Durable tube skin thermometer.

iTHERM SurfaceLine TM691:
Built for the toughest conditions.

- Tube skin measurement
- iTHERM SurfaceLine TM691
- Your benefits
- Product design
- Industry focus
- Support

Endress+Hauser

Tube skin measurement

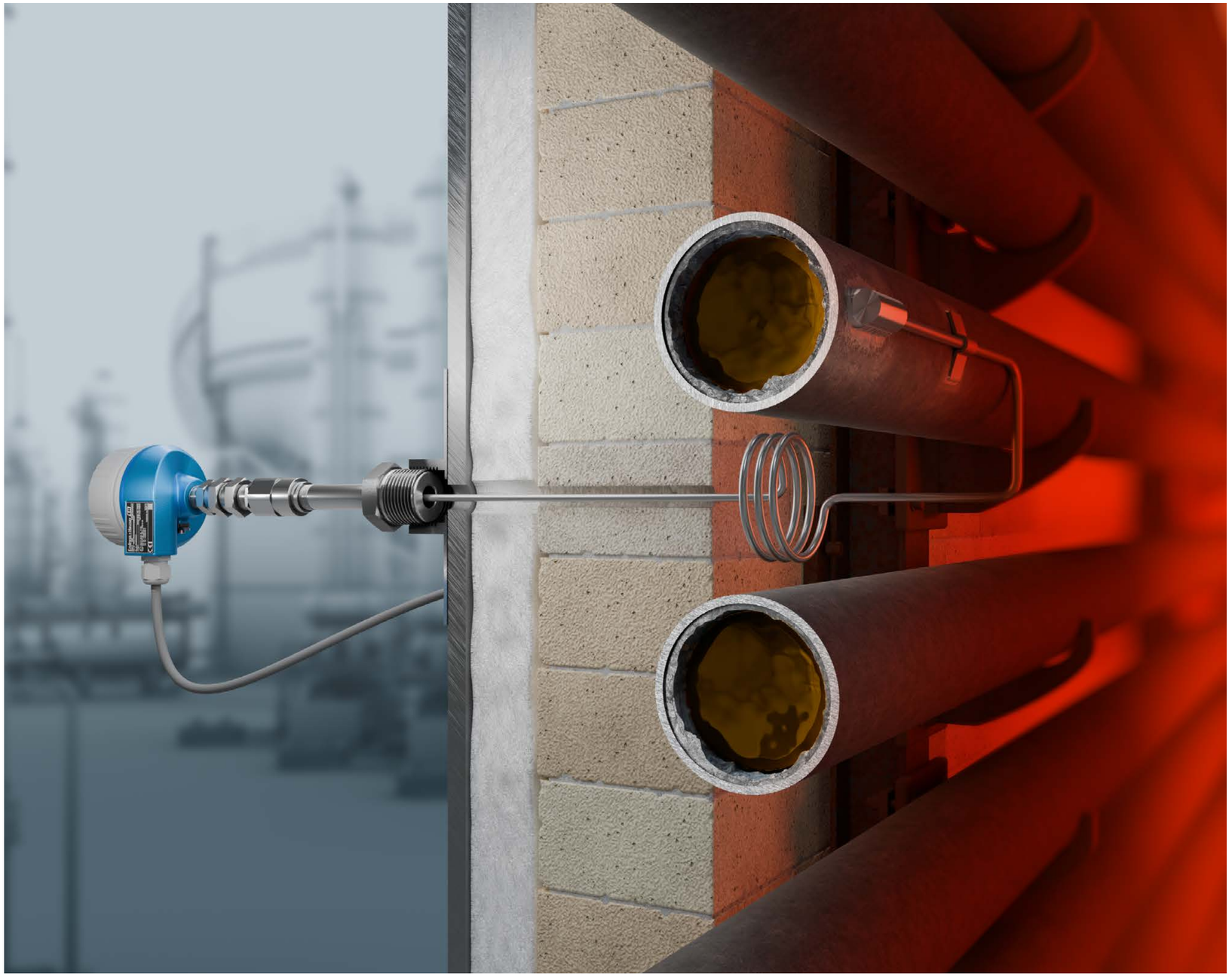
Tube skin temperature measurement determines the actual temperature of the outer pipe wall rather than the process temperature inside the tube.

It is used in demanding thermal applications such as fired heaters, reformers or heat exchangers where continuous monitoring of tube condition is essential.

Reliable measurement is challenging due to extreme temperatures, thermal expansion of the process tubes, vibration and harsh operating conditions. A well-designed installation is therefore essential to maintain measurement accuracy and long-term reliability.

