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SIMETAL EAF QUANTUM™ - THE FUTURE APPROACH FOR EFFICIENT SCRAP MELTING[1]

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Abstract

A new furnace concept with scrap preheating was developed in conjunction with flat bath operation, known under the trademark name. Simetal EAF Quantum™. It enables scrap melting with a specific energy consumption of only 280 kWh per ton of scrap. This new furnace stands for minimum conversion costs, maximized output and environmental compliance. 100% of the charged scrap is preheated through the utilization of the furnace offgas during the heat cycle. This leads to energy and cost savings with a reduction of the tap-to-tap time to 33 minutes. Pure flat bath operation with lowest flicker is the result of an adequate hot heel and a new tapping system. With this patent pending tapping system, a renewed variant of scrap charging and retaining technology as well as a revolutionary design of the offgas-processing system, this furnace is the melting aggregate of the future. An energy consumption of 280 kWh/t in combination with reduced consumptions of oxygen and fuel stands for itself.

Key words: EAF; Preheating; Efficiency; Flicker.

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1 INTRODUCTION

In previous years, productivity was the main focus for the steel industry as the market was booming and the steel producers were output oriented. Situation changed and the market downturn forced the industry to work on the efficiency of the equipment and the steel producers became cost oriented. In addition, more and more countries worldwide are implementing new rules and regulations not only concerning energy efficiency and CO2 emissions, but also with respect to hazardous off gas emissions.
Using more than 20 years of experience in scrap preheating technologies and more than 40 years of experience in electric steelmaking, Siemens VAI developed a new electric arc furnace concept with scrap preheating in conjunction with flat bath operation, the EAF Quantum™, improving cost, efficiency and environmental aspects over previous EAF concepts.

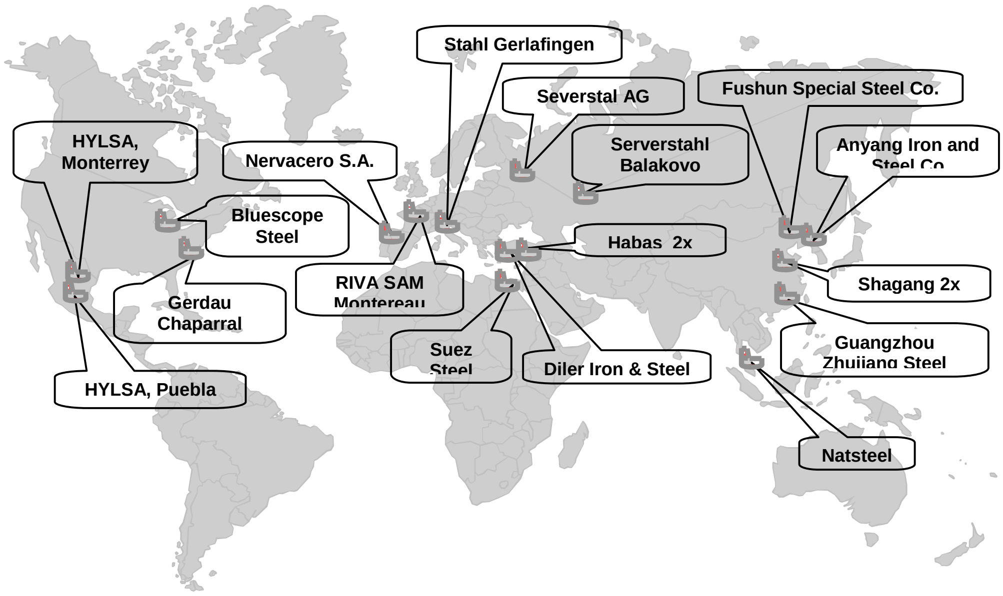

Figure 1. Operating shaft and finger shaft furnaces.

Nearly all components of the concept has individually proven its industrial operation in different installations around the world, like the moving lower shell concept at Sherness UK (today Thamesteel) or the Fast tapping system at Buderus Edelstahl.
The major differences compared to the above mentioned shaft and finger shaft furnace technology are the following and will be described in detail later on:

- improved tightness leading to minimized false air ingress due to fixed shaft structure and movable lower shell;
- trapezoidal shaped shaft design for optimum scrap distribution and efficient preheating, especially with lower scrap density;
- improved scrap fall into the shell through newly designed scrap retaining system;
- increased liquid heel for improved heat transfer and fast melting process;
- flicker free steel melting thanks to new shaft to electrodes configuration.

