

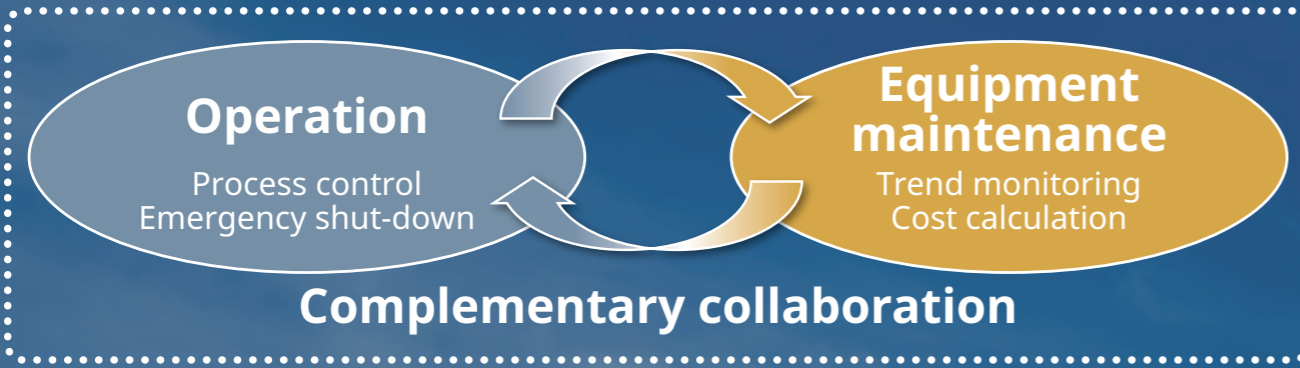


OpreX™ Asset Management and Integrity

A Wireless Solution for the Industrial IoT Sushi Sensor



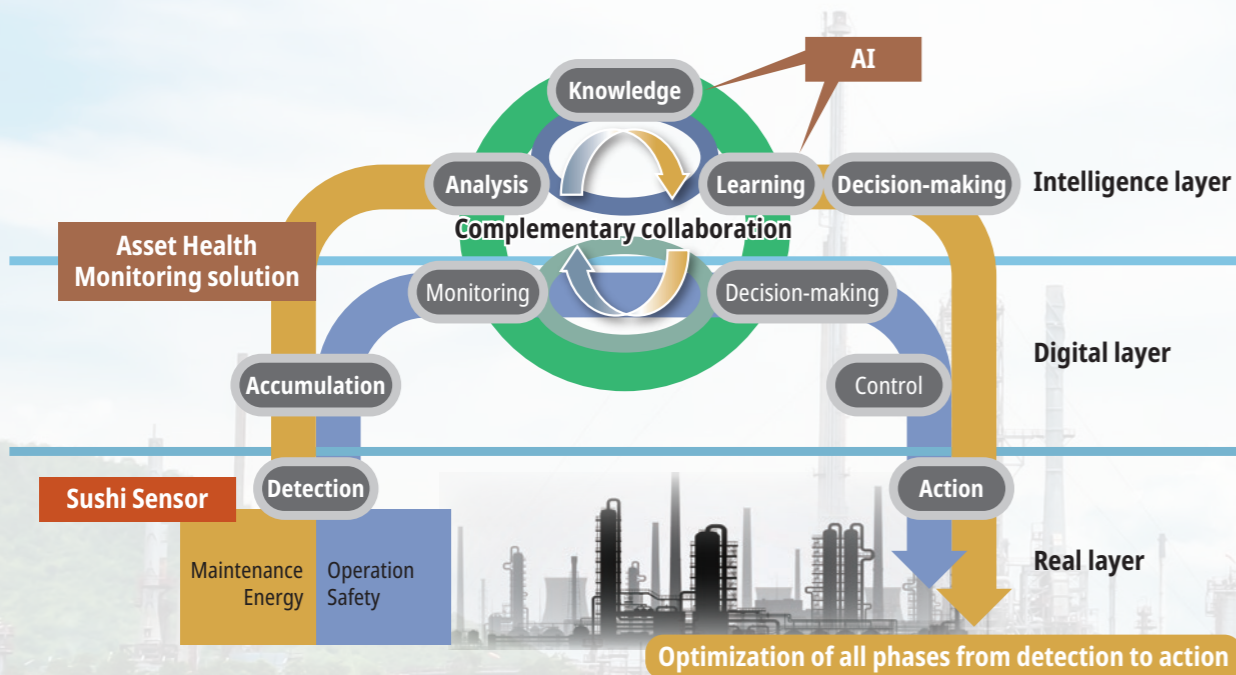
APM Advocated by Yokogawa



Yokogawa enhances the value of customers' equipment through asset performance management (APM).

