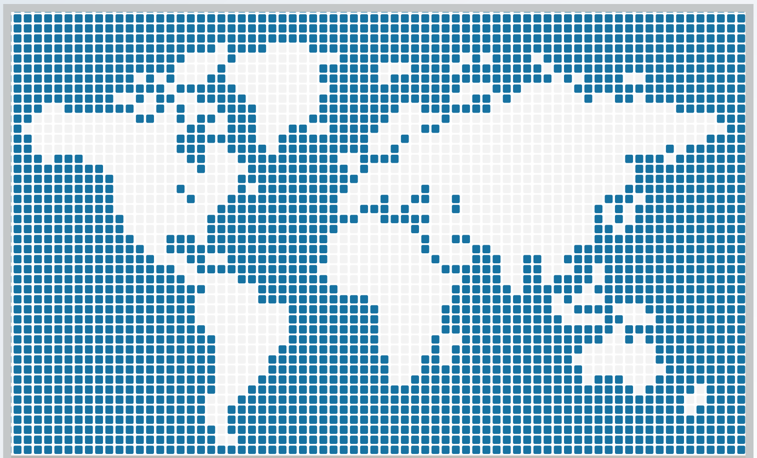

4TH QUARTER 2013

# DIRECT FROM MIDREX

CONTENTS



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## COMMENTARY

# EAF STEELMAKING AND DRI: A BRIGHT FUTURE!

By Henry Gaines
*Midrex, Director of Marketing*


**In the worldwide steel industry, few segments are as closely linked as EAF Steelmaking and the Direct Reduction of Iron Ore. The past 40 years have seen a major rise in Electric Arc Furnace steel production and; correspondingly, dramatic overall growth in the world production of Direct Reduced Iron. Within the construct of the modern steelmaking landscape, it is common for EAF's to rely heavily on DRI as feedstock for the charge...either as a supplement, or as a whole.**

It is sometimes easy to forget that this was not always the case. The perfect union of EAF and DRI was not readily apparent to the founding fathers of either industry, but humble beginnings have given way to a method that has advanced, and is advancing, the steel industry as a whole.

The first commercial electric arc furnace was developed and designed by the French scientist/metallurgist/inventor/promoter Paul Héroult and was installed by the Sanderson Brothers Steel Company in 1907 in Syracuse, New York. That furnace now stands in Station Square in Pittsburgh where it is an historic monument of the American Society for Materials (Information source: Crucible Industries, the modern day successor of Sanderson Brothers Steel). Then and for many years afterward, the EAF was used to produce specialty and spring steels. EAF steelmaking was viewed as a niche industry for high quality steel products, for steels that had to: "cook for a long time". The technology saw its first flirtation with overall acceptance following World War II. Electric arc furnace steel making really began in earnest with the development of the minimill concept in the 1960's. Names of pioneering industrialists come to mind: Jerry Heffernan and Lake Ontario Steel (LASCO), Willy Korf and Korf Steel, and of course Ken Iverson and Nucor. Since then interest and implementation of EAF Steelmaking technology has been driven primarily by the significantly lower capital cost of introducing a new steel production facility and the ability to use a relatively low cost, recycled material - scrap steel, as the primary raw material.

As EAF's gained momentum, they were employed primarily in the production of long products. Then in 1969, Willy Korf decided to build a MIDREX® Direct Reduction Plant alongside his EAF shops in Hamburg, Germany and Georgetown, South Carolina, USA. Those plants allowed him to enter into the business of making higher grade steels. Over the years, more and more electric arc furnace steel producers ventured into the production of higher grade products. Then, in 1987, Ken Iverson and Nucor broke ground on a new and revolutionary steel works at Crawfordsville, Indiana. Even though EAF technology had earlier been linked to flat products, this was the world's first commercial thin slab caster facility. As Dr. John Stubbles noted in his Brimacombe Memorial Lecture to the AISTech in 2006, "the commissioning of this compact strip process (CSP) qualifies as a turning point in our industry, ranking with Bessemer's process in 1856".

Since the new thin slab process

## COMMENTARY

*Continued from page 2*

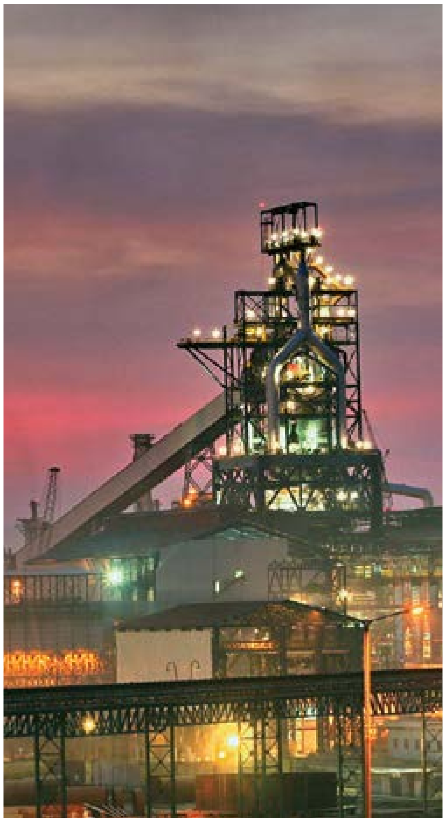
made flat products, the upstream EAF required low residual metallics as charge material. Very soon, similar CSP plants were built worldwide, especially in the United States. By 2006, the U.S. was using not only all of the prime scrap generated domestically, but also importing nearly ten million tons per year of low residual metallics (prime scrap, pig iron and DRI/HBI) to feed the hungry EAF flat products industry.

And with that, you have a very brief history of the EAF/DR industry, but "where do we go from here?" A recently released forecast by the World Steel Association calls for world production of crude steel to reach 2.07 billion tons per year by 2025. That's only twelve years from now. It also calls for a disproportionate amount of the growth to be by EAF's, 46%. That sounds very good for the DRI industry. Perhaps even more interesting is that the same forecast expects world output of DRI to slightly more than double to 159 million tons per year by 2025. Why would the growth of DRI so exceed the growth rate of the EAF industry? The answer primarily is because the modern DR industry is finding new avenues of growth*.