Tube skin thermometers support two key objectives:

- **Safety:** Monitoring tube condition helps detect coking, overheating and abnormal operating conditions at an early stage. This supports the prevention of tube damage, bursting and unplanned downtime.
- **Efficiency**: Monitoring heat distribution on the outer surfaces of process tubes provides valuable insights into burner performance and fuel consumption, helping operators optimize thermal efficiency.



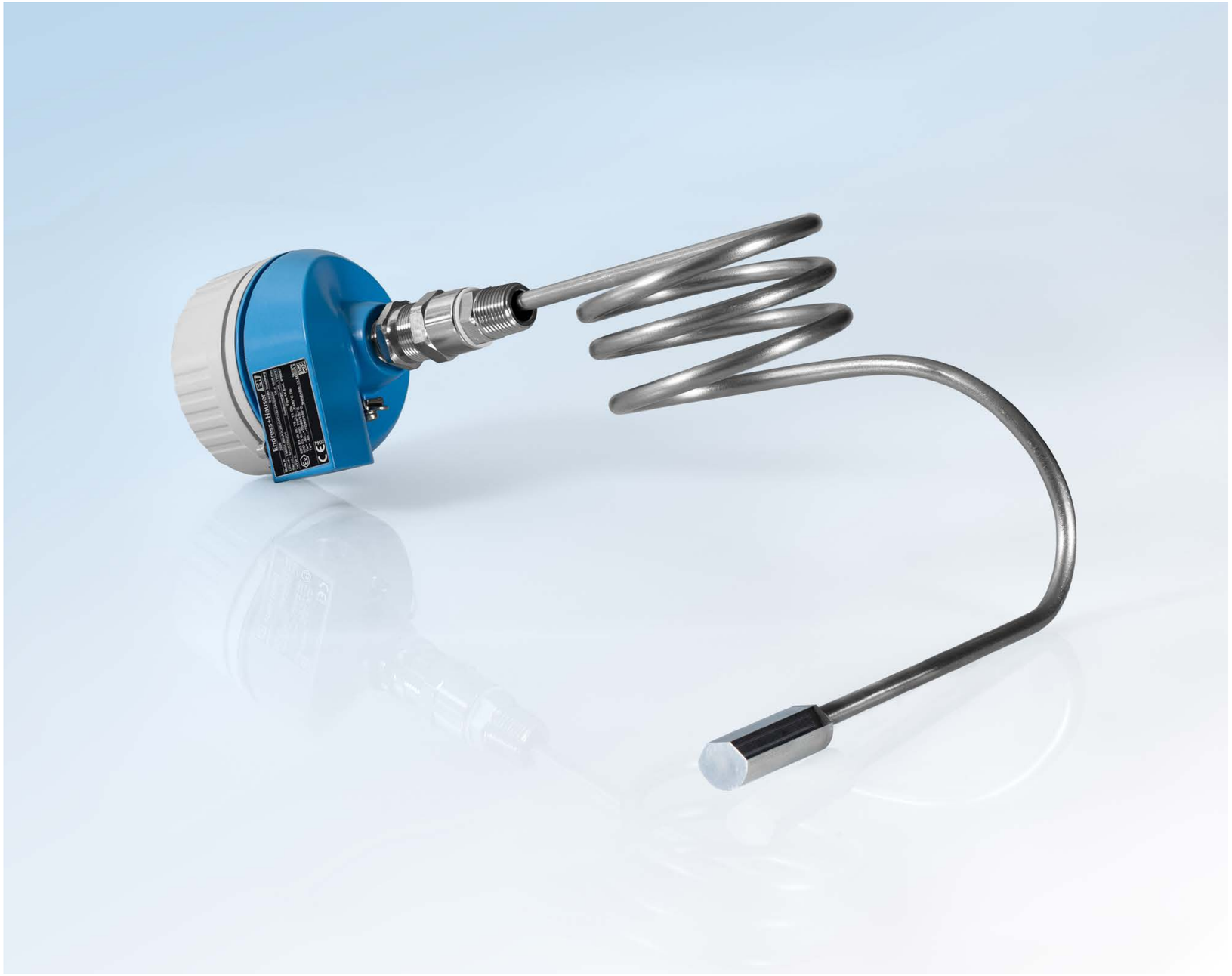
iTHERM SurfaceLine TM691

Metric/imperial TC tube skin thermometer for harsh environments such as fired heaters, reformers, heat exchangers, boilers

iTHERM SurfaceLine TM691 is a dedicated tube skin thermometer that measures tube wall temperature directly on the outside of process tubes, providing valuable insights into thermal conditions and tube integrity.

Combining a standardized product structure, high configuration flexibility and specialist expertise, it enables reliable application-specific solutions for demanding thermal processes and harsh environments.

