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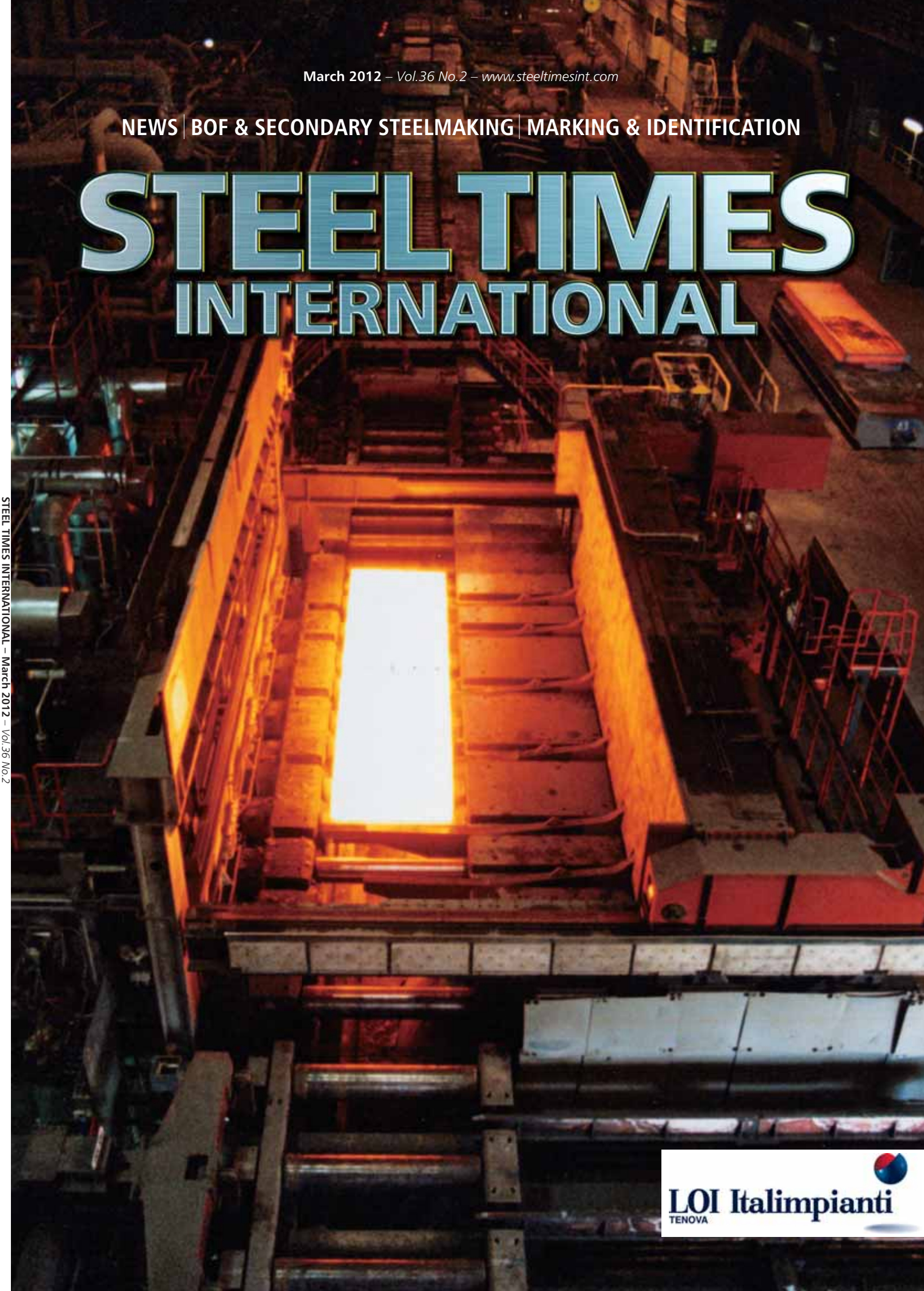
NEWS | BOF & SECONDARY STEELMAKING | MARKING & IDENTIFICATION

STEEL TIMES INTERNATIONAL



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Front cover image courtesy of **Tenova**

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Contents

BOF – *Page 17*

Marking & identification – *Page 26*

Tube – *Page 31*

Furnaces – *Page 41*

News

BOF & secondary steelmaking

Marking & identification

Tube

Conferences

Furnaces

NMDC and Severstal deal
India's largest and state-owned iron ore miner NMDC and Russian steel producer Severstal plan to set up a joint venture steel plant in Karnataka state, SW India.
The initial plant capacity is to be 3Mt/y of finished steel. It also confirms the intention of NMDC and Severstal to fully meet the joint venture's captive requirements of both iron ore and coking coal so that it becomes fully integrated for the primary raw materials.

Wusteel profit up 17.4%
Wuhan Iron and Steel Group Corp (Wusteel) said the company's full-year profit for 2011 is expected to rise to RMB3.5bn ($554M), or 17.4% more than the RMB3bn ($475M) in 2010. Its 2011 sales revenue is expected to increase 14.3% from the RMB185bn ($29.3bn) in 2010. Output of steel would likely go up 3% y-o-y to 37.65Mt.
Source: China Metals
e-mail chinametal@xinhua.org

Jeddah steel mill
Saudi Arabia's Rajh Steel is to commission a 1Mt/y rebar mill in May supplied by Danieli.
The plant at Jeddah already operates a long products mill of 325kt/y capacity. The company also has a plant in Riyadh where it produces 180kt/y of pipe and flat products.

Lisco to restart DRI/HBI
Libyan state-owned steel mill Lisco is looking to sign contracts to repair the oxygen, compressed air and nitrogen plants damaged during last year's fighting. Lisco's Midrex DRI capacity is 1.1Mt/y of which 650kt can be compressed to HBI.

Tunisian expansion
Tunisia's only steelmaker, El Fouladh, plans to build a 700kt/y steelmaking plant at Menzel Bourguiba, Tunisia. The company currently operates a wire rod and rebar mills of 200kt/y and 250kt/y capacities respectively but only has 200kt/y of steelmaking capacity requiting it to import billet mainly from Turkey and Ukraine to make up the shortfall.

Tenova Chinese contract
Tenova I2S to supply a ZR22BE-52" 20 High Reversing Cold Rolling Mill for GuangHan TianCheng Stainless Steel Products in Sichuan China.
The mill will produce precision stainless steel strip from 3.0mm to 0.1mm thick, at a maximum width of 1320mm.

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Outokumpu to buy TKS stainless division

Finland's Outokumpu Oyj plans to buy ThyssenKrupp's stainless steel business in a deal worth €2.7bn ($3.5bn).

Outokumpu will pay ThyssenKrupp €1bn in cash for its Inoxum unit – which has a market share of 35 to 40% – and will take on liabilities of 422M, as well as issuing a loan note of €235M to ThyssenKrupp.

The combined entity is expected to have the financial strength to take advantage of opportunities in the Americas and Asia which they believe offer growth potential.

The deal will involve:
- Closure of the Krefeld and Bochum, Germany meltshops by ends of 2013 and 2016 respectively.
- Increase in capacity through reallocation of production to Tornio in Finland and Terni in Italy.
- Planned reduction of cold rolling capacity in Sweden from 2014 onwards.

Outokumpu said the combination with Inoxum would lead to 850 job cuts in Germany as Krefeld and Bochum are shut in stages.

The two companies pledged no other production sites would be shut until at least the end of 2015 and there would be no mandatory job cuts until then.

Bluescope posts $530M half year loss

Australia's BlueScope Steel posted a net loss of Au$530M (US$570.7M) for the first half of the financial year, but said it was laying the foundation for a return to profitability.

In August the steelmaker revealed a Au$1.05bn full year loss, saying it would cut more than 1000 jobs and shut its Australian export business as it struggled under the soaring Australian dollar.

The company said the result for the six months to December 31 was much higher than the Au$55M loss posted for the same period the previous year but included significant one-off restructuring costs of some Au$260M.

BlueScope chief executive Paul O'Malley said the figures "demonstrated delivery of our improvement plan and was in line with market guidance." He said the operational restructure, with associated plant closures in Australia, significantly reduced exposure to the loss-making export market.

Essar Steel completes 10Mt/y expansion

The Essar Steel complex at Hazira, Gujarat, west India has more than doubled its capacity to 10Mt/y from its 4Mt/y capacity.

This expansion makes the Hazira Steel Complex the largest single location flat steel producer in India and the fourth largest single location flat steel producer globally. With this expansion the complex is now able to offer the entire range of flat products from thin strip to heavy plate, large diameter pipe, cold rolled and coated products.

This steel plant will play a major role in meeting the needs of capital and consumable goods, shipbuilding and the automobile sector. Being a port-based plant, its strategic location makes it an ideal gateway for meeting the global demand for steel.

It has set up a Service Centre network across India as well as in the UK, Middle East, Indonesia and Vietnam to provide cut to length sizes with JIT delivery.

French protest

Workers at an idled ArcelorMittal steel plant in northeast France occupied the site, seeking to put their plight on the political map.

About 200 workers invaded management offices at the factory in Florange, in the Moselle region close to Belgium and Germany, after ArcelorMittal announced it was prolonging the temporary shutdown of its two blast furnaces.

The plant's two blast furnaces were idled in July and October 2011 in the face of weaker demand and workers fear that the longer they stay idled, the greater the chance the factory will be permanently closed.

Chinese explosion

An explosion at a steel factory in north-eastern China has killed 13 people and injured another 17.

The blast took place late at a steel casting workshop belonging to state-run Angang Heavy Machinery in Anshan, Liaoning province. A spokesman for parent company, Ansteel Group, said investigations into the cause of the accident were ongoing. The accident happened when a mould exploded, the official Xinhua news agency reported.

Paris conference

The former ATS French Steel Association conference returns to Paris in December.

Following the financial crisis in Q4 2008 the regular event which took place in Paris each December was cancelled and the organisiing body, the Association Technique de la Sidérurgie Française (ATS) disbanded.

Now, in a vote of confidence in Europe's steel industry the FFA (Fédération Française de l'Acier – French Steel Federation) is restarting the event. It will take place on 18, 19 December, 2012 under the auspices of its technical publication, 'The Journées Sidérurgiques Internationales' (JSI).

Fédération Française de l'Acier - FFA
e-mail maryse.julien@ffa.fr
www.acier.org

Chinese output up 8.9% y-o-y

China's crude steel output increased 8.9% year-on-year to 683.27Mt in 2011.

This is a reduction of 0.4% compared with the growth rate of 2010, according to the latest data provided by the National Development and Reform Commission (NDRC), the country's top economic planner.

The NDRC also said that growth of rolled steel slowed by 2.4% to 881.31Mt, but total output increased 12.3% y-o-y.

China's imports of iron ore rose 10.9% y-o-y to 686.06Mt in 2011, while exports of steel products amounted to 48.88Mt, up 14.9% y-o-y.

Steel prices continued to decline in December 2011, with the steel price composite index falling to 120.95 points, down 1.44 points from November. The index wavered between 130.74 points and 136.04 points in the first three quarters of last year.

The profit of China's iron and steel industry in the first eleven months of 2011 amounted to RMB265.2bn, (US$42.1bn) say NDRC.

In January- November 2011, the profit was 29.9% higher over the same period a year earlier, but the rate of growth was 33.2% lower.

China's apparent consumption of crude steel is likely to add just 4% y-o-y to 700Mt in 2012.

Source: China Metals
e-mail chinametal@xinhua.org

Zimsteel revamp

Essar Africa Holdings Ltd (EAHL) is set to spend US$436M to refurbish and upgrade the former ZISCO government owned steelworks at Redcliff, Zimbabwe.

The work will take place in two phases. Phase 1 involves the refurbishment of the plant costing $115M to be completed in 12 – 18 months. This will deliver a production capacity of 500kt/y.

Phase 2 will increase production capacity to 1.2Mt/y, including the installation of a multi-fuel cogeneration 50MW power plant and an oxygen plant at an incremental investment of $275M. This is scheduled to be completed within three years.

Nucor to close Nuconsteel division

Pic source Emily.Schwarting from Flickr

Nucor Corporation will exit the business of fabricating light gauge steel framing and therefore will close its Nuconsteel division.

Nuconsteel has operations in Denton, Texas, and Dallas, Georgia. Nucor entered the residential and commercial light gauge steel framing business in November 2001 with the acquisition of Itec Steel, which became Nuconsteel shortly after.

Nucor expects to close Nuconsteel's facilities in the spring of 2012, after meeting current customer contractual obligations.

Nucor CEO Dan DiMicco said: "The fabrication of residential and commercial light gauge steel framing does not offer the returns or scale necessary for Nucor to remain in the business."

OneSteel to cut a further 430 jobs

OneSteel will cut a further 430 jobs before the end of the financial year, as part of its plan to drive Au$90M (US$96.7M) in annualised savings.

At the release of its half year results, the diversified Australian steel, mining and materials company confirmed it had already cut 300 employee jobs, and a further 170 contractor and casual jobs by the end of December.

A spokeswoman for the Australian company confirmed that the 430 jobs were new reductions in the workforce, and had not previously been announced. In presentation notes, the company said there was 'further planned reductions of 430 employees expected by end of financial year'.

It aimed to save Au$40M in labour costs from manufacturing operations, Au$30M from distribution, Au$12M from recycling and was also shedding jobs in the corporate division, which would account for Au$8M in savings.

The OneSteel board also plans to embark on a name change to reflect the company's changing profile as a mining and materials company.

The company, formerly owned by BHP, planned to be an exporter of 11Mt of iron ore, which would make it a 'pretty significant iron ore player', it said.

SAIL to increase iron ore output at Chira

The Steel Authority of India Ltd (SAIL) is planning a 15 fold increase in output from its iron ore mine at Chiria, Jharkhand state NE India.

Present output is 1Mt/y and, according to a plan submitted by the consulting group Hatch, output should be raised in two phases, the first to 7Mt/y.

An investment of INR50bn (US$998M) is envisaged for the expansion which will meet 40% of SAIL's needs and supply its works at Bokaro, Burnpur, Durgapur and Rourkela and a new steelplant to be built at Burnpur.

Reserves at Chira are estimated at 2.2bnt of high grade haematite ore – the largest deposit in the whole of Asia.

SAIL has obtained permission for forest clearance for the expanded mining operations, but such activities are often resisted by the local population leading to long delays in developing resources.

India is currently suffering a shortage of ore in some locations due to mining by private companies having been stopped in the southern state of Karnataka where illegal mining was taking place.

Bokaro JV

The Steel Authority of India Ltd (Sail) and South Korean steel major Posco have signed an MoU to commence a feasibility study to establish a joint venture company for the production of cold rolled non grain oriented electrical steel.

It also provides for formation of a joint venture company using Finex technology at Bokaro or another location. Finex is a development by Posco of the Corex process utilising fine ore and coal to produce liquid iron. The envisaged size of the plant is 3Mt/y and will include downstream operations.

Annealing line

CMI Chemline is to supply Guanghan Tiancheng Stainless Steel Products (TCSS) with a pickling and cleaning section of a new cold rolled annealing and pickling line. The line can produce 50t/h and is set to come into operation at the end of 2013.

TCSS aims to compete with domestic stainless steel players and to achieve this its end product must be of sufficient quality.

The cold rolling line is designed to process the 200 and 300 series of stainless steel grades.

Severstal sells Nordgold

Severstal, Russia's largest steel company has announced the sale of all its holdings in its former gold mining company, Nordgold.

It marks the end of Severstal's involvement in gold and means it can focus entirely on its core strengths.

Severstal produced 18.2Mt of crude steel in 2010 including output from its US subsidiary which itself was partly divested during 2011.

India to develop Afghan ore

A consortium of Indian companies led by state-owned SAIL has won the status of preferred bidder to develop the Hajigak iron ore deposits in Afghanistan.

The consortium Afghan Iron & Steel Consortium (AFISCO), submitted its bid for mining exploration rights at Hajigak which has an estimated reserve of 1.7bnt. The consortium now has the status of 'Preferred Bidder' for blocks B, C and D of the mines with an estimated reserve of 1.28bnt of high-grade magnetite iron ore (with 62-64% Fe content).

The consortium also proposed setting up of a 6.12Mt/y steel plant in Afghanistan in two phases of 3.06Mt each.

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Gauge expansion

Tata Steel has expanded its Rotherham, UK narrow strip mill hot rolled gauge capability to 13.5mm.

The increase in gauge (thickness) will allow customers to source thicker material than before, which offers the potential to increase their product portfolio and source their requirements from one place.

Cahel Ferguson, Tata Steel Commercial Manager for narrow strip, said: "This development keeps us at the forefront of hot rolled narrow strip developments and will appeal to our existing customer base as well as allowing us to increase our footprint globally."

The steel for the narrow strip is manufactured at Tata Steel's plants in South Yorkshire, UK, before being rolled to its final size at the company's mill in Brinsworth, Rotherham, UK.

The narrow strip is manufactured to the specifications demanded by sectors across the world such as cold rollers, keys, agricultural, automotive, yellow goods and aviation.

Finex JV in China

Southwest China's Chongqing Steel and South Korea's Posco will launch an ironmaking project in June in Chongqing province, according to the city's economy and information committee.

The pair will collaborate on the project, which will be built at a cost of $2.4bn, the committee said, with Finex technology a feature of the project.

The technology will allow the companies to save 20% in production costs and create more room for equipment in steel factories.

The production value of the project will reach RMB13.5bn (US$2.14bn) in its first year, earning RMB2bn ($317.5M)in profits and employ 2500 people.

The project is expected to have an output of 3Mt/y of iron and 3.14Mt/y of steel. Chongqing Steel is a state-owned industrial company in Chongqing.

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Chinese property bubble set to burst?

Fears that China's property boom has burst will impact the steel industry. Pic source Freeimageslive.com

Growing concern that a property bubble is bursting in China is leading to increasingly dire predictions for the country's steel industry.

In the February edition of its *China Steel Insight* report, steel consultancy MEPS International argues that these fears are misplaced and that demand for steel in China remains sufficient to support 8% growth in domestic apparent consumption this year.

There is little denying that a property crisis is currently unfolding in China. The cost of homes has fallen for five months in a row, according to SouFun, a company which tracks property prices.

In larger cities such as Shanghai, developers have been slashing prices by as much as one-third.

This is a concern because a downward trend in prices will reverse the logic that has underpinned growth in this industry over the past decade. This has the potential to halt the break-neck pace of construction.

JV for ITmk3 study

Indian state-owned SAIL and Kobe Steel of Japan have agreed to establish a joint venture company to carry out a detailed feasibility study to build an ITmk3 ironmaking plant in India.

Provisionally called Sail-Kobe Iron India Private Ltd, it plans to invest $284M in a 500kt/y ironmaking plant to be built at SAIL's Alloy Steels Plant in Durgapur in West Bengal.

The project would use iron ore from SAIL's mines in Jharkhand. Non-coking coal, sourced within India, is the intended reductant.

ITMk3 uses a rotary hearth operating as a sufficiently high temperature to melt the iron formed to produce nuggets of high carbon iron.

The first commercial plant started operations at Hoyt Lakes, Minnesota, USA as a jv between Kobe Steel and Steel Dynamics Inc in January 2010 but so far has struggled to reach half its design capacity.

After the detailed feasibility study is completed for Durgapur, with the environmental permits having been obtained, plant construction would commence in 2013 at the earliest and the plant would go into operation around 2015.

Anshan to launch service centres

Anshan Iron and Steel Group Corp (Angang) and the South Korea-based LG International have recently signed a letter of intent to set up steel products processing centres' in India and Brazil.

The move reflects Angang's ambition to enter the domestic automotive and home appliances markets. Angang insiders said the company had focused on the materials sectors and the downstream steel products processing areas when investing overseas. It is also offering value added services for the end users through extending its supply chains.

Currently, China's steel market faces overcapacity and weakening demand from downstream sectors, which has weighed on the steelmakers. Seeking opportunities in overseas markets is likely to be a good solution for the large domestic steel producers.

Source: China Metals
e-mail chinametal@xinhua.org

UK group goes bust

Thamesteel, the former Sheerness Steel minimill located at Sheerness, UK has gone into administration.

The company, owned by the Al-Tuwairqi group of Saudi Arabia since 2003, has not produced any steel since November 2011.

The company was set up by the Canadian group Co-Steel in 1972 as Sheerness Steel to produce rebar via the scrap based EAF route. The site was bought and reopened by the Saudi-based minimill group Al-Tuwairqi at the close of 2002, renamed Thamesteel, and reopened as a billet producer exporting to Al-Tuwairqi's plant in Damman, Saudi Arabia.

In 2006, as part of a £40M investment, a bar mill to produce rebar in coil was installed and the Fuch shaft furnace replaced with a conventional EAF supplied by Siemens VAI (Fuchs division) of 95t capacity.

While the furnace is capable of producing 1Mt/y, downstream capacity limits output to 840kt/y of billet and 600t/y of rolled product. Finished product includes rebar, wire rod, round bar and flat bar.

For a profile of the company see *STI October 2009* Vol 33 No7 p32-33.

MSCSA of Wadeville, South Africa, has installed a Red Bud Industries' Sure Grip stretcher leveler.

The stretcher leveler was installed as part of a half line retrofit of an existing cut-to-length line.

It will process material up to 13mm (0.500") at widths up to 2134 mm (84").

Due to trapped internal stresses, once material is cut, it can spring back. Stretcher leveling exceeds the yield in all of the material top to bottom and side to side. As a result, it produces flat material more stable than any other product available, which in turn also eliminates the possibility of spring back.

Breaker upgrade

Danish equipment manufacturer Fractum Aps has completed the tests for the model 100 of its Fractum Breaker.

The model was designed especially for mines, quarries and steel industry for breaking oversized rocks, desculling slag pots and breaking hot red skulls.

The design of the breaker is based on the existing model 200, where the only difference is the smaller size of the breaker and the impact energy delivered.

With the energy level of 100 000 Dj and a weight of 6.6t, the 100 model can be used on more excavators, with the minimum required weight of the carrier of only 30t.

Indian five year policy

India's next five-year plan – the 12th – is due to commence in April and will run to 2017.

Steel minister Beni Prasad Verma, has initiated the drafting of a new national steel policy in view of the changing economic environment, both domestically and internationally.

Under the previous plan, crude steel output is set to reach 100Mt by 2015. According to The Associated Chambers of Commerce and Industry of India consumption in 2015 is forecast to be 122Mt.

Output in 2011 is estimated at 72.2Mt for the calendar year, up 5.7% on 2010. This makes India the fourth largest producer in the world after USA, Japan and China.

