CONSTRUCTION OF STATE-OF-THE-ART BLAST FURNACES ONGOING WORLDWIDE – DESIGN AND TECHNOLOGY TRENDS

Steffen KÖHLER, Senior Manager Corporate Marketing
Georges RASSEL, Senior Vice-President
Fabio FABIOLA, Senior Vice-President
(Paul Wurth Group)

Abstract

Blast furnace iron making remains to be the most efficient large-scale industrial process for transforming iron ore into hot metal, the liquid ferrous base material for the production of almost the complete range of high-quality steel. The years 2010-2012 are witnessing a row of new, modern blast furnaces being commissioned around the Globe.

Be it Greenfield steel plant projects or Brownfield modernization and capacity increase, small-size specialized plants or large flagship furnaces – the tendency is to bring on stream state-of-the-art, cost-optimized production units which ensure a long campaign duration, efficient use of energy and raw materials, reduced environmental impact and best safety standards for personnel, plant and process.

The most common technological features and technical solutions for these new furnaces are:

- energy efficient generation of hot blast stoves (plants with waste gas heat recovery);
- reduction of temperature losses and increase of availability through the entire hot blast supply system (from stoves valves up to tuyere stocks and tuyeres);
- flexible stockhouse operations (screening and classifying provisions);
- BLT® charging for controlled burden distribution and process control “from top”;
- pulverized coal as the generally accepted reducing agent for tuyere level injection;
- thin wall shafts with all-height staves (including copper for the high heat loaded area and abrasion resistant cast iron solutions) cooling in closed loop circuits;
- long-campaign lining-cooling concepts and materials for the hearth area;
increased sump depth, dry hearth tapping practice, pool-type main runners, flat cast floor concept and full-hydraulic tapping machinery for stable, reproducible hot metal quality and cast house operations;

- the extended use of instrumentation and process monitoring/analyzing means (probes) combined with process automation, mathematical modelling and expert systems for an intelligent process control;

- immediate slag granulation in compact facilities (with pollution control and effective dewatering technique) as a standard feature for producing an added-value product (vitrified slag sand) for further use rather than a by-product;

- efficient stockhouse and cast house de-dusting systems;

- top gas cleaning systems providing controllable separation and, subsequently, supporting adequate dust and sludge recycling techniques and perfectly fitting for combined operation with TRT;

- top gas energy recovery by the use of expansion turbines;

- cold blast generation flexibly adaptable to changing blast furnace and hot stoves plant operation (blower design, valves technology).

These features and modern design concepts form the basis for blast furnace plants being currently under supply, construction, testing or commissioning in Brazil, South Korea, India, Russia and Kazakhstan. Some of them already started up and reached their hot metal capacity.

In the broader context of today’s global challenges, it is important to mention that the practical use of today’s contemporary solutions and technologies allow producing iron with fewer high-performance plants which stand for lower specific energy consumption and reduced environmental impact per ton of steel produced.

Blast Furnace Iron making remains to be the most efficient large-scale industrial process for transforming iron ore into hot metal, the liquid ferrous base material for the production of almost the complete range of high-quality steel. This article gives an overview about some of the most modern blast furnaces being currently constructed around the World and which are up for commissioning in the period 2010 – 2012.

In Brazil, the construction of ThyssenKrupp’s new integrated slab plant at Sepetiba (Rio de Janeiro state) is virtually finished. For the ironmaking facilities, ThyssenKrupp CSA Companhia Siderúrgica do Atlântico awarded contracts to Paul Wurth for the delivery of two new blast furnaces and all their sub-plants. Sized at 12 m hearth diameter each, these furnaces will jointly deliver 5.3 mtpy of
hot metal to the steelmaking shop. The order to Paul Wurth contained, inter alia, stockhouse and charging system, blast furnace cooling, re-cooling and water treatment plants, hot blast stoves, top gas cleaning system, pulverized coal injection, utilities systems as well as stockhouse and casthouse de-dusting plants. Both blast furnaces have two tap holes; the tapping equipment is of TMT design and supply. Electric equipment, instrumentation and automation for all mentioned systems were also part of the order. In addition, Paul Wurth provided advisory services for construction and erection as well as supervision of commissioning of all plant units. The scope of these advisory activities has even been extended, taking into account the demonstrated performance of Paul Wurth in managing the project execution. Figure 1: Blast Furnace Plant of ThyssenKrupp CSA, Sepetiba, RJ, Brazil