Visit the product website



Benefits at a glance

Reliable tube skin temperature measurement is only possible when the measuring assembly can withstand the demanding operating conditions of the application.

Combining application-specific design, robust mechanical construction and specialist expertise, iTHERM SurfaceLine TM691 supports reliable monitoring of tube condition and provides valuable insights into thermal process performance. The resulting information helps operators improve safety, increase energy efficiency and achieve more reliable plant operation.

Improved plant availability: Reliable temperature monitoring helps avoid unplanned shutdowns and supports stable production.

Improved energy efficiency: Assessing and optimizing burner operation and heat distribution

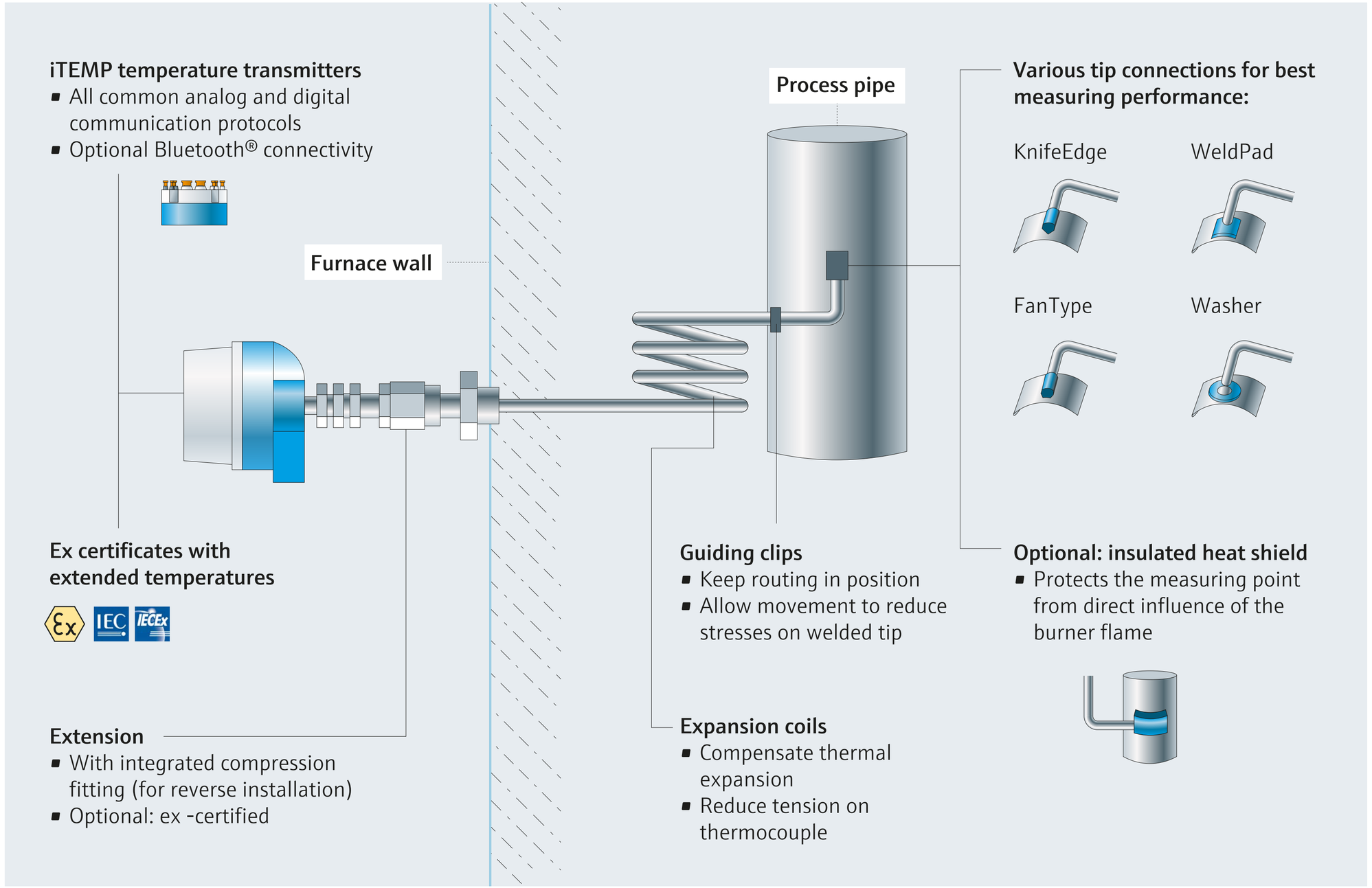
Improved product quality: stabilized process conditions due to accurate temperature measurement

Extended tube lifetime: Continuous monitoring of tube temperature helps detect overheating, protects critical assets and supports longer service life.