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2 GENERAL LAYOUT

Starting from scrap yard, scrap can either be loaded with trucks into the scrap chute on the elevator system or (Figure 2), with magnets and crabs via a so-called intermediate loading station, which then unloads the scrap into the scrap chute.

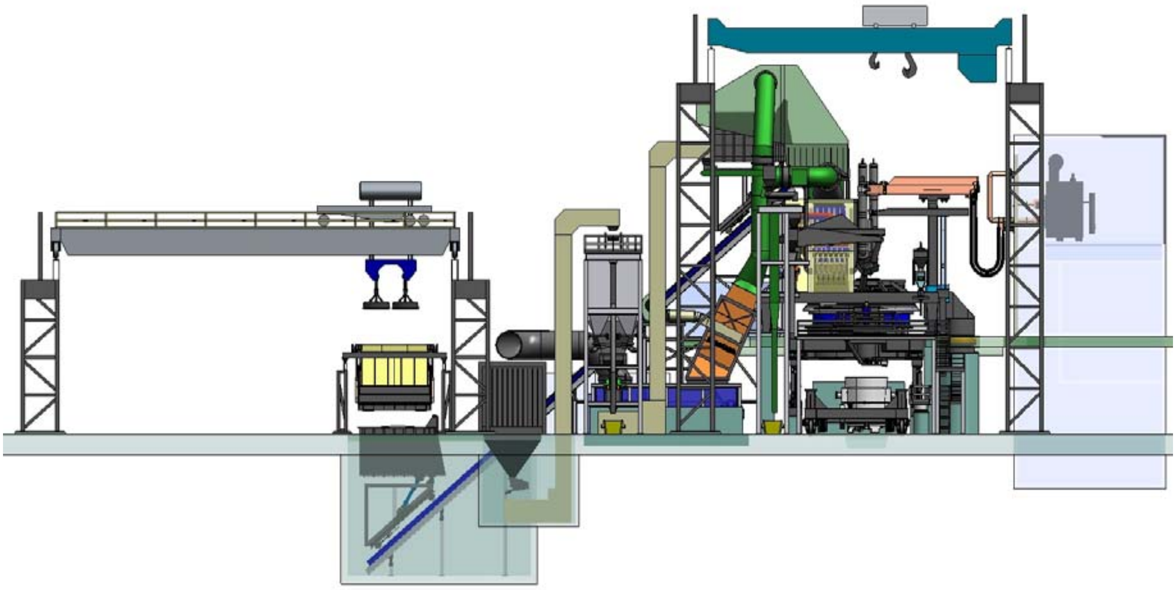

Figure 2. General view from tapping side.

2.1 Scrap Charging Via Elevator System

The new charging concept – an elevator system with chute for scrap transfer from a subsurface dumping station into the furnace - allows a defined and flexible charging logistic. A crane or basket for scrap charging is not necessary. Furthermore, based on an exact duty cycle and charging time, a full fledged automation concept is applicable. The complete cycle from loading of chute to charging of the scrap into the shaft is shown in Figure 3.

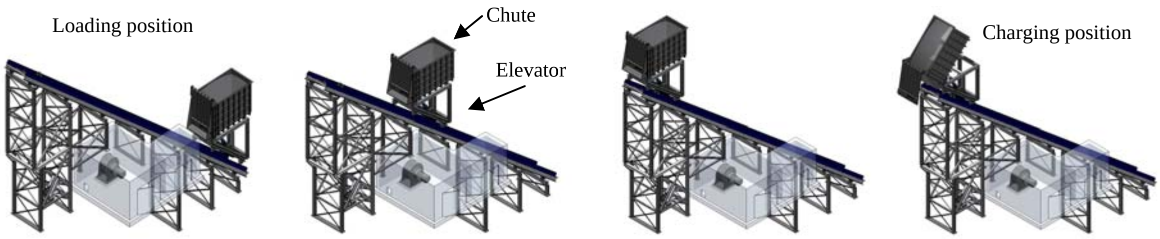

Figure 3. Scrap chute on elevator from loading to charging position.

