

1. Initiatives to Build a Comprehensive Operation, Maintenance, and Management Support System

1 Developmental Background

The Takuma Group has offered waste incineration plant monitoring services for more than 10 years since launching the Total Operational Support System (TIPLOS) in 2004. With the increase in DBO and O&M^{(*)1} projects in recent years, there is growing demand for service characterized by greater stability and higher cost performance.

In an effort to deliver higher-quality operation, maintenance, and management services for such projects, we leveraged the latest ICT^{(*)2} technologies to build the **POCSYS**^{(*)3} comprehensive operation, maintenance, and management system, a new system designed to provide more extensive functionality and to utilize data more effectively.

*1 O&M: Operation and Maintenance

*2 ICT: Information and Communication Technology

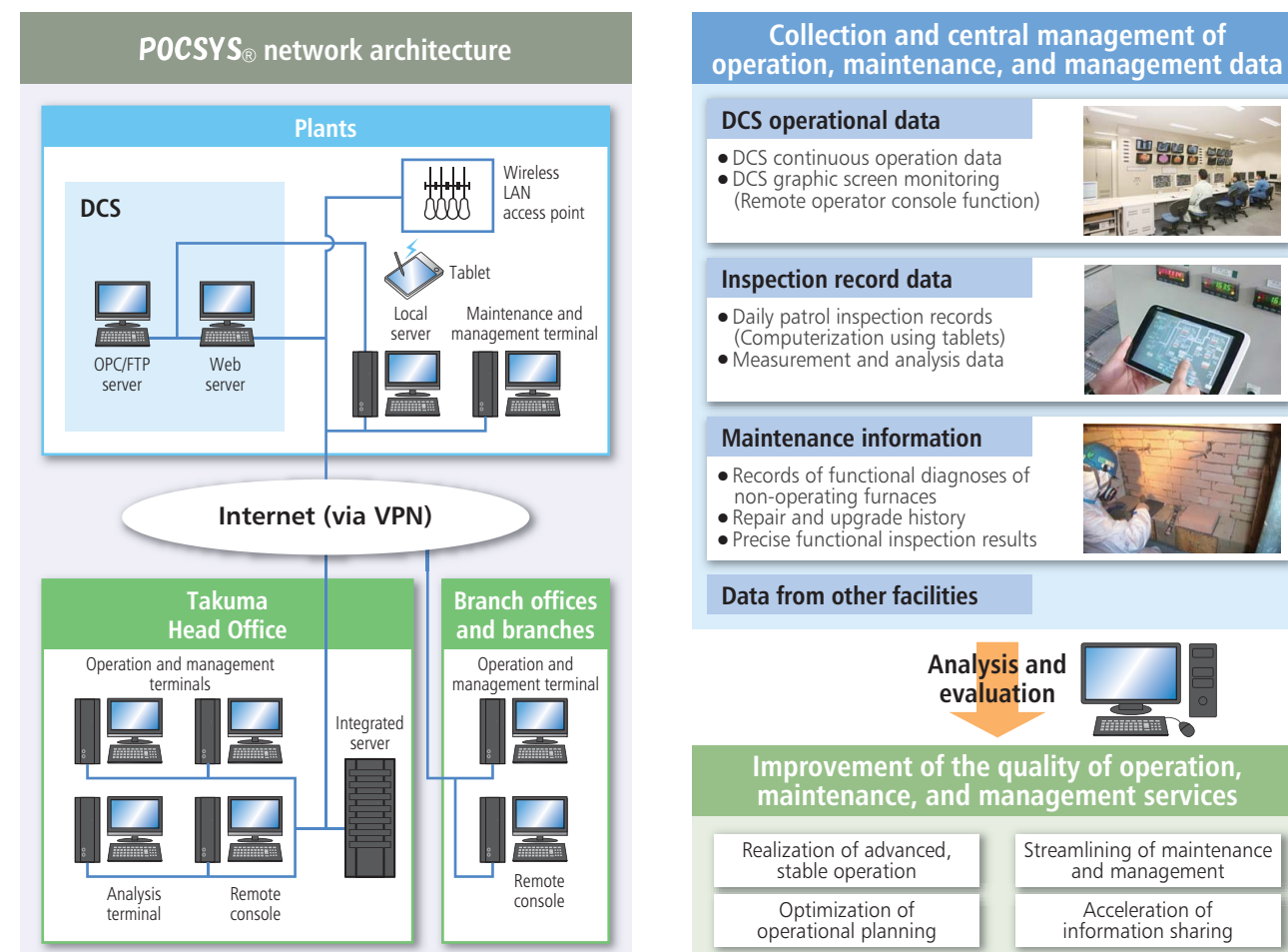
*3 **POCSYS**: Plant Optimization Comprehensive Support System

