

Featured Articles

Development of the Inverter Air Conditioner for Southeast Asia in FY2014

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OVERVIEW: Hitachi has released 2.8 kW and 3.7 kW cooling-only inverter air conditioners featuring sleep support function in Southeast Asia, where the demand for room air conditioners for home use is accelerating, due to economic growth. In Southeast Asia, a high percentage of room air conditioners are used in the bedroom. Hitachi developed these products by narrowing down the focus to actual consumer needs, such as a sensor on the air conditioner to detect human movement in a dark room in order to automatically detect when users are sleeping so that the temperature setting can be automatically controlled after users fall asleep. The air conditioner also features a cross-flow fan with undulating blades to reduce the wind noise of the cross-flow fan. Although Hitachi has already been working to improve energy-saving performance (as energy conservation regulations are being strengthened in various Southeast Asian countries), Hitachi is now focusing its development efforts even further, including an indoor unit with improved blowing efficiency, a high-efficiency compressor, and other developments.

INTRODUCTION

IN Southeast Asian countries in 2013, the demand for room air conditioners for use in the home was 821,000 units in Malaysia, 1,072,000 units in Thailand, and 1,103,000 units in Vietnam, representing an increase of 34% over the past three years.⁽¹⁾ The main type of room air conditioner sold in these markets is a constant-speed type that uses an induction motor for

the compressor. However, as energy conservation regulations have been coming into effect in each country, the demand for inverter-type air conditioners is starting to rise.

In response to this growth in the Southeast Asian markets, Hitachi is expanding its room air conditioner business based out of Hitachi Air Conditioning Products (Malaysia) Sdn. Bhd. (HAPM) (see Fig. 1).

This article describes air conditioning control technology that enables comfortable sleep through the use of sensors in the inverter air conditioner targeted at Southeast Asia (see Fig. 2), and technology aimed at improving the basic performance in terms of energy conservation.

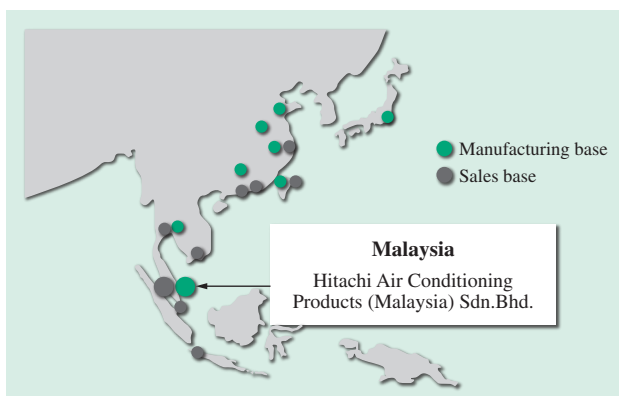


Fig. 1—Hitachi Air Conditioning Products (Malaysia) Sdn. Bhd. (HAPM).

Manufacturing and sales bases for room air conditioners and rotary compressors in Southeast Asia are shown.

DEVELOPING TECHNOLOGY FOR COMFORTABLE SLEEP

Because the demand for room air conditioners for master bedrooms and the family's private rooms (individual bedrooms) is high when considered together as a "bedroom demand" factor in both Malaysia and Thailand, Hitachi has developed a room air conditioner that uses inverter technology to enable comfortable sleep along with a high level of energy-saving performance (see Fig. 3).



Fig. 2—Cooling-only Inverter Air Conditioner for FY2014. The included sleep support mode determines when the user is sleeping, and automatically controls the temperature setting to provide comfortable sleep during operation.

For the room air conditioner to provide comfortable sleep in the bedroom, it must be able to determine the sleeping state of the user in a dark room, so that it can control the temperature setting automatically. This sleep support mode control system is described below.