To maximize the value of equipment, APM focuses on the availability and uptime of equipment and evaluates its performance. To maximize performance, APM should be performed not only in maintenance but also in operation and other areas where maintenance and operation must be collaborated to complement each other.

Complementary collaboration across departments



Conventionally, plant operation systems aim to improve production efficiency and product quality while equipment maintenance systems promote both maximize operational efficiency and minimize costs. However, when maximizing production efficiency, maintenance costs are not necessarily optimized. Although operation information and maintenance information must be combined to maximize profits for the whole plant, this is rarely achieved mainly because maintenance is not always quantified.

To solve this problem, Yokogawa has developed Sushi Sensor, which consists of a sensor that collects basic data for equipment maintenance and functions that quantify, accumulate, and analyze these data, enabling operators to make objective judgements.

Sushi Sensor strengthens collaboration between operation systems and equipment maintenance systems, achieving APM that optimizes all phases from the detection of equipment conditions by sensors to decisions on appropriate actions by operators.

Yokogawa's APM not only optimizes equipment maintenance but also improves the operation of the whole plant.

- Sushi Sensor** A wireless sensor solution including sensors for monitoring equipment conditions. Accurate identification of equipment conditions is the first step of APM.
- Asset Health Monitoring solution** This solution monitors equipment continuously and helps operators make quick decisions when a sign of abnormality is detected.
- AI** Based on accumulated maintenance records, AI can convert tacit knowledge and experience into explicit know-how.

In the following pages, some sections have an arrow, which shows the corresponding phase in the figure on page 1. The example on the right indicates that Sushi Sensor plays a role in the detection phase.



Sushi Sensor

Sushi Sensor ▶▶▶▶▶

Sushi Sensor is a wireless solution for the industrial IoT, including sensors for detecting equipment conditions.

Recently, there is an increasing need for advanced equipment maintenance such as CBM^{*1}. To do this, it is essential to identify the equipment conditions in detail. However, conventional operator rounds have been insufficient because equipment has become more complex, increasing the cost of man-hours and making the work environment harsher. Sushi Sensor helps solve this challenge by automatically acquiring data on the vibration, pressure, and temperatures of equipment and making the data available online. By quantifying and visualizing various data, Sushi Sensor enables the health condition of equipment distributed across a plant to be monitored.

Thus, Sushi Sensor reduces inspection man-hours of equipment and enables early detection of signs of abnormalities to prevent unexpected equipment shut-down, thus improving plant efficiency and productivity.

*1 CBM: Condition-based maintenance



Wireless temperature sensor

Wireless vibration sensor

Wireless pressure sensor

Features of Sushi Sensor



Sushi Sensor is a wireless solution for the IIoT, monitoring equipment conditions continuously.

Easy installation

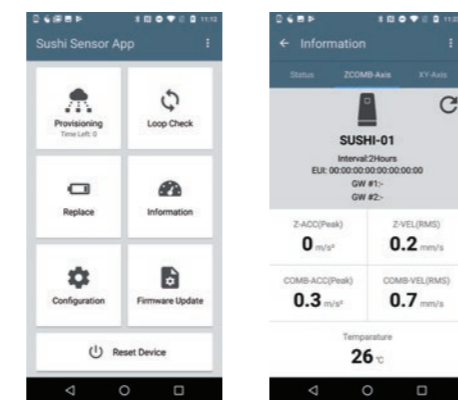
- The rugged Sushi Sensor can be installed in harsh environments including hazardous areas.
- The wireless function, battery, and sensor are integrated in a single body.
- The LoRaWAN standard enables long-distance communication and thus flexible installation.
- Easy mounting with a screw or magnet.

Easy setting

- Parameters can be set with a smartphone via near-field communication (NFC).
- A user-friendly application is available for setting.

Easy data collection and monitoring

- Data can be collected over a wide area via long-distance wireless communication.
- Collected data can be accessed from user applications regardless of the communication protocol.