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2.2 Re-Designed Preheating System

Efficient energy recovery due to 100% scrap preheating is the base for energy consumption lower than 280 kWh/t. This is realized by a trapezoidal shaped shaft design in combination with a re-designed retaining system which leads to a better scrap distribution and an improved offgas-routing for optimized heat transfer, avoiding scrap sticking and blocking inside the shaft.
After having preheated the scrap, the fingers are opened for charging by pulling the fingers out of the sidewalls of the shaft (Figure 4). Thanks to the new opening mechanism and a large "horse shoe" shell volume, the preheated scrap is dumped into the big liquid heel and the fingers can be closed immediately afterwards for loading and preheating the next batch of scrap. All this can be done under power-on.
The complete finger system is placed on a sturdy fixed roof/shaft structure in order to prevent the forces coming from scrap loading going towards the water cooled parts, thus avoiding the risk of water leakages.

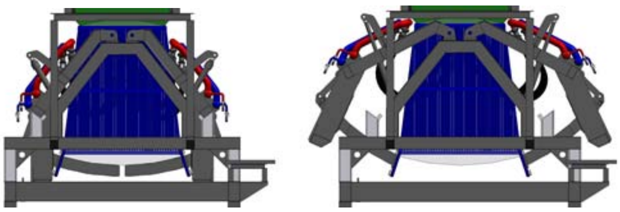

Figure 4. Scrap retaining system.

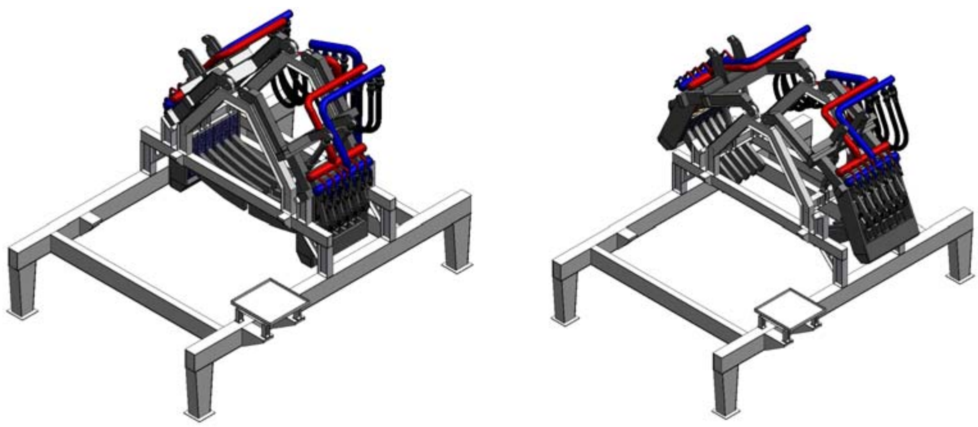

Figure 5. Scrap retaining system on main frame in closed and open position.

2.3 Pure Flat Bath Operation

Melting of scrap in big liquid heel leads to pure flat bath operation with lowest flicker and supports the preheating efficiency. In combination with the furnace advanced slag-free tapping system (Fast - siphon design) this new furnace concept allows charging, tapping and taphole refilling under power on and results in highest productivity with lowest tap-to tap time and virtually no power off time. Heat transfer from liquid heel to the preheated scrap and bath homogenization is improved by the operation of a bottom stirring system with nitrogen or argon.

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Continuous input of electrical energy not only improves the productivity but is important for the energy infrastructure with respect to Flicker problems in the respective power grids of the country.
The working profile for the process with 3 baskets can be seen in Figure 6.

