tenova

TENOVA *i*EAF® TECHNOLOGY

A Roadmap to Sustainable Long-Term Savings for EAF Steelmaking

TENOVA. INNOVATIVE SOLUTIONS FOR METALS AND MINING

tenova

Tenova is a worldwide partner for innovative, reliable and sustainable solutions in the metals and mining industries.
Building upon decades of experience, Tenova develops solutions that help mining and metals companies reduce costs, save energy, limit environmental impact and improve working conditions for their employees.

Tenova believes in on-the-job passion, and actively seek out professionals who truly love what they do. Their contributions to the business have helped make Tenova the industry-leading company it is today, and their passion is the driver behind the company business approach.
This approach can be summed up in four key pillars: Innovation, Reliability, Sustainability and Safety.

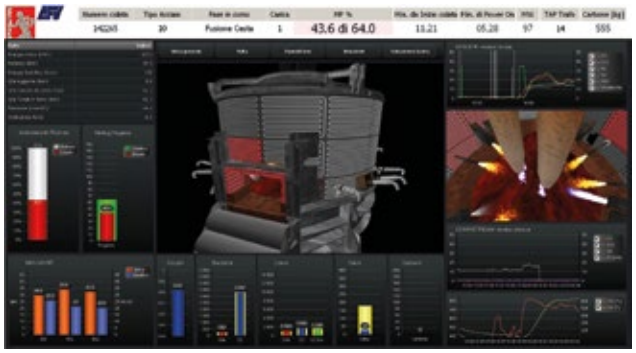
Tenova Melt Shops Business Line is a leader in the design and supply of EAF equipment for crude steel production. The Tenova Melt Shops Business Line heritage embraces historical brands like Tagliaferri Electric Arc Furnaces and innovative technologies like the Consteel® continuous scrap feeding and pre-heating system and EFSOP® NextGen off-gas dynamic control system. Tenova Melt Shops Business Line projects range from complete new melt shops to customized technological upgrades and revamps for existing production units. Its success is built largely on innovative technology, flexibility in meeting customer requirements and timely project execution. For Tenova Melt Shops Business Line , energy savings and effective environmental management are the keys to sustainable development and growth for its customers.

Tenova's innovative "intelligent Electric Arc Furnace", trademarked *i* EAF® is a progressive, modular technology package designed to provide EAF steelmakers with sustainable long-term savings from dynamic control and holistic optimization of the EAF process.

i EAF® enabling technology can be applied to all variations of the EAF process including:

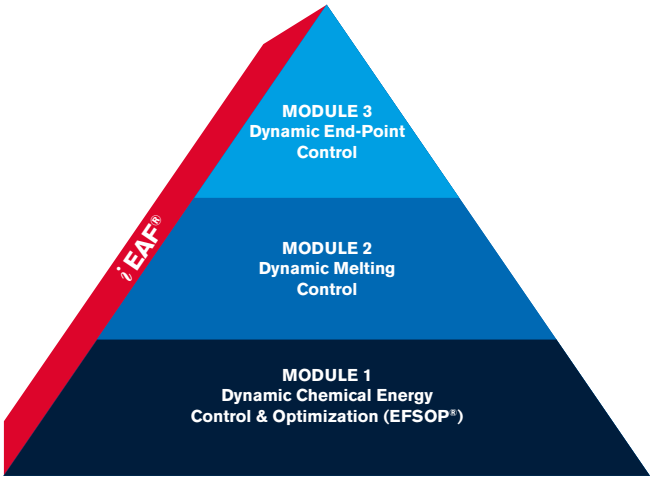
- top charge melting furnaces (bucket and/or shaft) using scrap, DRI and/or pig iron;
- the Consteel® process (i Consteel®) with or without hot metal;
- continuous DRI fed furnaces (i DRI®).

