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Conference report: Iron ore supply – Reports on recent conferences
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Chinese coke output slowing
China, which has been the largest producer of coke, saw its growth in output decline sharply to 1.2% a drop of 18.6% y-o-y in July 2012. The National Development and Reform Commission (NDRC) in a report on the performance of the steel industry in July said the country’s average daily output is decreased 5.8% y-o-y to 261.53Mt in January-July, but then slowed by 7%.
Source: China Metals

Chinese ore prices falling near $110/t as stocks build
Iron ore inventories at 25 major Chinese ports stood at 99.37Mt at August 20, up 780kt or 0.79% from the week earlier, according to the Xinhua-China Iron Ore Price Index (Xinhua-China IOP Index). The China Iron Ore Spot Trading Platform reported zero trading in the August 13-17 period, reflecting that steel mills and ore traders are bearish on a falling trajectory of the iron ore price.

Nucor sells Wire Products facility
Nucor Corporation say they have completed the sale of the assets of their Nucor Wire Products Pennsylvania facility located in New Salem, Pennsylvania, to an affiliate of Wire Mesh Corporation. Nucor acquired the facility in October 2007 after purchasing the assets of Nelson Steel, Inc. Nucor is continuing to produce wire and wire mesh products at facilities located in Utah, Connecticut and Laurel LEC Operations in Canada.

Steel price 3-year low in China
The average steel price in China was quoted at RMB 367/t (US$576.0) on Aug. 21, hitting a three-year low, according to the Xinhua New Line, a domestic steel spot trading platform. Steel prices still faced downward pressure in the short term. Profit for China’s iron and steel industry plunged 49.4% from a year earlier to RMB 66.4bn (US$10.4bn) in the first half of 2012, according to the NDRC.
Source: China Metals

India to set up a steel plant in Mongolia
In a bid to reduce costly imports of coking coal and its high dependence on Australian coal imports, India is attempting to acquire a coal mine in Mongolia and set up a steel plant there.

China’s crude steel production rose 2.1% year-on-year to 419.46Mt in the January-July period, but the growth rate was 8.2% lower than it was a year earlier. In July alone, China’s crude steel output rose 4.2% from a year earlier to 61.093Mt.
The country’s crude steel production continued to grow despite an industry-wide financial loss since the beginning of this year. Steel prices rose from the 2012 low falling to a level approaching production costs. Output, however, remains at a high level as the falling price of steelmaking raw materials has encouraged an increase in production.

Although steel prices rebounded a little in the week of August 14-20, the volume of trading remained low. In the face of mounting steel prices, steel mills have only purchased sufficient raw materials to maintain production. Many ore consumers strongly stick to their promises and stop to anything. They will continue a downward trend and was likely to approach US$110/t, a Xinhua analysts said.

However, the decline in the iron ore price was still less than that of steel prices.

Meanwhile, domestic banks have strictly controlled loans to steel mills and this has led to mounting difficulties for them. Given the high production capacity, steel prices still face downward pressure in the short term.
Source: China Metals

China’s steel output remains high
China’s Q3-2012 steel market outlook signals that market fundamentals may remain depressed longer than expected. Only from Q2 2013 onwards is EU steel demand forecast to improve again.

Eurofer director general Gordon Moffat said: “Weak confidence in combination with liquidity and credit issues is showing a negative impact on the EU business climate. With global economic growth currently hitting a soft patch, export growth is also cooling down, despite the weaker Euro. This is bad news for the manufacturing sector and for steel consumption in the EU”.

Despite Europe entering a technical recession in Q1-2012, available data signal that economic momentum continued to slow in the first half of the year. Moreover, sentiment has come again under pressure in recent months as concerns about the Eurozone crisis and particularly the indecisive way it is being dealt with by EU’s policy makers have resurfaced.

So far, solid order books have softened the manufacturing sector downturn, keeping activity and capacity utilisation at satisfactory levels. However, corporate and consumer retrenchment will translate into new orders remaining subdued for the time being. Meanwhile, construction activity across the EU will remain under pressure as well, due to a lack of new publicly or privately funded projects. This will backfire on steel demand in the EU. Apparent steel consumption is estimated to have fallen by 9% year-on-year in H1 2012. Demand in the H2 is seen as stabilising around the depressed levels of H2-2011. Total apparent steel consumption in 2012 is forecast to fall 5%.

www.eurowro.eu
Krakatau Steel to build $400M HSM next year

Indonesia’s largest steelmaker, PT Krakatau Steel (KRAS), plans to spend up to US$400M on a new hot strip mill as part of its expansion plans. The firm is conducting a feasibility study and should begin land acquisition gradually by the end of this year, president director Irvan Kanal Hakim said in Jakarta.

The company has yet to pick a location for the new facility, but the firm expects to develop in a new area, in a possible exchange of a 40-hectare plot which it was ready for release to Asia’s second-largest petrochemical producer, Honam Petrochemical Corp, he added.

The South Korean petrochemical giant reportedly plans to invest around $5bn to build a petrochemical complex in Cilegon, Banten, where major petrochemical plants are concentrated and KRAS is building a blast furnace and a steel mill there, the latter in a 50% with South Korean steelmaker Posco.

The capacity of the plant will be 1Mt/y and start-up is anticipated for 2015. The plant will include a hot strip mill, the largest share of output going to the domestic market, which sees significant demand for steel as the economy grows.

At present, Krakatau’s hot strip mill has a capacity of around 2.4Mt/y and its total rolling capacity is around 3.2Mt/y from the existing hot strip mill and wire rod mill, bar mill and section mill.

The planned hot strip mill is expected to help the firm to upgrade total rolling capacity to 4.25Mt/y.

To finance the new mill project, Krakatau will use funds generated from its initial public offering, according to Irwan. The firm raised Rp2.68 trillion ($281.11M) from floating its shares on the stock exchange in November 2010.

Apart from this expansion plan, Krakatau, which presently makes all its iron via the DRI route, is building a blast-furnace complex in Cilegon, near its existing steel plants, with an anticipated investment of $601M.

Construction is being undertaken by its subsidiary PT Krakatau Engineering and Chinese state-owned firm Metallurgical Group Corporation – Capital Engineering and Research Incorporation Ltd (MCC-CERI). Start-up is planned for 2014 when it will produce 1.2Mt/y of pig iron.

The firm recently obtained a $200M syndicated loan from Chinese banks – China Development Bank Corporation (CDB), and the Industrial and Commercial Bank of China Limited (ICBC) and The Hong Kong and Shanghai Banking Corporation Limited (HSBC) – to build the blast furnace.

Earlier, it also secured similar syndicated credit totalling $250M from state-owned banks — Bank Mandiri, Bank Negara Indonesia (BNI) and Bank Rakyat Indonesia (BRI).

Krakatau has also entered an advanced stages of development of its 580Mt plant in Cilegon, in a joint venture with South Korean steel giant Pohang Iron and Steel Company (Posco).

The plant is designed to produce 3Mt/y of steel slabs and plates and will come into commercial operation at the end of 2013.

As the economy grows, the development of new steelmaking facilities is crucial in Indonesia, Southeast Asia’s largest economy, as it will help improve the structure of the local industry that still relies heavily on imports, experts say.

Source: Daily The Jakarta Post, Jakarta; 29 Aug 2012

Chinese iron ore prices falling near $110/t as stocks build

Iron ore inventories at 25 major Chinese sea ports stood at 99.37Mt at August 20, up 780kt or 0.79% from the week earlier, according to the Xinhua-China Iron Ore Price Index (Xinhua-China IOP Index).

The price index for iron ore imports of 63.5% Fe content fell 4 points week on week to 117 by August 20 and that for iron ore imports of 58% Fe content also fell 4 points week on week to 98.

Previously, the China Iron Ore Price Index (CIOPI) for the August 6-10 period fell 5.95% from the week earlier to 416.17, according to the China Iron and Steel Association (CISA).

During the period, China’s domestic iron ore prices averaged $112.6 Mt (63.5% Fe) up 0.80% from the previous week, while imported iron ore CIF (cost, insurance and freight) fell 8.58% in the week to August 18 to $121.61/t, or RMB 902.75/t (tax included).

The iron ore price will continue a downward trend and was likely to approach US$110/t, a Xinhua analyst said.

After falling over a narrow range for two weeks, the price decline of imported iron ore accelerated in the week ending August 20. Meanwhile, shipments continued to increase, but market trading was thin as many steel mills and ore traders chose to take a wait-and-see attitude.

The China Iron Ore Spot Trading Platform reported zero trading in the August 13-17 period, reflecting that steel mills and ore traders are bearish on a falling trajectory of the iron ore price.

India, Australia and Brazil were the main sources of iron ore exported to China and the iron ore graded at 62% Fe, from the three countries saw a combined growth of 600kt in the previous week.

As a result of the high export duty imposed by the central government, iron ore exports to China from India’s eastern state of Odisha, the largest iron-ore producing state in the country, dropped by 46% in FY2011-12 to 12.96Mt as against 24.12Mt a year earlier. China is the single biggest market for iron ore exports from India, but due to the 30% duty now imposed exports from across India have dropped by nearly 40% to 60Mt in FY2011-12 from 98Mt in the previous year.

This steep export duty imposed by the Indian central government has rendered Indian ore uncompetitive in the export market, especially to China where shipments plummeted from 89.72Mt in 2010-11 to 52.47Mt in 2011-12 (to February 2012).

China bought 13% of its iron ore from India in 2010-11, but was now considering alternative supplies following the hike in export duty.

Source: China Metals e-mail infochn@public.bta.net.cn

Eurofer to move office

In October Eurofer will move its offices from Avenue Ariane to the EU quarter in the centre of the city at Avenue Cortenbergh 172, near BusinessEurope, the European business federation. www.eurofer.org
Capacity grows for Tata

Tata Steel Group’s plant capacity will grow to 33.5Mt/y by 2014 following the 2.9Mt/y expansion of the Jamshedpur plant and commissioning of the first phase of the 3Mt/y steelplant in Odisha, said Chairman Ratan Tata.

Tata said the ongoing 2.9Mt/y expansion in Jamshedpur is expected to go live this financial year, taking the company’s production capacity in India to 9.7Mt/y.

With its plants in UK, Holland and Singapore, Tata Steel should have a global steel capacity of 33.5Mt by 2014, he said in the company’s annual report for 2011-12.

Tata Steel’s India operations, he believes, will continue to remain strong on account of robust demand in the country.

The Company’s European operations would “continue to be under enormous stress for the next year or two until the Western European economy recovers”, he added.

In 2011-12, Tata Steel produced 14.27Mt in Europe, down from 14.80Mt in the previous year.

“The unprecedented rise in iron ore and coking coal prices coupled with the acute decline in market demand will continue to negatively impact company’s European operations” said, Ratan Tata, adding that the company has already started restructuring and capacity rationalising process to reduce costs.

The European operations of the company were particularly impacted in the second and the third quarter of the last financial year due to high raw material costs.

Coal based DRI lacks ore

Manufacturers of sponge iron (coal based DRI production) and the associated induction furnace operators that melt the product have had to halt production in the southern states of Karnataka, parts of Tamil Nadu and Andhra Pradesh, facing a severe shortage of iron ore lump and the high price at e-auctions.

US imports slow again in July on weaker market conditions

Preliminary import data by the Department of Commerce reported that US steel imports in July declined by 8.4% compared to the final data for June. “The data revisions from preliminary to final import data for some recent months have not been insignificant, but the downward trend continued in July based on the preliminary data. The downward trend in imports reflects weakened market conditions earlier in the second quarter for non-NAFTA arrivals and is consistent with the trends predicted in the AISI Monthly Importer Survey,” said David Phelps, president, AISI.

For the year to date in 2012 compared to 2011, imports increased by 17.1% and were down 1.5% for July 2012 compared to July 2011. “The year to date arrivals in 2012 remain above 2011 so far this year, but weakness in the steel market at mid-year slowed import ordering, especially from off-shore sources. While conditions for imports are currently improving for some products, the weaker market conditions are likely to depress arrivals for a couple of months until the improved market conditions we are currently experiencing work their way through the supply chain. The AISI Monthly Importer Survey is beginning to show some positives for ordering, but the trends at this point are still tentative,” said Phelps.

Total Steel imports in July 2012 were 2.582 million short tons (Mstons) compared to 2.820 Mstons in June 2012, an 8.4% decrease, and a 1.5% decrease compared to July 2011. For the year-to-date period, total imports increased from 17.266 Mstons in the first seven months of 2011 to 20.214 Mstons in the same period 2012, a 17.1% increase.

The data show that imported semifinished products increased by 5.4% in July 2012 compared to July 2011, from 526kstons in 2011 to 54kstons in 2012 and for the year to date period increased from 4.078 Mstons to 4.581 Mstons.

ZincOx ramping up treatment of Korean EAF dust

UK based ZincOx started hot commissioning its rotary hearth furnace (RHF) in Korea during Q1 2012 to process electric arc furnace dust (EAFD) to recover both a zinc oxide concentrate and briquetted direct reduced iron (HBI).

The project, being built in two phases, is designed ultimately to treat 400kt/y of EAF dust containing an average Zn content of 23%. The product is a lead containing zinc oxide concentrate assaying at 60%Zn 4.5%Pb which is contracted to be sold to Korea Zinc.

Phase 1 of the operation has a design capacity of 80kt/y of zinc concentrate plus 50kt/y of hot briquetted iron (HBI). When the second phase comes into operation the plant will have a capacity to treat 400kt/y of EAF dust sufficient to process all the EAF dust presently produced in Korea. 160kt/y of zinc concentrate will result from which 92kt/y of zinc metal will be able to be recovered. The process differs from other zinc recovery methods in that DRI is also produced, 100kt/y of briquetted DRI (HBI) being recovered along with the zinc concentrate.

In an interview with Steel Times International, Andrew Woollett, Executive Director ZincOx said they are contracted for the next 10 years to receive all the EAF dust from 26 of the 27 EAF steel plants presently operating in Korea starting in August and will supply a target of 5500 tonnes crude zinc oxide each month to Korea Zinc (66kt/y) once phase 2 is operational.

He continued that the plant has now ramped up to about 30% of capacity of zinc concentrate production and has produced HBI with an iron content of 80-85%, but modifications to the briquetting plant are currently being made as it has proved to be insufficiently robust.

Two competing technologies are being voiced by other operators. Global Steel Dust plans to use the long established Wealz kiln, but it is understood that financing of this project which is from Macquarie Bank has not yet been finalized or a site concluded and since ZincOx have contracted all but one steelmaker to supply it with dust little local material will be available should the GSD plant proceed.

Another company, Dongsan S&H, announced plans to set up a joint venture together with Mitsui Metal and Marubeni, a general trading company of Japan, to launch its EAFD recycling business using the Mitsui half shaft furnace with the aim to export most of its crude zinc oxide to Japan. However, industry analysts believe this process can only be feasible if highly subsidised and also, like GSD, will not be able to source sufficient dust locally.
July crude production slows

World crude steel production for the 62 countries reporting to the World Steel Association (world steel) was 130Mt in July 2012, an increase of 2.0% compared to July 2011.

China’s crude steel production for July 2012 was 61.7Mt, an increase of 4.2% compared to July 2011.

Elsewhere in Asia, Japan produced 9.3Mt of crude steel in July 2012, up by 1.2% compared to the same month last year. South Korea’s crude steel production for July 2012 was 5.9Mt, an increase of 4.4% compared to July 2011.

In the EU, Germany produced 3.6Mt of crude steel in July 2012, a decrease of -2.1% on July 2011. Spain’s crude steel production for July 2012 was 1.0Mt, 7.0% higher than July 2011. In July 2012, the UK produced 0.9Mt of crude steel, up by 6.6% compared to July 2011.

Turkey’s crude steel production for July 2012 was 3.1Mt, an increase of 9.7% compared to July 2011. Russia produced 5.9Mt of crude steel, an increase of 3.6% compared to July last year.

The US produced 7.4Mt of crude steel in July 2012, up by 0.9% on July 2011. Brazil’s crude steel production for was 3.0Mt, down -4.1% from July 2011. Crude steel capacity utilisation ratio for the 62 declined to 78.7% from 80.4% in June 2012. Compared to July 2011, it is 0.8% lower.

Latin American steel market H1 2012

In the period January-May 2012 Latin American steel consumption grew 13% compared to the same period 2011, driven mainly by Mexico (+16%), Colombia (+11%) and Brazil (+10%). Domestic output, however, fell leading to an increase of imports of 86% to 5.2Mt.

Apparent steel use in Latin America reached 28.6Mt in the five months January-May 2012, 13% more than in the same period 2011.

Crude steel production reached 33.7Mt in the six-months January–June 2012, 2% below that of the same period in 2011.

In June 2012, crude steel was 5.6Mt, a decline of -3% compared with the same month 2011.

Brazil produced 2.7Mt in June, contributing the largest amount from any one country in the region but this was -8% down on June 2011 when it produced 3Mt. The next largest producer was Mexico with 1.6Mt in June 2012. Argentina saw a drop of -7% in crude steel output compared to June 2011.

Trade of finished steel products for the five-months January-May 2012, saw a rise in the region’s deficit to -5.2Mt, while the imbalance in the same period in 2011 was -2.8Mt.