Another project of interest in Brazil is the new Greenfield seamless pipe mill Vallourec & Sumitomo Tubos do Brasil Ltda (VSB) which is currently under construction at Jeceaba, Minas Gerais state. The hot metal base of this plant will consist of two modern blast furnaces of the small-size range: each of them has 4.8 m hearth diameter, they are going to produce jointly 600,000 tons of hot metal per year. VSB’s order to the Paul Wurth Group for construction of the iron making plant includes design and delivery of the blast furnaces’ proper with cooling system, refractories (including carbon blocks) and the top, the stockhouse and charging systems, cast houses with tapping equipment, hot blast stoves plants, gas cleaning systems as well as slag granulation and dewatering facilities. Stockhouse, blast furnace tops and the casthouse areas are provided with pollution reducing de-dusting and filtering systems. Paul Wurth also delivers electric equipment, instrumentation and automation for all mentioned systems. Further, the application of pulverized coal injection (PCI) technology is foreseen. The plant configuration and equipment are in line with VSB’s strategy to have a state-of-the-art operation at Jeceaba; and the order to Paul Wurth acknowledges the value-for-money ratio of a compact plant designed by the leader in all-size iron making technology.

This leads us to Dangjin in South Korea, where one of the most ambitious Greenfield projects ever in steel is under realization. Hyundai Steel Company is constructing a new, large new integrated steel plant for flat products. The first stage of the projects includes two blast furnaces for producing 8 million tons of hot metal per year. With hearth diameters of 14.8 m each, they are now some of the largest in the world, and the first blast furnaces within the Hyundai Group. The order which Hyundai Steel placed with Paul Wurth contained the design of the two modern BF plants including burden preparation facilities and Bell-Less Top® charging systems, blast furnaces with modern staves cooling systems, hot blast stoves with external combustion chamber, axial cyclones and annular gap scrubbers for off-gas cleaning, pulverised coal injection plants and utilities systems. The two identical blast furnaces have four tap holes and two slag granulation plants each. Special care is given to environmental aspects; i.e. most
state-of-the-art emission control methods have been incorporated into the plant design. A maximum of process recording devices and the highest degree of plant automation including mathematical modelling of processes and plant condition ensure safe, reliable and efficient operations. The project schedule, being a challenging one from the very beginning, has never been subject to re-adjustment; subsequently, BF No. 1 has been successfully commissioned on 05th of January 2010; BF No. 2 has been blown in on the 23rd of November, even some 6 weeks ahead of schedule. Figure 2: Blast Furnace No. 1 of Hyundai Steel’s Integrated Steel Mill at Dangjin

In Russia, a new, modern blast furnace, becoming No. 7, is the centrepiece of NLMK’s hot metal capacity expansion within the modernization programme of their existing integrated plant at Lipetsk. This new furnace is sized at 13.1 m hearth diameter and will produce 3.4 mt py of hot metal. OAO “Novolipetskij metallurgicheskij kombinat” (NLMK) decided to go for innovative technologies combined with reliable project management and awarded the contract for design and supply of this furnace and important sub-plants to the Paul Wurth Group. This order comprises the complete blast furnace proper including shell and tower structure, all refractory lining and all cooling members. The belt-fed furnace will feature a new generation two-hopper BLT® charging system. The 4 tapholes will be fitted with full-hydraulic castfloor machinery, including runner cover manipulators. Numerous measuring and sampling devices as well as a SACHEM expert system will ensure a state-of-the-art operation of this blast furnace. The order comprises the engineering and supply of a modern blast furnace gas cleaning system with cyclone and annular gap scrubber and, on the blast side, the cold blast blower. Electric equipment, instrumentation and automation for the mentioned systems are also included. The new BF No. 7 will use PCI technology; the pulverized coal will be produced by coal grinding and drying facilities which will serve also the neighbouring, existing BF No. 6. This new coal grinding, drying and injection plant is entirely based on Paul Wurth design. The start up of BF 7 will allow abandoning some older iron making facility at NLMK Lipetsk which will contribute to pollution reduction and energy efficiency. Figure 3: Blast Furnace No. 7 of NLMK at Lipetsk, Russia