Chinese coke output set to rise to 450Mt

Growth of China's coke production is expected to slow to 5% in 2012 from the 11.8% in 2011 due to decreasing crude steel output growth, rising coke production cost and increasing losses for coking companies in the period 2011-2015 (the12th Five Year Plan).

Despite this, total coke output is expected to reach 450Mt in 2012, compared to 427Mt in 2011. Growth in output has declined since Q4 2011.

According to the National Bureau of Statistics (NBS), Chinese coke output dropped 7% or 8.08Mt to 100Mt in the last quarter of 2011. Monthly output bottomed at 6Mt in November 2011 compared to a peak 32Mt in February in the same year.

China exceeded Japan to become the largest coal importer in the world in 2011.

According to the General Administration of Customs, the country's coal imports increased 11% year-on-year to 1824Mt in 2011, outstripping the 1752Mt for Japan, which was 51% less than in the previous year.

Output of the top three coal-consuming industries in the country, namely thermal power generation, crude steel, and cement, grew 13.9%, 9.8%, and 17.2% year-on-year in 2011, which greatly drove up coal demand in China.

Statistics showed that coal consumption in the power sector rose 11.4% y-o-y in 2011, that in steel sector increased by 6.8%, that in building materials was up 7.4% and in chemical industry up 13.5%.

Source China Metals
e-mail chinametal@xinhua.org

Record output in 2011

Megatonnes (Mt)	2011	%2011/2010
Europe	**329.0**	**4.6**
of which EU (27)	177.4	2.8
CIS	112.6	4.0
North Americas	**118.9**	**6.8**
of which USA	86.2	7.1
South America	**48.4**	**10.2**
Africa	**14.3**	**-13.8**
Middle East	**20.9**	**6.9**
Asia	**988.2**	**7.9**
of which China	695.5	8.9
Japan	107.6	-1.8
Australia/New Zealand	**7.2**	**-11.1**
World	**1 526.9**	**6.8**

www.worldsteel.org/?action=stats&type=steel&period=latest

Table 1 World crude steel production 2010-2011

World crude steel production was a record 1.527bnt in 2011, an increase of 6.8% from 2010.

All the major steel-producing countries apart from Japan and Spain showed growth in 2011. Growth was particularly robust in Turkey, South Korea and Italy.

January 2012

World crude steel production was 117Mt in January – 7.8% lower than January 2011.

China's crude steel production was 52.1Mt, down 13% from January 2011. Japan produced 8.6Mt of crude steel in January 2012, down 10.6%. South Korea's crude steel production for January 2012 was 5.1Mt, 9.6% down compared to January 2011.

Germany's crude steel production for January 2012 was 3.4Mt, a decrease of 8.5% on January 2011.

Italy produced 2.2Mt of crude steel in January 2012, 4.6% higher than January 2011.

Turkey produced 3.1 Mt of crude steel in January 2012, 14.4% higher than January 2011.

Russia produced 5.9Mt of crude steel, an increase of 0.4% compared to January 2011. The US produced 7.6Mt of crude steel, an increase of 5.7% compared to January 2011.

Brazilian crude steel production for January 2012 was 2.8 Mt, 0.6% higher than January 2011. The world crude steel capacity utilisation ratio of the 59 countries in January 2012 rebounded slightly to 71.3%, 0.5 percentage point higher than from December 2011.

Compared to January 2011, the utilisation ratio in January 2012 decreased by 9.6 percentage points.

APRIL 2012

16-17 Steel Success Strategies Turkey
Conrad Istanbul, Turkey
www.metalbulletin.com/events

19-20 3rd Annual SBB Green Steel Strategies Conference
Berlin, Germany
www.events.platts.com

MAY 2012

07-10 AISTech 2012
Atlanta, Georgia, USA
www.aist.org/aistech

07-10 7th China International Steel Congress
Beijing, China
www.steelcongress.com

09-11 5th China International Metal Recycling Conference
Beijing, China
www.mc-ccpit.com/recycling

28-30 SEAISI Conference & Expo
Bali International Convention Centre
www.seaisi.org

28-31 Metallurgy Litmash
Moscow, Russia
http://www.metallurgy-tube-russia.com/

30-31 SBB Steel Raw Materials Asia Conference 2012
Singapore Marriott
www.sbb.com/us/Steel_Raw_Materials_Asia_Conference_2012/

JUNE 2012

10-13 Scanmet IV
Luleå, Sweden
http://www.scanmet.info/

18-20 27th Steel Success Strategies
New York, USA
www.worldsteeldynamics.com

19-21 International Metal & Metallurgy Exhibition
Guangzhou, China
http://www.julang.com.cn/english/Exhibition.asp

25-27 18th Iron Ore Symposium
Amsterdam, The Netherlands
http://www.metalbulletin.com/EventDetails/0/4740/18th-International-Iron-Ore-Symposium.html

26-28 Expo Steel - 23rd Brazilian steel conference
Sao Paulo, Brazil
http://www.acobrasil.org.br/congresso2012/eng/programa.php

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Steel industry hopes politicians will fight back against cheap imports from China

By Manik Mehta*

THE US steel industry was relieved after politicians leaders urged the leadership to fight back against cheap Chinese imports.

The industry had been unnerved by a December 2011 court ruling by a federal appeals court that would curtail the ability of the US to fight back against cheap Chinese imports. But Senators Sherrod Brown (D-OH) and Rob Portman (R-OH) urged both Congress and Senate to expedite legislation authorising the Commerce Department to impose tariffs and duties against Chinese imports that benefit from what the steel industry describes as 'unlawful export subsidies'.

Brown said countervailing duties were a critical tool in the hands of the industries to fight unfair trade and protect jobs. He argued that removing the ability of the Commerce Department to apply countervailing duties to illegal subsidised imports from China was putting thousands of Ohio jobs at risk

"Senator Portman and I agree that protecting Ohio jobs from China's unfair trade practices is of the highest importance – and that's why we are urging majority leader Harry Reid and speaker John Boehner to bring forward legislation that will restore the ability of our government to stand up for American jobs through appropriate trade remedies," he said.

Brown and Portman warned that should the Court of Appeals ruling become final, it would severely impact the economy and jobs for thousands of workers.

The American Institute of Iron and Steel, a consumer apex organization which touts itself as the 'only steel-related association which supports free trade', has welcomed the remarks recently made by the US Trade Representative, Ron Kirk, in Geneva, Switzerland. He said the US would eliminate the practice of 'zeroing in anti-dumping cases', ending a long-standing dispute with trading partners and also eliminating threatened retaliation against US exports.

"AIIS is pleased that the US Trade Representative has finally agreed to eliminate a practice that has now been duly confirmed as unfair within the global trading community. The elimination of zeroing, which illogically calculates anti-dumping duties while not taking higher priced imports fully into consideration, has been deemed in over a dozen WTO cases not to be consistent with WTO rules," said David Phelps, president, AIIS.

Buy America

Another landmark ruling for the steel industry comes in the form of a recent judgment delivered by the 3rd US Circuit Court of Appeals that a Pennsylvania law mandating that steel used in public works projects be made in the USA is 'not pre-empted by federal law or is unconstitutional'.

Delaware-based Mabey, Bridge & Shore Inc, part of the Mabey group of companies, an engineering group specialising in bridges, steel fabrication and construction projects, had argued Pennsylvania law prohibiting the use of foreign steel in public works projects, was pre-empted by the national 'Buy American Act.' This states that federal funds shall not be released for highway and transportation financing for road projects unless the steel, iron and other products used in the projects are made in the USA. Mabey also contended that the state law violated the Commerce, Contract and Equal Protection clauses of the US Constitution.

Mabey disputed the state law, arguing that its temporary bridges should be exempted from the federal law which exempted its temporary bridges. The federal law, it said, had an exception for highway and transit materials that include 'no permanently incorporated steel or iron materials'.

While the court agreed on that point, it made it clear that this point of agreement did not have any bearing on the eventual ruling.

Judge Maryanne Trump Barry, writing in an opinion issued January 25 and joined by Judges Thomas M Hardiman and Franklin S Van Antwerpen, said the Buy American Act did not pre-empt Pennsylvania's parallel law and "demonstrates Congress' intent to allow states to enact more restrictive requirements related to the use of domestic steel and, thus, that the Steel Act is not pre-empted."

The Pennsylvania Steel Products Procurement Act, enacted in 1978, mandates that steel products used or supplied in the execution of a public works contract must be made in the USA unless the head of a public agency determines that steel products are not produced domestically in sufficient quantity(-ies) to meet the requirements of a public works product.

But the law apparently had not been enforced against Mabey for more than 20 years because Mabey has been supplying temporary steel bridges, designed to handle traffic and pedestrians, while 'permanent' Pennsylvania Department of Transportation projects are under way. Mabey's products are made out of steel produced in the United Kingdom, the presiding judge for the case said.

US automotives

The US automotive sector is inherent with growth potential for the steel industry which went through a sharp downturn in the recent recession. According to industry estimates, the US car manufacturers, the nation's biggest steel consumers, were expected to produce some 13.4 million vehicles in 2011, up from 10.4 million in 2009. The steel industry is, however, facing competition from suppliers of aluminium, plastics and others which argue their products are lighter and more malleable – factors crucial in enhancing fuel efficiency and design.

To counter such arguments, the steel industry is developing advanced high-strength steels (AHSS) that, as experts put it, employs controlled heating and cooling during its manufacture designed to greatly increase its strength and therefore reduce the weight of a car component by reducing the thickness of the steel used. Production relies on the process of continuous annealing, where the steel is given hot and quench treatments, to modify its microstructure, and so mechanical properties.

This new steel, according to industry experts, represents the 'third generation' in automotive steel, a major advance on earlier 20th century based on carbon as an alloying element. The first oil shock of the 1970s underlined the demand for low-fuel consuming cars achievable by reducing total weight which led to the development of a new class of steel created with the addition of micro alloying elements such as niobium or vanadium.

Some experts say the development of such materials is not revolutionary but 'evolutionary' for the steel industry which is working overtime to demonstrate it is making continuous progress. Car manufacturers are watching but have not passed any judgment yet because, as one New York analyst told *Steel Times International*, it is "too early" to sketch out expectations and applications of such materials. Today's US car contains an average of 175lbs (79.4kg) of advanced high-strength new steel, a level that is expected to double by 2020, while the basic steel content of a car will probably decline to 980lbs (444.5kg) from 1542lbs (700kg).

Coke alternative in BF

Meanwhile, US Steel announced that modules expected to make substitute coke will start production in Gary, Indiana this year. These modules can produce a coke alternative from different types of coal and, once fully operational, will reduce airborne pollutants the facility creates from the coking process.

Speaking with analysts on January 31, John Surma, the company's chairman and CEO, said that the projects at Gary and its Mon Valley Works coke battery project in Clairton, Pennsylvania, would have go into full production in 2013. Carbonyx Inc., owns the technology which US Steel is licensed to use in Gary. The two carbon-alloy substitute production modules in Gary could produce up to 500 000 tons of a coal-based product each year while Clairton could produce about one million tons of coke a year.

US Steel also hopes that its first-quarter performance will improve on higher prices and better demand after the preceding fourth-quarter loss. The company recently forecast improved business from automobile and heavy machinery equipment manufacturers, appliance makers and the energy industry. The construction sector, badly hit by the financial crisis, "may begin the long climb out of the recessionary doldrums," as Surma put it.

Other US based steel companies, including Nucor Corporation have been making similar forecasts for the first quarter of the year. The last quarter of 2011 was challenging for the steel industry, with customers refraining from making large purchases amidst economic uncertainties. Steel prices have been falling and steel producers were further hit by rising competition from European imports. However, the last quarter was also seen as a 'turnaround point' in demand as the US economic outlook improved. ■

*STI New York correspondent

Ternium's investment in Usiminas: – Capital market's and corporate perspectives

Ternium's share price tumbled after it took a strategic stake in Brazilian steelmaker Usiminas. It was unpopular with market investors who considered the price paid too high, but Ternium believe this to be a long term strategy to enter the Brazilian market which would have taken up to a decade if they had pursued their original plan of building a greenfield steel mill.

By Germano Mendes de Paula*

IN mid-January 2012, Techint group's subsidiaries (Ternium, Siderar, Confab and Prosid Investments) acquired a stake in the Brazilian integrated steelmaker, Usiminas, a flat products producer with a crude steel capacity of 9Mt/y and its own ore mines capable of producing 6Mt/y. This move by Ternium which until now has concentrated its operations in Argentina and Mexico, was an important step towards consolidation in the South American steel market. However, this transaction has received many criticisms from capital market analysts, stressing the remarkable differences between the approaches used by Wall Street (focusing on short and mid-term periods) and by industrial companies (long-term period).

Reconnecting corporate links

As discussed in a previous article (*STI, Jul-Aug 2010, p 12*), Usiminas had acted as the preferred technological partner of Ternium from 1992 onwards. In April 2010, Ternium announced that it would invest in the Brazilian steel market via a greenfield project. The following month, Usiminas unveiled its intention to sell its minority shares in Ternium. This was undoubtedly a recognition that the strategic alliance was in trouble.

In February 2011, Usiminas sold its 14.2% participation in Ternium for $1.03bn. The divorce was then consummated. Nonetheless, in November 2011, Ternium and other Techint subsidiaries announced the purchase of 27.7% of Usiminas' ordinary shares (that is equivalent to 13.8% of Usiminas' total shares) for roughly $2.7bn, which implied a premium of over 80% in relation to the stock market price at that time. The strategic alliance would thus be re-established, but the holdings between the two companies would be the reverse of that in 2010 with Ternium now holding the share in Usiminas.

Capital market's criticism

Considering that Companhia Siderúrgica Nacional (CSN) had clear ambition to acquire more shares in Usiminas, and a merger between Usiminas and Açominas (controlled by Gerdau) would be a possibility, Ternium has won an important battle in the South American steel market. However, this was not the predominant view of capital market analysts.

According to Barclays, the price paid by Ternium was too high: "*Even after TX [Ternium] and Usiminas' conference calls to explain the transaction, we still struggle to fully understand why TX paid such a high premium to gain exposure to the Brazilian steel market. While we acknowledge that entering the Brazilian market was an old objective of TX management, we consider the transaction's high premium as significantly NPV (net present value) dilutive (we calculate a transaction IRR (Internal Rate of Return) of only 6.3% vs our cost of capital for TX at 13.5%). In summary, we would have preferred other alternatives for capital allocation and have reduced our level of confidence in management's ability to generate shareholder returns*".

The Bank of America Merrill Lynch's analysts criticised the reduced synergies: "*Expensive valuation, low returns & lack of strong rationale: We see limited synergies in this deal and estimate the valuation could only be justified with a US$250-300M annual gain for TX. As an efficient steel operator, TX could add value to Usiminas through better operating practices, but the lack of full control and tough operating dynamics in Brazil are obstacles. Presence in Brazil could be LT [Long-Term] strategic, but paying peak valuations is unjustified, in our view*".

Latin American headquartered Itaú-BBA Bank highlighted that the deal does not solve Ternium's strategic goal of reducing its dependence on third-party slab.

Even the choice of the new CEO, Julián Eguren, was criticised by Citi: "*Mr Eguren has been highly successful running Ternium's Mexico business and would be a loss to the core franchise. Moving Mr Eguren would appear to be a strong sign that Ternium has bigger plans for Brazil than its current 11% equity stake in Usiminas. This is potentially negative since investors are concerned about ROI (*Return on Investment*) on any investment in Brazil steel*". In other words, the choice of a good manager, paradoxically, can be a negative signal, as it may suggest an increase in investments.

Not surprisingly, Ternium's stock price has dropped (**Fig 1**). On November 16th, the day before the company confirmed that it was engaged in discussion with Uniminas' shareholders involving a potential acquisition, each share was equivalent to $25.20. It decreased to $20.67 on November 17th and to $16.03 on November 28th, the day after the transaction was announced. Therefore, it lost 36% of its market capitalisation in just twelve days. On January 17th, the day after the transaction was completed (and also the day that this article was written) the stock had partially recovered to $20.89.

The corporate approach

Mr Pedro Pablo Kuczynski, a Techint consultant, was quoted in mid-December in a seminar held by Argentine consulting company Abeceb saying that many market capital analysts have criticised the purchase of the shares in Usiminas. According to him, there is a misleading, because they "*do not understand that Techint is introducing new standards of efficiency in a company that was unable to improve its productivity*". In addition, he emphasised the benefits of controlling iron ore assets.

Fig 1 Ternium's share price tumbled in November following taking a major stake in Usiminus

Trying to comprehend the investment made by Ternium in Usiminas, Itaú BBA analysts mentioned that: a) Ternium was highly concentrated in just two countries (Argentina and Mexico); b) Ternium had a very limited footprint in Latin America's largest market – Brazil, which still offers strong growth potential; c) Ternium was a long-term player and likely believes that the current low profitability of Brazilian steel companies would reverse in the future; d) there is a possibility of Usiminas going ahead with a project to increase slab capacity and so guaranteeing a supply to Ternium; e) an iron ore supply guarantee for Ternium's operations in Argentina; and f) potential efficiency gains and synergies between Usiminas and Confab (also controlled by the Techint group).

Most importantly, this transaction delivers a quicker time-to-market and less competition in comparison with a greenfield project, which obviously would add new capacity.

Let us suppose that Ternium had not acquired the stake in Usiminas and decided to enter the Brazilian market with a greenfield project. It would take at least three to four years to build the mill. It is reasonable to assume that, in the first stage, this mill would produce only slabs. Another two to three years would be required to engage in vertical integration into rolled products. Add some two to three years to ramp-up output and to establish a commercial network, it would thus need roughly eight to ten years to reach a significant role in the Brazilian flat steel market. Added to this, Usiminas would be controlled by a competing player, such as CSN. Ternium was thus prepared to pay a large premium to avoid ten years to become established in Brazil and to gain a central role in the Brazilian steel arena. It is just a matter of gaining time and, consequently, paying the implicit 'interest rate' arising from it. ■

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China's demand for coke in 2015 to reach 380Mt

A slowdown in steel demand in China has resulted in a fall in the requirement for coke which has depressed prices to an extent. While some 25.3Mt of obsolete cokemaking capacity was closed in 2011 this was balanced by 23.5Mt of new capacity put on stream that year. **By Shi Lili***

CRUDE steel consumption in China in 2015 will be around 750Mt according to China's Industry and Information Ministry. This will require 1.13bnt of iron ore and 380Mt of coke. China has over 7000 steel mills, of which 500 produce crude steel.

The output of these 500 steel producers in 2011 was 659Mt. Production of the top four crude steelmaking enterprises accounts for 27.8% of total national wide production which is much lower than the level of concentration in USA (70%) or Japan or S Korea (90%).

This low level of concentration in the steel industry in China has given rise to duplication of investment in various plants and disorderly competition. Based on a plan launched in 2012, the concentration of output of the top 10 steel mills should increase to 60%.

This is to be achieved by mergers and acquisitions among China's steel mills, but a difficult task lies in the large scale of the industry, its diverse ownership and the fact that it is scattered over a wide geographic area.

Poor steel demand reducing coke requirement

China's domestic economy started to slow down due to the pressure from the adjustment of the real estate sector, drops in investment in infrastructure, and the deterioration of the economies of Europe's Euro Zone countries.

Such multiple pressures give rise to a slowdown of downstream steel consumption which in turn reduces the demand for coke.

It is projected that the demand for coke in China during 2012 will grow by just 3 to 4% over 2011.

Surplus of steel to demand requirements is still the major challenge for the whole industry which has damped down the price of coke, but also a limited supply and the relatively monopolistic ownership as well as the fact that thermal coal will continue to increase in price by a narrow margin in 2012, means the price of coking coal is expected to remain relatively strong. So there will be only limited room for a drop in the price of coke for steelmaking.

The output of crude steel is not expected to grow dramatically in 2012. The steel industry is the major downstream consumer of coke, accounting for around 80% of consumption in China at present. Being affected by the slowdown of infrastructure projects as well as construction and real estate, as well as a tightening of domestic credit, crude steel production witnessed a fall in growth rate in 2011.

This was especially evident during the second half of 2011 when crude steel production dropped on a month-on-month basis along with a weakening of the domestic steel market. Crude steel output in 2011 was 683.26Mt compared with 626.5Mt in 2010 a 9% increase, a growth rate similar to that in 2009/10.

As for the downstream steel consuming industries, investment in real estate began to slow in 2011. The growth in infrastructure projects in the second half of 2011 (July to November) remained strong at 24.5%, although this showed a drop of 1.1% in the first half 2011 – January to June.

In November 2011, the growth in sales of residential buildings in China dropped to 8.5% and the increase in square metres of new house builds dropped to 20.5%, which was significantly lower than the average increase of 30% during the first half of 2011.

Other steel consuming markets such as automobiles, household appliances, machinery, ships, etc are also not optimistic. Crude steel production in 2012 is forecast to be between 710 to 720Mt, which is 5 to 6% lower than previously expected and the growth in output is much lower than in 2011. This will reduce growth in coke demand. Therefore, China's domestic consumption for coke in 2012 is predicted to grow by just 3 to 4% over 2011.

Surplus coke production

To meet the fast growth of crude steel and pig iron output in 2010, China's domestic coke production reached 387.6Mt, up 9.13% from the year earlier. Growth in coke output exceeded that of pig iron which increased by 7.42%.

China's coke production continued to maintain a fast growth in 2011, with the total output for the whole year at 428Mt, which was a jump of 11.8% on the year earlier. In comparison, output of pig iron and crude steel during 2011 increased by 8.4% and 8.9% respectively over 2010, based on figures from China's National Bureau of Statistics. In 2012, output of coke is forecast to reach 450Mt despite a fall in growth rate to 5% from 11.8% in 2011.

The surplus in cokemaking capacities resulted in several adverse results. One is the lowering of profits in the cokemaking industry and its inability to lower or manage production costs.

Another is that most enterprises are forced to restrict production to maintain market prices at a time when there is lifeless demand downstream in the steel market. For example, since Q4 of 2011, coking enterprises in Jiaohua, Shanxi Province have been forced to reduce or lower production by around 30% to 50% due to lukewarm market demand.

As for adjustments in production capacities, although the Chinese government enforced 'energy saving and pollution reduction' measures in 2011 and tried to eliminate obsolete plant, new coking capacities inside the country continued to grow rapidly. Based on statistics from the China Coking Association, there were 42 new build coking batteries completed during January to November 2011 adding 23.54Mt of new capacity.

These new builds were mainly a result of mergers of cokemaking companies and expansion into downstream activities in by-products. According to the China Industry and Information Ministry, there were 25.33Mt of obsolete capacity eliminated in 2011, a figure very close to the newly added capability.

