Hukseflux
Thermal Sensors

NF01

Needle type heat flux and temperature sensor

NF01 is used for monitoring heat flux and temperature in high temperature environments, typically in walls and shells of blast furnaces and smelters. Measuring heat flux as well as temperature with one sensor is more accurate and practical than using distributed temperature measurements. The same technology is used to manufacture heat flux sensors for different applications.

Figure 1 *NF01, standard 8 x 10^{-3} m diameter model, with screwed coupling*

Figure 2 *NF01: special design with positioning piece and connection head*

Introduction

NF01 is used for measurement of the energy balance of industrial blast furnaces and smelters, in steel shells as well as in the graphite and brick refractory. It has been applied successfully in iron furnace emergency response systems and in smelters for titania slag production. The sensors inside NF01, a thermopile and a thermocouple, are protected by a fully sealed stainless steel “needle” body. The needle can withstand temperatures up to 700 °C, as well as the aggressive chemical environment of a furnace. Optionally the sensor temperature range can be extended to 1000 °C. The cable is made of PVC. The sensor outputs are heat flux, an analogue voltage signal in the millivolt range, and temperature using a thermocouple type K. The user must know the thermal conductivity of the surrounding material to calculate the heat flux.

What is better about NF01

The usual approach to measurement of heat flux is to estimate it from distributed temperature measurements. This leads to large measurement errors and is not practical.

- NF01 creates a single temperature difference signal. This is much more accurate than calculating a heat flux by subtracting two individual temperature measurements.
- NF01 sensors can be quickly installed; contrary to spatially distributed temperature sensors, the relative position of the sensors used for the temperature difference measurement is already determined during manufacturing. The exact depth of insertion is not a critical factor determining the accuracy of this relative position. Installation can be done quickly with little training.
- NF01 sensors are fully exchangeable. Contrary to spatially distributed temperature sensors, the sensors in the NF01 are “matched pairs”. This is essential to attain

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the best possible temperature difference measurement.
- NF01 has a fast heat flux response time: the high accuracy makes it possible to measure a temperature difference across a small distance.
- NF01 is durable; the swaged thick-wall needle lasts longer than normal sensors.

User-specific design

NF01's standard diameter is 8 x 10^{-3} m and its standard temperature range is 700 °C. We have made sensors with needle lengths up to 1.5 m. NF01 design is user-specific; needle diameter, needle length and temperature range are designed in cooperation with the user for the specific application.

Emergency response

In iron production, NF01 is used for detection of:
- failure of the water cooling system
- wear of graphite refractory
- wear of mortar/ brick
- process temperature over range

Figure 3 *NF01, optional 4 x 10^{-3} m diameter model, with screwed coupling*

Advantages

- more accurate than distributed temperature measurement
- easy installation; depth of installation is not critical
- robust, in particular at high temperatures
- low thermal resistance
- high sensitivity

Suggested use

- trend monitoring of heat flux in industrial installations
- detection of emergencies (see figure 4 for an application example)
- energy efficiency studies

NF01 specifications

Measurand	heat flux
Measurand	temperature
Heat flux sensor	thermopile
Sensitivity (nominal)	2 x 10^{-6} V·m/K
Temperature sensor	thermocouple type K
Needle length	specified by the user
Needle diameter	8 x 10^{-3} m
Needle diameter optional	4 x 10^{-3} m
Sensor design	swaged SS 310 sheath
Rated measurement range	0.05 to 50 x 10^{3} W/m^2 (typical)
Rated operating temperature range:	
Sensor	-30 to +700 °C
Sensor optional	-30 to +1000 °C
Cable	-30 to +85 °C
Standard cable length	10 m (see options)

NF01 design is user-specific; needle diameter, needle length and temperature range are designed in cooperation with the user for the specific application.

See the manual for recommended parts for installation

Options

- longer cable (specify total cable length in m)
- 4 x 10^{-3} m needle diameter
- wire cladding colour codes according to ANSI
- needle lengths (specify NL)
- needle rated operating temperature range up to 1000 °C

See also

- view our complete product range of heat flux sensors
- our industrial sensors
- NF02 miniature needle type heat flux and temperature sensor

About Hukseflux

Hukseflux Thermal Sensors offers measurement solutions for the most challenging applications. We design and supply sensors as well as test & measuring systems, and offer related services such as engineering and consultancy. Hukseflux is ISO 9001:2008 certified. Hukseflux sensors, systems and services are offered worldwide via our office in Delft, the Netherlands and local distributors.

