

Labor Savings Achieved through Application of MaiDAS[®] to Large-Scale Overseas Waste-to-Energy Plant

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To stabilize plant operations and reduce labor through a decrease in manual intervention in waste-to-energy plants, Mitsubishi Heavy Industries Group has implemented the Navigator automated operation system, a core feature of the MaiDAS[®] integrated plant operation system, along with operational monitoring and anomaly detection functions at a large-scale overseas waste-to-energy plant. The system commenced operations in October 2024 across all four incinerators at the target facility, following remote analysis and on-site adjustments. Since implementation, a high application rate of 94% (ratio of MaiDAS[®]-operated hours to total operating hours) has been maintained, with manual operations reduced by approximately 76%. Furthermore, control performance of the main steam flow rate and flue gas concentrations was confirmed to be equal to or exceeding manual control by operators. Consequently, an operational structure reduced to one operator per shift was realized in January 2025, achieving labor savings.

1. Introduction

The Mitsubishi Heavy Industries Group strives to create value for customers by stabilizing plant operations and improving business profitability through the MaiDAS[®] integrated plant operation system. Regarding such initiatives, this report presents efforts focused on achieving labor savings.

The Navigator automated operation system, a key function of MaiDAS[®] developed for waste-to-energy plants is shown in **Figure 1**⁽¹⁾. Navigator enables advanced automated combustion control in coordination with the Distributed Control System (DCS), using AI-based combustion flame image evaluation, main steam flow rate prediction, and soft sensors.

Verification of long-term application began at the large-scale overseas waste-to-energy plant in June 2024⁽²⁾. To achieve integrated control, optimized for collective operating of multiple large-scale incinerators, Navigator was implemented to allow for advanced combustion control, and constant evaluation of the individual status of each incinerator in order to detect any signs of change. Consequently, an operational structure which included a reduction to one operator per shift commenced in January 2025, and stable operations have since been maintained. This application case is reported here.

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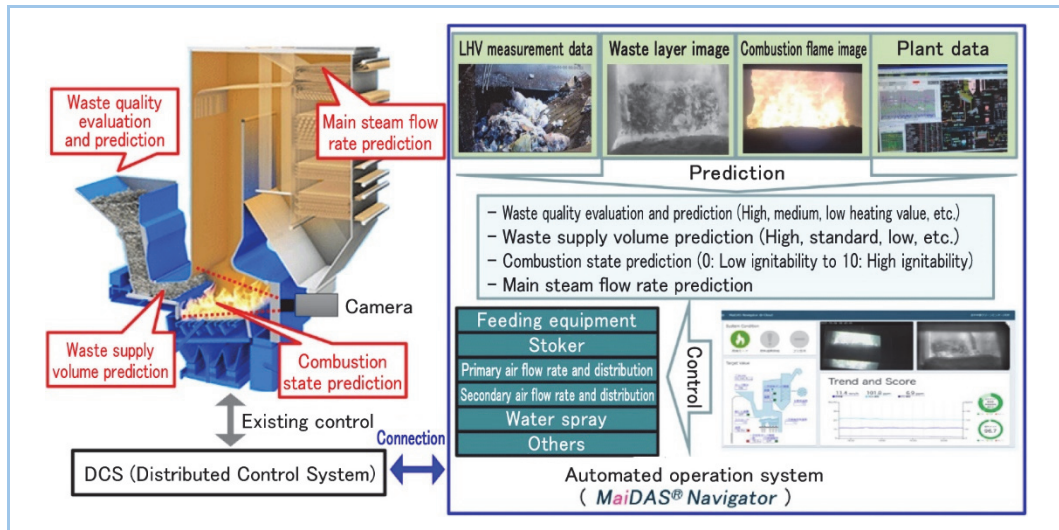