DRI (as HBI) is enjoying a major new application as feedstock for Blast Furnaces. Adding HBI can increase hot metal production and subsequently, decrease the coke rate, helping to lower the carbon dioxide generation of an integrated steel plant. This practice is not new, but until recently the practice was done mainly when the mills were hot metal short. In fact, only one major operation used HBI as part of its normal operating practice. The new voestalpine HBI Plant is helping to change this. The new MIDREX® plant to be constructed in Texas will send HBI to Europe where it will be used by the company's Austrian Blast Furnaces.

In addition, new technologies are opening up DRI production to areas that do not have low cost natural gas. MIDREX Plants are being built in India to employ coal gas and coke oven gas as the energy source. The MIDREX®/COREX® DR plant in South Africa, ArcelorMittal South Africa, has been using coal gas to make a reductant syngas since 1999. From this foundation, Midrex has worked to commercialize other technologies to allow use of both high sulfur coals and coke oven gas (COG) as detailed in this issue.

As we look towards 2014, there are many possibilities on the horizon. We see continued EAF growth, broader uses of fuels, and additional applications for DRI products. We even see that the integrateds will influence the DR market. But through it all, we see the long and productive relationship between DRI and



EAF steelmaking continuing at steady pace. The future of the DRI industry is bright, and you can continue to rely on Direct from Midrex to keep you informed on the latest DR developments. ■

** The WSA arrives at their DRI figure via a metallics balance. That is, they do not expect sufficient hot metal and scrap steel to be available to match the steel production, and thus the difference must be made by direct reduction. But we believe there are added factors that will lead to building of DR capacity.*

# NEW TECHNOLOGY FOCUS:

## MXCOL® and TRS™ using coal and coke oven gas to make DRI in India

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Midrex Technologies, Inc.

**EDITOR'S NOTE:** *The following article has been adapted from a recent presentation given at the International Conference on the Science and Technology of Ironmaking and Steelmaking (STIS 2013) held December 16-18th, 2013 in Jamshedpur, India. Although this paper focuses primarily on Direct Reduction Steelmaking for India, MXCOL® and TRS® have applications outside of India in areas without low-cost natural-gas as well as for steel companies looking to maximize their coke utilization for iron and steelmaking applications.*

### INTRODUCTION

As India continues to grow and its economy matures, it will require steel and increasingly higher quality iron products - specifically direct reduced iron (DRI). India is the world's DRI production leader, producing almost twice the amount of the next largest DRI producing country, yet faces unique economic hurdles that the other large DRI producers do not. India will continue to require more metallics, specifically DRI and moreover will need DRI process technology that has the flexibility to produce high quality DRI Products within the special challenges that the country currently faces. Midrex continues to address these issues through new technologies including MXCOL®. MXCOL® in combination with a coal gasifier uses Indian coals, or in combination with the new MIDREX® Thermal Reactor System™ (TRS™), uses coke oven off-gas (COG) to produce DRI in a MIDREX® Shaft Furnace. Multiple projects are underway which will use a synthesis gas produced by a coal gasifier and COG to produce DRI. This paper will examine the current global arena for DRI as well as how India may continue its DRI production growth and leadership through technologies such as the new MXCOL® TRS™.

### THE CHANGING FACE OF DRI

For decades DRI was essentially one product. Through years of development and use in the steel industry, it is necessary now to define DRI as three specific products. These are: cold DRI pellet and lump (CDRI) that is cooled before handling and use; Hot DRI (HDRI) - direct reduced iron discharged from the shaft furnace without cooling and charged into a melter; and Hot Briquetted Iron (HBI) - direct reduced iron discharged from the shaft furnace at ≥ 650°C and compacted to a density ≥ 5gm/cc. *(Figure 1 on next page).*

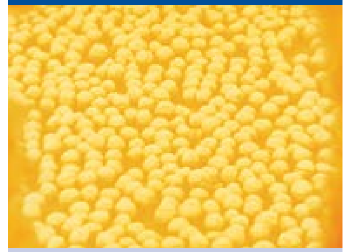
| DRI PRODUCTS | CDRI | HBI | HDRI |
|---|---|---|---|
| |  |  |  |
| **Product Form** | Pellet & lump | Briquettes* (density ≥ 5.0 grams per cubic centimeter (g/cc) | Pellet & lump |
| **Product Temperature** | Ambient | Ambient | 550° C or Higher |
| **Where used** | EAF & BOF | EAF, BOF & BF | EAF |
| **Charging Method** | Continuous & Batch | Continuous & Batch | Continuous & Batch |
| **Description:** | CDRI (Cold DRI) is a high quality metallic ideal for use in a nearby EAF. It can also be transported via rail to another site when proper precautions are made. It is not recommended for ocean transport. | HBI (Hot Briquetted Iron) is a premium form of DRI and is the industry and regulatory preferred method of preparing DRI for long term storage and transport. HBI is commonly used in EAFs and can also be added to the Blast Furnace and BOF. | HDRI (Hot DRI) is discharged hot from the shaft furnace and transported to an EAF for melting and provides the optimum way for DRI users to increase productivity and reduce cost. |
| **IMO Restrictions for transport** | Inerting ($N_2$) or passivation REQUIRED for cargo during the transport | No Special Precautions | N/A |
| **Number of MIDREX® Plants currently in operation** | 50 | 12 | 7 |

FIGURE 1 * *The MIDREX® Process requires less oxide coatings than competing DR technologies, which allows for easier briquetting of DRI and stronger physical HBI characteristics.*

These product forms each have special qualities that make them suited for different applications and purposes.