Application screen examples

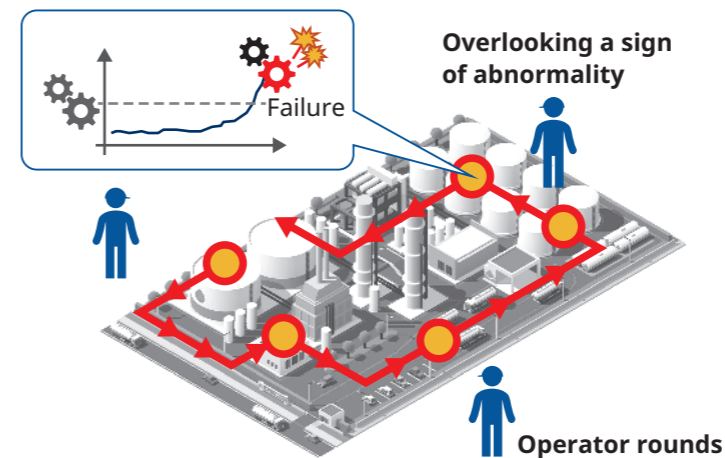


LoRaWAN is one of the low power wide area (LPWA) network protocols, which are now attracting attention as a wireless communication system for the IoT (for sensor devices). LoRaWAN is an open communication standard promoted by the LoRa Alliance of more than 500 IoT companies and users worldwide. Even in a plant packed with various equipment, this protocol ensures long-distance communication 1 km away from sensors to a gateway even in the "pipe jungle" of plants.

Benefits of Sushi Sensor



Before installation

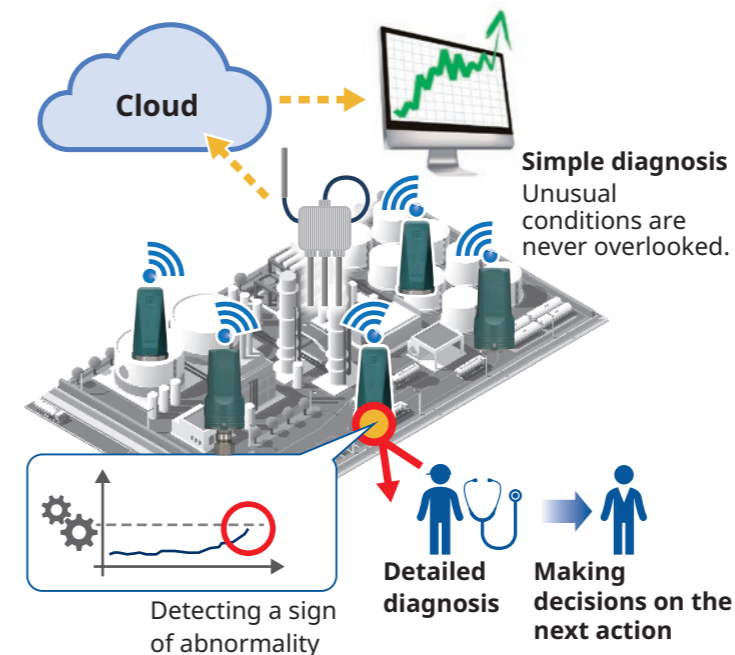


Operator rounds mainly confirm absence of abnormality signs in equipment, but are not ideal because:

- The required man-hours keep increasing as the number of equipment and items to be inspected keeps growing.
- In addition to manpower shortages, insufficient training results in insufficiently skilled field workers.
- Measurement results are not always quantified.

There is an increasing possibility of overlooking signs of abnormality.

After installation



Sushi Sensor continuously monitors target equipment. Data are quantified, accumulated, and used for simple diagnoses. Signs of abnormality in equipment are never overlooked.

Detailed diagnosis

When a sign of abnormality is detected, operators perform a detailed diagnosis to identify the cause.

Making a decision on the next action

Based on the results of the detailed diagnosis, operators decide an appropriate action and its schedule.

Benefits

- The required man-hours do not increase even when the number of equipment grow.
- Manpower shortages are resolved. Skilled workers can spend more time passing on their skills and know-how to other workers.
- Quantified measurement data help identify equipment conditions more accurately.

