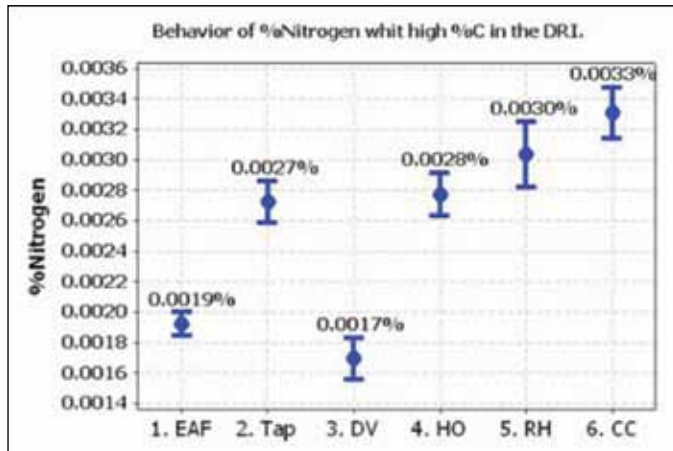
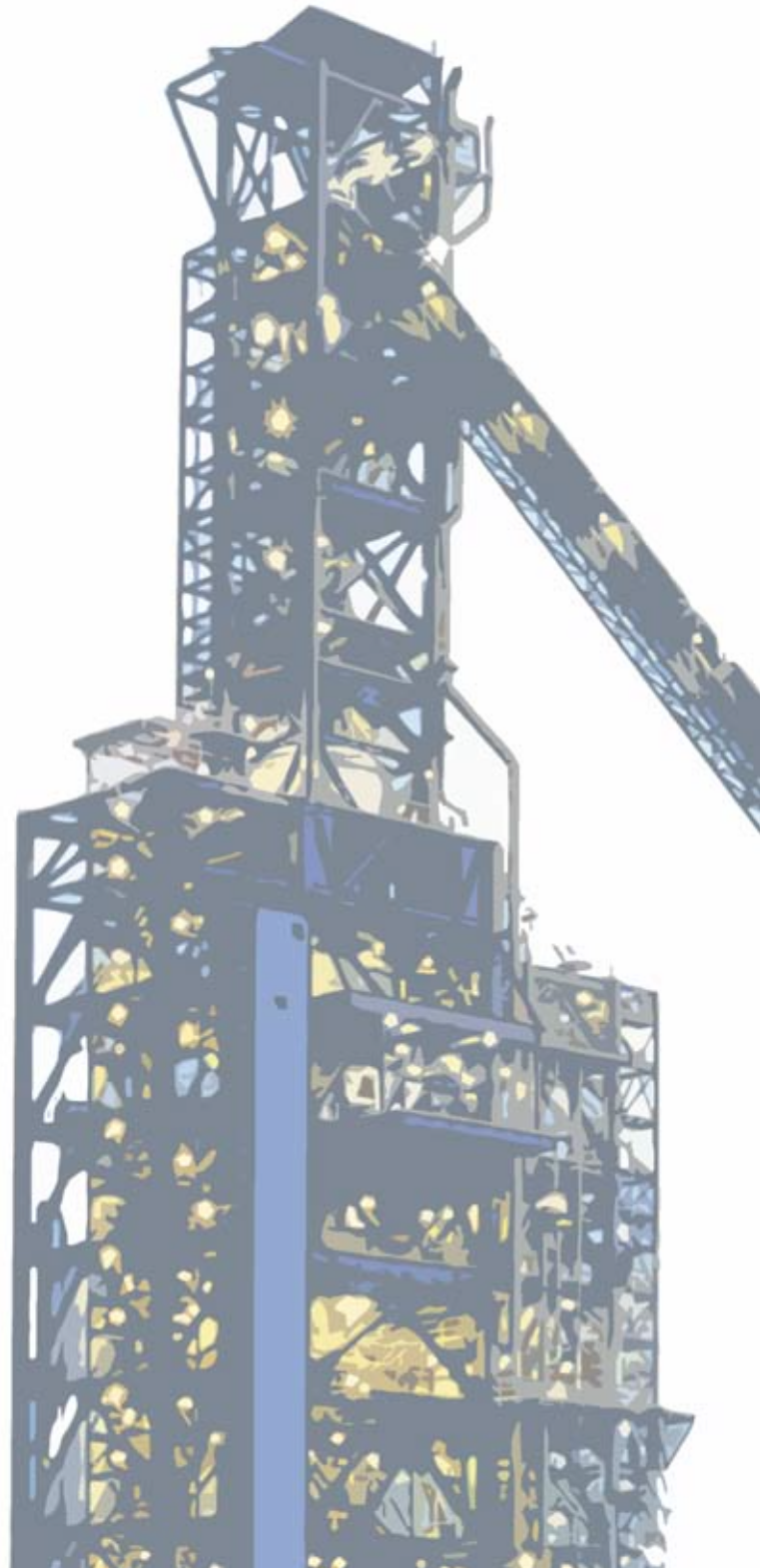