While the basic structure remains constant, the automation hardware, software and communication modules can be customized
according to the individual customer's existing automation system and network.



iEAF® main HMI screen

The off-gas analyser probe location of the EFSOP® NextGen system on the fume duct



MAIN BENEFITS

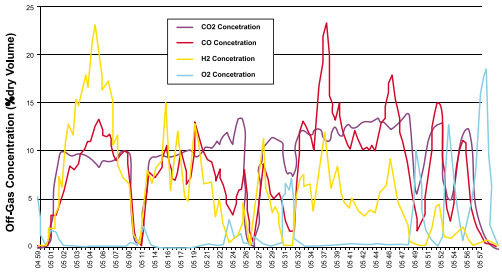
- Dynamic Control & Optimization of the Melting & Refining Process
- Electrical Energy Savings
- Fuel Savings
- Reduced Power On Time
- Increased Yield
- Reduced Tap Additions
- Electrode, Delta & Refractory Savings
- Reduced Tap-to-Tap Time
- Reduced Emissions

TENOVA *i*EAF® TECHNOLOGY

The *i*EAF® technology package with well-defined Modules allows EAF melt shops to improve process control, reduce energy consumption & operating costs, increase productivity and lower emissions in a progressive stepwise fashion. Each sequential step in the *i*EAF® program utilizes a combination of real-time measurements, dynamic process inputs and on-line process models.
While the *i*EAF® can be easily integrated with any existing automation and process control system, the cornerstone and necessary first step in the *i*EAF® technology program is EFSOP® NextGen off-gas analysis; other off-gas analysis methods which cannot provide complete analysis of CO, CO2, H2 and O2 lack a necessary prerequisite for determining an online Mass & Energy Balance which is critical for efficient energy utilization and effective dynamic control of the melting and refining processes.

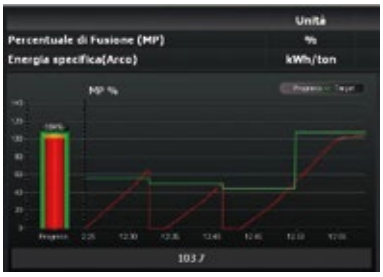
MODULE 1

Dynamic Chemical Energy Control & Optimization is based on the proven EFSOP® NextGen technology for continuous off-gas analysis with guaranteed optimal "In-EAF" chemical energy utilizatio



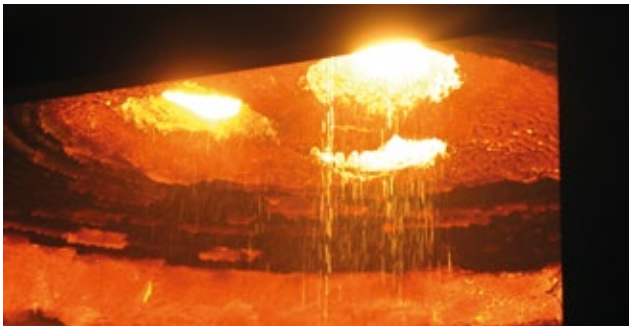
MODULE 2

Dynamic Melting Control utilizes novel sensors combined with on-line process models to pace the EAF operation



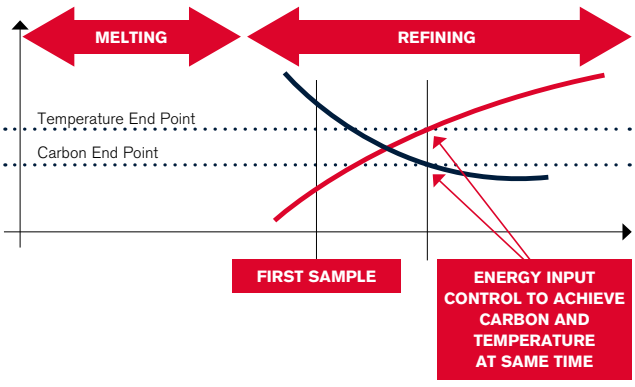
OPTIONAL STAND-ALONE SPECIALIZED TECHNOLOGIES

A full package of Tenova stand-alone technologies can be implemented in the iEAF® to enhance the furnace performances



MODULE 2

Dynamic End-Point Control determines the optimal strategy to reach the end-point conditions in terms of liquid steel temperature and carbon content



MODULE 1 - DYNAMIC CHEMICAL ENERGY CONTROL & OPTIMIZATION (EFSOP® NextGen)

