



Ceiling Cassette Four-way Type Indoor Unit with Improved Air Comfort and Installation

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Since Mitsubishi Heavy Industries, Ltd. (MHI) began using unit and panel sizes of 840 mm and 950 mm, respectively, in 1990, these dimensions (sizes) have become the de facto standards for ceiling cassette four-way type indoor climate control units that are well-suited to most buildings. Without changing these dimensions, demands are high for environmentally friendly products with low energy consumption. This paper discusses products with improved air comfort characteristics and maintainability to preserve a comfortable environment.

1. Introduction

With problems such as global warming and the need to keep pace with stringent energy saving requirements initiated by the United Nations Framework Convention on Climate Change, there is increasing demand for air conditioners that can provide both comfort and high performance. Contractors who install air conditioning units require compact, lightweight units for ease of installation.

To address these sometimes conflicting needs, this paper describes compact, lightweight ceiling cassette four-way type indoor units with improved air conditioning characteristics for maintaining a comfortable environment.

2. Outline of ceiling cassette four-way type indoor units

2.1 Compact design

Figure 1 shows schematic diagrams of the newly developed ceiling cassette four-way type indoor units.

There is a strong market demand for ceiling-type indoor units that can fit into narrow ceiling voids. MHI's indoor ceiling type units of 4HP or larger are 365 mm in height, which is

too large to fit into the ceiling voids in some locations. While ceiling voids of 320 mm or more are common in Japan, these are often 300 mm or less in European homes. Given these restrictions, MHI has developed units of 3HP or smaller with a unit height of 246 mm. These units are the slimmest available in the industry, and provide much more flexibility for installation.

Simply reducing the unit size could also reduce its performance. MHI undertook the following measures to maintain the performance characteristics of these units.

(1) Unitizing heat exchanger

Figure 2 shows a schematic diagram of the heat exchangers, which have a unitized design. MHI's conventional units are divided into left and right blocks. The unitized design uses the space inside the unit effectively, and reduces the vertical dimension to make the unit more compact.

(2) All models are equipped with DC fan motors

All models in the new series are equipped with a high efficiency DC fan motor, which was used only in some models in the previous series. This reduces electrical power consumption.

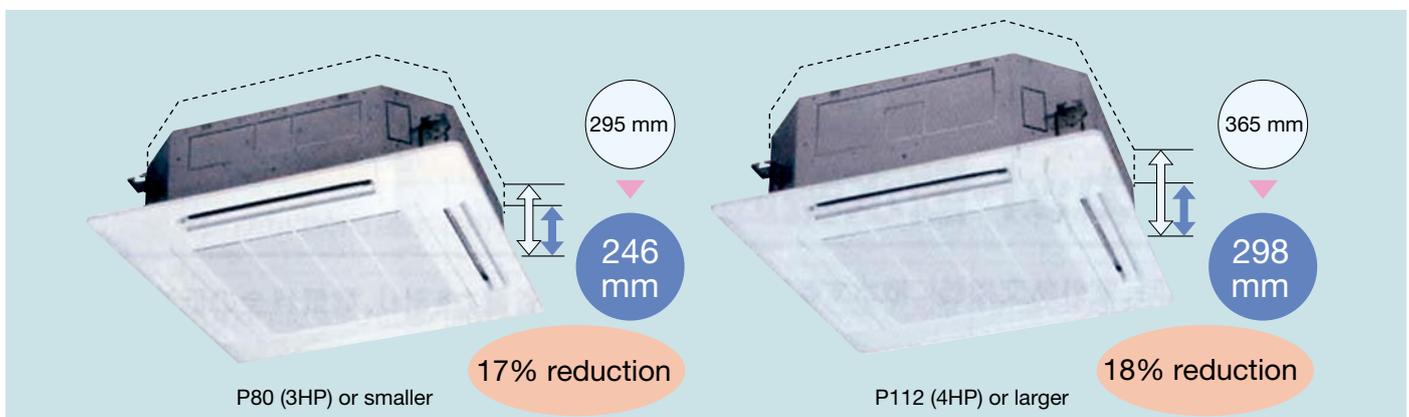


Fig. 1 Schematic diagram of the ceiling cassette four-way type indoor unit

The broken lines indicate the contours of the conventional unit. The new unit is lower than the conventional unit.

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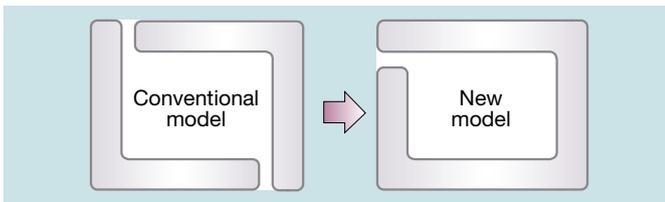


Fig. 2 Heat exchanger configuration in the conventional and new models

The conventional two-part heat exchanger is modified to one long unitized design in the new model.

