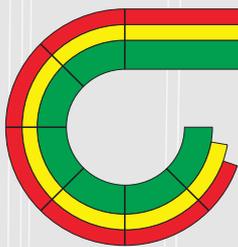


Refractory Monitoring Solutions



Saveway®

makes you more productive and safe

SAVEWAY

**Your qualified partner for furnace safety
and lining diagnostics**



Established in 1991 in Germany, Saveway is an international company and specializes in measuring and safety technologies. We manufacture and distribute diagnostic systems for refractory linings and other components of melting, holding and treatment equipment. Our company has forged a reputation of providing each customer with knowledge about how their particular practices influence lining life, resulting in more efficient operations and optimal safety. Global service is ensured by our internationally operating subsidiary companies and distribution partners.

Based on our long term experience we develop customized solutions even for very specific applications. The close cooperation with our customers, with universities and professional associations is an important component in turning innovative ideas into practical solutions.

What began as a degree dissertation at the Technical University in Ilmenau/Germany, has become an industry-wide standard for safety.

Imprint

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Find your solution here:

Measurement of remaining lining thickness during operation

SAVEWAY[®] 04

Comprehensive measurement of hot spots and wear monitoring

SAVELINE[®] 08

Extensive or selective temperature measurement

OPTISAVE 12

Drying measurement and leakage monitoring

SAVEDRY[®] 18

Selective monitoring of coil shunt insulation

SAVESEARCH[®] 22

Professional long term support

SERVICE 26

Voices of satisfied customers worldwide

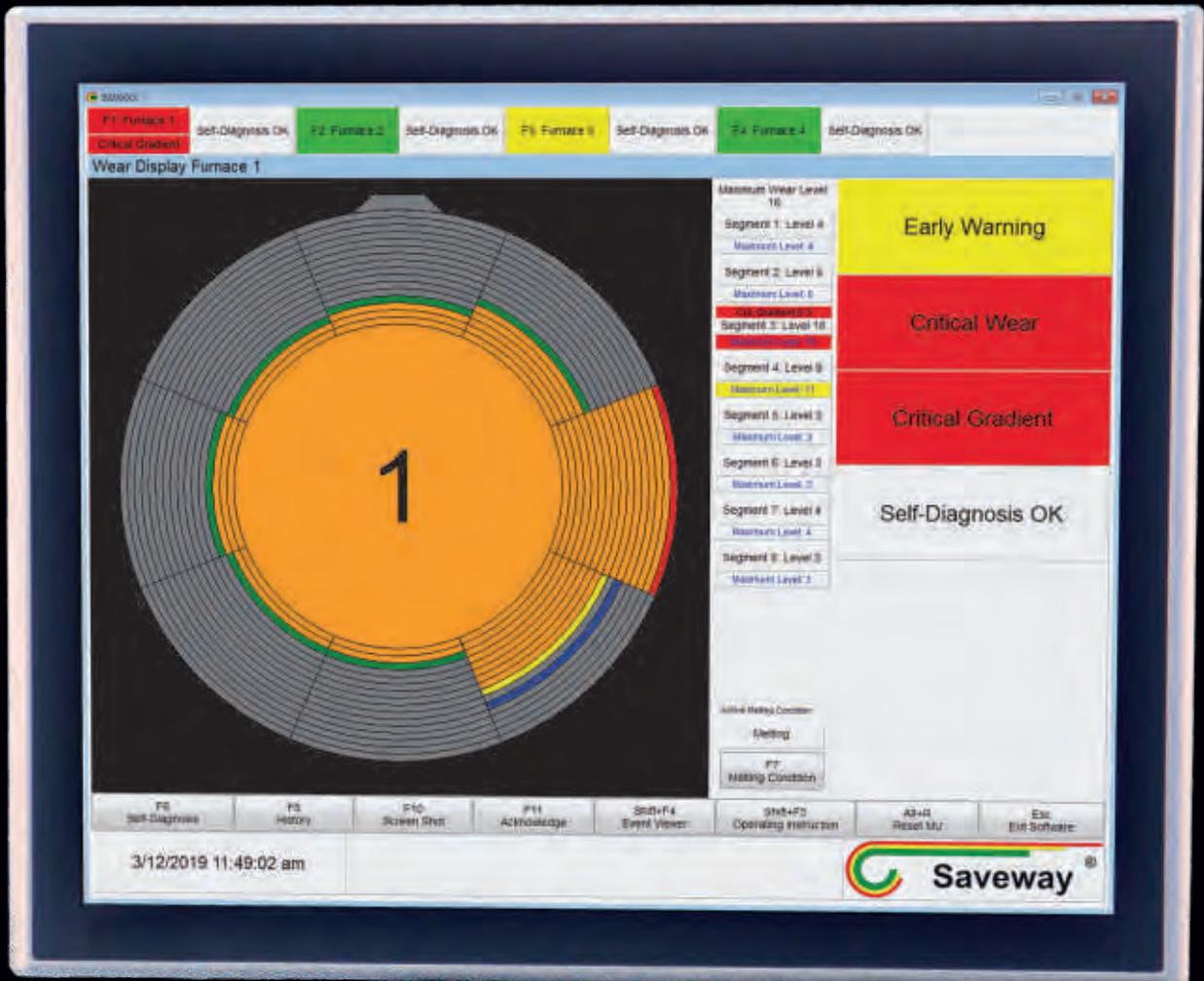
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Arguments which assure customers

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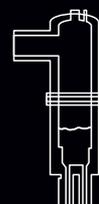
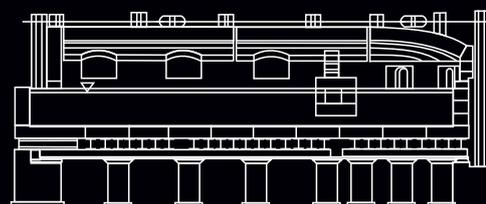
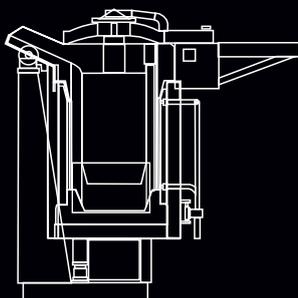
SAVEWAY® SYSTEM

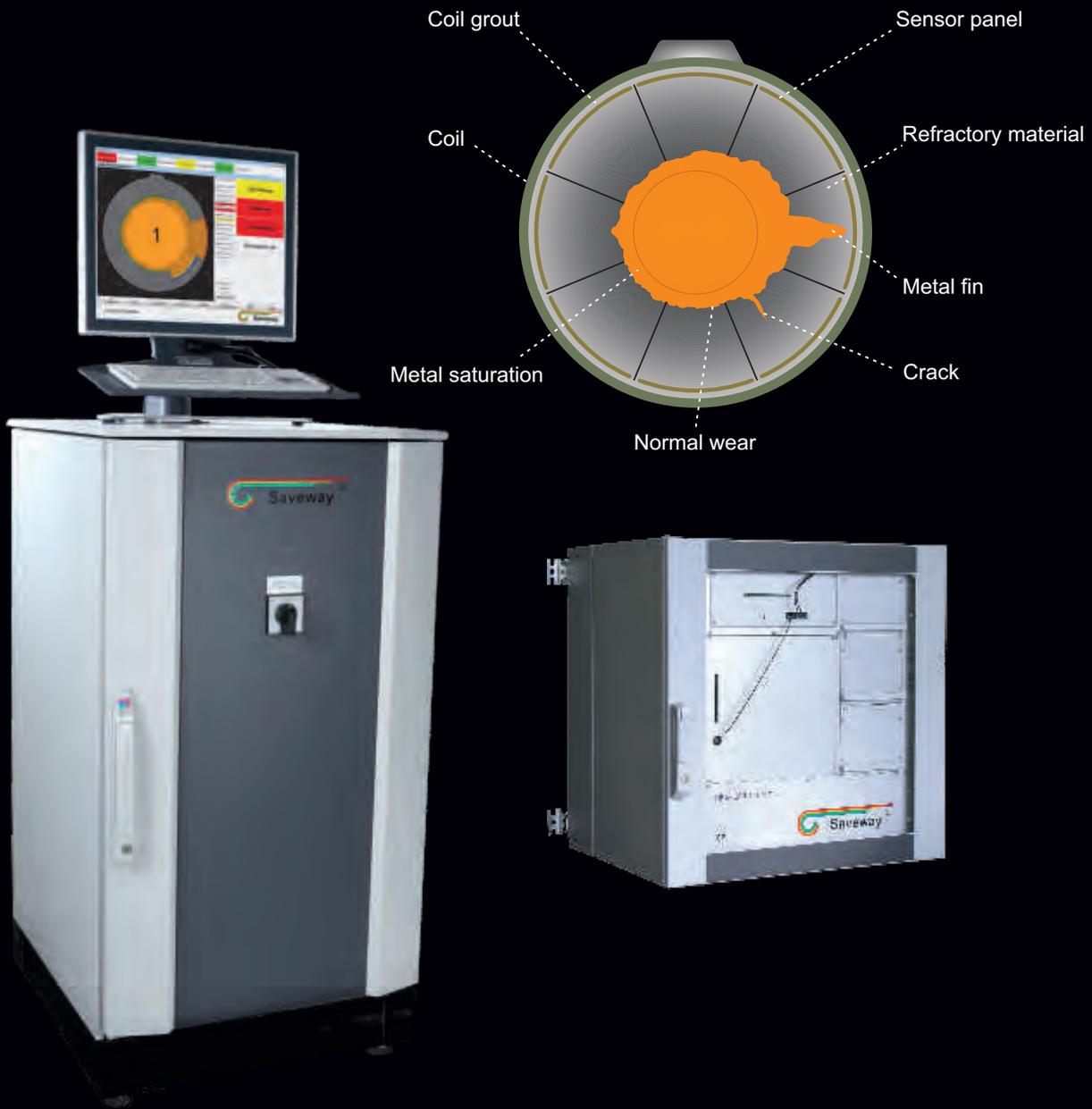
▶▶ The only system in the world which provides a measurement of the remaining lining thickness during the operation. ◀◀