Sleep-state Detection Technology

To detect the user’s sleep state, it was decided to use a non-contact method of detecting the user’s movement from the room air conditioner’s indoor unit. Since it is also necessary to detect the user when the bedroom is dark, a pyroelectric sensor is used to detect the infrared light radiated due to the user’s body heat. This pyroelectric sensor does not respond when user

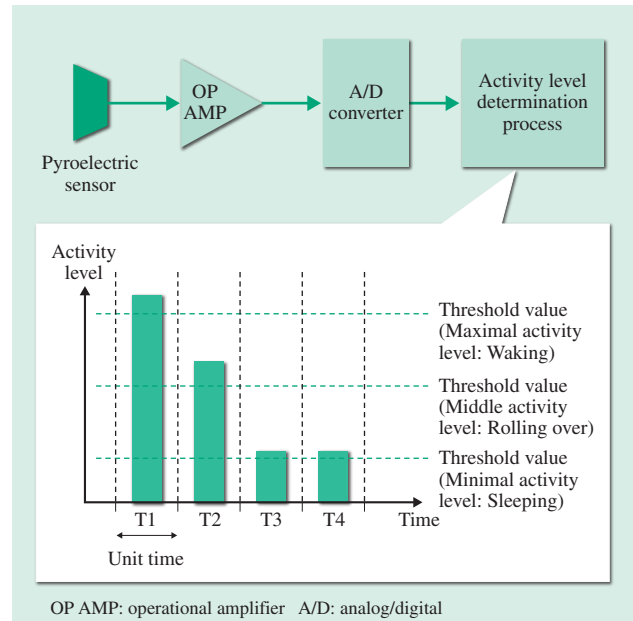


Fig. 4—Activity Level Determination Process Block Diagram. A system was included to convert the user’s activity state into data.

is motionless, and responds once again when the user moves. After the sensor output undergoes analog/digital (A/D) conversion, an activity determination processor computes the sensor response integration value for each unit of time, and classifies the activity level based on previously set threshold values (see Fig. 4).

Temperature Setting Shift Control

It is said that a way to ensure quality sleep is to gradually increase the room temperature.⁽²⁾ For that reason, when the aforementioned sensor determines that the user is sleeping based on their activity level,

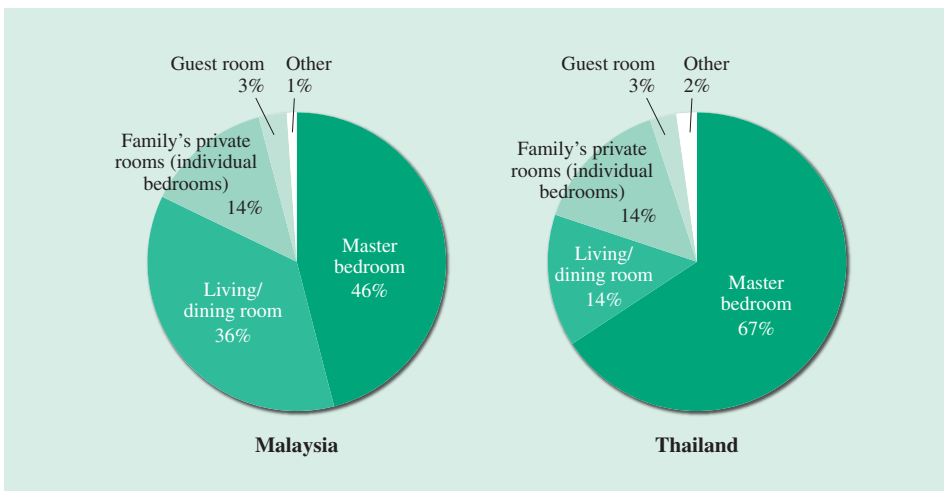


Fig. 3—State of Air Conditioner Installations in Malaysia and Thailand (Hitachi Survey from March 2013: n=309/country). The demand for air conditioners for use in the bedroom is high in Malaysia and Thailand.

the temperature setting is automatically increased by 1°C after one hour passes, and by another 1°C time after two hours. The rotational speed of the cross-flow fan is also reduced in synchronization with the temperature setting shift.

The cross-flow fan's blade shape has been redesigned from the previous trapezoidal shape to a new undulating shape, and the blade pitch was arranged using a sine function to reduce noise to 19 dB* (see Fig. 5).

* Measurement conditions: Sleep support mode, based on JIS C9612:2005.