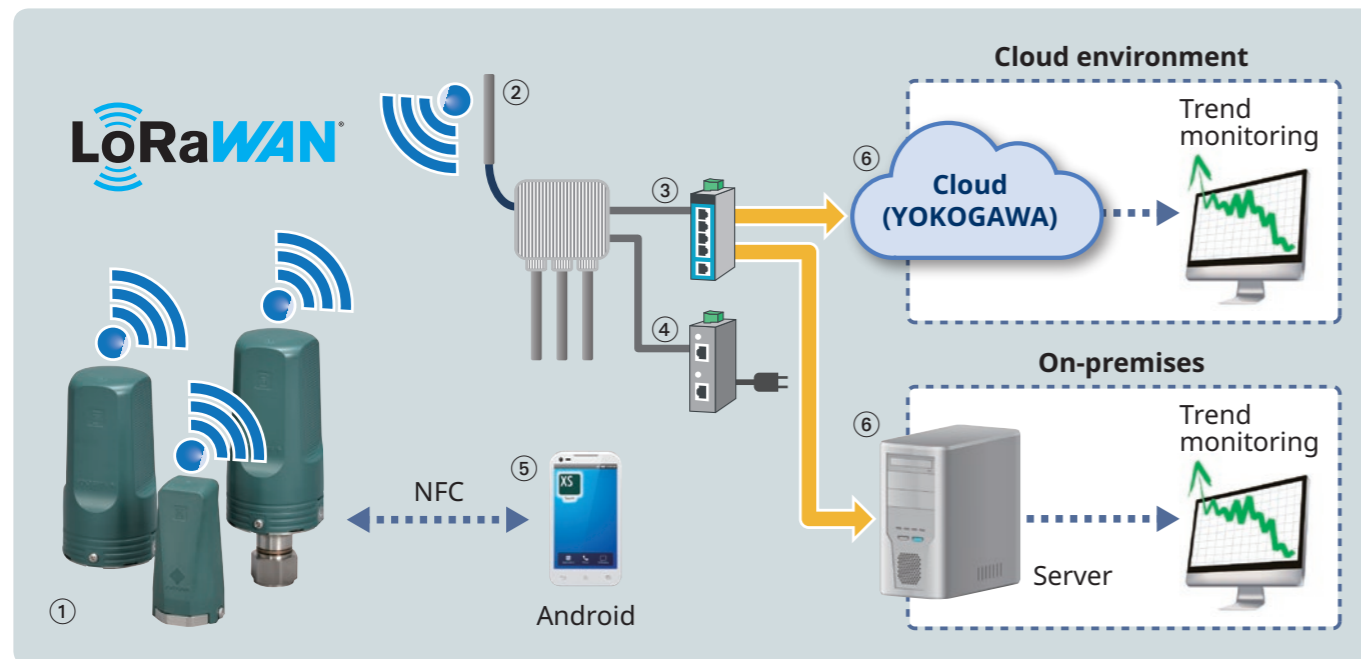
Operators can concentrate on high value-added tasks such as detailed diagnoses and making decisions on the next action. A sign of abnormality is never overlooked and CBM is ensured.

System Configuration



Sushi Sensor is composed of the following six components.

Acquired data are transmitted to host systems via the LoRaWAN gateway. Users can choose either the cloud environment or on-premises servers depending on their applications.



System components of Sushi Sensor

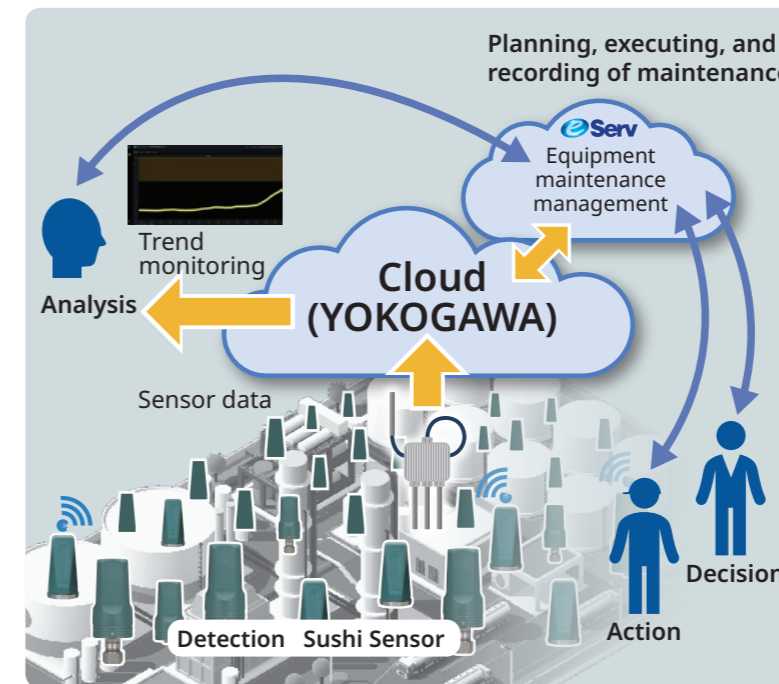
Number	Name or model		Description
①	Sushi Sensor		Measures vibration, pressure, and temperature.
②	LoRaWAN gateway		Receives measurement data from the Sushi Sensor and passes them to the cloud server or the on-premises server.
③	Ethernet switch with a PoE function*1		An Ethernet switch that outputs Ethernet signals on which 48 V DC is superimposed, and supplies power to the gateway
④	PoE injector*1		An adapter that superimposes 48 V DC on Ethernet signals
⑤	Android device		A device on which Sushi Sensor applications are used to set the Sushi Sensor
⑥	Cloud (YOKOGAWA) or On-premises		Accumulate the sensor data in the Cloud server or the On-premises server

