Establishing an Environmental Load Management System for Factories

- A Case Study of Introducing Enerize at Mercian’s Yatsushiro Factory -

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Mercian Corporation has established an environmental load management system at its Yatsushiro Factory by using Yokogawa’s Enerize factory energy management system. The system is intended to manage data not only on energy consumption but also on the environment relating to production activities such as the amount of water consumed in the factory. This paper describes the successful introduction of this system.

INTRODUCTION

As a company that has strong relationship with nature and provides products using nature's blessings, Mercian Corporation is committed to the environment. Its environmental philosophy is “Mercian thanks nature’s blessings and capability that sustain life, and seeks to balance environmental preservation with creating an affluent society.” To create a sustainable society, the company strives to conserve resources and energy, develop environment-friendly products, disclose information regarding environmental impact, and comply with laws.

This paper describes the environmental load management system which was established at Yatsushiro Factory, one of Mercian’s largest production bases, with Yokogawa’s Enerize factory energy management system for factories.

MID- AND LONG-TERM ENVIRONMENTAL GOALS AND OBJECTIVES OF THIS SYSTEM

Mercian recognizes that business activities inevitably impact on the environmental load. To fulfill its responsibility for maintaining the environment and creating a sustainable society, the company has set the following mid-term targets, based on its philosophy and management policy on the environment. (1)

**Target 1:** Reducing CO₂ emissions caused by energy consumption

Factories: Reducing emissions by 7% in FY2012 compared with FY2002

Logistics: Reducing emissions below those in FY2004

**Target 2:** Reducing the use of water for manufacturing

Reducing usage by 20% in FY2012 compared with FY2002

**Target 3:** Reducing waste

Reducing the amount below that in FY2004

**Target 4:** Reducing the emissions of substances designated in the pollutant release and transfer register (PRTR) system

Reducing the emissions to 1/5 of those in FY2002 in FY2012

**Target 5:** Reducing the environmental load caused by containers and wrappings for liquors

Reducing their weight per capacity below those in FY2002

When building the environmental load management system, we concentrated on the management and reduction of CO₂ emissions (target 1) and water for manufacturing (target 2) among these targets.

Table 1 shows the CO₂ emissions and use of water for manufacturing by each production base in FY2008. (1) The CO₂ emissions due to energy consumption and use of water across the company increased by 3.6% and 6.5%, respectively, compared with FY2002. As shown in the table, Yatsushiro Factory, which is the target of the management system, produces various items and thus emits more CO₂ and uses more water than other factories. Therefore, we put priority on these reductions in the factory than in other factories.
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<table>
<thead>
<tr>
<th>Production base</th>
<th>Main products</th>
<th>CO₂ emission [t]</th>
<th>Use of water for manufacturing [kt]</th>
</tr>
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<tbody>
<tr>
<td>Tomakomai factory</td>
<td>Cattle feed</td>
<td>4,766</td>
<td>15</td>
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<tr>
<td>Nikko factory</td>
<td>Rice wine, seasonings, drug products, others</td>
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<td>487</td>
</tr>
<tr>
<td>Fujisawa factory</td>
<td>Wine, others</td>
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<td>237</td>
</tr>
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<td>Katsumuma winery</td>
<td>Wine</td>
<td>347</td>
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</tr>
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<td>1,087</td>
<td>10</td>
</tr>
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<td>Yatsushiro Factory</td>
<td>Shochu (Japanese distilled clear liquor), medicine, chemicals, others</td>
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</tr>
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**Issues in Yatsushiro Factory**

**Issues Found in Yatsushiro Factory**

1) Increased tasks regarding environmental management

Including compliance with the Revised Energy Saving Act enforced in 2010, tasks related to environmental management are tending to increase at the company level as well as in each factory. Figure 1 shows the previous flow of operations in respective factories from collecting environmental data to announcing them. The review and implementation of measures for energy conservation and environment preservation were not included.