2.2 Free-flow control

Figure 3 shows some variations of flap airflow using free-flow control.

This design enables movement of the louver flaps in four directions independently, which allows adjustment of the flap angles for specific purposes or room layouts to provide more flexibility during and after installation. The wired remote control can be used to adjust the upper and lower limits of flap

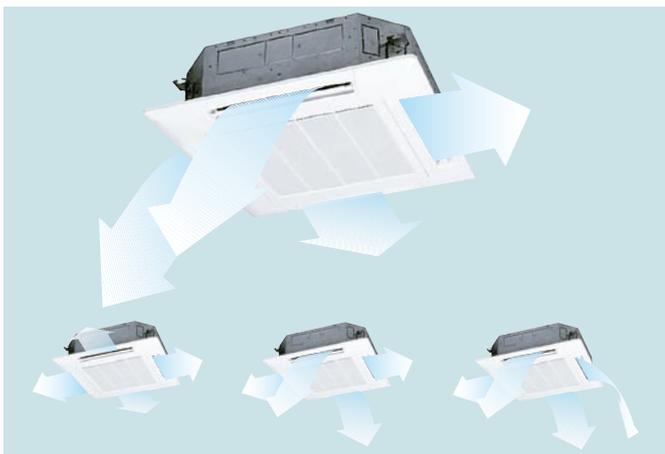


Fig. 3 Free-flow control

Indicating variations in flap airflow. Various patterns of airflow can be controlled by the wired remote control.

movement to provide a comfortable environment suited to the user's preferences.

2.3 Improving heating comfort

While the conventional design takes into consideration the feeling of a draft and the reach of the airflow, some improvement is required to ensure that warm air reaches foot-level in cases where a small unit is installed high above the floor.

The new models provide comfortable heating by improving the airflow path and increasing the airflow speed so that even a small-capacity unit can send warm air down to floor level. Another improvement is to have warm air flow out more quickly to increase comfort (**Figs. 4 & 5**).

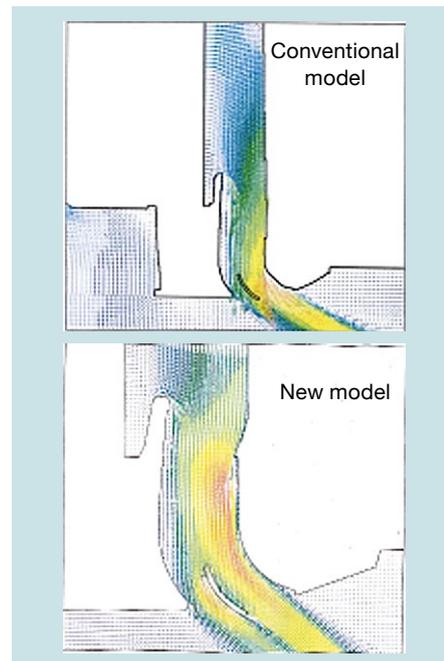


Fig. 5 Comparison of louver profiles

The conventional unit shows strong downward airflow. The new model lets air flow along the louver, showing the improvement.

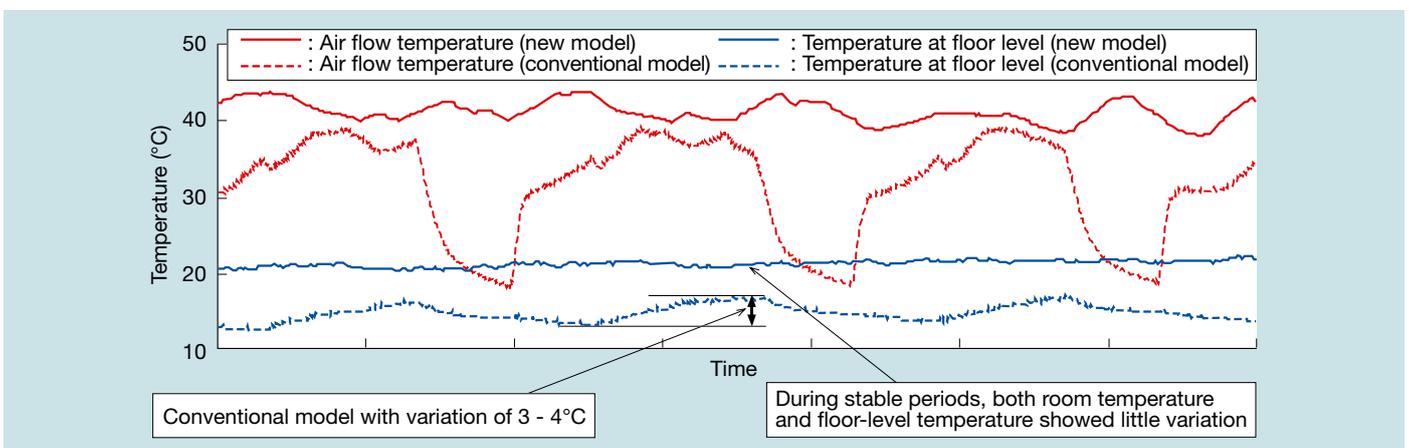


Fig. 4 Changes in temperature with time at floor level for the conventional and new models

The chart shows that the new model maintains a stable temperature with little variation.

