IMPLEMENTATION OF TENOVA PRE-HEATING TECHNOLOGY AT JSC KAZCHROME

A. PIET JONKER

Tenova Pyromet A trading division of Tenova Minerals (Pty) Ltd, pyromet@tenova.com

ABSTRACT

The patented Multiple Pre-Heater (MPH) is a system developed by Tenova Pyromet specifically targeting the ability to retrofit it into any existing Submerged Arc Furnace (SAF) plant. It can also easily be applied to new furnace installations.

Tenova recently concluded a contract with JSC Kazchrome, where the new MPH system will be installed as a part of the upgrade of Kazchrome's shop 6 at the Aksu Ferroalloy plant.

A key advantage of the Tenova MPH is its ability to be integrated into an existing furnace, as the MPH vessels can be located on the same floor as the electrode systems, and not above. This also minimizes the feed chute lengths, which in turn minimizes heat losses. Each MPH vessel is choke-fed to prevent feed material segregation which could result in gas channelling and poor heat transfer and to maximize raw material contact time with the hot gasses to ensure complete material pre-heating. The system can thus adjust instantaneously to the submerged arc furnace consumption rate with the burner system reacting accordingly. The burner system, integrated with the AUTOFURNTM furnace controller, reacts dynamically to the furnace consumption rate, and is controlled by a Tenova control algorithm linked to feed temperatures and combusted gas analysis.

The implementation of the MPH system will allow Kazchrome to decrease furnace power consumption per ton of FeCr metal by 15%. The system will further allow Kazchrome to increase furnace capacity without the requirement to build new furnaces and the additional infrastructure expenditure required.

1. INTRODUCTION

Tenova Pyromet is a leading company in design and supply of high capacity AC and DC furnaces and complete smelting plants for production of ferroalloys, base metals, slag cleaning and refining. Tenova Pyromet also designs and supplies equipment for material handling and pre-treatment, alloy conversion and refining, granulation of metal, matte and slag, furnace off-gas fume collection and treatment, as well as treatment of hazardous dusts and waste. Tenova Pyromet has several technologies to reduce operating costs and increase production power consumption.

The Multiple Pre Heater (MPH) is a system developed by Tenova Pyromet specifically targeting the ability to retrofit it into any existing Submerged Arc Furnace (SAF) plant. As such it is also easily applied to new furnace installations.

Pyromet were awarded a contract to supply the technology as part of a furnace package for a HCFeCr project in Kazakhstan by Kazchrome. Kazchrome manufacture, supply, and export ferroalloys to steelmakers in the Americas, Europe, Central and South-East Asia. Products include chromium alloys, ferrochrome, ferrosilicon, phosphorus silicomanganese, rutile, zircon, and ilmenite concentrates. The company was founded in 1995 and is based in Aktobe, Kazakhstan. Transnational Company Kazchrome JSC operates as a subsidiary of Eurasian Natural Resources Corp Plc.

The project involves four furnaces for completion over a period of four years.

2. THE TENOVA PYROMET MULTIPLE PRE-HEATERAND SAF SYSTEM

The main reason for pre-heating the furnace charge mix is to reduce the amount of electrical energy required to smelt the furnace charge mix by reducing / eliminating any moisture in the furnace charge mix, decomposing any hydroxides and carbonates (normally present in the ore) and increasing the temperature of the furnace charge mix as high as possible before the furnace charge enters the furnace. Any deviation inreaching the maximum elimination of moisture, decomposing of the hydroxides and carbonates as well as reaching the maximum temperature increases the amount of electrical energy required for smelting.

However, other external factors also play a role in the amount of energy saved and cannot be discarded i.e. the composition of the furnace charge mix batch, the mineralogy of the furnace charge mix and the retention time of the furnace charge batch inside the pre-heater vessel before being discharged, which also influences the final temperature.

2.1 Preheating principle

The purpose of the preheating is to eliminate the moisture from the furnace feed, to calcinate and preheat the feed to as high temperature as possible reducing the coke requirement. The maximum temperature is limited by the Boudouard reactions:

The preheating degree is thus limited to approximately 700 ^{o}C with an average temperature of the hot feed at 500 - 550 ^{o}C. The required thermal power input into the preheater for preheating depends of the furnace feed composition and metal production, this is normally 350 to 400 kWh/t of metal smelted.

Preheating not only reduces the electrical power consumption in the smelting process, but also increases the CO content of the furnace gas and stabilizes the furnace burden.