Options

Magnetic holder		A magnet for mounting a wireless vibration sensor (screw clamp)
NFC card		A storage medium to save the encryption key for LoRaWAN communication

*1 Either a PoE injector or an Ethernet switch with a PoE function is used.

Plant Asset Health Monitoring Solution



Sushi Sensor makes it easy to accumulate digitized data on equipment conditions in the cloud environment automatically. The quantified data help make consistent and uniform judgments in equipment inspections, which used to depend on intuition and experience.

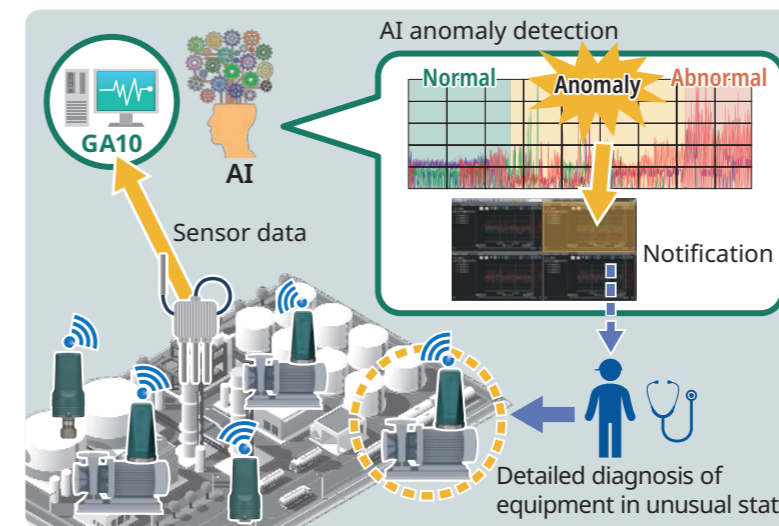
Signs of abnormality can be detected by monitoring the trend of equipment conditions using the acquired data. And users can efficiently draw up and execute appropriate maintenance plans through eServ linked to the cloud environment.

The Plant Asset Health Monitoring solution monitors equipment continuously and helps operators make quick decisions.

Benefits

- Reducing inspection man-hours by automatically acquiring data from equipment including in high places or hazardous areas and placing the data online
- Quantifying and visualizing inspection results that depended on intuition, experience and practical know-how in the field
- Reducing variations in inspection quality due to differences in the skill and experience of inspectors
- Early detection of signs of abnormality by equipment trend monitoring
- Quick planning of inspection and maintenance using eServ data, and saving the results like equipment medical records

AI Anomaly Detection Function



Human operators cannot monitor and judge the trends for numerous equipment deployed in the plant all; AI and machine learning assist such judgments and decisions-making.

Yokogawa's solution detects anomalies as signs of equipment abnormality using AI in the GA10 data logging software and equipment conditions gathered by Sushi Sensor, and issues alarms.

The equipment that requires closer monitoring is automatically identified in the plant.

Benefits

- Automatic learning and judgment by AI by just specifying a data period of normal condition as a reference, reducing the work of setting threshold values
- Early detection and notifying of anomalies even when experts cannot identify signs of equipment abnormality
- Supporting quick decisions-making by digitizing equipment data and AI anomaly detection
- Identifying the equipment that requires closer monitoring, achieving a simple, easy equipment maintenance