FIGURE 8 Nitrogen behavior in each process stage (100% DRI)

CONCLUSIONS

1. The usage of 100% DRI with high carbon (> 2.50%) is extremely important for the production of the steel grades that specify low nitrogen contents (< 45 ppm). Our experience allows us to produce 1.4 MT per year.
2. CO formation when DRI with high carbon (> 2.50%) is applied, promotes through all the heat vigorous CO formation. This CO formation helps to protect the metal bath from the air infiltration of the atmosphere providing a barrier between the steel and the atmosphere.
3. In 100% of the heats produced the hot heel practice is implemented. The vigorous CO formation takes place even before Power On of the EAF, preventing nitrogen absorption in the steel from this stage onward.
4. Proper selection of raw materials is very important in order to avoid sudden changes in the nitrogen content.
5. 100% of the steel grades with nitrogen restrictions receive VD treatment. Sulfur removal is extremely important in order to increase the efficiency of nitrogen removal in the VD process.
6. In continuous casting, argon bubbling for sealing the long nozzle and SEN must be appropriate. An excessive Air flow will promote the reoxidation of the steel and therefore cause an important nitrogen pick up.





Massive Savings in CO₂ Generation by Use of HBI

By Robert Hunter,
Product Application Manager
Midrex Technologies, Inc.

Carbon emissions are a growing issue on a global scale. Modern society has advanced through industrialization and that has led to better standards of living and prosperity worldwide but also contributed to increased emissions. As greater focus on CO₂ becomes more mainstream, alternative solutions and better methodology are working their way into common practice. The industrial world contributes in a significant way to CO₂ emissions and ironmaking, like agriculture and transportation, is a major culprit, but there is also room for improvement. This paper examines just one way the steel industry can lower carbon emissions through use of HBI.

IRONMAKING

From the dawn of the Iron Age, over 3,000 years ago until the early-1700's, all iron was made using charcoal as the reductant. Then, around 1710, Abraham Darby built the first blast furnace to be fueled by coke. Darby's development was revolutionary and it was one of the founding events of the Industrial Revolution. It was essential to provide the enormous quantity of iron used in modern times. Each of the past two years (2007 and 2008) the world produced approximately one billion tons of iron, an amount that would be unsustainable using charcoal, because there simply aren't enough trees in the world to make the requisite amount of charcoal year after year.

From charcoal to coke to natural gas

Even though it was a major innovation, ironmaking with coke took hold slowly. It did not become the dominant method of ironmaking until the mid-19th century. Today coke-fueled blast furnaces produce well over 90 percent of the world's iron. Natural gas (methane) is responsible for about five percent, coal for about two percent (primarily in rotary kilns) and only about one percent, or less, is made with charcoal. Many of the blast furnaces, especially the newer, larger ones, also employ an additional fuel other than coke (pulverized coal, oil, methane).



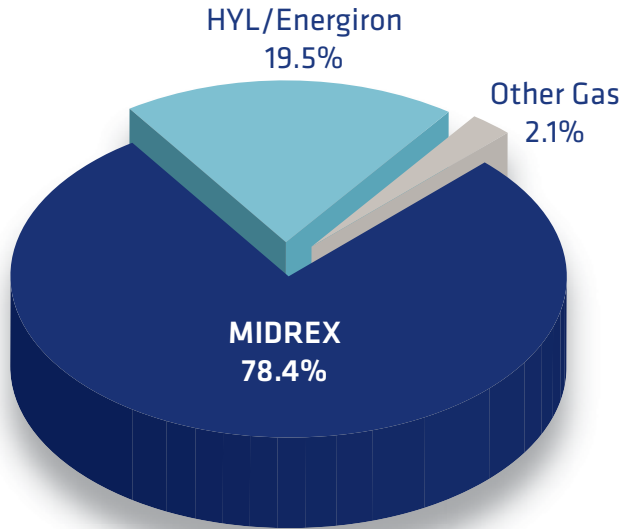
Ironmaking's contribution to the world's CO₂ generation