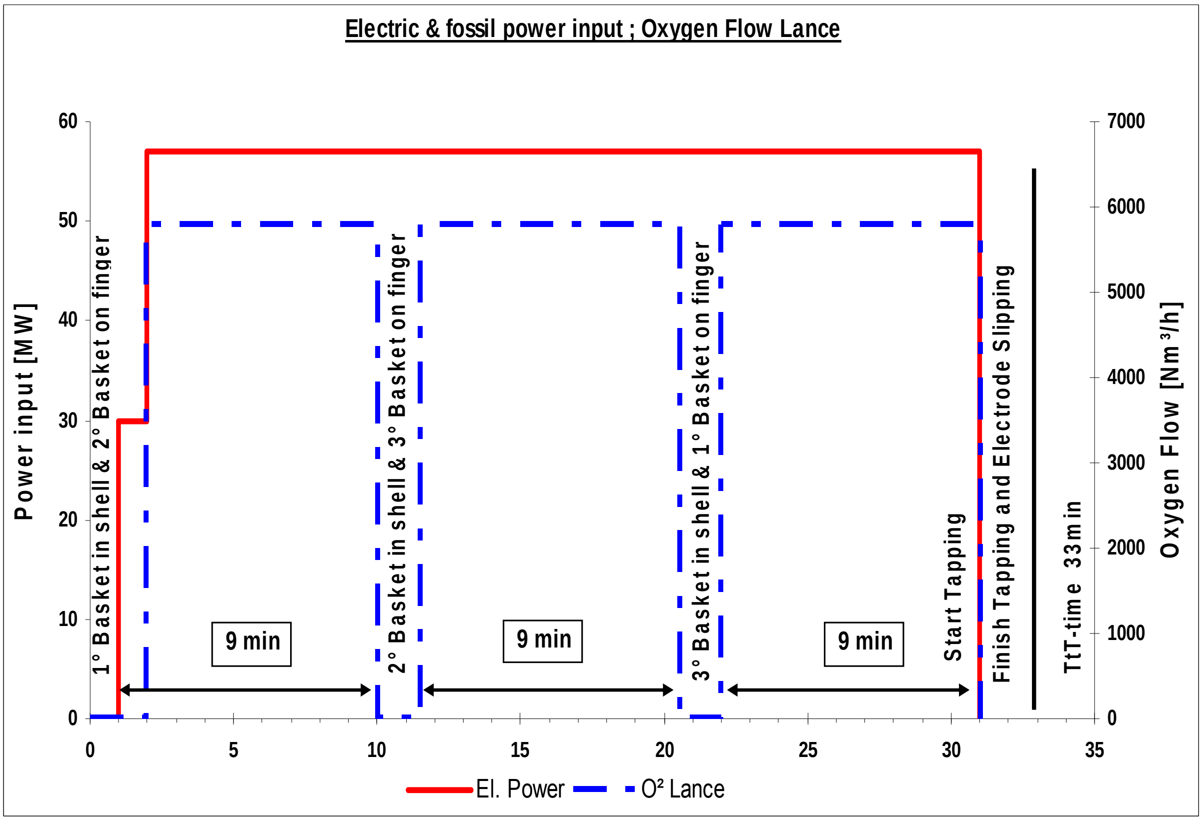

Figure 6. No power off during charging, tapping and taphole refilling.

A further advantage of this shell design is the slag free tapping concept that is enhancing the yield of alloys and de-sulfurisation performance. Following Figures 7 to 9 illustrate the tapping process. It can be seen that there is always steel above the tapping channel, no slag can enter and therefore be sucked into the ladle.

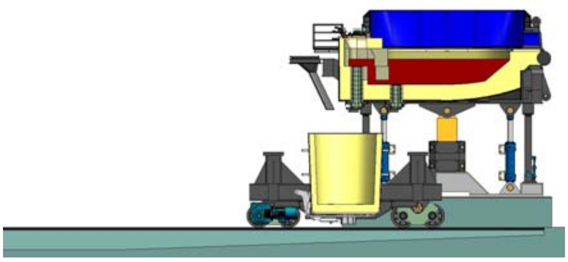

Figure 7. Ladle prior tapping.

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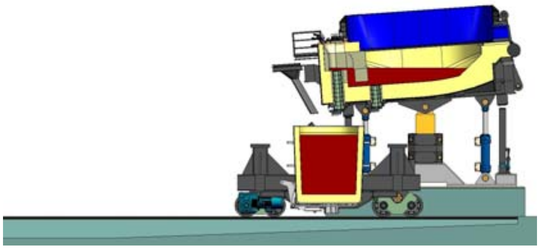

Figure 8. Ladle end tapping.