Measurement of Remaining Lining Thickness

Coreless induction furnaces | Glass melting tanks |
RH degassers

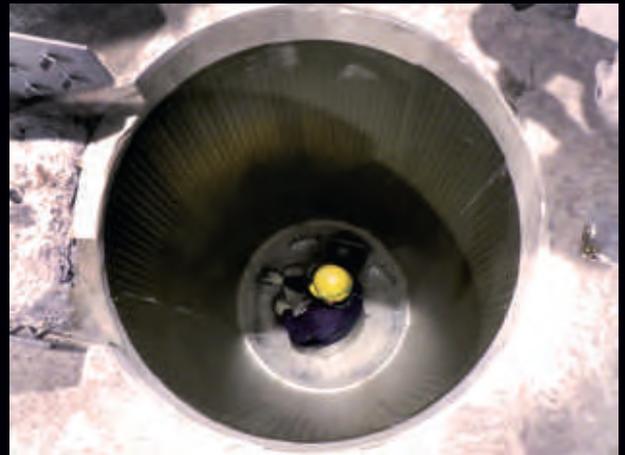
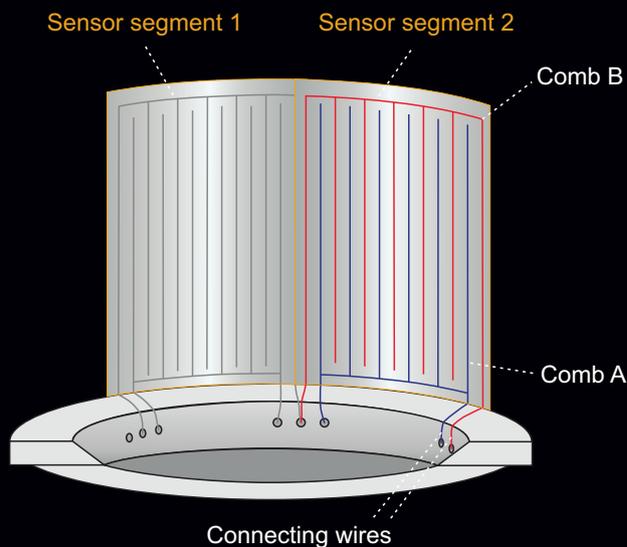




- Continuous measurement of refractory wall thickness during furnace operation
- Display accuracy: 1/16 of initial wall thickness
- Localization of wear
- Reliable indication of smallest metal fins and saturations
- Reliable indication of drying condition and cooling water leakages
- Detection of overheating caused by bridging

SAVEWAY[®] SYSTEM

Continuous measurement using sensor panels



Sensor panels installed in a coreless induction furnace

Basic technical information:

- Furnace monitored based on sensor segments
- Lining thickness is divided into 16 levels
- **Green:** Levels 1 - 8
- **Yellow:** Levels 9 - 14 **Early warning**
- **Red:** Levels 15 - 16 **Critical wear**
- Allows for optimization of furnace operation
- Risk-free extension of refractory life



Metal fin

Special applications:



RH degasser

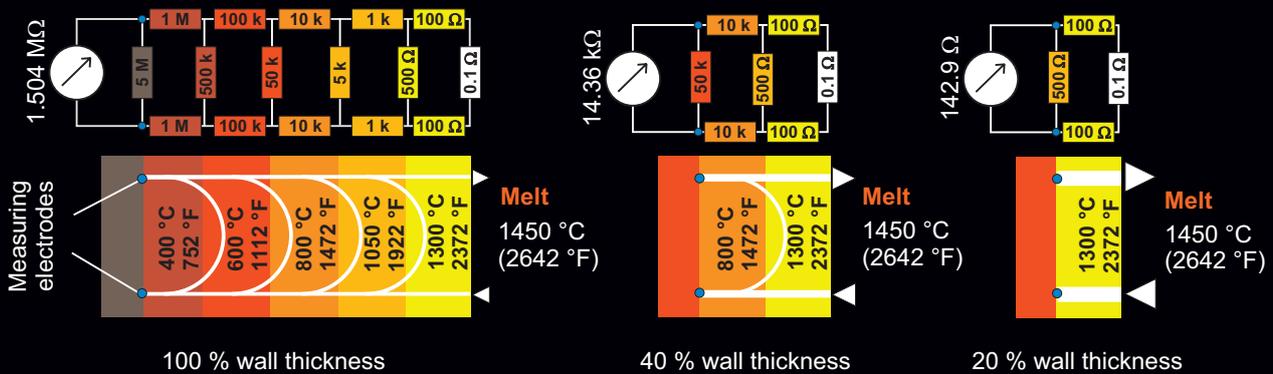


Submerged arc furnace



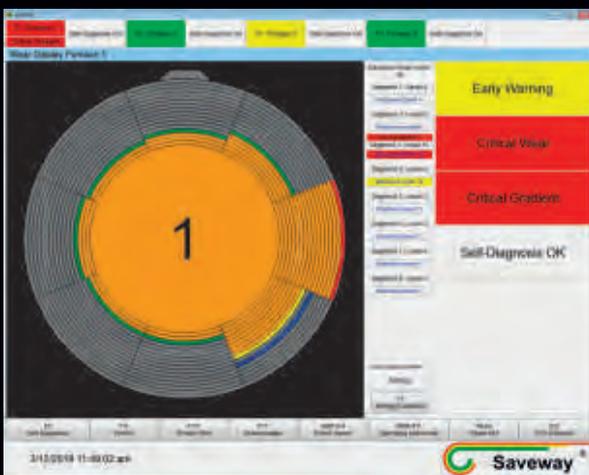
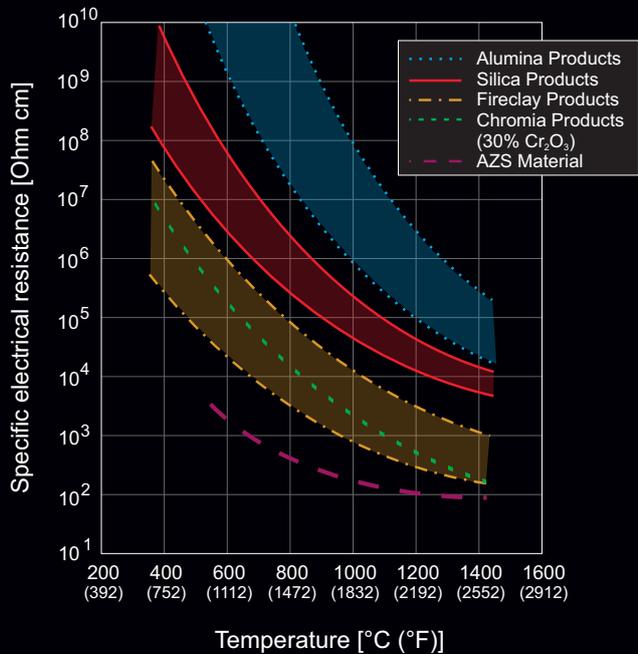
Glass melting tank

Operating principle & display

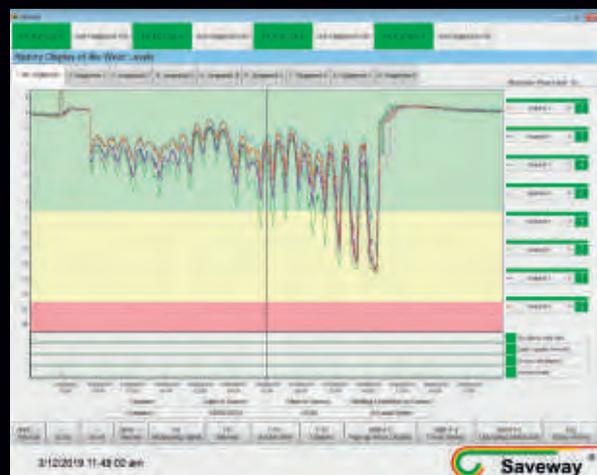


Principle flow of measuring current: electrode – melt - electrode

- Refractory material measured by sensor panels, displaying remaining wall thickness
- Measurement dependent on the decrease in electrical resistance of refractory material with increase in temperature
- As wear develops, molten metal penetrates towards the sensors and the temperature of the adjacent refractory material rises