During this period in 2012, all Latin American and Caribbean countries had a trade deficit in finished steel with Mexico presenting the greatest deficit of 1.8Mt. Likewise, Colombia with 595.507kt and Peru with 587.783kt were among those countries which presented significant deficits. The production of finished steel reached 28.7Mt in the first six months 2012, of which Brazil represented 46% of the output at 13.2Mt. Mexico was the second largest producer in the region at 8.1Mt representing 28% of the region’s output.

In June, production of finished steel reached 4.9Mt, 6% more than in the same month of 2011. Brazil and Mexico at 2.2Mt and 1.5Mt respectively were the countries which stimulated the growth in June 2012. Argentina experienced a decline of -3% compared to the same month of 2011.

The apparent steel use in the region reached 28.6Mt in the period January-May, compared to finished steel production of 23.8Mt.

In May 2012, apparent steel use was 5.8Mt, 16% higher than the 5Mt production of finished steel that month.

Latin American Steel: A retrospective in 101 essays

This collection of reprints from Steel Times International of articles authored by Dr Germano Mendes De Paula, Professor of Economics at the Federal University of Uberlandia (UFU), Brazil is available from http://steeltimesint.com/contentimages/news/Latin American Steel.jpg

World Stainless may reach 34Mt

Global crude stainless steel production, this year, is expected to reach 34Mt according to Sheffield based analysts, MEPS.

This represents a modest improvement in the revised outlook in 2011. ISSF have lifted last year’s output figures for China, resulting in a world total of 33.7Mt for 2011. This confirms MEPS assertion last April, that Chinese figures were being under-reported by substantial amounts.

The most significant growth continues to come from the developing markets, particularly India. In the traditional stainless steel-making regions, once again only the EU and South Korea look set to exceed their previous year’s output. Production in the USA, Japan and Taiwan is forecast to contract for the second successive year.

The latest Chinese output figures, presented by CSSC, acknowledge significant increases of previously unreported stainless steel production. The new figures suggest that the outturn for 2011 was a minimum of 14.1Mt.

The major of Chinese steelmakers have substantially curbed production in recent months as domestic growth has slowed and export demand has weakened. Consequently, MEPS have adjusted their prediction for 2012 to 14.2Mt, just 0.1% higher than the previous year’s total.

Source: MEPS - Stainless Steel Review

www.steeltimesint.com

News and Statistics

Events Diary
Auto industry to the rescue of the steel industry as steel prices face free fall

As steel prices seem to be going into free fall this year, the US steel industry is hoping that the invigorated automobile industry, a large consumer of steel, will come to its rescue. The US steel industry, hit by declining profits, has intensified its courtship of the automobile industry which has not only recovered from its past downturn but also strengthened its position in the face of buoyant demand.  

By Manik Mehta*

JULY automobile production figures show signs of rising sales, further enhancing the steel industry’s reliance on the automobile industry. Indeed, the current situation suggests that it is a steel buyer’s market, particularly if the buyer represents the automobile industry. Experts say they do not recall steel prices having fallen so low in recent years.

Advancing strength in steel

Actually, steel prices came crashing down a few weeks ago, but while the free fall seems to have been arrested, they have not risen substantially. For the automobile industry, which is increasingly focusing on light-weight materials in an attempt to boost fuel efficiency, the steel industry’s hesitance to provide advanced high-strength steels (AHSS) which offers benefits to the environment in the form of using less steel and achieving better miles per gallon for the automobile. In effect, the steel industry is increasingly juxtaposing the environmental benefits of using AHSS against aluminium. AHSS has become, to quote local steel circles, the ‘new kid on the block’.

Some of the steel players in the United States such as AK Steel, Nucor and Russia-owned Severstal are rubbing their hands in excitement over the prospect of AHSS’s environmental edge over aluminium. Industry pundits say that Severstal’s automobile customers have been speaking about a five-fold jump in demand for the AHSS material while AK Steel, which also produces electrical steels, has made investment in R&D for AHSS and expects it to sell well. ‘Green’ is the magical key that is expected to unlock many doors for the steel industry. Not surprisingly, Nucor has invested a huge sum on its recycling efforts that are expected to demonstrate the green advantages of steel production over that of aluminium.

ArcelorMittal representatives have been saying that the company’s AHSS technology will help automakers achieve the (Obama) Administration’s recent ruling to raise CAFE (corporate average fuel economy) standards to 54.3mpg US (65.4mp Impgal or 4.315 (corporate average fuel economy) standards to 200000 F-150s in 2011.

Steel versus Aluminium

US based publications, including the Wall Street Journal, have been reporting that US automobile manufacturer Ford is planning to replace about 700lbs (318kg) of steel with aluminium. The carmaker sold more than 200000 F-150s in 2011. While aluminium is a little under a third of the weight of steel, it costs more. The Steel imports declined in July

For the year to date period in 2012 compared to 2011, imports increased by 17.1% and were down 1.5% in July 2012 compared to July 2011.

Steel imports in July 2012 were 2.582 million US short tons (2.34 metric tonnes) compared to 2.820Mstons in June 2012, an 8.4% decrease, and a 1.5% decrease compared to July 2011. For the year to date period, total imports increased from 17.266Mstons (15.66Mt) in the first seven months of 2011 to 20.214Mstons (18.39Mt) in the same period 2012, a 17.1% increase. The data show that imported semi-finished products increased by 5.4% in July 2012 compared to July 2011, from 526kstons in 2011 to 554kstons in 2012 and for the year to date period increased from 4.078Mstons to 4.581Mstons.

Steel versus Aluminium

According to the SMDI, AHSS will be best suited for the automotive industry to meet standards for reduced greenhouse gas emissions without compromising safety, performance or affordability.

Advancing strength in steel

Indeed, AHSS grades are being developed to meet the challenges faced by automobile manufacturers such as crash performance requirements, the need to reduce vehicle mass for fuel efficiency and enhance formability to manufacture high strength parts.

Ron Krupitzer, vice president (automotive) at the SMDI, has been saying that the advanced steel grades are relatively new to vehicle design and are significantly different from the conventional steels they replace. These attributes, he adds, were developed through the creation of specific microstructures by precise and tightly-controlled steelmaking processes, resulting in lightweight automotive designs that are cost effective with low emissions that also provide unmatched safety performance. Motorists questioned on the safety attributes of a car, according to the SMDI, value the safety benefits of steel.

Advancing strength in steel

In addition, automobile manufacturers recognize that steel is recycled more than all other materials, and has an extremely high overall recycling rate. Indeed, the amount of automotive steel recycled can exceed the steel used in new models since the vehicles presently recycled contain a greater weight of steel than new models. Steel used in today’s cars can also help automobile manufacturers reduce the carbon footprint of tomorrow’s vehicles.

Another plus point for the AHSS, according to the Massachusetts Institute of Technology, is its affordability. According to a MIT study called ‘Process Cost Modelling: Strategic Engineering Economic Evaluation of Materials Technologies’, other alternative materials showed a significant cost disadvantage for all aspects of the body-in-white manufacturing process. For example, aluminium’s raw material costs are three times higher than those of steel, while in terms of conversion costs, aluminium is two times more expensive than steel.
Tenaris - High capitalisation and investments

Market capitalisation – also known as market value – is argued to be a better criterion to express how much a company is worth, rather than the volume of its output. By this measure, Techint’s Latin American subsidiaries, Tenaris and Ternium, together outrank the world’s largest steelmaker, ArcelorMittal. By Germano Mendes de Paula*

IN the ranking of the world’s largest steelmakers for 2011 there were six Latin American companies: Gerdau (Brazil), Techint (Argentina), although the formal headquarter is Luxembourg), Usiminas (Brazil), CSN (Brazil), Ahmsa (Mexico) and Sidor (Venezuela) (Fig. 1). Such rankings published by Metal Bulletin, and other classifications are usually based on crude steel production.

Although it is incontestable that the volume of production is an important indicator, it can be argued that market capitalisation – also known as market value – is a better one as it expresses how much a company is worth. In the second week of July 2012, Tenaris had the largest market capitalisation ($20.8bn) among all Latin American steel companies, followed by Gerdau ($14.8bn), CSN ($8.6bn), Usiminas ($6.6bn), CAP ($5.6bn) and Ternium ($5.8bn), as demonstrated in Fig 2. Tenaris and Ternium are subsidiaries of Techint giving a total capitalisation of $24.6bn which surpassed even the value of the world’s largest steel producer, Arcelor Mittal.

Despite the partial recovery in 2010 and 2011, it continued 17% below the maximum level of 2008. More importantly, the EBITDA margin has fallen from 34% in 2007-2008 to 28% in 2009 and even to 25% in 2011 (right axis of Fig 3). In other words, Tenaris’ profitability was very resilient in comparison with other steelmakers, which have been experiencing a profit squeeze since the eruption of the global financial crisis of 2008-2009.

Large investments

Tenaris, underpinned by high profits and low debts (only $162M as a net debt position in 2012-Q1), has been able to engage in a large capital expenditure (capex) programme (Fig 4). The left axis of Fig 4 demonstrates that the value increased from a plateau of around $400M during 2007-2009 to over $800M in 2010-2011. At the same time, capex as a proportion of net sales has also increased from 3%-5% to 8%-11%, respectively (right axis Fig 4).

Regarding recent investments, three project should be emphasised. In November 2010, Tenaris’ seamless tube capacity was increased by 450kt/y and steel capacity grew by 125kt/y following the completion of the new seamless pipes mill and the revamping of the EAF at its direct reduction integrated mill in Veracruz, Mexico. The new mill has the advantages of: – Being located adjacent to the existing facility; – Includes premium threading, finishing and heat treatment lines; – Incorporates state-of-the-art rolling technology; – Produces up to 7 inch diameter seamless tubes.

Furthermore, the reallocation of small diameter pipe production to the new mill makes operations more efficient. As the expansion of the rolling mill was greater than the melt shop, Tenaris signed an eight-year contract with Ternium Mexico giving it preferential rights to purchase up to 250kt/y of round steel bars. The new facility required an investment of roughly $850M over two years.

In April 2012, Tenaris TuboCaribe unveiled plans to invest some $200M in a second plant in Cartagena, Colombia. The capacity of this welded pipe plant will be doubled from 160 to 320kt/y by 2014. According to Techint, the additional tubes made in Cartagena will be destined for use in Colombia’s energy industry and markets elsewhere in the Americas.

In June 2012, Tenaris announced its intention to build a new 650kt/y seamless pipe mill in the USA. This would include heat-treatment and premium-threading facilities, and the investment would total $1.5bn. The company declared that the new plant is expected to start up in 2016, meeting the rapidly growing US market for oil country tubular goods (OCTG) and line pipe in the energy sector.

According to the company, ‘US market demand for high quality OCTG and line pipe products is growing rapidly due to the development of unconventional shale (oil and gas) reserves and the resumption of deepwater drilling activity in the Gulf of Mexico’. Tenaris has not specified yet where new mill will be located, but stressed that the new facility should reduce lead times for US customers.

A report released by Itaú BBA Bank in June 2012 commented this new investment in the USA: ‘We believe that the project adds value to the company, although it is small compared with current market cap, but we see risk of oversupply in the North American market. ……’ Oversupply, however, is a risk. Several companies have announced capacity increases in North America over the last year. For 2012, approximately 1.2Mt of pipe capacity is expected to come on stream in the US from companies such as Northwest, Lakeside, V&M and US Steel. Moreover, Tenaris has recently started-up a 470kt/y mill in Mexico, which has been exporting a significant part of its production due to the lower than expected demand from PEMEX. According to the Pipelogix consultancy, the North American market is expected to be oversupplied by 6Mt in the short term.

Overcapacity is a crucial issue for the global steel industry in general, and for the tubular product market segment, in particular. Tenaris expects that overcapacity in countries such as China (for seamless) and Korea (for welded tube) will continue in the near future, mainly affecting the low value-added market segments. Nonetheless, these producers were not yet able to compete with high value-added producers in supplying special products such as for deep water drilling and high pressure tubes. Tenaris’ sales of prime and value-added tubular products currently account for 54% of total sales volumes. The company aims to achieve 60% through investments in technology improvements and capturing higher participation of the prime market. To reach this goal, a large capex is definitely a mandatory condition.

*Professor in Economics, Federal University of Uberlândia, Brazil. Email: germano@ufu.br
China’s crude steel production forecast for negative growth in 2012

China’s crude steel production has been riding a ‘bullet train’ for the past few years which has impacted those industries involved with iron and steel whether as customers or suppliers to the steel industry. Yet 2012 may be the first year in 31 that negative growth has occurred and only the seventh time negative growth has been reported since the foundation of the PRC in 1949.

By Shi Lili*

FROM 2005 to the middle of 2011, the increase in China’s crude steel output grew at an average rate of 13.1%. As early as 2006, output reached 422.7Mt, an output greater than the combined output of the next three largest producers, in order, Japan, the USA and Russia.

Crude steel output this year continued on a high trend but has slowed significantly as the industry enters the second half of the year. This happened before following the economic crisis starting in 2008 as growth in output could not continue in the face of low steel prices which have fallen to the point where the selling price hardly covers the cost of production. Seeing that economic growth is dropping dramatically as the year proceeds and the demand for steel is plummeting along with the slowing in activity, crude steel production for the second half of 2012 could drop 10% compared with the first half of the year if the current trend continues. This would likely push the year as a whole into a negative growth in output (Table 1).

The economic conditions inside and outside of China tend to be more complicated now than before and both domestic demand and exports of steel are in decline. This has resulted in a slow-down of crude steel production and the prosperity experienced in 2007 is unlikely to return in the next few years. Between 2005 and 2010, the average annual growth of crude steel output stayed around 14.2% – except in 2008 following the start of the global financial crisis.

Manufacturing & construction slowdown

Another factor is the marked reduction in manufacturing and construction activity in the second half of the year. According to China’s Iron & Steel Association, China’s steel industry as a whole made a total loss of 118M Yuan or US$18.5M in June 2012 alone and sales profit stayed at a negative -0.04%. The overall profit margin, Coke and iron ore price constitute the major costs for steelmaking. These two major factors have always stayed high compared with the luke-warm steel market and it makes no sense for steel companies to continue high production levels at a loss.

Furthermore, the country’s crude steel production capacity has inevitably slow along with the drop in consumption of steel, a statement put forward at the time of the ‘twelfth five-year-plan (2011 to 2015) set out by central government. Although consumption of long-products in the first half 2012 witnessed some decline, it is expected that total consumption during the whole year will approach 700Mt and reach a balance between supply and demand.

Based on figures from China’s Iron & Steel Association (CISA), total crude steel demand will remain around 670Mt to 850Mt, with an annual growth rate of just 2-7%. As the demand for importing steel from China by other countries falls with the return of a recessionary period, the present surplus of steel will show up in the market appears to be more efficient than government policies and persuasion to cut overcapacity. There is also good evidence that the difficulties arising from the present economic situation is more severe than first thought.

Raw material hikes

Yet another factor are high production costs making it almost impossible for crude steel output to be increased profitably during the second half of this year. Historically speaking, steel mills will not decide to reduce or stop production even if there is little profit marginal. Coke and iron ore price constitute the major costs for steelmaking. These two major factors have always stayed high compared with the luke-warm steel market and it makes no sense for steel companies to continue high production levels at a loss.

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Overcapacity

Any positive economic news from central government such as a cut in interest rate and the release of funds into the market cannot solve the fundaments of the problem which are overcapacity in the industry in the face of falling demand. Production during the first half 2012 reached 357Mt, just a 1.8% increase year-on-year. Production of crude steel during the second half 2012 is expected to be lower than that in the first half of the year.

It may be that the automatic adjustment of the market appears to be more efficient than government policies and persuasion to cut overcapacity. There is also good evidence that the difficulties arising from the present economic situation is more severe than first thought.

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The conflict of supply and demand is more obvious when times are tough. The average decline in steel prices in July reached 300 Yuan or US$47/t. China’s domestic steel mills were forced to lower steel prices on a large scale. Losses from steel companies are expected to grow following this.

The average steel price in China was quoted at RMB 3670/t (US$576.0) on Aug 21, hitting a three-year low, according to the Xinben New Line, a domestic steel spot trading platform, and steel prices still face further downward pressure in the short term.

Profits for China’s iron and steel industry plunged 49.4% from a year earlier to RMB 66.4bn (US$10.4bn) in the first half of 2012, according to the NDRC.

The steel industry has been experiencing low profit margins or even losses for some time, and this is unlikely to change in the short term. Surplus capacity has been a major reason for the problem.

This cannot be solved completely in a short time through a market mechanism or by taking administrative measures. Although the market appears to be soft, steel mills are still producing at full capacity which is against what the market rules dictate.

The growing losses experienced by most steel mills has resulted in some recently stopping production, bringing forward maintenance and upgrades of plant. Some did so as planned routine maintenance while others simply brought forward their maintenance schedules. The result was that there was no overall reduction in output. But this is not a long term policy to resist the attack of the financial crisis. Steel mills need to adjust the types of products they produce and introduce diversification. To this aim, backward integration with upstream suppliers so eliminating intermediate suppliers, will increase their chance of capturing the value of being in the whole supply chain of steel industry activities.

