

Customer Portal Enhances Customer Experience Value in MHI Centrifugal Chillers



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Centrifugal chillers are mainly used as heat sources for factory air conditioning and district heating and cooling system. As with residential air conditioners, the electricity costs account for a large portion of their operating costs, so energy saving is important. However, it is not easy for customers to correctly monitor the equipment status and improve energy efficiency on their own. Furthermore, As the machine ages, it is more difficult to keep track of maintenance records, which makes it even harder to perform effective maintenance. To solve these problems, Mitsubishi Heavy Industries Thermal Systems, Ltd. (MTH) has launched a portal site which helps our customer s to easily access to machine specifications, recommended maintenance plans and records, as well as real time chiller operation status when necessary.

In addition, by integrating the portal site with the introduction of IoT to centrifugal chillers, MTH have visualized energy efficiency and loss, and have started to provide solutions for realizing data-based energy saving.

1. Introduction

Centrifugal chillers are used as heat source equipment in a wide range of various fields such as small machine factories, large semiconductor factories, district heating and cooling, hospitals, pharmaceutical and food plants. There are three major operating costs (i.e., electricity, water, and maintenance costs) for centrifugal chiller operation. Among them, as with residential air conditioners, the electricity cost accounts for the largest share, so efforts to save energy are important. However, it is not easy for customers to obtain the details of the electricity consumption and compare it with the operating conditions of the equipment to analyze and evaluate the operating rate, load conditions, etc., for the purpose of energy saving. Furthermore, centrifugal chillers are operated for a long period of time and it is crucial to share information in managing the maintenance history and handing over the related duties, but this comes with difficulties. In addition, since stable operation is the first priority in maintenance management work, it is impossible in many cases to obtain sufficient understanding for the improvement in energy saving. Therefore, there is considerable demand for consultation and assistance from the manufacturer regarding evaluation and analysis for energy saving.

Against this background, MTH decided to launch a platform that can enhance the customer experience value by allowing customers to see the operating conditions, electricity consumption, equipment operating efficiency, and maintenance history of their centrifugal chillers. MTH designed this customer portal site as a place to share maintenance and new technologies information that lead to energy savings, as well as to make proposals and considerations based on data in conjunction with remote monitoring, thereby expanding contact points with customers.

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2. Customer portal site for assisting customer's chiller operation

2.1 Overview

The customer portal site "MHI Centrifugal Chiller Club" provides all customers who have installed our chillers with various information on the cloud, such as final documentation of the delivered chillers, periodical inspection reports, Compressor overhaul reports, and chiller operation data. MTH started operating this portal site in December 2021 as a platform that allows customers to check the information and conditions of their chillers anytime and anywhere. This portal site can be accessed not only from PCs but also from tablet computers, smartphones, or the like, and realizes a system that allows customers to check the necessary information about their centrifugal chillers, which are important assets, anytime and anywhere as needed. **Figure 1** outlines the customer portal site.

By sharing equipment information, records, and data on the customer portal site between our customers and MTH, communication without misunderstanding has become possible.

In terms of security, the customer portal site was constructed and is operated in due consideration of data protection through SSL (Secure Sockets Layer) communication, anti-spoofing, etc.