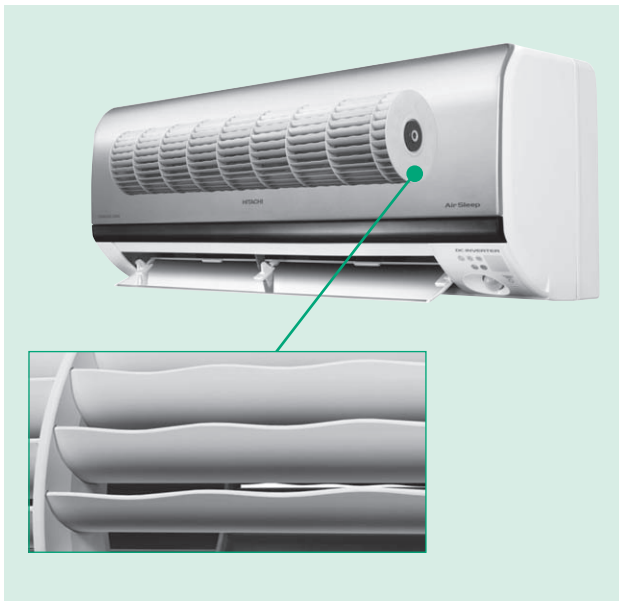


Fig. 5—External Appearance of Cross-flow Fan with Undulating Shape.

A cross-flow fan with an undulating shape was used to reduce the noise of blowing air in sleep support mode.

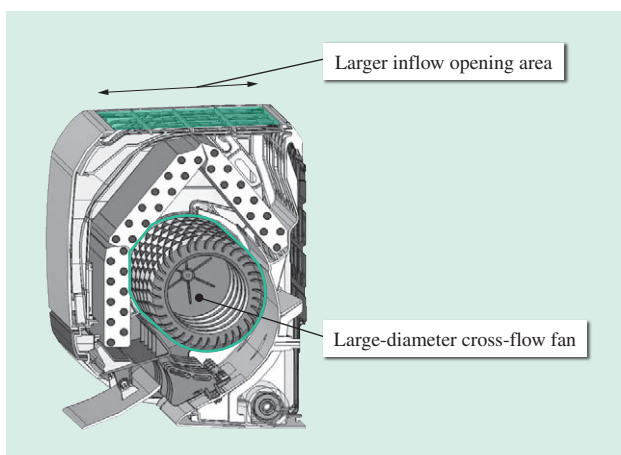


Fig. 6—FY2014 Indoor Unit Cross-Section.

The indoor unit's cross-sectional structure was designed to homogenize the flow velocity distribution passing through the heat exchanger.

ENERGY-SAVING TECHNOLOGY

The energy efficiency ratio (EER) is mainly used as an energy conservation index for room air conditioners in Southeast Asian countries, and to improve performance, the efficiency of blowers, compressors, and other basic components must be increased.

Indoor Unit

To homogenize the velocity distribution of the air flowing through the heat exchanger, and to improve heat exchange efficiency, the area of the indoor unit's top inflow opening was expanded. Blowing power was also reduced by setting the diameter of the cross-flow fan to $\phi 115$ (see Fig. 6).

Compressor

The following technologies were developed to achieve high efficiency in the rotary compressor.

Unlike the neodymium (rare earth) motor that was previously used, the included motor uses a bathtub-shaped ferrite magnet with an expanded surface area and thereby secures the required level of magnetism (see Fig. 7). Also, the shaft diameter was reduced to improve the efficiency of the compressor by reducing sliding loss. Furthermore, improvements were made including using the oil flow channel

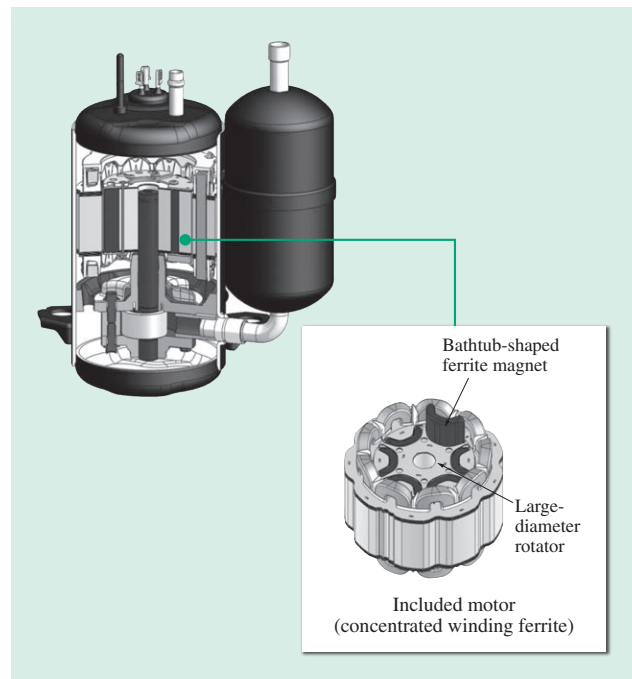


Fig. 7—FY2014 Rotary Compressor Motor.

