TEJ100A/TEJ100AM Electric Driven Inverter Type Refrigeration Units for Heavy Duty Trucks

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In recent years, lineups of HEV/EV trucks have been expanding in order to conform with regulations on fuel economy, exhaust gas, ZEV (Zero Emission Vehicle), etc., that have been imposed on vehicles throughout the world for the reduction of environmental load. Under such circumstances, the need for refrigeration units compatible with vehicle electric power is on the rise. Mitsubishi Heavy Industries Thermal Systems, Ltd. has developed the TEJ100A/TEJ100AM, all electric driven inverter-type refrigeration units with the capability to deliver high refrigeration capacity with a limited vehicle power supply. The units support a variety of power supply systems and feature the top-level operational efficiency in the industry. The details of the units are introduced below:

1. Outline of the products

Compressors in conventional refrigeration units for transportation were driven by a vehicle engine or a dedicated engine. In contrast, the TEJ100A/TEJ100AM is driven by a power supply system mounted on the vehicle with the capability to achieve high efficiency by incorporating a proprietary inverter speed control algorithm, hermetic 3D scroll compressor and heat exchanger featuring improved heat exchange performance.

2. Characteristics of the products

2.1 Reduction of environmental load

(1) The highest level of operational efficiency in the industry

The highest level of operational efficiency in the industry was realized by incorporating a proprietary hermetic 3D scroll compressor and a high-efficiency heat exchanger, as well as compressor speed control technology (**Figure 1**) that constantly maintains the system at the maximum efficiency..

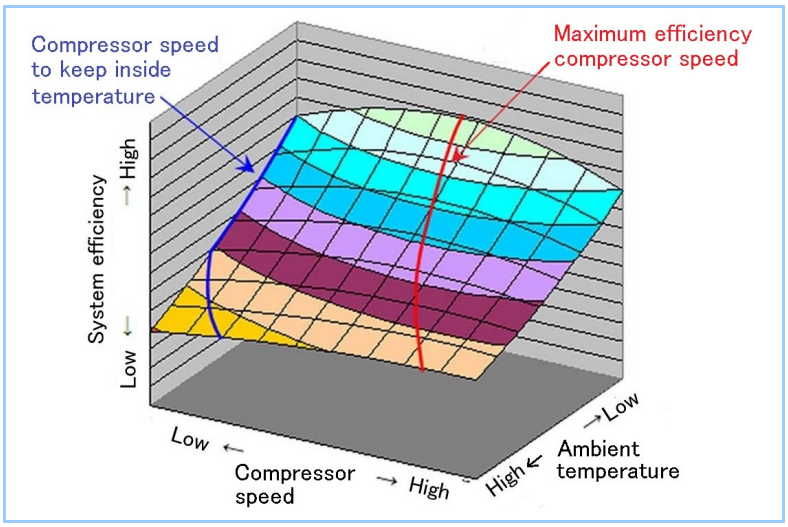

Figure 1 Control map for maximum efficiency
The compressor speed is controlled according to the ambient temperature, etc., so that the system is constantly operated at the maximum efficiency.

The hermetic 3D scroll compressor incorporates a gas injection mechanism for low temperature range operation to widely used air conditioner compressor. In addition, special tuning using proprietary inverter speed control system ensures high operation efficiency.

The heat exchanger was laid out at a position free from interference with the vehicle on which it is mounted, and with consideration for the maximization of the inside volume of the cargo compartment. In addition, the positional relation between the heat exchanger and the fan motor outside the refrigeration unit was optimized to maximize the heat exchange performance.

The air-cooling method incorporated for cooling the compressor drive inverter also contributes to the improvement of the operational efficiency, because it does not cause a loss of cooling capacity, unlike electric compressors for automobile air conditioners, in which the inverter is cooled by refrigerant.

(2) Incorporates refrigerant with limited impact on global warming

The TEJ100A/TEJ100AM uses R410A refrigerant featuring low GWP (Global Warming Potential: global warming factor), instead of the R404A used in conventional models, for the first time in the industry. The GWP value dropped by 47% to 2090, compared with the 3920 achieved by R404A, reducing the impact on climate change and the ecosystem as well as our daily lives.

2.2 Improvement of mountability

(1) Inverter control technology applicable to a wide range of voltages and power supply capacities

The proprietary inverter control technology, which makes it possible to maintain a constant compressor speed even if the voltage from the power supply system fluctuates, realizes application to a wide range power supply systems featuring different voltages (**Figure 2**).

The capacity control by the inverter makes it possible to operate even if the power capacity of the power supply system is limited, realizing operation by a variety of power supply systems according to customer needs.

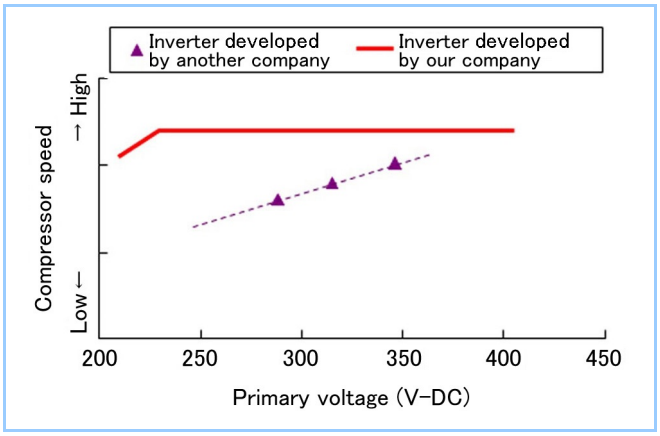

Figure 2 Dependence of compressor speed on voltage

(2) Communication circuit that supports various communication systems

The TEJ100A/TEJ100AM is mounted with a communication circuit that supports serial communication systems used in vehicle networks and vehicle-mounted devices, such as controller area network (CAN) communication and universal asynchronous receiver/transmitter (UART) systems. Because of this communication circuit, cooperative control by easy connection is realized just by changing the communication software, regardless of the power supply system.

