EAF integration into the blast furnace route at Wheeling-Pittsburgh

Wheeling Pittsburgh Steel Corporation has installed a Consteel® EAF at its Mingo Junction Works, Ohio, USA, replacing one blast furnace. The new plant is the largest Consteel EAF built, featuring a 225t tap weight and hot metal charging, provides greater energy efficiency and operational flexibility.

AUTHORS: Mauro Bianchi Ferri and Francesco Memoli
Tenova Metal Making

Wheeling-Pittsburgh Steel Corporation (WPSC) is an integrated steel producer of flat rolled carbon steel products. The Mingo Junction and Steubenville facilities on the Ohio river are the primary iron and steel production sites. Until 2004 the Works were equipped with coke oven batteries, two blast furnaces, BOF plant, continuous slab caster and a hot strip mill. The overall crude steel production capacity was about 2.6Mt/yr. However, blast furnace No. 1 was located at the Steubenville site, 5.6km from the BOF plant, thus around 3,000t of hot metal had to be transported daily to the steel site.

Some years ago WPSC considered installing an EAF to provide increased steelmaking flexibility. This idea offered numerous advantages for an integrated steel producer to react to market demand - as scrap prices vary closely with steel prices, this results in a variable cost structure for an EAF melt shop. However, as the new EAF was intended as a replacement for one BF, it needed to be a high productivity facility.

WPSC decided to invest in Consteel technology, which can generate production rates exceeding 300t/h from a single vessel shop, and also utilise hot metal. The new EAF permits important operational flexibility as it enables the plant to shift emphasis from BOF-based operation to EAF-based operation when scrap prices are low relative to the price of hot metal. Alternatively, when scrap prices are high, the EAF can use hot metal.

CONSTEEL

Installations Since 1989, when the first Consteel system started in North Carolina, 22 other installations have been ordered in eight different countries. Currently, all of these are operating, in construction, or being commissioned; a record that no other innovative melting technology can state. In the first ten years the Consteel system was mostly applied in the USA, where it was initially engineered. From the technological point of view

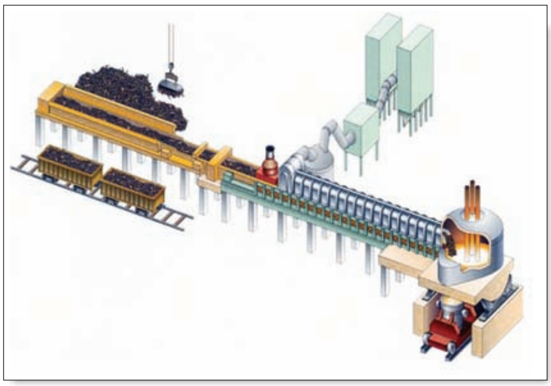

Fig.1 Schematic view of a typical Consteel system

the system' s function of scrap preheating was responding to the needs of variable cost reduction in the USA market, although it also improved productivity through the use of continuous charging. Both results have been achieved with an improved control of the emissions. During the subsequent five years Consteel expanded at an impressive rate in China where the first application commissioned in 1999. Today Consteel is expanding into Europe, with new applications in Italy, Greece and Germany.

The main drivers behind the current interest in Consteel are cost reduction, environmental improvement and productivity increases.

The process The Consteel system as seen in *Figure.1*, continuously charges scrap into the EAF by means of a conveying system that connects the scrap yard to the EAF. The scrap is loaded onto conveyors by the scrap yard cranes. Before reaching the furnace the scrap enters the preheating section where it is heated by the counter flowing hot gases (CO) exiting the EAF which are burnt with air.

There are two main characteristics that make this system different from most of the other technologies available for melting scrap in the EAF; namely continuous charging and preheating. Continuous charging has shown important benefits for the users in terms of fast payback, low production costs, high productivity, flexibility, reduced environmental impact and personnel safety.

Preheating the charge is very helpful to reduce the energy consumption of the EAF, saving between 80 and 120kWh/t of liquid steel.

The EAF roof is always closed and gas suction is constantly performed using the primary circuit, not by the canopies of the secondary circuit. The control system automatically adjusts the conveying speed to maintain the steel bath at the target temperature and controls the oxygen and carbon injection to maintain the proper foamy slag.

Water-cooled furnace sidewalls, roof and lances do not have leakage problems caused by arcing or scrap impacts, so minimising the risk of water in the furnace and contributing to a safer and more comfortable working environment compared to the typical standards in the steel industry.

Hot metal charging Scrap shortages and insufficient electrical systems are issues that can be overcome through the implementation of mixed BF-EAF installations. Charging hot metal into the EAF can be beneficial by providing thermal energy for the EAF, so reducing energy consumption and increasing productivity.

Experience has shown that charging hot metal into a traditional top-charged EAF is an unsafe procedure and is operationally difficult due to the risk of a strong reaction in the bath. This problem is related to the interaction between oxygen (in the steel and from the lance) and carbon (in the steel, in the hot metal and from the lance). Controlling the carbon content in the bath by feeding hot metal continuously and with an automated pouring/tilting device seems to be the most efficient way to achieve the maximum benefits in terms of operational safety, chemical control (with effect on tap-to-tap time) and foamy slag practice (with effect on energy and refractory consumption).