<table>
<thead>
<tr>
<th>Year</th>
<th>First half (kt)</th>
<th>Second half (kt)</th>
<th>H2 vs H2 (%)</th>
<th>2012 forecast (kt)</th>
<th>Annual change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012 (F)</td>
<td>357200</td>
<td>321480</td>
<td>-10.0</td>
<td>678680</td>
<td>-0.7</td>
</tr>
<tr>
<td>2011</td>
<td>350740</td>
<td>323530</td>
<td>-5.2</td>
<td>682720</td>
<td>0.0</td>
</tr>
<tr>
<td>2010</td>
<td>350540</td>
<td>276110</td>
<td>-21.2</td>
<td>626650</td>
<td>9.3</td>
</tr>
<tr>
<td>2009</td>
<td>319880</td>
<td>258980</td>
<td>-20.7</td>
<td>573570</td>
<td>14.6</td>
</tr>
<tr>
<td>2008</td>
<td>263100</td>
<td>237400</td>
<td>-9.8</td>
<td>500490</td>
<td></td>
</tr>
</tbody>
</table>

Source: China’s National Bureau of Statistics

Table 1 Crude steel output since 2008 and forecast for 2012
Revival for Japanese carmakers – but not yet for steel mills

After experiencing a very difficult time following the earthquake 18 months ago, the Japanese economy seems to have regained its dynamism in the latter half of 2011. In particular, Japanese auto manufacturers have regained strength on a global scale. The revival of this major steel consuming sector should provide help for Japanese steel mills. However, this is balanced by slower markets in Asia triggered by a slowdown in the Chinese economy resulting in sluggish financial performances for Japanese integrated mills in the first half of 2012. By Nobuhisa Iwase*

FOLLOWING the March 11 Earthquake in 2011, Japan’s economy recorded a large degree of negative growth in the first half of 2011. The annualised GDP growth rates in January-March and April-June quarters were -7.7% and -1.9%, respectively (Fig 1). The breakdown of the integrated supply chain for manufacturing in the country and a shortage of electricity were the major causes for the economic difficulties, both of which were brought about by the damage caused by the earthquake and the massive Tsunami wave which followed as well as by the shut-down of all nuclear power plants across Japan as a safety measure following the devastation of the Fukushima nuclear power plant.

Damage to production facilities in Japan extended globally producing a negative impact on the global supply chain of the major Japanese companies in such manufacturing sectors as automobiles and electrical appliances. However, the efforts undertaken to achieve a rapid recovery and revive manufacturing were enormous and never-ending, which has resulted in a sharp increase of the country’s economy since the third quarter of 2011. The annual GDP growth rate jumped to +7.4% in the July-September, 2011 period, and has continued to be positive ever since, even in the first half of 2012. Since the first quarter of 2012, the size of the country’s real GDP has surpassed what it was in the October-December quarter of 2010, ie before the Great East Japan Earthquake.

The most recent economic forecast by the government sets the country's real GDP growth rate as +2.2% for the fiscal year 2012 (April 2012 to March 2013) and at +1.7% for the fiscal year 2013.

Mind Games
Japan’s success of the 30th Olympic Games held in London is also helping the mind-set of Japanese consumers who gladly received much encouragement from the results to build better lives following the performances of the world’s top athletes especially those from Japan. (Japanese athletes won a total of 38 medals, seven of which were Gold, placing the 11th in the global ranking).

The recent revival of Japanese industry is typified by the automobile sector. Domestic production by the eight Japanese car manufacturers increased by 53% to 4.99 million units in the first half of the year compared to January-June of 2011 (Table 1). Honda recorded a remarkable jump of 120% followed by Toyota with a 77% increase. Overseas production by the same eight companies also increased by 28% to 7.95 million units during the same period 2012. Again, among others, Honda and Toyota recorded the largest recoveries of 52% and 43%, respectively. Honda increased production of the ‘Civic’ at its Indiana Plant in the USA by 75%, doubling its labour force to 2000 to do so. Overseas production of 1.58 million units in the first half 2012 was a record number for Honda. Toyota also increased output of its ‘Camry’ model at its US Kentucky Plant, and the company recorded a production increase of 70% in the USA as a whole. Such growth was brought about by a combination of a restrengthened global supply chain in the US market and by efforts to regain market share that declined in the USA during a difficult time in 2011.

In the Japanese market, there has also been help provided by the government in the form of tax incentives to consumers to purchase ‘eco-friendly’ cars.

Along with their sharply reviving production and sales volume, Japanese automobile companies made remarkable improvements in their financial performances in the April-June quarter. Toyota’s current profit (profit by its major car production and sales operation) during April-June period of 2012 reached ¥353bn (US$4.1bn at ¥80/US$), while the same figure for April-June in 2011 was a loss of ¥108bn (US$1.33bn). Profits of the eight major auto companies including Toyota were ¥720bn (US$9bn) in April-June, 2012, which was the largest figure after the Lehman shock in the autumn of 2008. Toyota expects that the total number of units produced by the Toyota Group which includes Toyota, Daihatsu and Hino, will surpass 10 million this year for the first time in the world car industry history. The current record high for the Group was 9.5 million units in 2007, but the number plunged to 7.23 million in 2009 due to negative impacts by the Lehman Shock.

Steelmills
In contrast to the constant growth of the Japanese economy and improving business performances by such major customers of high-quality steel products as the automobile companies, the Japanese integrated steel mills are not in such a favourable market and business condition at present. In April-June this year, Nippon Steel recorded a profit of only ¥9.2bn (US$115M), which was an 85% decline from the result in the same quarter in 2011. JFE Holdings reported a profit of only ¥9.8bn (US$123M), a 61% decline from the figure for the same period last year. The company fears it may record a loss of ¥4.8bn (US$60M) in the July-September period, while Nippon Steel also forecasts a break-even level in the July-September quarter this year. These results are largely attributed to the declining market prices of steel products in the Asian market. JFE’s unit sales price is forecast to fall by 17% to around ¥71,000/tonne (US$888) in July-September compared to the same period a year earlier.

A continued high level of steel production and increased inventory levels in China has made market prices fall in the Asian region. However, in the medium-term, China, Asia’s ‘never-stopping’ giant economy, is expected to make a ‘soft-landing’ as the economy slows to a target growth of +7% GDP set by the government.

Although Japanese steelmakers are now facing a short-term adjustment period in market conditions, they expect to once again enjoy constantly increasing demands for high quality steel products from Asia under the globally linked industrial chains in east and south-eastern Asian region.

Table 1 Production by the Japanese automobile companies in H1 2012 (thousands of units)

<table>
<thead>
<tr>
<th></th>
<th>Domestic production</th>
<th>Overseas production</th>
<th>Export from Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toyota</td>
<td>1,869</td>
<td>77</td>
<td>1,021</td>
</tr>
<tr>
<td>Nissan</td>
<td>578</td>
<td>29</td>
<td>333</td>
</tr>
<tr>
<td>Honda</td>
<td>587</td>
<td>120</td>
<td>147</td>
</tr>
<tr>
<td>Suzuki</td>
<td>554</td>
<td>39</td>
<td>99</td>
</tr>
<tr>
<td>Mazda</td>
<td>420</td>
<td>164</td>
<td>326</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>278</td>
<td>9</td>
<td>191</td>
</tr>
<tr>
<td>Daihatsu</td>
<td>422</td>
<td>65</td>
<td>6</td>
</tr>
<tr>
<td>Subaru</td>
<td>279</td>
<td>63</td>
<td>190</td>
</tr>
<tr>
<td>Total</td>
<td>4,987</td>
<td>53</td>
<td>2,314</td>
</tr>
</tbody>
</table>

* An independent steel economist, Karuizawa, Japan, Email nobykaru@seagreen.ocn.ne.jp
Injection of recycled tyres in EAF steelmaking as a slag foaming agent

OneSteel, in co-operation with the University on New South Wales, has developed a method to inject waste polymers and tyres as an alternative source of carbon for slag foaming in EAFs. Injecting a blend of coke and polymer has improved slag foaming characteristics resulting in improved yield and reduced quantity of injectant thus providing cost savings.

By A Fontana*, P O’kane**, D O’Connell***, V Sahajwalla* & M Zaharia**

STEEL production accounts for approximately 5% of worldwide energy consumption. New technologies need to be developed to lower electrical energy intensity and the consumption of fossil fuels, mainly coke and natural gas. One method to reduce the consumption of coke in steelmaking is to substitute it with carbon containing materials that can be sourced from recycled materials. The use of materials such as recycled tyres and end of life plastics not only reduces the demand for fossil fuels but also diverts these materials from landfills or being illegally dumped.

The recycling of waste tyres in particular is problematic due to their low bulk density, combined with their non-biodegradable nature. Storage of tyres in dumps creates potential fires and health hazards, as toxic pollutants are released in case of a low-temperature fire (<1000°C). Incineration of waste rubber generates environmental pollutants, such as greenhouse gases, tar and soot particles, dioxins, furans and polycyclic aromatic hydrocarbons.

OneSteel, in co-operation with the University of New South Wales (UNSW) has developed a method to use end of life polymers including recycled tyres as an alternative source of carbon injectant for the EAF, partially substituting coke while improving slag foaming and hence furnace efficiency. A number of experiments were conducted at the UNSW laboratory that significant improvements were observed in slag foaming properties on time, and an improvement in yield.

Carbon consumption in electric steelmaking and its interactions with molten slag and metal are key factors in generating a foaming slag. Conventional injectants to induce slag foaming include coke, anthracite and coal. Solid carbon is injected into the slag to reduce the FeO component of the slag. The reduction of FeO in the slag layer generates CO gas, which partially evolves into CO₂ due to excess oxygen, leading to slag foaming. In addition, injecting oxygen into the liquid steel oxidizes the carbon in the melt and this reaction also generates CO and CO₂ gases into slag phase. Slag foaming is also influenced by the melt carbon content, because the FeO in the slag can react with soluble carbon in the melt at the slag/metal interface and undergo reduction.

Foaming slag floats on top of the molten steel, shielding the electric arc and enabling the steel bath temperature to be raised more rapidly, resulting in substantial energy savings. Sufficient height of the foaming slag and therefore its volume inside the furnace is important and a sustained level of slag foaming is essential for efficient EAF operation. Slag foaming behaviour improves depending on the ability of the slag to contain gases (CO and CO₂) produced during the high temperature reactions.

**Laboratory studies**

Metallurgical coke is widely used by steelmakers as the primary carbon source in EAF steel-making. The properties of coke, such as fixed carbon content, ash level and composition play an important role in its interactions with molten slag. Sahajwalla et al. of the University of New South Wales, Sydney, suggested that waste plastics and ground up rubber tyres in combination with coke or coal, could be an effective alternative material for steelmaking. UNSW proved at laboratory scale that significant improvements in carbon interactions with molten slag can be obtained if the properties of the carbon are modified by blending it with other carbonaceous materials. It was observed that carbon/slag interactions improved when high density polyethylene (HDPE) and coke and rubber/coke blends were used, as compared to coke alone. Higher levels of CO and CO₂ emissions were associated with the formation of an improved slag foaming volume.

Slag foaming experiments were performed using the sessile drop technique in a horizontal furnace at a temperature of 1823K while high purity argon was used as carrier gas (Fig 1).

Fig 2 shows the high temperature in-situ reactions captured when coke and coke/rubber blends interacted with EAF slag. The foaming slag volume evolved over time was measured and compared to the initial slag volume (V/V0). Slag volumes produced with coke/rubber mixes were observed to be of larger over time compared to coke (Fig 3).

The polymeric blends appeared to have contributed to greater gas evolution, which was subsequently entrapped in the slag phase. Gas bubble size and distribution strongly affects steelmaking kinetics and slag foaming.

**Table 1 Technical data for One Steel’s Sydney and Laverton EAFs**

<table>
<thead>
<tr>
<th>Operating parameters</th>
<th>SSM Values/condition</th>
<th>LSM Values/condition</th>
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<tbody>
<tr>
<td>Chemistry</td>
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<td></td>
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<tr>
<td>Manufacturer</td>
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<td>Fushc</td>
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<td>Type</td>
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<tr>
<td>Transformer</td>
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<td>Shell Diameter</td>
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<td>Electrode Diameter</td>
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<td>24&quot;</td>
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<tr>
<td>Cooling System</td>
<td>Water-Cooled Wall Panels, Spray-Cooled Roof</td>
<td>Water-Cooled Wall Panels, Spray-Cooled Roof</td>
</tr>
<tr>
<td></td>
<td>- Fushc Combined Supersonic Oxygen &amp; Coke Door Lance</td>
<td>- Danieli/More Modular System, including 3 x Supersonic Oxygenjet 3000 l/min/hr</td>
</tr>
<tr>
<td></td>
<td>- Three Oxygen/Natural Gas Burners</td>
<td>- Total of 7 Oxygen/Natural Gas Burners</td>
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<td></td>
<td>- Pneumatic Coke Delivery System</td>
<td>- Pneumatic Coke Delivery System</td>
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<td>Additional Equipment</td>
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<td>- Pneumatic Lime Delivery System via Roof</td>
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<td>- Digital Electrode Regulator</td>
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<td>- Harmonic Analysis for Slag Foaming Measurement</td>
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<td></td>
<td>- XRF Slag Analyzer</td>
<td>- XRF Slag Analyzer</td>
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*Technical Superintendent Meltshops, OneSteel, Laverton, Australia; **Technical and Best Practice Manager, OneSteel, Sydney, Australia; B Metallurgy; ***Strategic Marketing Manager, OneSteel, Newcastle, Australia; Scientia Professor, University of New South Wales, Sydney, Australia; New South Wales, Sydney, Australia;

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their retention time in the slag matrix. Further studies showed that ash was present at the interface when coke was used as the carbon source which acted as a physical barrier hindering carbon dissolution into the molten steel, whereas rubber, due to its lower ash content, showed improved carbon dissolution.[9]

Industrial trials at OneSteel & UMC

Industrial trials commenced at the Sydney Steel Mill (SSM) in 2006 and at the Laverton Steel Mill (LSM) in 2007. Table 1

The use of rubber crumbs did not require any particular modification of the furnace infrastructure or operational procedures, other than the introduction of a dedicated storage silo and mixing system (Fig 4).

The improvements observed during the industrial trials at OneSteel are presented in Table 2. The use of polymer/coke blends considerably reduced the quantity of injectant required, and when combined with the raw material cost differential, resulted in significant conversion cost savings. Other benefits recorded at OneSteel included decreased electrode consumption, decreased lime consumption and improved yield due to a 1.4% reduction of FeO levels in the slag[8].

Polymer Injection Technology has also reduced OneSteel’s carbon footprint, lowering CO2 emissions as a result of decreased electricity consumption (generated by coal-fired power stations). The technology also provides the opportunity to differentiate the steel produced on its environmental benefits (‘greener steel’). OneSteel has conducted specific campaigns at SSM to check Sulphur pickup in the steel when injecting a rubber/coke blend, and compared the results with coke only injected heats[2]. Results have shown there is no pick-up of Sulphur in the steel as all reactions take place in the slag layer. Table 3.

Tests of dioxin emissions at the stack were conducted at three plants pre and post the use of a rubber blend. Results showed the rubber/coke mixture emitted a lower dioxin level than when using 100% coke[11]. It is the experience of OneSteel that scrap quality and blend, as well as operational delays, has a major impact on emission results. The scrap blend at Site 3 was altered between tests. OneSteel emission tests results are presented in Table 4. Polymer Injection Technology was commissioned at UMC Metals in Thailand in May 2011. Here it reduced the cost of carbon injectant by 35%[7]. The improvement in slag foaming has also resulted in a 12% reduction in the total amount of injectant used per heat as well as a reduction in furnace power on time and an increase in the average active power. In addition to the operational efficiencies achieved through the implementation, UMC also values the continuous technical exchange and the ongoing relationship with OneSteel[3].

Three months after initial commissioning, OneSteel returned to UMC to conduct trials with the aim of increasing the proportion of rubber in the injection blend to achieve greater cost savings. These trials proved successful and a higher rubber ratio practice was made standard practice, with a further reduction in total injectant per heat of an additional 8%.

In January 2012 further trials were conducted at UMC to validate the benefits being delivered by Polymer Injection Technology. A comparison was made of heats made using the higher rubber/coke blend, versus heats made with coke only, under controlled conditions. Heats made using the rubber blend showed clear improvement in average active power, power on time and productivity, as shown in Fig 5. The operational and cost improvements experienced by OneSteel and UMC as a result of implementing Polymer Injection Technology, combined with the environmental benefit of
diverting used rubber and plastics from landfill, have shown that this exciting new technology can be a ‘win’ for both EAF steelmakers, and the environment.

Contact
Daniel Miles, Business Development Manager
Tel +61 2 49354873 +61 4 08245545
steelmakingsolutions@onesteel.com

References


Electric steelmaking

EAF dust processing in a rotary hearth furnace – Proven or unproven?