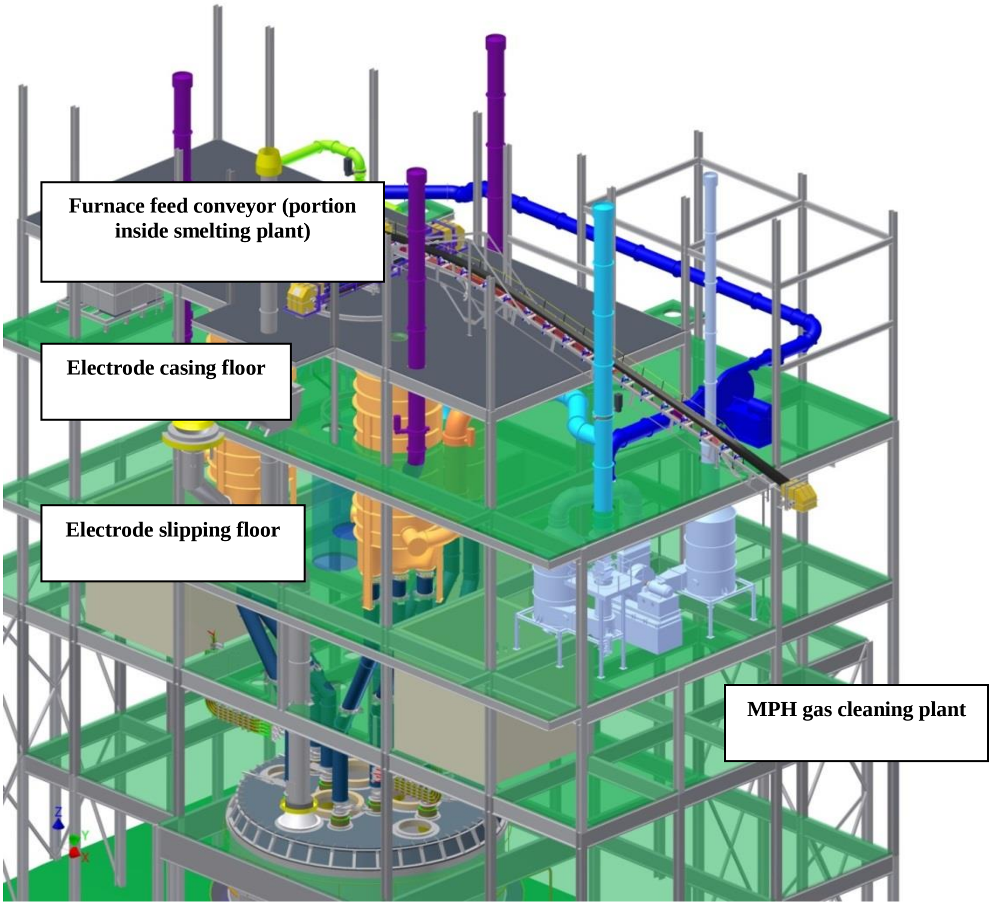

Figure 1. Sectional view of Tenova Pyromet Multiple Pre-heater

2.2 Benefits (internal and external)

- Reduction in furnace power consumption = approx. 15 %
- Reduction in volatile matter of the reductant = approx. 20% (this figure is dependent on the type of reductant used) which increases the CO content of the furnace gas generated
- Stabilized furnace operating resistance, which increases the power input by 0.5 to 1.0 MW due to less electrode movement / transformer tap changer changes as the feed is dry and hot
- Reduction in reductant consumption
- Increased degree of ore reduction

2.3 General

The Multiple Pre Heater (MPH) is a system developed by Tenova Pyromet specifically targeting the ability to retrofit it into any existing Submerged Arc Furnace (SAF) plant. As such it is also easily applied to new furnace installations.

The Tenova Pyromet MPH forms a uniquely integrated system with the SAF as well as the SAF feed, waste gas and water reticulation systems. The integrated design has been carefully optimized to maximize the system productivity. Particular features of the Tenova Pyromet MPH SAF system are as follows:

- Pre-heater vessels designed to be able to replace any existing feed bin arrangement