**Table 1 CO₂ emissions and use of water for manufacturing by each production base**

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**Targets in Solving the Problems**

To solve the problems and improve the efficiency, we set the following targets for the new system.

- Reducing workloads
- Creating a calculation tool well suited to the present configuration and a system that can easily handle the reorganization and innovation of factory facilities in the future
- Clearly showing the energy consumed per unit production by each product and production line to establish the PDCA cycle

To solve the problems on the site and encourage the PDCA cycle to be carried out, it is necessary to identify inefficient areas of the factory. To do this, it is necessary to visualize the site timely, define key performance indicators (KPI) which shows the status of products and production lines and can be used for decision making, and manage them based on the indicators. As the Indicators (KPI), we have adopted the energy consumption per each production line and facility. We decided to measure the indicators, set new targets of the indicators utilizing the measured values, and build an environment to support the daily PDCA cycle.

**Building the Environmental Load Management System**

To achieve the goals, we built an environmental load management system at the Yatsushiro Factory based on Yokogawa’s Enerize factory energy management system.

**Procedures to Build the System**

Figure 2 outlines the flow to build the system.

**Figure 1** Previous Flow of Operations from Collecting to Announcing Environmental Data

As shown in Figure 1, the previous workflow started with collecting data from the reports created by the control systems for utility facilities such as electric power, steam, and air-conditioning, and the measured data by visual reading of the field instruments at the end of every month. These data were then transferred manually into Excel worksheets for calculation and reporting. When any equipment or management organization was changed, the content of worksheets had to be adjusted accordingly and the calculation performed again. Reports were then created showing the energy cost for each organization and aggregation or allocation of energy and water to and from each organization and production line. It took about 20 man-days a month to perform this work, which reduced the time available for other activities including actually taking energy-saving measures. As a result, the management operations, which should have been carried out according to the PDCA cycle, were done only for collecting and reporting data.

2) Information ownership

Yatsushiro Factory is an old production base which started up in the 1940s, so it has repeatedly reorganized and upgraded its production facilities. The worksheets for calculation and reporting used in the work described above have been revised by successive Registered Energy Managers to reflect such reorganization. However, we could not find detailed records on the reasons for revisions; in the past, only the people in charge possessed such information.

**Figure 2 Outline of the flow to build the system**

The detailed procedures to build the system are as follows.

1) Creating a list of measurement points

A list of measurement points was created as follows.

- Determining appropriate measurement items by examining existing system specifications such as electric power
system diagrams and steam piping diagrams, existing Excel worksheets for managing and calculating the data, information on existing management reports, and the production sites.

- Checking the appropriateness of extracted measurement items by referring to the information that must be included in the report or management.
- Defining properties for each measurement item, including types of energy, location information (building, floor, line, process, and equipment), and usage, then arranging them as a list of measurement points.

2) Creating the energy flow

Based on the electric power system diagrams, steam piping diagrams, and existing Excel worksheets for managing and calculating the data, the energy flow was created by using Visual Builder of Enerize, and the relations between respective measurement points and equipment were defined and arranged.

Figure 3 shows the energy flow created by this work. This allows everyone to easily know the energy balance of the factory. This energy flow includes about 500 measurement points and about 2,000 steps related to converting to energy equivalent, CO₂ equivalent, and cost equivalent in 14 sheets.

3) Arranging and defining allocating information for each department

The rules for allocating energy consumption to each department were defined based on information on the existing worksheets for calculating and managing the data. As shown in Figure 4, this information was defined in terms of organization, data to be allocated, and allocation ratio by using Visual Builder of Enerize.

4) From definition of user tasks to definition of Human Machine Interface (HMI)

The most important requirement when building the system is its operational requirements. However, excellent the system is, its usefulness depends on how it is used. Since Enerize can define the configuration of screens depending on the flow of user operations and countermeasures for difficulties, we could define the development menu of HMI while arranging the flow and purpose of the user tasks.