This article reviews the history of the Rotary Hearth Furnace as a means of recovering metal from steelmaking dusts or from ore. It concludes that the only successful operations to date are for the processing of stainless steel dusts as the metals recovered are high value and the revenues from the recovered Ni-Cr alloys more than cover the costs of processing the dust. By N L Piret*

SINCE the 1980s when carbon steel EAF dust processing was initiated, it has been the Waelz kiln which has generally been used. It was the first process employed for this purpose and the most common in operation. Concurrently, the EAF dust processing industry has grown from zero to 2.8Mt/y. Of this, over 80% is processed in the Waelz kiln. Waelz technology has steadily improved both technically and metallurgically, resulting in higher efficiency, increases in capacity, reductions in cost and lower environmental impact. Nevertheless, these achievements have not halted investigation of alternative processes aiming to outperform the Waelz process. Most of these alternatives have failed. One of these failed technologies was the application of the Rotary Hearth Furnace (RHF). Yet, ten years after the last attempt, the process is again being touted as a promising replacement for the Waelz kiln. Past history of commercial operations and in-depth analysis of the RHF process, however, raises questions about the ability of this technology to replace the Waelz kiln in commercial practice.

Waelz Kiln for EAF Dust Processing

Electric Arc Furnace (EAF) dust has been recycled for the recovery of zinc by the Waelz kiln process since the beginning of the 1980s, mainly in the USA, Japan and Europe. Two factors favoured the application of the Waelz kiln for this purpose: the similarity of the EAF dust to zinc plant leach residue; and the availability of idled Waelz kilns which had become redundant since the commercial implementation of other treatment processes for the recovery of zinc from leach residues. This evolution was highlighted in a paper by RKola entitled ‘Renaisance of the Rotary Kiln’, presented in 1980, in Duisburg, Germany (the site of the first operation processing EAF dust in a Waelz kiln[1]).

Today recycling of EAF dust has grown to be an impressive and well-regarded industry, processing 2.85Mt of EAF dust in 2010, of which over 80% (2.3 Mt/y) is treated by the Waelz kiln process (Table 1).

This evolution can be attributed to several factors: the implementation of environmental legislation prohibiting or penalising the disposal of EAF dust as hazardous waste in landfill; the high growth rate of EAF steel production and to higher metal prices. Furthermore, since only just over 40% of the worldwide EAF dust generated is currently recycled, there is opportunity for additional growth. Table 2 shows that the opportunities for growth are unevenly distributed across the world. Yet these opportunities are limited by the constraints of minimum processable zinc content (>15%), remote locations, transportation costs, lack of regulatory or other driving forces, and availability of the landfill option.

The number of Waelz kilns in operation worldwide treating EAF dust is about 50, with a throughput capacity range between 40kt/y to 120kt/y (Table 3). Assuming an average of 60kt/y, then the global capacity is around 3.0Mt/y, which agrees with Table 1. These figures demonstrate that the Waelz kiln is not only well established but, by far the dominant process for the processing of EAF dust. It is also the accredited ‘Best Available Technology’ (BAT). It can be operated without waste effluent discharge and with emissions well below regulated limits. The iron-bearing Waelz slag is environmentally stable and fulfils international ecotoxicity requirements. As such, it is suitable for road and other construction applications. In spite of a long history of technical, environmental and economic performance enhancements, which continually cement the Waelz kiln’s future in EAF dust recycling, the search for a potential replacement process continues to be intensive.

Other EAF dust treatment processes

Multiple processes other than the Waelz kiln process have been applied to EAF dust treatment[2,3,4]. Their status reaches from having already failed, to currently commercial, and to being in the early stage of development. Proposed hydrometallurgical processes have not been successful because a complementary pyrometallurgical process would be needed due to the presence of ferrites. Commercially avail-

Table 1 EAF Dust generation and recycled in 2010 (Mt/y)

<table>
<thead>
<tr>
<th>World Crude Steel Production Mt</th>
<th>EAF Production Mt</th>
<th>EAF Dust Generated Mt</th>
<th>EAF Dust Recycled Mt</th>
<th>EAFD Recycling Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>1414</td>
<td>430</td>
<td>7.1</td>
<td>2.85</td>
</tr>
<tr>
<td>Japan</td>
<td>8</td>
<td>80</td>
<td>40</td>
<td>120</td>
</tr>
<tr>
<td>North America</td>
<td>17</td>
<td>90</td>
<td>40</td>
<td>120</td>
</tr>
<tr>
<td>Rest of World</td>
<td>55</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>44.6</td>
<td>100.0</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Table 2 Worldwide distribution of EAF dust recycling (2009)[2], updated to 2011 (%)

<table>
<thead>
<tr>
<th>Region</th>
<th>EAF Dust Recycled Mt</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>44.6</td>
</tr>
<tr>
<td>Japan</td>
<td>14.3</td>
</tr>
<tr>
<td>North America</td>
<td>34.3</td>
</tr>
<tr>
<td>Rest of World</td>
<td>7.4</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Piret & Stolberg Partners, Duisburg, Germany. e-mail nlp@p-stolberg.de

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1. Duisburg, Germany (the site of the first operation processing EAF dust in a Waelz kiln[1]).
2. AISTech 2011 Ore-based Metallics Seminar.
able alternative pyrometallurgical processes for the treatment of EAF dust and other waste iron oxide residues are listed in Table 4. This table excludes the processes in the USA that have been attempted since EPA regulations were promulgated, but which have already failed.

Most of the processes listed in Table 4 are being applied commercially, with the exceptions of the Contop process, which discontinued its semi-commercial plant some years ago, and the PIZO process, which halted operation after a fire a year ago. The Oxycup process, originally developed for EAF dust processing, has had to restrict its application to low-grade integrated steel mill residues. A more recent process is the Contop (HRD) process, which is being applied commercially, with the exceptions of the ZnOx process, which is still considered to be in the early stage of commercial application.

In addition to the processes listed in Table 4, the Ausmelt Top Submerged Lance (TSL) process, which can be operated in the mode with or without iron recovery (Aurison), is still in the early stages of commercial application. Of the alternative pyrometallurgical processes in Table 4, the technology currently being given the highest attention as a potential substitute for the Waelz kiln is the Rotary Hearth Furnace process (RHF). A new 200kt/y plant, known as KRP 1, has been erected in South Korea[17,18] by ZincOx which started hot commissioning in Q1 2012. In addition, there have been a number of commercial RHF applications in operation over the past twenty years, some on carbon steel dust, some on stainless steel dust but by far the larger number use a feed of low zinc-bearing integrated steel mill dust. All of the RHF plants for which performance information is available (about one third of the total) cannot, unfortunately, be labelled as excellent performers.

### Iron recovery from EAF dust

As can be observed from Table 4, some of the EAF dust processes do recover iron as a byproduct, in others the iron is slagged, as in the Waelz kiln process. Thereby the question arises whether an EAF dust process in which iron is recovered presents an economic benefit over a process in which the iron is rejected with the slag? Iron recovery will likely be marginally economic due to the added costs of achieving suitable grades of DRI, and highly questionable due to the possible contamination by Cu, Sn, and Ni which may be present in the dust. In addition, the process has been attempted in the mode with or without iron recovery (Aurison), is still in the early stages of commercial application.

### Crude Zinc Oxide (CO) processing

In all of the pyrometallurgical processes, the zinc oxide recovered in the form of Crude Zinc Oxide (CO), a Zn-intermediate containing as well as Pb, Cd, the halides and most of the alkaline component. A CO pretreatment step to remove halides and alkaline component is essential prior to leaching in a zinc plant or for direct pyrometallurgical zinc metal recovery in a zinc condenser.

None of the commercial EAF dust plants in the US and elsewhere had low alkaline and EAF dust testing at the Kakogawa METI pilot plant also showed high alkaline contents. A claim by ZincOx that the COZo of the ZincOx process can be completely freed from halides by alkaline leaching has not yet been substantiated.

### Historical development of the RHF-process

Rotary hearth furnaces have historically been applied for a number of applications, but only recently to the recovery of iron-bearing materials. A summary of the history of their use follows:

- **In 1978,** Inmetco[14] started-up the first commercial RHF operation for stainless steel dust recycling (Elhovo City, PA, 50kt/y)[15,16].
- **Start-up of the Kakogawa (Japan) RHF Fastmet demonstration plant (1995)** by Kobe Steel/Midrex, mainly for low grade zinc-bearing steel mill residues[17].
- **Since 2000 until 2008,** new generation of commercial RHF Fastmet operations by Kobe/Midrex at Nippon Steel (Hiroya[17,18], Kimitsu[19]) and by Nippon Engineering in East Asia[19,20,21,22] focusing on integrated steel mill residues for iron recovery in a form suitable for recycling to the blast furnace.
- **Set-up of large EU-funded demonstration plant with Lucchini SpA at Piombino (Italy)[23],** for BOF dust recycling. Failure as commercial venture, reconstructed by Paul Wurth in 2010, as the RedIron process[24].
- **In the meantime,** two facilities for carbon steel dust recycling were commissioned, the MRT process of Ameristeel (1997, 24kt/y dust) at Jackson, TN[25,26] and the Allmet Process of Nucor-Yamato Steel (1998, 80kt/y dust) at Blytheville, AR[4,6], both of which failed technically and commercially.
- **Later,** two small units were installed in Japan, the first at the NSSC Hikari plant of Nippon Steel (2001, 25kt/y) for stainless steel dust[19,25,26] and the second the Ashari Kogyo (2007, 10kt/y)[19] for carbon steel dust. Iron recovery had little effect on performance of these two operations is available.

- **Kobe Steel,** with support from Japan’s Ministry of Economic, Trade and Industry (METI), erected a pilot plant for processing EAF dust (2005, 20kt/y)[13].
- **Further developments in the US** included a larger unit at Rouge Steel in Dearborn, MI, for integrated plant iron residues (1999, 300kt/y waste oxides)[23,26]. The best it attained was 50% of capacity, and it was discontinued for economic reasons within two years.
- **An application for processing iron ore fines by Steel Dynamics (SDI) at their Iron Dynamics Inc plant (IDI) in Butler, IN (1999, 500kt/y of pig iron) using the Fastmet RHF process followed by a submerged arc furnace (SAF)[29] and, more recently, at SDI’s Mesabi Nugget operation, Hoyt...
In summary, in the United States, of the six RHF operations, three have been shut down for low performance while the other three has had its role changed. and one, while struggling with low performance, still continues to operate due to the willingness of the owner, SDI, to financially support the project. Only one, the stainless steel EAF dust processing at 50% capacity, has attained profitability, with revenues sufficiently large to absorb the significant operating costs. This margin is obviously unavailable to treat carbon steel EAF dust and even less so for integrated steel mill residues.

In Japan, and the other Asian countries, none of the installations have published any information of actual performance. In most of the Japanese operations the DRI or HBI product is returned to the blast furnace where a lower degree of metallisation is not such an issue. The predominant philosophy is that, for the sake of environmental safeguarding and resource conservation, the iron and steelmaking industry has little choice but to absorb the cost of recycling the wastes as part of the business.

Conclusions - RHF application to carbon steel EAF dust processing so far has commercially failed. From the recent status report of August 2012 by ZincOx on the KRP plant[32] now quoted as operating at 50% capacity, after about 6 months of commissioning, there is little reason to expect its fate will be better than other RHF processes.

- RHF application on stainless steel EAF dust have been the only commercially successful processes because of high alternative processing charges and high product revenues.
- RHF operation on integrated steel mill residues has not been well documented, and the few exceptions where information is available, performance is substandard.
- The mere existence of over a dozen RHF facilities in Asia is insufficient proof of plant profitability, and will not be until sufficient information is provided on actual performance.
- RHF operation on iron orees has been sub standard at both the US commercial plants.

References


References

Lakes, MN, (2010, 500t/y of iron nuggets) using the newly developed ITmk3 process of Kobelco, producing pig iron in the form of iron nuggets[30]. Neither of these two units have yet exceeded over 40-50% of design capacity since start-up.

RHF for Zn-bearing iron residues

The following summarises commercial performance of the RHF units discussed above:

Carbon Steel EAF dust processing

The two US plants, at Blytheville and at Jackson, performed extremely poorly due to the design of the plant and deficiencies in engineering the equipment which resulted in low plant availability, low production and a disastrous economic outcome. Both have been discontinued.

The Asahi plant is of very small size and apparently required over two years to fully commission the operation, with indication of significant halide content in the CZO.

The Kobe METI pilot plant does not appear to have been operated on a continuous commercial basis, and results indicate high halides in the CZO (5-16%) and sub-market grade DRI with 80% metallisation of iron oxide but as the gangue content is high the product contains only about 40% Fe as metal.

Stainless steel EAF dust processing

The two RHF stainless steel dust plants, Inmetco and Hikari, continue to operate, apparently halving and at more or less their design rates. Due to chrome and nickel residue processing, they benefit from high tipping fees and high prices for ferro-nickel and ferro-chromium alloy.

Integrated steel mill dust processing

Hardly any data are available on actual performance. Where data are available, actual throughput is well below design capacity and DRI metallisation and desizing below target.

Rouge Steel did not manage to produce more than about 50% of the design capacity of its RHF. After discontinuing in 2008, the equipment was acquired by ZincOx in 2010 and reinstalled after refurbishing in the new KRP 1 facility in Cheonbuok, South Korea.

Ironmaking RHF applications

The objective has been the production of iron suitable for use in an electric melt shop.

The DRI RHF plant of IDI[29], because of economic underperformance, was halted by the parent company, SDI, in 2003. In 2008, the plant was restarted after installation of new DRI hot briquetting equipment. Performance has never exceeded about half of the design capacity over its ten year operating life. This unit is currently processing mill scale from SDI and other mills with subsequent DRI melting in the SAF[31], allowing the recycling of iron in lost mill scale units.

The Mesabi Nugget operation[31] is still experiencing problems with maximum quarterly throughput through Q1 2012 reaching only 45% of design capacity. Modifications were made to the oigas handling system to prevent another explosion similar to that which occurred in December 2011, and hearth management practice changes were adopted attempting to improve online time.

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Steel Times International – September 2012 – 27
IN 2011 worldwide steel production reached the highest level yet. Around the globe 1.52bnt of crude steel were produced. Nearly two thirds of the steel made was in Asia. The Middle East and North Africa (MENA) region and Brazil and Russia are also becoming increasingly important as technology leaders. Asia produced 25.45Mt of DRI with MENA close behind at 25.05Mt followed by Latin America at 15.12Mt and Russia at 5.2Mt.

The relatively new Direct Reduction Iron (DRI) technologies produced 73.3Mt in 2011 representing 6.6% of world iron production, blast furnaces producing 1.10bnt. Direct reduction is no longer merely exotic or a secondary phenomenon. By 2020, DRI production is expected to increase to 130Mt/y.

There is in fact good reason for this increase, as DRI technology’s energy consumption is significantly lower than producing hot metal in the blast furnace. It is also a good feed for the electric arc furnace (EAF) adding residue free iron to the furnace to dilute impurities in the scrap charged, or to completely replace the scrap. It can also be continuously charged without the need to remove the furnace roof as in scrap charging – a practice which results in much heat loss when charging scrap – and its carbon content can be converted to energy so lowering the electrical energy requirements of the EAF.

In 2011, 29.2% of world steel production was in the EAF. A further significant energy saving and improvement in steelmaking productivity can be attained if the DRI is charged to the electric arc furnace while still hot. This can be achieved when the DRI shaft furnace is located close to the EAF.

Benefits compared with pneumatic systems and batch transfer trucks include:
- Availability and reliability, easy handling (no material fluidisation/slow-down required).
- Minimum loss of temperature in the hot DRI, minimised re-oxidation and carbon losses.
- Less degradation and fines generated.
- Significantly lower CAPEX and OPEX (vs pneumatic systems).
- Significantly lower energy consumption (vs pneumatic systems).

Contact:
AUMUND Fördertechnik, Division Metallurgy,
Saalhoffer Str. 17,
47485 Rheinberg, Germany.
Tel +49 2843 720, Fax +49 2843 602 70
e-mail metallurgy@aumund.de

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highest quality
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AUMUND Fördertechnik, Division Metallurgy,
Saalhoffer Str. 17,
47485 Rheinberg, Germany.
Tel +49 2843 720, Fax +49 2843 602 70
e-mail metallurgy@aumund.de

Electric steelmaking

Inert conveyors for hot charging DRI

Hot DRI conveyors require only one tenth of the energy of pneumatic systems

Inert conveyors for hot charging DRI
Hot DRI conveyors require only one tenth of the energy of pneumatic systems
A NEW development from SMS Siemag, Germany, is the ARC-CESS® steady EAF (S/EAF®), which allows real continuous operation for up to one week. The S/EAF® has been newly developed from scratch and combines innovations with proven technology. This technology arises from SMS Siemag’s long-standing experience in the fields of submerged-arc furnaces (SAF) with over 300 references, electric arc furnaces (EAF), with over 1300 references and CONARC® technology. The result is a new type of electric arc furnace, yielding a 30% higher productivity with lower energy consumption thanks to its reliable continuous process. The integrated energy recovery system further improves the efficiency by utilising the thermal energy of the hot furnace off-gas. All components have been designed to allow continuous power-on operation for around one week. Uninterrupted operating practice is made possible by a patented system derived from SAF technology, which allows the electrodes to be clamped and slipped continuously. Whenever an electrode has been used up, a fresh piece of electrode is joined on at its end. Both operations take place under ‘power-on.’ Similarly to the operation of a submerged-arc furnace, the process takes place in a uniform way and is almost free of fluctuations since the S/EAF is operated continuously in the flat bath phase with liquid initial bath. The geometry of the new furnace shell has been optimized accordingly and comprises a flat lower shell and a conical furnace roof placed closely on top. The S/EAF is continuously charged with direct-reduced iron ore (DRI/HBI), hot metal or scrap through a material handling system that is also rated for the use of hot DRI at 600°C. In addition to the electrodes, water-cooled oxygen blowing lances are introduced through the furnace roof. This technology has been adopted from Conarc® a furnace unit developed by SMS Siemag with the aim to rapidly decarburise melts with high carbon content. The level of foaming slag is controlled by a new, patented slag door system. The steel is tapped slag-free and likewise under power-on. Since the S/EAF® is not opened during operation, no roof hood for the secondary gas collection is needed. Primary gases are directly exhausted through a furnace nozzle. This allows the connected gas cleaning plant to be dimensioned much smaller. The power-off times that previously affected the EAF no longer arise. Continuous operation is interrupted only for regular maintenance work. For that purpose the lower furnace shell can also be driven to a maintenance stand. Heavy-duty gantry cranes with elaborate building structures and foundations are not needed. The steady input of electrical energy and the flat-bath process prevent negative feedback on the electricity grid (for example flickers). Further advantages are the protection of the refractory lining and lower specific electrode consumption.
Securing future success in steelmaking by training of young steelmakers

The German minimill group Badische recognise the workforce to be the driving success of a plant’s performance, people contributing 80% of productivity gains with only 20% attributed to investment in equipment. This article reviews their internal and external training philosophy.