New Value contributed by Sushi Sensor



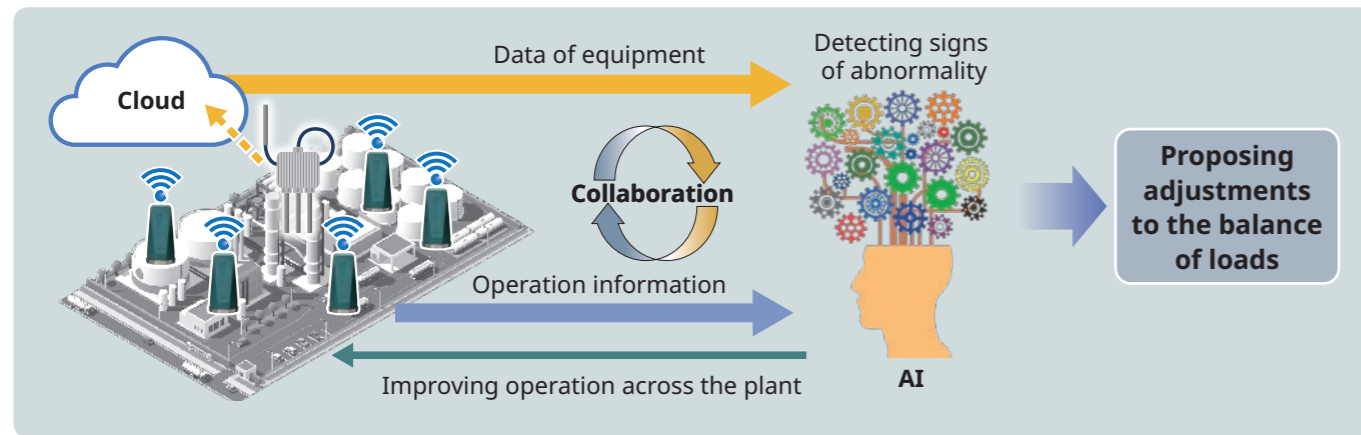
The benefits of introducing Sushi Sensor go well beyond improving the efficiency of equipment maintenance.

By quantifying equipment conditions, the equipment data and production process data of a plant can be collaborated. Thus, Sushi Sensor greatly improves operation efficiency and product quality, while securing safety and stability, besides improving maintenance of customer equipment.

Advanced AI and machine learning assist failure prediction, diagnosis of equipment, maintenance decision-making, besides detecting signs of abnormality. Moreover, integrating equipment and production process data helps make decisions that raise efficiency and quality.

Besides maximizing the profit of a plant, sharing data across plants via the cloud assists overall efficiency for individual plants, multiple plants, and the whole company.

Yokogawa aims to achieve digital transformation (DX) of all its activities and culture to raise the performance of plants and benefit customers.



Through collaboration between operation and equipment maintenance, Yokogawa will achieve APM for improving the entire plant and optimizing maintenance.



XS770A

Integrated Wireless Vibration Sensor



XS770A

Mounting



Trend monitoring for detecting signs of abnormality

The XS770A is a wireless vibration sensor with the sensor and wireless communication functions integrated in a unit. The XS770A measures vibration (velocity and acceleration) along the X, Y, and Z axes and 3-axis composite in addition to monitoring the surface temperature of the bottom. The measured data are transmitted wirelessly to the host systems.

The XS770A can detect signs of abnormality in rotating machineries and motors by measuring their vibration and monitoring the data trend.

Measurement data	Velocity (RMS), acceleration (peak), and surface temperature Axes: X, Y, Z axes and 3-axis composite Frequency range: 10 Hz to 1 kHz
Measurement range	Velocity: 0 to 20 mm/s Acceleration: 0 to 130 m/s ² Surface temperature: -20 to 85°C (-4 to 185°F)
Update time	1 minute to 3 days
Battery life	4 years (update time: 1 hour ^{*1}), battery replaceable
Dimensions and weight	97 × 46 × 46 mm, 260 g
Explosionproof	ATEX, IECEx, FM, CSA

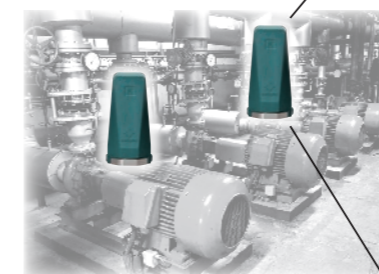
*1 Ambient temperature: 23 ± 2°C (73.4 ± 3.6°F)