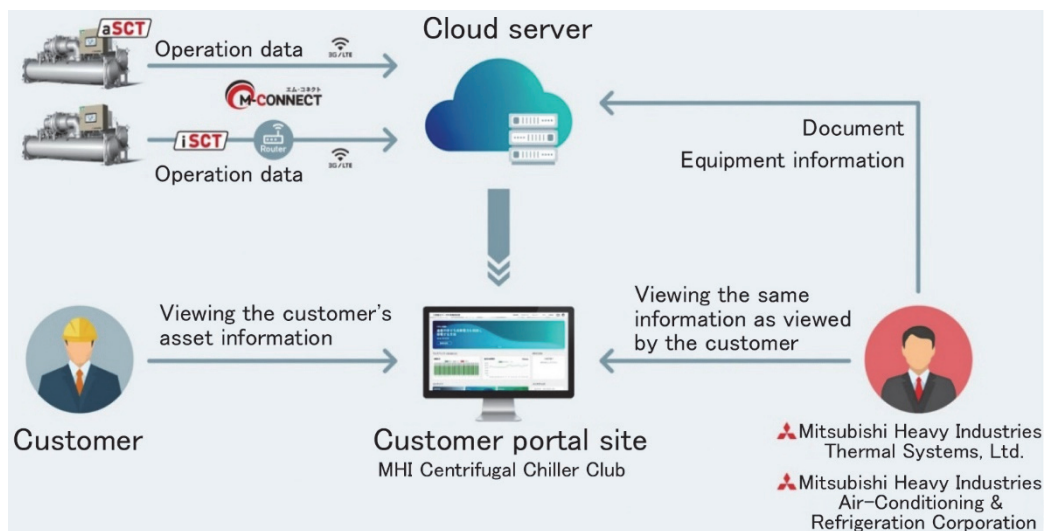


Figure 1 Outline of customer portal site* This information provides for Japan domestic market only

2.2 Services provided

MTH provide two levels, paid and free, of three services: (i) library, (ii) latest information from MTH, and (iii) operation data display. **Figure 2** shows the services, their contents, and corresponding provided values.

- (i) Library that provides documentation such as final documents, operation manuals, catalogs, Inspection records, compressor maintenance records, maintenance records and heat exchanger cleaning reports, etc.
 - (ii) Manufacturer information regularly provided in the form of columns
 - (iii) Equipment operation data displayed in an easy-to-understand manner in the form of graphs*1.
- In addition, various reports such as monthly, weekly, daily, and operation logs are automatically generated and provided on the cloud*2.

*1 Provided based on a separate contract for remote monitoring system M-CONNECT.

*2 Provided based on a separate service maintenance contract.




	Service	Content	Value provided
Free	Library 	Equipment information	<ul style="list-style-type: none"> ✓ High accessibility and at-a-glance visibility for asset information. ✓ Smoother handover of related duties at the time of a change of the person in charge. ✓ Reduction of the need for customers to manage documents and request materials by themselves.
		Maintenance information	
		Documentation	
Free	Latest information from MTH 	Column	<ul style="list-style-type: none"> ✓ Timely access to the latest technical information. ✓ Know-how sharing based on manufacturer's knowledge.
		Case study	
Paid	Operation data display 	Monitoring	<ul style="list-style-type: none"> ✓ Real-time monitoring of operating conditions from remote locations. ✓ Elimination of on-site handwritten work. ✓ Contribution to investigation of the cause of abnormalities and to preventive maintenance.
		Reporting	

Figure 2 Provided services

2.3 Technological features of customer portal site

MTH designed the customer portal site to be easy for everyday use, focusing on visually clear design and intuitive usability.

The customer portal site also meets the demands of customers with nationwide facilities who want to understand the maintenance and operation of their chillers installed at each facility. Even when the person in charge of equipment management changes, the maintenance history and equipment information on the customer portal site allow for easy handover. In addition, operation data that could only be confirmed by visiting the site and operating the chiller control panel can be downloaded in report format from the customer portal site. This allows workers to concentrate on equipment observation and inspection and leads to a reduction in their workload.

In addition, MTH uploads latest technical information on the customer portal site when it arises, so customers can access latest information as needed.

By thoroughly pursuing what information and operations are necessary for each screen and eliminating unnecessary information, the structure with less hierarchies and well-organized information was launched so that users can access the desired information with fewer operations and without getting lost.

Since some centrifugal chiller maintenance management workers have extensive technical knowledge and others do not, the user interface of the customer portal site was designed to be intuitive with a simple design.