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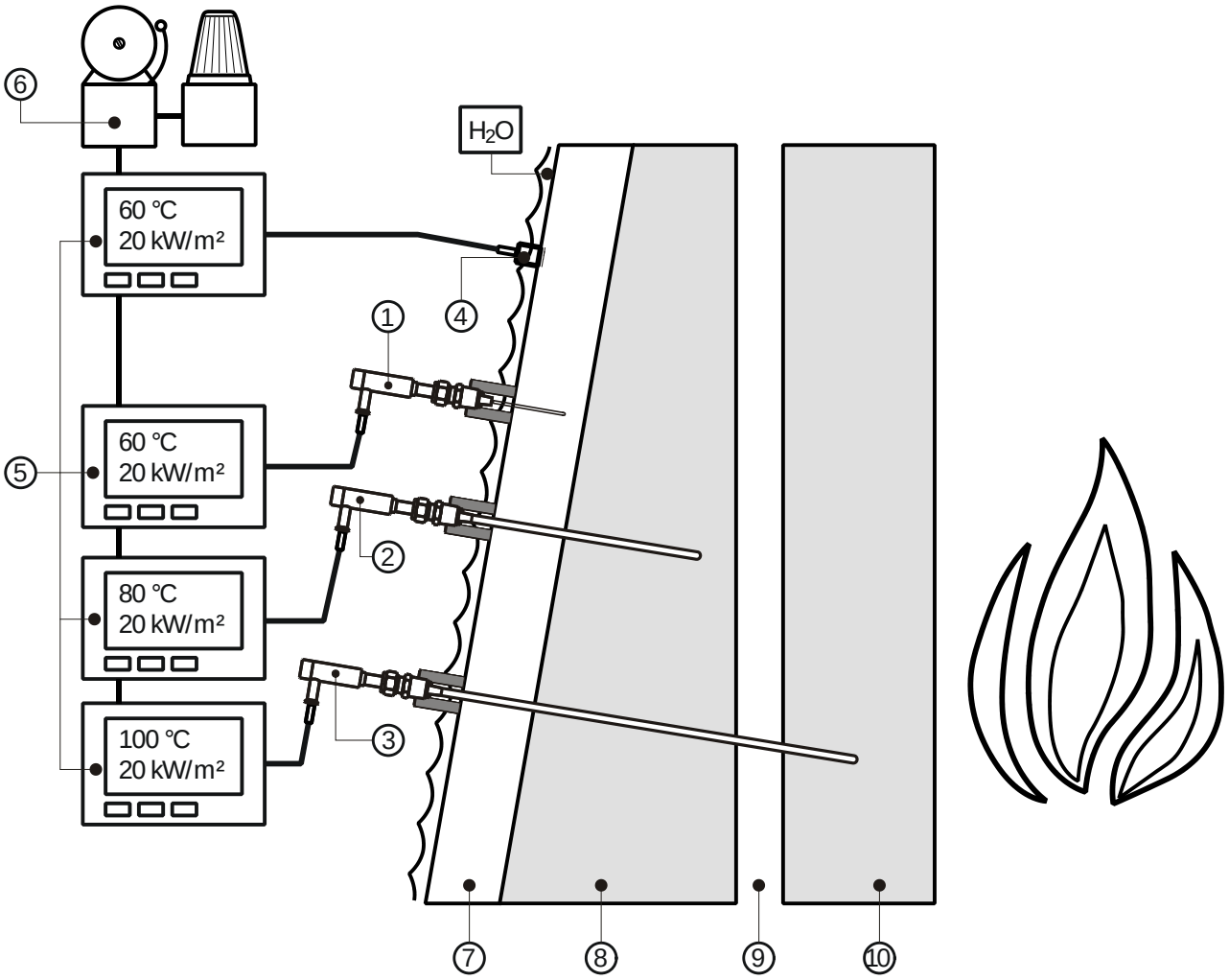

Figure 4 *needle type heat flux and temperature sensors model NF01 applied for process monitoring in a blast furnace. Sensor with standard 8 x 10^{-3} m diameter(1), (2), and (3), sensor with optional 4 x 10^{-3} m diameter (4), measurement and control system (5), alarm / warning system (6), steel shell (water cooled) (7), graphite refractory (8), mortar (9), semi-graphite (10). The sensors are part of the monitoring system to study energy balance and detect emergencies, for example failure of water cooling or process overheating.*

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