Application example

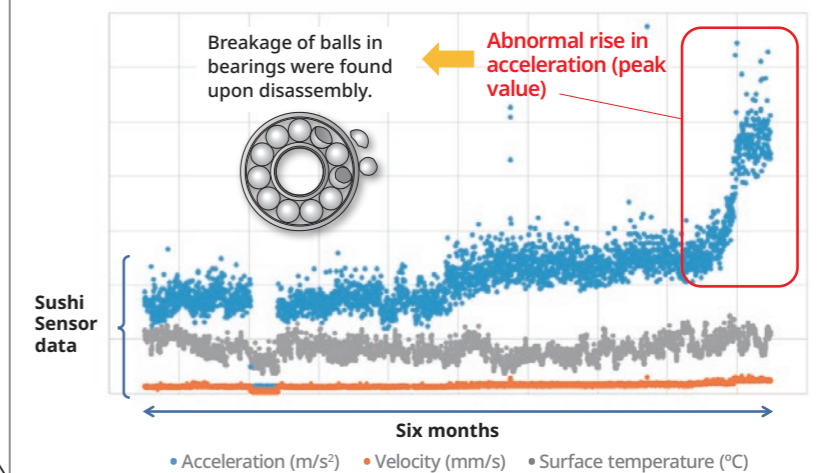
The figure below shows an example of detecting signs of abnormality at a chemical company. An integrated wireless vibration sensor performed hourly measurements of the vibration (acceleration) of a pump over six months. The data in the red frame showed an abnormal rise in the acceleration of the pump. Therefore, the ball bearing of the pump was disassembled, revealing broken balls inside. This example shows that hourly measurements can successfully detect signs of abnormality if accumulated long-term trends are monitored.

Example of detecting signs of abnormality at a chemical company

A sign of abnormality was detected by monitoring the vibrational acceleration of a pump for six months.



Vibrational acceleration of a pump was continually monitored over six months. Hourly measurements successfully caught a sign of abnormality.



XS110A XS530

Wireless Pressure Sensor



Replacing operator rounds and quantifying

The XS530 Pressure Measurement Module operates as a battery-powered wireless pressure sensor when combined with the XS110A Wireless Communication Module. This sensor measures the gauge pressure of gases and liquids and wirelessly transmits the measurement data to the host systems. The battery can be replaced by removing only the wireless communication module without dismantling the measurement module from the piping.

Measurement data	Gauge pressure Process temperature limits: -40 to 120°C (-40 to 248°F) Measured fluid: gases, liquids
Measurement range	-0.1 to 5 MPa or -0.1 to 35 MPa
Accuracy	Pressure: ±0.25% of Full scale
Update time	1 minute to 3 days
Battery life	10 years (update time: 1 hour ^{*1}), battery replaceable
Dimensions and weight ^{*2}	188 × ø68 mm, 1 kg or less
Explosionproof	ATEX, IECEx, FM, CSA

*1 Ambient temperature: 23 ± 2°C (73.4 ± 3.6°F)
*2 Dimensions and weight depend on the specifications selected.

Process connections



Expected applications

Replacing pressure gauges (PGs)

Challenge

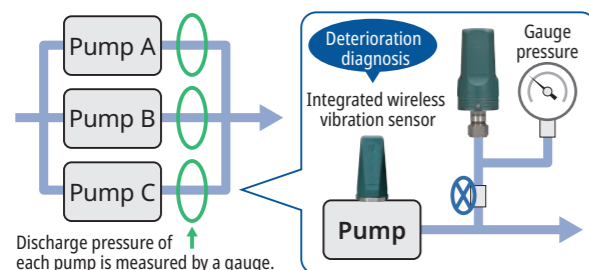
Conventionally, the discharge pressure gauge of each pump is visually inspected each time the pump is switched, for example, from Pump A to Pump B, or inspected during operator rounds. Customers want to be able to inspect such pump pressure gauges remotely.

Solution

Replacing PGs with wireless pressure sensors and making the pump discharge pressure data available online. Implementing pump diagnoses combined with a wireless vibration sensor.

Benefit

By making the pressure and vibration data available online and monitoring the state of deterioration of pumps, customers can identify which pump needs maintenance. Maintenance can then be conducted efficiently depending on the pump conditions.



Detecting leakage and clogging of dust collectors and their piping

Challenge

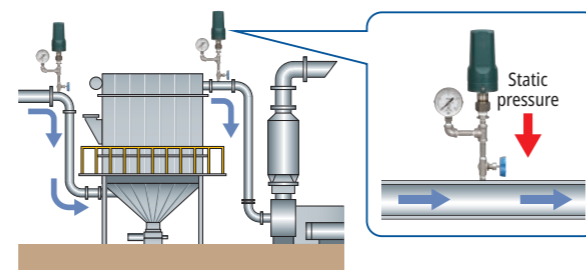
Pressure gauges (PGs) are visually inspected during operator rounds, because leakage or clogging in dust collectors will cause equipment failures or reduced operation efficiency. Although the measurement points are widely distributed throughout a plant, customers want to increase the frequency of operator rounds or the number of measurement points.