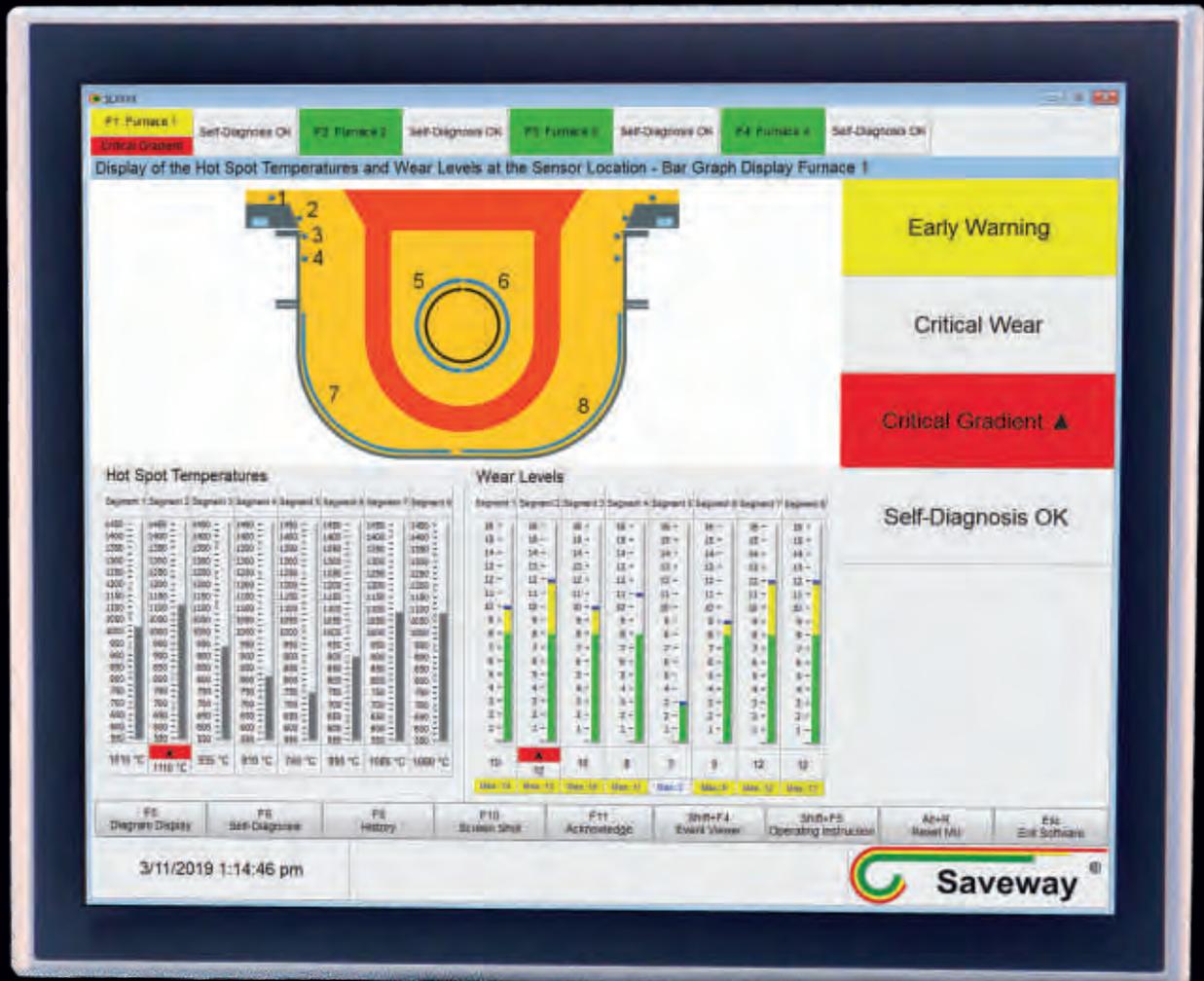


Operator's main display



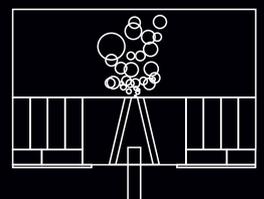
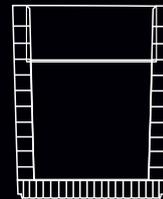
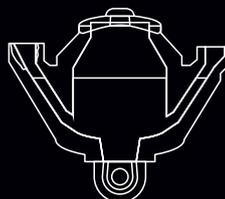
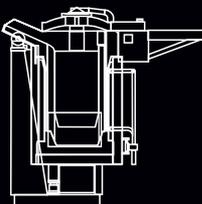
History display

SAVELINE[®] SYSTEM



Comprehensive Measurement of Hot Spots and Wear Monitoring

Channel and coreless induction furnaces | Porous plugs | Ladles | Arc furnaces | Cupolas | Smelting furnaces

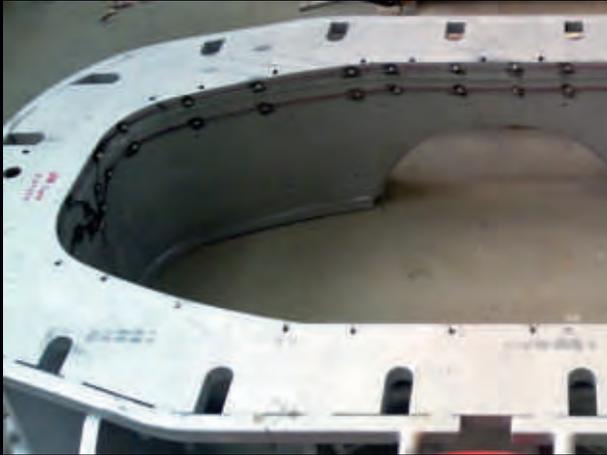




- Comprehensive temperature monitoring of refractory linings and components during furnace operation
- Calculation of remaining lining thickness
- Always measuring the highest temperature of a sensor segment
- Localization of wear by placement of multiple sensors
- Reliable measurement in electrically conductive linings
- Measuring range of sensors 100 °C - 1350 °C (212 °F - 2462 °F)

SAVELINE[®] SYSTEM

Comprehensive measurement of hot spots
and wear monitoring



Upper inductor case / flange



Bushing



Porous plug



Ladle furnace

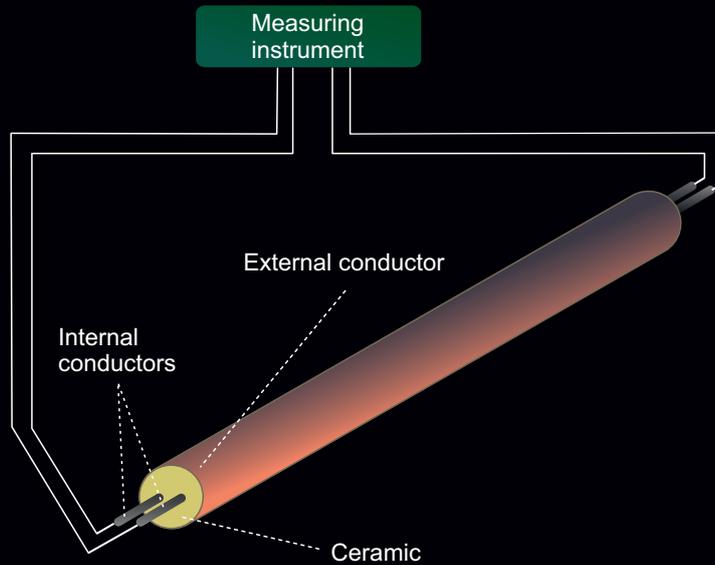


Drum furnace



Floor monitoring / Push out block monitoring

Operating principle & display

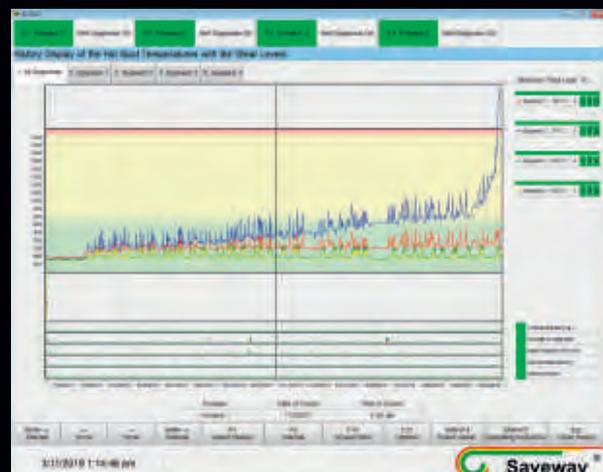


SAVELINE® sensor, Ø 3 - 6 mm (1/10 " - 1/4 "), length variable

- The system uses linear sensors to measure the temperature
- Temperature rise will decrease electrical resistance of the ceramic filling
- Temperature measurement over its entire length, always the highest temperature is indicated
- Remaining wall thickness calculated from temperature and thermal conductivity of lining