Since the 1970's the DRI industry has grown immensely. Last year's production topped 74 million tons. Reported HBI production alone was nearly 8 million tons; or the same as the world's entire DRI annual production up to 1983 *(Figure 2 on next page)*. Growth has been steady due to the continued need for metallics with low residuals, especially for use in EAFs; however, recent growth and interest is largely because of new energy sources and incentives for steelmakers.

As seen in *Figure 2 (on next page)*, world DRI growth continues; but growth has slowed in comparison to previous years, primarily due to domestic situation in India. Last year India saw a decline of 9% - from 21.97 million tons in 2011 to 20.05 million tons in 2012 - limiting total world growth to only 0.81 million tons. Not factoring in India, the remainder of the world's production increased by 5.3%, for total world growth of just over 1%. India has been the world's largest producer of DRI /Sponge Iron since 2003.

Even with the decline, India remained the number one producer making more than 27% of the world's DRI. Nationwide, India iron ore production was down by more than 40 million tons (about 20%). In some states iron ore mining was nearly shuttered completely. For example, in Andhra Pradesh, ore output was down by 85%. Simultaneously, allotments of natural gas were fully subscribed, causing the price of the gas to

## WORLD DRI PRODUCTION BY YEAR (MT)

| Year | Total | Year | Total | Year | CDRI | HBI | HDRI | Total |
|---|---|---|---|---|---|---|---|---|
| 1970 | 0.79 | '87 | 13.52 | '04 | 43.54 | 8.63 | 2.43 | 54.60 |
| '71 | 0.95 | '88 | 14.09 | '05 | 45.32 | 8.95 | 2.60 | 56.87 |
| '72 | 1.39 | '89 | 15.63 | '06 | 48.41 | 8.60 | 2.69 | 59.70 |
| '73 | 1.90 | '90 | 17.68 | '07 | 55.79 | 8.34 | 2.99 | 67.12 |
| '74 | 2.72 | '91 | 19.32 | '08 | 56.52 | 8.19 | 4.24 | 67.95 |
| '75 | 2.81 | '92 | 20.51 | '09 | 52.54 | 6.93 | 4.86 | 64.33 |
| '76 | 3.02 | '93 | 23.65 | '10 | 56.60 | 7.21 | 6.47 | 70.28 |
| '77 | 3.52 | '94 | 27.37 | '11 | 59.41 | 7.60 | 6.20(e) | 73.21 |
| '78 | 5.00 | '95 | 30.67 | '12 | 60.39 | 7.90 | 5.73(e) | 74.02 |
| '79 | 6.64 | '96 | 33.30 | | | | | |
| '80 | 7.14 | '97 | 36.19 | | | | | |
| '81 | 7.92 | '98 | 36.96 | | | | | |
| '82 | 7.28 | '99 | 38.60 | | | | | |
| '83 | 7.90 | '00 | 43.78 | | | | | |
| '84 | 9.34 | '01 | 40.32 | | | | | |
| '85 | 11.17 | '02 | 45.08 | | | | | |
| '86 | 12.53 | '03 | 49.45 | | | | | |

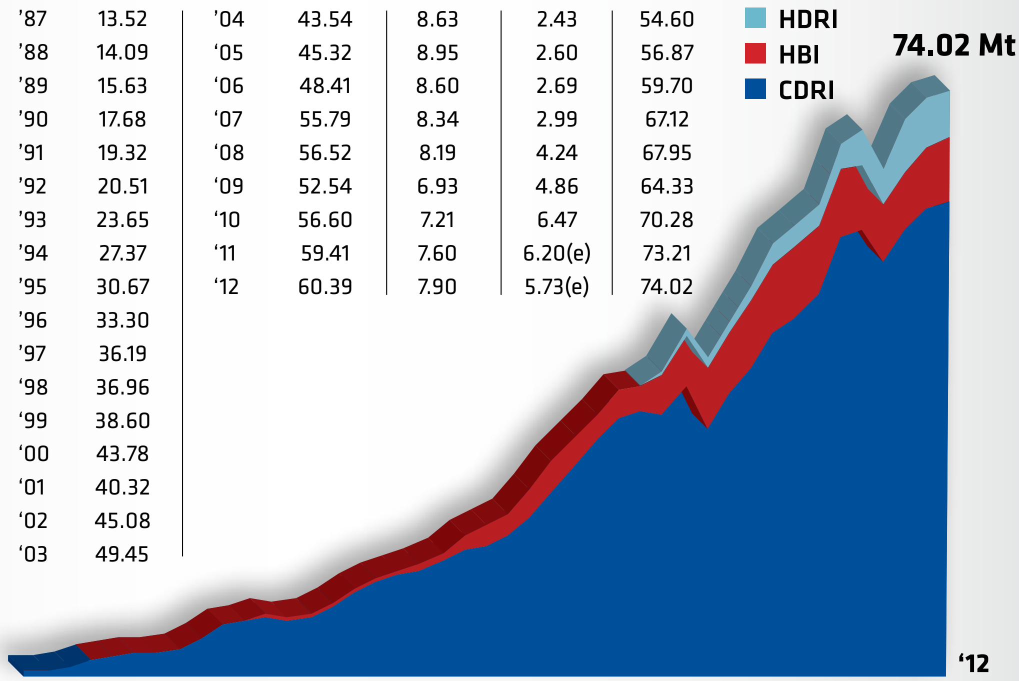



FIGURE 2

escalate rapidly. Both coal-based and gas-based DRI production fell; however, gas-based fell by a larger share because it was hit by both the ore shortage and the increased gas prices.

More than 70% of India's DRI products are made in rotary kilns. India's continuing growth will require high quality steel products, especially as its economy matures. To achieve this, India will need higher grade metallics and better quality DRI than rotary kilns can provide. Thus Shaft Furnace DR technology such as MIDREX® Direct Reduction Plants will be necessary for quality sponge iron production.

The "Shale Gas" phenomenon has garnered world attention. In North America and other areas of the world, Shale Gas is sparking interest in new DRI facilities as it has lowered natural gas prices; which for decades has been the primary fuel for shaft furnace direct reduction.