Coal prices

Changes in the price of coking coal have a direct impact on the cost of coke production. Along with the slow down in the domestic economy in Q4 2011, the domestic steel market remains sluggish.

Steel mills and coking companies had to reduce production due to the weakening downstream demand. The price of coke in the major producing regions started to drop from their high position.

Forecast

In 2012, China's domestic steel output is expected to grow at a slower pace than 2011 and the price of coking coal is under strong pressure to fall. Although the price of coke in 2012 is expected to weaken, it will not necessarily witness a strong downturn.

The overall coke market is expected to stay high but with small fluctuations and will not deteriorate significantly due to high transport costs. In addition, due to the present finite availability of coking coal reserves and the monopoly held by the state to develop these, the Chinese government has already carried out detailed exploration for coking coal but little increase in reserves have been found.

Imported coking coal met 10% of China's demand in 2011, at a time when imported coking coal had no advantage in price over domestic. Total imports in the first ten months of 2011 remained at 34.54Mt, a fall of 3Mt compared with the same period in 2010.

Because of the reduced international demand in 2012, Japanese steel and Australian mining companies reached an agreement to reduce the coking coal price by US$50/t to $285. Such a drastic drop may encourage Chinese buyers to go overseas for resources.

But compared with the huge demand for coking coal by China's domestic market, the amount of imported coal is only 'a drop in the ocean' of the total demand. ■

*STI correspondent in China

Glut of steel in China likely to last throughout 2012

The glut of steel in China is likely to last throughout 2012 due to the weakening demand from the downstream sectors. The country's total output of steel will continue to increase in 2012, but the growth rate will slow. China produced 52.1Mt crude steel in January as estimated by the China Iron and Steel Association (CISA). This was 13% less than in the same month last year. The daily output was 1.68Mt, roughly the same as that in December, and was the third consecutive month when daily output was below 1.7Mt.

This drop was much greater than those of its neighbours Japan and South Korea, and almost twice that of the average global rate of crude steel production which stood at 7.8%, according to the World Steel Association.

Source: China Metals
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Growth in Asia continues to be key for 2012

2011 was an unforgettable year for Asian economies, a time punctuated by the great loss of human life and capital stocks in Japan following the Great East Japan Earthquake and Tsunami, while Thailand experienced the worst floods on record which severely damaged major industrial areas vital to the global manufacturing supply chain. In Europe, the sovereign debt crisis, triggered by Greece, continues to present a serious headache to the global economy in 2012. However, in Asia, modest, but stable growth of economies and steel markets are expected to continue, led by demand increases in the world's largest market – China. While there remain many risk factors, growth in Asia continues to be key for the global economy in 2012. **By Nobuhisa Iwase***

CHINA, the giant Asian economy which appears unstoppable, recorded a 9.2% growth in GDP in 2011. Although the figure was less than that of 2010, (10.4%), it was still good enough to bring about an appropriate positive impact on economic developments in Asia and also on a global scale. Fixed capital continued to lead the country's economy with an increase of 16.1% in real terms and 23.8% in nominal terms.

The Chinese government has attempted to curb the progressive overheating of the country's economic development, which is causing a bubble in real-estate markets, and also is trying to control inflation as a priority.

Based on the statistical figures announced by the government, measures to promote a 'soft-landing' of the economy have been successful to a certain extent. The quarterly GDP growth rate slowed from +9.7% in Q1 of 2011 to +9.5% in Q2, to +9.1% in Q3 and +8.9% in Q4.

2011 was the first year of China's 12th 5-year social and economic development plan which runs to 2015. Many economists in China forecast the country's GDP growth rate will be between 8 and 9% and inflation to be around 3 to 4% in 2012. At the start of the 12th 5-year plan the government set a target of 7% as the average annual GDP growth between 2011 and 2015.

Japanese exports

Given the relatively stable economic development in the Asian region, Japan's iron and steel exports continued at near record high levels in 2011. Although the total export volume declined 5% to 41.2Mt, the figure was still the second largest ever which had occurred in 2010 (**Table 1**). The total value of exports in US dollar terms reached $49.6bn, up 10.6% on the previous year. This increase in dollar term reflects some positive effects of the continuing appreciation of the yen, while the decline in volume includes some negative impact due to the yen's strength.

Supported by the continued strong export market, production of both pig iron and crude steel in Japan remained at a high level in 2011. Crude steel output reached 107.6Mt, a 1.8% decline from the previous year, while pig iron production at 81Mt, was a 1.5% decline from 2010. Both figures, however, are more than 20% higher than those of the difficult time in 2009 following the failure of Lehman Brothers bank.

When examining production and trade figures in major Asian steel producing countries, some differences can clearly be seen between them and Japan. From 2009 to 2011, output of pig iron and crude steel in South Korea grew by +55% and +41%, respectively, while that in Taiwan increased +63% and +42%, respectively. These growths far exceeded those seen in Japan. The sharp increases in Korea and Taiwan are attributable to further expansion of production capacities for both ironmaking and steelmaking.

South Korea

In Korea, Hyundai Steel celebrated the start of commercial operation of its No1 blast furnace in April 2010, which marked the eventual realization of Hyundai Group's long-time dream of entering the integrated steel business. The new steel plant is located in the coastal town of Dangjin, about 120km southwest of the capital Seoul. The blast furnace has an inner volume of 5250m^3 and has a capacity of 4Mt/y. Downstream, there are two wide hot strip mills, one conventional and one CSP thin slabs, and a bar mill.

Furthermore, the company completed construction of its No 2 blast furnace in November 2010 which will give it a total capacity of 8Mt/y of crude steel production at Dangjin.

Hyundai Steel was already the world's second-largest EAF steel producer following the acquisition of the troubled former Hambo Steel in 2004 at Incheon. It also has an EAF steel mill at Pohang. The company embarked on a massive investment and construction project to build blast furnaces in 2006 to produce high-quality virgin steel for the manufacture of cars, ships and consumer goods. Hyundai Steel is part of the huge Hyundai-Kia Automotive Group that has around 60 large companies, including automobile assembly plants around the world manufacturing Hyundai Motors or Kia Motors, as well as owning the world's largest shipbuilding company.

Hyundai Steel closely cooperates with its affiliates in the Hyundai-Kia Automotive Group, and the steel company plans to start to increase supplies to both Hyundai and Kia Motors in 2012. The group's other steel processor, Hyundai Hysco, specialises in producing cold-rolled coil. Furthermore, Hyundai Steel started construction of its No 3 blast furnace at Dangjin in April 2011, which will lead to a further increase in the company's crude steel production capacity in 2013 to 24Mt/y, including EAF capacities of 12Mt/y.

It is reported that the Hyundai Group as a whole plans to invest around $12bn in 2012 both in its domestic and global operations, a 16% increase over the 2011 figure, which is a record high for the group.

The Bank of Korea forecast the country's GDP for 2012 as 3.7%.

The impact of this increased capacity has already been felt in Japan. A decline of steel exports to Korea and an increase in imports from there in 2011 shows import substitution is taking place in Korea but also the effect of a relative depreciation of the Korean Won has impacted trade. It is necessary for Japan to watch carefully the degree of this trend in the medium and long-term.

However, it is also most likely that the Asian economies, particularly China, will continue to record modest growth in 2012 and into the future.

Japanese integrated steel producers will continue to supply high-grade steel products that are consumed and processed by Japanese companies investing in Asia in the steel-consuming sector as well as supply Japanese domestic companies and Japanese owned companies, some even located in South Korea.

The globally linked industrial chains, particularly in East and South-eastern Asia, will ensure that the Japanese steel industry will continue to enjoy relatively good market conditions in 2012. However, it will also be true that the growth of Asian countries will continue to be key to the world steel market, particularly for Japan. ■

Exports	Volume (kt)	% change	Share	Value (US$M)	% change	Unit price (US$/t)	% change
TOTAL	**41 240**	**-5**	**100 00.0**	**49 616**	**10.6**	**1 203**	**16.4**
Semi products	5111	-15	12.4	3270	19.4	640	21.3
Plate	3672	-3.4	8.9	3338	16.6	909	20.7
Hot rolled coil	8728	-4.5	21.2	6543	9.6	750	14.8
Cold rolled coil	3713	-7.4	9.0	3317	1.7	893	9.9
Galvanized sheet	4935	-12.4	12.0	5033	-0.8	1,020	13.2

Exp. & import by destination (origin)	Export by volume (kt)	% change	Share	Import volume (kt)	% change	Net exports* (kt)	difference in kt
to (from) Korea	8853	-19.2	21.5	3704	29.9	5150	-2956
to (from) China	6899	-8.2	16.7	1511	6.4	5388	-707
to (from) Taiwan	3525	-4.6	8.5	956	15.8	2570	-300
to Thailand	4618	-4.5	11.2	(World total)		(World total)	
to USA	1330	35.9	3.2	**8301**	**15.2**	**32940**	**-3266**

*: Figures in the right column (difference) show changes of Net Exports from those of 2010 (Kt).

Source: Japan Iron and Steel Federation

Table 1 Exports and imports of iron & steel from and to Japan in 2011 (kt)

* An independent steel economist, Karuizawa, Japan, Email nobykaru@seagreen.ocn.ne.jp

Optimising slag composition & gas purging in a LF to reduce noise and improve refining

The modification of slag properties by the addition of calcined bauxite to the flux mix added to the ladle during tapping from the BOF produces a more fluid slag. This, along with the ability to add ferro-alloys and carbon during refining in the ladle furnace to foam the slag, has resulted in a reduction in noise level during arcing, a fall in purging gas consumption of 30%, improved refining in a shorter time and cleaner slag removal from the emptied ladle.

By K K Keshari*, S Kumar, S Roy & T K Pratihar

A fluid slag is essential for good refining

STRINGENT quality requirement of customers with respect to inclusion rating and strict chemical composition have maximised the use of Secondary Refining processes in steelmaking. The Ladle Furnace (LF) is the most versatile secondary refining unit requiring low installation cost and serves to meet most of the quality requirements except degassing. But a poorly designed flux practice and gas-purging regime in the LF leads to the formation of a viscous slag during refining and exposure of the metal bath surface. Poor fluidity of the refining slag and arcing on the bare metal bath produces a high noise level during arcing and disturbs the normal working environment around the LF. Therefore, an optimum slag composition and properly designed gas purging regime is essential for smooth functioning of secondary refining units. In the present work, slag composition and the gas purging regime has been optimised to ensure a fluid top slag in the ladle with the desired surface turbulence for temperature homogenisation and smooth arcing at a reduced noise level. The work was carried out in a LF at the Steel Authority of India (SAIL) Durgapur steel plant.

The Steel Melting Shop (SMS) of Durgapur Steel Plant (DSP) was commissioned in 1994 with three BOFs, two Argon Rinsing Units (ARU) and two six strand billet casters. The shop was modernised in 2008 with one four strand bloom caster, two 120t capacity in-line LF for refining steel supplied from any two of the three converters (one being idled for maintenance). There is a common control room for LF-1 and LF-2 which is located between the steel transfer car rails due to space constraint in the shop. Mostly Si-killed and semi-killed grades of steel are produced which are continuously cast through either the six strand billet caster or the four strand bloom caster. The deoxidation practice adopted at DSP is to use carry-over slag from the primary BOF vessel into the ladle on tapping to which a flux addition is made leading to the formation of a highly viscous top slag in the ladle. The ladle is then conveyed to the LF where the presence of this highly viscous slag during refining results in insufficient mixing of slag and metal, and, when this is coupled with the high gas flow rate required for temperature homogenisation during arcing. This higher gas flow rate is necessary to dissipate the intense heat of arcing from the top zone to the entire melt to avoid any refractory failure in the slag zone of the ladle. Hence a high flow rate during arcing is maintained when the slag is viscous in nature. This not only reduces the refining efficiency but also leads to a high noise level, especially when both ladle furnaces coincide at the arcing stage of the refining cycle. A critical analysis of the secondary refining practices at DSP and characterisation of the refining slag revealed the following probable operational parameters or a combination of these are responsible for the high noise level during arcing;

- High melting point and viscosity of refining slag;
- High gas flow rate;
- Arcing on bare metal bath.

A fluid slag in secondary refining units improves slag-metal mixing for de-sulphurisation, absorbs the de-oxidation products, reduces gas consumption, helps in slag dumping from the ladle after casting is completed and avoids formation of a slag roof in the slag zone of the ladle. It is important to design a slag chemistry to produce a top slag with a low melting point (40-50°C lower than the liquidus temperature of the steel grade being cast) to maintain a liquid top slag in the ladle even at the completion of casting. A high fluidity (low viscosity) of the slag is an essential requirement for smooth functioning of secondary refining units.

Theoretical understanding

Slag viscosity

The fluidity of the refining slag plays an important role in governing the heat transfer and fluid flow behaviour during ladle treatment. The slag used in ladle refining consists mainly of a mixture of CaO, SiO_2, Al_2O_3 and MgO. Any change in the composition of these constituent changes the melting point (MP) and viscosity of this refining slag. A study of viscosity by P G Jonsson, L Jonsson & D Sichen[1] revealed the effect of the replacement of CaO by Al_2O_3 on viscosity. The three slags have the same MgO and SiO_2 contents, viz, 10% MgO and 10% SiO_2 but a slight change in the ratio, wt% Al_2O_3 / wt% CaO results in a considerable change in the viscosities in the range of temperatures of interest for refining.

Ladle stirring and mixing time

Argon purging by bubbling through porous plugs mounted in the ladle bottom is the most important requirement in every secondary refining operation to achieve a homogeneous temperature and composition of the steel in the ladle. Secondary refining operations are designed to achieve the necessary physico-chemical conditions of the product depending upon the steel grade to achieve the various refining steps such as de-sulphurisation, inclusion flotation and sulphide shape modification.

Homogenisation of the bath temperature and composition by bubbling gas through the melt in the ladle, primarily results from a combination of the dissipation of the buoyant energy (true buoyancy) of the injected gas, the work done by volume expansion of the gas due to its increase in temperature, a decrease in hydrostatic pressure during the bubble's rise through the steel and the transfer of kinetic energy of this purging gas to the melt. The effective stirring power of the purged gas is expressed by the following thermodynamic relationship derived by Nakanishi[2]

$$\dot{E}_b + \dot{E}_{ex}^{(2)} = 371 Q_0 T_b \left[2\ln(1+0.67H) - \frac{H}{1.50+H} \right]$$

Where;

$\dot{E}_b$ True buoyancy power
$\dot{E}_{ex}^{(2)}$ Expansion work per unit time by gas on the bath during rise
Q_0 Gas flow rate at NTP in Nm^3/sec
T_b Bath temperature in K
H Bath depth in m

The stirring time to achieve 95% homogenisation is defined as the mixing time 't'. A relationship expressing the mixing time t, in terms of the stirring power 'ε' (Watts/tonne), ladle diameter D (m), and depth of injection H (m) was obtained by Mazumdar and Guthrie[3] and is most commonly used for calculating mixing time.

$$\tau(s) = 116(g)^{-1/3}(D^{5/3}\, H^{-1})$$

The effect of the location of the bottom stirring plug on mixing times has been studied by several authors and the common finding is that the mixing time decreases when the bottom stirring plug is placed off-centre ie, at half the ladle radius.

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Sample No	CaO (%)	SiO_2 (%)	MgO (%)	Al_2O_3 (%)	MP (°C)	Viscosity at 1600°C(Pa s)	Basicity
1	44.67	29.71	12.00	2.89	1517	1.507	1.50
2	48.38	24.01	10.01	3.32	1515	2.209	2.01
3	49.43	23.90	08.94	2.43	1520	2.607	2.07
4	45.09	28.62	10.09	2.68	1521	1.672	1.58
5	45.08	29.01	11.75	2.70	1517	1.618	1.55
6	40.41	28.10	12.39	2.88	1514	1.364	1.44
7	45.44	26.59	10.83	5.08	1511	1.405	1.71
8	47.20	24.48	09.30	1.90	1521	2.480	1.93
9	41.03	22.22	17.05	5.59	1489	1.313	1.85
10	45.26	29.07	10.83	3.95	1517	1.418	1.56

Table 1 Calculated melting point and viscosity of LF final slag for original practice

Flux and ferro-alloy addition

When the slag on the top of the metal in the ladle is viscous high purging gas flow rates are required for mixing and this can result in an area of bare metal appearing at the surface unprotected by slag. The arc strikes directly onto this bare metal producing a loud noise and also causing metal to splash.

The addition of a flux and a high carbon ferro-alloy during arcing at an optimised rate makes the slag foam, which in turn, helps to reduce the noise level as well as reducing metal splashing. Most new LF installations have a facility for flux and ferro-alloy addition during arcing but the original design of the LF at DSP did not enable additions during arcing due to the many electrical interlocks and the positioning of the discharge chute.

Modification from the present flux and ferro-alloy addition system to enable additions during arcing has other benefits apart from noise reduction ie:

- Reduction in processing time since no separate time is required for flux and ferro-alloy addition;
- Faster lime dissolution and better desulphurisation reaction;
- Regular addition of flux and ferro-alloy during arcing acts as coolant and keeps the top zone temperature low and hence improves slag zone life of the ladles;
- Ensures ease of operation during refining and improves heating rate.

Steel refining practice

The process route adopted for steelmaking and refining at DSP, Durgapur is:

BOF - LF - CC (Bloom/Billet). The average number of heats processed through the two LFs per day is around 38. To understand the specific reason for poor performance (low slag fluidity, high noise level during arcing and high gas consumption) the existing practice of secondary refining was studied in detail. Ladle top slag samples were collected at the LF final stage of refining to measure the slag melting point and viscosity using empirical correlation.

Analysis of the existing practice of steel refining at the LF revealed the following probable operational parameters or their combination are responsible for highly viscous slag and high noise level during arcing;

- *High Melting Point and Viscosity of Refining Slag:*

The theoretical calculation of the slag melting point by empirical correlation for normal heats showed that the average melting point of the slag was ~1514°C (**Table 1**) which is close to the liquidus of the 0.20%C steels normally being processed through the LF. It is well established that the difference in MP of slag and liquidus should be a minimum 40 – 50°C to help maintain a fluid slag cover during refining and casting. The evaluation of dynamic viscosity at 1600°C (1.80 Pa s) indicates that the slag is highly viscous in nature. Optimisation of slag composition and adoption of suitable flux addition practice is necessary to make a fluid top slag for smooth operation of the LF and absorption of de-oxidation product and non-metallic inclusions.

- *High Gas Flow Rate:*

The study of the steel refining process at DSP revealed wide variation in input gas flow rate of 20-30Nm^3/h during arcing and 60-65Nm^3/h during mixing. Processing the heat at such high flow rate leads to great surface turbulence causes metal electrode 'bumping' during arcing, metal splashing and high specific gas consumption. The stirring power requirement (Watts/tonne) has been calculated for DSP ladle conditions and was found to be very high during arcing (**Table 2**).

- *Arcing on Bare Metal Bath:*

High gas flow rate and a highly viscous slag exposes the metal bath region immediately above the location of the porous plug and forms an open 'eye'. Arcing on the bare bath exposed produces loud noise and also splashes metal onto the LF hood reducing yield and causing the hood to jam.

Optimising the gas flow rate as well as the fluidity of the slag to always ensure a thin slag layer is maintained on the metal surface and an envelope of slag around the arc reduces the noise level during arcing and prevents steel re-oxidation.

Flow (Nm^3/hr)	Flow (Nm^3/min)	Bath wt (t)	Bath ht (m)	Pressure (atm)	Bath temp (K)	Nakashi St power (Wt)	Themelis St power (W/t)
10	0.167	120	3.90	1.00	1873	41	41
15	0.250	120	3.90	1.00	1873	62	62
20	0.333	120	3.90	1.00	1873	82	82
25	0.417	120	3.90	1.00	1873	103	103
30	0.500	120	3.90	1.00	1873	124	124
35	0.583	120	3.90	1.00	1873	144	144
40	0.667	120	3.90	1.00	1873	165	165
45	0.750	120	3.90	1.00	1873	186	185
50	0.833	120	3.90	1.00	1873	206	206
55	0.917	120	3.90	1.00	1873	227	227
60	1.000	120	3.90	1.00	1873	247	247

Table 2 Gas stirring power for DSP ladles

Industrial experimentation

Based on the theoretical stirring power, the rate of energy input to the system was designed keeping in view the stirring power (W/t) requirement for the arcing and mixing of a 120t of steel in the ladle. The flux and de-oxidation practice were modified by the addition of Al_2O_3 in the form of calcined bauxite added to the ladle during tapping of the BOF to achieve an optimum slag composition of low melting point and viscosity.

A plant trial was carried out by adding 500kg of calcined bauxite per heat to the ladle during tapping the BOF. This was made for 15 experimental heats by placing the bauxite in a container which was positioned over the side chute feeding the ladle during tapping the BOF.

The gas purging of experimental heats in the LF were carried out at 10Nm^3/h during arcing and 30Nm^3/h for mixing operations. The flux and ferro-alloy addition (FAFA) system was modified to enable addition of ferro-alloy during arcing without any interruption except when adding pet coke and aluminium which is necessary when producing certain grades of Al-killed steel (eg SAIL Tower, SWR-14, CK-45). If pet coke and Al are added during arcing loss of these materials results due to them burning under the arc.

The encouraging result in the LF instilled confidence to the steelshop management and three dedicated bunkers in the BOF shop, one for each of the three converters, have been commissioned for regular additions of calcined bauxite.

To assess the effectiveness of the modified flux practice, ferro-alloy addition practice and optimised gas purging regime, data was collected for gas consumption in the LF as well as the noise level during arcing measured when refining the experimental heats (**Table 3**).

Sound monitoring was carried out with the assistance of the Environment Management Department (EMD) of DSP and showed a reduction in noise during arcing when using a fluid slag and optimised gas purging. The LF final slag was also collected to determine the viscosity and melting point of the modified slag (**Table 4**).

In all the experimental heats, the slag was completely fluid in nature. In one of the trial heats, slag became highly fluid because of low carry over of slag from the BOF to the ladle. In this heat, more bumping was observed during arcing in the LF.

In order to avoid this kind of situation and to further optimise the calcined bauxite addition, the bauxite addition was reduced from 500kg to 350kg in steps. After subsequent experiments, it was observed that 350kg/heat of calcined bauxite is optimum for the conditions at DSP. Although there was no spare bunker at the LF some 50kg bags of calcined bauxite are kept by the LF to be added through the hopper if necessary after physical observation of the condition of the slag.