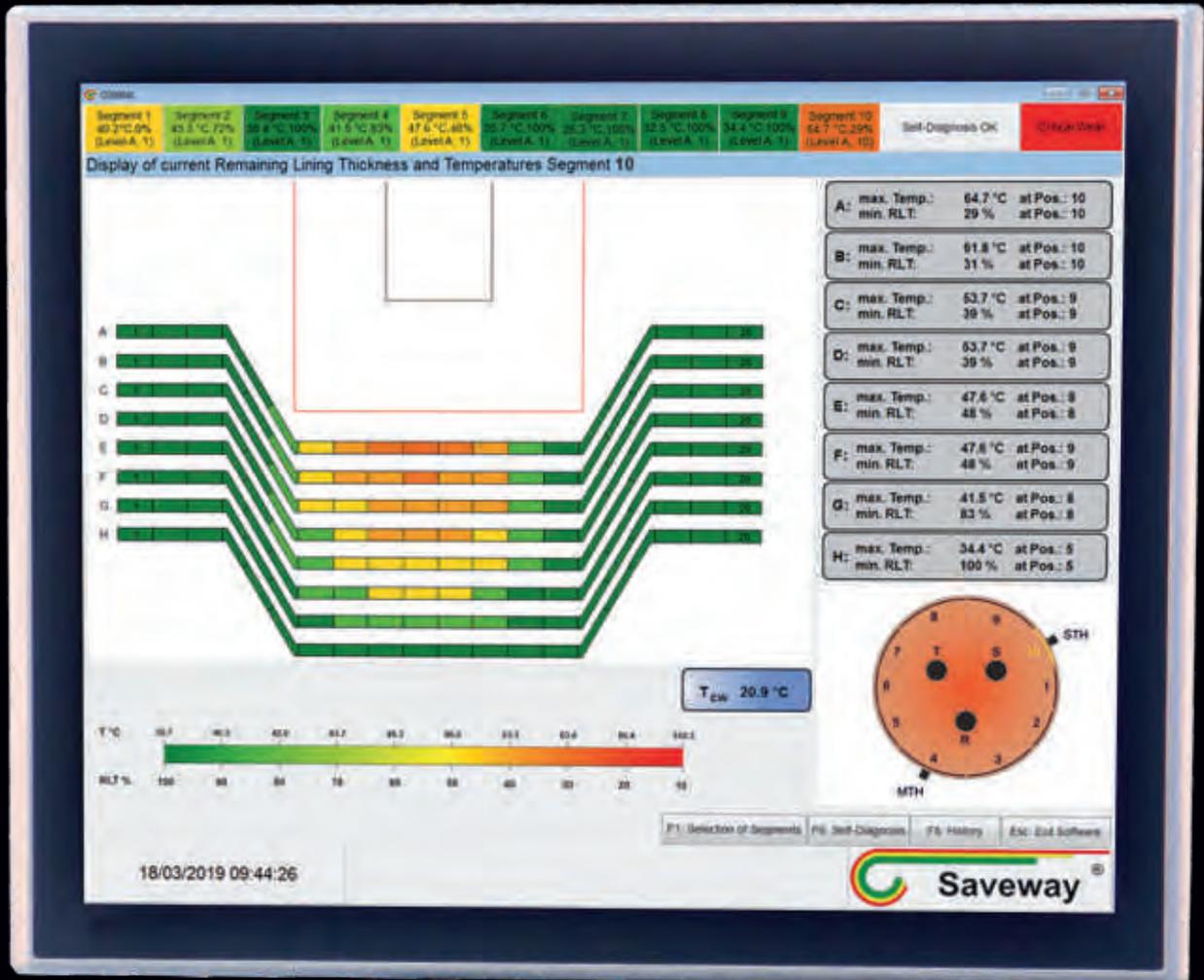


Operator's main display



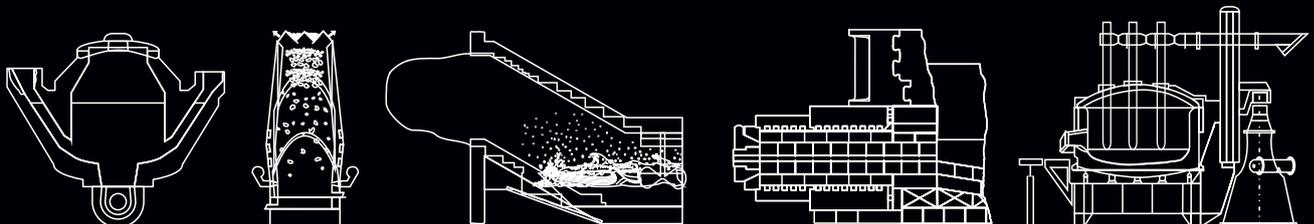
History display

OPTISAVE SYSTEMS



Temperature measurement & determination of lining thickness

Multiple furnaces | Water-cooled components and surfaces



OPTISAVE F SYSTEM

Comprehensive temperature measurement & determination of remaining lining thickness

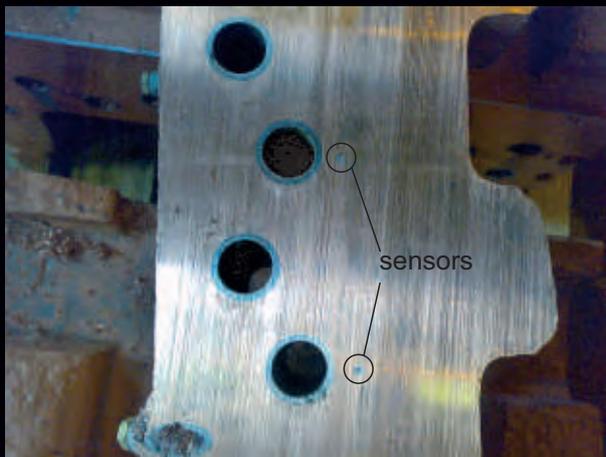
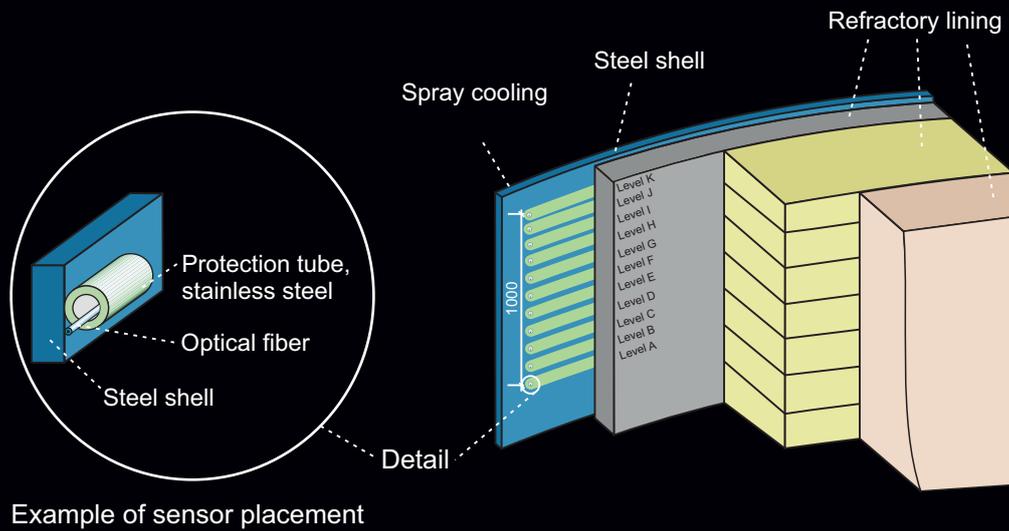


OPTISAVE

- Continuous extensive temperature measurement up to 600 °C (1112 °F)
- Local resolution: 0,25 m (9,8")
- Maximum 8 sensors with sensor lengths up to 2000 m (1,24 miles)
- Up to 8000 temperature values per sensor
- Insensitive to electrical and magnetic fields
- Calculation of remaining wall thickness

OPTISAVE F SYSTEM

Comprehensive temperature measurement & determination of remaining lining thickness



Cross section of a worn out water cooled wall panel with embedded OPTISAVE sensors

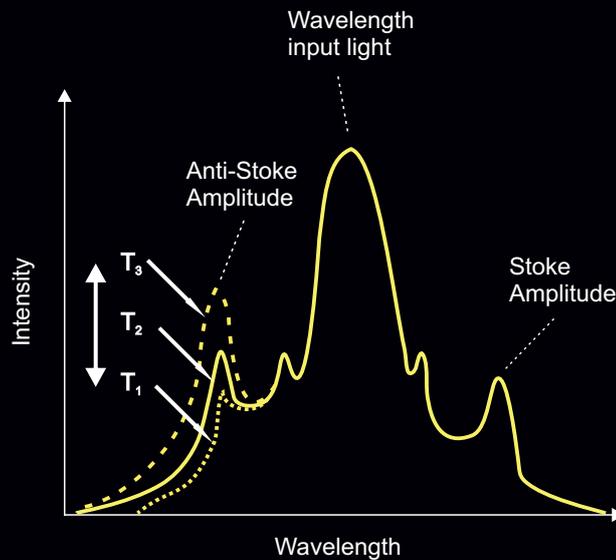
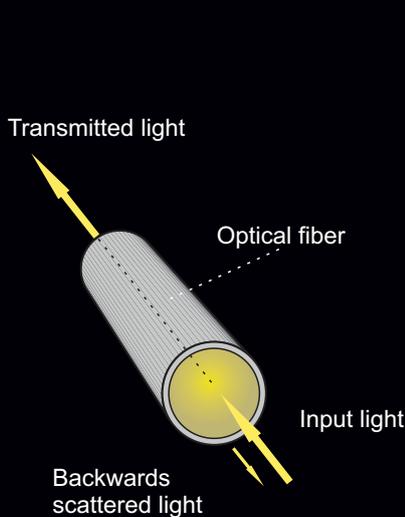