Figure 1 Functions of MaiDAS® Navigator

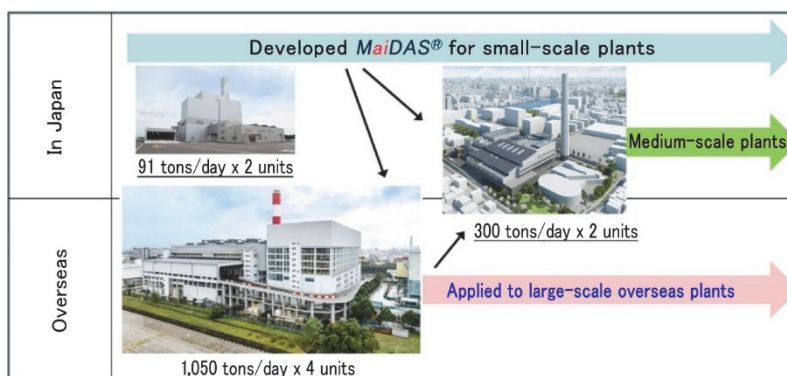
2. Implementation of MaiDAS®

2.1 Development and application workflow of MaiDAS®

The development and application workflow of MaiDAS® is shown in Table 1. Following development and implementation for MaiDAS® at small-scale waste-to-energy plants in Japan (hereafter referred to as "small-scale plants"), the results were expanded in 2024 to application at one of the world's largest overseas large-scale waste-to-energy plants (hereafter referred to as "large-scale plants") with a processing capacity of 1,050 tons per day.

This facility consists of four incinerators. During simultaneous operation of all four units, a simultaneous deterioration in the status of multiple incinerators necessitated manual intervention by multiple operators, which had become a bottleneck in the labor savings process. Furthermore, industrial waste is occasionally accepted in addition to general waste, resulting significant fluctuations in waste bunker levels. Therefore, the facility was characterized by extreme variations in waste quality. Consequently, operating conditions were considered highly challenging for the implementation of automated control.

Table 1 Development and application workflow of MaiDAS®



2.2 Challenges in reducing manual operations

The breakdown of manual operations by operators at the target overseas large-scale waste-to-energy plant is shown in Figure 2. At this facility, manual interventions for the feeding equipment due to variations in waste supply and quality accounted for 70%, and interventions for the air system during combustion state changes accounted for 20%. Therefore, automating both operations was essential in order to reduce manual intervention.

For this reason, a function that could constantly monitor and evaluate the detection of signs of changing conditions was implemented to reduce the frequency of manual operations and achieve labor savings. The operational monitoring and anomaly detection function is shown in Figure 3.

This function enables monitoring and evaluation of the operating state of all four incinerators, allowing for the detection of anomaly signs exceeding the control range of Navigator and then notifying the operator. Consequently, operators could identify signs of anomalies in advance and proactively implement measures before conditions deteriorated. Previously, cases of large-scale manual intervention for multiple incinerators after conditions had deteriorated had occurred. However, proactive response through anomaly detection contributed to the avoidance of simultaneous large-scale interventions across multiple incinerators, leading to a reduction in total manual interventions and the maintenance of stable operations.

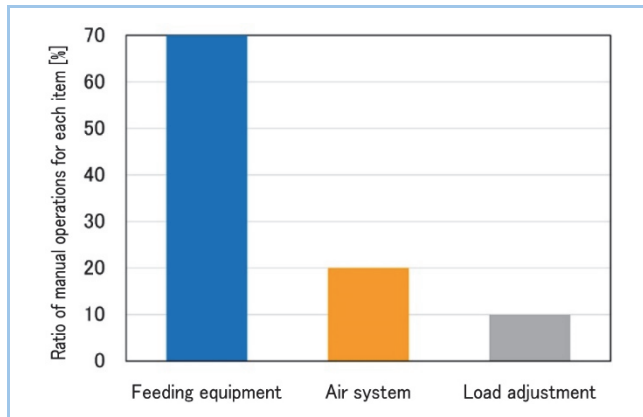


Figure 2 Breakdown of manual operations by operators (March 15–21, 2024)