The equipment operation data display, which is available to customers who subscribe to the remote monitoring service, was designed to be light and easy to operate, using a system that can process large time-series data at high speed. **Figure 3** shows an example of the monitoring screen. The displayed trend graphs show a structure that incorporates the knowledge unique to us. They display the measured values and the threshold values set in the centrifugal chiller in an overlaying manner (as indicated by the arrows in Figure 3) to provide a visual indication of the normal operating range. In the past, it was necessary to check and compare the measured values with the threshold values described in the final documents to determine the operating conditions. However, since this trend graph enables instantaneous confirmation and judgment, the need for preparation work for confirmation is eliminated, enabling clear determination.

Another feature of this customer portal site is that it can be constantly extended and improved because it is on the cloud.

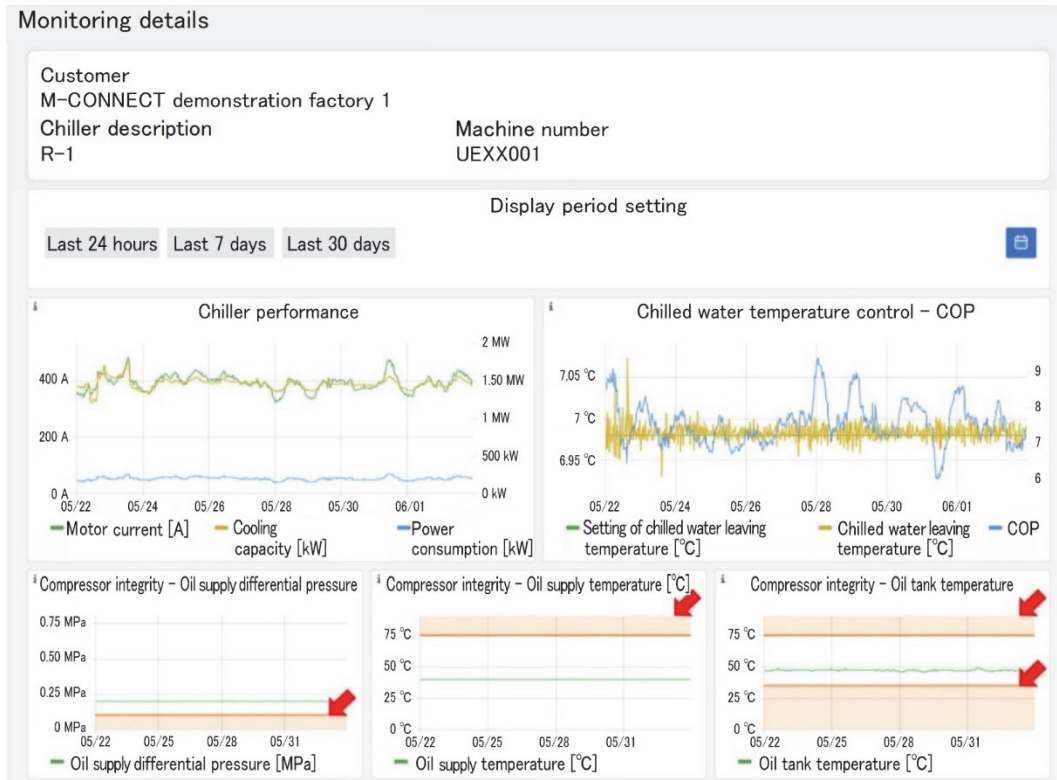


Figure 3 Monitoring screen on which the chiller thresholds and measurements can be checked on a single graph (example)

2.4 Customer feedback after release

"Due to the maintenance conditions provided in a tabular format, maintenance items that were performed in the past and that were not performed can be clearly identified, so planning future maintenance has been made easier and overlooking of necessary maintenance was avoided, and it has become no longer necessary to list maintenance items that have been performed by referring to the contents of past reports," said a customer who realized labor saving in their examination work related to maintenance.

"The customer portal site allows us to receive operation data in the form of a report such as daily operation logs, so hand-recording operation data required for grasping and evaluating the operating conditions is no longer necessary and the inspector can concentrate on the inspection work of the equipment condition," said a customer who had been required to inspect their equipment at multiple facilities, "and the burden of travel has been reduced as a result of reduction of travel time and frequency due to on-the-web accessibility of operating conditions."