The noise level during arcing in the LF was significantly reduced. The ladle condition after casting was completed and the ladle changed was also monitored and it was found that the dumping of the remaining slag improved leaving the ladle bottom comparatively clean. Regular use of calcined bauxite in all the heats has also eliminated the problem of thick slag roof formation in the ladle slag zone.

Result and discussion

- *Slag Fluidity and Melting Point:* The physical observation of the experimental heats treated with calcined bauxite and using the lower gas purging rates showed that the refining slag in the LF was much more fluid compared with established practice.

The analysis of the slag and determination of slag properties using empirical correlation supported the physical observation. The slag viscosity was reduced from 1.80 to 0.59 Pa s at 1600°C and slag melting point reduced from 1514°C to 1449°C.

- *Noise level:* The introduction of the stirring gas through a porous plug in the ladle bottom at a controlled flow rate coupled with a fluid slag maintained the desired stirring power for arcing and mixing. This helped to reduce bath metal exposure and always maintained a fluid slag layer over the complete surface of the metal. The fluid slag layer between the electrode tip and metal bath suppress the loud noise level during arcing. The noise level measured shows dramatic reduction of dB(A) in trial heats, bearing in mind the results presented in **Table 3** are on a logarithmic scale.

	Distance from sample door (m)	Initial arcing dB (A)	Mid time of arcing dB (A)
Earlier Practice			
	1	103-108	98-105
	10	100-108	96-101
Experimental Heats			
1.0	1	88-96	83-87
2.0	1	89-100, 84-92	92-96, 94-96
3.0	1	96-100	84-90
4.0	10	88-93	88-93, 92-93
5.0	10	92-94	91-92
6.0	10	91-93	89-91

Table 3 Comparison of noise level during arcing

Table 4 Calculated melting point and viscosity of LF final slag in experimental heats

Sample No	CaO (%)	SiO_2 (%)	MgO (%)	Al_2O_3 (%)	MP (°C)	Viscosity at 1600°C(Pa s)	Basicity
1	43.17	18.01	11.55	13.71	1457	0.674	2.40
2	40.11	21.45	12.77	12.97	1447	0.553	1.87
3	42.44	20.41	11.59	12.27	1451	0.697	2.08
4	42.58	18.70	10.45	13.69	1449	0.632	2.28
5	40.90	18.60	11.40	16.16	1441	0.438	2.20
6	41.61	19.97	11.54	13.97	1447	0.558	2.08
7	40.94	21.82	9.89	14.84	1449	0.446	1.88
8	46.00	20.80	10.02	12.67	1456	0.776	2.21
9	42.21	19.90	10.24	14.38	1448	0.544	2.12
10	42.82	18.69	12.09	14.12	1445	0.618	2.29

- *Gas consumption*: Two basic operations ie, arcing and homogenisation of melt with respect to, temperature and chemical composition in the LF have different stirring power requirements.

Optimisation of the gas flow rate for the conditions at DSP and the plant trial shows a reduction in specific gas consumption by 30% – from 145Nl/t to 97Nl/t. ■

Reference

1 P G Jonsson, L Jonsson & D Sichen, 'Viscosities of LF Slags and Their Impact on Ladle Refining' ISIJ International, Vol 37 (1997) No 5, pp 484-491

2 M P Schwarz, 'Buoyancy and Expansion Power In Gas-agitated Baths' ISIJ International, Vol 31 (1991) No 9, pp 947-951

3 D Mazumdar and R I L Guthrie, Met Trans B, 17B (1986): 725

Sulphur control measures for the production of rail steel at Bhilai Steel Plant

To control the level of sulphur in rail steels to be consistently at 0.015% or below in the Bhilai Steel Plant, a two stage desulphurisation treatment is now employed in which the blast furnace hot metal is first treated by co-injection of a Mg compound plus CaC_2, and subsequent treatment with a synthetic slag former ($CaO - Al_2O_3$) added to the ladle during tapping of the BOF. **By S K Gupta*, S K Srivastava*, S Ghosh*, Sanjay Agarwal**, & K C Gupta****

STEELMAKING at BSP has been optimised for sulphur control in the hot metal and liquid steel for rail production. The addition of coke in the steel ladle increases sulphur in the steel bath by 0.04-0.08%. Mapping of sulphur during downstream processes has been analysed. The reaction efficiency of the steel and hot metal ladle treatments has been ascertained. The extent of slag raking after hot metal desulphurisation on the subsequent processing has also been investigated. With effective slag skimming after desulphurisation and the addition of 300-500kg of synthetic slag in the steel ladle, a sulphur content of 0.015% or below was consistently achieved in the final rail product.

The steelmaking shop No 2 of Bhilai Steel Plant, Bhilai, India has installed a desulphurisation unit with two stands. It is based on co-injection using calcium carbide and a magnesium based reagent to achieve a maximum of 0.01%S in the hot metal to be treated in the BOF. Hot metal tapped from the blast furnace first goes to a Mixer vessel from where it is tapped into an open ladle for transfer to the BOF. Treatment takes place in this ladle prior to charging to the BOF. The new installation is equipped to treat 100% of the hot metal passing through the shop amounting to over 66 heats per day.

Previously, steel desulphurisation with a synthetic slag was used to achieve the low sulphur specification required by the products especially for rail steel. With the introduction of co-injection (Mg + CaC_2) BF hot metal desulphurisation, a proper balance is required between the BF hot metal and steel desulphurisation.

Previous practice

Steel for rail production was previously processed through the BOF-ARU-LF-RH-CC route. A carbon content of 0.6 - 0.65% with sulphur controlled to below 0.025% was required. 700 - 800kg of petroleum coke was added to the steel ladle during tapping of the BOF to achieve the specified carbon content in the steel bath. But the addition of coke increases sulphur in the steel bath by 0.04 – 0.08%. Sulphur mapping of heats for rail steel was conducted at various stages of refining and is shown in **Fig 1**.

The average bath sulphur was observed to be 0.024% after adding the petro coke. A synthetic slag (calcium aluminate) was also added during BOF tapping for sulphur control. In the case of too high a sulphur level in the BOF bath the heat needed to be diverted to another grade of steel or required deep desulphurisation. The latter increases the treatment time by requiring further additions of the synthetic slag.

Revised practice

In the present revised practice, all heats are aimed to be routed through the desulphurisation unit before BOF treatment. This ensures a low sulphur content in the hot metal before charging to the BOF. The overall refining process needed to be re-stabilised for optimum sulphur in the end product. The target was redefined to reduce sulphur to as low a level as possible for rail heats by the use of new and existing facilities. A new target was set to achieve S at or below 0.020% consistently in all rail heats.

Desulpurisation of hot metal

The desulphurisation process employs co-injection from a single lance using injection rates of different ratios and rates. Nitrogen is used as the carrier gas. Presently, the ratio of CaC_2 and a Magnesium containing proprietary reagent is kept at 5:1. The Mg-based reagent has good desulphurising ability. It keeps the treatment time short resulting in only a marginal decrease in the hot metal temperature. The specifications of the reagents are given in **Table 1**.

The steel shop receives the hot metal with a sulphur level in the range of 0.025% - 0.060%. Based on the sulphur content of the hot metal, the automatic system controls the set point for the quantity of desulphurisation reagent to be injected to keep the post desulphurisation sulphur content at or below 0.01%. Pneumatic tilting of the ladle follows slag skimming. The general parameters for the hot metal desulphurisation process are tabulated in **Table 2**.

Desulphurisation by synthetic slag

A further desulphurisation treatment is required after tapping from the BOF due to S pick-up from the coke added during tapping to achieve the required carbon content of the final steel. This desulphurisation is carried out using a synthetic slag consisting of a low melting point $CaO - Al_2O_3$ mixture which helps in the formation of a $CaO - Al_2O_3 - SiO_2$ type refining slag [1,2]. This desulphurises the steel by increasing the sulphur partition ratio as the CaO and alumina contents increase. The efficiency of desulphurisation in the ladle depends on the activity

CaC_2 (CAD-9)		Mg Reagent (Mg-97)		
Technical carbide	70%	Typical	Mg	97%
CaC_2 (Chemical)	52 ± 2%	Analysis	Coating	3%
Gas generating Hydrocarbon	5%	Typical sizing		1.0 X 0.15 mm^2 2% max. > 1200mm
CaO	Rest			10 % max. < 150 mm
Bulk Density	1000 kg/m^3	Mg Chemistry		99.8% min.
Grain Size	85% min, 63 micron	Bulk Density		0.88 – 0.98 g/cm^3

Table 1 Specification of reagents

Operating parameters	Specification
N_2 flow rate	30 – 50 Nm^3/h
CaC_2 : Mg reagent ratio	5:1
Avg CaC_2 consumption	160 kg/heat
Avg Mg Consumption	30 kg/heat
Avg input [S]	0.035 %
Avg post deS [S]	0.01 %
Avg %S drop	70%
Avg injection time	5 min.

Table 2 Desulphurisation process parameters

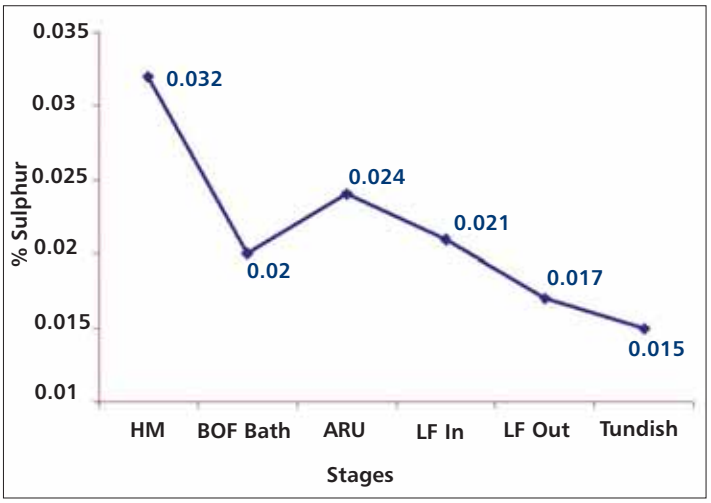

Fig 1 Sulphur mapping for rail heats in prior BOF-ARU-LF-CC route

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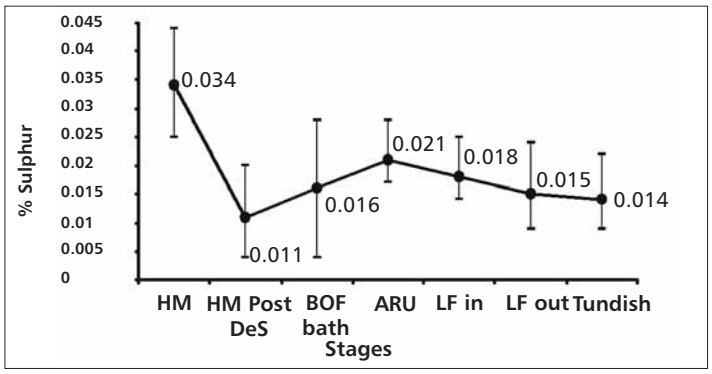

Fig 2 Sulphur mapping for rail heats with synthetic slag addition

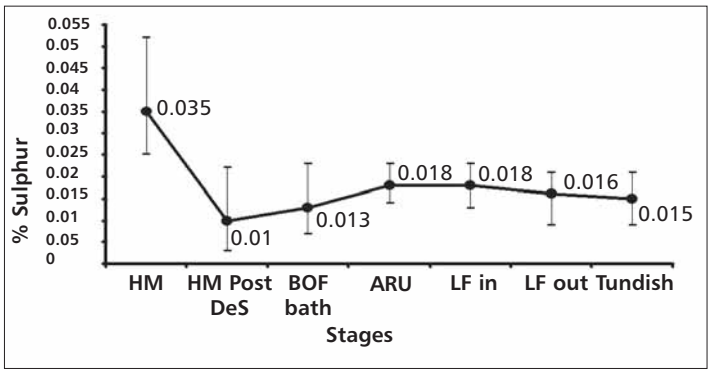

Fig 3 Sulphur mapping for rail heats with no synthetic slag addition

Si No	Initial [S] (%)	Initial slag depth (cm)	Final [S] (after DeS) %	Final slag depth (cm)	Ladle lip condition /jamming	BOF bath [S] (%)	% skimming
1	0.04	9	0.01	4	OK	0.014	55
2	0.04	-	0.01	5.5	OK	0.013	~ 50
3	0.04	12	0.011	7.5	High	0.015	38
4	0.039	11.5	0.019	6.5	Slight	0.02	44

Table 3 Measure of slag skimming efficiency

Nomogram1		Nomogram 2	
Bath sulphur (%)	Addition of synthetic slag (kg/heat)	Bath sulphur (%)	Addition of synthetic slag (kg/heat)
Up to 0.018	Nil	Up to 0.015	Nil
0.019 – 0.021	300	0.016 – 0.020	300
0.022 – 0.024	400	0.021 – 0.025	500
0.025 & above	500	0.026 & above	600

Table 4 Synthetic slag addition regime on tapping BOF

of the oxygen, and the circulation rate of the steel bath. Desulphurisation of Si- killed steel (rail steel) has less favourable thermodynamic conditions then when an Al – killed steel is desulphurised. There are instances of desulphurisation of Si- killed steels with a sulphur partition ratio of up to 50 achieved through SiC deoxidation[3]. Better efficiency of desulphurisation using synthetic slag may be achieved by ensuring an adequate deoxidation level.

Trial plan

Sulphur mapping with hot metal desulphurisation

More than a hundred heats were monitored from the HM - DeS - BOF- ARU - LF- CC route with and without synthetic slag addition. Mapping with and without synthetic slag is shown in **Fig 2** and **Fig 3** respectively. A high and variable sulphur pick-up to reaching 0.012% was observed after processing the hot metal in the BOF. The average pickup of sulphur was 0.005%. A large number of heats (40%) were observed with sulphur pick-up of ≥ 0.005%.

Slag skimming efficiency

Slag skimming is necessary to remove the desulphurising slag from the ladle prior to processing in the BOF[4]. Poor skimming often occurs and the consequent slag left behind may cause significant performance losses when the sulphur in the residual slag re-enters the steel under the oxidizing condition in the BOF thus nullifying the desulphurisation effort. Better slag skimming leaves less slag in the BOF but may result in greater metal loss. An optimum level of slag skimming is therefore needed.

A study was planned to measure the slag depth in the ladle before and after skimming, by dipping an iron rod into the hot metal. Since the hot metal temperature is nearly 1300°C, the rod was submerged for sufficient time in the hot metal to melt the tip back to the junction of the slag metal interface. The difference in the slag depth so measured before and after skimming was used as a measure of the slag-skimming efficiency (**Table 3**).

Optimisation of ladle steel desulphurisation

Studies were conducted on the amount of synthetic slag added to the ladle based on the sulphur level attained when tapped from the BOF. A Nomogram for the amount of slag to add was prepared with the objective of maintaining a final sulphur level below 0.02%. The addition of 300-500kg of synthetic slag (depending on residual S content) to the refining ladle on tapping from the BOF was carried out on heats which had a S content > 0.015%. No synthetic slag was added if the sulphur content was 0.015% or below, measured in the BOF. The method of adding the synthetic slag was redefined in a subsequent trial using a modified nomogram. Both nomograms are tabulated in **Table 4**.

Results and discussion

Hot metal desulphurisation

The average sulphur content of the BF hot metal treated in the desulphurisation unit was 0.035% with a range of 0.025-0.052%. The amount of desulphurising reagent injection varied between 0.197-0.448kg/t for Mg and 0.985-2.24 kg/t for CaC_2. The time for injection varied from 3.2 to 7.2 minutes. The final sulphur content varied from 0.003 to 0.022%. The amount of sulphur removed during desulphurisation has therefore, varied from 40 to 94% with an average of 71%.

Slag skimming

The slag skimming study results are shown in **Table 3**. Sulphur pick up can be optimized to within 0.005% by ensuring 40-50% of the slag is removed by skimming. Regular cleaning of the ladle mouth jam ensures a high efficiency of skimming.

Various heats were monitored with the new slag skimming practice employed. In this way, more than 80% of the heats monitored showed a sulphur pickup of less than 0.005% with a maximum pickup of 0.008%. The BOF bath sulphur level was found to be under 0.015% in more than 50% of the heats.

Steel ladle

The synthetic slag addition after BOF treatment was performed as per nomograms 1 & 2 tabulate in **Table 4**. The trial was conducted for 46 rail heats as per nomogram 1. Only in three cases was the final sulphur found to be over 0.02%. The average final sulphur was 0.017%. In the second stage, the trial was conducted as per the second nomogram on 20 heats. Only in one heat was the final sulphur just above the target value of 0.02%, being at 0.021%. The average sulphur content was 0.015%.

Conclusions

Optimisation of sulphur in rail steel heats was achieved by controlling the sulphur level at each stage of treatment. Slag skimming followed by hot metal desulphurisation controls the sulphur pickup in the BOF.

Good slag skimming is required to control sulphur pick up to less than 0.005%. Further desulphurisation of the steel in the refining ladle, achieves 0.015% sulphur in the end product by the addition of a synthetic slag.■

References

1. A Ghosh, Principles of Secondary Processing and Casting of Liquid Steel, Oxford & IBH Publishing Co Pvt Ltd New Delhi, 1990
2. L E K Holappa, International Met Review, 27 (1982), 53
3. J Seneviratne, Electric Furnace Proceedings, 2000, 581-590
4. A T Peters: Ferrous Production Metallurgy, John Wiley & Sons, New York, NY, (1982)

Intelligent logistics in steel production

To optimise workflows and maximise cost efficiencies, it is essential to move from a production environment where there is a lack of coordination between different units to integrated business processes. Software solutions which integrate logistics and planning processes, assisted by technological advances to track movements such as GPS and Local Radar, can help achieve this change. **By L Loeper***

Fig 1 Logistics Managements systems need to manage each storage location with their specific restrictions according material, storage conditions and processing characteristics
Source: ThyssenKrupp

METAL-producing industries are facing growing customer requirements in terms of product diversity, logistics capability, on-time delivery and constant quality, while downward cost pressure continues to increase. Producers and processors are being forced to dramatically reduce cycle times and to set and monitor ever-tighter time schedules, as well as achieve higher processing and quality standards.

Common challenges

Switching to an integrated approach to material tracking cuts costs and boosts profits but there are a number of challenges which first have to be overcome.

Locating materials

Many producers frequently encounter difficulties in creating a transparent overview of their materials inventory. Often, producers have difficultly pinpointing where materials are, and rely on 'walking the warehouse' to find them, wasting valuable time and energy.

In traditional scenarios, materials are identified by location, and if materials are moved the inventory can all too quickly become unreliable. Not only is it important to know where specific materials are located, but workers should also be able to have a clear view of what materials need to be moved, when and where these should be transported, and an inventory system that is automatically updated to reflect any changes.

Tracking materials

Due to the high complexity of the manufacturing process, real-time tracking with integrated operational quality processes becomes a substantial task for metals producers. Without accurate tracking systems, companies have no way of ensuring that the correct materials have arrived at the correct place. This can lead to further problems around timely utilisation.

For example, if electrical steel is incorrectly managed – if it is placed in a storage area without temperature control – then it will lose its specific material properties, resulting in a considerable loss of revenue. Being able not only to track materials location but also to add timed alerts for specific usage conditions could save significant wastage costs (**Fig 1**).

Integrating production planning & storage

The lack of proper integration of production, storage and transportation of materials can pose difficulties for producers and processors. Works in progress and finished materials should be moved on as rapidly as possible to the next process step, which will help production efficiency and reduce working capital requirements.

For this to be possible, producers must have a clear view of the next process steps to be taken for each product, in order to transport it to the next location in the smallest number of trips and without delay. Avoiding the use of interim storage as much as possible is essential, as all materials in interim storage represent dead capital. The reduction of rotating stock is only possible with optimized storage conditions and integrated planning, without which valuable time, money and effort are often wasted (**Fig 2**).

Maximising production efficiency

To ensure that requested materials are supplied time, and to avoid wasting time searching for materials, producers must be able to pinpoint materials' locations, right-first-time. Not only is the material's place in the stock yard of interest, but, especially in slab, plate or billet yards, it is essential to know the exact position of a material in a specific pile to avoid subsequent re-arranging.

The next major aspect of an overall efficient production process is efficient handling of materials as they are moved between storage locations, staging locations and production units. To optimise this material flow, a modern logistics management system for metals producers must meet three fundamental requirements:

- The precise location of each piece of material must be known and tracked at all times.
- The system must recognise and react to the stacking requirements, not just with respect to physical limitations and safety-oriented rules, but also in consideration of any future material movements that will be required.
- The system must be flexible, adaptable, and user friendly for administrators as well as operators.

PSImetals Logistics

To better understand workflows and maximise cost efficiencies, it is essential to move from an environment where there is a lack of coordination between different production units to an integrated solution that supports the entire production process. The PSImetals solution line integrates logistics and planning systems for a comprehensive approach that streamlines the process flow by optimising material storage and requested transports according to the further material processing (**Fig 3**).

With PSImetals Logistics, customers can track and control all material movements for the entire metals production, from ore to tailored product, providing dramatically enhanced visibility of information for materials at every stage and as a whole. For slab, heavy plate, billet, coil, tube or other products, the PSImetals Logistics solution optimises product stocks, supports the improved utilisation of existing warehouse capacities, optimises all internal transports at both ends of production facilities, and makes decisions for the optimum use of the means of transport available in each case.

The solution is built around a structure of halls or yards, subdivided into logical areas based on functionality. For example, areas can be designated for long-term storage, production line staging, re-work, loading, shipping, and transport to annealing or painting. Each of these areas (called fields in Logistics) is optionally divided into rows and spaces. Each space has a specific location, dimension and orientation. This structure provides the basis for the processes of destination finding and route finding, which lie at the core of warehouse and transportation management.

