EAF Modernization with Increased Power Input by PrimetalsTechnologies

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Siemens VAI Metals Technologies has now become part of Primetals Technologies, which is a joint venture company of Siemens, Mitsubishi Heavy Industries and partners.

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Summary

For Electric Arc Furnaces (EAF) high performance and productivity can be reached by fully utilized existing transformer capacity with a rigid electrode lifting system and with the associated process knowhow for a mostly uniformed heat load operation.

The electric transmission path to the arc has to be designed for a maximum power input or as alternative installation of a more powerful transformer with a suitable high-current system up to the electrodes. Cycle times during power off and power on times may be reduced with faster single movements with new hydraulic settings

The latest modernization developments for maximum electric power input allows to:

• Increase productivity

• Decrease conversion costs

• Operate with a symmetrical power input

• Limit refractory wear

• Improve plant availability and life time with heavy duty components

In this paper, the latest results of EAF Modernization with Primetals Technologies for maximum electric power input will be shown.

Key Words

Electric steelmaking, Electric Arc Furnace, increased power input, increased productivity, improved availability

Introduction

In the real world, steel producers face multiple challenges. Rising raw material and energy prices and stricter environmental regulations are major challenges to the electric steelmaking industry of today and tomorrow. In this highly competitive and globalized market, steelmakers constantly need to find new ways to optimize their cost structures and decrease their conversion costs. Consumption figures can be reduced with continuous improvements in technology, equipment and system maintenance. Enhancements in plant availability and utilization boost productivity and improve the quality and consistency. Steelmakers strive to achieve maximum improvements with minimum investments in order to attain high plant performance and production efficiency.

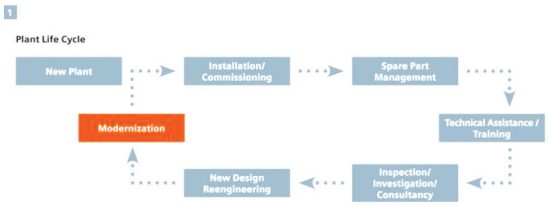

Figure 1: Plant lifecycle

All of these requirements are met by adopting a strategy of continuous modernization over the entire lifecycle of a steel plant. Combining modernizations with commensurate services extends the plant lifecycle for more than the initially planned service life and ensures flexible and competitive operation.

Primetals Technologies does not only build metallurgical mills and plants but also services and modernizes the installed base in order to ensure a long and extended service life. We provide our services at an early stage of the project in order to define the initial spares, and we are present during the commissioning phase to ensure a smooth startup. Spare parts are defined and managed to account for equipment wear and to ensure subsequent high levels of plant uptime. This is where the lifecycle begins. The plant must be fine-tuned with additional technical assistance and training to reach highly efficient performance. This assistance is best provided by the OEM during operation as well as during scheduled plant shutdowns. The subsequent inspections and on-site inspections serve as a basis for recommendations of ongoing process improvement. If problems are identified, the OEM continuously improves and re-designs the corresponding components. And if significant modifications are required, plant components are modernized and revamped. Throughout a long-term partnership, the manufacturer offers multi-dimensional onsite technical and technological support with engineering and process expertise.

The steps described below constitute the typical lifecycle loop of a plant, which is repeated several times. The benefit of such a procedure is continual or increasing asset value that enables the plant operator to deliver consistent product quality and even to improve profitability.

A typical estimate of EAF service and modernization expenses is about 1.5 times the original investment cost during the lifecycle. The following typical expenses are generally incurred over the entire EAF lifecycle. Water-cooled panels make up the largest share of the spare parts budget, which is half of the spare and wear part expenses of approximately 8€ million in an EAF service life of ten years. Personnel costs for service, technical assistance, training and studies amount to roughly 100,000€ per year, corresponding to 1€ million in a decade. The ten-year average is one major revamp package that costs 3–2€ million and three smaller revamp cycles that cost 1.0–0.5€ million each. All in all, this amounts to approximately 5€ million in a decade. Approximately %20 (1€ million) of these modernization expenses are required for erection, commissioning and tuning. This short calculation provides a summary of the important service and modernization expenses in the EAF service life and underscores the need to invest in continuous improvement to steadily decrease conversion cost and boost productivity

Figure 2: Copper-clad current-conducting electrode arms

Figure 3: EAF 150t at Outokumpu Stainless

Modernization of EAF electrical power input system

Energy consumption and the energy input strongly influence productivity and conversion costs of EAF operation. One possibility of boosting productivity is increasing electric power levels during the power-on phase. This may be achieved by fully utilizing the existing transformer capacity and assuring that the entire electric transmission path to the arc is suited to the maximum power input or installing a more powerful transformer with a suitable high-current system up to the electrode. Productivity also means reducing the power-off time and thus upgrading EAF movements and reducing delays. A hydraulic system revamp with gantry modification, for example, an EAF equipment tuning and process optimization can lead to further increases in productivity.