**By S Feger*, B Wiegele**, J Greinacher***, & T Berger****

TODAY, managing the demographic change is one of the most crucial topics for many steelmakers and mills worldwide. With the demographic change a number of challenges arise that have to be overcome. At the forefront are shrinking birth-rates and a lack of adequately skilled labour. Thus, a systematic and continuous recruitment, education and training of the workforce are important levers for securing future success in steelmaking.

Demographic change & training

Usually the demographic change is accompanied by a shortage of talents influenced by a multitude of reasons. Significantly declining birth-rates are leading to an unprecedented shift in the age distribution of the population. This results in a lack of young people making it difficult to recruit beginners. In addition, the steel industry has to face a worldwide lack of skilled personnel suitable to take posts in hierarchical layers. Most industrialised nations are facing both a shortage of school graduates as well as of skilled young professionals and engineers. At the same time, industrialised nations are facing a lack of qualified experts due to rapid capacity expansions and thus demand in these countries.

Besides this, countries and also companies are no longer providing education facilities for young people making it extremely difficult to recruit well educated operators, fitters and electricians with a steelmaking background. Finally, the steel industry has to cope with overwhelming perceptions that working in a steelmaking facility, ie the ‘old smoke stack’ industry, is a synonym for working in a noisy, hot and dirty environment with inflexible structures and very hierarchical systems. It is thus difficult to motivate new graduates to join a steel plant when it is supposed that other ‘modern’ industries can offer talented people more entrepreneurial freedom as well as a working place more acknowledged by society. All this leads to the same basic questions: How to overcome the talent shortage? And how to get the most out of newly hired employees? For sure, a systematic and continuous recruitment, education and training of the workforce are important levers for securing future success in steelmaking[1].

Recruitment, training & education as a key

The Badische Group in Germany offers an example of how to answer these questions. Attracting and retaining talent is becoming increasingly difficult as demand for highly skilled people outstrips supply. The recruitment concept of Badische Group (hereinafter called Badische) caters to potential talents when they are still frequenting primary school. The Group’s own training centre BSW Anlagenbau und Ausbildung GmbH (BAG), established in 1989, cooperates with selected primary schools by organising two half-day workshops at the training centre in order to create interest in steel as a material and Badische as a steelmaker. Thus, when reaching secondary school age, the target group has already heard of Badische and has a positive attitude about industry and informs other pupils about the potential of Badische as a possible employer.

To further register with its target group, BAG closely cooperates with local secondary schools by conducting a 5-day internship for the whole class twice during their period of secondary schooling in an attempt to create enthusiasm for technical issues and build further interest in Badische. In addition, the two 5-day-blocks allow pupils to gain deeper insights into the industry rather than superficial ‘flash lights’, so positively influencing the hit rate to recruit at the end of their schooling. In addition, Badische benefits by becoming better known as a potential employer and by already knowing the calibre of the candidates who apply for work. Furthermore, the training centre participates at career and job fairs organised by schools, cities and local communities. As a result, each year, Badische is able to recruit plenty of apprentices to meet its own demand (Fig 1). In 2011, Badische recruited 34 apprentices for different apprenticeship programmes. It is worth mentioning that workforce planning is actively done by Badische, including analysis of the age structure, job terminations and future demand. From starting the recruiting process until the end of the apprenticeship takes four and a half years. Thus, Badische makes forecasts for at least 3 years. Fig 2 shows an example of a 10-year forecast. One result of the workforce planning is that after detailed job termination analyses the number of apprentices increased to cope with the demographic change without losing expertise. This is illustrated in Fig 1 where the number of apprentices rose to 55 in 2008.

In total, 160 vocational apprentices were trained by seven full-time instructors in the training centre that year including some apprentices for local companies which had no training centres of their own or lacked the competences for special training modules in house. The advantages of training apprentices from external companies are numerous:

- The apprenticeship’s quality has to be on a stable level;
- BAG has to stick to the learning schedule;
- Broader information exchange among the apprentices avoids the adoption of tunnel vision;
- The enlarged candidate pool improves and facilitates selection;
- Additional income to BAG is gained by charging a fixed monthly training fee.

But how does Badische comply with the increased evidence for extensive education a company has to provide? And how does Badische manage to educate its newly hired school graduates according to the demand of its plant?

In general a German apprenticeship programme takes three and a half years. It is a combined education of technical school and
practical experience in the company (Fig 3). This profound education can be seen as the backbone of the German industry and has many advantages in comparison to purely work-based or school-based training. These are:

- Broad, company unspecific set of skills acquired at vocational school being responsible for conveying theoretical technical knowledge and deepening the apprentice’s general education.
- Work-based training allowing for adapting the apprenticeship programme to the needs of the company.
- A uniform standard of qualification for the trained persons is reached by using standardised content in all courses throughout Germany.

Training in mechanical engineering is Badische’s most important programme. About 75% of apprentices are trained to become industrial or process mechanics (all male at the current intake), a further 10% are trained to become industrial electricians and the remainder various other professions. Training is organised in such a way that the apprentice spends up to two years exclusively split between attending vocational school and in the BAG training centre. The goal is to acquire basic technical and theoretical knowledge and to be in contact with the working materials as well as to get to know the working processes. This includes, for example, gaining a forklift and crane driving license, completing first aid courses, attending health seminars and coping with stress and work pressures as well as accomplishing small projects such as making parts for lance manipulators or flanges for valve racks. In the third year, at the latest, the apprentice starts working at Badische Stahlwerke GmbH (BSW) steelworks, one of the most productive minimills in the world, which produced more than 2.14Mt of good billets in 2011 using just two 100t heat conventional EAFs. During the first weeks at BSW, the apprentice moves between the various working areas with the intent to get to know the working places as well as the associated requirements and working conditions. This allows Badische to test the employee and to detect strengths and weaknesses. This generates very good cooperation between trainers, plant managers and the supervisors responsible for the area during the apprentice’s on-site presence. That is why Badische also sets a high value on the qualification of its existing workforce: Only well-trained and qualified employees can pass on their expertise and special skills to the young and inexperienced employees. During the second part of the third year the apprentice works as a full member of a shift team. This enables the seamless transition from apprenticeship to plant employee once the apprenticeship is completed and the person is transferred to the Badische Group.

Fig 1 Development of recruitment figures by type at the Badische Group 2005 - 11

Another factor of Badische’s training is that there is no specific, exclusively production related apprenticeship programme for operators. Even the process mechanistic apprenticeship programme designed for operators includes a lot of mechanical training modules. The reason for this is simple: Badische wants operators who are able to detect the wear of equipment and to support the maintenance team during delays and downtimes. At Badische, apprentices with a mechanical background do not work necessarily as fitter in the maintenance department after having completed their apprenticeship; they more likely work as a melter, caster or rolling mill operator benefiting from their mechanical background. As a result, plant downtime has decreased significantly and plant availability has risen enormously.

Even when the apprenticeship programme is completed and the person is transferred to the plant workforce, training does not stop. Badische invests much time and money in the continuous training of its workforce because the steelmaker realised that nowadays a steel plant’s workforce is confronted with constantly growing demands. Equipment, technologies and processes are becoming increasingly complex. In addition, pressure of time increases steadily to be more productive and to reach the highest efficiency. To cope with this, a workforce’s knowledge and skills have to be continuously and systematically developed. Only a well-qualified staff is able to take responsibility on complex work and to make the necessary, independent decisions. Badische is therefore convinced that well qualified employees are a precondition to achieve high performance and excellence in operation[3].

As to the training of the workforce, Badische applies a multitude of different concepts. The basis of all training is that the employee knows his working environment, i.e. basic conditions and guidelines as well as expectations and requirements in order to work in a self-reliant and purposeful way. Badische complies with this precondition by issuing job-related documents such as statements of job requirements and job descriptions, providing safety standards, accident analyses and procedures. Additionally, written instructions such as descriptions of equipment, operating patterns and checklists are implemented.

However, beyond doubt, the most important training for Badische is the practical on-the-job training. Mentoring and coaching via supervisor and foreman allows specific, job-related training with immediate application of the newly acquired knowledge including immediate feedback. The on-the-job training is performed using training manuals worked out by highly experienced senior supervisors. Finally, Badische’s training portfolio is completed by at least 16 hours of classroom training per shift and year, discussions with suppliers, external seminars and experience exchanges with other steelmakers around the world. These are so-called ‘off-the-job’ training measures.

The BSE Academy

The example so far described proves that Badische is aware of the vital importance of training. The workforce is seen as the most important success factor. This also shows Badische’s philosophy stating that 80% of an enterprise’s success depends on people, whereas only 20% is related to the equipment in place. However, Badische Stahl-Engineering GmbH (BSE) experience in consulting services...
Safety and training

Work-based and school-based training Chamber of Industry and Commerce as an intermediary

- Work-based training (70-80%)
  - Offers theoretical training and conveyed practical skills
  - Pay by the company (fraction of salary for skilled workers)

- School-based training (20-30%)
  - General education
  - Technical education
  - Vocational training (apprenticeship)
  - Means certificate

Company
- Register apprenticeships contracts
- Supervises apprenticeship programmes
- Sets up dispute
- Organises the interim and final examination

Vocational school
- General education
- Specialised training in theory and practice (not tuition granted)
- Intermediate examination
- Final examination

Fig 3 National German apprenticeship programme [2]

Vocational school
- General education
- Technical education
- Vocational training
- Means certificate

Fig 4 Content of Badische's tailor-made apprenticeship programmes 'Industrial mechanic' and 'Process mechanic'

All the training possibilities provided by the Academy have one thing in common: The classroom training is combined with visits to BSW to witness one of the world's most efficient mini mills in action. Moreover, to further close the gap between general theoretical training and training on specific equipment and essentials of day to day needs for efficient plant operation, the training methods applied emphasise practical experience ranging across:
- Show-how training at the Badische steel works;
- Instructors with hands on experience, specific from and to the minimill industry: from practitioner to practitioner;
- Theoretical class room training;
- Interactive learning in work-groups using case studies; and
- A testimonial at the end of successful participation.

Further to the different teaching methods, all the courses are held in or close to Badische's steel plant to enable practical application at each stage. Training is thus closely related to the real life plant atmosphere [3]. This is also reflected by the motto of the BSE Academy:
- Look: at one of the world's most efficient mini mills in action!
- Listen: to our instructors which are steel industry experts!
- Do: through practical exercises within our seminars and transfer your experiences to your home plant! (Fig 3).

Conclusion
The steel industry has to face the challenge of recruiting qualified personnel in the face of strong competition from other industries. The need to find talented people is compounded by the demographic change causing a shortage of labour in the upcoming age group. Thus Badische must continuously improve the knowledge and skills at all hierarchical levels of its employees. It is essential to qualify young people not only to meet the 'skill demand' but also to overcome the aging of the workforce. Badische is of course conscious of the costs involved in educating and training its workforce, but as the Group is convinced that investment in this boosts motivation in its workforce which is followed by higher productivity and lower costs.

In addition, BSE has, for many years, trained steelmakers across the world as part of transfer of 'know-how' contracts, today called 'classical' courses. During this time, one thing has become clear for the whole Badische Group: People are the driving success of a plant’s performance!

Contact
BSE Badische Stahl-Engineering GmbH, Robert-Koch-Str 13
D-77694 Kehl-Ausenheim Germany
Tel +49 7851 8770 Fax +49 7851 877133
e-mail Stephania.Feger@bsa-keh1.de web www.bsa-keh1.de

References

www.steeltimesint.com
Straddle carrier solves wind tower transport

Increasing the height of a wind turbine tower from 80m to 125m reduces generating costs 25%. Andresen Towers is building ‘bolt-to-gather’ towers in sections to be assembled to such heights and Combilift is providing Straddle Carriers to move tower sections weighing up to 40t.

IRISH based materials handling provider Combilift and Danish manufacturer Andresen Towers pooled expertise to address the logistical challenges involved in manufacturing and moving a new design of steel wind turbine tower.

Andresen Towers is part of the Ib Andresen Industri (II) Group and has more than 25 years of experience in the production of bent and bolted steel towers. The company has taken its original concept a stage further with the design of its shell towers. It has secured a long-term contract with Siemens Wind Power, which will sell its products. New production and warehouse facilities have been set up at Andresen’s HQ in Nyborg and nearby Langeskov, Denmark, which cover an area of 25 000m².

Shell towers

Andresen’s shell towers’ concept sees the wind tower made up of a number of segments each made of high-strength steel and each about 13.6m long (Fig 1). These are bolted together with tension-controlled bolts to form the overall tower. The bolts mean there is no need for welding in the tower shell resulting in less consumption of steel and avoiding long-term problems with fatigue and cracks in welds. The tower segments are bolted together on site in about three days and each tower contains about 400t of steel. The shell tower can easily be dismantled at the end of its life cycle, with its scrap value covering any dismantling costs.

“To make wind energy a more competitive alternative to fossil energy sources we have harnessed our technology to build the next generation of much higher towers,” said CEO Tom Andresen. “These can exploit the better wind conditions to generate a larger output, which in turn reduces costs.”

The height of wind towers varies in country to country and depends on domestic legislation. Generally, a tower height is about 70m but there are plans to increase the size of some towers up 125m to generate more power.

An increase in the hub-height from 80m to 125m decreases the price per kWh by 25%.

The increased height of the towers compared to those currently available is due to their larger diameter and their reduced material thickness, which allows them to be produced from steel coils. These are cheaper than traditional heavy steel plates and result in lighter towers.

Traditionally, tower structures have been limited to a diameter of 4.3m. This is due to existing road infrastructure such as bridge height when it comes to the transportation of these extremely oversized loads (Fig 2). Andresen’s shell tower sections are designed to be bolted together on site so can be carried on ordinary trucks or in 45’ containers. This avoids extra costs for special transport, reduces disruption to traffic and enables the shipment of towers to previously inaccessible areas.

Straddle carrier

Having solved the problem of moving the sections to their destination, a further issue was how to safely and efficiently handle and store the shell tower segments – which are nearly 14m long, 3.3m in diameter and weigh up to 30t – at the production facilities. This is where Combilift came in and a dialogue with Andresen’s management led to the choice of a Combilift Straddle Carrier (SC) as the single machine solution for each of the two sites (Fig 3). The design of each SC was adapted to take into account the slightly differing loads at Nyborg and Langeskov, the latter being built with a larger frame to cope with double-stacked high cube containers.

“Straddle carrier solves wind tower transport is costly and can have a large impact on traffic.”

“There were a number of options open such as a combination of mobile cranes and traditional counterbalance forklifts or reach stackers, but Tom Andresen did not want to invest in pieces of equipment that could only carry out one specific job,” said Ulrick Staudal, National Accounts Manager of Combilift Denmark. “He was also focused on the total cost of ownership, which is becoming more of an issue for customers than just the initial investment.”

Advantages

A major advantage of the SC compared to a counterbalance truck capable of lifting the required capacities is its much lower vehicle weight and therefore greatly reduced ground pressure. A counterbalance truck capable of handling a 40t load will weigh at least 50t, resulting in a tonnage of 90t when loaded. This puts extreme pressure on the ground surface, which will need special and costly reinforcement to cope. With a weight of just 18t, the combined weight of the SC and load is just 58t, which has cut out the need for any expensive foundation work at Andresen’s sites. “Our calculations based on a ten year operating lifetime took in initial capital outlay, fuel consumption, service costs and the reduction in wear and tear on the surfaces and proved that Andresen could achieve major operational savings compared to using any other type of equipment,” added Mr Staudal.

“The dimensions of Combilift’s SC and its three wheel manoeuvrability enable it to access the production area to load crates containing up to seven steel shells, weighing from 1.3t to 3.25t each which are ready to dispatch,” said Mr Andresen. “The sheer physical size of a counterbalance truck would have made this nigh on impossible. We can then load onto HGV’s without the need for a crane. In addition the SC handles incoming containers of components we manufacture elsewhere. The spreader beam attachment with different lift points also enables us to lift varying sizes of loads. Both inside and out, the SC has been ideal for our needs and an added bonus was that it was a lot more economical than any other options we looked at.”