A motor with a new structure was developed using a ferrite magnet with a new bathtub shape.

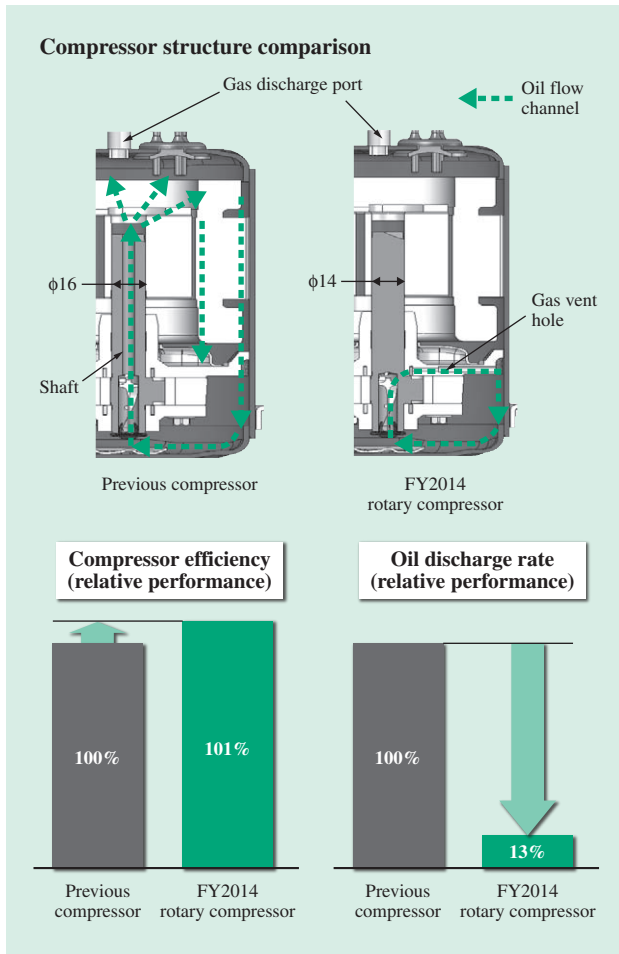


Fig. 8—Performance Comparison between Previous Compressor and FY2014 Rotary Compressor.

The newly developed rotary compressor improves compressor efficiency by approximately 1% over the previous compressor, and reduces the oil discharge rate by approximately 87%.

inside the compressor as the oil circulation method in the compressor bottom far from the gas discharge port, and greatly reducing the amount of discharge oil because this reduces the air conditioner's heat exchange performance (see Fig. 8).

TECHNOLOGY FOR RESPONDING TO THE STATE OF THE POWER SUPPLY

Power supply is not always stable in some Southeast Asian countries, so dealing with instantaneous power failures and other such issues is one way to improve consumer satisfaction levels.

Instantaneous power failures and other sudden voltage fluctuations can cause pulsations to occur in the compressor's motor current, which may activate the overcurrent detection function. This is why changes in voltage are constantly monitored, and if a



Fig. 9—5.2 kW Inverter Air Conditioner with Imaging Camera Made in Japan.

An inverter air conditioner with heating and cooling capabilities and a imaging camera was introduced to the Thailand market.

change in voltage per unit time is large the compressor is temporarily brought to a normal stop and the system is restarted. The indoor unit continues blowing air during the compressor's temporary normal stop, reducing the user's feeling of discomfort.

CONCLUSIONS

The demand for room air conditioners is expected to continue growing in Southeast Asian countries, with the use of such devices spreading from the bedroom to the living room. For this reason, Hitachi has began selling a model featuring monitoring system using an imaging camera, which was previously released on the domestic Japanese market, as a premium model in April 2014 (see Fig. 9).

Hitachi will continue developing products aimed at achieving comfortable air conditioning during both day and night while improving the basic performance of room air conditioners and deploying reasonable price models that employ imaging camera to Southeastern Asia.

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