Example: 150 t, 110 MVA AC EAF in Finland

• Key facts

- New electrode lifting system implemented in existing gantry
- New hydraulic system
- New current - conducting electrode arms

• Key results

- Symmetrical power input (reactance un-symmetry from %17 to %5)
- better melting operation
- constant tap weight

EAF improvements for lower conversion costs

The primary factors determining conversion costs are plant availability and reliability. Optimally, the steel plant staff and the vendor's service department cooperate on establishing an ongoing feedback process of plant problems and jointly develop customer-specific solutions. Initial activities focus on optimized spare-parts management and subsequently on identifying specific components that need to be re-engineered to suit the plant operator's specific requirements. Then, these solutions are implemented on-site and the results monitored. In general, the solutions discussed in this context

are small modifications and revamps that produce maximum short term effect.

The next factor in reducing conversion costs is boosting productivity. To do so, the existing productivity of an EAF must first be determined within a fact finding mission at site. The productivity of an EAF is defined as the number of tons that can be produced per hour. Productivity can be influenced by increasing tapping weight while keeping the same cycle time. Other factors which influence productivity are electrical power input, power-on time during every cycle, and improvements of the EAF's mode of operation. Energy consumption is another parameter that has an influence on conversion costs.

A further possibility to boost productivity is to use higher electrical power levels during the power-on phase. This requires the full utilization of the existing transformer capacity combined with a revision of the entire electrical transmission path to the arc or the installation of more powerful transformers.

Productivity means also to reduce Power off time and therefore upgrade EAF movements and reducing delays. A revamp of the hydraulic system with a gantry modification, for example, as well as an EAF equipment tuning and process optimization can yield further increases in productivity. To reduce power off time and increase productivity the steel producer needs to involve technical assistance for fine tuning and process optimization. The aim follows in an operation with less delay and less maintenance, quick diagnosis and short reaction time, quick spare replacement, efficient handling with minimum waiting time, trained operator for synchronized operation, as well as applying standard mode of operation.

A further promising modification is to better utilize the fed energy by charging the EAF using larger scrap buckets and a correspondingly optimized EAF geometry.

The tapping weight can be increased by using higher and bigger shells and a bottom shell with higher capacity.

Additional improvements can be implemented by including new design features with additional technologies such as injection tools and cooling blocks in the shell. The deployment of an additional injection system using a chemical energy medium is another way to increase the total energy input, and to improve the efficiency of the thermal and metallurgical processes.

Customer tailored solutions from a lifecycle service provider

It takes close and continuous cooperation between a plant operator and a service provider to identify which of the measures above will yield the maximum gains for a given process and production situation. It is also helpful if this cooperation extends over the entire service life of the EAF so that the service partner has a detailed understanding of all of the customer's specific operational and maintenance aspects.

The service provider needs to hold a wide range of skills that span from equipment design, service and maintenance management and technological competence all the way to process control. This expertise is necessary to offer the multidimensional solutions required to preserve asset value over the entire EAF service life. Problems with the plant have to be resolved with tailor-made technological upgrade solutions that are implemented in short installation times and that fit into scheduled plant shutdowns. The supplied components and systems need to be designed for reliability, low maintenance, safety and environmentally friendly operation. In case of emergencies, fast response and short delivery times for the service provider are of vital importance.

Besides having a long track record as an equipment manufacturer, Primetals Technologies also provides services and is capable of covering all aspects of system operation across the entire

Figure 4: RCB Temp; contact free temperature measurement

lifecycle of a plant. Primetals Technologies service support goes far beyond spare parts and emergency service: the company's specialists provide plant operator trainings and help to analyze equipment performance, and to develop customized upgrade and revamp packages which can be installed easily in normal, scheduled service breaks. In recent years, Primetals Technologies has made a name for itself for competent process support and highly efficient upgrading and revamping projects for all aspects of a plant, from electrical and mechanical up to plant erection and all project execution steps.

Ancillary process solutions

Apart from offering EAF upgrades and modernizations to cover the aspects described above, Primetals Technologies has also developed a number of innovative solutions for specific aspects of EAF operation.

Precise, reliable and predictable acquisition of temperature data is important to ensure consistently high product quality as well as safe working conditions.

