Smart Maintenance Case Study for a HV Product - Dry Air-Insulated Eco C-GIS as Green Transformation (GX)

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Abstract

In recent years, customer have faced a number of challenges in the maintenance of electrical equipment, including shortages and the aging of maintenance personnel, aging electrical equipment, and an increasing maintenance workload. To address these challenges, we have been expanding our range of smart maintenance products and solutions by utilizing information and communication technology (ICT). These include remote monitoring and labor-saving inspection technologies, equipment deterioration diagnosis based on big-data analysis of accumulated monitoring data, and technologies that enable faster assessment of equipment conditions in the event of an abnormality.

At the premises of our Numazu Works, there is a high-voltage substation. It includes the cubicle-type dry air insulated switchgear (Eco C-GIS). It installed a vacuum monitoring device and pressure sensors as part of a continuous monitoring system for the Eco C-GIS. Information detected by the system is assembled on the cloud-computing system, and by analyzing this big data, we could solve the above issues and we could obtain certification as a "Smart Maintenance Technology Model."

1 Preface

In recent years, customer challenges in equipment maintenance have included a shortage and aging of electrical safety personnel, the aging of electrical equipment, and the increasing burden of maintenance. To address these challenges, our company is developing smart maintenance products that utilize information and communication technology (ICT) for remote monitoring and labor-saving inspections, equipment deterioration diagnosis through big data analysis using accumulated monitoring data, and rapid situation assessment in the event of an anomaly.

In 2022, our Numazu Works's high voltage substation and the related equipment maintenance technology received certification as a "Smart Maintenance Technology Model" from the National Institute of Technology and Evaluation (NITE) Smart Maintenance Promotion Committee.

This article introduces a case study of applying smart maintenance to a cubicle-type dry-air insulated switchgear (Eco C-GIS) applied as an environmentally friendly product to the Green Transformation (GX) high-voltage substation completed at our Numazu Works in 2021.

2 Smart Maintenance

Smart maintenance is defined as follows: "① Based on scientific evidence derived from sufficient information and data, and based on neutral and fair judgment; ② Constantly pursuing safety and efficiency in industrial maintenance works through the introduction of new technologies that enhance safety and efficiency, such as IoT and AI, on-site ingenuity, and streamlining of on-site works; ③ Continuously promoting the strengthening of self-maintenance capabilities and improvement of productivity in businesses and the job sites; and ④ Creating peace of mind and safety for the nation's citizens for the future by continuously reviewing regulations and systems" (1).

To realize smart maintenance, it is essential to

install various sensors that detect data necessary for maintenance and to ICT-enabled equipment.

3 Case Study

Fig. 1 shows the Eco C-GIS supplied to our Numazu Works. Our Numazu Works's Eco C-GIS is equipped with a vacuum monitoring device and pressure sensors as a continuous remote monitoring system.

Fig. 2 shows the external appearance of the vacuum monitoring device, and Fig. 3 shows its detection mechanism. The vacuum monitoring device is a device that monitors the deterioration of the vacuum level during operation of the vacuum interrupter (VI). When the vacuum level deteriorates, the pulse signal of the discharge generated inside the VI is captured by a sensor placed near the VI and detected by this device. When an abnormality occurs, the device notifies the external system via a contact output and also displays the abnormality on the device's panel using LEDs.

Fig. 4 shows the external appearance of the pressure sensor, and Fig. 5 shows the relationship between pressure and output current. A pressure sensor is a device that converts physical pressure

Fig. 1 Eco C-GIS

The External appearance of the Eco C-GIS being operation as a extra-high voltage substation for Green transformation (GX) at our Numazu Plant is shown.

Fig. 2 Vacuum Monitoring Device

The External appearance of the vacuum monitoring device is shown. The occurrence of an abnormality can also be confirmed by the light emitting diodes (LED) indicator lamps on the front of the device panel.

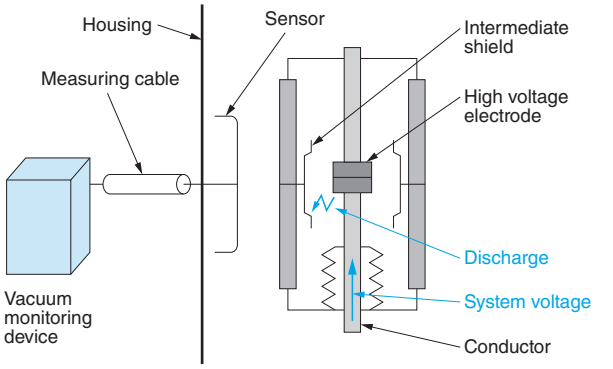

Fig. 3 Continually Monitored Mechanism

The continually monitored mechanism of a vacuum monitoring device is shown. Using the relationship between vacuum pressure and insulation breakdown voltage (Passchen's law), it is continually monitored that discharge has started within VI, and it is determined that the vacuum degree has deteriorated.

