Tenova is a worldwide supplier of advanced technologies, products and engineering services for the iron & steel and mining industries. Its innovative integrated solutions combine process automation and metallurgical know-how to enhance the value delivered to the customers. At the same time, Tenova is committed to develop its technology in the areas of greatest significance for the future of the industries it serves: product quality, energy saving and environmental sustainability.

tenova
GOODFELLOW

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GOODFELLOW

Tenova Goodfellow is the Tenova Melt Shops' Center of Excellence for process control technology. As the world leader in real-time off-gas process control, Tenova Goodfellow provides the highest quality and most technologically advanced industrial equipment and process control technology for the markets it serves. Through R&D partnerships with government, universities and industry leaders, Tenova Goodfellow works at the cutting edge in developing next-generation optimization control strategies.

SLOP CONTROL
Lance Vibration Sensors
for advanced warning of a slop

END-POINT CONTROL
EFSOP®, Temperature,
Flow & Pressure Sensors
for accurate end-point detection

AUTO TAPPING CONTROL
Advanced Image Analysis for safe
automated tapping control

POST COMBUSTION CONTROL
EFSOP® & Dual Flow Lance
for maximum energy
utilization & productivity

*i*BOF® TECHNOLOGY

***i*BOF®** is a breakthrough technology designed to reduce GHG emissions while improving yield, productivity and scrap-melting capability and cutting operating costs. ***i*BOF®** technology delivers unprecedented value and an unparalleled level of customized control by employing a combination of reliable off-gas analysis, novel sensors and process models linked by a comprehensive automation system.

***i*BOF®** is a modular solution available as a unified package or as standalone systems designed to meet specific customer needs.

*i*BOF® BRINGS PROVEN BENEFITS SUCH AS:

- Reduced Tap Alloys

- Reduced Consumables

- Increased Productivity

- Increased Yield

- Reduced GHG Emissions

- Improved Safety

- Reduced Maintenance & Repair
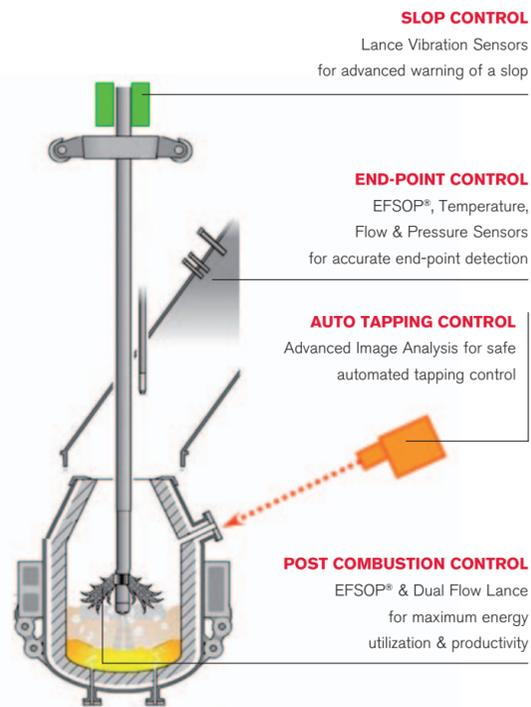
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TECHINT GROUP

Tenova *i*BOF® Technology

The innovative modular solution
for BOF steelmaking optimization

TENOVA is a worldwide supplier of advanced technologies, products and engineering services for the iron & steel and mining industries.

iBOF® TECHNOLOGY

*i*BOF® is a modular technology, available either as an integrated technology package or as independent standalone modules to meet the specific needs of each melt shop.

The technology consists of:

■ Module 1, Improved End-Point Detection to reduce conversion costs, improve yield and increase productivity, without costly sub-lance technology;

■ Module 2, Intelligent Slopping Detection System to warn operators in advance of an impending slop to increase productivity and yield;

■ Module 3, Optimized Post-Combustion to increase productivity from enhanced scrap melting;

■ Module 4, Auto-Tapping Control to improve safety and minimize slag carry-over and tap alloy additions.