The continuous feeding concept, during which the bath is always liquid, is ideal to achieve fast dissolution of the carbon charged with the hot metal. By keeping the carbon at 0.15-0.25%, the bath temperature is maintained as constant as possible, the foamy slag practice is optimised and the undesired oxygen/carbon reactions in the bath are avoided, thus achieving more energy efficient operations, fewer problems for the equipment and safer environment for the personnel. *Figure 2* illustrates a typical continuous scrap and hot metal charging layout.

THE MINGO JUNCTION PROJECT

The WPSC EAF melt shop was built at the end of the existing BOF shop following demolition of an existing

EAF type	Consteel AC EAF
Transformer power	140 MVA
Furnace inner diam.	8.5 m
Heat size	225 t
Conveyor inner width	2.4 m
Productivity	1,630 kt/y (225 t/h) (100% cold charge) 2,180 kt/y (300 t/h) (using 40% hot metal)
Electrical power requirement	107 MW (100% cold charge) 67 MW (40% hot metal)
Tap to tap time	60 min (100% cold charge) 45 min (40% hot metal)

Table 1 Technical data of the Wheeling Pittsburgh EAF melt shop

scrap bay and offices. The existing track of the CAS-OB facility was revamped for the new ladle furnace facility.

The main technical data of the melt shop are summarised in *table 1*. The continuous scrap charge into the EAF comes from the south, starting from the new scrap facility. Hot metal from the blast furnace is fed to the EAF through a launder on the right side of the slag door, opposite the scrap entrance side. The hot metal ladle is placed in an automated pouring stand equipped with the relevant load cells to control the pouring rate into the EAF. The EAF is equipped with load cells to control the liquid steel bath weight and a material handling system for flux, synthetic slag and carbon additions. HBI and pig iron are provided by another material handling system. All material handling systems are interconnected through a system of transport conveyors which deliver materials to the appropriate chute system for each process equipment.

Steel is tapped into ladles carried by a new tapping car that transports the ladle to the twin station ladle metallurgy facility downstream to the west. Material ▷

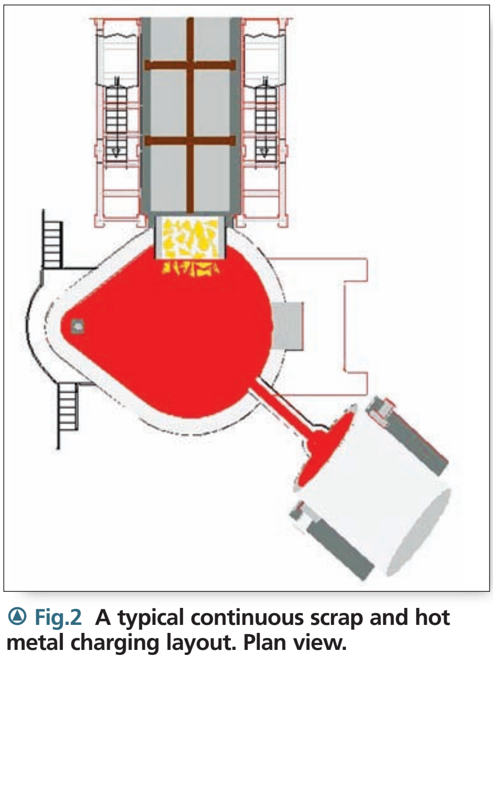

Fig.2 A typical continuous scrap and hot metal charging layout. Plan view.

additions are performed by a fully automated handling system that can weigh the batch materials for both ladle metallurgy positions.

The new melt shop is equipped with an integrated process control system which provides uniformity of automation and communication both within the new installation and with the pre-existing equipment. Three PLCs are the heart of the design, each associated with a particular part of the process; Consteel EAF, ladle furnace, and gas cleaning system.

The new equipment provided Wheeling-Pittsburgh EAF with the ability to produce 1.8Mt of liquid steel per year on the basis of a 250t/hour production rate, however, it can ramp up to 300t/hour in order to provide 2.4Mt/y.

START UP

The first heat was tapped in November 2004, some weeks ahead of contract schedule, an exceptional result considering the tremendous size of the project which has involved supply of components from all over the world.

Two months after start-up of the new steelworks WPSC officially informed all the partners involved in the project that performance levels were higher than expected.

RESULTS AND CONCLUSIONS

Wheeling Wheeling-Pittsburgh Steel's Mingo Junction plant is, to date, the largest Consteel unit in operation in the world and the first in the U.S.A designed to continuously feed hot metal.

It provides integrated steelmakers with a demonstration of how they can benefit from the unique characteristics of the Consteel melting process, especially if they are facing limited or weak power supply and have environmental constraints.

The major operating cost benefit when using hot metal is the savings in electrical energy. A reduction of 62kWh per liquid steel ton was realised with 69.1t (21.7%) of hot metal charged per heat. This agrees favourably with the theoretical energy content of hot metal.

As an acknowledgement of the performance Wheeling-Pittsburgh won the American Steel Institute's Project of the Year 2004 award for its new Mingo Junction steelworks.

Mauro Bianchi Ferri is Vice President Marketing and Sales and Francesco Memoli is Area Manager North & South America, both at Tenova Metal Making, Milano, Italy

CONTACT: tenova@it.tenovagroup.com