Much has been publicized on this in the press, but not as much focus has been placed on practical solutions for areas without access to shale gas or low cost natural gas. As one of these places, India faces its own challenges with limited access to low cost natural gas and is thus looking to utilize coal and COG fuel sources for DRI plants.

### ADVANCED DIRECT REDUCTION TECHNOLOGY: MXCOL®, COREX®/MXCOL® & TRS™

Midrex is commercially offering technology based on proven groundwork utilizing both gas derived from coal and natural gas. These include technologies such as MXCOL®, COREX®/MXCOL® and the new Thermal Reactor System™ (TRS™).

MXCOL® is the name and trademark for the commercially proven MIDREX® Shaft Furnace technology that uses syngas derived from coal. MXCOL® can receive syngas from many sources including commercial gasifiers (using high or low quality coals or other alternative fuels) to produce reducing gas for the MIDREX® Process to make DRI *(Figure 3 on next page)*. Typical Indian coals are high in ash content. MXCOL® can work with a variety of gasifiers that can easily handle high ash coals.

Midrex's first successes in commercialized DR technology using gas derived from coal began in the late 1990s. The world's first application of coal gasification to produce DRI in a MIDREX® Plant began operation in 1999 at ArcelorMittal Steel

South Africa (formerly Saldanha Steel). This is known as the COREX®/MXCOL® Process *(Figure 4)*. This facility includes a COREX® Plant, supplied by Siemens VAI, which uses a melter/gasifier to simultaneously produce hot metal and a by-product synthesis gas that feeds a MIDREX MEGAMOD® Shaft Furnace. Advancements to successfully and reliably produce DRI from other coal sources have steadily progressed from this milestone.

MXCOL® can receive syngas from sources other than gasifiers because of technological advancements currently underway. These advancements include the new Thermal Reactor System™ (TRS™) as detailed in *Figure 5 on next page*.

Midrex and Praxair announced the formation of a strategic alliance in 2012 to demonstrate and develop the TRS™. The TRS™ uses innovative partial oxidation technology to convert and reform various gases, like COG, into a high quality, high temperature synthesis gas for Direct Reduction. The TRS™ large scale demonstration facility has been constructed and commissioned at Midrex's Research and Technology Center in North Carolina, USA. Testing is underway to address a wide number of operational scenarios. To date the Midrex and Praxair team have completed more than 1000 hours of successful operation of the TRS facility. Test results have shown that the TRS can economically and reliably convert COG to syngas suitable for production of quality DRI *(Table 1 on next page)*.

Using the COG Demonstration Plant results as an example, a Midrex MXCOL® Plant utilizing typical fuel gases available from an integrated steel works can be envisioned. The TRS™ not only opens up new DR production by being able to use COG for up to 100% of reducing gas, the long term implications of the technology will have an