Steelmaking is all about knowing the exact liquid steel temperature at any time given. Until now, this has been accomplished through time-consuming and dangerous manual cartridge taking. With its supersonic oxygen injection technology based on Refining Combined Burner technology RCB Temp offers an innovative new approach. The burner preheats the scrap during power-on time, accelerates the melting process and injects a supersonic oxygen stream during the refining phase. As soon as the defined homogenization level is reached, the system switches to temperature mode and measures the temperature at short intervals in a contact-free procedure. Compared with manual sampling this allows for a quicker and easier decision as though tapping the EAF.

This results in shorter tap-to-tap times and higher productivity, and precludes any risks for the plant operator. Additionally, this system reduces operating costs by eliminating expensive cartridges.

Another solution is the LiquiRob for EAF, a highly flexible robot-aided automatic measuring and sampling system that is optimized for the rough environment of EAFs, converters, secondary metallurgical plants and casters.

The system gives the plant operator the needed flexibility and reliability to ensure uninterrupted, fail-safe and controlled EAF steel production. The

Figure 5: EAF at Swiss Steel, modernized in 2013 with a new furnace gantry, roof, tilting platform, hydraulic system and lad car

Figure 6: EAF LiquiRob for Temp & Sampling probes

LiquiRob replaces mechanical manipulators and performs fully automatic temperature and sample measurement cycles, and it also takes care of automatic cartridge replacement.

Thanks to the LiquiRob, manual work in hazardous areas is largely eliminated.

Other EAF-specific modernization solutions target process optimization and help to boost productivity while decreasing energy consumption: A DC revamp including a Fin-Type anode modernization contributes to an extension of EAF service life by offering a faster exchange time and improved safety, since no cooling water is underneath the EAF.

In steel plants in which hot metal is available, more flexibility of raw material choice is leading to an economic advantage. The implementation of the EAF hot-metal charging turret with tilting ladle and launder offers increased flexibility for material input.

AC EAF Modernization at Swiss steel shortens process times and cut conversion costs

The main goals of the modernization were to shorten process times and cut conversion costs. The production capacity rose to 650,000 tons of steel per year and, at the same time, operating safety was increased and maintenance costs reduced.

- Production capacity increased to 650.000 tons of steel per year
- Tap--to-tap time reduced from 55 to 52 minutes
- Idle times will be reduced by appr. 50 hours per year

Swiss Steel Ag has singed the FAC for the by Primetals Technologies Germany GmbH modernized Electric Arc Furnace.

The production capacity has been increased to 650.000 tons per year, which increases the capacity by approx. %11 compared to prior to modernization. This has been reached by reducing the Tap-to-tap time from 55 to 52 minutes and by reducing the power off times considerably. Furthermore, the energy consumption has been reduced accordingly.

Shaft furnace Modernization at Natsteel, Singapore

Primetals Technologies modernized the finger-shaft electric arc furnace and increased productivity and decreased energy consumption. The new furnace is equipped with a new FAST (furnace advanced slag-free tapping) system, renewed furnace shaft and lower shell, and a state-of-the-art automation system.

In order to increase the productivity of the furnace and even further reduce the specific energy requirement, Primetals Technologies installed new mechanical equipment based on the EAF Quantum solution platform especially developed for electric arc furnaces, and new automation equipment. The main feature of the furnace modernization was the installation of the FAST system, as well as a new anode.

The lower shell of the furnace has also been adapted, and the opportunity will be taken to

automate the plugging of the tap hole.

The FAST system helped to reduce the tap-to-tap time, and so increase productivity by around six percent. At the same time the specific energy input falls by some five kilowatt-hours per ton.

Conclusion

When investing in an EAF expenses for service, maintenance and modernization need to be included in the overall lifecycle cost calculation. There is a wide scope of EAF modernization and revamping solutions to help maintain or even increase the EAF asset value.

The corresponding activities extend over a long period of time and require that a service partner gains a deep understanding of the customer's operation and processes.

Cooperation with a lifecycle partner such as Primetals Technologies Germany GmbH helps to ensure an optimum EAF performance, flexibility and efficiency.

Primetals Technologies, Limited, headquartered in London, United Kingdom, is a worldwide leading engineering, plant-building and lifecycle partner for the metals industry.

The company offers a complete technology, product and service portfolio that includes the integrated electrics, automation and environmental solutions. This covers every step of the iron and steel production chain that extends from the raw materials to the finished product – in addition to the latest rolling solutions for the nonferrous metals sector. Primetals Technologies is a joint venture of Mitsubishi Heavy Industries (MHI) and Siemens.

Mitsubishi-Hitachi Metals Machinery (MHMM) - an MHI consolidated group company with equity participation by Hitachi, Ltd. and IHI Corporation - holds a %51 stake and Siemens a %49 stake in the company.

The company employs around 7,000 employees worldwide. Further information is available on the Internet at www.primetals.com.

Figure 7: NatSteel finger-shaft electric arc furnace modernized in 2013