

# Reactor/Furnace Wall Healthiness Monitoring with a Fiber Optical Temperature Sensor

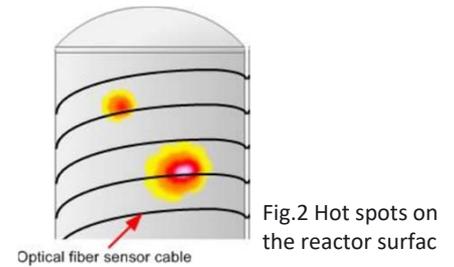
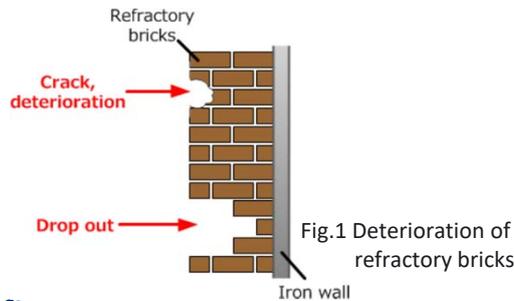
Distributed Temperature Sensor

The DTSX is a unique and innovative temperature monitoring system that uses a high-bandwidth optical fiber cable as a temperature sensor.

## Customer Concerns

### Early detection of failures in refractory materials

Temperatures inside a harsh condition reactor such as synthesis gas reactor that produces carbon monoxide can reach as high as 1,600 degrees Celsius, and the outer surface of the reactor vessel can get as hot as 300 degrees Celsius. To protect their iron walls and enhance combustion efficiency, these facilities are lined on the inside with refractory bricks. As these bricks age and deteriorate, a variety of problems such as a drop in combustion efficiency and breaks in the iron wall can occur and result in the initiation of an emergency shutdown by the plant control system. In addition to being a safety issue, such unplanned shutdowns result in lost production and financial losses.



## The Solutions and the Benefits

### Quick detection of hot spots

Hot spots on the outer surface of a reactor or furnace occur wherever there are breaks in the refractory brick lining. With its optical fiber sensor cable, the Yokogawa DTSX distributed temperature sensor is able to constantly monitor for changes in the temperature of the outer wall and quickly spot problems early on, before they have a chance to grow into big problems and result in plant shutdowns or worse.

### Proper maintenance period according to the conditions

Any reactor or furnace with a refractory brick lining needs to be shut down more frequently than other industrial facilities so that personnel can look inside and check the condition of the bricks. With the DTSX's ability to monitor surface temperature 24/7/365, maintenance can be performed as soon as any signs are detected that indicate deterioration in the refractory liner. This switch to condition-based maintenance ensures that problems are caught early on and corrected.

## How DTSX Works

### Measuring the intensity of Raman scattered light

Using pulses of laser light beamed through an optical fiber cable, the DTSX is able to detect temperature-dependent variations in signal frequency that are the result of a phenomenon known as Raman scattering that occurs along the entire length of the optical fiber cable, and it also can determine the locations of those temperature readings using light that is bounced back (backscattering) to the source.

**Example: Along a 6,000 meter optical fiber cable, nearly 6,000 measurement points**

By measuring how long it takes light to make a round trip back to the source (backscattering), the DTSX is able to calculate the location for each temperature reading. Abnormalities can be located with a spatial resolution of just one meter.

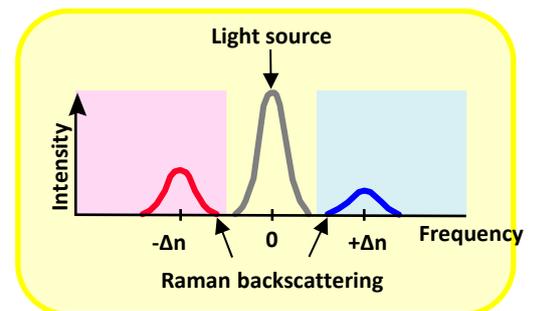


Fig.3 Raman backscattering

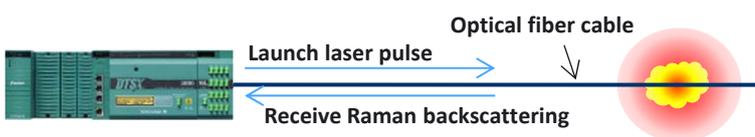


Fig.4 Temperature monitoring using optical fiber cable

# Installation of the Optical Fiber Sensor Cable

## Measuring the intensity of Raman scattered light

There is no need to install a large number of temperature sensors. A single length of optical fiber sensor cable can be affixed to the surface of the reactor or furnace using aluminum tape or something similar. Figure 5 shows the layout of the optical fiber sensor cable on a reactor outer wall.

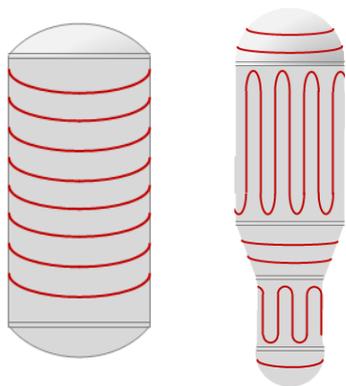


Fig.5 Installation examples

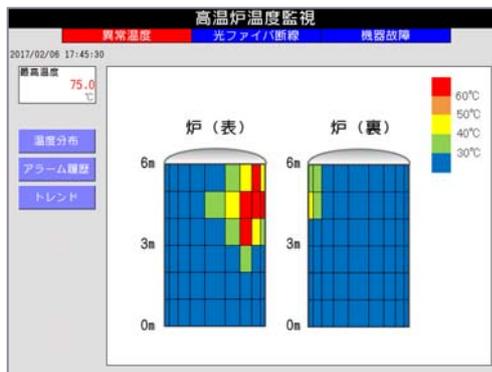


Fig.6 Paperless recorder's monitoring screen

## Advantages of the DTSX

### Long distance, wide area coverage

Temperature can be monitored anywhere along a single optical fiber sensor cable that is kilometers in length. No longer is it necessary to install numerous temperature sensors for a specific application. A single DTSX can monitor variations in surface temperature at any point on the outer wall of a large reactor vessel or furnace.

### No power supply required for the sensor

The optical fiber sensor cable does not need a power supply, and is immune to electromagnetic noise. It is thus intrinsically safe and can be installed in hazardous locations.

### Flexible installation

The DTSX only needs to be wrapped around objects or affixed to surfaces to measure temperature in specific locations. As such, the DTSX can flexibly accommodate the needs of all kinds of facilities, both greenfield and brownfield.

### Able to operate under a wide range of conditions

The DTSX optical fiber cable is encased in a metal tube and can withstand temperatures of up to 300 degrees Celsius. Unlike thermal cameras, it performs well in outdoor locations where ambient temperatures are high.

## Related Applications

In a wide range of applications, the DTSX is able to quickly detect temperature changes that are the result of equipment failures and other abnormal situations.

### ✓ LNG tank leak detection

Leaking natural gas can catch fire or explode. If cold (-162 degrees Celsius) liquefied natural gas (LNG) starts to leak from a tank, the temperature in the area immediately surrounding the leak will fall. A DTSX optical fiber sensor cable placed around the tank will detect that temperature change so that emergency corrective measures can be immediately taken.

### ✓ Abnormal heat detection in power distribution networks

Ageing power transmission cables can fail, resulting in power outages and even fires, and bringing life to a standstill. To detect and locate problems before they can escalate, an optical fiber sensor cable can be laid together with the power cable in a conduit.

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