This review journey continues in India, the country with probably the highest development potential for steel consumption and production. After the successful completion of a brand-new BF “H” at Jamshedpur, Jharkhand, works in May 2008, Tata Steel ordered to Paul Wurth and partner L&T, the construction of blast furnace “I”. The furnace will have an inner volume of 3,814 m³ and largely repeats the plant configuration of BF “H”. This includes proven solutions and state-of-the-art technology: the blast furnace proper with copper and cast iron stave coolers, and the new GEN2 two-hopper Bell Less Top® charging system. Two flat castfloors with four tapholes are fitted with TMT full-hydraulic casthouse machinery including runner cover manipulators. The high-performance hot blast stoves with internal combustion chamber are equipped with a heat recovery
system, using the waste heat from the stoves’ exhaust for savings in fuel consumption. Additional energy (electrical power) is going to be won from the BF gas stream by means of a top gas recovery expansion turbine. The scope of Paul Wurth’s supplies also includes a pulverized coal injection system and two INBA® slag granulation plants. Tata intends to operate the “I” furnace on a production rate of 3 million tons of hot metal per year. Figure 4: Casthouse of Blast Furnace “H”, Tata Steel, Jamshedpur, Jharkhand, India.

At Vishakhapatnam, Andhra Pradesh, Rashtriya Ispat Nigam Ltd. (RINL) is currently building its new Blast Furnace No. 3, which is of similar size (3,800 m³ for a yearly production of 2.5 million tons) and design. The same applies to the construction of the new Blast Furnace No. 2 of Bhushan Steel at Meramandali, Orissa. Both projects include most of Paul Wurth’s advanced technological solutions, such as: last generation BLT, copper cooling elements, pulverized coal injection, slag granulation, cast house equipment and probes of TMT design, top gas cleaning, stockhouse including de-dusting facilities, hot stoves with heat recovery system as well as the instrumentation, control and automation means (level 1 & level 2, intelligent supervisory assistance tools) for efficient BF operation. Figure 5: Construction site of RINL’s Blast Furnace No. 3 at Vishakhapatnam, India.

Besides these new blast furnaces currently being constructed, Paul Wurth is the lead designer and technology supplier for rebuilds and modernizations of existing iron making units. Two typical examples are blast furnace No. 2 at SAIL’s Bokaro Steel Plant in Jharkhand, India, and blast furnace No. 2 of Arcelor Mittal’s Temirtau Works in Kazakhstan. Within the existing plant configuration, size and productivity of the units are to be increased, and the design shall ensure extended campaign duration and less maintenance.

All these projects around the world are currently in the status of advanced development: site activities - from erection of steel structures and refractories down to cold tests of already installed unit equipment - are underway. Along with Hyundai Steel’s furnaces, № 1 and 2 of ThyssenKrupp CSA and No 2 of SAIL Bokaro were commissioned in 2010. All the mentioned plants will add value to the customers’ iron making operations and to Paul Wurth’s strong blast furnace plant making expertise.

In the broader context of today’s challenges, it is important to mention that the today’s state-of-the-art solutions allow producing iron with fewer high-performance plants which stand for lower specific energy consumption and reduced environmental impact per ton of steel produced.
Figure 1: Blast Furnace Plant of ThyssenKrupp CSA, Sepetiba, RJ, Brazil

Figure 2: Blast Furnace No. 1 of Hyundai Steel’s Integrated Steel Mill at Dangjin, South Korea
Figure 3: Construction of Blast Furnace No. 7 at Novolipetsk Iron & Steel (NLMK), Lipetsk, Russia

Figure 4: Casthouse of Blast Furnace “H”, Tata Steel, Jamshedpur, Jharkhand, India.
Figure 5: Construction site of RINL’s Blast Furnace No. 3 at Vishakhapatnam, India.

Footnote: TMT (Tapping – Measuring – Technology) is a joint company of Dango & Dienenthal and Paul Wurth