2 Overview of the **POCSYS** comprehensive operation, maintenance, and management support system

POCSYS augments the DCS^{(*)4} operational data captured by our previous TIPLOS system by capturing inspection record data and maintenance information, gathering and storing that data on a dedicated server, and facilitating central management of data from multiple plants. By comprehensively analyzing and evaluating the stored data, the system is able to provide higher-quality operation, maintenance, and management services.

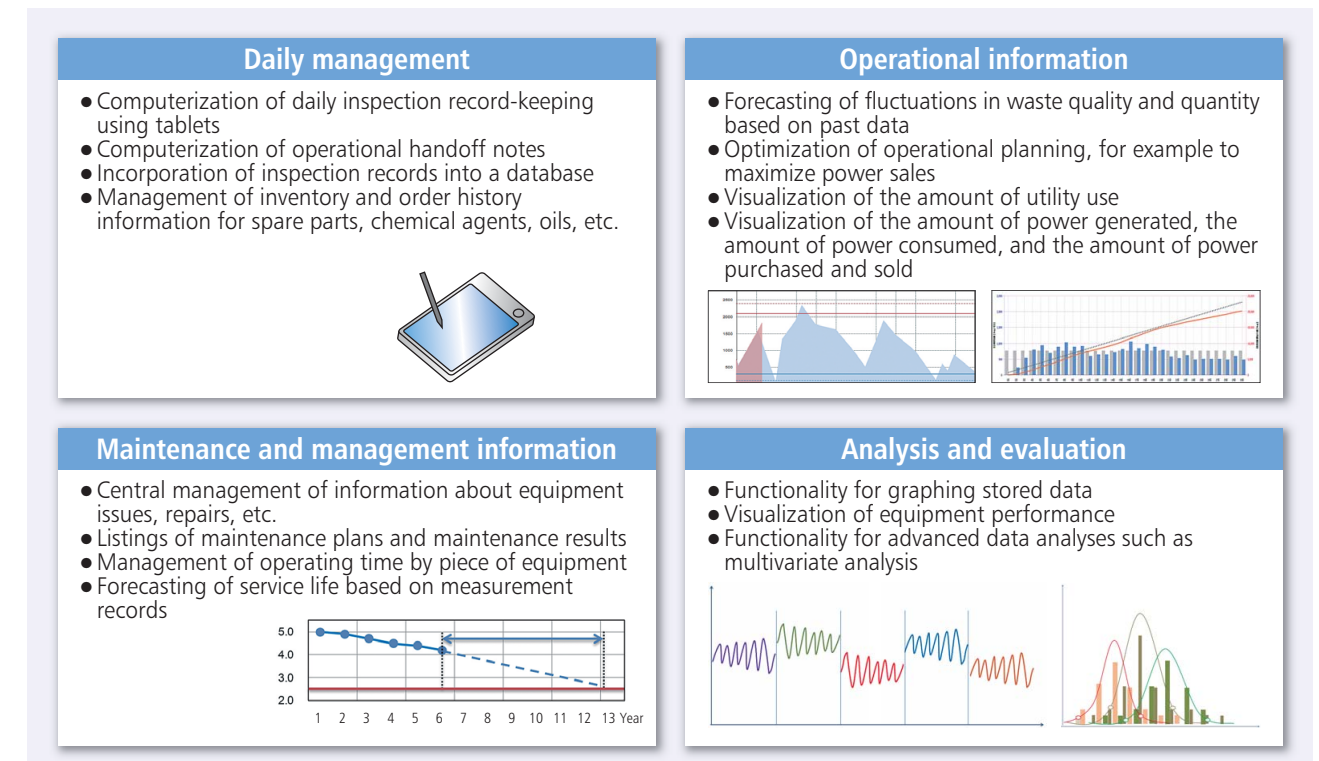
In addition, **POCSYS** makes possible more stable operation through advanced, data-based operation, maintenance, and management, contributing to user-friendliness and the safety of everyone involved with managed facilities.