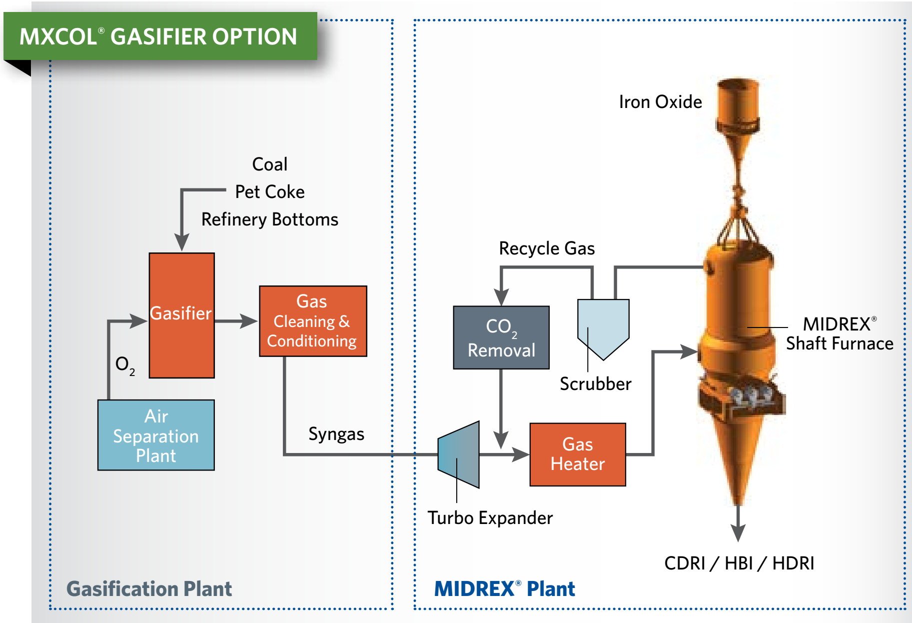



FIGURE 3 *MXCOL® with gasifier Flowsheet*

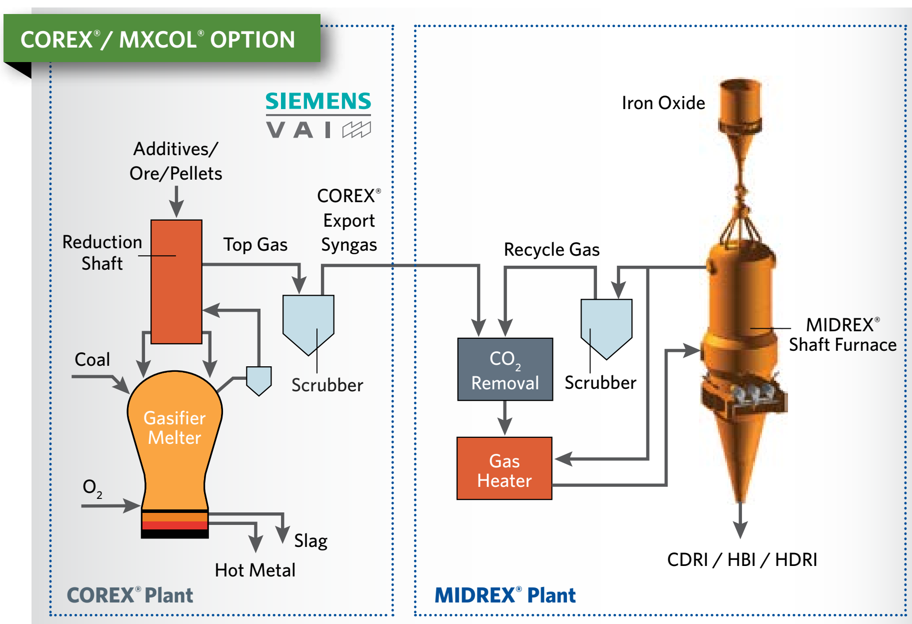



FIGURE 4 *COREX®/MXCOL® Flowsheet*

impact upon integrated mills. While use of HBI at integrated mills is not common in India, HBI has already been shown to increase hot metal production in the BF and reduce coke consumption at multiple BFs. HBI has also proved to be a useful alternative to scrap in the BOF. This is a fact that is gaining momentum as Midrex's most recent contact with the voestalpine Group for a 2.0 mtpy MIDREX® HBI Plant being built in Texas, USA will primarily provide HBI for blast furnaces in Austria.

The TRS™ allows integrated steel producers to take even greater advantage of their resources by converting COG to a high grade reductant and fuel for an MXCOL™ Plant. COG is relatively high in $H_2$ and $CH_4$ content, which is good for the MIDREX® Direct Reduction Process. Using COG for DRI Processes had not been possible in the past because the long chain and cyclic hydrocarbons typically found in COG are detrimental to the DRI process unless properly reformed. In fact, the use of the COG to reduce iron is often more valuable because producing steel is more profitable than producing power or chemicals.

In addition, if HBI is produced, it can then be fed to the blast furnace(s) on site, increasing the capacity of the blast furnace thus reducing the coke required as well as the overall environmental footprint for the facility.

In addition, since MXCOL® Plants use the MIDREX® Process and Shaft Furnace, the MXCOL® Plant can provide the same flexibility of operation, production, products and product quality as natural gas-based MIDREX® Plants. Thus iron product quality and rate of production is comparable to natural gas–based MIDREX® Plants and can offer the same product options; including simultaneous production of multiple DRI products (such as HDRI & HBI or

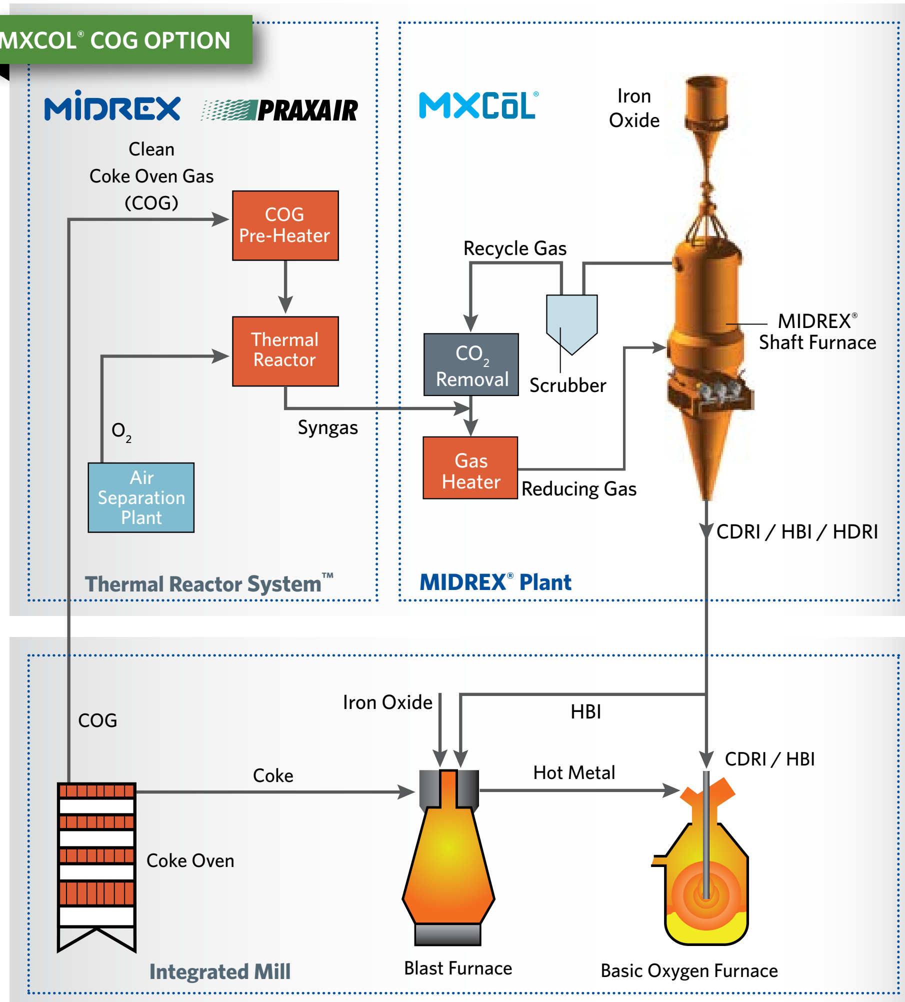



FIGURE 5 *MXCOL® with TRS™ Flowsheet*

TABLE 1 **TYPICAL RESULTS OBTAINED FROM THE COG DEMO TEST OPERATIONS**

| | COG Gas Analysis TRS Inlet | Syngas Analysis TRS Outlet |
|---|---|---|
| CO | 4 to 6 % | 22 to 28 % |
| $CO_2$ | 1 to 3 % | 1 to 3 % |
| $H_2$ | 55 to 65 % | 55 to 65 % |
| $H_2O$ | 0.4 to 0.8 % | 0.5 to 2.5 % |
| $CH_4$ | 20 to 30 % | 0.5 to 3.0 % |
| $N_2$ | 2 to 4 % | 3 to 8 % |
| BTX | 0.3 to 2.0 % | 0.0 % |
| HHC | 0.2 to 0.6 % | 0.0 % |
| Soot | | ≤ 0.01 mg/NCM |

CDRI & HBI), without ceasing operations. HDRI production is available through multiple safe and proven forms of hot transport systems that are flexible and suitable for both greenfield and brownfield sites.