OPTISAVE installation on the inside of a water-cooled submerged arc furnace



Sensor installation on the cooling water system of a copper block before casting

Operating principle & display



OPTISAVE

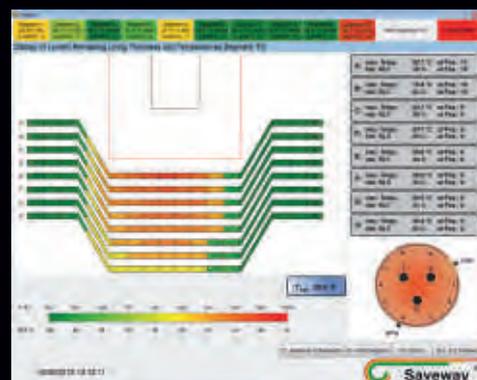
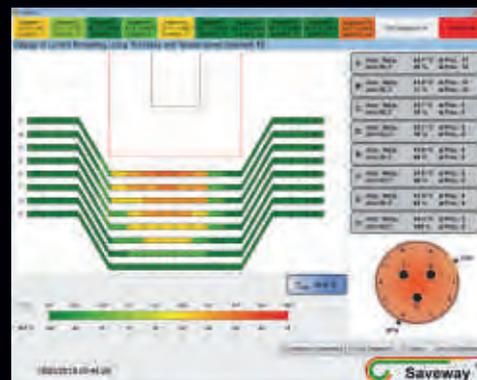
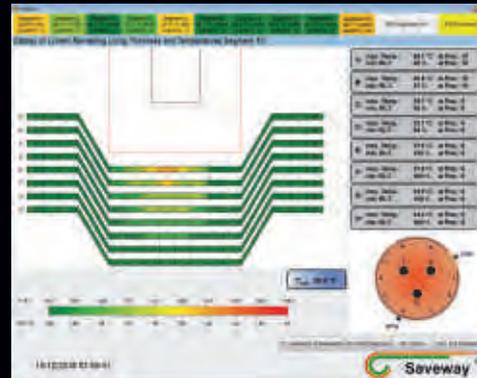
Determination of temperature by Raman effect

$$T \sim I_A / I_S$$

T ... Temperature
 I_A ... Intensity Anti-Stoke Amplitude
 I_S ... Intensity Stoke Amplitude

Principle of fiber-optic temperature measurement

- Uses the Raman effect to determine the temperature
- Light will be transmitted through the optical fiber
- The backwards scattered light will be analyzed
- Temperature distribution over the fiber length is determined by the run time of the backward scattered light
- the average temperature of each 250 mm long fiber section is displayed
- Runtime of the light determines location of temperature spots



Developing of the hot spot beneath the taphole area over 6 months

OPTISAVE G SYSTEM

Local spot measurement

Specification:

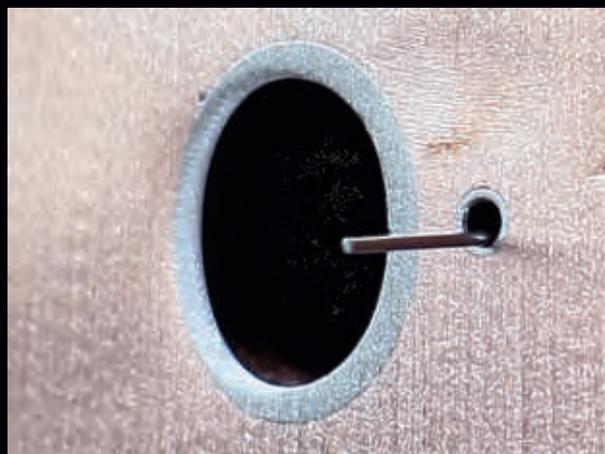
- Continuous temperature measurement up to 650 °C (1202 °F)
- Up to 20 sensor points/gratings per fiber, distance freely selectable/customized
- Maximum 8 sensors per system
- High measurement accuracy, temperature resolution 0.1 K