Product design

Tube skin temperature measurement places significant mechanical and thermal stress on the measuring assembly. Extreme temperatures, tube expansion, vibration, corrosion and radiant heat require specialized design features to maintain reliable long-term performance.

iTHERM SurfaceLine TM691 combines features that help protect critical components, accommodate tube movement and maintain stable measurement performance throughout the operating lifecycle.

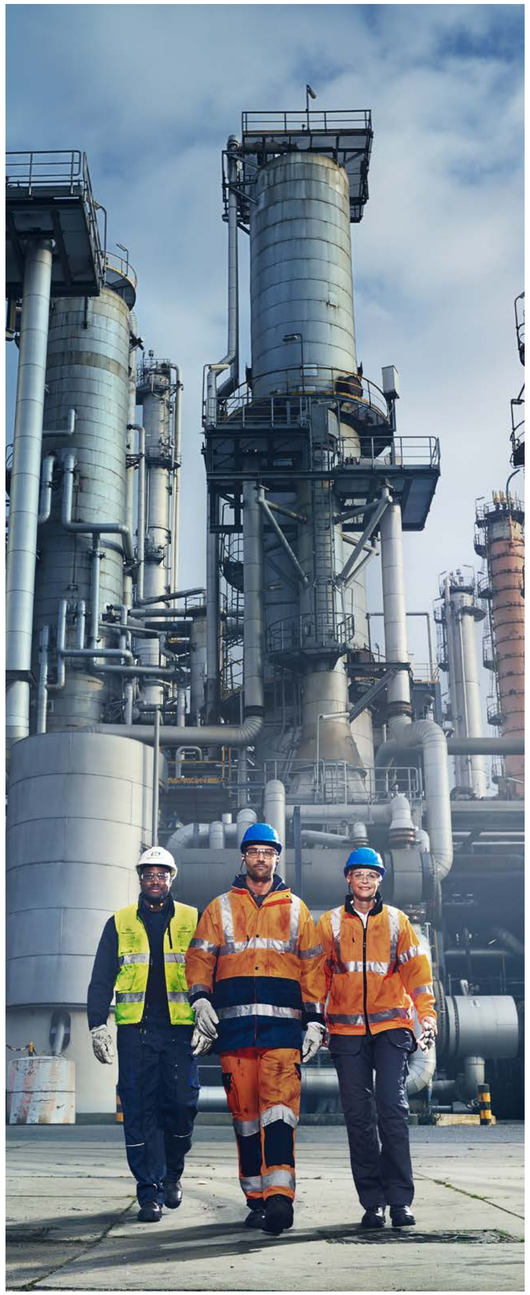


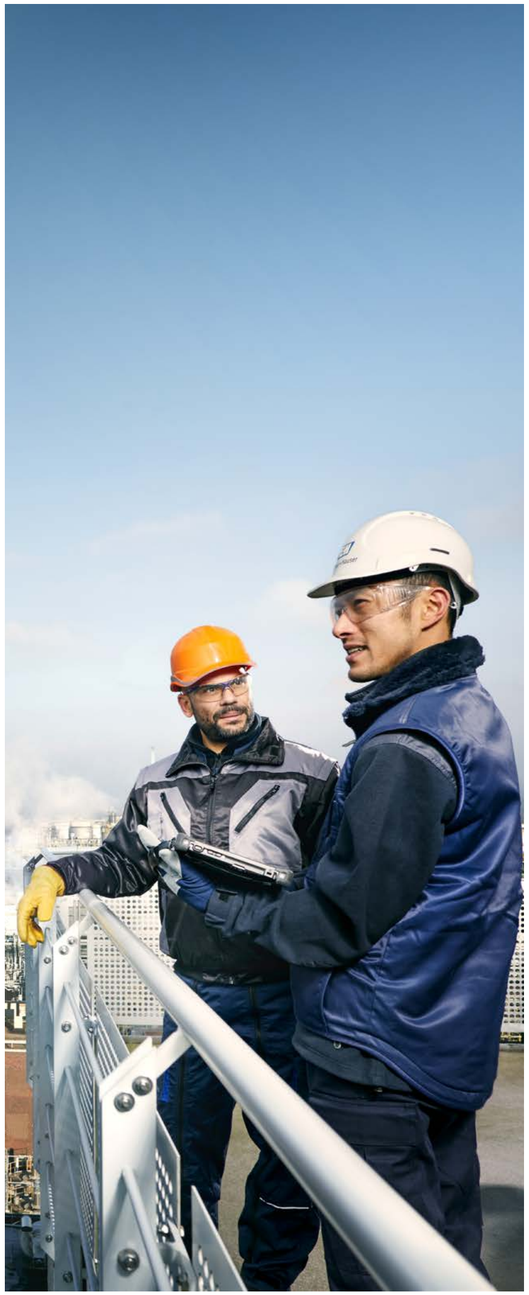
Industry focus

iTHERM SurfaceLine TM691 is used in a wide range of thermal process applications across the Oil & Gas, Chemical and Power & Energy industries. It enables reliable tube skin temperature monitoring in fired heaters, reformers, heat exchangers, boilers and other demanding thermal applications.