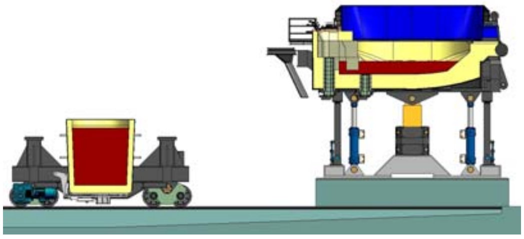

Figure 9. Ladle in crane pick up position.

2.4 Minimized Furnace Movements

As all the shaft structure is fixed installed, the shell has to be manipulated for tapping and deslagging (if required). This is realized in a manner that the shell is sitting on base frame with cylinders and guides, allowing the shell to be tilted in both directions – tapping and slag side.

The gantry with the electrode lifting system and the lance holders for the oxygen and carbon lance is not tilting, but only swinging out for electrode slipping and fast roof center piece exchange. Heavy stress from furnace tilting like the gantry at the conventional EAF with all its consequences on support and bearing, high current cables etc. is not existent.

For maintenance reasons, a simple shell transfer and moving concept reduces furnace movements and improves system maintenance aspects through quick shell exchange.

The transfer car is acting as tapping car as well as shell transfer car. The sequence of shell exchange is show in the Figures 10 to 13. In order to pick up the shell from the frame, the car has to be placed into the exchange position, underneath the shell. The shell will be lowered by means of the cylinder and guide system. When sitting on the car, the shell is free and can be moved outside the furnace area for refractory maintenance or shell exchange.

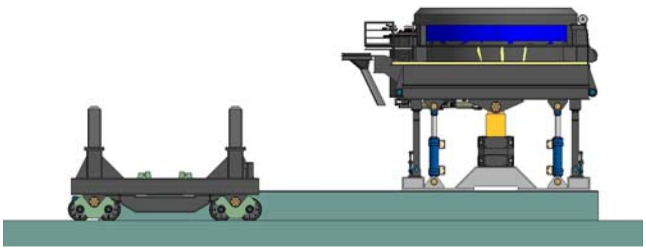

Figure 10. Ladle car before shell change.

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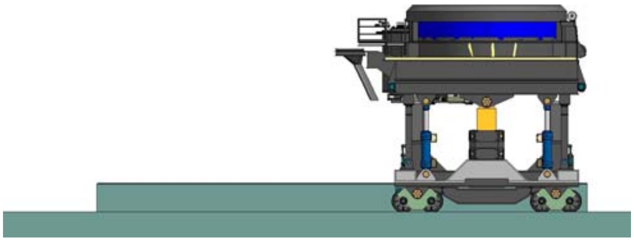
Figure 11. Ladle car in shell change position.

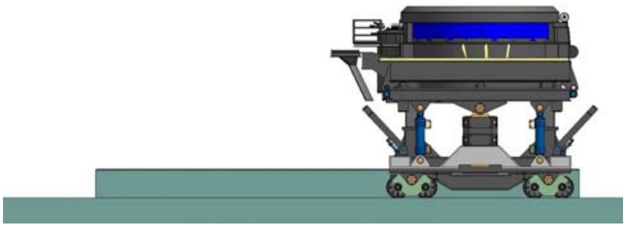
Figure 12. Ladle car with shell in pick up position.

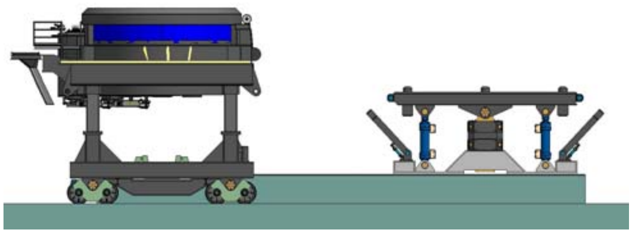
Figure 13. Ladle car with shell in maintenance position.

In order to prepare the furnace for restart, the shell can be loaded with remaining liquid steel or scrap prior moving to the operating position. Once again in operating position, the cylinder and guide system is moved up and then connecting the base frame with the shell.

2.5 Offgas Processing Concept

This new approach is completed with an offgas-processing with automated offgas-stream guiding, maximized leak tightness and a special hood to cover dust and offgas emissions during charging. This concept fulfills the future environmental compliance and leads to reduced canopy installation.