*4 DCS: Distributed control system



3 Functional enhancements

The enhanced functionality provided by **POCSYS** falls into the four categories of Daily Management, Operational Information, Maintenance and Management Information, and Analysis and Evaluation. This functionality both makes possible efficient facility operation and provides an environment in which data can be effectively utilized.



4 Creation of new added value

During FY2016, the operator of a waste incineration plant in the Kyushu region began using **POCSYS**, and we are planning on a progressive deployment at new and existing facilities for which the Group provides operational management services in DBO and O&M projects.

Furthermore, we will strive to create new added value through initiatives such as the following that utilize **POCSYS**.

Establishing next-generation combustion technologies

We will analyze combustion characteristics that are influenced by multiple factors contained in stored data and operational characteristics, and in the future we will strive to establish next-generation combustion technologies to provide real-time feedback of analysis results to combustion control.

Expanding remote monitoring and operation support services

We will further expand the remote monitoring and operation support service offered as part of the TIPLOS system to date in an effort to establish operation support structures with a view to reducing manpower requirements through remote operation of plants.

Bringing innovation to private-sector plants

By deploying **POCSYS** to private-sector boiler plants such as biomass power plants and expanding the maintenance and management services that use it, we will help ensure customer profits while reducing CO₂ emissions.

2. Jointly Developing a Gas-fired, High-efficiency Simple Once-through Boiler

—Improving operating efficiency by up to 6% through innovations such as reduced minimum output and use of a four-stage combustion control system

Working jointly with Tokyo Gas Co., Ltd.; Osaka Gas Co., Ltd.; and Toho Gas Co., Ltd., Takuma Group company Nippon Thermoener Co., Ltd., developed the EQRH-1001NM high-efficiency simple once-through*1 boiler (with equivalent evaporation*2 of 1,000 kg/h) featuring improvements in the operating efficiency thanks to innovations such as reduced minimum output and use of a four-stage combustion control system.

Simple once-through boilers, which are distinguished by the fact that no special license is required in order to operate them, are being used by facilities in a broad range of fields, from small businesses to manufacturing plants. The company's corporate partners proposed the product in August 2015, and it is being sold by Nippon Thermoener.

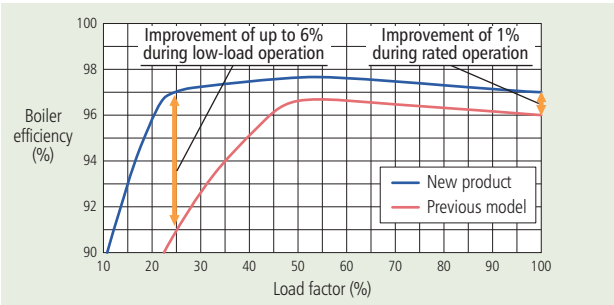
Features

By reducing the minimum output from the 50% rating used in previous models to 25% and adopting a four-stage combustion control system that controls output at four stages (100%, 50%, 25%, and 0%), we were able to reduce the number of combustion start-stop events (i.e., the on/off frequency)*3 and thereby to improve the boiler's operating efficiency*4 during periods of low-load operation. The design is the first simple once-through boiler in Japan to use a four-stage combustion control system. In addition, by developing a multi-path flow of combustion gas in the boiler body*5 and implementing low-air-ratio combustion, we were able to improve the boiler efficiency during rated

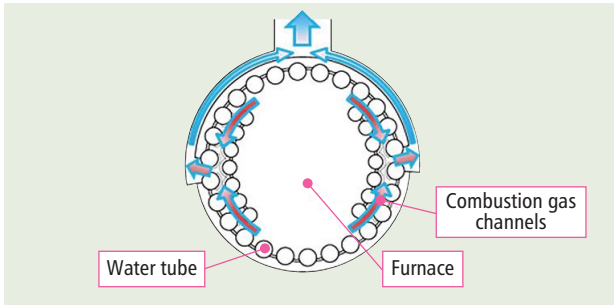
operation while simultaneously reducing the fan power consumption and improving its quietness. As a result of improvements in the boiler efficiency during low-load and rated operation, we were able to improve the operating efficiency*6 by about 3% to 6%.