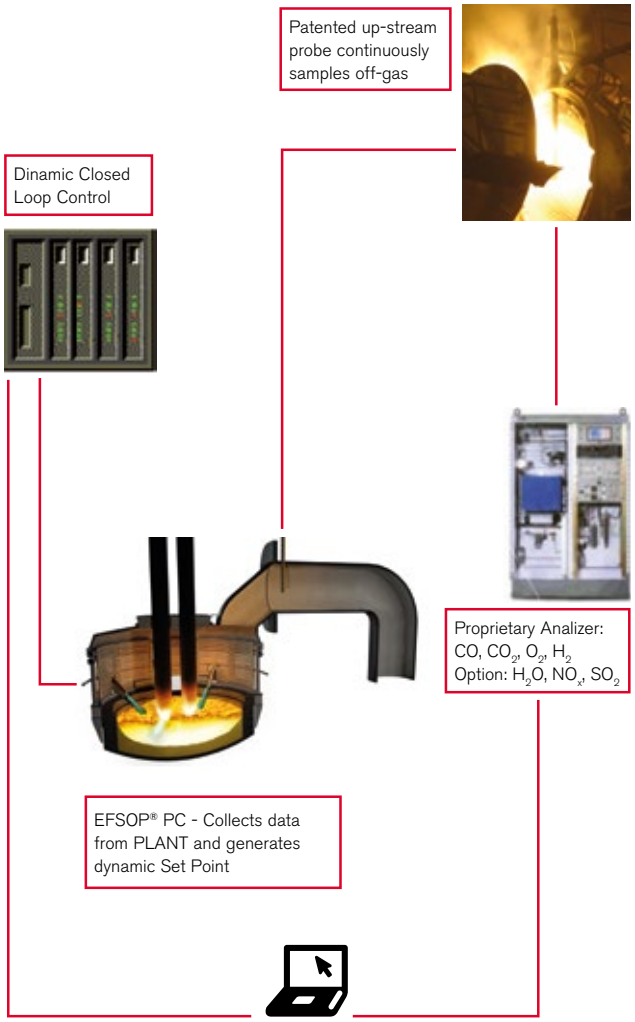
The *i* EAF® Chemical Energy Control & Optimization module is based on proven EFSOP® NextGen off-gas analysis to dynamically control and optimize chemical energy inputs. The module is used to:

- Optimize burners, lances and injectors.
- Lock-in the optimized practice with a proven closed loop control methodology fully integrated with the plant automation system.

The fume system can also be dynamically controlled using full EFSOP® NextGen off-gas analysis to avoid over- or under-drafting conditions. Dynamic control of the furnace atmosphere ensures a slightly reducing atmosphere, which not only maximizes overall energy efficiency but also minimizes yield loss, electrode consumption and refractory wear, exacerbated when the freeboard is over oxidizing.

BENEFITS

- Reduced operating costs
- Reduced carbon, oxygen, methane & electrical energy consumption
- Reduced electrode & refractory consumption
- Increased productivity
- Increased yield
- Reduced emissions



MODULE 2 - DYNAMIC MELTING CONTROL

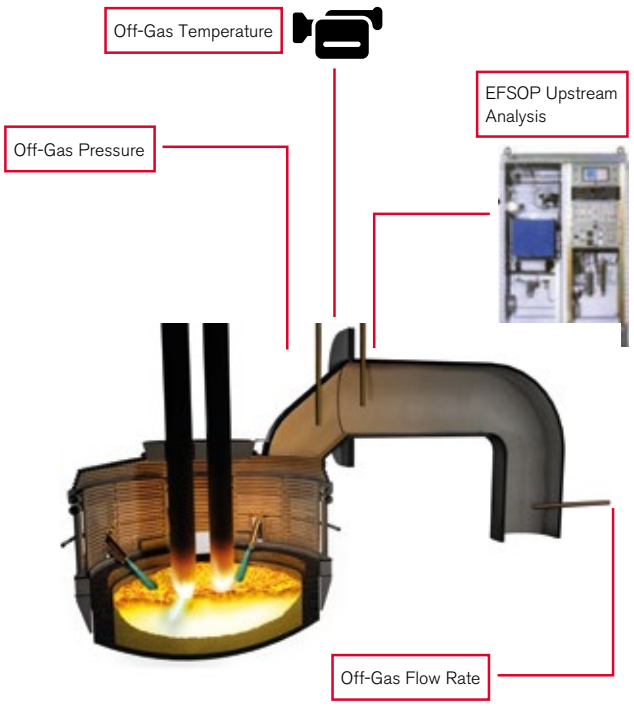
The *i*EAF® Dynamic Melting Control module is based on a set of novel sensors combined with real time mathematical models for mass energy balance, in order to pace the EAF according to the Net Energy Input. Novel sensors include:

- Off-gas temperature/pressure/flow-rate measurements.
- Slag and liquid weight measurement or calculation.

In other words, heat control is based on real-time calculation of the melting percentage, rather than on the traditional kWh per ton method. With this approach, *i*EAF® Dynamic Melting Control is a ground-breaking innovation in the pacing of EAF operations.