The detailed subdivision of the storage yard into many fields allows for a rules-based optimisation of storage destination for materials, which can take into account the specifications of a material to find an optimal location. This process pre-sorts materials, which leads to faster and more efficient retrieval. If in addition the planned sequence of the material is available from a planning system (such as *PSImetals Planning* or other existing planning systems), materials can be stored in correct order in

* Director Competence Centre Logistcs PSI Metals GmbH

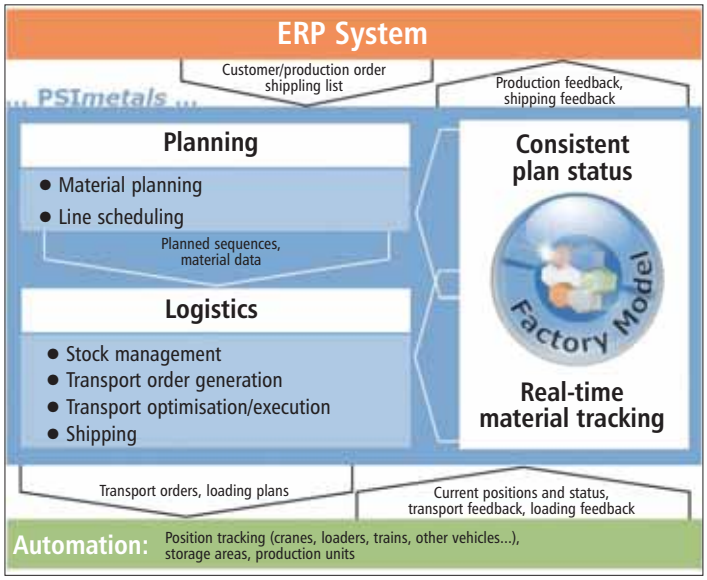

Fig 2 The integration of planning and logistics systems enables overall process optimisation Source: PSI Metals

Fig 3 Slab yard overview in PSImetals Logistics providing different levels of detail (yard field, detailed spaces, position in pile)
Source: PSI Metals

Fig 4 Slab transport by crane to the best target position (green-framed slab on bottom left)
Source: PSI Metals

readiness for further processing. This accelerates access when production commences, and avoids excessive restacking operations.

Material tracking

For materials tracking, modern coordinate detection technologies such as GPS, radar, laser and others can be integrated with PSImetals Logistics. The solution is based on a flexible warehouse topology that enables a yard overview by logical or coordinate-driven positions. All warehouse and transport management processes are covered, whether they are manually processed or fully automated.

Within PSImetals Logistics, the automatic destination finding function determines the best target position for each item (such as loading stations or processing lines). These target positions then form the basis for transport orders, which are displayed to the crane operator in the operator's cabin (**Fig 4**).

Crane tracking systems

Standard crane locator systems employing distance measurements with lasers are increasingly being replaced by local positioning radar (LPR) technology, such as that developed by Symeo. The crane position is determined via appropriate transponders and antennas, providing a contact-free and robust solution. With precise information of the crane's position and of the crane's boom, the materials location can be identified. LPR can be used by many cranes on the same runway simultaneously, including vehicles that travel at ground level (**Fig 5**).

By combining the software and Symeo technology, customers can benefit from a competitively-priced LPR system. The crane's position can be followed by PSImetals Logistics along the entirety of their tracks using the LPR technology, in a covered or open hall, since the area can be optimally illuminated by the radar transponders. This position information is used further to calculate materials positions, so the real position of each piece in the pile is managed by the system.

Combining LPR and GPS

For mixed storage areas (inner and outer yards), tracking is more complicated, as vehicles travel with slabs or plates out of the areas where the radar transponders provide well-defined coverage. As they move, they are automatically passed from one LPR area to another; if LPR coverage is not available, the position is determined via Symeo GPS. PSImetals Logistics receives the position data regardless of the technological source, while the Symeo software ensures transition between LPR and GPS positioning (**Fig 6**).

Where LPR and GPS are both available, PSImetals Logistics can provide operators with the ability to announce the arrival and departure of transport vehicles at specific locations. The result is that the software records where each means of transport is located at all times, and can allocate loading and unloading instructions according to the transport orders for the material.

Case Study – LPR for tracking plate

A leading European plate steel technology group uses the joint PSImetals Logistics and Symeo LPR solution to support production logistics at its plate finishing and dispatch departments. The company uses materials tracking, monitors transport routes and equipment used, and manages available storage areas with their associated restrictions. The precise location of an individual plate is determined using the Symeo LPR system, which acquires the relevant data from 16 overhead cranes located at the company's main plant and production facility. Whenever the crane sets down a plate, PSImetals Logistics uses these coordinates to graphically display its location within the stack as well as the position of the plate in the layer.

Case Study – GPS for tracking slab

Depending on the kind of material produced and the kind of storage available, requirements for material tracking are different. For example, at a Canadian steel producer, material identification in PSImetals is actioned exclusively via GPS. Most slabs are kept for further processing in outer yards and transported on Kress carriers or straddle port cranes. As the accuracy of a typical GPS system depends on the number of satellites and can only be guaranteed up to a distance of 20 metres, PSImetals uses a more detailed GPS technique to ensure correct material identification. In this case, a second receiver compensates for measuring errors and the accuracy can be enhanced to within one metre.

Benefits

PSImetals Logistics uses storage in the most efficient way, minimizes material movements, provides an accurate inventory image, and locates and tracks any materials in the yard. The solution helps to reduce costs and increase throughput by optimizing warehouse and transport performance between lines, plants and sites.

Improved yard overview

The software provides an accurate view of inventory, so that customers always know where every piece of material is located, so that materials are supplied in time, helping to avoid time wasted in searching for materials. A complete overview of inventory can be produced at the push of a button. Automatic inventory counts can also be performed without stopping production, delivering time savings.

Reduced material damage

By using PSImetals Logistics to better define and map material destinations and routes, cus-

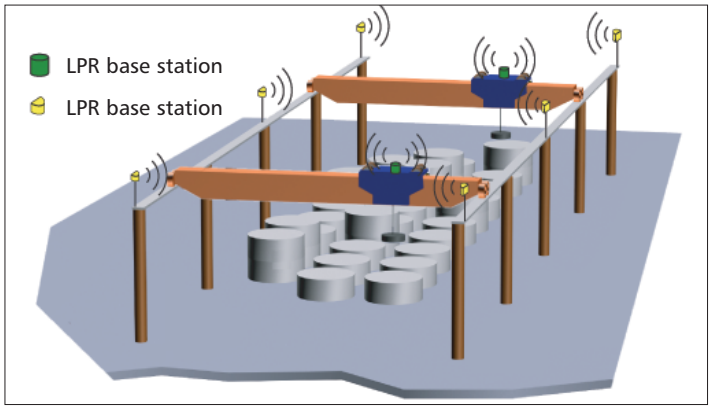

Fig 5 The LPR technology enables the precise measurement of each crane position whether there are two ore more cranes on one crane way Source: Symeo

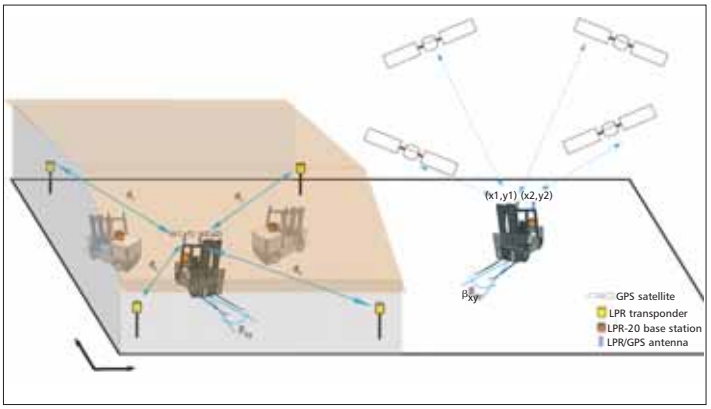

Fig 6 Combining LPR and GPS material transports in areas with inner and outer yards can be completely tracked Source: Symeo

tomers can maximize the use of their transport fleet. As every transport movement incurs the risk of damage, storing materials in the proper order, ready for subsequent processing, minimises the number of transport movements, resulting in lower costs and fewer losses.

Improved transport management

The software's integrated, automatic tracking of transport order execution means that exact positions in the piles enables further optimisation of the work order. Materials can be located quickly and delivery schedules planned more efficiently, ensuring the timely and properly-sequenced delivery of materials to production facilities for processing and the movement of finished goods for final transport from the plant.

With a clear, integrated view of logistics and planning processes, producers can ensure that the correct orders are transported in time. Improved adherence to delivery schedules reduces the amount of time materials spend in costly interim storage, resulting in greater cost savings for producers.

Conclusion

Metals producers are seeking to optimise throughput while simultaneously achieving lower operational costs. Customers increasingly require a fully scalable logistics solution that provides full integration with planning and production, as well as the capacity to grow according to the customer's changing requirements.

The PSImetals Logistics solution offers both localised and complete process optimisation. By delivering greater production management integration, the warehouse and transport management solution optimises the flow of materials and improves the overall efficiency of the production process.

Leading steel producers applying this integrated approach achieve optimal capacity utilisation, reduced costs and increased production throughput, helping gain a competitive edge in today's customer-driven market. ■

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Hot barcodes for steel

HEEDING the call to increase steel production turnaround IML offer solutions; delivered through the use of barcode track and trace data which can be applied earlier in the manufacturing process than previously thought possible.

Barcode asset tracking at temperatures up to 600°C was previously only available if a substantial budget was set aside for the implementation of a metal based tagging system. IML's Thermotag 600 offers a non-metallic alternative. It is a synthetic woven glass material coated with PTFE which is crease and tear resistant and compatible with everyday thermal transfer printers. It withstands temperatures up to 600°C.

IML's labels of the type can be overprinted with barcodes, batch data and corporate graphics, on-demand via an in-house thermal transfer printer, to give users the flexibility to customise the design of the label and communicate vital data whilst promoting the company's brand. The majority of IML's tags can be overprinted with barcodes on standard thermal transfer printers. IML's thermal ribbons have been rigorously tested and developed to ensure print legibility compliments the durability of the label itself. In contrast, metal labels need a CO_2 laser marking system (Pannier System) to overprint the data.

One of IML's key UK based steel producing customers said: "We began using IML's Thermo Tag 600 on products which come off the production line at around 500°C. They are stored both inside and outside for long periods of time. No other tag, suitable for printing on a standard thermal transfer printer, could survive these initial temperature or storage conditions. We are extremely pleased with the amount of time and effort IML put into research, development and continual improvement in the area of high temperature labeling".

Numbering the UK's leading steel manufacturers amongst its clients, IML also exports to Europe and the Middle East – supplying and servicing each and every steel mill in Egypt from its secondary sales office in Alexandria, Egypt. To promote the benefits of track and trace labeling internationally, the company will showcase its product range at the Metal & Steel show in Jeddah, Saudi Arabia in February and at Tube & Wires, Düsseldorf, Germany in March 2012. ■

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The 1.5Mt/y heavy plate mill started up at OMK in November 2011

OMK commissions Russia's third heavy plate mill for large diameter pipe

The United Metallurgical Company (OMK) has commissioned a 1.5Mt/y heavy plate mill adjacent to its two large diameter pipe production lines thereby creating an integrated manufacturing complex no longer reliant on previously imported plate.

By Alexander Gurov*

THE heavy-plate mill 5000MKS was put into operation on 25 November 2011 at the Vyksa site of the United Metallurgical Company (OMK). OMK invited *Steel Times International* to take part in the commissioning ceremony.

At 6am buses containing OMK's guests which included suppliers of equipment, bankers, their main partners from the metallurgical and oil and gas companies departed Moscow for the military airport of Chkalovsky on the outskirts of the city. Two chartered Tupolev aircraft flew the 45 minutes journey to Vyksa and by 10am all invited guests were present at OMK's Vyksa plant ready for the official opening of the Heavy Plate Mill 5000.

Vyksa is a small town of some 60 000 inhabitants 300km east of Moscow and 150km SW of the regional centre of Nizhny Novgorod. Located on the Oka river, the name of the town means '*The stream flowing from the lake*' The region meets a visitor's expectations in terms of primeval forest and scenic lakes. Founded in 1757, it is one of the historic centres of Russian metallurgy.

The Group was founded in 1992 and in 2012 celebrated its 20th anniversary. OMK includes two divisions: Pipe-Rolling which comprises three plants: Vyksa Steel Works (VSW), Almetyevsk Pipe Plant and Trubodetal at Chelyabinsk (a producer of pipeline fittings). OMK's Metallurgical division consists of its casting and rolling complex and was built in 2008 at Vyksa.

Today the Vyksa Steel Works (VSW) is the leader in the Russian steel pipe sector with production of over 2.2Mt/y of pipes, serving about 25% of the domestic market and more than 40% of large diameter pipe (LDP) demand. VSW is also the world's largest producer of solid rolled railway wheels for passenger and freight cars.

Its main products are steel pipes with diameters ranging from 15 to 1420mm for the oil and gas market, and well casing pipe for oil- and gas-drilling. For the manufacture of large diameter pipes there are two production lines each using a different forming processes: UOE and JCO.

The UOE-forming line produces pipe with a single longitudinal electric-welded seam of diameters ranging from 20" (508mm) to 42" (1067mm) capable of applications of up to 9.8 MPa (100 atm) pressure.

The JCO-forming line makes pipes of diameter up to 56" (1422mm) from steel grades for construction of oil and gas line pipe with working pressures up to 24.7 MPa (250 atm).

These pipes are protected with two or three layers of anticorrosive coating which fully comply with international standards for oil and gas line pipe, including gas pipelines for use under water, for use in arctic regions at temperatures as low as -60°C and are also capable of conveying sour gas (of high hydrogen sulphide content).

Import substitution strategy

For the past 40 years Russia has had to import tens of billions (expressed in US dollars) worth of 1420mm large diameter pipe (the so-called 'Russian size' pipe), largely in exchange for gas.

The pipe sector in Russia is one of the few sectors offering the potential of import substitution as all large diameter welded pipe was imported from Europe or Japan and some twin seam welded pipe (necessitated by the lack of wide plate) was imported from Ukraine as the pipe mills manufacturing this product fell within that territory on the split of the Soviet Union. OMK developed its Import Substitution Strategy in 2003, when it decided on the construction of a large diameter pipe manufacturing line for the production of 1420mm pipe. It chose this investment despite no contract guarantees from Gazprom or Transneft, the two major Russian customers.

In 2005 OMK put on stream Russia's first and most modern LDP 1420mm line, located in Vyksa, but the manufacture of the LDP depended completely on the purchase of imported steel plate.

Over the past seven years about US$4bn has been invested by OMK in new facilities to produce high quality pipes in accordance with the international standards. This enabled it to participate in challenging projects such as Nord Stream (Russia to Germany), Bovanenkovo - Ukhta, Eastern Siberia - Pacific Ocean Oil Pipeline, and others.

OMK became the sole Russian supplier of pipes for Nord Stream and has supplied 460kt of pipes of diameter 1220mm for this, including pipes with a wall thickness up to 41mm for use at pressures up to 220atm for the subsea sections of the gas pipeline.

Steel pipe consumption in Russia in 2010 reached close to 9.5Mt, of which 3.2Mt was LDP and of this OMK supplied 1.3Mt. Today Russia's pipes' companies can satisfy the requirements of 98% of the home market. At present, Russian owned installed capacity for LDP exceeds 5Mt/y manufactured by four companies within Russia (OMK, CTPZ, TMK and Izhora) and Russian owned MetalInvest Holdings which manufactures LDP at Khartsyzsk Tube Works in the Ukraine. However, at present the utilisation ratio of Russian LDP plant is only around 40%.

The HPM-5000 complex

OMK's import substitution strategy was to put into operation a heavy-plate mill capable of

*Steel Times International representative in Russia, Moscow.

The opening ceremony was addressed by cosmonauts on the MKC-30 spaceship

rolling plate up to 5m wide in steel grades suitable for pipe manufacture. Such wide plate was required to produce longitudinal welded pipe with a single seam for oil and gas pipelines. Previous manufacturing techniques required the welding together of pairs of plates to produce sufficient width for forming into LDP, resulting in a twin seam pipe with inherent flaws in the welds.

Depending on the application, the plate produced in the new mill must be precisely geared to the application, with precise material properties, chemistry and dimensions. In 2011, the import of hot-rolled thick plate from abroad fell to 1Mt.

The new HPM-5000 is capable of rolling plates up to grade X120 and aims to provide all the plate required for its pipe requirements rolled from brought in slab from Russian steel producers. About 1.2Mt/y of plate output will be used by OMK to produce welded LDP, the remaining 300kt will be sold on the free market for such applications as shipbuilding, nuclear power and mechanical engineering.

OMK's mill is Russia's third HPM-5000. Severstal has had such a mill at Izhora for several years while Magnitogorsk Iron and Steel Works opened such a mill of 1.5Mt/y capacity at Magnitogorsk in 2009 (*see STI May/June 2011 Vol 35 No 4 p52*). At present, Russian heavy plate output totals 3.6Mt/y (600kt at Severstal and 1.5Mt each at Magnitogorsk and OMK). This is sufficient to fully cover the domestic market for LDP pipe production.

The distinguishing feature of OMK's HPM-5000 is in combining plate production and LDP manufacture on a single site with two large-diameter pipe production lines each of 2Mt/y capacity. This will enable OMK to complete the construction of a vertical integrated chain and gain control over production costs, quality and reduce the delivery time for LDP orders.

This new HPM-5000 complex has taken the name 'MKS-5000' in honour of the International Space Station (MKS in Russian) due to the high complexity of the 'Metallurgical Complex Mill-5000'. The name reflects the rolling technology used and the qualities produced to meet today's gas and oil line pipe demands. Indeed, OMK received congratulations from cosmonauts on the spaceship MKC-30 after the start-up of mill-5000. The celebrations really were an event at a 'cosmic level' for the small Russian town of Vyksa and coincided with the 50 anniversary of the first space flight by Yuri Gagarin.

Financing and contractors

OMK started building the HPM-5000 in 2007. The project was put on hold in 2008 due to the financial crisis but was resumed at the end of 2009. Initially the project cost was estimated at US$2bn. However it actually came in under budget costing around US$1.6bn.

Financing the purchases of the mill which is supplied by SMS Siemag of Germany was achieved using OMK's own capital and by loan capital. The credit agreement raised in January 2010 extends to February, 2022 and was financed by a pool of banks in Germany and France. Commerzbank Aktiengesellschaft Frankfurt am Main acted as the adviser for VSW for the transaction and is also the co-coordinating organizer for the transaction and registration agent. The Export-credit agency for the transaction is Euler-Hermes Kreditversicherungs AG (Germany). The pay-back period of the project is about 10 years, according to OMK.

The general contractor for building was the Austrian company Strabag. SMS Siemag completed the general engineering technology, equipment supply, infrastructure, plant design and construction of the mechanical equipment and core elements of the automation in cooperation with UkrGipromez, Danieli, Siemens VAI, NKMZ, and others.

MKS-5000 is one of the world's most modern and high-performance heavy plate mills with a reduction force at 12 000t (120 000kN). The mill has a single four-high reversing stand equipped with CVC® plus technology for shape control, hydraulic roll gap adjustment and segmented work roll cooling. It is designed to produce thick plates (7-48mm) up to 4900mm wide with excellent surface finish and high weldability in steel grades of strength up to X120 for the manufacture of high quality LDP.

Fives Stein (France) designed, manufactured and commissioned the two 200t/h walking beam reheat furnaces (Digit@l Furnace®) including charging and discharging manipulators, rollers and weighing tables. The first furnace successfully discharged its first hot slab on September 30, 2011.

The specialists at OMK's engineering centre highlighted the technological advantages of the furnaces, such as temperature homogeneity, individual heat control for each burner and reduced fuel consumption. During the official ceremony in Vyksa the president of OMK Vladimir Markin expressed its gratitude to the employees of Fives Stein, and added that these furnaces were the first to be put into operation in the mill.

The complex is equipped with roll-grinding machines from Tenova Pomini (Italy) and overhead cranes from Konecranes (Finland) as well as of Ukrainian manufacturer.

There are 28 cranes in all each with energy saving technology installed at the shop, including one of load-carrying capacity of 400t supplied by Konecranes in the roll-grinding workshop.

Slab is purchased mainly from two suppliers, NLMK (Lipetsk) and Alchevsky Iron and Steel Works (Ukraine). These two companies export up to 25% of their slabs production (about 8-9Mt/y) hence there are no problems with assuring the slab supply to OMK Vyksa.

The slab yard has a capacity of 50kt of slabs with thickness up to 400mm, width 1300 to 2600mm and length up to 4.8m. This is sufficient stock reserve to supply the mill for two weeks if slab supply is interrupted.

Post rolling, hot and cold levelers straighten the plate and there is a plate cutting station equipped with duplex side-trimming shears and a double-sided shearing machine.

A key feature of the mill run out table is two-section cooling using a combination of spray cooling (75 spray heads) and laminar cooling, to achieve controllable accelerated cooling within a 36m length.

Ultra precise modes of thermo mechanical processing which allow the plate to be cooled between mill passes provide a uniform structure and properties along the length and across the width of rolled plate.

The process is fully automated and includes a plate tracking system at each stage of production, as well as during loading-and-unloading for stacking in the retarded cooling area. Production control is integrated into OMK's SAP system.

The buildings and bays of the MKS-5000 complex cover an area of about 52 hectares and contain 57 buildings. The plant process equipment installed has a total weight of 28 000t and the steel structures add more than 40 000t to the total.

Transportation of plates from the capacious finished plates warehouse to the LDP shop is made using special heavy trucks.

The mill is expecting to reach design capacity of 1.5Mt/y by first quarter 2013. ■

The mill – large diameter complex covers 52 hectares and contains 57 buildings

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Upswing on the market for tube welding plants

MANUFACTURERS will introduce new and innovative solutions at the international tube trade fair *Tube Düsseldorf* on March 26 to 30 where the tube industry will again gather for the world's largest showcase of the sector.

The focus of the event is on plants and machinery for the production and processing of tubes as well as services, used machinery and much more.

Among the major suppliers in welded tube segment is SMS Meer of Mönchengladbach, which is a member of the SMS group of Düsseldorf. After a difficult 2009 financial year, SMS Meer was again on a growth trajectory in 2010. The company reported increased demand mainly from China, India, the Middle East, Brazil and Western Europe. It opened a manufacturing facility in Shanghai in 2010.

In mid 2011, Dr-Ing E h Heinrich Weiss, President of SMS group, said: "The ramifications of the worldwide economic and financial crisis could still be felt on the market for tube welding plants in 2010. In this segment, business was focused mainly on plant modernisation projects."

Management of SMS believes that the recovery of the global economy will also reach the market for tube welding plants in 2012. The outlook is much more positive than a year ago. The demand for industrial tube equipment rose noticeably in 2010, and the willingness to invest has improved significantly. According to the company, the market for spiral welded tubes has undergone positive development in 2010.

Seamless tubes

SMS considers its PQF technology (Premium Quality Finishing Mill) remains as a major growth driver for seamless tube production. According to SMS Meer, about 32% of all plants installed globally are using this technology. Together with its predecessor technology, the MPM procedure (Multistand Plug Mill), the company has a world market share of over 50%.