Thanks to its configurable design and extensive options it can be adapted to diverse installation concepts and process requirements.

- Power & Energy
- Chemical
- Oil & Gas





Optimizing Heat Recovery Steam Generator (HRSG) efficiency

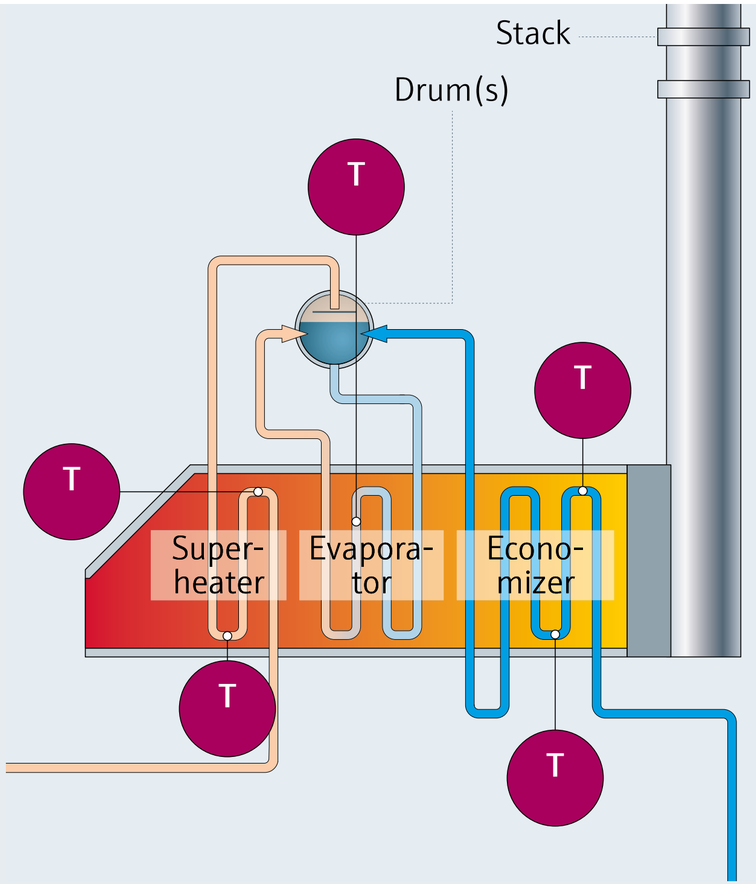
HRSG captures the thermal energy of hot exhaust gases and uses it for steam power generation, process heating, or cogeneration applications. The steam-water cycle occurs in three sections:

- **Economizer:** feedwater is heated up to saturation temperature.
- **Evaporator:** water forms saturated steam, separated in the steam drum.
- **Superheater:** steam temperature is raised above steam saturation point.

Superheated and dry steam is sent to a steam turbine or process users. In all three sections, accurate heat exchange monitoring determines the steam quality leaving the superheater, and the steam turbine efficiency.

Temperature tracks how fast heat is released by the hot stream and absorbed by water and steam, controlling steam generation efficiency and detecting heat exchange degradation from tube fouling or overheating, leading to tube creep ruptures and incidents.

Accurate temperature mapping of tube outer surfaces reveals abnormal heat flux, unwanted phase change and thermal stress – driving feed-rate optimization, steam quality, safety, integrity and steam turbine performance.



Your challenge
Measuring task: Temperature measurement on outer tube surfaces
Measuring points: On outer surfaces of the heat exchanging tubes in the economizer, evaporator, and superheater sections
Medium: Hot gaseous stream, liquid water, two-phase water, high-pressure saturated and superheated steam
Process temperature:

- Exhaust hot gas:
  Tin = 500 ... 650 °C (932 ... 1202 °F)
- Economizer feedwater:
  Tin = 120 °C (248 °F); Tout = 230 °C (446 °F)
- Economizer exhaust gas:
  Tin = 250 °C (482 °F); Tout = 120 °C (248 °F)
- Saturation temperatures:
  Tin = 311 °C (591 °F); Tout = 450 °C (842 °F)
- Superheated steam:
  T = 540 °C (1004 °F), P = 100 bar (1450 psi)

Our answer
iTHERM SurfaceLine TM691 offers a wide choice of sensor materials and tube-skin attachment solutions for long operating life and repeatable accuracy.