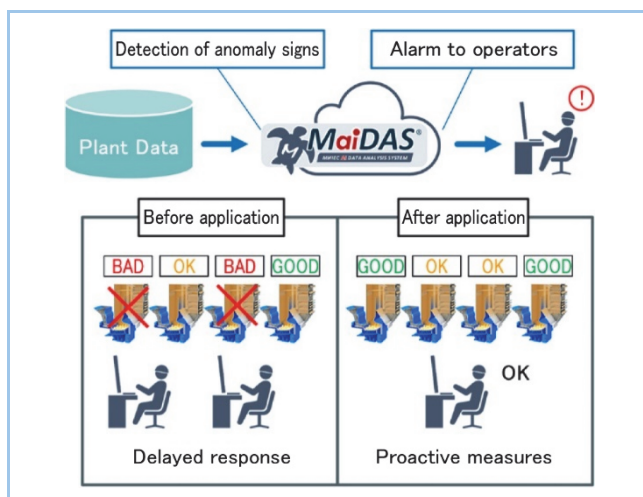


Figure 3 Operational monitoring and anomaly detection function

2.3 Implementation flow of MaiDAS[®]

Implementation of MaiDAS[®] was conducted according to the following procedure. First, plant operation data was collected and analyzed, and parameter adjustments were performed remotely in response to steam flow setpoints and based on implementation achievements at small-scale plants in Japan. Subsequently, operational verification and additional adjustments to the system were carried out on-site at the overseas large-scale plant, followed by a transition to full-scale operation. This process significantly reduced the required costs and duration of on-site verification work compared to conventional methods.

3. Automation of manual operations

3.1 Application of MaiDAS[®]

By early October 2024, implementation of MaiDAS[®] across all four target incinerators was complete and plant-wide operations commenced. Application rate (the ratio of MaiDAS[®]-operated hours to total operating hours, excluding downtime for maintenance or special tests) of MaiDAS[®] for the entire plant is shown in Figure 4. In 2024, the application rate reached 94%, with most manual operations by operators replaced by MaiDAS[®] automated control. Consequently, a

reduction to one operator per shift was achieved on January 1, 2025.

Following this labor saving, a high application rate of 96% was maintained from January to November 2025, confirming continuous and stable use of MaiDAS®.

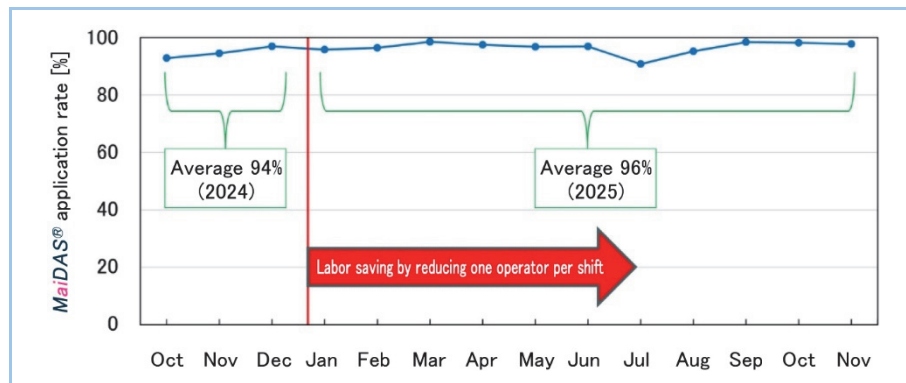


Figure 4 Average MaiDAS® application rate for the four incinerators (downtime for maintenance or special tests excluded from the calculation)

3.2 Reduction in the frequency of manual operations

The breakdown of the frequency of manual operations before the application of MaiDAS® (March 15 to March 21, 2024) and after its application across all four incinerators (October 7, 2024, to September 30, 2025) is shown in **Figure 5**. Following application, the total frequency of manual operations was reduced by 76%, with a 77% reduction in feeding equipment intervention and an 86% reduction in air system intervention. Conversion from manual operations, which had been a challenge for labor savings, to efficient automated control could be confirmed.