Fig. 4 Pressure Sensor

Shows the External appearance of the pressure sensor. Noise measure is applied to the pressure sensor, and pressure measurement with high reliability is possible.

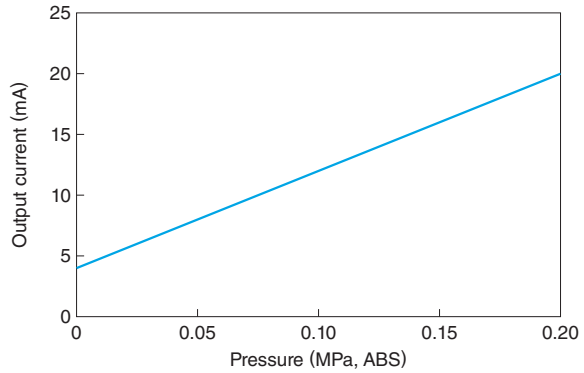

Fig. 5 **Relationship between Pressure and Output Current**

The relationship between pressure and output current is shown. Since the output current also changes when the pressure changes, the tendency of pressure change can be confirmed remotely by Instrument the output current and transmitting it to an external system.

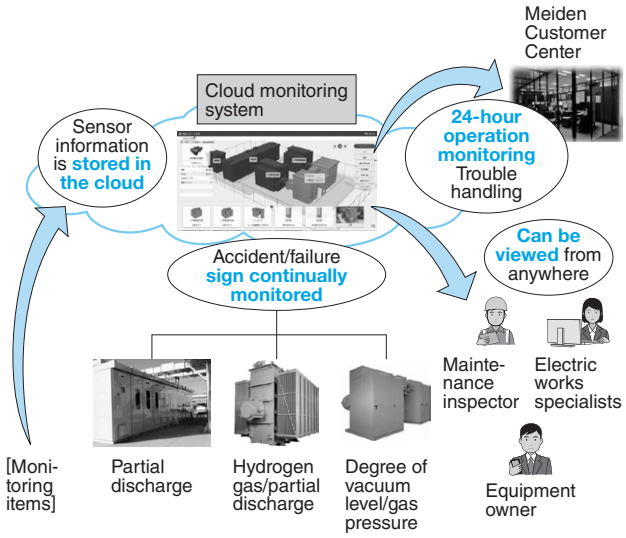

Fig. 6 **Sensor Information Exploitation Image**

An image is shown in which information continually monitored from sensor is stored in a cloud and Exploitation. With the cloud monitoring system, it is possible to check remotely 24 hours a day.

into an electrical signal. Pressure sensors are installed in each gas compartment, measuring pressure changes in real time and transmitting data to an external system, allowing for remote monitoring of pressure change trends.

Information from the Eco C-GIS vacuum monitoring device and pressure sensors is assembled on the cloud-computing system and stored as big data. **Fig. 6** shows an image of how information detected by the sensors is stored and utilized in the cloud.

Furthermore, by analyzing big data, the following can be achieved:

(1) Labor-saving in daily inspection work
(2) Deterioration diagnosis based on long-term trends
(3) Remote monitoring from distant locations
(4) Rapid situation assessment in the event of trouble

Based on the above, our Numazu Works's high-voltage substation was able to obtain certification as a "Smart Maintenance Technology Model" from the NITE Smart Maintenance Promotion Committee. In addition, we revised the maintenance-related internal regulations submitted to the Industrial Safety Supervision Department, a regional branch of the Ministry of Economy, Trade and Industry, responsible for ensuring the safety of electrical installations and receiving notifications (amendments) of internal maintenance regulations. Owners of private electrical equipment are obligated under the Electricity Business Act to notify the head of the relevant Industrial Safety Supervision Department of any changes to their safety system or in the event of an accident. The inspection of electrical equipment was performed during a scheduled power outage every year, but it was changed to once every six years.

4 Postscript

Starting with the expansion of the application of smart maintenance, which we are currently working on, we aim to develop highly reliable products that reduce the burden on our customers by expanding the scope of labor-saving in maintenance inspections and establishing equipment deterioration diagnosis technology.

・All product and company names mentioned in this paper are the trademarks and/or service marks of their respective owners.

《Reference》

(1) Ministry of Economy, Trade and Industry: "Basic Policy for Promoting Smart Maintenance" (June 2020)
https://www.meti.go.jp/shingikai/safety_security/smart_hoan/pdf/kihon_hoshin.pdf