Solution

Replacing the existing pressure gauges (PGs) with wireless pressure sensors, or adding sensors.

Benefit

Sensors can be monitored continually by making the sensor data available online. Adequate inspection frequency can be secured for the points of required. Thus, equipment failures can be avoided and operation efficiency can be improved.



XS110A XS550

Wireless Temperature Sensor



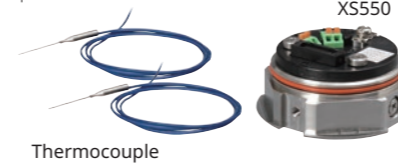
Temperature measurements with thermocouples

The XS550 Temperature Measurement Module operates as a battery-powered wireless temperature sensor when combined with the XS110A Wireless Communication Module and one or two thermocouples. The sensor supports IEC standard (IEC60584) thermocouples (9 types) and wirelessly transmits the measurement data to the host systems. The battery can be replaced by removing only the wireless communication module without dismantling the measurement module.

Measurement data	Temperature, 2 points (non-insulated)
Measurement range	Thermocouples of types B, E, J, K, N, R, S, T, C -200 to 2315°C (-328 to 4199°F) ^{*1}
Reference contact compensation accuracy	±1.0°C
Accuracy	Refer to the General Specifications for the XS550 Temperature Measurement Module.
Update time	1 minute to 3 days
Battery life	10 years (update time: 1 hour ^{*2}), battery replaceable
Dimensions and weight ^{*3}	141 × ø68 mm, 800 g or less
Explosionproof	ATEX, IECEx, FM, CSA

*1 Depends on the type of thermocouple used. *2 Ambient temperature: 23 ± 2°C (73.4 ± 3.6°F) *3 Dimensions and weight depend on the specifications selected.

Thermocouple mounting



Two thermocouples can be connected to the XS550.

Expected applications

Monitoring temperature for multi-stage heat exchangers

Challenge

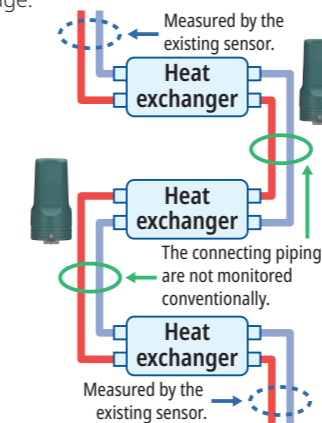
Multi-stage heat exchangers have channels for measuring the input/output temperatures of the whole heat exchanger from a process operation point of view. Customers want to know the health condition of respective heat exchanger comprising each stage of the piping connecting each other.

Solution

The health condition of the piping can be monitored by adding wireless temperature sensors on the heat exchangers of each stage.

Benefit

This solution makes it easy to identify the heat exchanger that requires maintenance. Thus, maintenance can be conducted efficiently according to the conditions of the target heat exchangers.



Detecting leaks of safety valves

Challenge

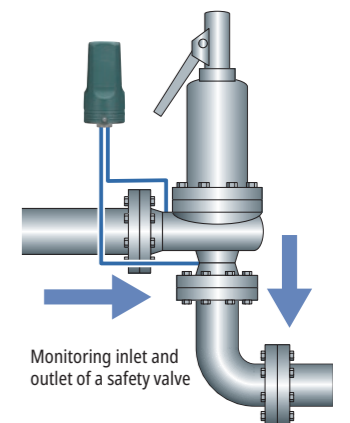
Safety valves are mounted for relieving the pressure in case of a pressure rise in equipment or piping. Due to the effect of the internal environment, a slight amount of seat leakage may occur that requires operation shut-down and maintenance. Since safety valves cannot be visually inspected during operation, customers want to monitor them remotely without equipment shut-down.

Solution

The temperatures at the inlet and outlet of a safety valve are measured by wireless temperature sensors to monitor the temperature difference.

Benefit

Monitoring the temperature difference enables early detection of seat leakage to avoid unscheduled operation shut-down.



Sushi Sensor was named after sushi, a hand-pressed traditional Japanese food which combines rice with various toppings, just like the rice base of sushi, the wireless capability and battery technology are common to all types of Sushi Sensor while various sensor functions will be added to this core part like the toppings of sushi.



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