"Due to the aggregation of materials related to chillers and their maintenance in the customer portal site, material storage work is no longer necessary and desired materials can be found more easily," said a customer who realized the reduction of their workload.

Clearly, customers are pleased with the service of the customer portal site, its intuitive operation and easy information to access.

3. Introduction of IoT(Internet of Things) to centrifugal chillers - Make chillers "connected"

3.1 Remote monitoring system M-CONNECT

MTH provide the remote monitoring system M-CONNECT, which is a service that connects centrifugal chillers to a cloud server on the Internet using IoT technology to enable remote monitoring. The feature of this service is that the chiller conditions can be monitored on the web.

The remote monitoring system M-CONNECT provides the following functions.

- To upload chiller operation data to the data server on the cloud constantly and instantaneously. (Operational data as well as various reports, i.e., operation logs and daily, weekly, and monthly reports, are viewed on the customer portal site.)
- To notify the specified mail address of chiller trip information.

Chiller operation data are handled in the customer portal site, so the chiller conditions can be known from any location as long as an internet connection is available.

3.2 Dedicated communication device aSCT, which removes barriers to introduce remote monitoring

In the past, the connection between chillers and the cloud for providing the chiller remote monitoring service was made using the optional iSCT⁽¹⁾. However, it was necessary for the customer to make arrangements and/or work for the modification of the chillers and the improvement of the customer's equipment (installation location, power supply and wiring work between the iSCT and chillers), so there was a problem that the cost had increased, particularly when introducing the remote monitoring service during extending or upgrading work. In order to solve this problem and make the remote monitoring service easier to introduce and more widespread, MTH have developed aSCT, which enables mobile connection. **Table 1** compares the developed aSCT and the conventional iSCT and Figure 1 shows the system configuration. The aSCT characteristically has fewer components required for mobile connection than iSCT.

The aSCT has a built-in communication module, so remote monitoring can be started once its antenna is installed and the activation is made, so installation of the Internet on the equipment side and the preparation of a Wi-Fi communication device are no longer necessary. In addition, the aSCT is mounted on the chiller control panel and powered thereby, so there is no need to consider the equipment layout plan. As a result, introduction of remote monitoring into existing chillers can become easier.

The ETI-Z series and the JHT-Y series centrifugal chillers are equipped with aSCT as standard equipment, and have realized the removal of barriers through introduction of remote monitoring by eliminating the need to install aSCT as optional equipment, as was the case with previous models.

For long-used existing chillers, MTH have also prepared solutions for realizing IoT to centrifugal chillers without the need for modification of the customer's facilities by replacing the old controller board in the chiller control panel with a newly designed renovation controller⁽²⁾ and installing aSCT.

Table 1 Comparison of MHI dedicated communication equipment

Item	aSCT	iSCT (conventional)
Installation location	On chiller control panel	Separate installation*
Power supply	Powered by control panel	Separate 100 VAC power required**
Wiring	All on control panel	Introduction of communication line required**
Communication method	Communication module built in aSCT	(1) Router and Internet line** (2) Router and Wi-Fi communication device
Communication line construction	Installation of antenna and activation of SIM	(1) Introduction work of Router and Internet line** (2) Introduction work of Router and Wi-Fi communication device

* Shall be layout-planned by the customer.

** Shall be arranged by the customer.

3.3 Case studies of analysis and evaluation of remote monitoring

Through these efforts, MTH have been promoting the introduction of IoT not only for newly installed chillers but also for existing chillers. As a result, MTH can provide our customers with solutions represented by the customer portal site.

This section presents a case where monitoring of operation data on the customer portal site visualized performance degradation and encouraged maintenance.

A customer who operates a chiller in an environment where heat exchanger (condenser) tubes are likely to become dirty used a timer for setting the schedule of chemical injection to improve contamination. In the past, they used a hand-written operation data numerical table to analyze the trend in order to determine the effectiveness and schedule-resetting of chemical injection.