As the Chinese market is considered mostly saturated the first major Chinese tube manufacturers are planning to build capacities abroad.

Of the 20 PQF mills installed worldwide, the first plant began operation in the west in 2010 at the world's largest seamless tube manufacturer, Tenaris in Veracruz, Mexico. The strong demand for this technology is due to the expansion of the size range that can be produced, SMS believe. During the current year, the world's first PQF mill for 20"-tubes is expected to be commissioned in Jiangsu Tianhuai, China. The company states that customers would benefit from material savings, better quality and lower energy consumption.

Optimistic outlook with reservations

Generally, SMS group expects further growth in India, China, South America and the Middle East. The reason: These regions show a comparatively low per capita utilisation of steel, which means that further investments can be expected. However, before the backdrop of the unresolved debt crisis in Europe and the USA, the political instability in the Middle East and the high volatility of the raw material prices, there remains insecurity with regards to the further growth of these markets in the view of the company. ■

www.tube-tradefair.com/

SMS Meer's plant in Shanghai which opened in 2010 is its first manufacturing facility outside of Germany

ILAFA becomes Alacero – A new name but an old threat: A report on the 2011 conference

The ILAFA (renamed Alacero) Conference was largely dominated by talk of the Chinese threat from exports of steel as semis and finished goods. Despite the growing output of India and Russia, neither of these were seen as major exporters. This year, greater attention was paid to the environmental challenge. **By Germano Mendes de Paula***

THE 52nd ILAFA Conference was held in mid-November 2011 in Rio de Janeiro, Brazil. At the event, the organising institution was rechristened the 'Latin American Association' (Alacero). There were two main differences regarding the previous name: '*Association*' instead of '*Institute*'; and the exclusion of the word '*iron*'. This follows a similar trend taken by others such as the former International Iron & Steel Institute (IISI) which was renamed the *World Steel Association* (worldsteel) in 2008 and some national steel associations such as Germany's VDEh, which dropped '*iron*' from its name in 2003. Under its new name, Alacero continues to promote Latin America's annual steel conference, the largest in the region. Around 1000 delegates attended.

The conference usually focuses on two main issues: the global economy and the world steel market. Although this year it paid more attention to environmental challenges than in the past, the traditional formula of topics was maintained. Furthermore, the previous threat – China – continues to be the protagonist.

World economy

Raghuram Rajan, Professor of Finance at the University of Chicago's Booth School of Business and former Chief Economist of the International Monetary Fund (IMF), delivered a presentation that emphasised the macroeconomics. According to him, there has only been a weak recovery in industrial countries, especially given the magnitude of the shock in 2008. In addition, stimulus after stimulus is proving ineffective to produce a sustainable recovery. In the case of the USA, one of the reasons why the stimulus has not resulted in the quick return of good jobs is the structural change in the labour market. Jobs characterised by routine operations have been replaced by machines or outsourced locally or abroad, arising in a skills mismatch resulting in a lack of appropriate skills in the labour force.

Prof Rajan stressed that the politics, in a time of low growth, tends to be very ugly, as can be observed in the United States (eg the debate about the debt ceiling) as well as in Europe (the hesitance in solving the problems in the Eurozone). The global macroeconomic scenario is definitely not bright, due to the following features:

- Deep problems in industrial countries that took many years to build;
- Political leadership is constrained by profound divisions in the electorate;
- Emerging markets will help, but not immedi ately.

In the experience of the Eurozone, Prof Rajan highlighted that the elite is far more Europhilic (supporting the European Union) rather than is the general public. In addition, he highlighted the key role that Germany will play in constructing the new basis of Euroland, which can result in any of three main outcomes:

- The first possibility was termed 'the hopeful solution', which means the peaceful path.
- A second option – not mutually exclusive with the first – deals with some isolated defaults.
- A third and dramatic possibility is the break-up of the Euro area.

An interesting part of Prof Rajan's presentation was related to emerging markets. In 2010, these countries were responsible for 50% of international trade, 50% of inward foreign direct investment (FDI), 30% of the outward FDI, 50% of investment, 40% of output, 35% of consumption, 55% of oil demand, and 70% of steel demand. Although emerging markets are performing better than industrialised nations, they would grow better if industrialised markets were growing too.

China

On the key topic of China, Prof Rajan said that it is impossible to foresee if China would face a 'hard landing'. He believes that the country is unlikely to have room for stimulus measures similar to those of 2008. He also observed that inflation is rising significantly and the country's government knows that its current economic policies cannot continue forever. As a consequence, exports from China are likely to slow considerably from a combination of rising inflation and credit tightening. The 'Dragon' will become less export-oriented, focusing more on domestic demand.

Barry Naughton, Prof of Chinese Economy at University of California San Diego, scrutinised China's situation one more time for the delegates. This was the fourth lecture delivered by him to the ILAFA (now Alacero) annual conference since 2005.

According to this expert on China, looking at the situation in October-November 2011, the growth of credit has gradually been brought down (the blue line in **Fig 1**) and the inflationary pressures have moderated (green line in **Fig 1**). The macroeconomic tightening phase has ended, and there is space for loosening the monetary policy. Nonetheless, for the next few months this will be only partial and technical; policy-makers will wait to ensure that inflation stays in control and external demand does not collapse.

It should be remembered that, as demonstrated in **Fig 2**, economic growth has slowed in China, but only slightly. The latest available information (Q3 2011) shows that GDP expanded roughly 9%. Thus, so far, China appears to be heading for a 'soft landing', which is good news for the entire global economy.

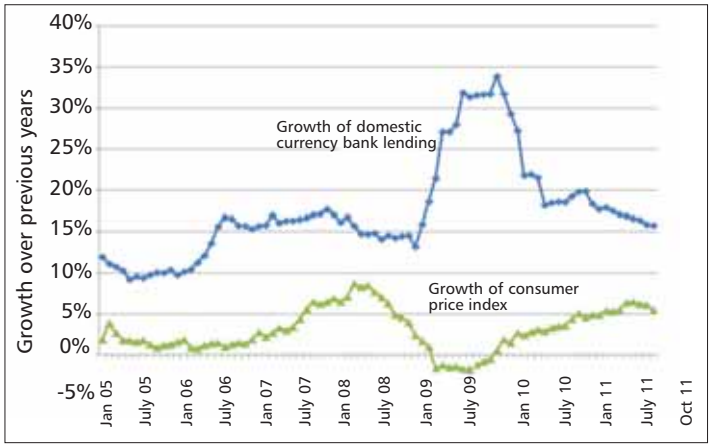

Fig 1 China's growth of credit and consumer price index, 2005-2011 (% y-o-y). Source: Prof B Naughton
(Blue line growth of credit; Green line inflationary pressures)

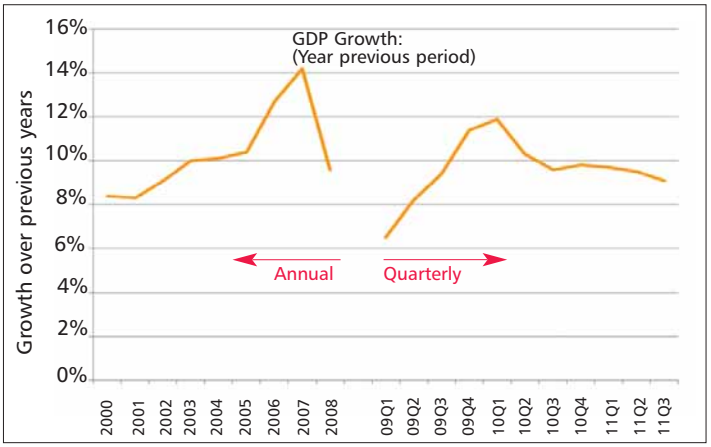

Fig 2 China's GDP growth, 2000-2011 (% y-o-y)
Source: Prof B Naughton

*Professor in Economics, Federal University of Uberlândia, Brazil. e-mail germano@ufu.br

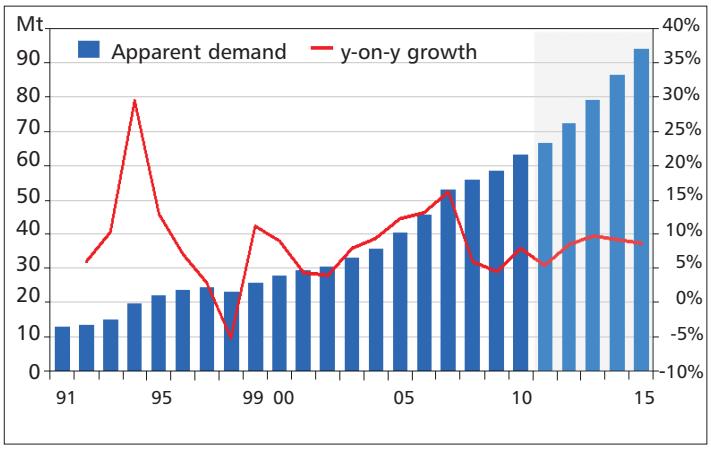

Fig 3 Indian apparent consumption of total finished steel, 1991-2015 (Mt). Source CRU

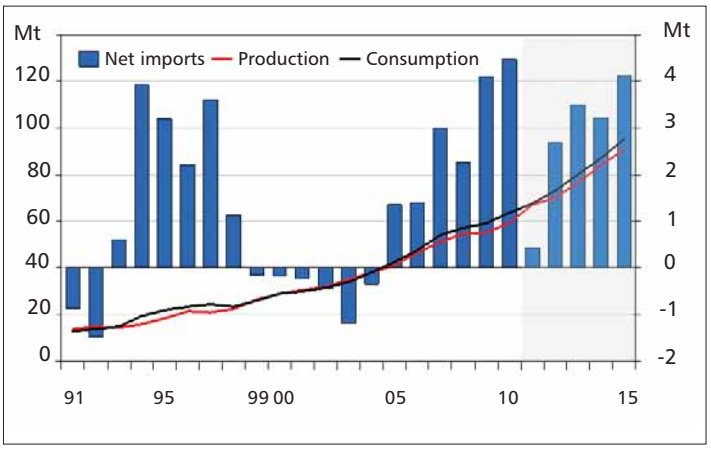

Fig 4 Production, apparent consumption and net imports of finished steel in India, 1991-2015 (Mt). Source CRU

Prof Naughton also highlighted that the Chinese government has been trying to change the drivers of economic growth to a new phase dependent more on skill-intensive and 'lighter' industries. This is a consequence of the fact that China's seemingly inexhaustible pool of low-skill and low-wage labour has ended. China has obtained some positive features in accomplishing this goal:

- A rapid increase in college graduates from less than a million in 2001 to over five million in 2010;
- It is well-positioned regarding the global production networks for upgrading; and
- some experience concerning a cost-effective locale for certain kinds of research and development.

On the other hand, the effective outcomes have been relatively frustrating, considering that the Chinese leaders' commitment to transform the development strategy started in 2005. In addition, some problems have accumulated from the failure to shift the growth strategy, such as:

- massive new infrastructure with low utilisation ratio;
- educated youth are under-employed;
- housing has grown rapidly but has low occupancy rates.
- Furthermore, investment rates cannot increase indefinitely.

Prof Naughton said that China, in its race towards middle-income status, is facing two competing policy agendas. The first is the current strategy of 'government-led transformation'; the second, the 'renewed reform and macroeconomic balance'. Government-led transformation has dominated since about 2006. It takes for granted, 'the market', and seeks to achieve additional social and transformational goals on top of this. There is rising resentment over the government's previously dominant agenda which opens space for a new wave of reforms aimed at fostering high-quality services, curb excess investments, relax financial repression and to allow small and non-state enterprises equal access to financing opportunities.

Prof Naughton concluded his presentation by stressing that new political leaders will take over in Autumn 2012. They have a voice, and an interest in tackling problems now, so that they can start with a (reasonably) clean slate. In particular, they would like to see inflation thoroughly under control before they take on the administration. The credibility of those who promote macroeconomic balance is now higher than it has been since the 2008 financial crisis. Thus, it is unlikely to see a resumption of rapid credit growth or new stimulus programmes, moderating economic growth in the short-term. Despite this, China continues to receive a lot of attention – and fear – from the Latin American steel community.

Indian steel industry

Due to the relevance of the BRIC countries, it was not a surprise that the Conference organisers invited speakers to address the situation of the steel industry in India and Russia. Regarding India, Chris Houlden, from the British consultant company, CRU, analysed many topics, such as: a) economic growth; b) prospects for steel-using industries and steel demand; c) plans for capacity additions, production and the international trade outlook.

Mr Houlden stated that the impressive growth in India's economy, including the manufacturing sector, is forecast to continue in the coming years. He expects that GDP will achieve a Compound Average Growth Rate (CAGR) of 8.3% during the period 2011-2015, while the respective figure for industrial production will be equivalent to 8.2%. Meanwhile, the GDP per capita will improve to an outstanding 32.2% between 2011 and 2015.

CRU's principal consultant stressed that the robust economic growth will reflect in the expansion of all the main steel-consuming industries in the following years. He also informed delegates that infrastructure and construction projects were responsible for 65% of the steel demand in India in 2011. This was followed by capital goods (19%), automotive (10%), consumer durables (3%), shipbuilding (1%) and others (2%).

Looking at each major steel-consuming sector, Mr Houlden mentioned that the infrastructure output increased from $50bn in Fiscal Year (FY) 2005-06 to $110bn in FY 2010-11 and is forecast to reach $180bn in FY 2014-15. The number of cars produced in India rose from 1.39M in 2005 to 3.24M in 2010 and should achieve 6.42M in 2015. CRU estimates also that engineering good and consumer goods would perform a 7% CAGR in the period 2009-2015.

As a consequence, Mr Houlden affirmed that the demand for steel products in India grew from 40.3Mt in 2005 to 63.2Mt in 2010 (**Fig 3**). More importantly, it might reach 94.1Mt in 2015, which implies a CAGR of 8.3%, which is similar to the expected growth in GDP.

On the supply side, significant greenfield and brownfield capacity additions have been planned in India. These investments will not only meet the high growth of steel consumption, but also will capitalise on some of India's steelmaking competitive advantages: a) large resources of iron ore and; b) low labour costs. In relation to the latter, Chinese labour costs were 10% higher than in India in 2005, this difference jumped to 66% in 2010 and is anticipated to reach 92% in 2014.

However, there are a number of challenges that limit the increase in output, one major drawback being the lack of sufficient coking coal. Other important hurdles are related to acquiring mineral concessions in India, remembering the excessive delays in obtaining the environmental and forest clearances and the difficulties of land acquisition experienced to date. The country faces considerable infrastructure bottlenecks, regarding ports (inadequate handling capacity and lack of deep draft), railways (availability of rakes and slow speeds) and roads (national highways are 2% of total roads but carry 40% of freight).

Mr Houlden also presented an estimate of finished steel products in India, which have increased from 41.2Mt in 2005 to 59.5Mt in 2010, and he predicts will total 90.1Mt in 2015 (left axis of **Fig 4**). If this scenario is correct, Indian net imports of steel products, which grew from 1.4Mt in 2005 to 4.5Mt in 2010, would experience a sharp retraction to 400kt in 2011 and then would return to an increasing trajectory to achieve 4.1Mt in 2015 (right axis of **Fig 4**). The key message from CRU is that India will have quite a well balanced steel market, putting the risk of increased exports very low. Indeed, the threats from exports continues to be from China.

Russian steel oligarchs

Prof Stephen Fortescue, from the University of New South Wales, Australia, dedicated his speech – (presented in his absence as a recording), – on the Russian steel industry. The most interesting feature analysed by him was the ownership structure of Russian steelmakers. Viktor Rashnikov retains 86% of the MMK share capital. Aleksei Mordashov controls 78% of Severstal, while Vladimir Lisin owns 85.5% of NLMK. The main shareholders of Evraz are: Roman Abramovich (35%), Aleksandr

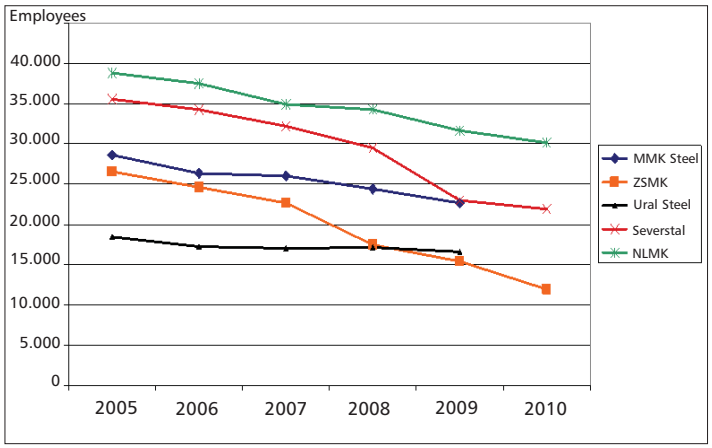

Fig 5 Employment in some Russian steel companies, 2005-2010
Source Prof S Fortescue

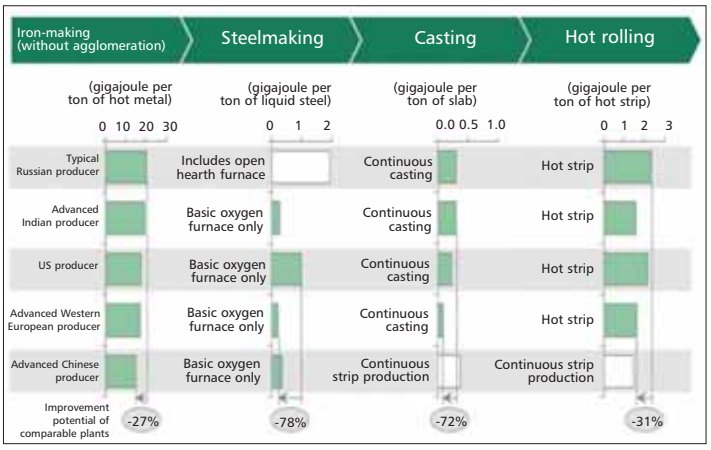

Fig 6 Energy intensity differences of selected integrated steel plants using blast furnace route. Source M Woerther BCG

Abramov (24%) and Aleksandr Frolov (12%). Igor Zyuzin has a 67% stake in Mechel, whereas Metalloinvest is controlled by Alisher Usmanov (50%), Andrei Skoch (30%) and Vasilii Anisimov (20%).

It can be argued that it is well known that Russian steel companies have a high degree of private ownership. Nonetheless, Prof Fortescue added interesting information about the age of the Russian steel barons and their heirs (**Table 1**). Indeed, the key owner-managers are relatively young as well as are their children. Thus, any discussion regarding a succession in running the business can be considered premature. The only exception is MMK, in which Viktor Rashnikov's daughter, Olga Rashnikova, at the age of aged 26, was appointed director of financial resources and control of MMK in January 2011. Considering that many steel enterprises are family-controlled, this look at the age profile of the steel oligarchs' and their inheritors seems a curious approach.

Statistical information about Russian steel industry was also provided by Prof Fortescue. Some less known data refers to the number of employees. As presented in **Fig 5** major steel companies have reduced the workforce significantly in recent years. In the period 2005-2009, for which there are figures for all companies, the reduction in jobs was: MMK (21%), ZSMK (belonged to Evraz, 42%), Ural Steel (owned by Metalloinvest, 10%), Severstal (35%) and NLMK (18%). Although Prof Fortescue did not put in this way, it should be remembered that Russian steel companies have engaged in massive investments since 2004, but that only had the effect of maintaining output at best. However, these investments allowed a considerable improvement in labour productivity.

According to Prof Fortescue, Russian steel exports in 2010 were 28% lower than in 2007. Consequently, as Russia, like India, is not growing its exports, the key threat is from China, not only by exports of steel products per se, but mainly via indirect steel exports as manufactured goods.

Environmental challenge

Mr Martin Woertler, Senior Partner in the Boston Consulting Group (BCG), addressed the environmental challenge for the world steel industry. According to him, steel production differs substantially from plant to plant in terms of efficiencies and operational practices. Along the production value chain, the largest energy consumption occurs in the ironmaking phase, in which the typical Russian producer requires some 20GJ/t of hot metal (**Fig 6**). In comparison, an advanced Chinese producer can consume 27% less energy at the same stage of the process.

The greatest relative deviations among steelmakers generally take place in the steelmaking phase (78%), owing to missing or nonexistent gas recovery from basic oxygen furnaces, inefficient operation modes, or inadequate automation of electric arc furnaces. Outdated technologies, such as open-hearth furnaces and ingot casting, also consume considerable amounts of energy.

BCG identified six main levers along the steel production value chain that steelmakers can use to reduce energy consumption and so lower environmental impact. These are:

- Improving the installed base and enhancing operations offers a 20% saving or globally 2-4EJ (EJ = 10^{18}J = bnGJ = 0.2778TWh)
- Upgrading industrial power plants offers a 0.5EJ saving
- Expanding other industries' use of steelmaking by-products achieves 0.5EJ of credits;
- Adopting new technologies and alternative production concepts can achieve the most dramatic reductions, halving the coke rate, for example;
- Enhancing the quality of input materials and logistics can also make dramatic savings up to 60% on logistics;
- Improving control of environmental pollution can again be large as well as reducing CO_2 emissions.

According to Mr Woertler, the enhancement of existing steel plants and their operations to bring them up to the best-practice standards can deliver an annual saving of some 2 to 4 exajoules of final energy consumption. The upgrade of industrial power plants can generate a saving of 0.5 exajoule, the same amount that can be derived from the increase in the use of steelmaking byproducts (such as blast furnace slag in cement production).

The good news from BCG's diagnosis is that energy efficiency can be improved with existing technology. Furthermore, in many applications, the payback times are less than five years and, sometimes, only two years. Additional benefits will be gained by companies in terms of shareholders relationship, innovation and differentiation, brand, talent management, and risk mitigation. The final phrase of Mr Woertler's presentation was: "*Over time, the relevance of sustainability issues can only go up*". Who can deny that? ■

Company	Owner	Date of birth	Age	Number of children	Date of birth
MMK	Viktor Rashnikov	13 Oct 1948	63	2	1985
NLMK	Vladimir Lisin	7 May 1956	55	3	?
Severstal	Aleksei Mordashov	26 Sept 1965	46	3	1985, 99 & 2000
Evraz	Aleksandr Abramov	20 Feb 1959	52	3	1991, 92 & 94
Metalloinvest	Alisher Usmanov	9 Sept 1953	58	1 step son	
				1 nephew	1983
Mechel	Igor Ziuzin	29 May 1960	51	2	?