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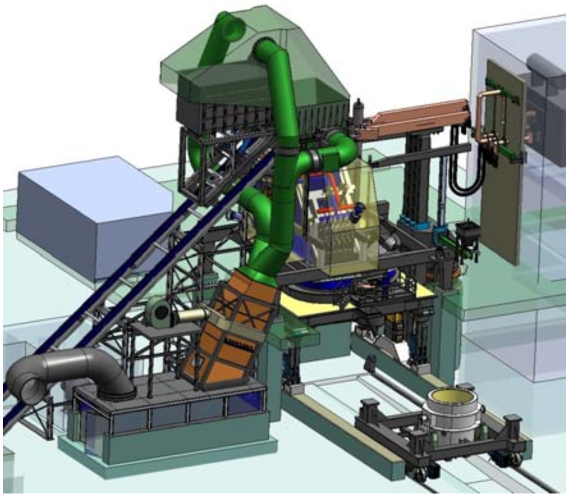

Figure 14. Quantum™ shaft side view.

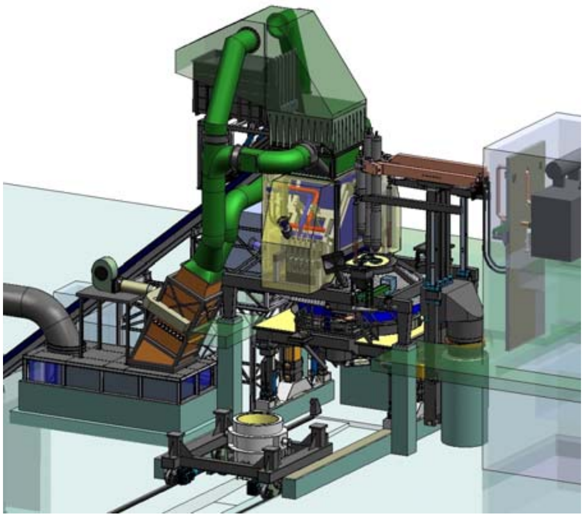

Figure 15. Quantum™ transformer side view.

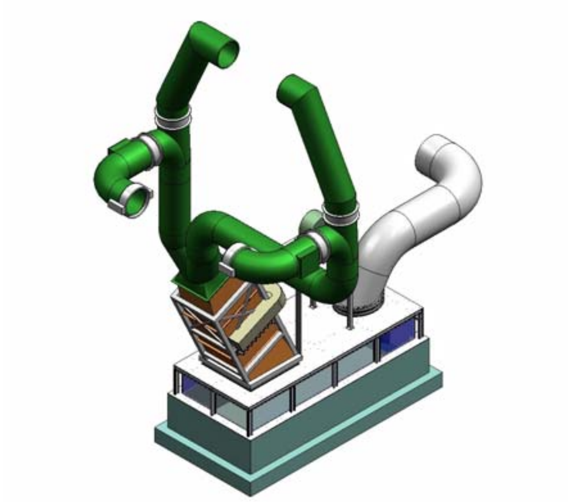

Figure 16. Offgas evacuation from shaft.

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The size of the dedusting system can thus be reduced tremendously.

3 CONSUMPTION FIGURES

In the following Table 1, the main technical data with corresponding consumption figures are shown. The EAF Quantum™ is flexible to melt various kinds of scrap densities still keeping high productivity paired with low conversion cost.

Table 1. Main data and consumption figures

		3 batch	4 batch
MAIN DATA			
Heat size, average	T	100	
Hot Heel size	T	70	
Diam ter Lower Shell	Mm	6.300	
Height Upper Shell	Mm	1.720	
Scrap density	t/m³	0,65 - 0,7	0,5 - 0,65
Number of charges per heat	-	3	4
Transformer Rating	MVA	80	
INJECTION TECHNOLOGY			
Oxygen Injection capacity	Nm³/h	2 x 2.900	2 x 2.600
Carbon Injection capacity	kg/min	2 x 20 - 60	2 x 20 - 60