3. Component development

3.1 Development of units and panels

(1) Improving unit assembly

Three-dimensional (3D) computer aided design (CAD) was used from the initial planning stages of this new unit. Ease of assembly was evaluated in the factory. The provision of positioning pieces for assembly of parts and improving the method for mounting the cabinet sheet metalwork pieces and drain pan contributed to the ease of assembly.

The use of commonly available parts helped reduce the number of unique components in comparison to MHI's existing units, and this helped reduce costs.

(2) Improving automatic vertical motion panels

In an industry first, MHI developed an automatic lift panel in 1993. This motor-wire mechanism that moves the grill vertically has been a market hit because it simplifies filter cleaning without requiring a stepladder.

If the grill encounters an obstacle while it is being lowered, such as a shelf, the cleaning mechanism stops the vertical motion motor automatically and safely if the wire becomes loose.

3.2 Design of high-performance turbofan

To improve the performance of the unit, studies were performed to increase the efficiency and reduce the noise. The focus of these studies was a 3D blade¹ with the potential for higher efficiency and lower noise than the 2D blades used in MHI's conventional units (Fig. 6).

However, due to the material costs and molding capability required for the 3D blade, the study was reoriented to improving the 2D blade. The results were a higher fan efficiency and lower noise (Fig. 7).

3.3 Reducing circuit board size

Changing the controller circuit from one- to two-sided circuit boards greatly reduced its size. Maintaining the setup data in non-volatile memory reduced the number of slide switches, permitting a further reduction in circuit board size.

The use of common parts, borrowing a portion of the circuit used on the outdoor unit of multi-system building air conditioners, and sharing some parts used in residential air conditioners helped reduced the costs even further.

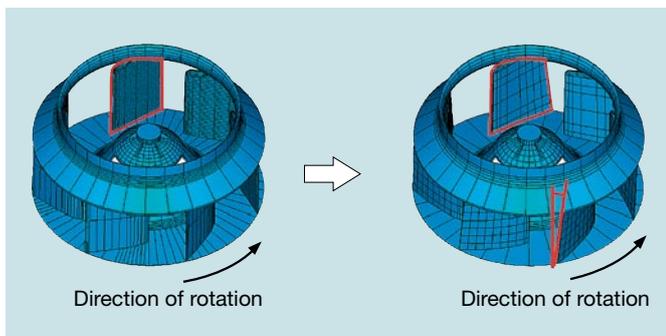


Fig. 6 Conventional and new model turbofans
A 3D blade profile achieves high performance.

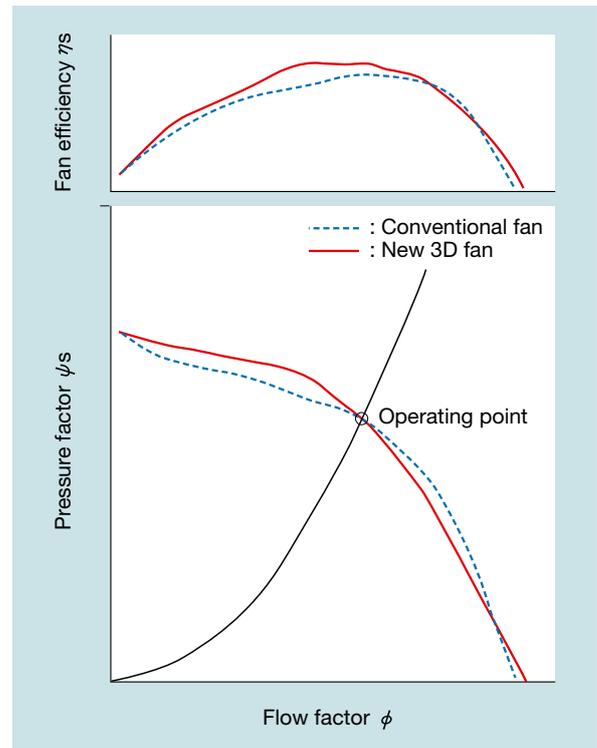


Fig. 7 Turbofan characteristics

The performance of the new turbofan is higher than the conventional fan.

3.4 Introducing a new type of wired remote control

Figure 8 shows the new wired remote control unit. The conventional wired remote control used a polarized three-wire communication system, while the new type uses non-polarized two-wire communications. A non-polarized communication line helps prevent problems with incorrect wiring during installation.