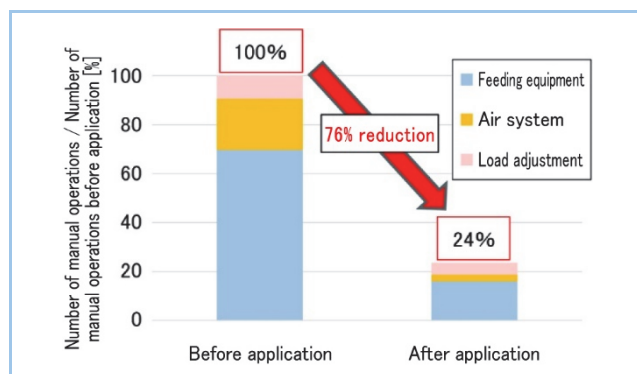


Figure 5 Change in the frequency of manual operations before and after MaiDAS® application

4. Performance during MaiDAS® application

At the target waste-to-energy facility, suppressing fluctuations in the main steam flow rate is needed to ensure stable power generation, and operating with flue gas components such as CO and NO_x below regulatory limits is essential. Main steam flow rate deviation, CO concentration, and NO_x concentration before the application of MaiDAS® (March 15 to March 21, 2024) and after its application (October 7, 2024, to November 30, 2025) are shown in **Figure 6**. All parameters were either equivalent to or improved compared to those before the application, confirming that MaiDAS® control could provide performance equal to or exceeding manual control by operators.

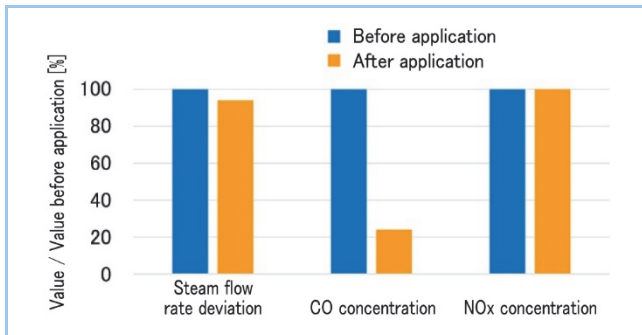


Figure 6 Performance during MaiDAS[®] application
(Before: March 15–21, 2024; After: October 7, 2024–November 30, 2025)

5. Operational support system

The successful implementation of MaiDAS[®] was supported by the establishment of a remote support system designed to ensure that local operators could confidently transition to automated control. The MaiDAS[®] support system is shown in **Figure 7**. During the long-term verification period, notifications regarding sudden variations in waste quality and operational improvements occurred frequently. This information was systematically collected through feedback forms, and parameter adjustments through remote monitoring, along with advice on operational policies, were continuously provided. Furthermore, the local site was constantly updated of the improvement status by regularly sharing the details and effects of the adjustments through monthly reports, significantly contributing to the building of trust in MaiDAS[®] operations. This continuous support facilitated the acceptance of automated operations, leading to the establishment of the labor-saving operational structure.