Combilift’s Logistic Services also assisted the company with layout diagrams as to the best use of available space for storing finished shells.
Siemens VAI – 6th Media Summit

Siemens Metals Technologies is developing solutions to ensure plant operations and performance can remain competitive throughout its useful life – which can be 40 years or more – by continuously upgrading the plant and its capabilities to improve flexibility in operation to meet changing customer demand. A report by Tim Smith – Editor Steel Times International

LIFECYCLE strategies was the theme of Siemens Metals Technologies 6th Media Summit held in Mexico in May

Continuously changing production conditions require continuously upgrading plant to maintain the quality of product and economic operation needed for a plant to remain competitive.

Siemens Metals Technologies is developing solutions to ensure plant operations and performance can remain competitive throughout its useful life which can be 40 years or more. This requires a partnership between plant builder and customer not only to maintain and upgrade existing plant but also to integrate activities along the whole production chain.

Werner Auer, CEO Siemens Metals Technologies said new automation packages and the implementation of new IT applications enable better management of the entire production chain. This is necessary to enable steelmakers to become more flexible in operations to respond to changing market conditions and customer demands. New steel grades, lower costs of production and increasingly stringent environmental regulations all had to be met by existing plant.

Competition from developing nations which today make commodity grades of steel but tomorrow may make quality steels also had to be faced. Mr Auer said “Every steel mill will need a sustainable innovation strategy more than ever in order to keep production and investment competitive, as well as partners like Siemens who help them keep their plants fit over 40 years and more”.

Siemens Metals Technologies returned its headquarters from Erlangen in Germany to Linz in Austria last year – the home of the steel plantmaking division VAI – and is now an autonomous Business Unit within the Siemens Industrial Sector. Currently it holds a portfolio of supply covering ironmaking, steel-making, minimills, environmental technologies, casting, rolling, electrical, automation and services. Recently, it added furnaces to this with the acquisition of the US based company FCE. This Pennsylvania based company provides sales, engineering, equipment supply and project management expertise in strip and plate heat treatment furnaces. It is an authorized licensee for Drever Company technology as well as providing continuous strip galvanizing and annealing, and plate quench and temper lines and quench and temper furnaces for API pipe and tube for the fast growing global energy markets.

In 2011, Siemens MT had a global order intake of which China accounted for the largest individual segment at 14%, but followed by India and USA at 12% each and Brazil at 10%. Equipment supplied was divided evenly between the four technology Competence Centres (Fig 1) which are located throughout the world including a Competence Centre in Minhang China and an assembly and manufacturing facility in Shanghai (Fig 2).

In 2012, Mr Auer said Siemens MT would investigate adding further to its portfolio of technologies; explore industrial IT as a strong business opportunity; develop its lifecycle plant support to customers and improve process technology using advanced automation systems.

Looking ahead to 2015, the Group will endeavour to improve its cost position by standardisation and modularisation and in-house manufacture; improve its market position by further localisation, strengthen its market by vertical integration; focus on energy reducing technologies and support customers with lifecycle solutions involving modernisation, service packages and mechatronic modules which integrate mechanical, electrical and automation on customers’ plant.

Market trends mean that globalisation favours low-cost manufacturing sites. New high-strength steel grades call for new production technologies: The quality of raw materials is decreasing while their costs and that of energy are increasing which calls for greater efficiency in use and consolidation of producers continues.

Automation & IT

Michael Irnstorfer, General Manager Metals Technologies Electrics & Automation introduced Siemens’ involvement in the four levels of process control:

• Level 1: Basic automation to optimise process steps to improve speed, repeatability and without operator intervention.
• Level 2: Process Automation which contains the process models to optimise production in a plant.
• Level 3: Management Execution System (MES) which contains the software for the optimisation of the entire value chain of a steel mill or across multiple sites and;
• Level 4: Enterprise Resource Planning (ERP) which involves the merging of orders, financial data and optimise the overall running of the company.

Siemens offer a large number of modules to cover each level as illustrated in Fig 3. As an example of Level 2 control for a hot strip mill:

– SIROLL speed optimisation enables smooth running of the mill to achieve high productivity and quality by avoiding stoppages;
– SIROLL MSM monitors the conditions to produce the optimum steel microstructure from furnace to cooling. From this it predicts the properties of the hot rolled coil – yield and tensile strength, hardness etc. This is achieved on-line during production in minimising the need to take samples for laboratory determination.
– Microstructural Target Cooling uses mathematical models to compute temperature and phase fractions along the entire cooling section of the mill adjusting the water sprays to achieve the required microstructure.

Similarly, Level 2 control modules are available for the blast furnace, BOF converter, vacuum degasser, continuous caster, cold rolling mill and final processing.

Each of these process steps are overviewed
Target Cooling (MTC) and enables new grades of steels. As previously discussed, the prediction of mechanical properties of the strip can then be computed by the SIROLL MSM module. This enables new cooling strategies that allow reducing the time to design a process function.

Mechatronics, which integrates the mechanical, electronic and software elements of a process plant was key to enabling new systems or process functions.

Again, using the hot strip mill as an example, Andreas Flick described the evolution of control from simply controlling the cooling temperature prior to year 2000 through three stage cooling from 2000 to 2006 with the final cooling zone for fine tuning of the temperature to microstructural control since 2006 in which the proportion and refinement of pearlite can be controlled by an increased initial cooling rate at the exit of the final finishing stand (Fig 4).

Mechanically, this can be achieved using turbo and standard laminar headers with excellent dynamic phase transformation models (DPTM). The principle is to improve productivity, process stability, product quality and yield. Table 1 illustrates the differences in cost between a low cost producer of slab compared with a high cost producer and shows the potential for a 73% improvement in operating costs.

### Siemens in Mexico

Siemens has a workshop in Monterrey producing mechanical components and steel structures for electric arc furnace such as the frame and water cooling systems. It employs over 100 people involved in manufacturing, project management and sales, serving not only Mexico, but also the United States, Central America and Brazil.

Christian Kaltenböck, Siemens MT, Mexico introduced two of the current projects being undertaken by the company there at the moment.

#### AHMSA

The AHMSA plant at Monclova, in northern Mexico – which was also the subject of a site visit – is progressing its Fenix modernisation project started in 2006 with the aim of increasing the annual output of the plant built in 1941 by 1.3Mt to 4.6Mt.

Altos Hornos de Mexico (AHMSA) is the largest integrated works in the country. Currently, crude steel production is 3.8Mt/y and it mainly produces flat products for the construction, metal working, automotive and domestic appliance industries. It is the only supplier of heavy plate in the country. In addition, it produces heavy and light profiles.

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**Table 1** Benchmarking of performance expressed as Euros per slab

<table>
<thead>
<tr>
<th>Yield</th>
<th>Energy</th>
<th>Refractories</th>
<th>Personnel</th>
<th>Maintenance</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Cost</td>
<td>3.7</td>
<td>1.1</td>
<td>1.8</td>
<td>4.6</td>
<td>3.2</td>
</tr>
<tr>
<td>High Cost</td>
<td>4.1</td>
<td>6.8</td>
<td>2.7</td>
<td>7.8</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Siemens MT in Mexico
The company is privately owned and employs some 19,000 people in two steel works in Monclova. It also owns an iron ore mine at La Perla some 250km to the NW of the steelworks – from where the ore is transported as a slurry by pipe-line for pellet manufacture at the steelworks, and also has two coal mines at Barrotérán and La Sauscda 100km from the steel plant. Financially, the company presently remains under Chapter 11 creditor protection, its situation since May 1999.

In 2006, AHMSA launched the Fénix Project to modernise steelmaking financing it out of its own resources. This is the largest investment since the 1990s. During the global financial crisis of 2009 activity was suspended but restarted in 2010. A new blast furnace (No 6) was commissioned in 2011 with a 1.4Mt/y capacity of hot iron.

Presently nearing completion, the project includes an EAF and ladle furnace each with a capacity of 1.2Mt/y and a fourth continuous slab caster of 1.2Mt/y capacity. The 130t/heat size EAF will charge a mixture of scrap, HBI and hot metal, the proportions depending on the grade of steel being produced and the prevailing costs of the charge components. To meet the additional requirement for hot metal the capacity of blast furnace No 4 has been increased by 26% and output from the pelletising plant increased to 4Mt/y. Also, 28 new coke ovens are planned which will increase coke production by 21%. A new oxygen plant and medium voltage distribution system are also envisaged.

Siemens MT, in a €200M order, is equipping the steelshop with a 150t EAF, a ladle furnace of similar capacity, dedusting equipment and the continuous slab caster and ancillary equipment. The slab caster is fitted with Siemens’ DynaGap Soft Reduction to reduce centre line segregation and make the product suitable for the manufacture of such steel grades as line pipe X65. Annual capacity will be 1.2Mt.

Siemens is also modernising and converting a plate rolling mill to a steel mill with first coil due to be rolled in early 2013. Siemens VAI has also been awarded the upgrade of the existing hot strip mill (HSM) in a €20M project – work to be completed by the close of 2012. The finishing train of the mill dates to the plant’s origins in 1941 but a new reversing rougher has since been added.

Siemens VAI have also been given the project to modernise converter No 1 in the BOF shop including a new BOF. Converters 2 & 3 were modernised earlier.

Tyasa

Minimill Talleres y Aceros SA de CV (Tyasa) is building a compact mill at Ixtacaquisquitlan near Orizaba in the State of Veracruz. This will have a capacity of 1.2Mt/y and Siemens MT is to install its new design of EAF, the Simetall Quantum EAF (Fig 6). This furnace has a scrap preheater using the proven shaft furnace with fingers to control the rate of scrap descent which is preheated by the ascending furnace offgas but the concept differs in that the shaft is continuously fed with scrap via a conveyor rather than the previous bucket charging by crane. Also, a new method of tilting the furnace shell for tapping has been introduced and an optimised tapping system included which is anticipated will reduce Tap-to-Tap times to around 36 minutes and will enable the Power-on time to be maintained for 98% of the operation thereby improving productivity and reducing energy demand by a calculated 20%.

Power consumption is calculated at 280kWh/t, much lower than conventional EAFs and even EAFs with scrap preheaters and conversion costs are expected to be 20% cheaper than when using a conventional EAF.

The Quantum furnace – the first in the world – is due to be commissioned in 2014.

Environmental factors have not been neglected and a dedusting system capable of reducing the particle content of emissions to below 10mg/m3 is included.

The scope of the project includes a 100t double ladle furnace and 100t double vacuum degassing plant and a six strand combined continuous caster able to cast 130mm square and 200mm square billets as well as near net shape profile shapes of dimensions 300x200x80mm.

Tyasa is a privately owned company established in 1985 with a bar mill at Mérida in Yucatan state with a capacity of 450tcy/t of billet and a 700tcy/t bar mill.
A report on the 27th Steel Success Strategies New York conference

This year’s Steel Success Strategies (SSS) conference was held amidst uncertainties and challenges – many steel industry executives being unsure of the impact of these uncertainties and challenges on business. By Manik Mehta, New York

THE 27th annual Steel Success Strategies conference organised by World Steel Dynamics and American Metals Market took place from June 18 to 20 in New York under the shadow of growing global economic uncertainties and challenges. Many US steel company executives acknowledged that they did not ‘know how these uncertainties and challenges will affect our business’.

Following the deep recession starting Q4 2008, that adversely affected the steel industry, there had been growing optimism amongst steel companies as the US economic recovery seemed to be ‘gaining steam’. Nevertheless, four years on, as many delegates at the conference were privately saying, the recovery has not been ‘a full-fledged one’.

With prices and demand falling, the mood at the conference was sombre, not least because of the crisis in Europe and the slowdown in China’s once-booming construction industry.

The “age of low prices of iron ore, coke, etc. is over”

Peter Marcus

This year contrasted the mood of the conference in 2011 when, thanks to the upsurge in the automotive and energy industries, steelmakers, were upbeat because they could push price rises and increase output. Last year’s conference, for the first time since the 2008 financial crisis, had confirmed a positive turnaround for many steel companies in which profits had previously been impaired.

Even as the duo of managing partners of World Steel Dynamics, Peter Marcus and Karlis Kirsis, fired the opening salvo at the conference with a ‘realistic assessment’ of the global steel outlook, many of the speakers at the conference voiced fears that the economic uncertainty in the United States and worldwide would stifle strong growth. Marcus, resorting to his usual eloquence, said that “steel never rusts” because its industrial structure is always subject to rapid change.

But Marcus also admonished that the “age of low prices of iron ore, coke, etc. is over”. Over the duo’s introductory remarks, most speakers who followed referred to China as the global steel industry’s driver, particularly when it comes to consumption of raw materials. China produced nearly 754Mt of steel in 2011, eight times the volume of steel produced in the United States, according to the World Steel Association’s figures.

Lakshmi Mittal, chairman and CEO of the world’s largest steel producer, ArcelorMittal, gave a keynote address on the ‘Global Economic Downturn and its Impact on the Steel Industry’. He predicts that China will continue growth at “good levels” in the coming years. Mittal also said that he expected consolidation in the Chinese market within the next five years. His company would be willing to work with a steelmaker in China if some transparency and corporate culture changes are instigated with companies in that country.

Turning to Europe, Mittal said that the situation in the world’s largest economic area, was “preying on everyone’s mind”. Although the disaster scenario of a euro zone collapse had been averted, the enormous economic and political complexities of finding the right solutions had resulted in numerous threats to the fragile fiscal compact, he cautioned.

Comparing Europe with the USA, Mittal said: ‘Although the US has recently seen three consecutive months of weak job figures, indicators remain broadly supportive. Auto sales, although weakened on month-on-month figures, are up 17.5% year-on-year. And while Goldman Sachs expects the knock-on effects of the European crisis to reduce US GDP by between 0.2 to 0.4% this year, (overall) growth in 2012 is likely to be over 2%, which is much healthier than growth in the EU.

End of high prices for raw materials?

A panel comprising John Liechtenstein, manage
Conference report

The Company recently signed a strategic agreement with Praxair Inc – a supplier of industrial gases – to develop and market a new thermal reactor system (TRS) that will allow DRI production using a variety of fuels such as coke oven gas. The TRS will use an innovative partial oxidation technology to convert hydrocarbon fuels into high quality, high-temperature syngas suitable for DRI production.

The world’s total DRI production in 2011, according to Midrex, touched 73.3Mt, a new record for the industry. This was an increase of about 3Mt over the 70.4Mt in 2010.

Gaines pointed out that while gas-based reduction increased by 7% to 35.9Mt in 2011, coal-based reduction by the rotary kiln process decreased by 9% from 18.1Mt to 17.3Mt. This is attributed to an economic slowing in India, where the most of the rotary kiln plants are located, and disruption of suitable ore supplies. India is the leading producer of DRI making 22.0Mt in 2011, down from a 23.4Mt peak in 2010, but this is still twice as much as the next highest individual country, Iran which produced approximately 10.4Mt. Mexico was third ranked producer with production of 5.9Mt, well above its 2010 figure, but still short of the all-time high of 6.5Mt in 2004. Saudi Arabia and Russia were fourth and fifth respectively. These five nations produced more than two-thirds of the world’s supply of DRI.

With smaller amounts of natural gas anticipated for industry use, coal-based technology options are currently being pursued by some Indian steelmakers.

Jindal Steel and Power Ltd is currently building a 1.8 MXCOL® Plant in Angul, Orissa, India which will produce reducing gas from coal for a Midrex DRI module and Jindal South West Projects Ltd is installing a 1.2Mvpy coal based Corex ironmaking plant which will use the offgas in a Midrex DRI plant, the complex to be built at Vijayanagar, Toranagallu, Karnataka State, India.

Jindal’s search for raw materials

India’s Jindal Steel & Power Ltd (JSPL) is scouting for alternative coal and iron-ore sources after the recent fiasco with the Bolivian government over power supply. The company, according to Naveen Jindal, the chairman and managing director of JSPL, terminated its iron ore and steel investment in the country because of “lack of support from the (Bolivian) government”.

Jindal told Steel Times International in an interview on the sidelines of the conference that his company was now scouting for iron-ore and coal sources in other parts of South America, as well as Africa and Australia, to meet its needs.

The company’s search for alternative sources of raw materials is part of its strategy aimed at increasing its self-sufficiency in raw materials to about 80-90% by 2015, up from the present 70%.

According to JSPL’s 2007 contract with Bolivia, Bolivia was expected supply some 100Mt of natural gas per day, necessary for DRI production. Jindal maintained, however, that the Bolivian Government had retracted from its original commitment and was now offering only a quarter of that volume.

Speaking about the situation in India, where foreign steel companies such as Posco and others have faced difficulties in investing, Jindal said that acquiring land in India was “a big challenge”. New legislation is being passed to ensure “fair prices” to landowners. Jindal also spoke about the gasification of coal to produce synthesis gas for use in his DRI operations. “We are setting up a plant employing Midrex technology, (for DRI production)” he said.

He was optimistic about steel consumption in India. “It is very important for our region because steel consumption in India is still low and we expect growth in consumption to rise”, he said.