All of these fuels, except for natural gas, share one important characteristic. They are comprised almost totally of carbon and generate lots of carbon dioxide as a by-product. Including the processing step to make the coke from metallurgical coal, approximately 1.8 tons of CO₂ are produced for every ton of iron that is made. Different sources give figures varying from 1.6 tons of CO₂ to 2.2 ton of CO₂. The differences evolve from how one accounts for other by-products of coke making. For instance, if some of the coke oven gas is used to generate electricity, the CO₂ produced by burning that coke oven gas should not be counted against the iron. On the other hand, any coke oven gas that is burned to heat the coke battery should be accounted as being used in ironmaking.

Regardless of how one calculates it, ironmaking is clearly responsible for a massive amount of CO₂ generation. Using the 1.8 tons of CO₂ per ton of hot metal figure and multiplying by the tonnage of hot metal produced each year gives about 1.8 billion tons of CO₂ per year. Figures for the total contribution of CO₂ for all of mankind also vary, from 31 billion tons per year to 35 billion tons per year. Ironmaking is responsible for five to six percent of the entire production of CO₂ by all of civilization!



2008 World Gas-based Production by Process



Total World Production: 50.9 Mt

	2007	2008
MIDREX	76.3%	78.4%
HYL/Energiron	21.7%	19.5%
Other Gas	2.0%	2.1%

Source: Midrex Technologies, Inc.

The remainder of processing steps in steelmaking generate an additional one to two percent. Note that each one percent represents 310 million tons per year.

Using Natural Gas Direct Reduction

So, let's return to the question of how iron is reduced from the oxide into metal. In 1957 in Monterrey, Mexico, Juan Celada of Hylsamex started up the first commercial ironmaking plant using methane as the reductant. In 1969, Don Beggs of Midland-Ross commissioned the first MIDREX® Direct Reduction Plant for Gilmore Steel in Portland, Oregon. Today the heirs of these technologies make over 50 million tons per year of direct reduced iron using natural gas. In 2008, 40 million tons were made by the MIDREX® Process, almost 10 million tons by the HYL/Energiron Process and an additional one million tons by a plant in Venezuela which operates using the Finmet Process.

What is different about using methane instead of charcoal or coke? *Answer: the environmental effects.* Methane is a far cleaner fuel, especially when CO₂ generation is considered.

To reduce iron with coke or charcoal each atom of oxygen in the iron oxide (iron ore) requires one atom of carbon. In a blast furnace the carbon from the coke or charcoal is first partially oxidized to carbon monoxide (CO) using gaseous oxygen. This oxygen is provided by the blast air (heated air enriched with additional oxygen, then

injected into the blast furnace at the tuyeres). This carbon monoxide diffuses into the highly porous ore and collects an additional oxygen atom from the iron oxide, creating metallic iron (Fe) and forming carbon dioxide. On the other hand, when methane is used, each molecule of CH₄ is first reformed into one carbon monoxide molecule) and two hydrogen molecules (each is H₂). Each of these three molecules will take one oxygen atom from each molecule of CH₄ is first reformed into one carbon monoxide molecule) and two hydrogen molecules (each is H₂). Each of these three molecules will take one oxygen atom from the iron oxide. So the products of the reduction reaction are two water molecules (H₂O) and one carbon dioxide molecule (CO₂). Only one-third as much CO₂ is generated.

Were it possible to produce the entire world's iron with natural gas direct reduction plants, over one billion tons of CO₂ could be avoided per year. While that is not likely, the CO₂ savings through use of DRI are significant. An example is the use of DRI in the blast furnace, as is done by AK Steel of Middletown, Ohio.

RESULTS: EXPERIENCE AT AK STEEL

For nearly two decades, AK Steel has been adding hot briquetted iron (HBI) to the charge mix of their blast furnace. This is quite similar to the practice of adding prepared scrap or other metallic sources of iron (used grinding balls, for instance) to a blast furnace. It greatly enhances the productivity of the furnace while



simultaneously achieving vast savings of fuel (on a 'per ton of hot metal' basis). For each 10 percent of the iron burden (charge to the furnace) that is metallic, the productivity of the furnace increases by 8 percent. And, for each 10 percent metallic, the fuel consumption decreases by 7 percent.

