THE NEW CONTINUOUS ELECTRIC ARC FURNACE ARCCESS® *STEADY* EAF (S/EAF®)[1]

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Abstract

SMS Siemag has continued its development of the electric arc furnace: the novel combination using tried-and-tested components from the submerged-arc furnace (SAF) save energy and production costs and improve productivity by up to 30 percent. The Arccess® steady EAF (S/EAF®) is a stationary electric arc furnace that is designed for the use of DRI, HBI, hot metal and steel scrap. The key component that ensures continuous operation is the electrode holding and slipping device. It allows the S/EAF to operate continuously, with energy consumption reduced to a minimum level. Continuous flat-bath operation using foamy slag reinforces this effect. Against the background of rising energy and production costs, a profitable electric steel production requires innovative solutions that are flexible to use and reduce life cycle costs. At SMS Siemag, submerged-arc furnaces and electric arc furnaces are products with a more than 100-year old tradition. With references for electric arc furnaces and electric smelting furnaces for the international ferro-alloy and non-ferrous metals industry, SMS Siemag is the world leading supplier. This know-how is now combined in the S/EAF.

Key words: Electric arc furnace; Steelmaking; Energy efficiency.

1 *Technical contribution to the 44nd Steelmaking Seminar, May, 26th-29th, 2013, Araxá, MG, Brazil*
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1 INTRODUCTION

The electric arc furnace is the core unit of an electric steelmaking plant and has a decisive impact on annual production and energy costs. A new development from SMS Siemag is the Arccess® steady EAF (S/EAF®), which allows true continuous operation for up to one week. The S/EAF has been newly developed from scratch and combines innovations with proven technology.
The result is a new type of electric arc furnace, yielding a 30 percent higher productivity with lower energy consumption thanks to its reliable continuous process. Depending on the raw material mix, the S/EAF is individually designed to cover a wide range with capacities known from standard EAFs up to several hundred tons.