Source: Prof Stephen Fortescue

Table 1 Age and children of key owner-managers of Russian steelmakers

ILAFA is now Alacero

Formerly known as the Latin American Iron & Steel Institute - ILAFA - the organisation has rebranded itself under the name Asociaión Latinoamericana del Acero (Alacero).

The new brand aims to integrate the value chain of steel and reflects the attributions of innovation and sustainability distinctive for this industry.

By changing the brand, the association is consolidated as an entity which represents the value chain of steel in Latin America. According to its President, Daniel Novegil, the launch of the new trademark "will contribute to strengthening the relations and promoting integration between the different links which make up this chain." Alacero represents 51 active companies from all over Latin America, which as a whole produce 70Mt/y.

At the same time, the rebranding is aligned with the process of image repositioning the steel industry, and also emphasizes a wider presence in the media and enhances interaction and communication between its associated members.

www.alacero.org/Paginas/default.aspx

The 5th North American CRU Steel Conference

Steel analysts CRU have established a regular annual conference in Chicago to examine the US steel industry and the wider perspective of the global industry on its function. In 2011, numbers attending were well up on 2010, probably reflecting the growing activity in the US steel sector. **Dr Hans Mueller** reports on the event.

THE title of the opening keynote session of CRU's 5th North American steel conference was 'Steel Industry Dynamics and Trends'. Keith Laurin of ThyssenKrupp put China's growing share of global output, from 46% in 2011 to an estimated 49% in 2014, in the forefront of trends that would shape the future path of the international and US steel industries. Other trends having this effect would in some degree be sensitive to the actions of US steel market participants, including volatile steel pricing, growing demand for JIT services and greater acceptance of hedging, although in this area steel remained far behind such industries as oil and copper.

Still other trends – such as slower than normal job creation and political groups gaining more influence over corporate practices – would affect not just steel producers but all manufacturers or entire economies. Laurin briefly showed a bird's eye view of his company's new plant in Alabama, but refrained from gauging the impact this plant would have on the dynamics of the US steel market.

Michael Rehwinkel of Evraz North America stressed the importance of looking beyond market trends to understand the needs of end-use customers and of aligning company operations to meet those needs. In his view, the outlook was good for two of the products lines in which Evraz had specialised, tubular goods and rails, due to a strong energy market and expanding railway services. In contrast, the demand for other long products was in need of prodding by a more vigorous approach to infrastructure renewal.

The next two speakers, Aldo Mazzaferro of Macquarie Securities Group and Michelle Applebaum with her own consultancy, discussed the changing role of imports in the US steel market. Both expressed concern about the anticipated slowing expansion of steel demand in China setting off a wave of exports that would cause severe price disruptions in the US market. But again, there was no word about the effect on pricing wrought by the entry of considerable quantities of new domestic capacity.

Held in Chicago, this well organised event, one of several in the CRU steel portfolio, has become a regular on the North American conference scene each Autumn. Held on October 24-26 2011, it attracted 195 delegates – considerably more than last year's count of 119. Among those from outside the USA, 18 were from Canada, four from the UK, two each from Mexico, Switzerland and Turkey and one each from Germany, the Netherlands, the Philippines and Ukraine. Of the 13 CRU officials acting as speakers, chairpersons or supporting staff, 10 had come from the UK.

US economic outlook

Anika Kahn of the Wells Fargo bank predicted slow growth ("not over 2%") for the US economy in 2012, a lack of skills required by the transition from a manufacturing to a service economy, a housing market that will remain swamped with properties 'under water' (the owners' equity being negative) and a modestly positive outlook for non-residential properties. As to the skills deficiency, she did not mention the critical shortage of trained workers confronting many US manufacturing firms. Moreover, in the Q&A, she dismissed a Wall Street Journal's 'nearly 4%' inflation estimate as exorbitant, preferring instead the government's estimate of less than 2% for core inflation, a rate that excludes food and energy costs. Unfortunately, for most American families those additional costs are far from irrelevant.

Edward Sullivan of the Portland Cement Association noted that major US steel producers quickly shut down capacities in response to the drastic weakening of demand during the 2008-2009 recession, thus preventing deeper losses and bankruptcies. He thought some producers were reactivating shuttered operations with undue haste and failed to mention major new operations started up by Germany's TKS in Alabama and by Russia's Severstal in Mississippi. According to Elizabeth Johnson of CRU Analysis, US industrial output and private fixed investment will see only slight improvement in 2012 as will the lacklustre US long-products market (**Fig 1**). Production of wire rod, rebar, merchant bar, and structurals will remain far below pre-recession levels. However, barring any severe disturbances of the economy or trade balance, the mills will be able to earn slightly higher margins despite lingering excess capacity (**Fig 2**).

The topic 'Excellence in Capital Projects' was addressed by Steve Mehltretter of A T Kearney. Large capital projects are often quite steel intensive. But instead of making this point the focus of his presentation – which would have been a good fit for this conference – Mehltretter discussed organisational shortcomings of project performance, among them inadequate identification of project risks, failure to share best-practice experience across departments and, another frequent occurrence, senior company officials as well as major suppliers not getting involved in all phases of risk management.

The China phenomenon

Four specialists – Ken Hoffman of Bloomberg Research, Donald Gallagher of Cliffs Natural Resources Inc, David Hodory of the D J Joseph Company (absorbed by Nucor in 2008) and Peter Simon of CRU Strategies – talked about China's demand for iron ore and metcoal as well as US exports of scrap and metcoal. Large economies are closely linked nowadays or, as Hoffman put it, "what happens in Wuhan, China, will determine steel prices in Toledo, Ohio". With more than two thirds of global seaborne iron ore destined for China, the country exerts a strong influence on iron ore prices paid by steelmakers elsewhere in the world. And when China recently switched a portion of its metcoal imports from Australia and Canada to newly exporting Mongolia, the impact on prices was noticed by all metcoal importers.

Gallagher saw certain megatrends staying the course, specifically the long-term quality decline and rising cost of both iron ore and metcoal and a continuing shift in the demand for raw materials toward the developing world. Hodory, after noting that his company was the largest US scrap dealer and the world's largest buyer of merchant pig iron, said he expected the US scrap surplus to remain stable during the current decade. Turkey's deficit was likely

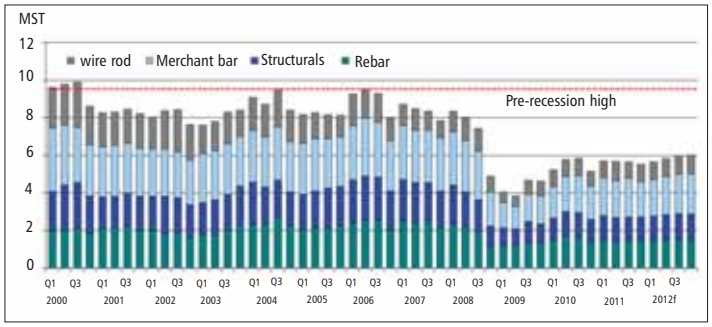

Fig 1 US long products apparent consumption by product (M stons) **Source: Johnson CRU**

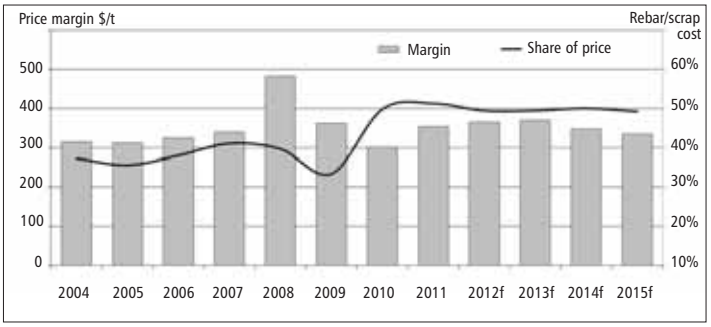

Fig 2 Steel price margins for rebar 2004 – 2015 (left axis rebar price margin over scrap ($/t), Right axis US scrap price as percentage total rebar costs (%) **Source: Johnson CRU**

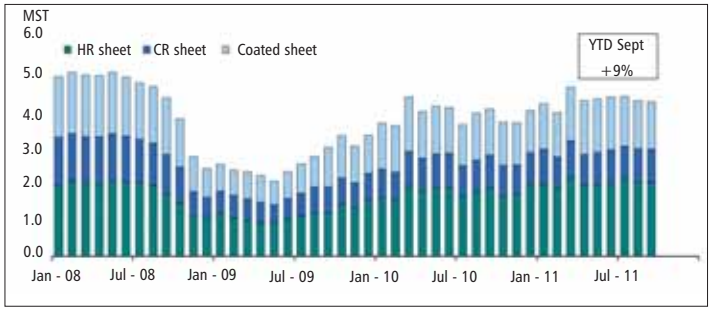

Fig 3 US Apparent consumption of sheet steel (M stons)
Source: Edwards CRU Analysis

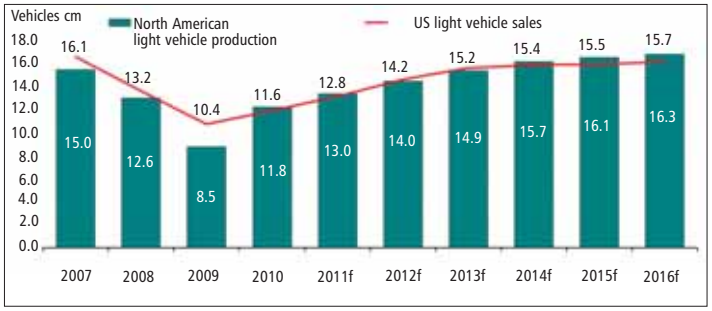

Fig 4 North American light vehicle production and US sales (M units) **Source: Edwards CRU Analysis**

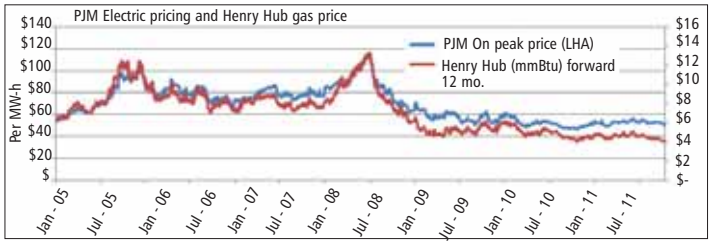

Fig 5 Electricity generated by Natural Gas in USA (Million MW)
Source: D Hackworth

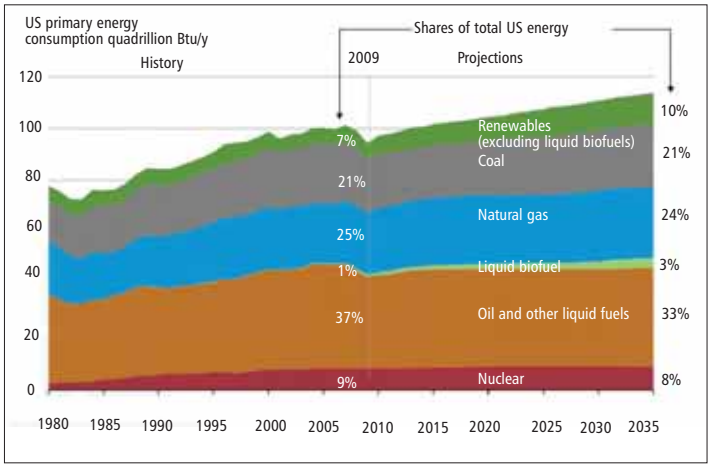

Fig 6 US energy mix 1980 – 2035 – Fossil fuels will still provide 78% of energy needs in 2035 **Source Seeger JMC**

to widen moderately whereas China's net imports, still significant at this time, would shrink to almost nil by 2020.

Simon predicted prices for seaborne metcoal to remain strong due to robust demand and long delays with the start-up of new mines in the Third-World. In the Q&A, Simon acknowledged that the high cost of traded coke would serve as an incentive for building more reduction plants using either natural gas or non-coking coals.

Five executives presented their views on the topic 'Sourcing in a Volatile Market': – John Sunderman of Owen Industries, Mike Taylor of Cargill Steel Service Centers, Jeremy Flack of Flack Steel, Michael Dykstra of Dover Corporation and John Short of Newedge. Because steel is a major cost in Sunderman's build-to-order fabricating and manufacturing plants, SAP software applications were adopted to introduce full transparency into the system. This enabled senior managers to keep track of steel stocks and flows throughout all operations. Cargill – which has interests in steel-supply chains in Europe, Asia and the Americas – sought to manage pricing volatility, whenever possible, with long-term fixed-price contracts or else with floating-price contracts. Future fixed prices for HRC were hedged at the Nymex. Flack tried to cope with volatility by getting a bearing on the inflection points of price movements and linking decisions on specific transactions to elasticity estimates for steel products. Dykstra relied for his sourcing decisions on a system of alliances with suppliers who were chosen after a lengthy 'profile development' placing special emphasis on their past commitment to cost reductions. Short began by explaining such terminology as '*backwardation*' – when the market assessment of a price at some point in the future is below the spot price and '*contango*' – when it is above the spot price. For example, by securing a forward derivative for purchasing slabs and another for selling coils, a rolling mill operator could lock in the margin to be earned at a future date. However, this only works for CRU base prices. Extras would have to be negotiated separately.

The sheet products market

The second conference day opened with discussions by Rob Edwards of CRU Analysis regarding the US steel sheet market and Richard Schultz of Ducker Automotive Materials Practice on steel's changing role in the North American market for light vehicles (cars, SUVs, personal vans and small trucks). According to Edwards, during the first two thirds of 2011 prices and margins did well in the US sheet market, then came under pressure due to existing producers' uncharacteristic aversion to output restraints. (He did not mention another likely reason, the ramping up of new capacity in the south of the country). Following the slowdown in late 2011, the GDP growth estimate for 2012 suffered a downward revision. It would not be surprising if Edwards' forecast of a 'fairly strong' sheet market in 2012 would also be toned down (**Fig 3**). At the global level, his 2011-2016 forecast of a 4.8% growth in demand for sheet in China appears within a feasible range. Whether sustained growth rates of 4.0% can be achieved by Europe during this period and 9.0% by India is less certain. According to Schultz, the automotive producers' concern is no longer just the feasibility of higher fuel consumption standards but keeping the average cost of necessary design and materials changes to less than $3000 per vehicle (**Fig 4**). Public worries about rising fuel costs had caused the US government, with the consent of leading auto producers, to set 2025 performance standard for light vehicles at 54.5 miles per US gallon (about 23 km/litre or 65mpg - UK), nearly double the previous mandate. In the long-raging battle between steel and aluminium, the focus shifted from environmental impact to production economics. The life cycle argument, the steel lobby's favourite, is less relevant now that attention has turned to issues of material density, stiffness and cost. As Schultz saw it, weight and stiffness advantages were likely to increase aluminium's share of total vehicle weight from the current 9% to 18% or even 20% by 2025. Non-metallic materials will also compete for a share of the automotive market as is suggested by plans of a newly formed GM-Teijin partnership to use carbon fibre in automotive parts[1].

Changing energy costs

Three company executives and a CRU expert discussed the impact of energy shifts on the steel industry. David Hackworth of Consol Energy, David Seeger of JMC Steel, Robert Hunter of Midrex and Fraser Campbell of CRU Analysis all presented views. Hackworth traced the historic relationship of oil and natural gas (NG), with their prices 'uncoupling' in the 1990s as NG began partially to displace oil and other energy inputs consumed by electric power plants (**Fig 5**). The shale industry, which is less than 10 years old in the USA, gave an additional impetus to that trend. Hackworth predicted that, overall, fossil fuels would remain the largest energy source of the US electric power industry. It was not clear, he added, what effect the current entry of oil 'super majors' (ExxonMobile, Shell, etc.) into the NG industry would have over the longer term on industry consolidation and NG prices.

Seeger listed the following share (and estimated 2035 share within brackets) of primary US energy consumption: Renewables 8% (13%), nuclear 9% (8%), coal 21% (21%), oil 37% (33%), NG 25% (24%). In his view, the principal challenges to the faster expansion of renewables were insufficient government seed money, an incomplete national grid system, lack of skilled labour and national as well as local opposition. He described various types of both solar and hydrokinetic energy sources and noted that additions to nuclear power generation had been put on hold after the accident in Japan. Although in absolute terms renewables would expand rapidly, 'under current policies fossil fuels will still provide 78% of US energy use in 2035' (**Fig 6**). In the Q&A, Seeger

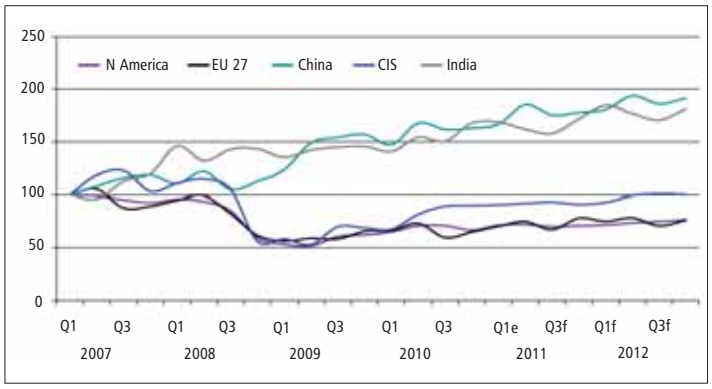

Fig 7 Demand for long products is expected to grow in 2012 with China and India leading demand Source: Johnson CRU

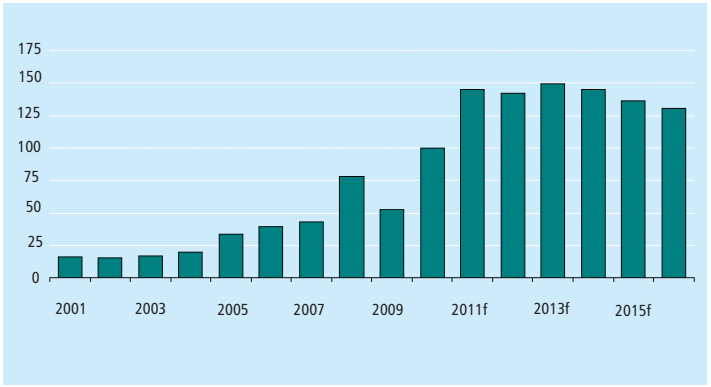

Fig 8 Itabira ore fines contract price (2010 = 100) Source Edwards CRU

expressed uncertainty about the comparative size of US and Chinese subsidies to the renewable energy industries. Hunter illustrated the growing importance of natural gas in the production of iron by pointing out that during the 1994-2010 period 60.2Mt of new capacity added outside of China was of the DR type and 58.6Mt from blast furnaces (BF). He thought that by 2020 twice the amount of NG would be produced than had been anticipated just a few years ago and that BF operators would do well to emulate AK Steel's practice of charging large quantities of DRI into their BFs. Campbell – cautioning that inflation, bad weather and natural disasters posed major risks to the assessment of future events – nevertheless provided an intrepid forecast of global GDP growth until 2030, which showed developing regions sprinting ahead at a faster pace than developed. In his comparisons of steelmaking costs, Europe appeared in the worst position at $600/t as compared with $509/t for North America and $453/t for Mexico. Steel producers in North America were shown to pay less for their raw materials than most other major producers. Campbell predicted that ten or eleven years hence China would turn into a net scrap exporter.

Transport

The final speaker at the conference, John Woodcock of TTX Company, talked about the impact of high fuel costs on North American rail transportation. TTX acts as a railcar cooperative and is in charge of directing and maintaining a North American pool of railcars numbering over 200 000 units. Directing or managing is mostly concerned with arranging backhaul loads for the owners. In 2011 the price of diesel fuel rose by one third. TTX wanted to know the impact this cost increase had on the demand for different distances of freight service. The hauling distance was segmented into large categories of 0-499 miles, 500-1999 miles and 2000 plus miles. The technical indicator of that impact, demand elasticity, was low for haulage services covering distances under 500 miles as well as for long distances over 2000 miles. The elasticity was high for intermediate distances. In contrast, on international hauls, the negative effect of higher fuel cost was greatest for services beyond 2000 miles. ■

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[1]The Wall Street Journal, Dec. 9 2011, pB5

Efficient combustion and insulation in a normalising furnace

A new roller hearth furnace for normalising plate, designed in-house by SAIL, has resulted in a 28.5% saving in specific fuel consumption from a level of 0.26 Gcal/t of product while increasing throughput by 38%. These savings have been achieved through improved burner design, better roof insulation using ceramic fibre modules and better temperature control through the furnace zones. The in-house designed burners cost just one-tenth the price of purchased burners.

By P Kumar* Dr A K Bhattacharya* I N P Gupta* P Jha* B K Jha* S Ramaswamy and P Kumar****

IN integrated steel plants, normalising is employed to soften the steel, refine its structure and to increase toughness. In this heat treatment process, steel is heated to 30-50°C above the Ac_3 or Acm temperature, as determined from the Fe–Fe_3C phase diagram, into the 100% austenitic phase and held there for sufficient time to obtain homogeneous austenite in which any carbide in the steel has dissolved. The temperature of heat treatment thus depends on the C content of the steel as Ac_3 has a negative gradient (from 911 to 723°C) for hypo-eutectoid steels to the eutectoid composition of 0.8%C while Acm has a positive gradient (from 723 to about 1150°C) for hyper-eutectoid steels with C contents of 0.8%C to 2.1%C (the maximum C content of plate steels is typically 0.1-0.22% for BSP).

The product is then cooled in air. The cooling rates during normalising are faster than during a full anneal. Therefore, the transformations from austenite to ferrite and iron carbide occur at a lower temperature ie, at a greater degree of under cooling. This results in a finer grain structure in the ferrite (α Fe) and finer lamella pearlite structure (α Fe+Fe_3C). Such refined structures improve mechanical properties and are essential for heavy cross section rolled material, such as plate.

The Plate Mill of Bhilai Steel Plant (BSP), a unit of Steel Authority of India Ltd (SAIL), India has a continuous normalising furnace with a design capacity of 160kt/y of normalised plates. This furnace is 72m long, 3.5m wide and is equipped with 144 driven rollers to carry the plate through the furnace over at a speed ranging from 0.015m/sec to 0.15m/sec depending on plate thickness (**Table 1**). The furnace is divided into nine zones for temperature control. Mixed gas of calorific value 1500Kcal/Nm^3 is used as fuel to fire 117 direct gas fired burners, 78 located above and 39 below the roller pass line. The furnace temperature is typically maintained at about 930°C. All zones are provided with temperature and air-fuel ratio controllers for proper control of furnace zonal temperatures and furnace atmosphere.