## TECHNOLOGY IN PRACTICE

Various fuel sources including natural gas, coal, COG and process syngas have all been used to create a good quality syngas for use as a reducing gas in the MIDREX® Process *(Figure 6)*. Midrex has the only commercial scale shaft furnace technology currently in operation that is using syngas derived from coal to produce DRI (the COREX®/MXCOL® Plant at ArcelorMittal South Africa).

Midrex has multiple other projects, all in the construction phase and all in India, that use syngas produced by a coal gasifier, COG and the COREX® Process. These include JSPL Angul I –the world's first DR Plant with coal gasifier located in Angul, Odisha, India. The plant is currently under construction and will use indigenous iron ore and coal. JSW Projects Ltd., a group company of JSW Steel Ltd., is building another COREX®/MXCOL® Plant featuring multiple discharge options. This new facility is being erected at JSW Steel Ltd., located in Vijayanagar, Toranagallu, Karnataka, India. Lastly, JSW Dolvi is modifying their existing MIDREX® Plant to utilize coke oven gas (COG) to supplement its natural gas supply for production. The plant is located at the JSW-Dolvi Works (formerly JSW Ispat, Ltd.) Maharashtra, India.

## CONCLUSION

India's steel industry will continue to grow to keep pace with the growing economy. As a result, the DRI/sponge iron industry will be forced to consider advanced DR technologies that can successfully utilize gas derived from coal and other alternative fuels. Even though India faces unique hurdles with raw materials, advances in MXCOL® and MIDREX® Process technology offer practical solutions that are currently being implemented within the nation. Midrex continues to address these unique technological needs in India through continuous process and technology development. Test work continues on the new TRS™ with expectation to implement at the commercial scale soon. ■

FIGURE 6 *MIDREX® Process Energy Source Flexibility*

**MIDREX® Process Energy Source Flexibility**

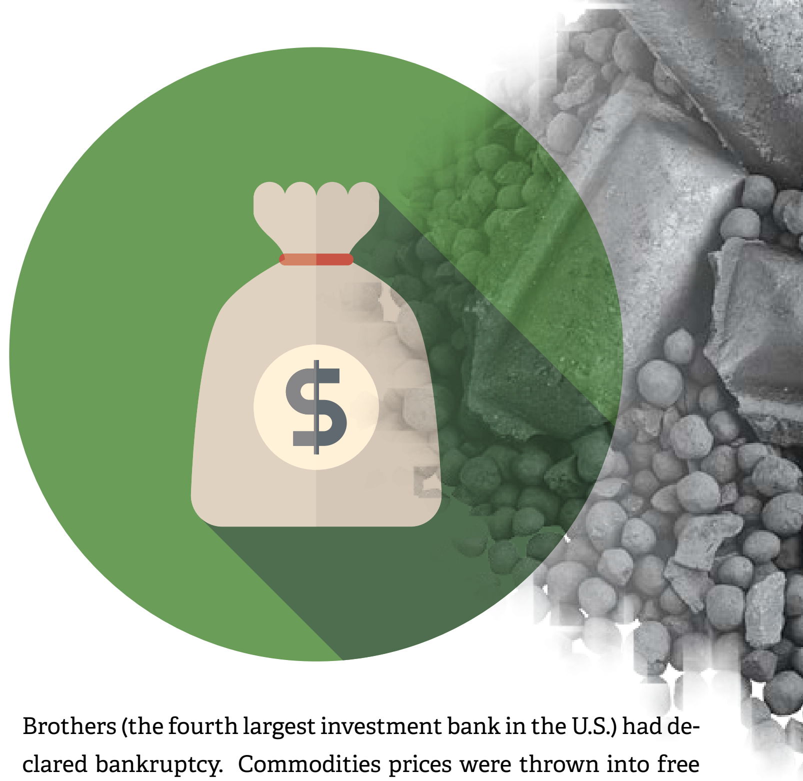
| Energy Source | MIDREX® Plant Reference | Reducing Gas Train | Reducing Gas $H_2$:CO | Start-up |
|---|---|---|---|---|
| Natural Gas | More than 60 modules in operation | MIDREX® Reformer | 1.5 to 1.7 | Since 1969 |
| Natural Gas | FMO (formerly OPCO) | Steam Reformer, Heater + MIDREX® Reformer | 3.2 to 3.9 | 1990 |
| COREX® Offgas | Arcelor Mittal South Africa | $CO_2$ Removal + Heater | 0.3 to 0.4 | 1999 |
| COREX® Offgas | JSW Projects Limited | $CO_2$ Removal + Heater | 0.5 to 0.6 | Construction |
| Coal Gasifier | JSPL Angul I | $CO_2$ Removal + Heater | 2.0 | Construction |



# MARKET ANALYSIS: METALLICS AND MOMENTUM

## A look at the industry since 2008

By Robert Hunter



**Editor's Note:** *It's been a little over five years since the Financial Crisis of 2008 ended the great commodities boom. Much has happened in that time on many different global political and economic levels. Because of these changes and the idea that the Steel Industry itself is cyclic, we thought it would be good to look to the past to help prepare for the future. This article will examine a few of the factors affecting the metallics industry today and how different the current environment is from the one that influenced the years prior to the Financial Crisis.*

### INTRODUCTION

**The Financial Crisis of 2008 was the last major economic force to dramatically affect the metallics industry. There is a radical difference between now and then.** Prior to the crisis, all forms of steel and metallics along with the raw materials for producing them - DRI and HBI, scrap steels, iron ore and metallurgical coal - were at spectacular highs following the dismal lows of the early 2000's. Using published data from CRU, in mid-2008, pig iron delivered to New Orleans and loaded into a barge was selling for $900 per ton, almost ten times the price from six-and-a-half years earlier when it had hit a low of $93 per ton in November of 2001. Many other commodities were experiencing the same surge in pricing; other metals such as nickel and copper, fuels such as petroleum and coal, grains such as rice and corn. Each was reaching real dollar (constant dollar) highs not seen for many decades.