Water cooled copper module of a slag tap hole with integrated OPTISAVE sensors

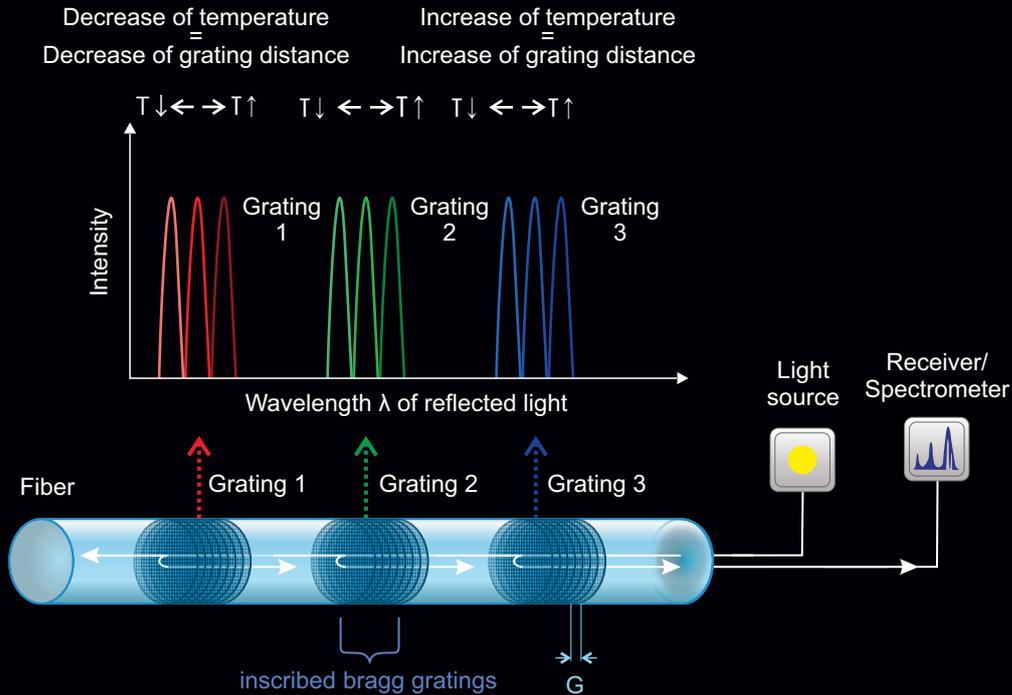


Tap hole block in place

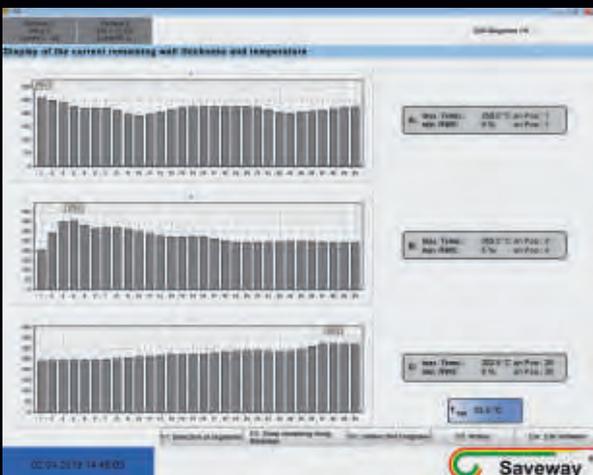


Embedded OPTISAVE sensor

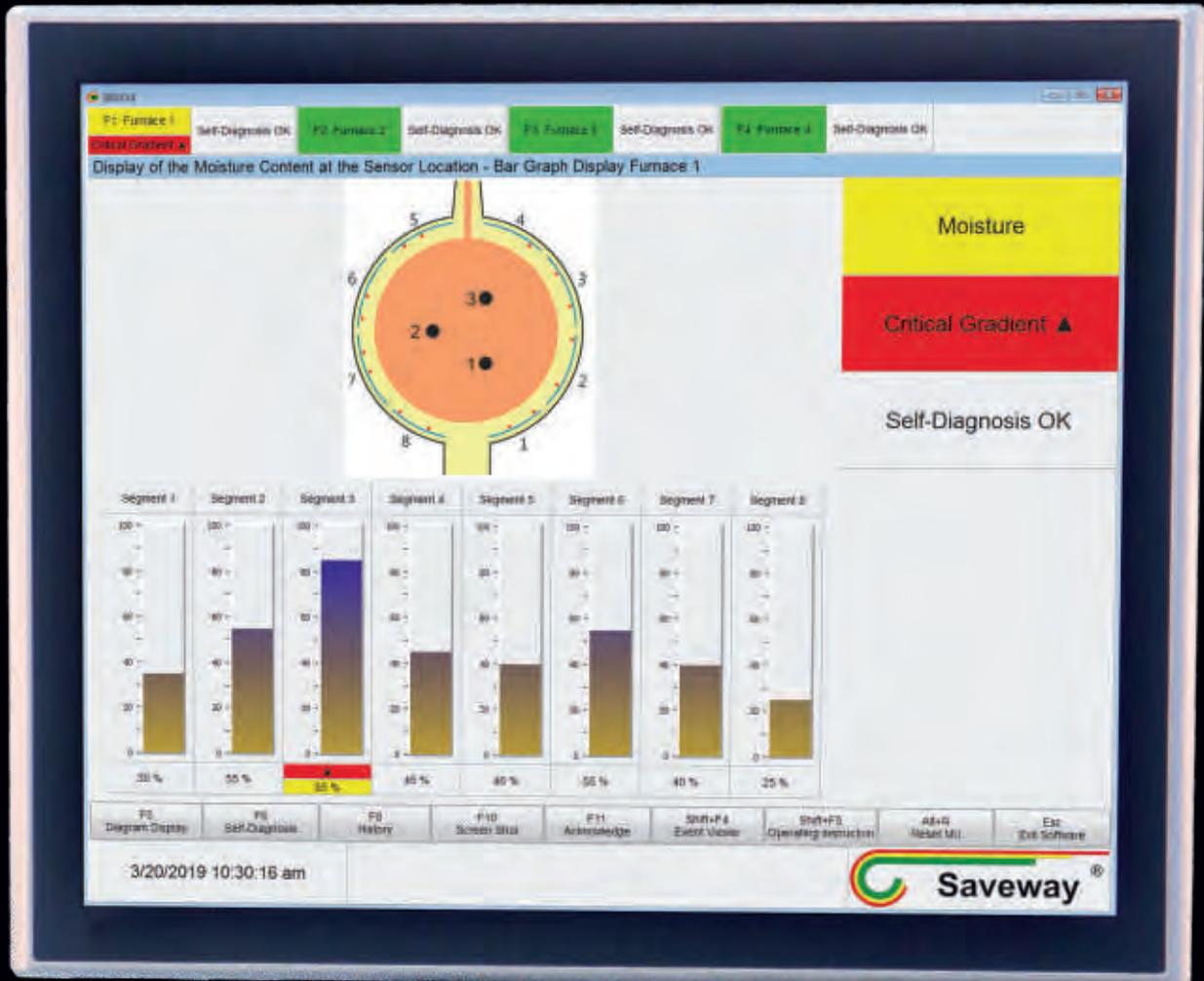
Operating principle & display



- Layers of different refractive indices are inscribed into the fiber (gratings)
- Every grating reflects the light with the wavelength of the grating distance (G)
- Different grating distances allow a multiplex measurement with one fiber
- If the temperature of the fiber is increasing the grating distance will increase (thermal expansion)
- Consequently the wavelength of the reflected light will change
- The change will be measured by a spectrometer and transformed to temperature

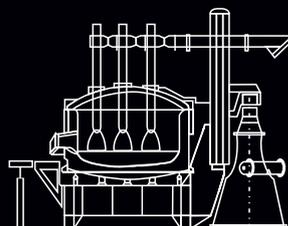
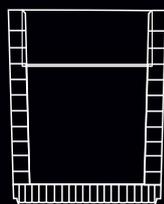


SAVEDRY® SYSTEM



Drying Measurement and Leakage Monitoring

EAF | Multiple furnaces | Water cooled furnace components





- Continuous measurement of moisture content in refractory linings
- Reliable detection of cooling water leakages
- Localization of moisture problems
- Reliable display of drying condition
- Monitoring of furnaces during relining, sinter heat and regular operations

SAVEDRY[®] SYSTEM

Drying measurement and leakage monitoring



Changeable SAVEDRY[®] sensor type 4



Heat shield of graphitisation furnace, sensor type 1



Submerged arc furnace, sensor type 3

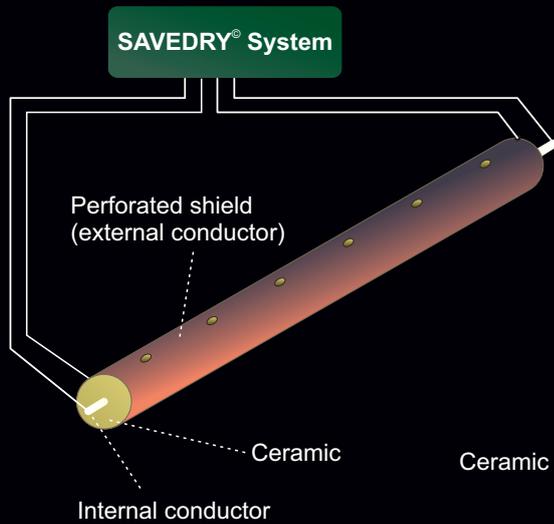


Submerged arc furnace, sensor type 4

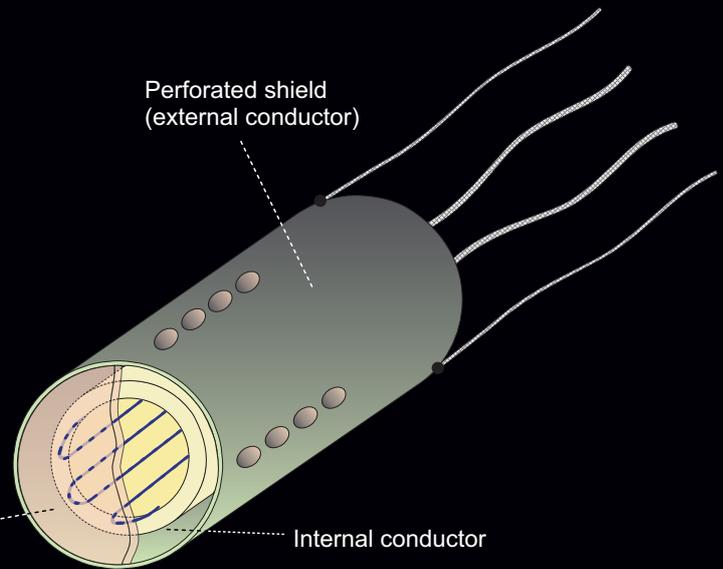


Electric arc furnace, sensor type 4

Operating principle & display

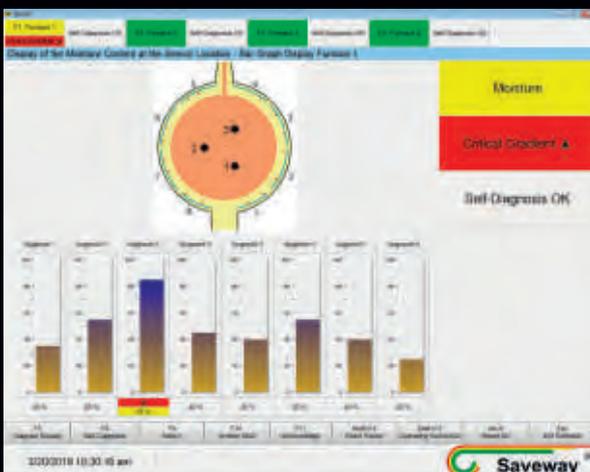


SAVEDRY® sensor type 1,
 \varnothing 2,6 - 6 mm (8,5' - 19,7 '), length variable



SAVEDRY® sensor type 4

- Materials such as salts and oxides separate in water becoming free moving ions
- Ions are conductive
- The higher the water content in the sensor, the higher the electrical conductivity
- The sensors measure the conductivity and the system determines the content of moisture
- Sensors are placed on refractory or furnace wall. Depending on sensors they can be replaced during relining or retrofitted during furnace operation