Furthermore, by implementing fine-grained control over the water level in the boiler in response to output, we are able to supply high-dryness, high-quality steam over a broad range of operating pressures, from low to high loads.

Going forward, we will propose the product as a heat source for a broad range of customers, including dry cleaners, food plants and other business uses.



Load factor*7 and boiler efficiency



Multi-path flow in the boiler body (cross-section)

- *1 **Once-through boiler:** A boiler made up of tubes in which water enters on one end and leaves the other end as steam. Because the design is compact and lightweight, and because it holds a little boiler water, it can be started in a short period of time. Once-through systems are classified as boilers, small boilers, or simple boilers depending on specifications such as their maximum operating pressure and heating surface area. Simple boilers are the smallest type of once-through boiler, and no special license is required in order to operate them.
- *2 **Equivalent evaporation:** An index of boiler capacity. Equivalent evaporation indicates the amount of evaporation that occurs when water at 100°C is converted into steam at 100°C.
- *3 **Reduction in the number of combustion start-stop events (i.e., the on/off frequency):** Boilers control the evaporation by switching output levels such that the steam usage does not fall below the minimum output level. Where steam usage would fall below that level, the evaporation is regulated by cycling combustion on and off. After stopping combustion and when restarting the boiler, the furnace is purged with fresh air to ensure safety. During this purge process, heat inside the boiler escapes to the outside, causing thermal loss. Reducing the number of combustion on-off events serves to limit thermal loss, helping to increase the boiler operating efficiency.
- *4 **Boiler operating efficiency during low-load operation:** The ratio of the amount of heat absorbed by steam produced to the total amount of heat supplied to the boiler during low-output operation ranges from 50% of the rating to 25% of the rating.
- *5 **Boiler body:** The part of the boiler in which steam is generated. The new boiler's heat transfer efficiency has been improved thanks to innovations such as the optimization of the combustion gas channels (registered utility model No. 3196892, "Multi-pass Multi-tubular Once-through Boiler").
- *6 **Boiler operating efficiency:** The boiler's overall efficiency under actual operating conditions including operation during load fluctuations as well as stops.
- *7 **Load factor:** The ratio of steam generation to the boiler's rated output.

Basic specifications		New product (EQRH-1001NM)	Previous model (EQRH-1000NM)
Equivalent evaporation	kg/h	1,000	
Boiler efficiency during rated operation	%	97	96
Combustion	Turndown ratio*8 (minimum output)	4 : 1 (25%)	2 : 1 (50%)
	Combustion control method	Four-stage control	Three-stage control
Air flow rate control method		Damper + inverter	Damper
Equipment ambient noise		73 or less	76 or less
Boiler dimensions	Width	920	920
	Depth	2,210	2,340
	Height	2,300	2,400

*8 **Turn-down ratio:** A ratio indicating how much the combustion amount can be limited during operation relative to the boiler's rated combustion amount.



3. Launching a High-efficiency, Proportional-control Gas-fired Once-through Boiler

In January 2016, Takuma Group company Nippon Thermoener Co., Ltd., launched the SUPER EQOS EQi(H)-6001NM (with equivalent evaporation of 6,000 kg/h), a high-efficiency once-through boiler that achieves 99% rated load efficiency (and 101% partial load efficiency) while improving load tracking by means of high-turndown 8:1 proportional control.

Other product features include the ability to supply high-dryness, high-quality steam across a broad range of operating pressures; to recover heat from blow water at a higher level of efficiency than previous designs; and to take up less space when used in connected installations.

Going forward, Nippon Thermoener will propose the product as a heat source for a broad range of customers operating facilities such as manufacturing plants and large buildings.

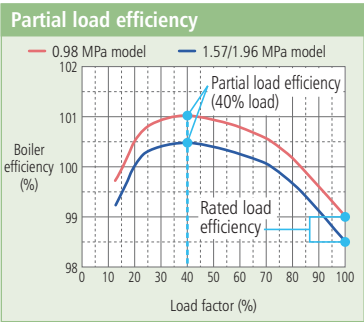


Features

1 Improved operating efficiency

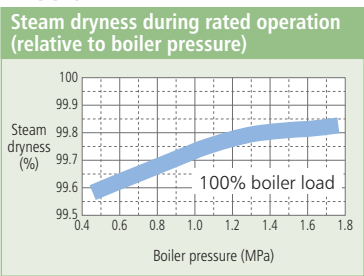
The new product achieves a rated load efficiency*1 of 99% (and a partial load efficiency*2 of 101%).