### THE CHINA FACTOR

All of the price peaks were caused by the same force -the rapid, unprecedented growth of the Chinese economy. By 2008, China's demand for raw materials had grown so rapidly that the entire world was experiencing difficulty meeting the supply requirement.

In early-summer 2008, demand slowed and prices started to drop. The subprime mortgage crisis, originating in the United States, was underway. By the middle of September, Lehman Brothers (the fourth largest investment bank in the U.S.) had declared bankruptcy. Commodities prices were thrown into free fall. By March 2009, pig iron delivered to New Orleans was down to $256 per ton, less than one-third of its price at the peak nine months earlier.

However, the price of metallics soon stabilized. The price of pig iron, even though it was down by three-to-one, was still nearly three times as high as it had been in late 2001. Although demand for pig iron in the Western world had nearly disappeared by mid-summer 2008, there was still sufficient demand from China to hold prices at these levels.

Following the price collapse, a recovery began. In less than two years, prices were back up to levels that would have seemed extremely high in comparison to most time, but being in the shadow of the 2008 peak, they appeared moderate. Pig iron delivered to New Orleans and loaded into a barge was at $546 per ton by May of 2011. Except for the 2008 peak, such prices had never been seen. Even when viewed in constant dollars, this price was at a 98th percentile level for metallics pricing over the past century.

In eary-2011, the recovery seemed to stall - prices stopped rising. Throughout 2011, 2012 and 2013, prices have been in a very slow decline. The reason for this was due to lackluster Chinese demand combined with an absence of any substantial growth by the other large economies. The U.S. is out of recession and growing, but growing so slowly as to not stress the supply chain for iron metallics and thus, to not cause any large price increase. For much of this period, Europe has been suffering from the Sovereign Debt Crisis and associated austerity measures. As a result Europe has been in recession. Some analysts are saying they expect that the effects of the sovereign debt crisis will continue to limit European steel production for another 2 to 3 years. Japan, which was demonstrating growth, has slowed recently; latest reports show growth of the Japanese economy at barely over 1%. Meanwhile, in order to insure sustainability of their economy and to ward off inflation, China has purposely slowed its growth. Whereas Chinese GDP growth averaged 11% per year from 2003 through 2010, peaking at over 14% in 2007, they have intentionally brought it down to about 7.5% per year now and are expected to hold it to around 7% for the next few years. A graph of China's GDP growth rate since 2000 and with a forecast through 2018 is shown on the right. Data and forecast are from the International Monetary Fund (IMF).

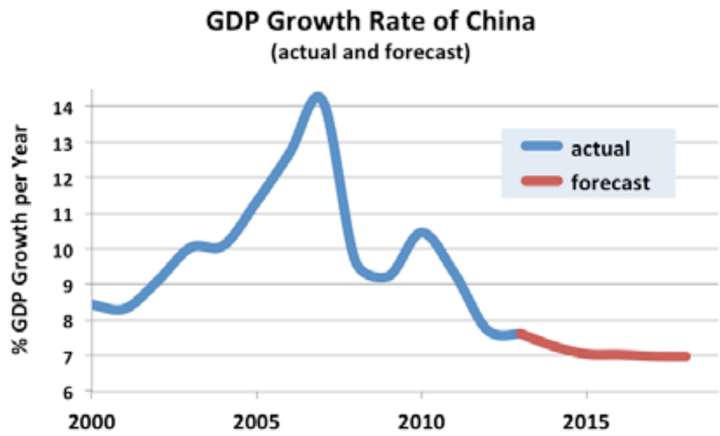
China has raised its bank reserve ratio to limit the amount of funds being loaned to help control its' GDP growth rate.

The required ratio for large banks, which was as low as 7% in 2004, was gradually and repeatedly raised. Since 2011 it has been held at and above 20%. Obviously, this has a marked effect on the credit market within the country. One major effect has been a rapid decline in the growth of fixed asset investment (FAI). The urban year-on-year change in FAI had been as high as 33% in 2009, but has slowed to slightly less than 20% in 2013. Primarily, this means that new urban housing is no longer being built as rapidly as it once was. In response, demand for steel in China is slowing, thus production is slowing.

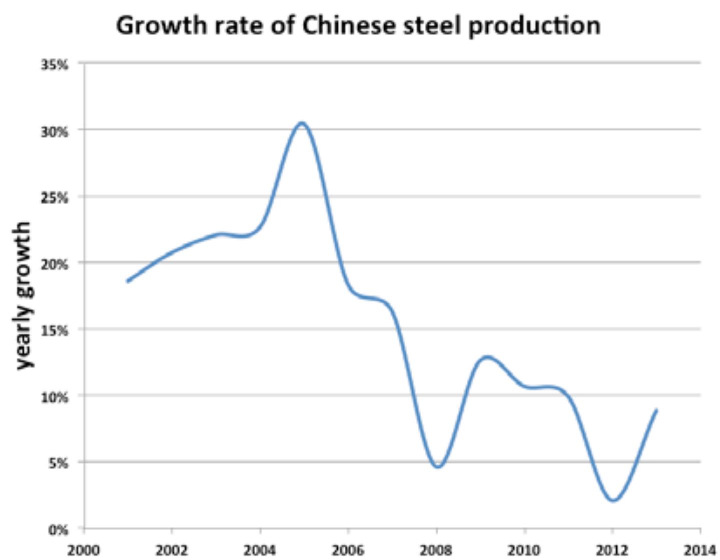
A graph showing the annual growth rate of Chinese steel production follows. *(Data is from the World Steel Association.)* Quite notably, the growth rate was already slowing as early as 2006. A slowdown is only to be expected when you consider the growth rate during 2005 was at a remarkable, but clearly unsustainable 30%. At that time, China was commissioning a new integrated steel works, on average, every four or five weeks!