Figure 4 shows graphs representing the performance degradation caused by heat exchanger (condenser) tube dirt and the performance recovery after taking appropriate measures. The vertical axis represents the terminal temperature difference of the condenser and the horizontal axis represents the passage of time. It is indicated that with the passage of time, the terminal temperature

difference, which is an index of tube dirt, rose, the power consumption increased correspondingly, and the COP (Coefficient of Performance), which indicates the ratio of the cooling capacity to the energy consumption, lowered. The customer confirmed performance degradation, and decided to add a chemical. The trend graph shows that the tube dirt was removed and the performance level was restored as a result of the chemical injection.

In the future, MTH plan to expand the scope of our remote monitoring service to include "Ene-Conductor"⁽³⁾, a controller that optimally controls the entire heat source system, in addition to chillers. Through these ongoing efforts, we hope that more and more customers will experience "connected" chillers.

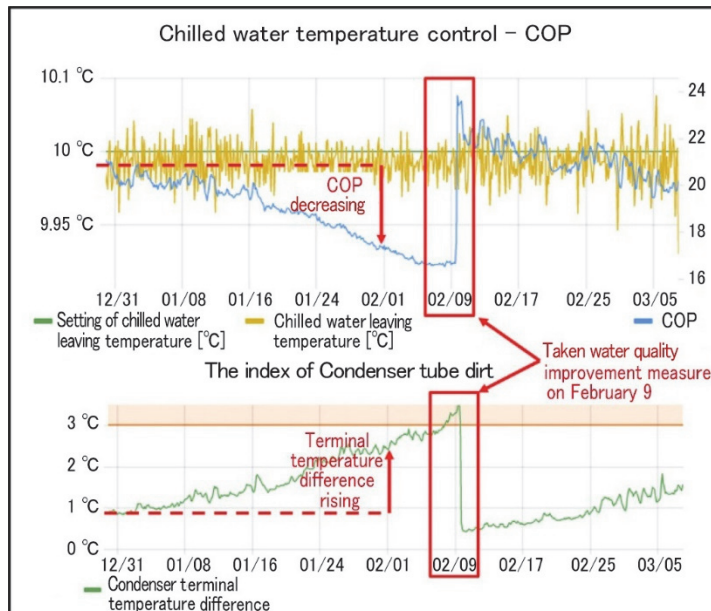


Figure 4 Performance degradation caused by heat exchanger (condenser) tube dirt and performance recovery after treatment

4. Future prospect

Since the release of the customer portal site, MTH have received various opinions and requests from our customers. In response to these, MTH will make efforts to provide our customers with the higher level of convenience.

In addition, we will expand the range of its cloud-connected remote monitoring service from centrifugal chillers to the entire facility, and promote activities that contribute to the visualization and energy-saving operation of customers' facilities (e.g., labor saving in maintenance and operation through optimal facility control and condition monitoring) to further improve customer satisfaction.

5. Conclusion

MTH launched a customer portal site that enables central management of maintenance histories, reports, and operation data, which are necessary for the long-term use of centrifugal chillers.

The customer portal provides a selection of necessary and important functions for customers of various ages and technical levels involved in the operation and maintenance of centrifugal chillers through a simple user interface. In addition, centralized viewing and evaluation of operation data on PCs, tablet computers, and smartphones, such as the load conditions of centrifugal chillers, electricity consumption, and the progress of heat exchanger tube dirt are enabled using a system capable of processing large time-series data at high speed. By sharing this information with our customers through the customer portal, MTH is able to make highly accurate after-sales service and energy-saving proposals, which help customers to reduce the burden of daily maintenance and operation on them.

In addition, by providing communication terminal aSCT with mobile connection capabilities and M-CONNECT remote monitoring system, MTH will promote the introduction of IoT from centrifugal chillers, the starting point, and expand the connected range to all the equipment. Through

these efforts, MTH will improve customer satisfaction by realizing the optimal control and condition monitoring of our customers' equipment.

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