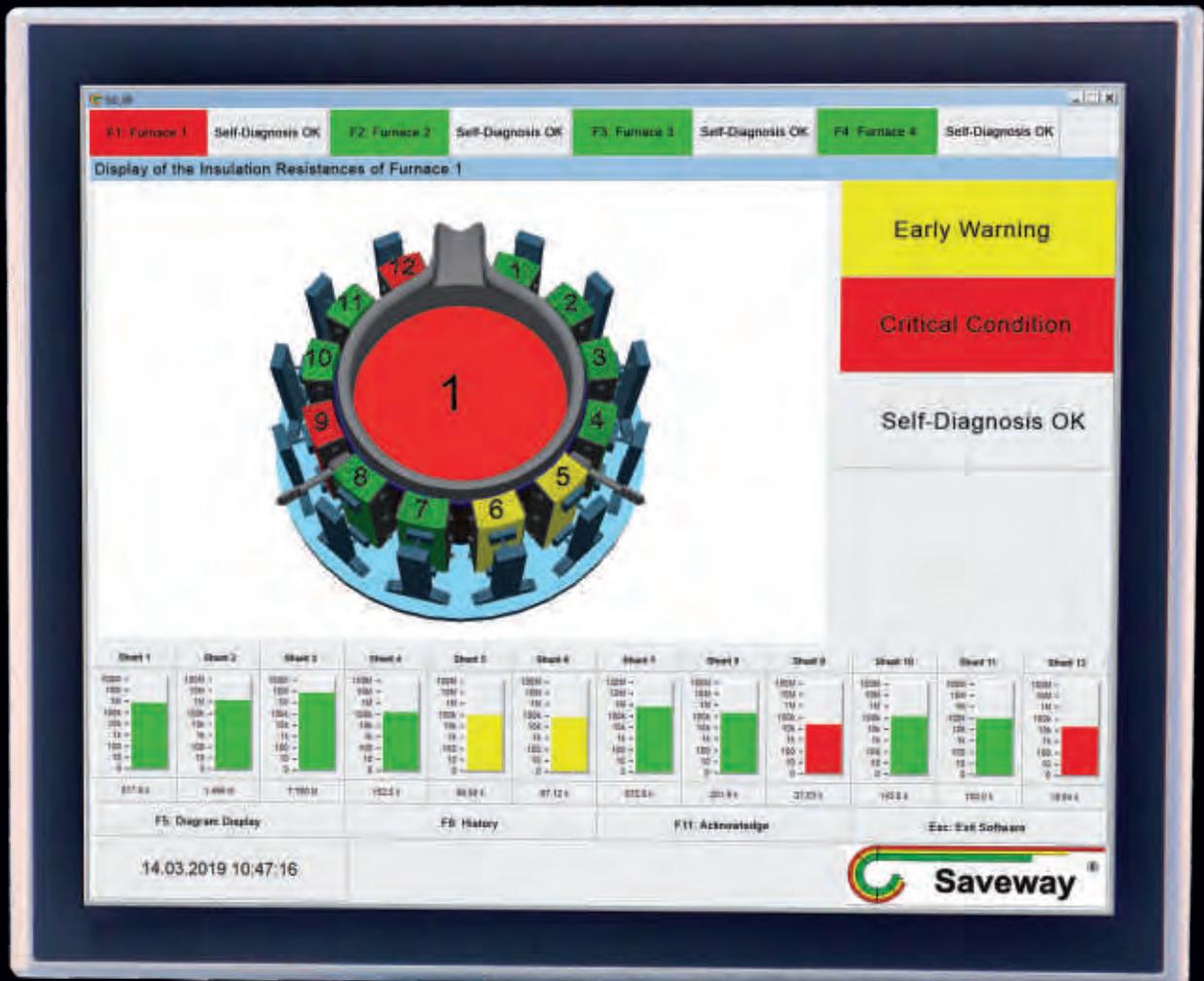


Operator's main display



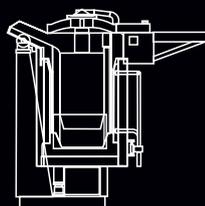
History display

SAVESEARCH[®] SYSTEM



Selective Shunt Monitoring

Coreless induction furnace

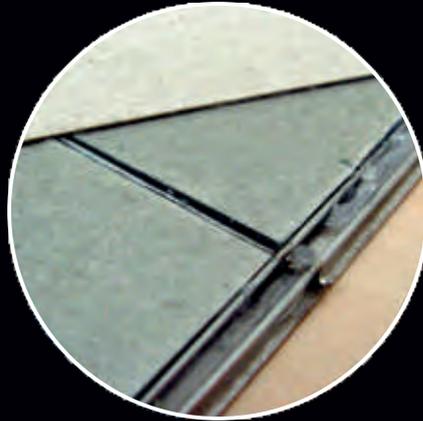




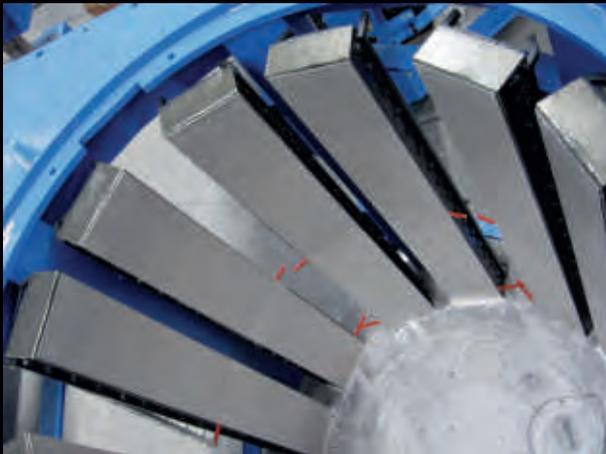
- Preventive maintenance tool for coreless induction furnaces
- Detection of developing insulation faults
- Separate monitoring of each shunt
- Clear localization of insulation faults
- Significantly higher ohmic measurement range compared to ground leakage indicator
- Moisture detection in the insulation structure

SAVESEARCH[®] SYSTEM

Selective monitoring of coil-shunt-insulation



Structure of a SAVESEARCH[®] electrode



SAVESEARCH[®] electrodes in a 12 t furnace

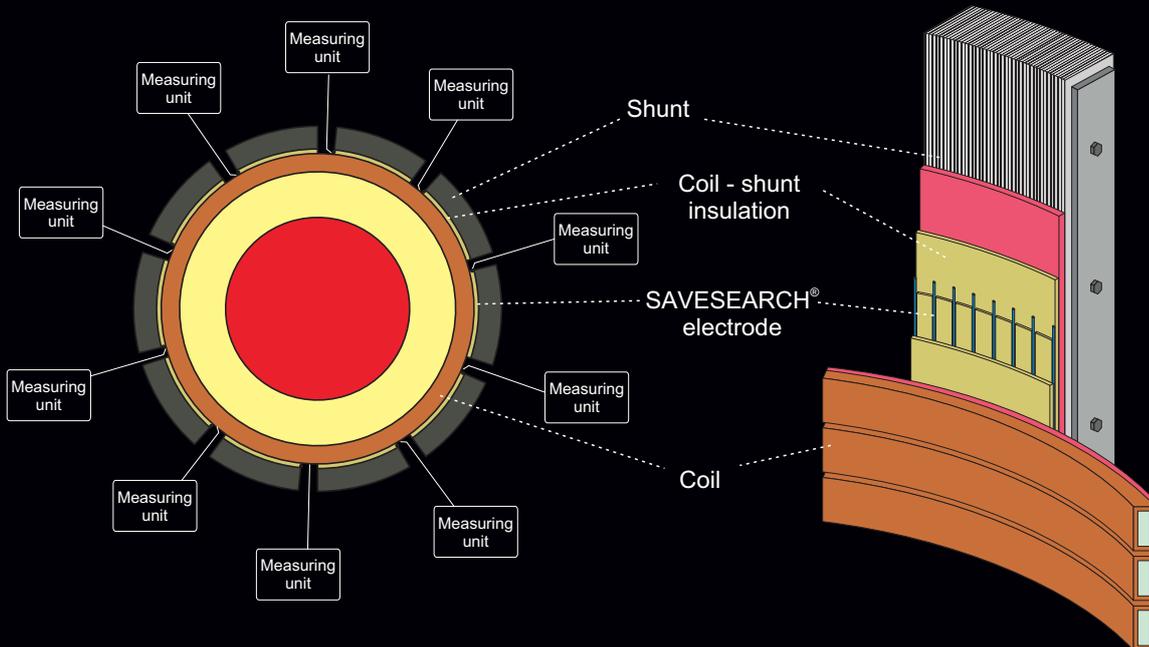


Detail of SAVESEARCH[®] electrodes in a vacuum furnace



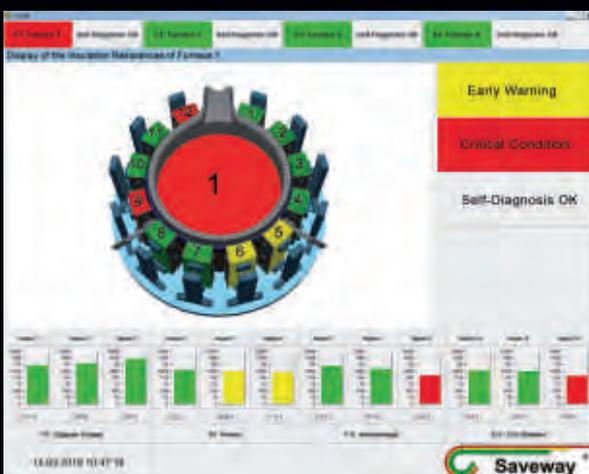
Electrical connections of the SAVESEARCH[®] electrodes on a 10 t furnace

Operating principle & display



Replacement of the standard shunt insulation by SAVESEARCH[®] electrode

- Sensor electrodes are embedded in the coil-shunt insulation without weakening the regular isolation strength
- Measures isolation resistance between ground isolated sensor and coil
- Electrical insulation condition of each shunt is monitored separately
- System is able to measure much higher resistances than the ground leakage indicator



Operator's main display



History display

Saveway SERVICE

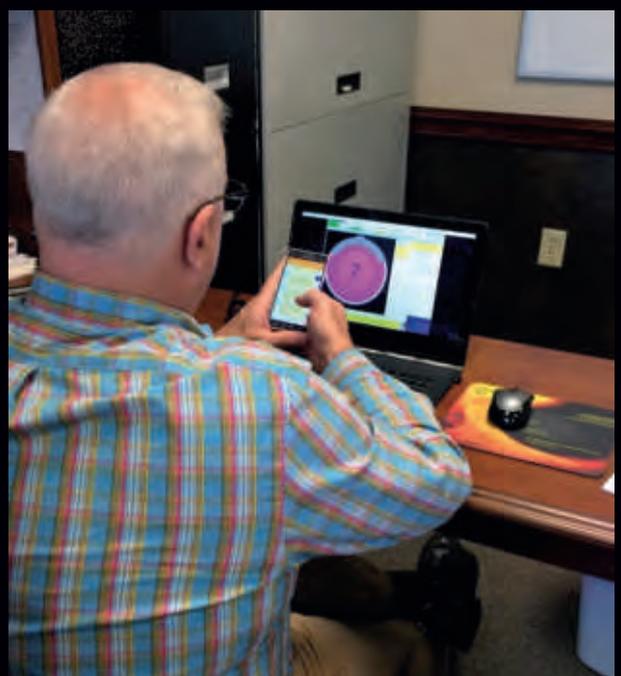


We confidentially say you will:

- ✓ Drastically improve safety
- ✓ Better understand your furnace
- ✓ Avoid furnace explosions
- ✓ Improve lining life



Technical training: installation of the sensor panels with the customer



Real-time consulting and support via Team Viewer and mobile communication by a Saveway engineer

The power of knowledge



Technical training: break out lining material with the customer, identification of lining failure



Technical training: instructions for an installation of the OPTISAVE system

At Saveway we take pride in our continuous service to our customers. Our company is backed by worldwide sales and service partners that are available as well with expert advice and qualified after-sales service support.