The liquid-crystal display (LCD) uses dotted characters.

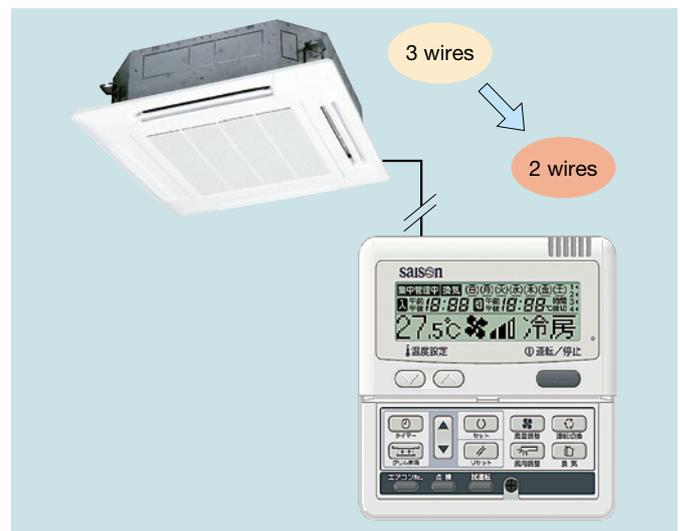


Fig. 8 New wired remote control

Changing the wiring from a polarized 3-wire system to a non-polarized 2-wire system makes installation easier.

The switching functions for the control settings on the indoor unit and the wired remote control were changed to improve performance. The functions for monitoring the unit operating conditions were enhanced to ensure better maintainability.

4. Improving execution characteristics and maintainability

The new model unit has various features that are useful to both installers and maintainers, not only for new installations but also for replacement and day-to-day maintenance.

4.1 Improving execution characteristics: temporary installation of panel

Normally, one person holds the panel while it is being installed on the unit. However, it is difficult to tighten the screws while holding the panel. To make installation easier, the panel is provided with a wire hanger that loops over a hook on the unit so that the panel can be attached temporarily to the unit. This eliminates the requirement for holding the panel during installation (Fig. 9).

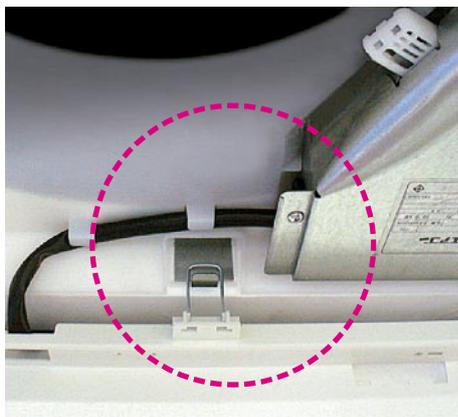


Fig. 9 Temporary hook arrangement
Attaching the panel temporarily with a hook helps ease the installation on a ceiling

4.2 Improving maintainability: Opening for inspecting dirt on drain pan

Dust collecting on the drain pan causes accumulation of slime, and building management hygiene regulations require periodic cleaning. Visual inspection of the drain pan on previous units was not an easy process without disassembly of the unit. The maintainability has been improved significantly as the new model is equipped with a transparent inspection

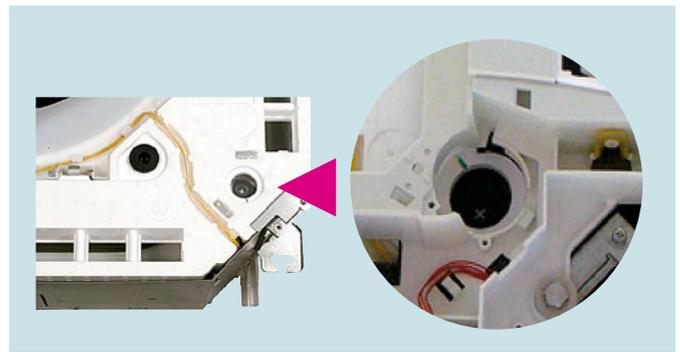


Fig. 10 Drain pan inspection window

The inspection window improves maintainability by allowing the user to check for dirt on the drain pan from the corner of the panel.

window to make inspection easy without removing the panel or the controller (Fig. 10).

5. Conclusion

The newly developed ceiling cassette four-way type indoor unit is lighter, more compact, and works better than conventional models. Its free-flow control offers better air comfort, and the new wired remote control makes installation and maintenance easier.

MHI is continuously improving its products to satisfy market demands and reduce power consumption to contribute to the conservation of the global environment.

Reference

1. Kondo et al., Noise Reduction in Turbo Fans for Air Conditioners, Mitsubishi Heavy Industries Technical Review Vol.26 No.3 (1989) p. 173



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