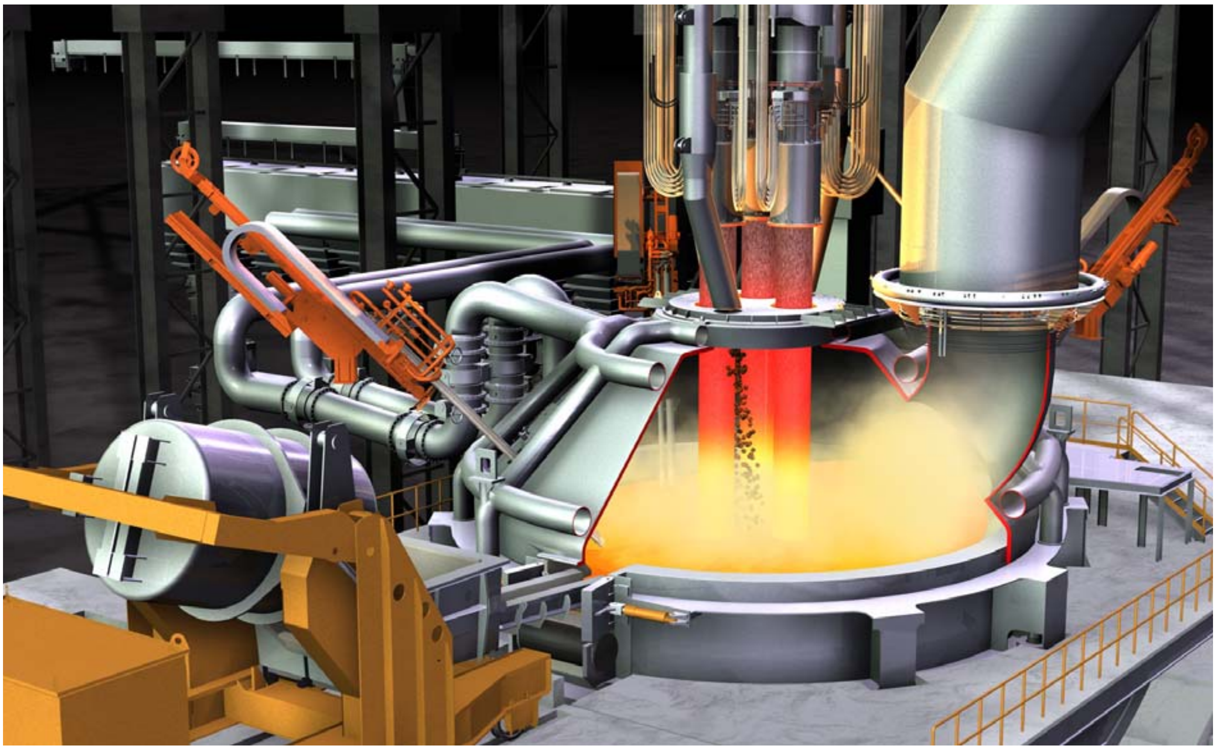

Figure 1. Illustration of the steady EAF (S/EAF) with electrode slipping system and optional launder for hot metal charging.

To produce high-quality steel for flat products, electric arc furnaces that are charged with direct-reduced iron (DRI) gain special importance. The charge mix can partly or completely consist of DRI. The S/EAF is most efficient for the continuous charging of DRI. With this solution, the idea of a continuously operated EAF turns into reality.
Due to the fact, that the S/EAF can be operated continuously, it is specially suited for the direct charging of hot DRI with temperatures up to 600°C. Cold DRI and hot briquetted iron (HBI) can be charged as well in case the direct reduction plant is not in service. With optional equipment the S/EAF can also be charged continuously with shredded scrap or hot metal.
All components have been designed and rated to allow continuous operation for around one week with the power on. This steady and uniform operation under power-on sets new standards for the economic use of electric energy. It also prevents negative feedback on the electricity grid (for example flickers) due to the prevention of switching the power on and off.

2 PROCESS SEQUENCE

The quantum leap towards the real continuous operation of an electric arc furnace is realized by the elimination of non-productive power-off times for tapping and electrode handling. Furthermore, the S/EAF is equipped with a patented tapping system that allows for slag-free tapping with the power on.

Figure 2. Electrode slipping device of a submerged-arc furnace.

Figure 3 shows the process sequence of the S/EAF in comparison to a conventional electric arc furnace for a 100 percent hot DRI scenario. The S/EAF is operated with maximum input of electric energy for about 90 percent of the time. During this phase, hot DRI is continuously charged. Simultaneously, carbon and oxygen are injected to build up a good foamy slag layer. Only during the last minutes shortly before tapping, hot DRI feeding is interrupted to superheat the melt to the appropriate tapping temperature and to reliably adjust the proper carbon content.