We offer

- 24 hour support to your equipment through online connection. We see what you see. This makes it easy to aid you with any furnace readings that are being shown on your system
- On-site training for your employees in the use of the measurement technology for an optimal furnace operation
- In-house training courses to deepen the knowledge for users of our products
- Consulting for optimization of refractory material, lining design and furnace operation



Tear out and identification of metal fin



Tear out and confirmation of displayed wear on the channel furnace

REFERENCES

„The first system was installed in 1996 on a conventional **single chamber 15-ton furnace** while the second system was installed as a part of a **20-ton VIDP** furnace that was commissioned in March of 1997. [...]

District advantages we have observed with the SAVEWAY system are:

1. **Elimination of metal damage to the induction coils** due to early detection of metal penetration through the refractory lining. 2. Identification of problem regions in refractory linings that help to **improve lining construction techniques**. 3. The impact of raw material charging practices on refractory lining life can now be evaluated. 4. The impact of various refining practices on refractory lining life can be determined which allow improved melting practices to be developed. 5. **Maximum refractory lining** life can now be obtained **without risk** to induction coil components. 6. **Moisture elimination** from the refractory lining at the beginning of the campaign **can now be clearly determined**. 7. **Production operations can be managed much more efficiently** since the completion of melting campaigns can now be estimated based upon SAVEWAY system data.“



CARPENTER

Dwight D. Wegman (Area Manager- VIM Process Technology)
Carpenter Technology Corp. | PA, USA

„Improved utilization and maximum safety by using SAVEWAY® and SAVEDRY®

Since 2003 we have been using the Saveway system successfully on our **8-ton, 14-ton and 17-ton vacuum induction furnaces**. As the **only safety monitoring technology which measures the remaining lining thickness** between the approaching melt and coil grout, the SAVEWAY® system constantly and accurately determines the remaining refractory lining thickness. This **gives us the opportunity to use the maximum life of the refractory effectively and risk-free**. Besides visual wear like erosion and molten leaks, hidden wear conditions like dangerous metal fins and defects in the lining are reliably detected.

[...] Due to our success with the system, we requested that Saveway solve our problem of “detecting cooling water leaks on an electric arc furnace”. In 2007 we installed the SAVEDRY® system. [...] Thanks to our **close partnership** with Saveway **we have achieved a high degree of safety in our melting equipment. We can count on the Saveway measuring equipment and the personal service of the Saveway team any time.**“



DI Dr. Hans-Peter Fauland (Division manager steelworks)
BÖHLER Edelstahl GmbH & Co KG | Kapfenberg, Austria

„We installed Saveway's lining monitoring system in 2006, after 2 runouts that caused damage to the furnace and resulted in costly downtime. In one case the plant was down for 4 weeks. **Since installing SAVEWAY, we have run over 7,000 heats and had no melt-to-coil failures.** I can **recommend their technology and services with confidence.**“

VDM Metals

Steve Chapman (Plant Manager)
VDM Metals USA, LLC | NJ, USA

REFERENCES

„In summer 1993 VAC Hanau installed a **SAVEWAY System on a 4-ton vacuum induction furnace (VIM)** for the first time. The main reason for that decision was the fact that there was a potential risk of explosions and serious injuries to employees caused by run outs. Our experiences proved that **only the SAVEWAY System provides appropriate and reliable safety concerning run outs.** [...]

Due to these positive experiences and our safety philosophy, **all our furnaces have been equipped with a SAVEWAY System.** This includes VIM, VID and open induction furnaces with a melting capacity between 0.2 and 6.0-ton. Consequently, we currently have 11 SAVEWAY Systems in operation. [...]

Since 1993 when a SAVEWAY System was applied to a vacuum furnace for the first time in history, **the relationship between us VAC and SAVEWAY is absolutely positive.** Solutions to technical questions are solved jointly and in a very proficient and prompt manner.“



Dipl.-Ing. Timm Scheidig (Manager Technical Investment)
VACUUMSCHMELZE GmbH & Co. KG | Hanau, Germany

„In **excellent cooperation** with Saveway, a monitoring system was developed. This system now allows us to accurately localize insulation faults. [...] The **SAVESEARCH system has worked trouble-free since its installation.** The advantage of the system is its ability to localize insulation faults between the coil and the shunts. Hence the difficult and time consuming dismantling of all the shunts, which normally makes a cold start of the furnace inevitable, becomes unnecessary. [...] **By saving production losses** (no long searches for ground faults) **the SAVESEARCH system paid for itself within a short time.** [...] So **coil damages** caused by a “flashover” to the shunt, **and cooling water leakages can be avoided.** The insulation **can be replaced at a time that does not affect production.** For us **the system is a reliable and well established tool to avoid production losses, to improve the availability of our coreless induction furnaces and to increase the operational safety.**“



Ing. Jürgen Bromm (Maintenance Manager)
Fritz Winter Eisengießerei GmbH & Co. KG | Stadtallendorf, Germany

„In January 2015 we installed the **SAVEWAY system on three (1t, 1,2t and 2,5t) coreless induction furnaces because of positive experiences at other Federal-Mogul melt shops.**

At this time we had a lining life time of 110 melts.

Skeptic at first **we are really impressed by the possibilities the SAVEWAY system gives us now.** We were **able to increase the time of melts up to 165 per lining campaign!** We **optimized our lining and melt process using the Saveway system,** which gives us continuous information about our lining status, so **we do not risk losing our furnaces.**

At the end these two effects allow us to **work more effective** but also to **give our workers more safety and trust in material and technique.**“



Göran Fredriksson (Production Manager Powertrain)
Federal-Mogul Göteborg AB | Mölnlycke, Sweden

REFERENCES

„Within the Exxaro Resources group, Exxaro FerroAlloys employs a “no compromise” approach to health and safety on our powder-based production plant. [...]

In addition to the **safety targets**, Exxaro FerroAlloys strives to **optimize production** through the **minimization of production down-time**. The **SAVEWAY system greatly assists** with this target. Through the **optimal utilization of our refractory linings**, Exxaro FerroAlloys has **extended its refractory life** compared to the previous base on the old plant before the upgrade.

Exxaro FerroAlloys utilizes both **SAVEWAY** electrode panels and **SAVELINE** sensors in its furnaces, and **can recommend induction furnace operators to consider both these solutions.**“



CG Potgieter (Manager Operations)
Exxaro FerroAlloys | Pretoria, South Africa

„We have been operating a SAVEWAY monitoring system since July 1993 at a 16-t-medium-frequency induction furnace. [...] Our alloy production program, the interrupted operation over the weekend as well as the use of often very big pieces of scrap put the furnace under great stress. In the past this repeatedly caused **metal run-outs**.

They **are reliably avoided since the SAVEWAY system has been introduced**. Besides this it is possible for us for **the first time to quantify the wear of a refractory lining** and with that to reduce it. **Lifetime of the furnace has nearly doubled. This system has proved to be very useful for us [...]**“



Dr.-Ing. Jürgen Loh (Plant Manager)
Krupp VDM GmbH Werk Unna | Unna, Germany

„We are pleased to act as a reference for the successful operation of the SAVEWAY system. Our company is using **medium frequency furnaces for melting of high-quality non-noble metal alloys** for dental applications. [...]

After several melting breakthroughs in the casting nozzle area of the furnaces, we decided to invest in the SAVEWAY system in 2004.

We are **monitoring the wall and floor area** of our furnaces which are lined with prefabricated crucibles and backup ramming.

As the **SAVEWAY system signalize an approaching metal run through in time, any damage to the furnaces could be reliably prevented since then.**

In addition, **the data supplied by the SAVEWAY system allows us to predict the end of a crucible campaign**. Premature break outs or relining during busy production times can be avoided.

The **overall positive experiences** are a result of the **good co-operation with the Saveway service team** that helped us with sophisticated advice and interpreting indications on the system at any time.“



Martin Born (Department Manager Process Engineering)
DeguDent GmbH | Hanau, Germany

BENEFITS

Safety and Saving

- Decrease of costs for loss of production and reduce maintenance costs
- Reliable prevention of metal runouts and explosions
- Increase of plant availability and operational safety
- Improvement of process control and documentation
- Real safety for operating staff
- Tool for improving refractory construction, lining life and furnace operation

Usability

- Data processing as base for Industry 4.0
- Easy and safe operation
- Wide application range for all kinds of metallurgical equipment: winning, refining, melting, holding and pouring
- Systems adaptable to different refractory materials, tapping temperatures and process technologies
- Display and recording of the wear, temperature, moisture content and insulation
- Simultaneous monitoring of several furnaces or vessels, also different equipment with one system
- Hard- and software interfaces for warning signals
- Easy integration into customer network to transfer the data into customer's information systems
- Remote diagnosis of the system and service via online connection allows efficient and quick service by the Saveway team
- Intuitive system operation with multi touch
- SAVEWAY®, SAVELINE® and SAVEDRY® systems can be combined

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Est. 1991

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