The sensor can be routed to any detection point, with immersion length up to 20 m on request and resistance to thermal gradients and expansion, regardless of the distance from the process connection.

Heat exchange and energy monitoring in cracking furnaces for olefins production

The production of light olefins like ethylene and propylene involves several phases, from feed preparation to compression and separation of the cracked gases passing through very fast quenching steps.

The main sections of the process are the cracking furnace, quenching, compression, chilling and separation column where the key utilities are: preheaters, steam generators, drums, cracking furnace, heat exchangers, compressors and separators. The heart of the process is the steam cracking furnace, one of the most challenging utilities, requiring continuous thermal behavior and efficiency monitoring due to the high energy consumed in operations to get the cracking reactions occurring at the right ratios and quality.

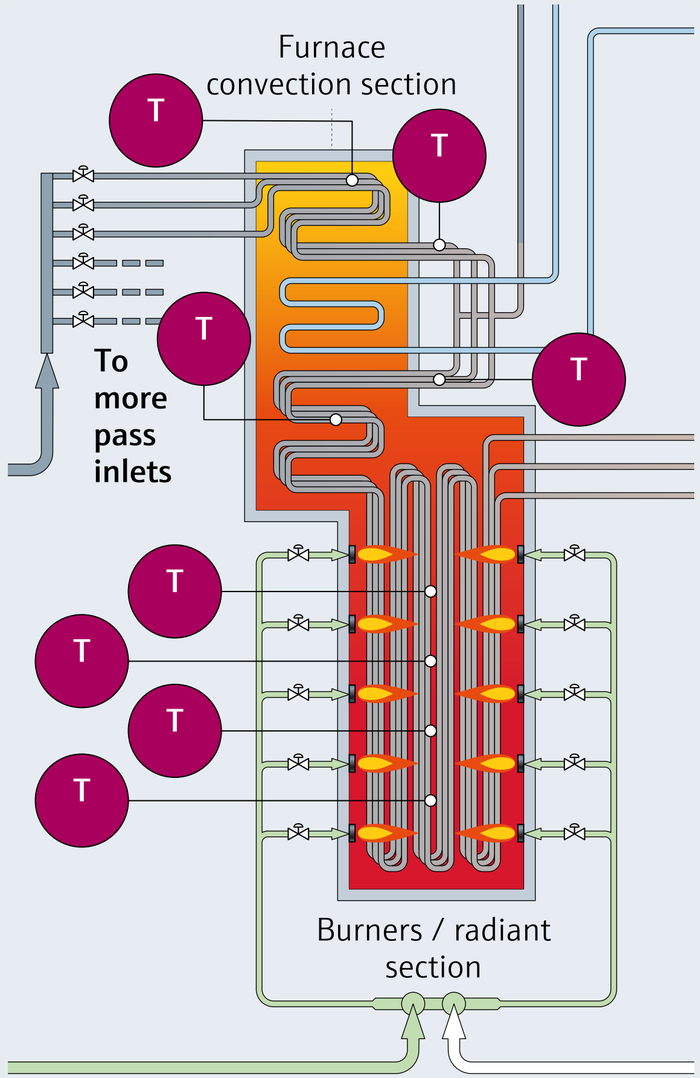
Accurate temperature measurement at several points, from the convection to the radiant section, is the key variable for tracking real-time furnace performance and tube integrity. Coiled tubes face extreme thermal stress at up to 1200 °C (2192 °F) when directly exposed to burners or when firing is increased to offset uneven heat distribution. Skin temperatures must stay balanced between the level needed for cracking without coke formation and the maximum allowable temperature for the tube alloys.

Your challenge
Measuring task: Temperature measurement on outer tube surfaces
Measuring points: On outer surfaces of process coiled tubes in convection and radiant sections and on structural internals. Steam generators, quenching units, compressors and columns are also utilities with additional points of measurement.
Medium: Gaseous, two-phase fluids, high-pressure and superheated steam
Process temperature:

- Convection section:
  500 … 680 °C (932 … 1256 °F)
- Radiant section:
  800 … 1200 °C (1472 … 2192 °F)
- Quenching units:
  900 … 500 °C (1652 … 932 °F)

Our answer
iTHERM SurfaceLine TM691 offers a wide choice of sensor materials and tube-skin attachment solutions for long operating life and repeatable accuracy. The sensor can be routed to any detection point, with immersion length up to 20 m on request and resistance to thermal gradients and expansion, regardless of where the burners and process connection are positioned.