- *1 For the 0.98 MPa model (0.49 MPa, air supply temperature of 35°C, water supply temperature of 15°C)
- *2 At a boiler load factor of 40%



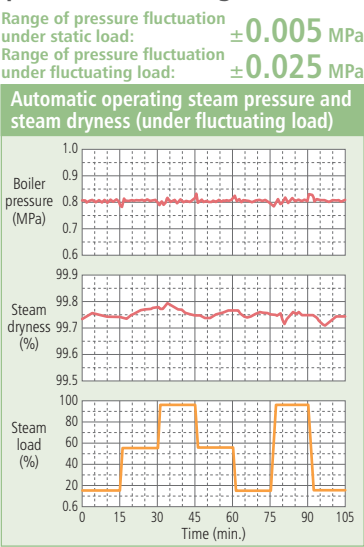
2 High-quality steam supply

The new product delivers steam dryness of at least 99.5% across a broad range of pressures.



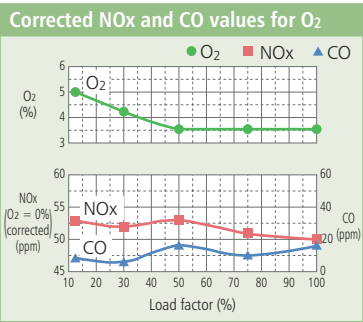
3 High load-tracking performance through PI control

The new product uses proportional integration (PI) pressure control, allowing it to supply high-quality steam by maintaining stable steam pressure and high steam dryness under all evaporation loads.



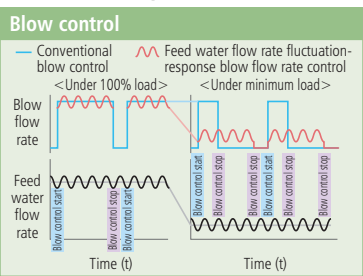
4 High turn-down ratio (8:1) and exceptional combustion performance

The boiler's newly developed burner is capable of low-air-ratio combustion, and it achieves NOx emissions of 55 ppm or less at an air ratio of 1.2. Furthermore, proportional control that varies the combustion amount from 12% to 100% allows the boiler to accommodate load requests in a fine-grained manner.



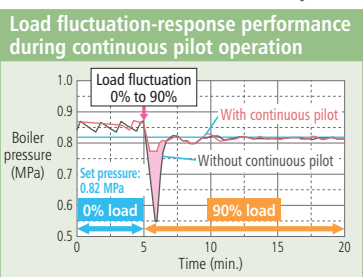
5 Feed water flow rate fluctuation-response blow flow rate control (patent No. 5826539)

Since the blow flow rate changes to accommodate changes in feed water flow rate during continuous blow operation, the boiler can recover heat from blow water efficiently under all boiler loads.



6 Continuous pilot control (it is available as an option)

The new boiler can minimize the drop-off in boiler pressure as the load increases from 0%.



7 Quietness

Thanks to a quiet design, the new boiler generates 74 dB or less noise measured in front of the unit (6 dB less than the previous model), making it compliant with the Boiler Noise Labeling Program (administered by the Japan Society of Industrial Machinery Manufacturers).

8 Connected installations

Multiple units can be connected together, yielding a space savings of about 20%*3.

*3 Compared to previous models

4. Awards Received from Outside Organizations

—Takuma's on-site regeneration system for catalyst denitrification equipment receives the METI Industrial Science and Technology Policy and Environment Bureau Director's Award at the 41st Outstanding Environmental Systems Awards*

Takuma's on-site regeneration system for catalyst denitrification equipment received the METI Industrial Science and Technology Policy and Environment Bureau Director's Award at the 41st Outstanding Environmental Systems Awards, which are hosted by the Japan Society of Industrial Machinery Manufacturers. As a leader in waste treatment, we look forward to continuing to propose systems which enable customers to reduce the environmental impact.