(3) Integral type unit structure

Mounting onto vehicles was simplified by incorporating an integral structure, where a heat exchanger, a 3D scroll compressor and a control box are built into the refrigeration unit. Because of this structure, the mounting time was reduced, realizing a short delivery time.

2.3 Improvement of transportation efficiency

(1) Single-compressor 2-way system that effectively controls the temperature of two cargo compartments

In recent years, when transporting products at a constant temperature in heavy duty trucks, in particular, needs have been increasing for carrying cargo of different temperatures, such as frozen products and chilled products, by changing the ratio of the cargo compartment depending on the volume of the cargo. Responding to the need, the TEJ100AM features a function to efficiently control the refrigerant flow distribution to each cargo compartment by a single compressor, and the ratio of cooling capacity distribution is automatically controlled depending on the thermal load of each cargo compartment. Because of this system, customers can operate their trucks with the maximum transportation efficiency without limitations due to transport temperature and cargo volume.

2.4 Improvement of maintainability

(1) Less maintenance operations

Compressor drive belts and refrigerant hoses were eliminated following the introduction of a fully-electric system, and the service life of devices including the fan motor was improved, which significantly reduced the maintenance cost.

(2) Layout design with considerations for inspection

The electrical components including solenoid valves and sensors for the refrigerant, as well as the hermetic 3D scroll compressor and the inverter, are laid out on the sides or top of the refrigeration unit main body, targeting easy access for maintenance and the reduction of maintenance time.

3. Specifications and structures

The specifications and structure of the TEJ100A/TEJ100AM are shown in **Table 1** and **Figure 3**.

Table 1 Specifications of TEJ100A/TEJ100AM

Model type			TEJ100A	TEJ100AM	Remarks
Operating temperature range	Compartment temperature	°C	-30 - +30	-30 - +30	
	Ambient temperature	°C	-20 - +40	-20 - +40	
Cooling capacity (Ambient temperature 35°C /Compartment temperature 0°C)	Integrated unit	W	11700	11700 *1	By received power *1: In the case of single unit operation
	Rear compartment evaporator	W	---	7100 *1	
Refrigerant		kg	R410A, 4.4	R410A, 5.9	
High voltage DC power source	Voltage	DC-V	250 - 400 (Operation guaranteed at 200 - 400)	250 - 400 (Operation guaranteed at 200 - 400)	Operation is possible at DC200 - 250V, but the cooling capacity is not guaranteed.
	Power	W	<7500	<7500	
Low voltage DC power source	Voltage	DC-V	27.0	27.0	
	Power	W	Max. 800	Max. 1200	Included in high-voltage DC source power
Outline dimensions	Integrated unit	mm	W2354×H1013×D1007	W2354×H1013×D1007	
	Rear chamber evaporator	mm	---	W1520×D623×H151	
Weight		kg	288	340	
	Integrated unit	kg	255	255	
	Rear compartment evaporator	kg	---	27	
	Accessories	kg	33	58	

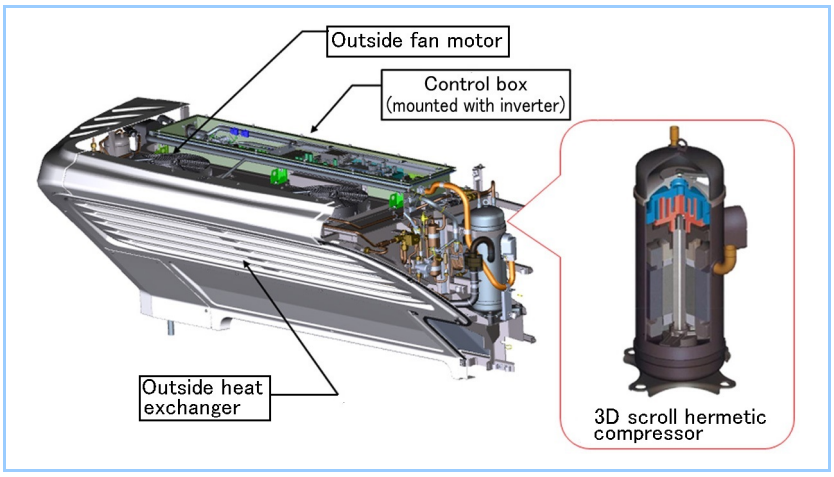

Figure 3 TEJ100A/TEJ100AM: Configuration of the integrated unit

4. Future development

We will continue to improve the performance of the all electric driven inverter-type refrigeration units for transportation and expand the lineup to support a variety of power supply systems, aiming to make contribution to human life through the reduction of environmental load and quality improvement of products transported at a constant temperature (**Figure 4**).

Figure 4 A truck equipped with the TEJ100AM All-Electric Inverter-Type Refrigeration Unit for Transportation