Accurate temperature mapping across furnace sections enables continuous control and optimization of energy consumption, cracking efficiency, product quality and the integrity of tubes and furnace internals.

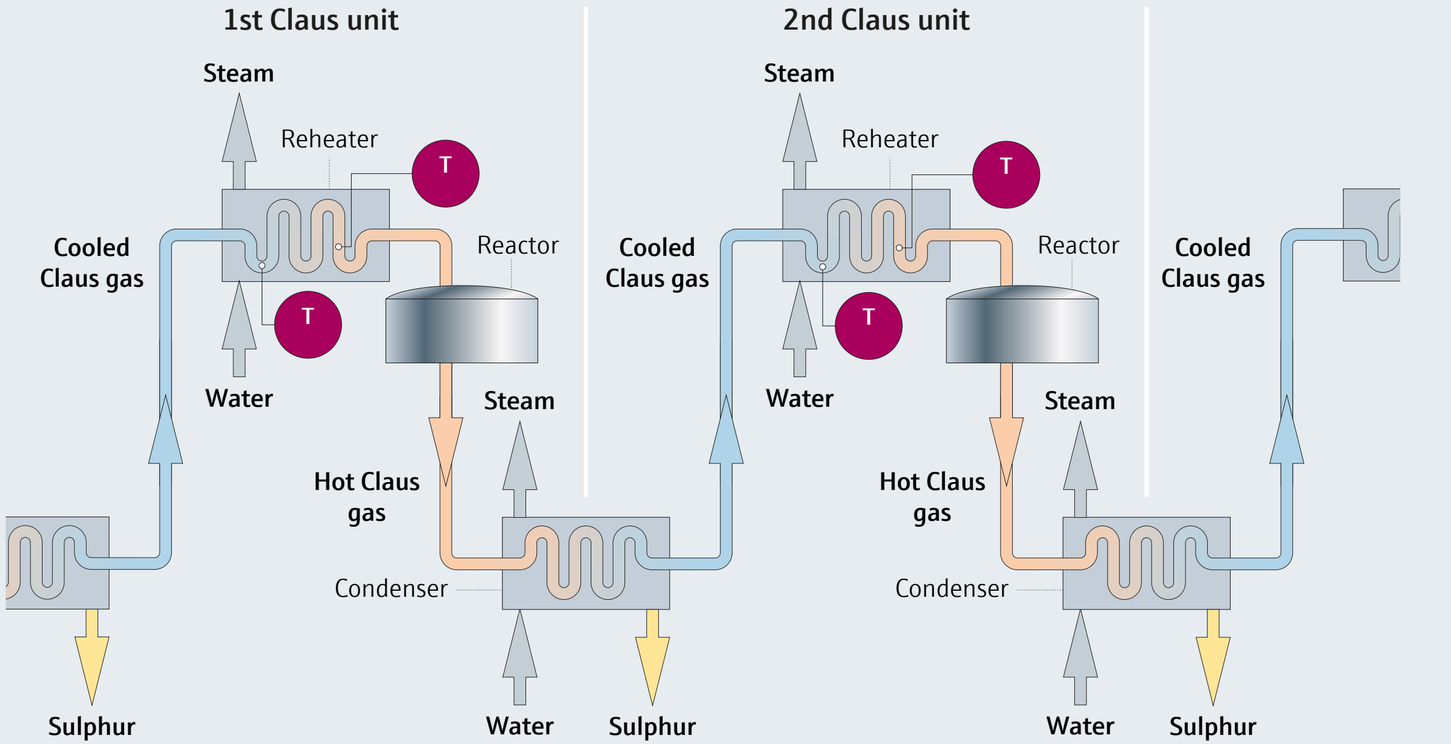


Reheater performance monitoring in Sulphur Recovery Unit (SRU) operations

In a Sulphur Recovery Unit (SRU), reheaters restore the process gas temperature for the catalytic reactors after sulphur condensation. They keep the gas above the sulphur dew point and at the optimum reactor inlet temperature, ensuring efficient sulphur conversion and stable catalyst performance.

In SRU operation, both underheating and overheating of the process gas must be avoided. Temperatures that are too low can cause sulphur condensation, tube fouling, corrosion, pressure drops, and catalyst deactivation. Excessive temperatures can reduce sulphur recovery efficiency, damage catalysts, and increase energy consumption once the stream enters the catalytic reactor. Maintaining tight temperature control is essential for process reliability, asset integrity, and energy efficiency.

Accurate temperature measurement is therefore the key process variable for reheater performance optimization. Continuous monitoring at the reheater inlet, outlet, shell, tubes, and associated steam lines enables precise control of heat transfer, early detection of abnormal conditions, improved energy efficiency, prevention of sulphur condensation, and maintenance of optimal reactor inlet conditions.