- The number of pre-heater vessels can be adjusted to suit the particular SAF arrangement
- Pre-heaters vessels designed to integrate the cold storage, gas collection and heating sections into one vessel
- The raw material batching system located outside the smelting plant is integrated into the MPH unit feed control algorithm. Batches of furnace feed is loaded into the cold storage section of preheater vessel based on material levels
- The MPH is choke-fed from the cold storage section to maximize raw material contact time with the hot gasses to ensure complete material pre-heating. The feed system instantaneously adjusts to the SAF consumption rate and the burner system reacts accordingly
- The internal feed system link between the cold storage and heating sections prevent feed material segregation which could result in gas channelling and poor heat transfer. A patent application is pending for this novel solution to prevent feed material segregation
- A unique gas/solid separation approach within the pre-heater vessel
- A unique gas distribution system is used to which Tenova Pyromet has the sole global license rights. The design of this system lends itself to ease of maintenance and replacement at end of life cycle
- A dual burner system ensures the ability to achieve the power input to the MPH in line with the furnace power input and rate of furnace feed consumption. The design ensures the ability to maintain power across a very large range of furnace feed rates
- The MPH system is fired using gasses being produced in the SAF with surplus gas available to a power generation plant
- A unique Tenova Pyromet temperature control algorithm ensures maximum energy input to each of the MPH units individually which maximizes the level and consistency of pre-heat temperature
- The Tenova Pyromet unique control algorithm ensures consistent levels of hot feed to the SAF, which is essential for efficient control of the SAF. A patent application is pending for this unique algorithm
- The Tenova Pyromet MPH/SAF design minimizes the feed chute lengths, minimizing heat losses. The feed chute lining design maximizes refractory life and, together with the short length, minimizes the refractory costs over the life of the plant
- The MPH gas system is controlled by a Tenova Pyromet algorithm linked to gas analyzers to minimize the presence of oxygen in the system thus minimizing the carbon burn-out in the system. This algorithm forms part of the unique control algorithm patent application
- The control system is designed by Tenova Pyromet to ensure there are no safety risks associated with the reticulation and use of CO/H2 containing gasses
- The unique control system and equipment selection ensures market leading MPH availability, in the order of 90% of SAF power on time
- Tenova Pyromet dimensions the SAF to be able to handle the requirements of both hot and cold furnace feeds with the varying burden resistances and resulting rates of metal
- The Feed Batching System, MPH, SAF and Gas Cleaning/Reticulation Systems are highly automated and totally integrated allowing control by one operator per complete furnace system

2.4 Process description

2.4.1 *Batching*

The furnace feed proportioning system is located outside the smelting plant. The furnace feed material is fed through an automated batching system onto the furnace feed conveyor that conveys the feed to the top floor of the smelting plant.

Accuracy of the feed system is critical in controlling the furnace feed and the batching. Batch calculations are performed according to a predetermined recipe with automatic feed corrections based on actual weighed mass done in the following batch.

The capacity of the feed conveyor is sized as such to ensure that the level in each preheater cold storage section vessel can be maintained during the tapping cycle.

2.4.2 *Preheating*

The multiple preheaters are steel vessels located on the electrode slipping floor and extend through the floor above (normally the paste addition floor) to the underside of the feed conveyor floor.

Each vessel comprises a feed zone where the cold feed material is stored, a gas zone where the top gas from the pre heating process is stored and extracted, a upper heat zone where feed material is heated by the hot gas and lower heat zone where the hot feed material is stored prior to being conveyed into the smelting process. The gas - and heat zones is one large portion of the vessel with the feed zone located directly above the gas zone and connected to the heat zones through multiple feed ducts extending through the gas zone, thus one vessel. These multiple feed ducts create a choke feed arrangement to ensure that gases present in the gas - and heat zones do not escape to the ambient surroundings. All zones are uniform in shape and cylindrical, except the lower part of the heat zone which is divided into at least two sections that are connected to the SAF through at least one thermally insulated duct per section.

The gas distribution device which directs and distributes the hot gas required for the pre heating, is located in the lower part of the heat zone. This hot gas is produced by burning CO gas supplied from the SAF gas cleaning plant in a separate combustion chamber - the CO gas is burnt with combustion air less than stoichiometric conditions to avoid oxidation of carbon in the MPH and cooled prior to being supplied to the gas distribution device.

Once the hot gas has been directed downwards inside the gas splitter of the gas distribution device, the gas rises through the bed of feed material in the upper heat zone heating up the feed material.

The top gas leaving the bed of feed material accumulates in the gas zone around the multiple ducts prior to being extracted by a gas cleaning plant which can either be a wet or dry type for cleaning. A portion (approximately 60 %) of the cooled off-gas is circulated as secondary gas for controlling the gas temperature in the combustion chamber and exit duct supplying the hot gas to the MPH. The rest of the gas is vented to atmosphere.

CONCLUSIONS

The implementation of the MPH system will allow Kazchrome to decrease furnace power consumption per ton of FeCr metal by 15%. The system will further allow Kazchrome to increase furnace capacity without the requirement to build new furnaces and the additional infrastructure expenditure required.

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