BENEFITS

- Further reduction in total energy consumption
- Reduced Power On Time
- Correct timing for bucket charging
- Precise onset of fl at bath condition



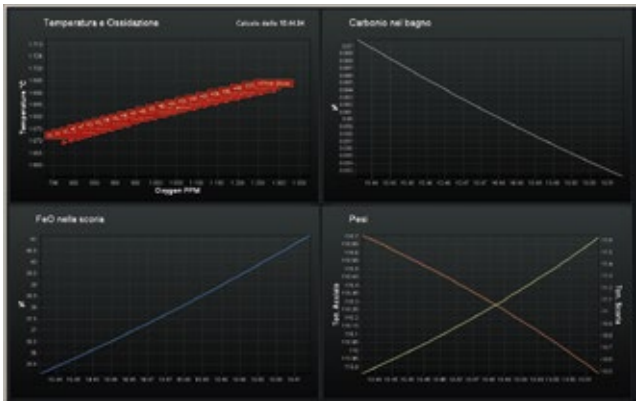
MODULE 3 - DYNAMIC END-POINT CONTROL

The *i*EAF® Dynamic End-Point Control module facilitates dynamic control of the refining process, thereby allowing endpoint temperature and carbon conditions to be reached in a dynamically optimized way. The module uses data from the novel sensors combined with Bath & Slag process control models to:

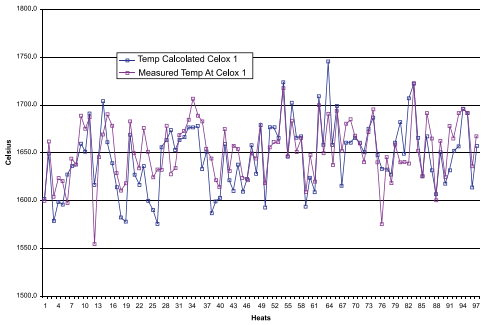
- Dynamically monitor and evaluate various refining scenarios, including different Natural Gas, O2, C, Lime Injection & Electrical Power profiles.
- Dynamically optimize the refining path by selecting the optimum chemical and electrical profiles.
- Determine when the end-point condition (temperature & carbon content) is reached.

BENEFITS

- Increased productivity
- Reduced tap alloy addition
- Increased yield
- Reduced Power On Time
- Reduced process variability



End-point control HMI

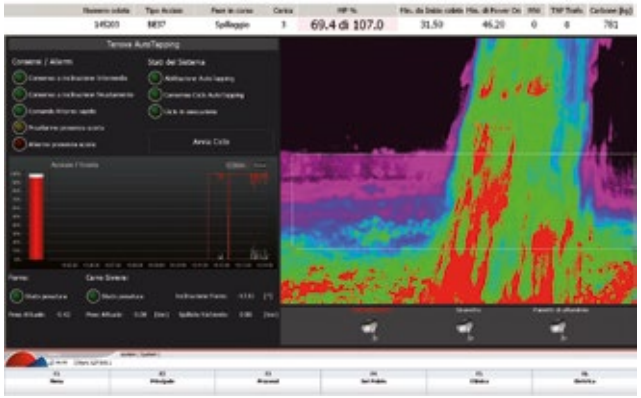


Comparison between calculated and measured temperature

OPTIONAL STAND-ALONE SPECIALIZED TECHNOLOGIES

For greater competitive advantage, integration of Tenova's innovative stand-alone technologies enhances *i*EAF® operational efficiency and safety. Optional stand-alone technologies include:

- **Water Detection Technology.** This technology is specifically tailored to each specific EAF characteristic (furnace dimension, cooling flow-rate, charge scrap) and operating requirements. Importantly, *i*EAF® Water Detection is the only technology capable of detecting both H2O and H2. Even though it is not a certified safety device, *i*EAF® Water Detection significantly enhances EAF safety. *i*EAF® Water Detection Technology is also self-adapting to changing process conditions, including changes in ambient weather and scrap conditions.
- ***i*TEMP®**, a worldwide patented system for no-contact liquid steel temperature measurement.
- **TAT** (Tenova Auto Tapping), an automatic remote system for slag free tapping and EBT cleaning and refilling.
- **TDR-H** (Tenova Electrode Digital Regulation).
- **KT system** (Tenova chemical injection system).
- **MHS** (Material Handling and Scrap Data Acquisition system).



TAT HMI

*i*TEMP® HMI

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