Your challenge
Measuring task: Temperature measurement on outer tube surfaces
Measuring points: On outer surfaces of the heat exchanging tubes of reheaters and condensers
Medium: Gaseous and corrosive stream, low- and high-pressure saturated steam
Process temperature:
Heated gaseous stream through the catalytic cycles:
- Tin = 160 … 250 °C (320 … 482 °F)
- Tout = 250 … 315 °C (482 … 599 °F)

Heating steam saturation temperatures and pressures:
- T = 240 … 260 °C (464 … 500 °F)
- P = 35 … 45 barg (508 … 653 psig)

Our answer
iTHERM SurfaceLine TM691 tube-skin sensor monitors tube surface temperatures, detects cold spots, evaluates thermal gradients, and supports mechanical integrity assessment during start-up and normal operations.

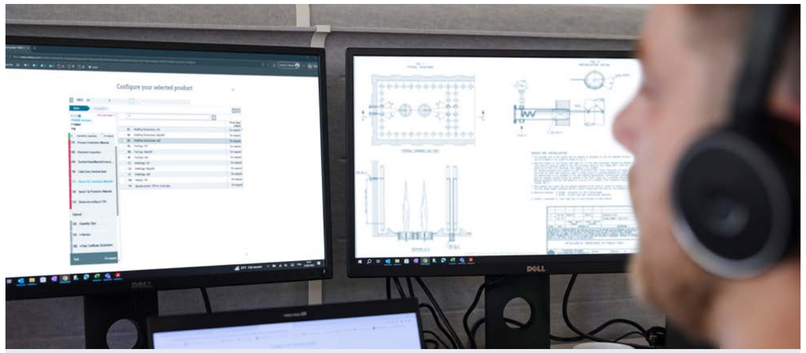
These measurements provide complete visibility of the reheater thermal performance, prevention of sulphur condensation, improved catalyst protection, early detection of corrosion risks, and stable reactor inlet conditions.

Endress+Hauser support

Accurate tube skin temperature measurement requires more than a thermocouple. **Each application comes with specific process conditions, installation constraints and mechanical challenges.**

That is why sensor design, attachment concept, routing strategy, material selection and expansion management must be aligned with the actual heater or process design.

Endress+Hauser supports customers with application expertise, configurable product design, detailed documentation and installation supervision to help define a reliable tube skin measurement solution.

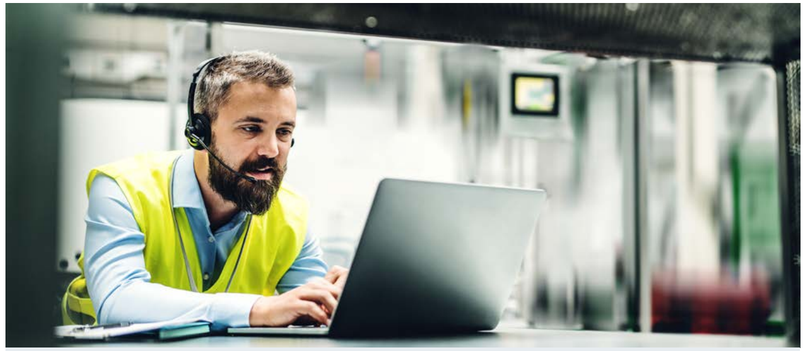


Engineering expertise

- Application-specific sensor design
- Customized routing and expansion management

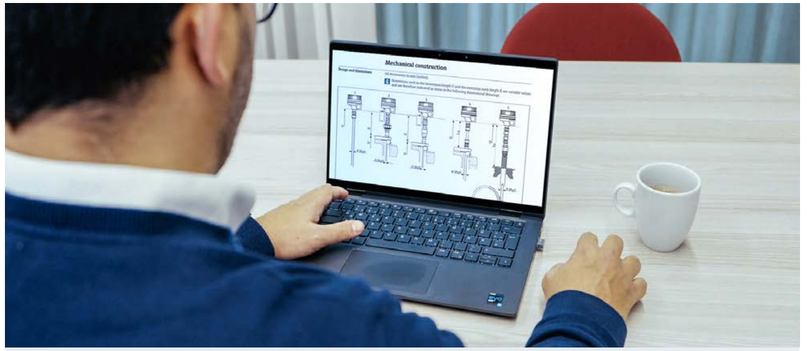
Installation support

- Installation concept review
- Welding and mounting guidance
- Installation supervision available



Global support network

- Local support throughout the project
- Access to global application expertise
- Worldwide project experience



Product documentation

- Detailed technical documentation
- Extensive operating and installation manual
- Safety instructions for hazardous areas

People for Process Automation

Visit us on social media

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