		3 batch	4 batch
TIME BALANCE			
power-on time	min	30	34
power-off times	min	3	3
• charging (under power)	min	0	0
• tapping, tap hole filling & electrode slipping	min	1	1
• delays	min	2	2
tap-to-tap, ttt	min	33	37
Productivity	t/h	182	162
Productivity per Year with 7.500h	t/a	1.360.000	1.220.000
CONSUMPTION FIGURES for tapping temperature 1.610°C			
Electrical energy, up to	kWh/t	280	295
Electrode consumption, up to	kg/t	0,9	0,9
Oxygen, up to	Nm³/t	25,0	25,0
Natural Gas Post Combustion & FAST, up to	Nm³/t	4,0	4,0
Total Carbon (charged & injected), up to	kg/t	25,0	25,0

4 MAIN BENEFITS

In order to conclude, the main benefits are the following:

- energy consumption of ≤ 280 kWh/t;
- tap-to-tap time of 33 min;
- increased productivity of 1.35 mio. t/a with an 100 t EAF and a 3-batch process;
- charging, tapping and tap hole refilling under power on;
- direct energy recovery due to 100% scrap preheating with smaller transformer installation;
- optimized environmental compliance due to revolutionary design of offgas processing;
- highest output, even with weak power grids due to pure flat bath operation resulting in lowest flicker;
- up to 30% reduced electrode consumption;
- total conversion cost advantage of 20%.

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Additionally, safety improvements can be claimed due to

- full automation concept feasible;
- no crane movements in furnace area reduces danger from moving loads.

Due to the overall concept (Figure 17) and taking into consideration the cost savings for the dedusting system and other facts like no necessity of scrap baskets and scrap crane, the EAF Quantum™ is a profitable investment for the steelmaker. The return on investment can be seen between 2 years to 4 years only, depending on energy cost and production program.

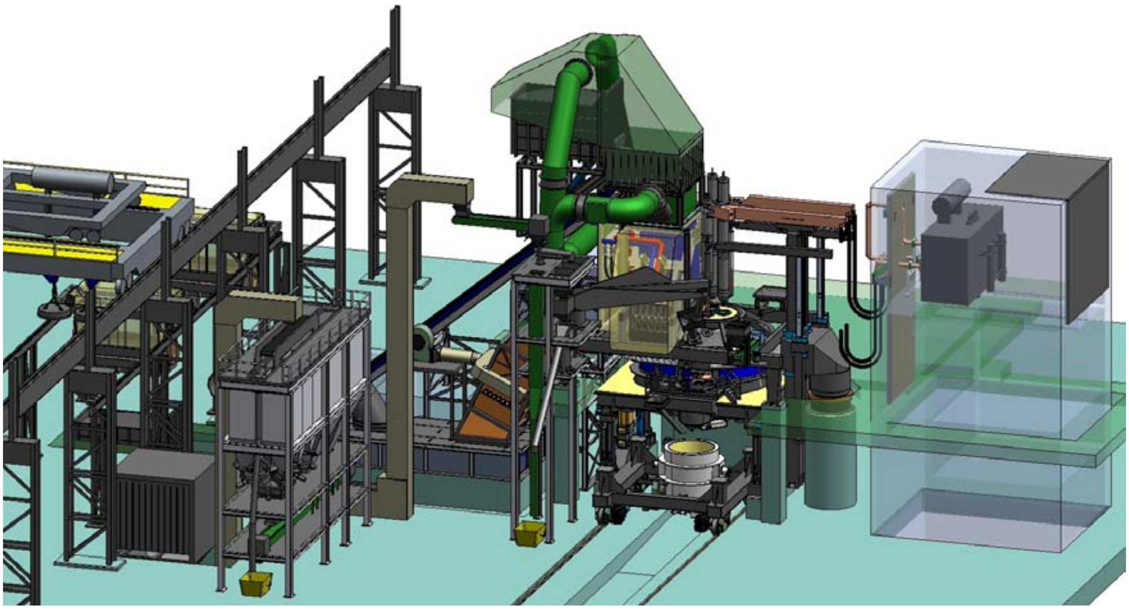

Figure 17. General view of EAF Quantum™.

5 CONCLUSION

Siemens VAI Metals Technologies is glad in offering a pragmatic solution to meet the request for highest energy and cost efficiency, increased productivity and lowest emissions in electric steelmaking whether charging scrap, but also partly Hot Metal or DRI.
With the Simetal EAF Quantum™, Siemens VAI Metals Technologies has developed an EAF that can enable the steelmaker to achieve a high productive steelmaking at extra low conversion cost.