Sustainable DANIELI DIGIMELTER technology featuring Q-ONE power feeder for lower power and electrode consumption and zero impact on the power grid.

A technological breakthrough in arc melting

MAIN TEXT

SYNOPSIS
The Danieli DIGIMELTER, powered by Q-ONE, represents the available, proven and sustainable solution for new steel plants or for the substitution of Blast Furnaces with Electric Arc Furnaces, to minimize impact on the grid, achieve minimum Operational expenditure for furnace operation, with the possibility of Hybrid feeding with renewable sources, intelligent process controls and safe operation.

Thanks to the unique power control on the arc, Q-One allows for a new approach to melting process, with frequency control and freedom of choice on working points.
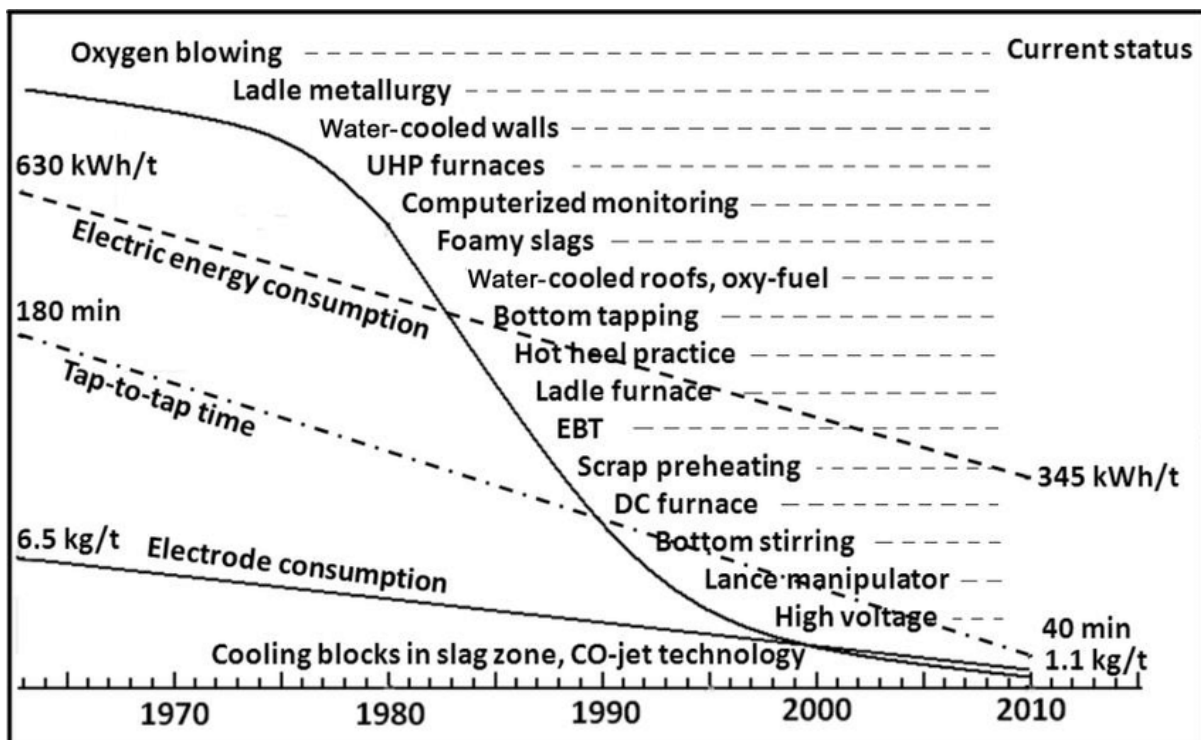
Fig. 1

Electric Arc Furnace technology has seen a continuous evolution in the last 50 years (see fig.1), towards an increased efficiency, with halved electric energy consumption, a tap to tap time which has been reduced down to 4 times, electrodes consumption reduced more than 5 times. These results have been achieved thanks to a combination of chemical packages (oxygen blowing, burners), design improvement (water cooled walls, EBT, lances, bottom stirring) and enhanced process controls.

Another important tendency has been the increased average power for single furnace, which has led to the development of EAF able to produce up to 300t of tap steel.

An electric arc furnace has a strong impact on the electric grid, with consequences on flicker, a phenomena characterized by quick voltage variations that are visible on lamps (with a flickering) and that can affect with malfunctions on power electronics, such as inverters in a rolling mill or similar, but the arc furnace impacts also on harmonic distortion and power factor with possible significative voltage drops, again impacting on all plant auxiliaries, causing even stops of machines.