## WHERE WILL METALLICS PRICING GO FROM HERE?

China has been producing steel at greater than 100 million tons per year since 1996. It is often suggested from many industry analysts that from within China very large amounts of obsolete scrap steel should soon arise as the life cycle of these consumer goods reach their end. Midrex does not fully subscribe to this belief.




*Courtesy of the International Monetary Fund (IMF)*




*Courtesy of the World Steel Association*

Steel that is used to make consumer goods, such as appliances and automobiles, can return as scrap rather swiftly since the lifetime of the goods is only a few years. When steel is used in the construction of buildings, the turnaround time before it again becomes scrap is quite a bit longer. Over the past few years, less than 10% of the steel made in China has gone to the manufacture of automobiles and appliances. Meanwhile, over 60% of Chinese steel has gone to construction. This should be compared to the U.S. market where nearly 30% of the steel produced goes to autos and appliances and only about 40% goes to construction. In addition, life cycles of buildings, construction materials and goods are also seemingly increasing as technology progresses. The life cycle time for the 'average ton' of steel will be longer in China than it is in the U.S.

The belief that excess scrap from China would then flood the world market does not account for current common practices of the Chinese steelmaker, including BOF cold charge scrap ratios and widespread use of cold pig iron charging to the EAF. The cold charge rate of oxygen furnaces in China is extremely low relative to the other parts of the world. In China, the cold charge rate is approximately 9% of the total metallics charge. This number is up from 5-6% a few years ago, as more scrap steel is available today than it was then. By comparison, in the U.S. the cold charge rate is around 20%. The low number for China is primarily because its steelmakers simply haven't had enough scrap steel to use as cold charge. (For the non-steelmaker: Liquid hot metal from a blast furnace is charged to an oxygen furnace for decarburization and refining. If a steelmaker used only hot metal to make a heat of steel, after the carbon was burned out of it, the steel would be too hot to cast; therefore, the liquid steel would have to wait so it could cool. By adding scrap steel as cold charge, this excess heat is used to melt the scrap. Thus, the steelmaker solves the problem of having too much heat for casting and simultaneously is able to produce additional liquid steel.)

As China begins to have more local scrap in the coming years, they will almost certainly apply it toward usage as cold charge.

Another fact to consider is that much of the iron charged to EAF's in China is cold pig iron. Cold pig iron is often cast because there was some sort of upset in the steelmaking process, such as the blast furnace production got ahead of the steelmaking furnace and there was nothing that could be done with the liquid hot metal other than to cast it. As China's steelmaking industry matures, the frequency of this occurring will lessen, just as it has done in other large steelmaking locales (Europe, North America, and Japan). So, less pig iron will be available for the EAF's. Scrap steel will help fill this void.

With China not growing as rapidly as it was and with the other major economies growing very slowly, Midrex does not expect metallics prices to continue to decline.

Metallics prices correlate well with the rate of world GDP growth. When GDP growth is rapid, metallics prices rise, and vice versa. The forecast by the International Monetary Fund for World GDP growth is positive. Forecasted world growth (constant dollars) at 4.0% average for the next five years (2013-2018) is a full percent higher than actual growth over the past five years. China, which has been the world driver, is not expected to reaccelerate; however, the drag on world growth by the large western economies is expected to abate. The biggest factor is that Western and Central Europe, which actually experienced negative growth over the five year span 2008-2013, are forecasted to grow. In addition, the U.S. economy is forecasted to grow slightly faster than in the previous five years. China's growth rate is not expected to skyrocket, but it is still likely to be far higher than the growth rate of other large economies.

Furthermore, the emerging market nations (EMN) in general are likely to continue to enjoy relatively rapid growth. Most of the EMN growth is forecast to be by the BRIC nations (Brazil, Russia, India and China). We have discussed China in detail already, but India merits additional comments. With its extremely large population and its burgeoning growth, much has been made in recent years that "India is the next China;" however, there are fundamental differences between the two countries that suggest otherwise.

In many ways India has been hidden in the shadow of China over the past decade. India's population continues to grow and is projected to surpass China's in the near future. It situation is more complex than can truly be handled in this article. It is easy to see why some may think India will spark the same effects that China's growth created; however, the Chinese economic transformation is unprecedented in history

and a repeat of it by other countries is not likely. With very large populations there are greater logistical problems and complexity. China's government policies may not be embraced by the entire world, but it has been effective in handling its immense population and growth. Conversely, India is heavily burdened by a complex bureaucracy, with extensive debate of issues required by the Indian democracy before major national decisions can be made. This is a major reason for why many believe that India will not have the same influence as China. India will have impact; but not on the scale and surge of China. Nonetheless, India has been growing quite rapidly and the IMF forecasts an average growth rate around 6¼% over the next five years. If such growth can be sustained, India would become the third largest economy on earth by the early-2040s. Such long term forecasts are interesting, but cannot be depended on.

## CONCLUSION

With China and India continuing to grow at rates of 6-7% and with the other emerging market nations also growing more swiftly than historic norms, the outlook for metallics pricing appears to be quite positive. There no doubt will always be factors that can alter these scenarios in the short term. However, based upon the factors discussed, most likely metallics prices will remain at or above the levels of the past two years. In response, steel prices should also rise gradually. China, as it has for the past decade, will greatly influence the industry and global economics. India will also have its impact but not on the same level as China; and other emerging market nations will add to the growth scenario. ■

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**Editor's note:** All references to "tons" are metric tons.

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