Taiwan’s China Steel Corp

China Steel Corp, the leading Taiwan-based steelmaker, feels that the global demand for steel is still weak. It has also, therefore, lowered its domestic wholesale steel prices for September in an effort to counter the weak demand. CSC has slashed the wholesale prices of hot-rolled steel products, cold-rolled steel products and electrical steel coils. The Company has been closely monitoring trends in the global economy which, it says, has been hit by lingering debt problems in the Eurozone, with key players such as the United States and China affected by the developments.

Midrex upbeat for Asia

Henry Gaines, director of marketing at Charlotte, North Carolina-based Midrex Technologies, was upbeat about Asia where it has expanded its operations.

“Asia is a growing market for us. Its huge demand would seem insatiable. By comparison, the mood currently in the USA is one of cautious optimism. But we are also excited about reasonably priced energy such as shale gas.” Gaines later said in an interview with Steel Times International.

Midrex Technologies, a wholly-owned subsidiary of Kobe Steel Ltd, has established itself as a pioneer in direct reduction technology using natural gas. More than 11Mt of new Midrex annual capacity will be commissioned and started in the next two years. Midrex has partnered with Kobe Steel Ltd, Siemens VAI, the SMS Group, Koppern, Aumund and Praxair to provide solutions for the steel industry.

The Company recently signed a strategic alliance agreement with Praxair Inc – a supplier of industrial gases – to develop and market a new thermal reactor system (TRS) that will

Jo-Chi Tsou chairman CSC

……business with China was not getting easy’.

Dan DiMicco, Nucor CEO

The steel industry faces chronic job losses

David Phelps, President of the American Institute for International Steel

…….the US may be moving from slow growth to a downturn. (but) Anything related to the energy and automotive industries is doing fine’.
CSC does not make construction steel, but sells some 1.7Mt as wire-rod steel bars for the machine-tool and the auto-part industries. “China Steel’s products are of a higher quality and 30% of our production is exported. Our exports go, mainly, to East Asia, China and, to a small extent, to India,” he said.

Asked if he could offer any advice to the steel industry in such critical times, Tsou replied that one should not be pessimistic “but we must control our costs. There will be fierce competition for market share and this will put pressure on prices”. CSC’s mantra for survival had been self-sufficiency. “68% of our iron ore needs are met from Australia, 25% from Brazil and the rest from Canada, South Africa, etc”, he said.

But he cautioned that business with China was not getting easy. China suffers severe over-capacity, with its integrated steel mills competing for market shares. China has 150,000 steel traders who were all looking for business.

He envisaged consolidation to push on in the steel industry. “But the big question is what will the steel industry look like after consolidation?” he asked.

CSC recently signed a Memorandum of Understanding (MoU) with the Industrial Extension Bureau, the investment promotion company of the Government of the Indian state of Gujarat, with the state’s chief minister, Narendra Modi, personally witnessing the signing. CSC has created an Indian subsidiary called China Steel Corp India Pvt Ltd to set up an electric arc steel plant on 145 acres of land at the Dahej GIDC estate. According to the Gujarat state government, CSC will be investing around US$178m in the first phase, and a total sum of US$1.2bn by the completion of the second phase in 2016.

The groundbreaking ceremony is scheduled to start in June 2012, and the steelworks should be initiated from the beginning of 2014. CSC first visited Gujarat in May 2011 to explore investments in the state, after which there were more visits from the company’s technical team to gather information including electricity, gas supply, water availability, etc.

According to CSC, the per capita steel consumption in India is presently less than 50kg. India’s steel consumption is expected to rise in the near future.

Mixed feelings for US economy

David Phelps, President of the American Institute for International Steel (AIIS) had some ‘mixed feelings’ about the US economy. Phelps told this correspondent that “construction is not on the radar. Indeed, infrastructure is not developing the way it should. Also, infrastructure development takes time.” While steel consumption had increased in the United States, there was concern that the US may be facing a downturn. "Anything related to the energy and automotive industries is doing fine,” he added.

On legislation concerning China, Phelps said that China is not such a big player in steel supplies as it was three years ago.

Call for Greater Investment in US

John Surma, chairman and CEO of US Steel Corp, in a keynote address, urged US politicians across party lines to grasp the significance of upgrading the nation’s infrastructure and investing in it, though he acknowledged that anything substantive would happen only after the November elections.

The steel industry has called for a long-term infrastructure support plan to boost activity in the sector by funding pipeline and bridge projects.

Surma’s company has been making long-term investment at its Gary Works complex, the company’s largest in terms of raw steel-production capacity.

He said construction of two modules to produce a substitute for coke to use in blast furnaces is “well under way” and start-up is expected later this year.

Surma criticised the surge in imports of steel products into the United States, and said this could threaten the market for steel pipes for the oil and gas industry, currently one of the strongest sectors in the US market.

Imports of steel pipe into the United States jumped sharply in the first four months of 2012 over the year-earlier period, a sign that foreign companies could be breaching global trade rules, Surma added. “That is a case for major concern,” Surma told the gathering in New York.

A boom in drilling for oil and gas in the United States in recent years has triggered a jump in demand for steel pipes used in wells and to transport fuel to the market.

Steel imports into the United States jumped to 2.7Mt in April, up more than 17% over the year-earlier month, according to the most recent government data. US import data showed overall steel imports had jumped near-ly 28% so far this year, raising fears in the US industry that China’s economic slowdown had prompted producers there to ship excess production to North America.

Nucor CEO does not see China Consolidating

Dan DiMicco, Nucor Corp’s chief executive, a keynote speaker at the conference, did some ‘plain speaking’, fetching applause from the audience when he responded to a question about the economic recovery in the United States with a curt: “What recovery?” He pointed out that unemployment was high and the manufacturing sector was losing crucial jobs. “The steel industry faces chronic job losses,” he thundered. “The nation’s infrastructure is crumbling. So, America is not secure for the steel industry,” he said.

DiMicco said that he did not expect China’s steel industry to go into a consolidation mode anytime soon. Indeed, the US industry has been sharply critical of the heavily-subsidised Chinese steel shipped to the United States which violates international trade laws, he claimed.

DiMicco also lashed out at China for not opening up its steel market to the type of international investment that would spur consolidation and provide an impetus to merge and shed many of the unprofitable facilities.

“If they (the Chinese) wanted consolidation to happen, they’d let the world come into their steel market and help make it happen,” DiMicco told this correspondent after delivering his keynote speech at the conference.

Nucor Corp, the second-largest US steelmaker by production, recently blamed weak prices on surging imports from China and other countries, including Turkey and Russia, for its weaker-than-expected profit forecast for the current quarter.

Steel logistics providers

The global economic slump — and its impact on the steel industry — has also affected the steel transportation business. A US based carrier specialising in the transport of heavy steel coils,
Conference report

IABr 2012 Conference: Long-term forecast better than short-term

The 23rd Brazilian Steel Conference was held in late-June 2012, in São Paulo. The event – organised by Instituto Aço Brasil (IABr) – attracted approximately 500 delegates, which was well below the close to 800 of the previous year. This fall can be partly explained by the negative environment that characterised the Conference the consensus being that while the long-term perspective is positive, the short and medium-term situation will be challenging for steel companies. By Ger mano Mendes de Paula*

EDWIN Basson, Word Steel Association’s Director-General, discussed the future of the steel sector. According to him, the outlook for the global steel industry will be driven by population growth, raw materials availability, and environmental sustainability.

Mr Basson argued that the steel industry is vital to modern society. In addition, there is a correlation between global GDP growth and crude steel production. Nevertheless, the output of steel shows uneven growth among regions. In order to explain the differences regarding the dynamism of steel production, he highlighted three issues: a) population growth and economic development; b) development of infrastructure; and c) raw material availability.

There were sharp discrepancies between regions in terms of growth of GDP during the period 2000-2010. Indeed, the average economic growth reached 10.5% per annum in China, 3.7% in South and Central America, 2.7% in Asia-Pacific (excluding China), 1.6% in NAFTA and 1.4% in the European Union. Concerning population growth, the figures were 1.4% per annum in Asia-Pacific, 1.3% in South and Central America, 1.0% in NAFTA, 0.6% in China and 0.4% in the European Union.

Fixed investment, which can be considered as a proxy of the infrastructure development, had relevance regarding the selected regions, showing a 13.1% CAGR in China in the period 2000-2010, 6.1% in South and Central America, 1.8% in Asia-Pacific, 0.5% in the European Union and -0.2% in NAFTA. Mr Basson commented that although the availability of raw materials is not linked to growth in steelmaking capacity, it becomes a key differentiator.

The worldsteel Director stressed that expectations of population growth will support steel industry growth for a considerable time. World population will grow until 2050, before stabilising at around 9 billion people. Assuming that global consumption per capita will be similar to the levels observed in NAFTA and the European Union during the period 2005-2011, and the population will be equal to 8 or 9 billion, the global demand for finished steel would reach 2.2 to 3.0bnt a year (Table 1 hatched area in lower right corner). This estimate will be equivalent to a 4% growth rate over a 20-year investment cycle. The excess capacity in the industry will be difficult to reduce quickly, but can be absorbed in the long-term.

Trade flows reflect imbalances between regional demand and production capacity. CIS, which was the largest net exporter in 2011, had the benefit of being located close to the MENA region, the largest net importer (Fig 1). China had a considerable trade surplus, while the rest of Asia was largely balanced. The European Union and South and Central America were relatively self-sufficient too. NAFTA has declined as a net importer as the internal steel demand has stabilised. From worldsteel’s standpoint, the (substantial) trade of steel across borders will remain a characteristic of the industry.

Mr Basson believes that iron ore has long-term availability in most of major production countries, but warned about the reduction in its iron content. More importantly, he highlighted that coking coal reserves have fallen sharply. Its lower availability could force a change in the technology used by steelmakers to make steel. This important warning, however, passed almost unnoticed, as the questions raised by the audience during the Conference paid more attention to short-term market conditions.

Regarding environmental matters, the worldsteel director stated that currently iron and steel sectors account for 6.5% of the world’s total CO2 emissions. He acknowledged that the industry will face considerable challenges to lower these emissions. However, he claimed that the innovative use of steel saves six times as much CO2 as is caused by the production of that steel.

Mr Basson’s presentation highlighted satisfactory long-term perspectives, which somehow was peculiar, because most of the remaining presentation looked mainly at the short and medium-term period.

China, China, China... Although the Conference was held in Brazil, China seemed to be the theme that many speakers gave the most attention. Mr Antonio Sun, partner of McKinsey & Co Shanghai, delivered a comprehensive presentation regarding the Chinese economy and its steel industry. According to him, there are only two simple questions regarding the Chinese steel industry that really matter: a) Will Chinese steel demand peak and if so, when and at what level? b) What will be the long term ‘mature’ level of Chinese steel demand?

Nonetheless, there are many answers for these simple questions. He compared the forecasts of Chinese finished steel demand to 2020, made by seven analysts. He observed a large variation between the lowest (625Mt) and the highest (1,360Mt). It is interesting to note these strong disparities even come for the same analyst. For instance, according to one, the high-case scenario is 118% higher than the low-case estimate.

McKinsey has a quite optimist view of Chinese economic growth for the coming years, based on five key drivers: a) a gradual move from an investment to a consumption driven growth model; b) an increase of the degree of urbanisation, reaching roughly 70% in the next 20 years; c) an explosion of the size of the middle income group; d) a balancing of external trade, which means that the trade surplus will decline in its ability to contribute to GDP growth; and e) increasing heterogeneity in regional performance – regions in the East and Central South will remain dominant but those in the West of China will grow faster.

Mr Sun selected some important figures concerning the Chinese economy. McKinsey forecast that China’s GDP will grow 7.8% per annum during the next ten years. The GDP per capita (measured in RMB at 2005 value) for the urban population will increase from RMB44,000 in 2012 to RMB72,000 in 2020, which is equivalent to a 6.3% CAGR. Meanwhile, the respective figures for the rural

Table 1 Global finished steel consumption, according to population (billion metric tonnes a year)

<table>
<thead>
<tr>
<th>Region</th>
<th>Kg/ Capita Ave ‘95’11</th>
<th>Finished steel</th>
<th>Estimated Steel use (billion tons per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>193</td>
<td>1.351</td>
<td>1.544</td>
</tr>
<tr>
<td>C&amp;S America</td>
<td>88</td>
<td>0.616</td>
<td>0.704</td>
</tr>
<tr>
<td>NAFTA</td>
<td>281</td>
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</tr>
<tr>
<td>EU</td>
<td>335</td>
<td>2.345</td>
<td>2.68</td>
</tr>
</tbody>
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Fig 1 Net steel export by region, 2011 (Mt)

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

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population will be RMB11 000 and RMB15 000, a 4.0% CAGR. As a consequence, urban areas will expand their contribution to the GDP from 82% in 2012 to 88% in 2020. The middle class population will grow from 137M in 2010 to 247M inhabitant in 2020. Some 40bnm2 of floor space will be built by 2025, in five million buildings.

The most important figure presented by McKinsey’s partner is reproduced in Fig. 2. It shows that finished steel demand in China will expand only 3.0% per annum, which is quite below the expect GDP growth, inverting a trend observed until recently. Therefore, Chinese steel demand will achieve 814Mt in 2020. The joint participation of residential building, commercial building and public infrastructure in total demand will drop marginally from 56.2% in 2011 to 52.8% in 2012.

Fig. 3, for its turn, demonstrates the factor that will be responsible for additional steel demand in China in 2020 vis-à-vis 2011. The 191Mt supplementary consumption will be distributed among: a) growth in annual floor constructed space (31.9%); b) increase in weighted steel intensity per sqm (27.2%); c) others (22.0%). The small relevance of the rise in demand for vehicle construction (5.8%); growth in manufacturing intensity (27.2%); d) consumption (5.8%); e) others (60%); the most important market for iron ore – hit a new record level, being 5% higher in comparison with the same quarter of last year.

Given the record hot metal production, it was no surprise to see iron ore imports into China also achieved a new record level, surpassing 180Mt in 2012-Q1. In fact, China’s imports have been growing faster than its demand, so the market share of local mines has fallen from 180Mt in 2011 to 85Mt in 2012-Q1. Mr Scott emphasised that the growth in hot metal production has started to moderate in China. At the same time, the supply from the major ore producers in Australia and Brazil has increased sharply. The iron ore price is likely to continue to be squeezed out of the market, reducing further its market share to 17% in 2013-Q4. Given this, there is little chance that prices will rise significantly above current levels for any sustained period in the short-term. The iron ore price will reach $145/t in 2013-Q4 (Fig. 4).

Looking further ahead, the rate of growth in hot metal production is set to slow. At the same time, China will find it increasingly difficult to competitively produce iron ore, reducing its annual output from 180Mt in 2011 to 85Mt in 2016. Consequently, the rate of growth in seaborne iron ore trade is expected to exceed that of hot metal production. Bearing in mind that Indian ore exports will fall from 80Mt in 2011 to 40Mt in 2016, iron ore exports from Australia are expected to rise sharply, augmenting its market share in the seaborne market from 41% in 2011 to 54% in 2016, while Brazil will maintain its participation at around 28% plateau. As a conclusion, in the mid-term period, high cost existing capacity will continue to be substituted with lower cost new projects. The iron ore price will reduce from $160/t in 2011 to $120/t in 2016 (Fig. 5).

Brazilian economy
Octavio de Barros, Chief Economist of Bradesco, one of the largest Brazilian banks, discussed the impact of the poor mood globally
Conference report

Fig 6 Global exports and economic activity in Brazil (IBC-Br), accumulated 12 months, 2005-2012 (%)

Fig 7 Brazilian retail sales and industrial produced by volume, 2005-2012 (Jan 2003 = 100)

Iron ore on the web

Iron ore supply – A report on recent conferences

By J J Poveromo*

This article reports on two recent ore mining conferences: The SME 85th Annual Meeting – Minnesota Section AIME, held concurrently with the 73rd University of Minnesota Mining Symposium held April 17-18, 2012, at Duluth, Minnesota, and on Metal Bulletin’s 18th International Iron Ore Symposium which took place in Amsterdam, June 25 - 27, 2012.

The Society for Mining, Metallurgy and Exploration (SME) Annual Meeting is held each year in, Duluth, Minnesota, USA. This year, saw the 85th SME meeting reflecting the long heritage of mining in the region and its activities today.

These meetings in particular attract operators of the taconite mines and pellet plants in Minnesota and Michigan and the vendor base which supplies these plants. The meeting is the only international meeting held annually which addresses iron ore pelletizing so it also attracts participants from outside the USA. Conference attendance was a record 305 reflecting a strong local mining economy and the strength of the conference programme.

Held concurrently with SME, the University of Minnesota Mining Symposium has reached its 73rd event. Sessions covered a wide range of subjects related to the mining industry iron mining technology, to concentration and pelletizing, and, of course, mitigating the environmental impact of operations.

Metal Bulletin’s Ore Symposium

Metal Bulletin’s 18th International Iron Ore Symposium is now held annually, it previously having been held every two years for the past 30 years. The venue moves around Europe. Attendance is led by iron ore producers (25%) but with traders now the second largest group (20%) while steel companies are less prominent (15%). Financial companies (15%) are a growing group while the balance of the attendees include engineering companies, shippers, consultants, lawyers and journalists. Few came from the Asia-Pacific region.