To reduce such effects on the electric grid, many solutions have been developed to dynamically compensate such disturbances, namely SVC (Static Var Compensator) and Voltage Source Converter SVC. These are high power electronic systems designed to superimpose controlled reactive power to mitigate the impact of furnace disturbances.

The possible solutions for electric power transfer to the arc were the AC furnace and DC furnace. While AC furnace is the most common technology applied, where arc voltage and current are controlled thanks to the positioning of electrodes, DC Furnace uses rectifiers in order to impose the current of the arc, but with some significant implications on furnace design and maintenance.

DC Furnaces reduce flicker generation and improve furnace control but require a different and more expensive mechanical design and a more complex maintenance on furnace shell.

A BREAKTHROUGH TECHNOLOGY

In 2016 DANIELI AUTOMATION installed the first Q-ONE, the first application of power electronics to control arc current and voltage in EAF. In other words, using the conventional furnace design, this solution can impose arc current, with the consequent benefits in process stability and also reducing drastically the impact on the connecting electric network.

In fact, Q-ONE operates with a power factor at medium voltage above 0,96, generates a very low flicker, avoiding use of compensation systems also because harmonic generation is well below IEEE limits.

The system is modular by design, not only the needed power can be adjusted by selecting number of modules, but also the solution can be designed for a progressive growth in stages, meaning that initial power can be increased just adding modules in a second stage.

This modularity is also improving reliability and availability of the system, considering the possibility to produce at reduced power (disabling one module) or even with two phases only instead of three.

Considering the need for high availability, modules have also been designed with same components and inverters, which is minimizing the quantity and value of spare parts. The digital control allows also for remote monitoring and troubleshooting.

The working points are not anymore discrete, dictated by the taps on a transformer, but can be chosen freely according to process needs.

One additional degree of freedom is given by the change of frequency, possible in arc furnaces only with Q_ONE. A frequency higher than network nominal is improving arc stability, therefore is used during boring stage, while a frequency below nominal, down to 20Hz was already tested, is perfect to reduce energy consumption in the refining stage and a deeper penetration of arc in the bath.

FIT FOR HYBRID and for TRANSITION FROM BF to EAF.

Q-ONE fits very well the sustainable approach to steel making, thanks to the possibility to connect the DC Link to renewable energy sources such as photovoltaic but also hydro or wind power.

With hybrid feeding, the opex of a furnace would be further improved, not to mention the reduction of carbon footprint. A software suit, named Q3-JENIUS, has already been designed to manage the different available sources, depending on their cost and availability, with consideration also of forecast energy consumption for the specific products.

Having a very low impact on the grid, the digimelter represents an ideal solution for the decarbonization path, considering new arc furnaces in substitution of Blast Furnaces. In fact, the electric network close to integrated plants was usually not designed for high electric power, required by arc melting, and the impact of traditional transformer EAF solutions on the electric grid is critical. With Q_ONE, even for high power furnaces, in most cases there is no need of any additional compensation system to meet the electric authority requirements.

Furthermore, the modularity of the Q-ONE makes it suitable for the furnace evolution in phases, where liquid steel can be added in high percentage in a first phase, while DRI and scrap will be mainly used, with higher power requirements, in a second stage.

AN INTEGRATED INTELLIGENT SUITE

The unique, reliable and flexible green power solution benefits also of AI applications and advanced control solutions. In fact, DANIELI DigiMelter offers dynamic and automatic dynamic melting profile adjustment, thank to the Q-MELT, designed with the Danieli Intelligent Plant architecture for continuous learning and improvement of the process. Automatic scrap yard management, with connection to melting process control for accurate and consistent working points set up and quality assignment. To conclude, the control pulpit is ergonomically designed to integrate human expertise and machine precision to achieve unique performances and superior quality with best cost strategy.

Most important, these results are achieved with a no-man-on-the-floor philosophy, powered by the advanced automation and the adoption of robots in the field to perform dangerous and repetitive operations, to achieve safe operation in steelmaking.

CONCLUSION

The Danieli DIGIMELTER, powered by Q-ONE, represents the best available solution for the substitution of Blast Furnaces with Electric Arc Furnaces of 250 t and more, to minimise impact on the grid, achieve minimum Opex for furnace operation, with Hybrid feeding, intelligent process controls and safe operation, in other words, to be a step ahead.