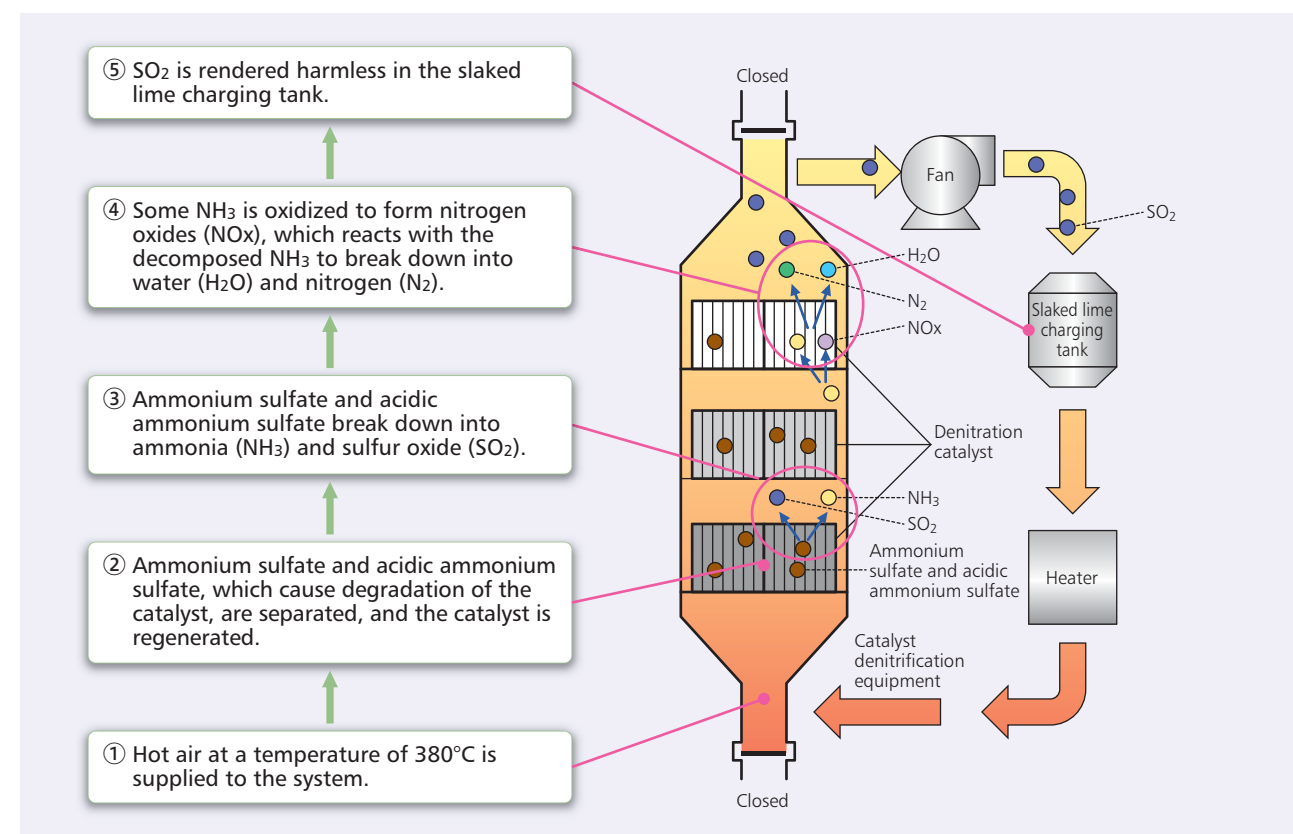
Catalyst denitrification equipment

Municipal waste incineration facilities typically install catalyst denitrification equipment to efficiently eliminate nitrogen oxides and dioxins from their exhaust gases. The catalysts, which are set in the catalyst denitrification equipment, must be regenerated at a regular interval in order to restore system functionality. In conventional systems, catalyst regeneration requires catalyzing equipment to be removed and transported to a specialized plant for regeneration.

Overview of Takuma's award-winning system

Takuma's on-site catalyst regeneration system allows catalyst regeneration to be performed without removing the catalyst from the catalyst denitrification equipment, dramatically reducing the risk that the equipment will be damaged as well as the time and cost associated with the regeneration process.

The system consists of a fan, slaked lime charging tank, heater, and circulating duct. With the exception of the circulating duct, a single system's equipment can be shared by multiple incinerators, thereby reducing the initial cost. The figure below illustrates the flow of gases through the system as well as the regeneration procedure.