*i*BOF® technology employs key sensors and comprehensive process models to predict slag & bath chemistry and temperature from start to end of blow, for accurate end-point determination.
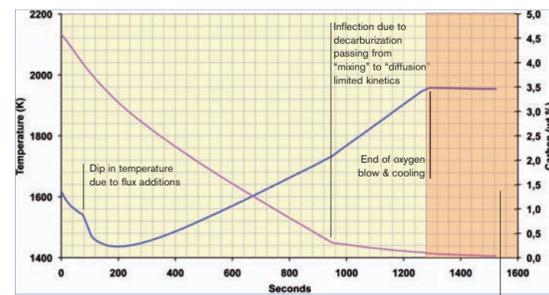
— Temperature (K)
— Carbon Concentration (wt%)
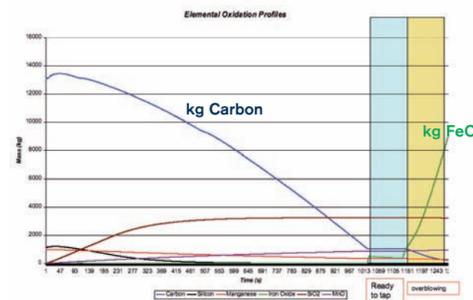
Effect of the overblowing with respect to liquid steel oxidation with consequent decrease of the yield

EFSOP Off-Gas Analysis Probe
Off-Gas Flow Sensor
Off-Gas Temperature
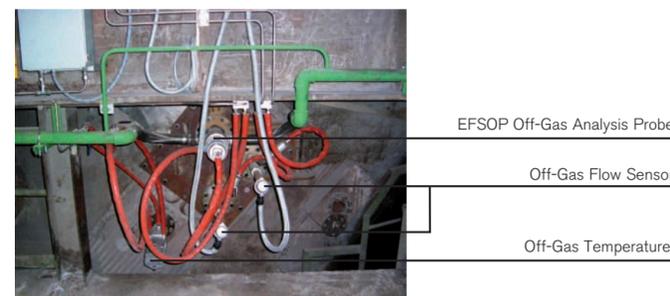
A typical installation of the novel sensors on the fume duct.
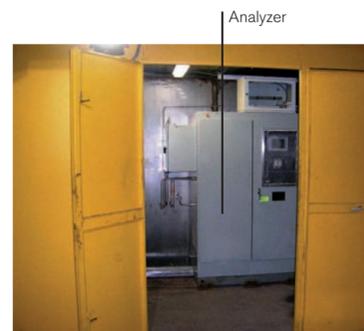
Analyzer

Analyzer room installation.

MODULE 1: END-POINT DETECTION

*i*BOF® End-Point Detection technology is based on industry-proven EFSOP® off-gas analysis, proprietary off-gas sensors to measure temperature, flow and pressure, and BOF process control models designed to enable "**Blow & Tap**" practice without the additional cost and delays associated with Sub-Lance technology.

Thanks to its innovative features, *i*BOF®:

■ predicts slag & bath chemistry and temperature from start of blowing;

■ alerts operators of the correct time to drop in-blow Celox;

■ alerts operators when to pull the lance based on aim Carbon & Temperature.
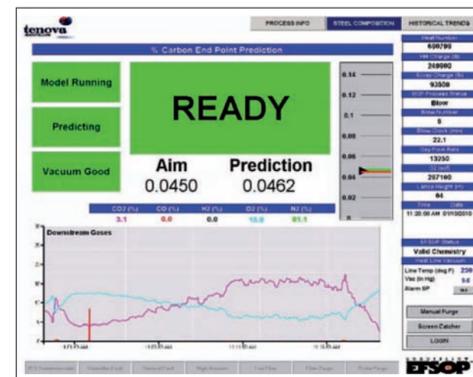
*i*BOF® operator screen for comprehensive process control

iBOF® End-Point Control Steel Plant Verified Benefits

Factor	Benefit
End-point C, 90% of heats	± 0.010%
End-point C, 97% of heats	± 0.015%
End-point Temperature	± 12 C
Catch Carbon, reduction in standard deviation	60%
SAVINGS	
Oxygen, saving	0.7%
Ladle Carbon, saving	2.7%
Tap Ferro Alloys, saving	1.6%
Tap Aluminum, saving	4.0%

MODULE 2: INTELLIGENT SLOPPING DETECTION SYSTEM (ISDS)

*i*BOF® slop-detection technology uses lance vibration analysis with real-time alerts to give operators advance warning of the onset of a slop and a measurement of slop severity. The system is designed to provide direct feedback control of lance position and oxygen flow rate, for rapid mitigation of the effects of a slop.