Sl No	Thickness in mm mild steel and BQ	Thickness in mm BQ with impact	Thickness in mm HT & Grade C	Roller speed	Travel time in minutes
1	8 - 10 - 12	8	8 - 10	0.07	17
2	14 - 16	10	12	0.06.	20
3	18 - 20	12	14 - 16	0.05	24
4	22 - 25	14 - 16	18 - 20	0.04	30
5	28 - 30	18 - 20	22 - 25	0.03	40
6	32 - 36 - 40	22 - 25	28 - 30	0.025	48
7	45 - 50	28 - 30	32 – 36 - 40	0.020	60
8	56 - 63	32 - 36 - 40	45 - 50	0.015	80
9	>63	45 - 50 - 56 - 63	56 - 63	0.0125	100
10	>90	>63	>63	0.01	120

Notes: Sl No. – Serial Number, BQ – Boiler Quality, DMR – Defence Metallurgical Requirement (low carbon low alloy grade), HT – High Tensile, Plates with impact properties require high residence time in the furnace as compared to the plates without impact properties.

Table 1 Plate travel time in the furnace for different thickness and steel grades

The demand for plate was such at BSP that the existing normalising furnace was not able to meet demand. To augment the normalising capacity, it was decided to construct a second normalising furnace of in-house design, fabrication, construction and commissioning using internal resources to the maximum extent. This paper describes the efforts made by the Research and Development Centre for Iron and Steel (RDCIS) to design, install and commission an efficient combustion system comprising burners, refractory burner quarls and the necessary gas and air pipe line network. It also describes the work carried out in installing a ceramic fibre roof insulation system.

Current technological status

The present scenario of global competitiveness in cost and quality of product has become important. Until the late sixties, all efforts of improvement in the furnaces were aimed at improving the productivity and life of the furnace elements. The energy crisis in the seventies changed the direction of research and development activities towards fuel saving. Today, the emphasis is on product development and product quality as well as cost. The above objectives can be met by adopting the latest technology or by suitable design and operation improvements in existing furnaces.

During normalising plates, the duration of heating depends on the thickness and composition of the plates. In a roller hearth furnace, the speed of the rollers is set such that the plates are properly heated and soaked to achieve a uniform temperature, before discharge from the furnace. The speed of the rollers and travel time through the furnace of a plate is presented in **Table 1** for different plate thicknesses and compositions of steel.

In any furnace, operational improvements are the most vital factors for fuel saving and improving the quality of heating. Any improvement or modification in the design of a furnace and combustion system has to be appropriately adopted in the operating practice to gain the benefits. Successful implementation of most of the operating improvements depend on the

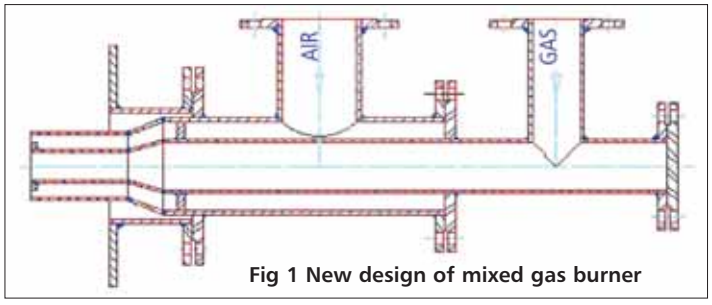

Fig 1 New design of mixed gas burner

Fig 2 Series of burners mounted on furnace wall

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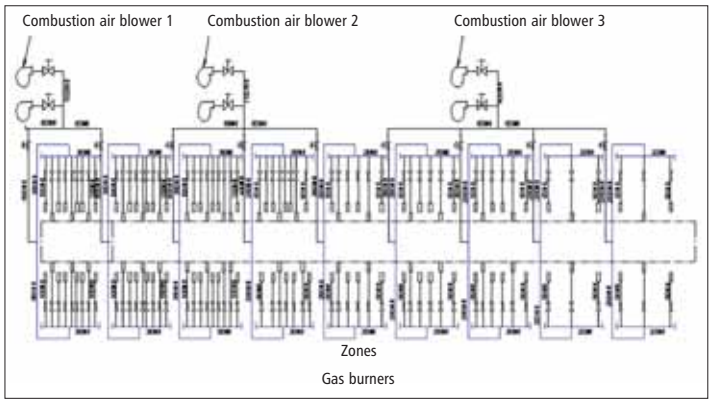

Fig 3 Scheme of air pipe line network

Fig 4 Furnace flue outlet and dilution air blowers connected to chimney

operators. With the advent of computers and automation, dependence on human factors is increasingly falling.

As with the design aspects of the furnace, all the operational aspects from simple steps such as closing doors and apertures of the furnaces to complicated tasks such as maintaining optimum temperature regimes have some bearing on the quality of heating and fuel saving. Some important operational aspects are:

– Optimisation of combustion regimes,
– Optimisation of thermal regimes and
– Optimisation of pressure.

The basic requirements for good combustion of fuel are:

– Complete combustion of fuel,
– Desired flame configuration,
– Minimum oxygen in the outgoing product of ombustion,
– No occurrence of overheating of furnace elements and
– Minimum pollution (reduction of NOx).

The basic requirement of heating of stock in the furnaces is that the metal should reach the desired normalising temperature within the permissible tolerances. In the case of a continuous furnace, it is necessary to maintain the required temperature profiles along the length of the furnace such that the metal is fully normalised when it reaches the discharge end. In case of batch-operated furnaces, the stock is heated at a prescribed rate of temperature increase (known as RAMP heating or step heating mode) with the help of programmable temperature controllers.

The temperature profiles to be maintained in different zones of the furnaces are called thermal regimes. Sometimes, regimes are also worked out in the terms of fuel supply to each zone. Thermal regimes are calculated using mathematical models for heating of the charge. The model is capable of computing thermal regimes with the help of a dedicated computer for heating the metal charge at the desired rate.

The pressure inside the furnace is normally maintained positive to avoid ingress of atmospheric air. The pressure can be measured either at the roof or from the side wall. The pressure in the bottom zone (below the charge/stock) of the furnace may be negative. When the furnace pressure exceeds the normal limits, flames shoot out of the doors causing heat loss and damage to furnace elements. A greater detrimental effect is the loss of combustion air. Normally the burners are designed for a specific discharge pressure at the burner tip. Whenever the furnace pressure increases, the back pressure for the discharge of gas and air increases leading to a reduction of gas and air flow rates. Therefore, the reduction in the flow of combustion air is greater when the furnace pressure is abnormally high.

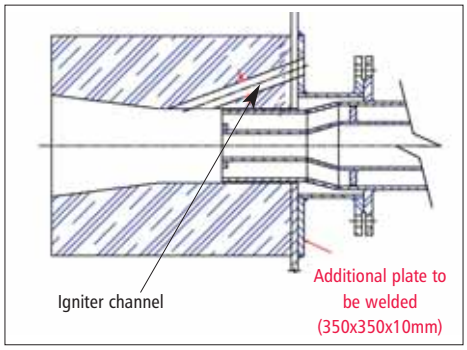

Fig 5 Refractory burner block (quarl) (diameter 350mm)

The furnace pressure exceeds the recommended level when the volume of the combustion products exceeds the throughput capacity of the flue track. The volume will be high when the fuel input is high and/or when infiltration of atmospheric air into the flue line takes place. When improper thermal regimes are present, the discharge temperature of the flue gas will be high. Under these conditions it is necessary to allow ingress of atmospheric air into the flue line before the chimney to cool the flue gas to prevent over-heating of the chimney, but this increases the pressure in the furnace. Therefore, it is essential to maintain the correct input of fuel to maintain the correct furnace pressure regime.

Many advancements have been reported in the literatures with respect to the latest combustion technology. The use and advantages of 'on-off' sequential firing for high temperature furnace operation has been recommended, but is not recommended for furnaces operation below 850°C due to safety reasons. Even with the support of a pilot flame, delay in ignition and fluctuation in pressure has been observed[1]. The idea developed by Professor George J Paulonis and later Kroschroder developed the controls and special valves that are the heart of successful pulse combustion technology. The paper describes a frequency-modulated and amplitude modulated mode of firing. Valve operation at a frequency of ten cycles per minute restricts its application due to operating and maintenance problems[2]. The effect of scale formation on the charge on heat transfer in the furnace has also been studied[3] using mathematical modelling.

Furnace roof insulation

The present economic necessity to achieve maximum fuel economy has given impetus to the use of engineered ceramic fibre roof systems. Stack bonded module systems provide the capability to use ceramic fibres to their full potential and, as a result, have become extremely popular with furnace designers, builders and operators, throughout the world. The basic system of stack-bonded modules uses 25mm thick ceramic fibre blanket, or mat, which is cut into strips of the appropriate size. The strips are turned on edge to the heat flow and applied in one of several ways – directly to the furnace lining, or to a backing material, or onto a metal substrate, or panel, or multi-component. Each may include one of several grades of fibre, or more than one type of insulating material on the hot face.

The standard stud welded module used at BSP is an all ceramic fibre of low thermal mass manufactured from high density, high purity, ceramic fibre blanket, pre-assembled into blocks, 305x305x305mm dimensions and is made up of fibre strips bonded onto an expanded metal substrate using a special water, acid and chemically resistant mortar. A specially designed welding stud is incorporated in each module so that it can be attached quickly and easily to the furnace shell by means of a welding stud gun.

In the steady state condition, the ceramic fibre modular lining has a lower thermal conductivity than alternative systems, at all temperatures, between ambient and the maximum operating temperatures. This means that the low thermal mass modular lining provides substantial fuel and financial savings, as well as the other design advantages of low capital cost, fast, simple installation and easy maintenance.

In addition, the furnace may be put into service immediately after the lining is completed, with no delay for drying, curing, or heating slowly through the refractory phase changes otherwise necessary, to minimise thermal expansion and to prevent damage. Since the thermal mass of the lining is very low, a much faster cycle time is possible. All of the above contribute to a considerably higher productivity per unit and per capital invested.

Experimental

The combustion system for the new furnace was designed taking into consideration the total heat load requirement for the production capacity and flame configuration. The heat load calculation was based on a normalising capacity of 50t/h (max), a gas calorific value of 2200Kcal/Nm^3 and a discharge temperature of

zones	No of burners (above/below)	Gas flow Nm^3/hr	Air flow Nm^3/hr	Burner capacity Nm^3/hr
I	18 (12+6)	2700	7500	Burner Type # I
II	18 (12+6)	2700	7500	Gas flow = 150 Air flow = 420
III	18 (12+6)	2700	7500	
IV	15 (10+5)	1500	4000	Burner Type # II
V	12 (8+4)	1200	3500	Gas flow = 100 Air flow = 275
VI	12 (8+4)	1200	3500	
VII	12 (8+4)	1200	3500	
VIII	6 (4+2)	600	1500	
IX	6 (4+2)	600	1500	
Total	**117 (78+39)**	**14400**	**40000**	

Table 2 Zone-wise burner distribution with gas and air flow details (Calorific Value of mixed gas = 2200Kcal/Nm^3, Excess Air = 30%)

Chemical (wt%)		
	Al_2O_3 70 min	
	Fe_2O_3 1 max	
	CaO 1.5 max	
	SiO_2 balance	
Physical characteristics:		
	Bulk Density at 110°C/24hrs	2.8g/cc min
	Cold Crushing Strength after firing	
	At 900°C/2hrs	600kg/cm^2 min
	At 1400°C/2hrs	1100kg/cm^2 min
	Hot modulus of rupture at 1400°C /3hrs	5kg/cm^2 min
	(on fired blocks at 1400°C/3hrs)	
	Permanent Linear Change at 1400°C/3hrs	± 0.5% max
Water required for casting in high intensity mixer		4-5%

Table 3 Specification of low cement castable burner block

Ceramic fibre	HTZ grade	STD grade
Chemical Composition (wt%)		
Al_2O_3	33-36	45-48
SiO_2	44-48	52-55
ZrO_2	16-19	--
Bulk Density (g/cc)	128 - 96 - 64	128 - 96 - 64
Fibre Dia (μm) max	3.0	3.0
Shot content (%) max	15	15
Tensile strength (Kpa) min	60	40
Shrinkage after 20h firing (%) max	At 1400°C – 3.0	At 1200°C – 3.0

Table 4 Specification of different grades of ceramic fibre

the plate of 950°C. The furnace was divided in to nine zones along the furnace length for temperature control. The heat load distribution above and below the furnace roller level has been kept at about 60-70% above and 35-40% below using 117 direct gas fired burners in total with 78 above and 39 below the roller pass line. The selected combustion control strategy is proportionate control/amplitude modulation of gas and air.

New mixed gas burners for two different heat capacities ie, gas flow rate of 150 and 100Nm^3/h were designed. To produce a stable flame anchored to the burner mouth, the gas nozzles were provided with a flame stabilising disc. A drawing of a burner is shown in **Fig 1**. 54 high capacity burners were installed in zones 1-3 (18 burners in each zone – 12 above and 6 below the roller level), and 63 low capacity burners installed in zones 4-9. A photograph of a row of burners mounted on the furnace wall is shown in **Fig 2**. Details of the zone wise burner distribution and gas and air flow rates are given in **Table 2**. New gas and air pipe-line network was designed and standard pipe sizes for different zones were chosen. The air pipe line network is shown in **Fig 3**.

A photograph of the furnace flue outlet and dilution air blowers connected to the chimney is shown in **Fig 4**. A single piece of pre-shape pre-fired burner block of low moisture content was made from a castable refractory of high quality with good abrasion resistance and spalling resistance. The burner quarl for both burner sizes was designed with an inclined hole included to ignite the burner from the pilot flame. The sketch of a burner quarl is shown in **Fig 5** and the specification of a Low Cement Castables (LCC) based refractory burner block is given in **Table 3**.

The products of combustion are taken out of the furnace through three flue outlets provided in the furnace roof and then discharged into the atmosphere through three 40m high chimneys. Each chimney is provided with two ID fans, one as stand-by. These serve as dilution air blowers and prevent the un-insulated part of the chimney from being damaged by the temperature of the flue gas. They also serves as induced fans and create suction at the flue outlet points in the furnace roof through the up-stream in the flue duct system (**Fig 4**). Furnace pressure is maintained by regulating the damper valve and by varying the speed of the ID fan motor. All ID fans are provided with VVVF (variable voltage & variable frequency) drive motors. A PLC based control system has enabled furnace operation in auto/cascade mode.

The low thermal mass ceramic fibre module based roof lining used enables rapid heat up of the furnace. Specifications for the different grades of ceramic fibre are presented in **Table 4**.

The desirable properties of ceramic fibre in their various forms may be summarised as: Very low density, very low thermal conductivity, very low thermal mass, high flexibility in use, high melting point, high resistance to chemical attack, high spalling resistance.

Results

After incorporating the new combustion and insulation system in the new normalising furnace, detailed thermal engineering investigations were carried out to assess furnace performance. The new combustion system has resulted in uniform heating of the plates charged and all important grades of plate steels are being normalised in this furnace. The turn down ratio of the new burners is 8:1 and the burner is producing a stable flame for the whole range of the turn down ratio. The furnace zonal temperatures are being maintained in auto/cascade mode as per the set temperature and the air gas ratio fed to a newly installed Process Logic Controller (PLC).

The ceramic fibre module lining in the furnace roof has resulted in a reduction in heat loss. The temperature of the roof of the new furnace is 40-50°C, compared to 70-80°C for the refractory brick lined roof of the original furnace. Also, furnace shut down as a result of brick failure has been eliminated.

The improved efficiency of the combustion system, improved roof insulation and better furnace operation in the auto/cascade mode has resulted in 28.5% reduction in specific fuel consumption and a 38% increase in product throughput as presented in **Table 5**. The cost of the in-house designed burner is about one tenth that of the price quoted by commercial suppliers. The improved furnace performance has resulted in an annual saving of IRs 45M (US$912k). ■

Parameter	Period	Unit	Old furnace	New furnace
Production	April 2010-March 2011	t	189332	Not commissioned
Av Prod/month	April 2010-March 2011	t	15778	Not commissioned
Production	May 2011 – Sept'11	t		108603
Av Prod/month	May 2011 – Sept' 11	t		21721
Increase in monthly production		%		38
Average hourly fuel consumption		Nm^3/h	7000	5000
Reduction in fuel consumption		%		28.5

Table 5 Productivity and fuel consumption of the new vs old normalizing furnaces

Acknowledgements

The authors wish to thank the management of Bhilai Steel Plant (BSP) and Research and Development Centre for Iron and Steel (RDCIS) of Steel Authority of India Ltd (SAIL) for taking up the challenging work in Normalising Shop of Plate Mill at BSP. We would like to thank Dr D Mukerjee, Executive Director and Shri Arunabha Das, General Manager, who were the source of inspiration for writing this paper. We would also like to thank all our colleagues for their help rendered during the successful implementation of this work. We also wish to thank our management for according permission to publish this paper in the International Journal.

References

1 Development of new on/off sequential firing combustion techniques, M Tomolillo et al; AISE Fall Convention, Cleveland, September 1999

2 Pulse Firing for Ceramic Industry, George J Paulonis et al; Literature from Internet

3 N P Kuznetsova and G I Kolchen Ko, 'Influence of Scale Formation on Heat Transfer Intensity in Furnaces', Steel in USSR, July 1988, Vol 18, pp 332-333

Pioneers of the Steel Industry: Part 8 casting of steel

By Fathi Habashi*

Fig 1 Ingots of 20thC Swedish iron

Fig 2 Solidified steel ingots in foreground and teeming into mould in background

Fig 3 Solidified ingots being charged to a soaking pit while still hot from casting

PRIOR to the development of tonnage steelmaking in the 19th century, iron tapped from the blast furnace flowed into sand moulds prepared on the ground in front of the furnace tapping arch. Here the metal solidified into 'pigs' – so called as the moulds were set at right angles to a central runner – the sow – which fed them rather like piglets suckling from the mother sow. Once solidified, the 'pigs' were broken from the feeder by a sharp hammer blow and removed from the sand mould for later remelting and refining to reduce the concentration of carbon and other impurities, or for sale to foundries to melt and cast into finished artefacts (**Fig 1**). This operation is no longer used because it involved extensive manpower. Instead, if pigs are to be made, continuously moving casting machines consisting of water cooled permanent moulds on a continuous belt are used. By the time the cast pigs have travelled from one end of the belt to the other they have solidified and drop away from the moulds as the belt inverts them as it passes over the final roller on its way back to the start of the process.

From the 20th century onwards, the bulk of iron from the blast furnace was transferred in the molten state to the steelmaking plant for refining in a converter or open hearth furnace. Until the 1960s, the refined steel was usually teemed (ie cast) into a row of ingots moulds made of cast iron (**Fig 2**). As the steel solidifies it shrinks leaving a cavity at the top of the ingot requiring the top part of the semi-product formed after rolling or forging the ingot to be cut off to avoid defects in the final product. To reduce the amount of metal that has to be removed – which is recycled to the steel plant for remelting – the top of the ingot is kept molten as long as possible by placing insulating tiles inside the top of the mould and adding an exothermic powder once the metal is cast thereby retaining molten metal to feed the shrinkage cavity as it forms. Such steels are fully deoxidised by the addition of aluminium or ferro-silicon or ferro-manganese and are known as 'killed' steels. Alternatively, in low C steels for strip production, only partial deoxidation may be carried out so as to form a rim of bubbles of carbon monoxide a few centimetres beneath the surface of the ingot as it solidifies following the contours of the mould. These bubbles compensate for the shrinkage and readily weld up when the hot ingot is later rolled to slab. Such 'Rimming Steels' have a thin surface of almost pure iron after rolling which provides an excellent surface finish and imparts good formability characteristics excellent for pressing.

In either case, when the steel is fully solidified, the mould is stripped from the ingot by crane and the still hot ingot placed in a soaking pit (**Fig 3**), in order to homogenise the temperature and reheat the ingot to the temperature required for the next operation of rolling or forging. This means handling the batch of hot ingots many times with a loss of heat at each stage and a loss of metal due to the shrinkage problem.

The introduction of continuous casting improved the metal yield, reduced energy requirements and dramatically reduced the manpower required.

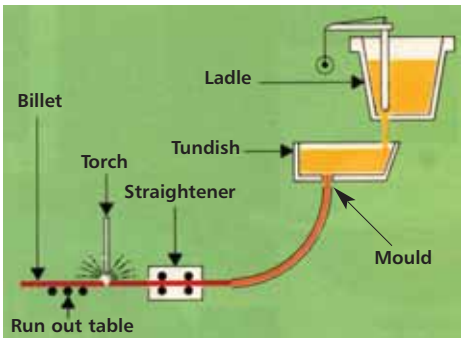

Fig 4 Schematic of a continuous caster

Fig 5 Multistrand bloom caster simultaneously casting five strands

Continuous casting

Introduced commercially in the early 1960s, in continuous casting the molten metal is continuously fed from a ladle of molten steel via a tundish, which acts as a reservoir, located above a permanent water cooled mould which has no bottom (**Fig 4**). The metal in contact with the chilled mould solidifies rapidly to form a skin and the resultant 'strand' is slowly withdrawn from the bottom of the mould by rollers. At all times there is a small pool of molten metal in the top of the mould which feeds the shrinkage as the metal solidifies. The contraction of the freezing metal causes it to pull away from the mould walls assisted by oscillation of the mould. The pinch rolls withdrawing the cast metal are arranged in a curve to slowly bend the casting from the vertical to the horizontal plane (**Fig 5**). On exiting in a horizontal plane, an oxyacetylene flame automatically cuts the emerging metal into the required lengths.

The process is well adapted to large scale production. It produces much less scrap than in batch casting, no cavities because the metal is frozen as soon as it is cast, and a small grain size in the solidified product because of rapid cooling. Continuous casting also provides a significant indirect reduction in energy consumption through improved yields of up to 12% compared with ingot casting. The process has now gaining great success and accounted for 94.7% of the 1332Mt of steel cast in 2010. Only a few special high alloy steels or very large forging ingots are still cast by the traditional ingot route. ■

Suggested readings

F Habashi, Extractive Metallurgy Today Progress and Problèmes, Métallurgie Extractive Québec, Québec City, Canada 2000, 325 pages Distributed by Laval University Bookstore

F Habashi, Textbook of Pyrometallurgy, Métallurgie Extractive Québec, Québec City, Canada 2002, 660 pages Distributed by Laval University Bookstore www.zone.ul.ca

M M Wolf, 'History of Continuous Casting,' pp 83-137 in Steelmaking Conference Proceedings, 75, Iron & Steel Society, Warrendale, PA 1992

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