* Outstanding Environmental Systems Awards

The Outstanding Environmental Systems Awards are held by the Japan Society of Industrial Machinery Manufacturers. The awards are conceived to contribute to the preservation of the environment and to facilitate R&D into environmental protection technologies as well as the widespread adoption of outstanding environmental systems by selecting outstanding environmental systems designed to address an increasingly diverse range of domestic- and global-scale environmental issues and recognizing their developers, manufacturers, and development partners.

CSR Initiatives

Consumer Issues

Activities Involving Product Quality

In 1997, in addition to defining our Quality Policy of "Manufacturing products that result in customer satisfaction," registering for "ISO 9001: Management Systems" certification (Registration No.: JQA 1952), and improving product quality based on our quality management system, we carried out concrete activities to enhance customer satisfaction. The present status for ISO 9001 certification includes having switched to ISO 9001:2000 in FY2002 and then to ISO 9001:2008 in FY2010.

In order to produce products that customers truly appreciate, it is necessary not only to boost the quality of the product itself, but also to improve the content of that work as well as each individual's ability to create a good product in each process up to delivery (sales, design, procurement, manufacture, construction, and management).

Based on that Quality Policy, Takuma is pursuing a variety of measures in each sales, design, procurement, manufacture, construction, and management process towards improving the quality of our products and services.

● Improving organizational operations

As measures for heightening the quality of the organization as a whole, we establish quality objectives in each section and department at the beginning of the fiscal year and regularly report (twice per year) the status of achievements to the QM committee (quality management review).

● Improving individual employees' capabilities

We create a "Work (Technical Capability) Achievement Checksheet" in order to improve the work capability of the personnel required for each process. In addition to allowing us to assess current skill levels of individual employees on a regular basis, this system is used to review targets.

● Internal quality audit

We raise the accuracy of each job through standardization of the work procedure within each process, confirm the operating status of the quality management system by carrying out internal quality audits in each section and department, and enhance work content as necessary.

These audits are carried out on a regular basis by employees who have been certified as internal audit member training seminars that are taught by lecturers from outside organizations. These seminars enable those personnel to acquire knowledge ranging from fundamental knowledge about ISO 9001 to specific methods for implementing internal audits.

● Review of quality control and processes

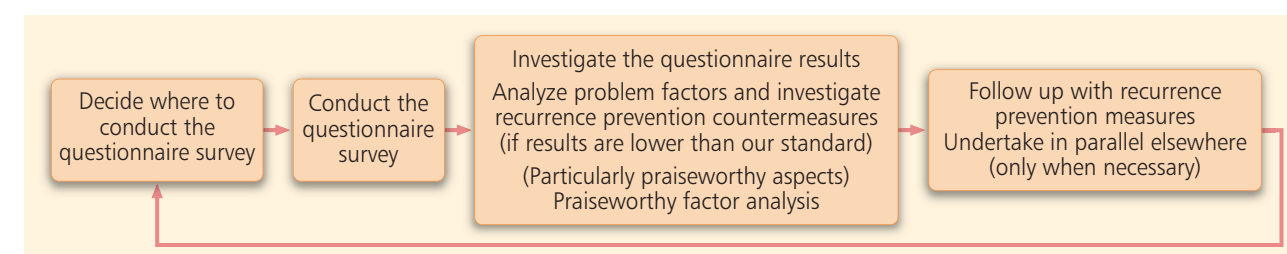
Quality is an important aspect of producing excellent products.

When a non-compliant product is discovered, we implement the measures (remedies) provided in the corresponding manual (standard). Even in processes that did not go so far as to produce a non-compliant product, a review is carried out on processes that might have caused the issue as a preventive measure.

In order to also prevent procurement of non-compliant products, we provide further education (instruction) for all suppliers.

● Customer satisfaction survey

We created the Customer Satisfaction Survey Committee in FY2007 and have been conducting customer satisfaction surveys since as an initiative to improve quality by asking customers how they feel about delivered products and Takuma staff and using their feedback to improve quality.



Customer satisfaction surveys

FY2007: 73.4 points (37 plants)

FY2015: 88.2 points (19 plants)

Average evaluation scores from questionnaire surveys (out of a possible 100 points)