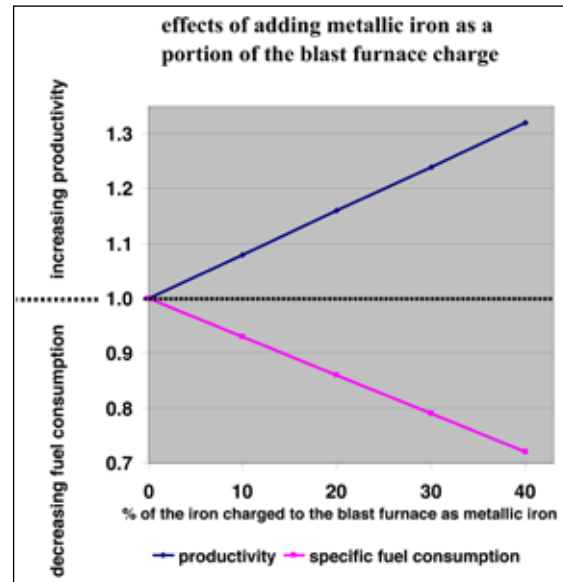
For the past few years, AK Steel has typically charged 30 percent of the burden as metal, primarily HBI from Venezuela, together with some B-scrap. The furnace productivity has averaged over four tons per day per cubic meter of working volume, the best in the world. Similarly, total fuel consumption is remarkably lowered, to about 440 kg per tonne of hot metal.

The extraordinary advantage this gives AK Steel is primarily the increase in productivity. With the blast furnace as the limiting operation of the entire steel works at Middletown (as is typical of many integrated steel works), additional tonnage from the blast furnace means additional tonnage of salable product. When profit margins are good, this has extraordinary leverage at the "bottom line." When profit margins are lower, this still allows the works to maintain a broad customer base.

Also, at AK Steel an additional advantage was available. Prior to raising the productivity of the Middletown blast furnace, AK Steel operated another blast furnace at a nearby site (about 30 miles away) in Hamilton, Ohio to supplement the hot metal output of the Middletown furnace. This was necessary to keep the steel shop running at a good rate. Once the Middletown furnace raised its production rate, the Hamilton furnace could be closed. Thomas Graham, then president of AK Steel, stated at World Steel Dynamics' 1994 Steel Survival Strategies conference that the closure of the Hamilton blast furnace saved AK \$60 million dollars per year in fixed costs. (Those were 1994 dollars; today the equivalent figure would be over \$80 million.)

Usage of HBI in US, Europe, and Japan blast furnaces:

Since AK Steel began using HBI on a regular basis, nearly every integrated works in the United States has also employed it as blast furnace charge. However, the others typically only use it when they need a production boost, or when one blast furnace is down in a works which has multiple furnaces. Some mills in Western Europe have also tested the concept. In each of the cases in North America and in Europe, the focus was on improving production rates. Recently, in Japan, at least two of



the major integrated steelmakers have conducted extensive tests (hundreds of thousands of tons of HBI each) with the focus being CO₂ savings. And, in China, where over half of the world's iron is made, a major feasibility study regarding CO₂ saving by the steel industry targeted blast furnace usage of HBI.

Copenhagen Climate Change Conference

For most of December the United Nations Climate Change Conference, made world headlines. It still remains to be seen to what extent the conference will have on various countries in the next few years; however, one thing is definite: the importance of DRI.

The Stockholm Environmental Institute issued a report for the conference on "Europe's share of the Climate Challenge" that states "Perhaps the most promising route [to reduce CO₂] is to replace Blast Furnace Iron with Direct Reduced Iron." In addition there is very likely decisions to be made which will lead to further monetization of CO₂ emissions. With this in mind, Midrex has thoroughly examined the economics of charging HBI to a blast furnace with CO₂ penalty/bonus as an added factor. Using expected levels of CO₂ pricing from \$20/t up to \$80/t, and the probable extent of HBI usage, varying from 5% up to 30% metallization of the blast furnace burden, the potential CO₂ savings is a very significant factor. But, in none of the cases was CO₂ as important as the already well known factors, productivity increase, fuel savings and capital cost savings.