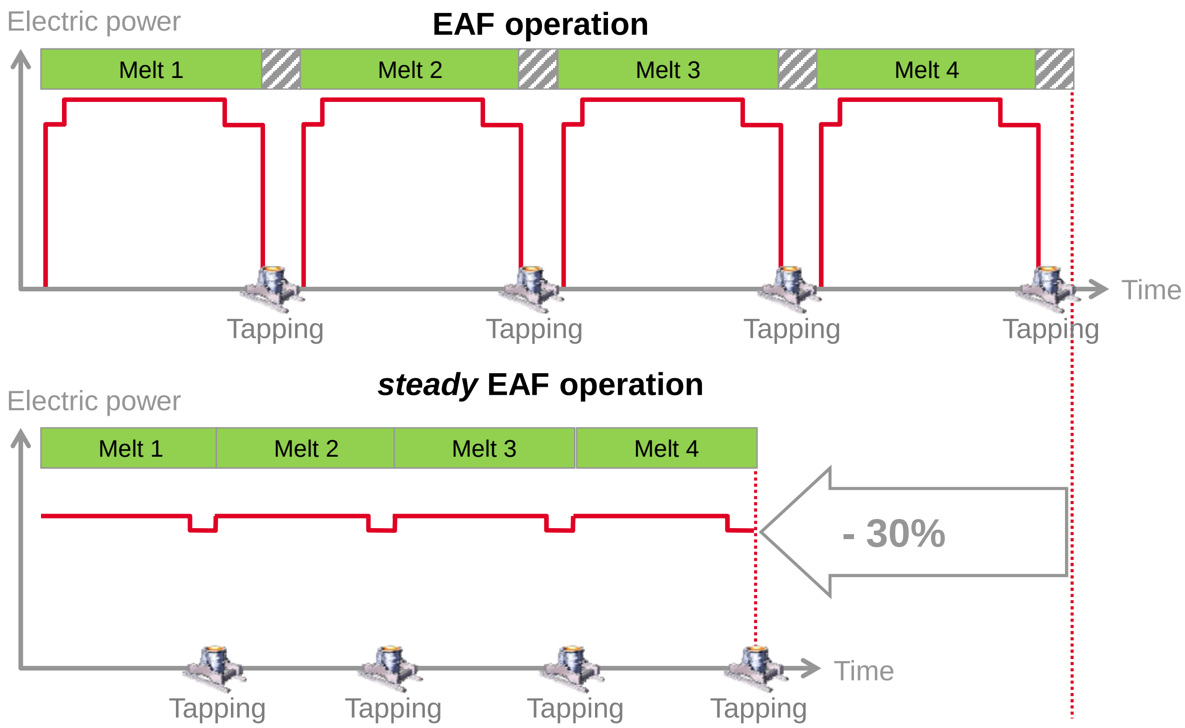

Figure 3. Process sequence of the S/EAF compared to a conventional EAF.

At the end of this phase, slag-free tapping takes place under power-on with slightly reduced power input. As soon as the ladle is ready filled, DRI charging can be resumed into the hot heel with maximum power level.

3 ENERGY RECOVERY AND FURNACE OFF-GAS SYSTEM

The whole off-gas system has been designed to meet the continuous process of the S/EAF and its steady-state operation. The process-related boundary conditions are very similar to the circumstances that can be found at submerged-arc furnaces. As far as volume flow rate and temperature conditions are concerned, the implementation of an energy recovery system is perfectly suited to make use of more than 50 percent of the thermal off-gas energy.

Due to continuous S/EAF operation, the off-gas temperature stays the same for a long period of time. This fact makes it possible to realize an off-gas system that features a continuous steam generation unit to recover the thermal energy of the hot fumes. These are routed through an energy recovery system (ERS) that generates steam and serves for the necessary cooling of the off-gases 1.200 C down to 200°C.

Steam is a valuable medium that can be used for various applications within the steelmaking plant to improve overall energy efficiency. Possible applications – among others – are the propulsion of vacuum pumps for VD plants, air conditioning, serving a steam network or generating electric energy. The benefit depends on the individual plant configuration.

In an exemplary configuration, power generation via a turbine-generator unit makes it possible to drive a unit with an electrical output of 20 MW (for a 250-t S/EAF configuration). Other applications even yield higher recovery rates.