Keynote Presentations featured two of the ‘Big Three’ iron ore producers: Rio Tinto and Vale, and the leading North American producer, Cliffs. The McKinsey company made a presentation analysing the Chinese economy – one that consumes 56% (618Mt) of global traded ore in 2010 – in great detail projecting a gradual shift from investment driven growth to consumer driven growth. They expect steel demand in China to grow at nearly 4% CAGR driven by the detailed growth in each sector. Beyond 2020 the long term maturity levels at 450-550kg per capita and ~630-770Mt of steel consumption are projected.

For the full article please visit www.steeltimesint.com/ and click on ‘Features’ on the left of the page.

*Raw Materials & Ironmaking Consulting, 1 (610) 974-9553; jpe.poveromo@rawmaterialiron.com

Brazil’s industrial production will expand only 0.4% in 2012, and there will be no growth in 2013. As can be seen in Fig 7, there has been a decoupling between retail sales (due to a large increase in retail consumption) and industrial production, especially in the past three years. Although Mr Barros has not analysed the steel industry closely, he discussed very important issues that affect this business. At the global level, he highlighted the oversupply of manufactured goods.

On the domestic level, he stressed the need to improve the rate of investment and the poor industrial performance (in comparison to economic growth). Somehow, he was quite optimistic about the perspectives of the Brazilian economy, including denying the myth of overindebtedness in the country. Nonetheless, economic growth in Brazil will not necessarily improve the rate of investment and the poor industrial performance (in comparison to economic growth).

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Mr Barros highlighted that there are four pillars of the Brazilian economy: a) strong credit growth running at high annual rates; b) aggressive social policies, by the inclusion of millions of consumers; c) appreciated exchange rate and increasing revenues and consumption by the families and; d) public expenditure based on a strong tax burden. He argued that the Brazilian model is not impotent, but it is crucial that there should emerge new growth drivers focused on productivity and efficiency. In this way, Brazil needs to look at the opposite route to that which China is trying to take right now.

The Bradesco’s economist expressed a mea culpa by affirming that he clearly underestimated the impact of the Brazilian industry problems on the economy as a whole. In fact, the debate on de-industrialisation is currently one of the most controversial themes in the country (see STI Jan/Feb 2012 p10). He estimates that the global crisis is the drama in the industrial sector of the steel industry, closely, he discussed very important issues that affect this business. At the global level, he highlighted the oversupply of manufactured goods.

Conference report

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Mr Barros highlighted that the contagion threatened by the current crisis is essentially a result of the poor mood of the markets affecting the local and global decision making process. According to him, Brazil is much more sensitive to China than it is to Europe, and China is much more impacted by European problems compared to the impact of these on the USA. So, even indirectly, Brazil is affected for the short-term period. Good times seem relatively far away at the moment.

Fig 6 Global exports and economic activity in Brazil (IBC-Br), accumulated 12 months, 2005-2012 (%)

Fig 7 Brazilian retail sales and industrial produced by volume, 2005-2012 (Jan 2003 = 100)
Advanced design methods for rotary hearth furnaces

By A Della Rocca* M Fantuzzi*, V Battaglia** & E Malfa**

THE CFD modelling approach developed by Centro Sviluppo Materiali together with Tenova to develop the FlexyTech® range of low NOx emission burners has been extended to the application of any type of complete reheating furnace.

The main problems overcome to set up such a comprehensive furnace model were:
- The size of the computational domain required.
- Modelling of the steel progressing through the furnace. In principal, the heating of the charge (bloom and tubes) requires unsteady state calculation as the charge is conveyed through the various zones in the furnace. To model this requires a large amount of computation time. The model implemented by CSM iteratively performs a simulation of the fluid dynamics of the gases inside the furnace around each bloom when stationary as well as simulating the unsteady state of heat transfer to the charge during its passage through the furnace. The saving in computation time is achieved by simulating the fluid pattern in the steady state while simulating the heat transfer in the solid in an unsteady state. It is necessary, however, to iterate each simulation to achieve convergence with respect to the energy balance. If the fluid pattern was also simulated in the unsteady state the computation time would be extremely long. The charge model has been developed using the Ansys FLUENT® UDF software and can be applied to any geometry of the steel charged and handling system in the furnace.

The paper describes the application of the model to the simulation of a large rotary hearth furnace equipped with side regenerative burners and roof burners. Using the approach outlined the computation time required to perform the simulation of the heating of blooms as they pass through the furnace is limited to a few days when using four quad-core Intel XEON processors, a time compatible with the design cycle of an industrial reheating furnace. In a conventional design process for a furnace information is limited to the temperature distribution in the charge and the energy required for optimal heating. Modelling the fluid pattern has to be simplified. The task typically takes one day. In contrast, the CFD approach makes a far more detailed simulation of the fluid flow and heat in the solid charge optimising the design and, thanks to modern high-speed multi-core processors, the time to achieve this is comparable with conventional design time.

The full paper is available as a download from www.steeltimesint.com/features

*Tenova LOI Italimpianti, Italy, **Centro Sviluppo Materiali SpA, Italy
The Basics of iron and steelmaking Part 4

In this fourth introduction to the steel industry, Dr Walker takes the reader through the various types of rolled product and commonly applied coatings. By Keith Walker*

It is worth noting that steelmakers often try to transfer the as-cast steel into the re-heat furnaces before it is cold, saving energy, and some modern mills achieve this almost completely. In older plants, the logistics of doing this are often insurmountable. Where hot charging is achieved, this is often referred to as ‘hot connect’.

The actual re-heating temperature varies but is generally between 1100 and 1200°C. This is sufficient to transform the steel, from the ferrite phase it exhibits up to around 730°C, into the austenite phase region and ensures that it remains in this phase region whilst it cools during rolling. Austenite is much more workable than ferrite but additionally the high temperature allows the steel to re-crystallise during rolling. This means that the crystals (or, in metallurgical language ‘grains’) which are flattened during rolling change back into a rounder shape in between passes. This has a beneficial effect on the steel properties. The next article will provide further details about the metallurgy of steel.

It is worth noting, because it surprises many, that the change from ferrite to austenite causes a significant contraction of the steel, more than offsetting its expansion due to heating. It will then be obvious that the steel expands accordingly when it cools after rolling.

Steelmakers tend to use a cast product which has a suitable cross section for the intended rolled product. So slabs are cast for strip and plate, blooms for large sections (although there are a few examples of large beam mills which use slabs) and billets for bar and rod. In some cases steelmakers have moved further towards section mills – now almost obsolete – called ‘cross country’ and tend to be section, rail or bar mills - in these, the rolls are mounted next to each other in the their housings (called ‘stands’), often on the same drive shaft and motor. The steel is rolled in one set and then moved progressively sideways to the next stand and so on. In such mills each roll can contain several grooves. These have the advantage of only requiring a small building, but rolling is slow, requires more labour and is more difficult.

Such mills have been largely replaced by ‘in line’ mills in which the successive roll stands are not side by side but arranged in a line – such mills can be well over a kilometre in length. The steel passes quickly from one stand to the next, speeding up the processes and offering easier control.

By changing the rolls, different section sizes and shapes can be made, and since this is a clear requirement for any mill, great attention is paid to the case with which the rolls can be changed quickly.

Section mills

In the particular case of sections or shapes, these have flanges which are at right angles to the web. This presents problems for rolling, since it is clear that one set of horizontal rolls will not permit rolling of the flanges. In beams, there are therefore a second set of vertical rolls at the sides.

*Dr Walker was formerly with Corus Group and is now MD of the steel consultancy SteelFolk e-mail keith.walker@steelfolk.co.uk
Bar & rod mills
Whereas sections and rail emerge from the mill as long products to be laid out on cooling banks, in bar mills there is the frequently used option of coiling them as they emerge from the rolling process. In rod mills (rod and bar are the similar but traditionally bars become rod below around 15mm in diameter) it is always coiled, otherwise the length is too great to handle easily.
In rod mills, it is common to use accelerated cooling after rolling. This is achieved by loosely coiling the product immediately after rolling to final diameter and laying it out on a specially designed rack. The laying temperature is carefully controlled and air is blown to quickly cool the product. Its small diameter permits such cooling which is not possible for thicker sections. This radically improves the mechanical properties of the product, especially for high carbon grades.

Plate mills
Moving on to flat products, the first to consider is heavy plate. This product, although similar to strip in shape, tends to be associated with long products in steel companies. This is because its applications, and therefore mechanical property requirements, are more in line with sections than strip and therefore the steelmaking plant upstream is more suited to their production than is that used in strip production.

Laminar Strip Cooling (Hot-Rolling) - Saudi Arabia Pic courtesy Siemens VAI MT
Heavy plate mills are usually reversing mills. This means that the hot steel moves back and forth between the rolls, each time the gap between the rolls being reduced. Because plate is simply flat, this is possible because there are no grooves in the rolls, unlike section, rail, bar and rod mills. The product is often called ‘quarto plate’. This is to distinguish it from coil plate, which tends to be thinner, and is coiled up immediately after rolling. Otherwise, they are similar.
Unlike long products (apart from the special cast of sheet piling), plate is wide – often the greater the better from an end-user point of view and some mills are rolling over 5m width. This presents rolling problems due to the length of the rolls allowing deflection. This causes the thickness of the plate to be greater in the middle than at the edges and is know as ‘crown’. Similar problems are found in wide strip rolling mills. Therefore, back-up rolls are used, mounted in the stand above the rolls in contact with the steel, to provide additional stiffness to the set. In many mills, specially engineered solutions to the problem are installed, for example continuous variable crown (CVC) or work-roll bending.

Plate Mill – Poland Pic courtesy Siemens VAI MT
To reduce the requirement for expensive alloys in the steel (and to facilitate welding of the plate in some cases), plate mills tend to rely on metallurgical working and cooling to achieve the required mechanical properties. By careful control of the plate temperature and a heavy amount of reduction to replace the effect of the alloys, it is possible to obtain the same strength and toughness. This is commonly known as thermo-mechanical controlled rolling (TMCR), or just controlled rolling. Tight metallurgical control is required so the level of mill instrumentation tends to be high, and the need to tightly control the temperature of the plate before the final pass may lead the mill to install a ‘delay station’ – this takes the plate off-line briefly so that the mill can work on other plates whilst it is cooled.

Another plate mill option for special grades is accelerated cooling (AC) (and sometimes direct quenching – DQ), which is applied after the final rolling pass. With tight control of start temperature and cooling rate, using water sprays, excellent mechanical properties can be achieved. It is notable that some section mills have also applied these principles to a degree, but the variable cross section of the product presents difficulties in controlling the process to the extent possible with plate, and its use is therefore limited.

Before considering strip products, it is worth noting that a great deal of testing is carried out for sections, rail and plate in order to meet international specifications. Often the test houses are an important part of the smooth running of the mills. Generally speaking, long products producers will spend around 10 times more on testing than strip producers, and will suffer the yield losses associated with production of additional steel to allow that testing. In special, high alloy steels production for aerospace, for example, the testing is even more stringent.

Hot strip mills
Hot strip mills use an in-line layout comparable with section mills. The thin gauge and therefore length of the product does not make a reversing mill sensible even if it were desirable. For similar reasons, the product is coiled after rolling.
Like plate mills, strip mills commonly use accelerated cooling to improve mechanical properties – this requires particularly good control of the water impacting the steel. To achieve this, the water is applied carefully such that its flow is laminar, rather than turbulent, and the system is called ‘laminar cooling’.

Cold strip mills
For some applications, improved mechanical properties, a smoother surface finish and also economic tight control of the gauge of the strip required, and this requires an additional cold rolling process after hot strip production. First the strip is cleaned to remove the oxide coating (mill scale) formed during hot rolling. This is achieved by uncoiling the strip and passing it through a series of tanks containing acid in a process known as pickling.
When cleaned, rinsed and dried the strip is recoiled ready for the cold mill. Since the steel is initially at room temperature it is not as workable as it is in the hot mills and therefore the loading on the mill is much higher. The difficulties with roll deflection mentioned earlier are even greater and cold rolling mills may have a large number of back-up rolls to improve stiffness.

Coating
One of the features of strip production is that it is common to apply coatings to the steel at the mill. Perhaps the most widely known is galvanising. This means coating the steel with a thin layer of zinc to provide corrosion resistance. It is particularly effective in that the zinc will continue to protect the steel even if a hole or scratch is made through the coating. The coating is commonly added to cold rolled strip but can also be added to hot rolled material once the steel is cut and surfaced by pickling. The zinc can be applied either by dipping the strip in baths of liquid in a continuous process, with careful control of the thickness achieved by ‘wiping’ the strip with air knives immediately after it emerges from the bath, or by electro-plating. Both require a considerable amount of additional plant to uncoil the strip, coat it and re-coil it. The product made by emersion is commonly known as hot dip galvanising (HDG). Tinplate is also well known. It is widely used for food and drink containers where galvanizing presents potential health problems and is not suitable. Again it can be applied by emersion in liquid tin or more commonly today by electro-plating which enables a much thinner coat of expensive tin.
Polymer coatings and paints are also applied to strip, with the considerable downstream advantage that the product can be bent and shaped into final products without the coating detaching.
Long products are often coated with zinc by dipping them in long tanks containing molten zinc, after thorough pickling. These coatings are most often added downstream after fabrication. An exception is weldable mill scale which is common to apply coatings to the steel at the mill, because such fabrication (welding) usually requires a lot of heavy welding and it is important that the wets, as well as the steel product, are coated after completion.
ALFRED Krupp (1812-1887) (Fig 1) was born in Essen, Germany, the son of Friedrich Krupp (1787-1826) who had established a small steel foundry in Essen in 1811. At his father’s death in 1826 he had to leave school at the age of fourteen and take on the direction of the works. He invested heavily in new technology to become a significant manufacturer of railway materials and locomotives. In 1862 he introduced the Bessemer process in his works the first outside Scandinavia and Great Britain in Europe. He acquired mines in Germany and France.

The company began to make steel cannon in the 1840s. At the Great Exhibition of 1851 in London, Krupp exhibited a cannon made from cast steel. Also he displayed a large solid flawless ingot of steel weighing 907kg, more than twice the weight of any previously ingot made. The exhibit caused a sensation in the engineering world. Another large cannon was also shown at the Paris Exhibition of 1867 (Fig 2). Krupp became a major supplier of cannons for the Russian, Turkish, and Prussian armies during the Crimean War (1853-1856) and also during the Franco-Prussian War (1870-1871). Alfred Krupp provided social benefits to his workforce that were ahead of his time but suppressed any attempt to form labour unions. When he started managing the firm, it had five employees; at his death it employed 20,000 making it the world’s largest industrial enterprise.

Friedrich Albert Krupp
Great financial expansion took place under his son Friedrich Albert Krupp (1854-1902) (Fig 3). During World War I, Krupp sold cannons to the Central Powers (an alliance of Germany, Hungary, Bulgaria and Turkey) as well as to the Entente (an alliance between Britain, France and Russia), a policy which generated huge profits. Friedrich developed the economic side of the business and in 1896 he took a lease on the huge ship-building yard ‘Germania’ in Kiel, and by 1902 the company had acquired the complete shipyard. At that time the Krupp works in Essen employed over 40,000 workers.

Bertha Krupp
Bertha Krupp inherited her family’s company in 1902 at the age of 16 when her father Friedrich Albert Krupp died. She married Gustav von Bohlen und Halbach (1870-1950) in 1906 (Fig 4). Gustav became company chairman in 1909. During this period the German Navy was expanding rapidly and the company made huge amounts of money providing the navy with armaments and submarines, forcing Krupp to significantly reduce its labour force. The company therefore diversified to agricultural equipment, vehicles, bridges, locomotives and others.

However, using subsidies from the Weimar government, Krupp began the re-arming of Germany through subsidiaries in Sweden. He helped finance the election of 1933, which enabled Adolf Hitler to strengthen his grip on the government. During World War II Krupp built the largest gun ever constructed (Fig 6). It weighed 1344 tonnes and had a bore of 800mm and fired 1400kg projectiles 45km using smokeless powder. Gustav Krupp suffered failing health and handed over the running of the business to his son Alfred in 1943.

Alfred Krupp von Bohlen und Halbach (1907-1967) (Fig 7), son of Gustav Krupp, took over the management in 1943. After Germany’s defeat in World War II, the Nuremberg Military Tribunal tried Alfred as a war criminal for his company’s use of slave labour. It sentenced him to 12 years imprisonment and ordered him to sell 75% of his holdings. In 1953 he was pardoned and resumed control of the firm.

Krupp foundation
After the death of Alfred, the company became a corporation and the Krupp Foundation was created in 1968. The Foundation funds have been allocated exclusively for charitable purposes.

Thyssen-Krupp AG
In 1999 Krupp merged with its largest competitor Thyssen to form Thyssen-Krupp AG, Germany’s fifth largest firm and one of the largest steel producers in the world. Thyssen was founded by the German industrialist August Thyssen (1842-1926) in 1867 in Duisburg.

He built the first 500-ton blast furnace in Germany and the first 100-ton Martin (open hearth) furnace.

Through the 1920s the Thyssen companies continued to expand and employed 200,000 people.