Vibration Sensors installed on Oxygen Lance
✓ A measure of slop severity
✓ Advanced warning of the onset of a slop

*i*BOF® Intelligent Slopping Detection System main screen.
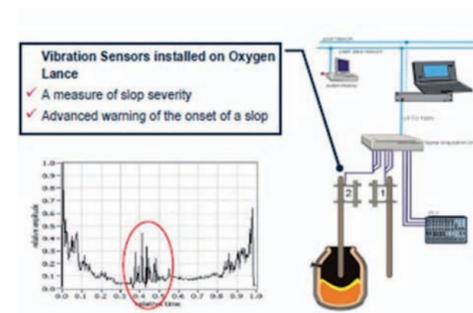
ISDS schematic configuration and slopping on set visualization.

iBOF® Slop Detection Steel Plant Verified Benefits

Detection Capability	> 95% slop events detected
Advance Warning	20 − 40 seconds

MODULE 3: OPTIMIZED POST-COMBUSTION

*i*BOF® post-combustion uses EFSOP® off-gas analysis together with temperature, flow and pressure sensors and a dual-flow lance with independent control of primary and secondary oxygen to control secondary oxygen flow-rate, penetration and timing. The result is optimal post-combustion efficiency and scrap-melting capability with minimal refractory or lance wear.
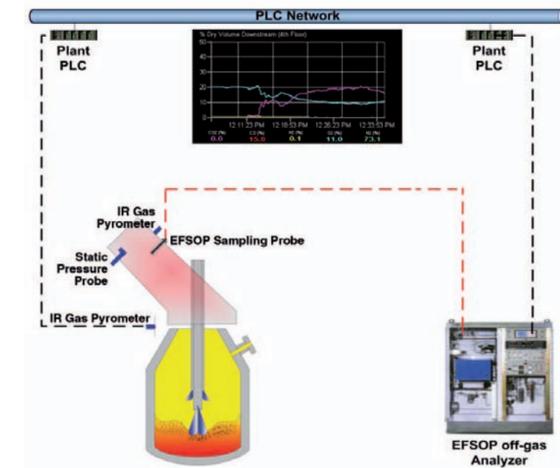
With typical BOF blowing practice, 85%-90% of gas exiting the converter remains as uncombusted CO. This CO represents a significant amount of process energy, since full combustion of C to CO_2 generates 3.5 times more heat than partial combustion to CO. Controlled injection of secondary O_2 above the lance tip promotes in-converter combustion of CO to CO_2, providing additional energy for higher productivity from increased scrap melting.

iBOF® Post-Combustion Benefits

■ 3 - 6% increase in scrap melting

■ Slop mitigation from slag reheating

■ Reduced lance and mouth skulls

MODULE 4: AUTOMATIC TAPPING CONTROL

*i*BOF® auto-tapping technology employs advanced image analysis together with process models to control tapping practice, in either an operator-assist mode or a fully automatic mode.
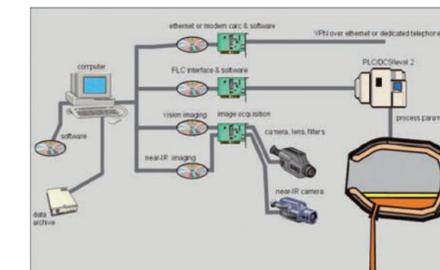
*i*BOF® tapping control: schematic configuration.

Typical installation of the *i*BOF® tapping camera.
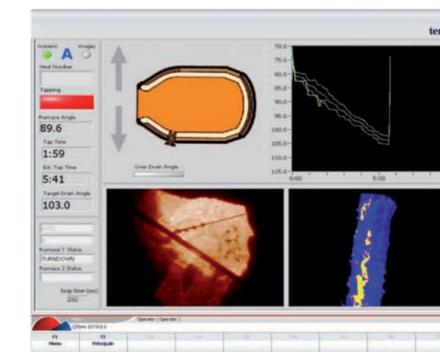
*i*BOF® tapping control main screen.

iBOF® Auto-Tapping Benefits

■ Decreased tap time and variability

■ Reduced slag carry-over

■ Reduced ferroalloy and aluminum consumption

■ Up to 0.5% increase in yield

■ Improved operator safety