TEJ35A Electric Transport Refrigeration Unit Using Inverter for Light Trucks

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In recent years, automotive manufacturers have launched HEV and EV light truck models with a secondary battery similar to passenger vehicle models, and the improvement of environmental performance has been progressing in combination with the electric equipment mounted on the truck. Mitsubishi Heavy Industries, Ltd. (MHI) has developed the TEJ35A inverter-driven electric transport refrigeration unit that operates with power fed from a secondary battery to attain a higher temperature stability and higher environmental performance. This paper presents the TEJ35A.

1. Product summary

Transportation refrigeration units are required to have sufficient cooling capacity for rapid cooling to the set temperature, temperature controllability for maintaining the temperature after the attainment of the set temperature, and energy saving characteristics.

The developed TEJ35A has achieved cooling down capability (cooling down speed), accuracy of temperature retention, and energy saving characteristics on a high level due to the employment of inverter-based variable speed control, which operates according to heat load conditions, for the DC twin rotary compressor proven in MHI's air conditioning systems.

2. Advantages of the product

2.1 High temperature stability

The TEJ35A is operated using power from a secondary battery and therefore can deliver stable cooling capacity regardless of the operating conditions of the vehicle. This enables constant-temperature transportation even under conditions where the vehicle is stopping with the "idling stop" function turned on, stuck in traffic congestion, or waiting for traffic signals to change (**Figure 1**).

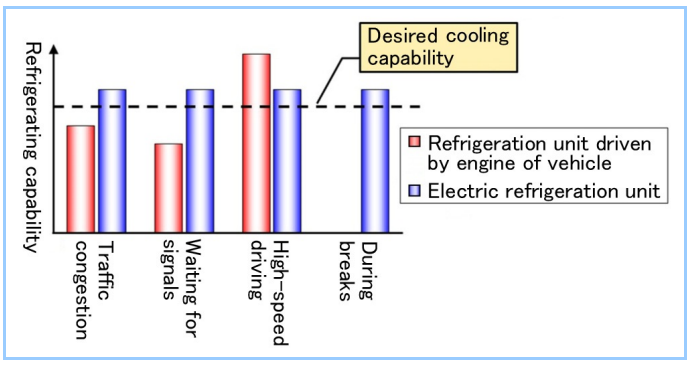

Figure 1 Cooling capacity during transportation

In addition, the TEJ35A enables compartment temperature stability with high accuracy by raising the compressor speed just after the start of cooling so that the temperature can reach the set value in a short period of time, and finely controlling the compressor speed according to the compartment temperature after the attainment of the set temperature (**Figure 2**).

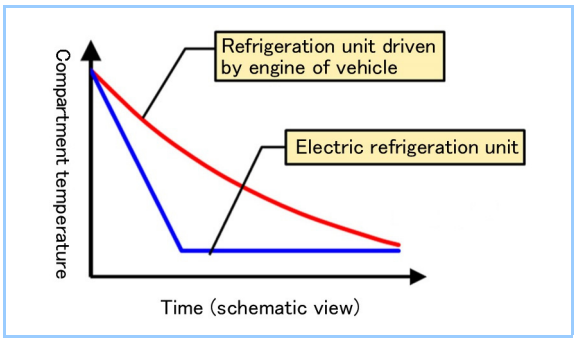

Figure 2 Cooling speed and compartment temperature stability

2.2 Maintenance saving

The TEJ35A eliminates components that need to be replaced such as drive belts and refrigerant hoses that are used in MHI's existing models to enable a considerable reduction of the maintenance cost. This results in the elimination of the need for down time of the vehicle for maintenance, and hence a significant reduction in the time the vehicle is out of service because of maintenance (opportunity loss).

2.3 High environmental performance

The TEJ35A uses R410A refrigerant, which has a lower GWP (Global Warming Potential) than the R404A used in existing models, resulting in GWP being lowered by 47% from 3920 to 2090 and thus a reduction of global warming effect by half.

In addition, the compressor is controlled to the optimum speed at which the operating efficiency is enhanced according to the compartment temperature and the operating pressure. This enables the improvement of annual operating efficiency by 15% and a reduction of annual CO_2 emissions by 15% compared with MHI's conventional models that are driven by the engine of the vehicle.

2.4 Flexibility in mounting on vehicle

The TEJ35A is designed so that it has compatibility with MHI's conventional models in mounting, allowing for high mounting flexibility.

In addition, the TEJ35A can be power-fed from a 250 to 400 VDC power source, which covers all secondary batteries used for Japanese HEV and EV, making it flexible in terms of power source. When the supply voltage falls, the TEJ35A uses MHI's unique inverter-based motor control technologies such as field weakening control and overmodulation PWM (Pulse Width Modulation) control to stabilize the motor speed and refrigeration capability is maintained over a voltage variation.

3. Specifications and structure

Table 1 and **Figure 3** show the specifications and structure of the TEJ35A, respectively.

Table 1 Specifications of TEJ35A

Model type			TEJ35A
Operating temperature range	Compartment temperature	°C	-30 to +30
	Ambient temperature	°C	-20 to +40
Cooling capacity (Ambient temperature 35°C/ Compartment temperature 0°C)		W	1400 to 4300 (*)
High voltage DC power source	Voltage	VDC	250 to 400
	Power	W	Max. 3600 (at 360 VDC)
Low voltage DC power source	Voltage	VDC	13.5 or 27.0
	Power	W	Max. 490
External dimensions	Main body	mm	W1780 x H785 x D570 (Outside 470, Inside 100)
Weight		kg	97
	Main body	kg	92.5
	Accessory	kg	4.5
Refrigerant		kg	R410A, 1.7
Noise		dB(A)	60/7.5 m

* The maximum cooling capacity varies depending on the electric power received.

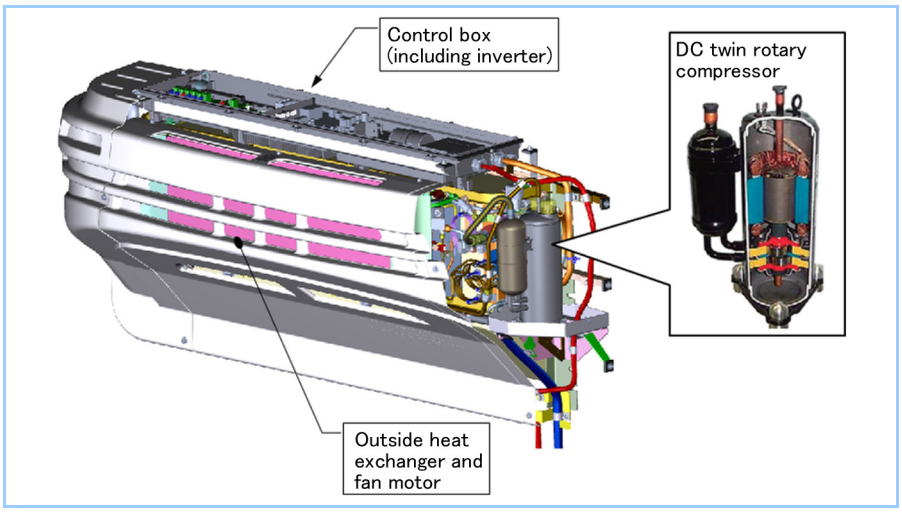

Figure 3 Structure of TEJ35A

4. Future prospects

In the future, MHI will continuously contribute to the quality improvement of constant temperature transportation items and the establishment of a low carbon society through efforts on improving the performance of electric transport refrigeration units reflecting the opinions of customers and the expansion of our product line-up in response to market needs.