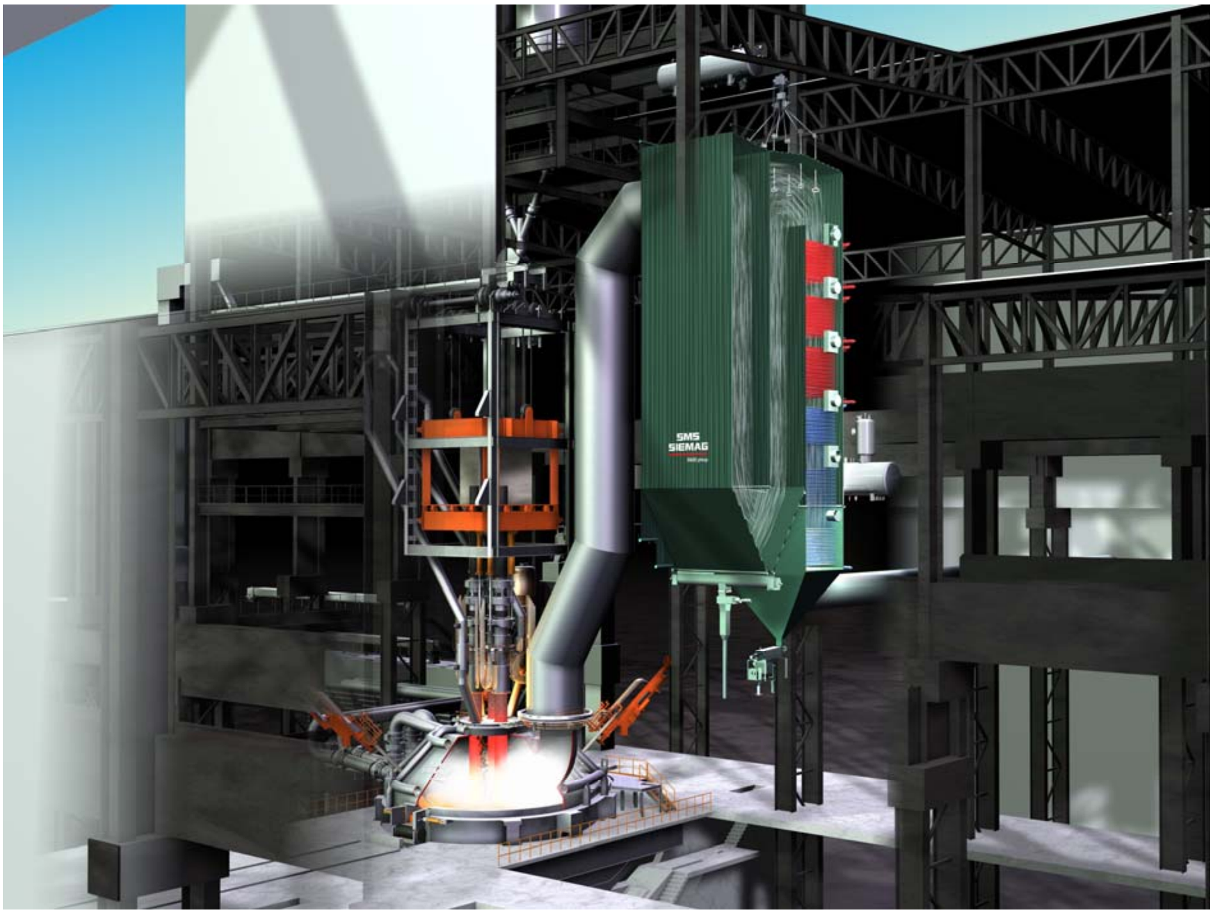

Figure 4. S/EAF with connected energy recovery system.

As the S/EAF can be connected to a primary gas cleaning system only, it can be targeted to the very special purpose of off-gas treatment indepently from the secondary fume extraction system.

4 TECHNOLOGICAL FEATURES

To ensure a high availability of the S/EAF furnace system, it is equipped with a vessel quick-exchange system. When a new refractory relining is required, the complete lower shell is driven to a maintenance stand and replaced by a freshly relined vessel. This procedure is realized by a vessel exchange car. Thereby, heavy-duty gantry cranes with elaborate building structures and foundations are not needed. Investment costs for this equipment can be reduced by 25 percent.

5 BENEFITS FROM STEADY EAF TECHNOLOGY

The performance figures of the S/EAF show a productivity that is up to 30 percent higher compared to a conventional electric arc furnace. To achieve the same annual production capacity, it is possible to realize a plant configuration that reduces investment and operational costs at the same time. Compared to the conventional EAF, the S/EAF allows to realizing a transformer capacity that is 20 percent lower. With respect to the refractory wear index (RWI), the S/EAF can be designed with a vessel diameter that is almost 20 percent smaller. This solution enables the use of electrodes with smaller diameter and has major influence on operating costs. The

minimization of process interruptions yields a reduced consumption of electric energy.
The permanently closed furnace makes it possible to abandon the canopy hood for secondary fume extraction. The primary off-gases are extracted directly from the furnace by means of a fume elbow. A furnace enclosure reduces noise and fugative secondary fume emissions to a minimum. This results in a dramatically reduced off-gas volume. The downstream gas cleaning plant can be dimensioned for much smaller flow rates. Again, this fact reduces investment costs and marks a new level of environmental compliance. As mentioned before, cranes and civil structures can be designed a cost-saving way.