Total System Configuration

Figure 5 shows the system configuration and other systems. Yokogawa's CENTUM CS3000 and TriFellow are used for the boiler control system and power relating facilities monitoring system. PLCs are used to control and monitor the electricity relating facilities and production facilities in the factory. These systems, PLCs and Enerize are connected through the OLE for process control (OPC) interface, and Enerize collects data periodically.

Data is sent to client PCs via a Web server. To ensure security, it is preferable to build an independent LAN between client PCs and the Web server, as well as between the Web server and data collecting systems such as Enerize. However, constructing a LAN over a wide area would require major work, so we compromised to use the existing in-house LAN and built a virtual local area network (VLAN) by installing routers for restricting unauthorized access to areas that need strict security. To do this, we worked closely with Mercian’s in-house information service department.

Mercian’s original per unit production management system and Enerize are connected through the file interface. The system accumulates and manages the information for energy per unit production generated by Enerize based on information such as manufacturing items, production lines, number of measurement points, amount of calculations, equivalent to about 2000 steps, and 14 worksheets.
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production quantities, and start and completion times of each manufacturing lot.

**Overview of System Functions**

Figure 6 shows the functions of the environmental load management system and the flow of the data. The main functions are summarized below.

- **Collecting data**: Data is collected with the time stamp every minute through the OPC interface.
- **Calculating following energy models**: Total energy costs, costs in supplying one energy unit, and CO2 emission at each measurement point are calculated following the energy flow defined by Visual Builder by using calorific values converted from measured raw data. Coefficients of performance (COP), calorific energy loss, and cost loss of each energy conversion equipment are also calculated.
- **Closing**: Maximum, minimum, average, and total values, and the number of counting are calculated for the measured or calculated data. The hourly, daily, monthly, and yearly closing calculations are performed.
- **Allocation**: Specified data is allocated based on an allocation table, which is defined by using the occupying area and rated values of each equipment.
- **Summing up for each category**: Total values for each category are summed up based on the defined tree structure (hierarchy of organizations and processes).
- **Designing and displaying graphs**: Various graphs are designed and assigned to be displayed simultaneously with the management criteria. These graphs can be displayed respectively by calling up their name.
- **Designing and displaying images by HTTP**: Screen images are designed using the Hyper Text Transfer Protocol (HTTP) format to show the screens registered for Web browsing on any PCs connected to the in-house LAN. Internet Explorer is used to display them.

**RESULTS AND EXPECTED EFFECTS OF THESE ACTIVITIES**

The results and expected effects of these activities are as follows.

1) Improving the efficiency of management operations

Workloads for compliance with regulations such as the Revised Energy Saving Act tend to increase. As mentioned in the “Issues in Yatsushiro Factory” section, many man-hours were needed merely to create reports. The new system reduced the time required for management work to just 20%. This is because each operation such as collecting data and converting raw measurements to CO2 emissions, costs, and energy consumption is now carried out automatically. The man-hours thus made available can be used for preventive maintenance and improvement activities to improve productivity.

2) All members are Registered Energy Managers.

Previously, only Registered Energy Managers were engaged in environmental preservation and energy conservation activities. This new system can present clear indicators for energy and water (per unit production), and thus helps all members involved in production to be aware of energy consumption.

3) Preventing ownership by limited people

Through building this system, we organized measuring items and energy flow related to the target equipment and clearly wrote down them as the correct information reflecting the actual status of the factories. The information previously belonged to limited people was made public, and that increased the degree of information sharing and created an environment where all members can utilize it. Especially, worksheets for data calculation were changed so easy by the energy flow as everyone, not just the author, can understand.

**CONCLUSION**

Companies must comply with increasing management requirements such as the Revised Energy Saving Act, ISO14000, and ISO50001. Moreover, they need to respond to the carbon footprint system that requires marking for CO2 emissions. Thus, the circumstance of companies’ environment-oriented management is becoming more severe.

We expect this approach in Yatsushiro Factory can be deployed to other Mercian’s manufacturing bases, thus promoting beneficial environmental management throughout the company.

**REFERENCES**

http://www.mercian.co.jp/company/eco/pdf.html

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