Nonetheless, the additional saving is such that we strongly recommend any and all integrated facilities to conduct their own economic analyses. Following Copenhagen, the economy of using HBI will have one more positive feature, massive savings of CO₂.



MIDREX News & Views

Jindal Steel & Power Limited Announces New Coal Gasification MIDREX® Plant in India

(CHARLOTTE, NC, USA) Jindal Steel & Power Limited (JSPL) has announced that it will build a 1.8 million ton per year coal gasification-based MIDREX® Direct Reduction Plant in Angul, Orissa, India. The new MIDREX® Module will pair commercially available gasification technology from Lurgi GmbH of Germany, together with a 7.15 meter MIDREX® Shaft Furnace to produce direct reduced iron (DRI) for use in meltshop applications. This will be the first time a Lurgi gasifier will be paired with a MIDREX® Furnace; the new installation will use indigenous coal and iron ore.

The new MIDREX® Plant will have the flexibility to produce both cold and hot DRI (HDRI) for a new greenfield meltshop to be supplied by SMS Siemag AG of Germany and will use a hot transport conveyor similar to that installed at Hadeed Module E in Saudi Arabia. This commercially proven system is supplied by AUMUND Fördertechnik of Germany.

The Angul MIDREX Plant will utilize syngas produced in the gasification plant to produce high quality DRI for melting in an EAF. Coal gasification is the process that converts coal to Synthesis gas by partial oxidation using oxygen and superheated steam as the reactants. The synthesis gas mainly consists of carbon monoxide, hydrogen and methane which will be utilized as a reducing agent for the iron oxide to produce DRI in the MIDREX Shaft Furnace.

The world's first application of coal gasification to produce DRI in a MIDREX Plant started up in 1999 at ArcelorMittal Steel South Africa (formerly Saldanha Steel). This facility includes a COREX® Plant, supplied by Siemens VAI, which uses a melter/gasifier to simultaneously produce pig iron and a by-product synthesis gas that feeds a MIDREX MEGAMOD® Shaft Furnace.

The Coal Gas MIDREX® Direct Reduction Plant is an economic and environmentally sound solution for the iron and steel industry in areas of the world where natural gas as a fuel is not a viable option.



Midrex and Jindal have signed an agreement for a new 1.8 million ton per year coal gasification-based MIDREX® Direct Reduction Plant in Angul, Orissa, India. Pictured are (left) Mr. Naveen Jindal, Executive Vice Chairman and Managing Director of Jindal Steel and Power Ltd (JSPL), with (right) James D. McClaskey, President & CEO of Midrex Technologies, Inc. on Saturday, December 12, 2009 at the signing ceremony.

A coal gasification plant can use a wide range of low cost fuels, such as bituminous and sub-bituminous coal, lignite, pet coke, and petroleum refinery bottoms to generate a synthesis gas. This syngas can be an acceptable reducing gas source for producing DRI in a MIDREX Plant.

JINDAL STEEL & POWER LIMITED

<http://www.jindalsteelpower.com>

With an annual turnover of over US \$2.00 billion (Rs. 10,000 crore), Jindal Steel & Power Limited (JSPL) forms a part of the US \$12 billion (over Rs. 60,000 crore) Jindal Group. JSPL is a leading player in steel, power, mining, oil & gas and infrastructure.

JSPL has consistently tapped new opportunities by increasing production capacity, diversifying investments, and leveraging its core capabilities to venture into new businesses. JSPL's investment commitments in steel, power, oil & gas and mining have touched more than US \$30 billion (Rs. 1,50,000 crore). The company, today, is the largest private sector investor in the state of Chhattisgarh with a total investment commitment of over US\$6.25 billion (Rs. 31,250 crore).



MIDREX News & Views

Midrex Opens UK Office



Midrex is proud to announce its first European Office, Midrex UK, Ltd. Located in the heart of London, England at 2 London Bridge, Midrex UK marks a strategic move for the company to position Midrex Technologies, Inc. for the future by increasing projects coordination throughout the world.



With much of Midrex's present and future direct reduction business in the Middle East and Eastern Europe/CIS, this office provides an exceptional location for holding meetings with potential clients, suppliers, and others. In addition, it will prove useful in the future for coordinating and managing projects.

A further benefit is that given London's preeminence in global financing, there is ready access to a wealth of commercial and investment banks, financial consultants, and other financial expertise.

Christopher M. Ravenscroft: Editor

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