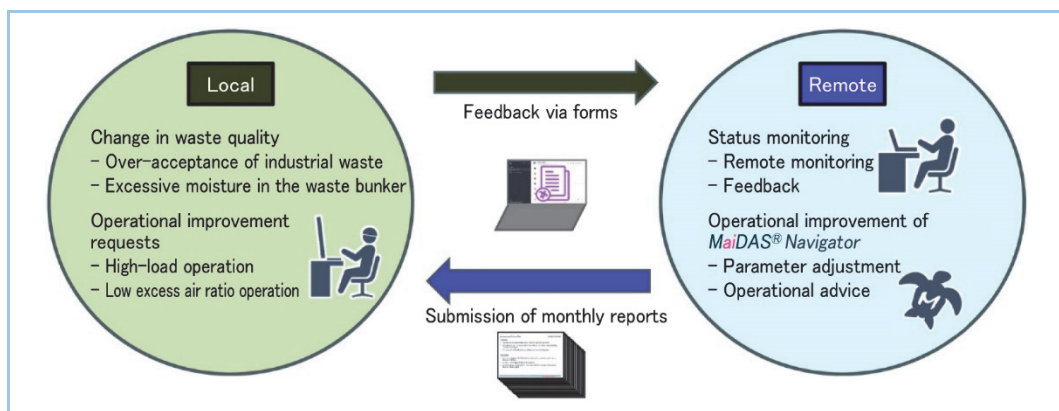


Figure 7 MaiDAS[®] support system

6. Emergency simulations

There was a local concern whether total power generation of the plant could be maintained in the event of equipment failure or other issues in a single incinerator under labor-saving conditions. In waste-to-energy facilities, as total power generation is nearly proportional to the combined steam flow rate of all incinerators, the overall steam flow rate can be maintained even if the load of one unit decreases, provided that the loads of the other units are appropriately increased. For example, even if the load of one of the four incinerators drops to 55% of its normal operation (a 45% decrease), the total plant load can be maintained at the same level as before the incident by increasing the loads of the remaining three units to 115% of their normal operation (a 45% increase in total). Consequently, a decline in total power generation can be avoided even in the event of a problem.

For this reason, in the efforts presented here, the control responsiveness of MaiDAS[®] when the loads of other incinerators rapidly increase during a load decrease of one incinerator was evaluated. As shown in **Figure 8**, a 22% reduction in the time required to reach the target load

when the steam flow setpoint was increased, could be achieved after application, confirming that the response capability of MaiDAS[®] was equal to or exceeded that of manual operators even in case of emergency. Furthermore, these results were highly evaluated by the operation and maintenance managers of the target facility, contributing to the development of understanding and trust in the labor-saving operations.

By the successful application at a large-scale overseas plant under challenging operating conditions and transitioning to actual operation, universal application of MaiDAS[®] could be demonstrated, regardless of furnace scale or facility conditions. In the future, deployment and application of MaiDAS[®] to all types of incinerators, from small-scale to large-scale plants, is considered possible.

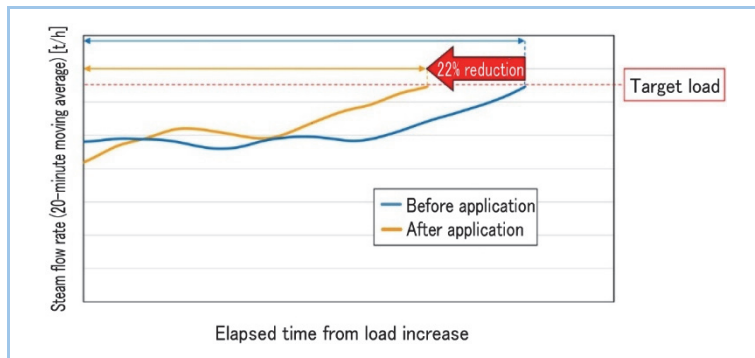


Figure 8 Load increase test during MaiDAS[®] application
(Before: March 23, 2024; After: October 9, 2024)

7. Conclusion

In the efforts presented here, the MaiDAS[®] integrated plant operation system was applied to a large-scale overseas waste-to-energy plant, achieving the following results:

- 1) The introduction of the Navigator automated operation system and the operational monitoring and anomaly detection function significantly reduced operator intervention in the feeding device and air system, enabling stable operation even during multi-furnace operation.
- 2) A high application rate of 94% to 96% could be maintained since implementation, and the frequency of manual operations was reduced by approximately 76%, achieving both labor savings and stable operation.
- 3) Fluctuation in the main steam flow rate and concentration of flue gas were either equivalent to or improved compared to those before application, confirming that automated control could perform equal to or exceeding manual control by an operator.
- 4) Secure operational capability during an emergency due to improvement in responsiveness during load fluctuations could be demonstrated.
- 5) Establishment of an operational support system, including remote support, contributed to improvement in reliability of the waste-to-energy facility. This enabled an operational structure with a reduction to one operator per shift as of January 2025, thereby achieving the labor-saving goal.
- 6) By the successful application at a large-scale overseas plant under challenging operating conditions, the effectiveness of the automation technology could be demonstrated and indicated that the system can be deployed universally regardless of furnace scale or facility conditions.

Based on these findings, the Mitsubishi Heavy Industries Group will continue to commit to providing products and services that meet social demands and customer needs.

MaiDAS[®] is a registered trademark of Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd. in Japan (Trademark Registration No. 6333918).

References

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