
TE Series Small Electrically-driven Refrigeration Units with Generator for Delivery Trucks



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The rise of E-commerce industry and home delivery services have rapidly increased the amount of cargo handled by logistic industry worldwide. This development poses both a social as well as environmental challenge to reduce the burden on truck drivers as well impact on environment. In particular, for delivery trucks that require refrigerated transportation, there is growing demand for improved temperature maintenance, operability and lower running costs through the adoption of electric refrigeration units.

Mitsubishi Heavy Industries Thermal Systems, Ltd, has developed all-electric ‘TE series’ refrigeration unit compatible with diesel trucks, which make up the majority of transportation vehicles to meet the aforementioned market demand with a dedicated alternator and battery. This report introduces the developed refrigeration unit TE series.

1. Product overview

The TE Series with dedicated alternator and battery has ability to deliver constant performance independent of truck speed and maintain temperature even during vehicle stops for delivery without truck engine power. Additionally, unit can automatically switch the operation mode between truck engine, battery and commercial power without stopping thereby improving the operability and reducing the driver’s burden considerably.

2. Product advantages

2.1 Reduction of driver's burden

- (1) Continuous operation function due to automatic switching of power supply to refrigeration unit (hereinafter seamless operation function)

A generator and battery dedicated to the refrigeration unit is incorporated into the vehicle. The battery power is boosted by our proprietary converter and the refrigeration unit is operated at a controlled compressor speed using an inverter.

As shown in **Figure 1**, during vehicle running and precooling operation, the refrigeration unit is operated and the battery is charged by the generator power during vehicle stops for delivery and idle stops, the refrigeration unit operation is automatically switched to battery power. Thereby, it is possible to continuously operate the refrigeration unit without stopping from start to the end of delivery operation and maintain the refrigerated cargo room temperature constant with high accuracy.

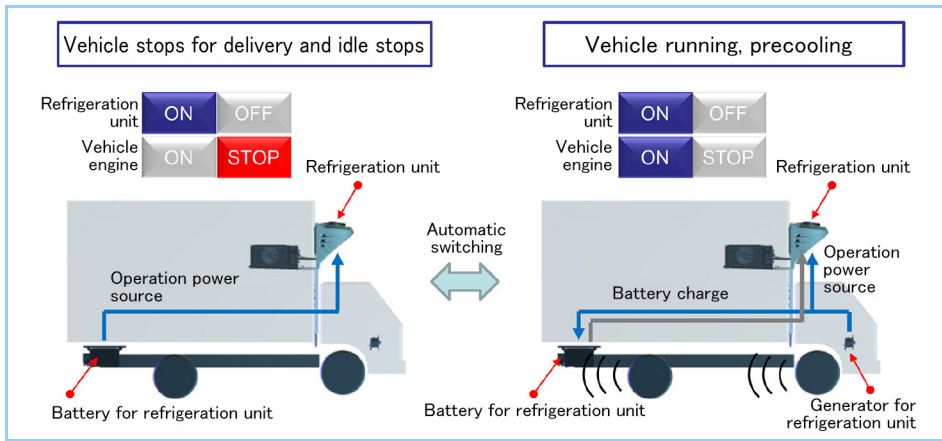


Figure 1 Automatic power switching system realizes seamless operation of refrigeration unit

For the seamless operation function, a charge/discharge monitoring sensor is installed on the battery dedicated to the refrigeration unit. By controlling the cooling capacity and power consumption with an inverter as shown in **Figure 2** according to the battery charge level and the operating condition, autonomously optimized refrigeration unit control for all-day delivery is realized.

This autonomous control solves the problem of the temperature rising during vehicle stops which is an issue for drivers and hence, can reduce the driver's burden.

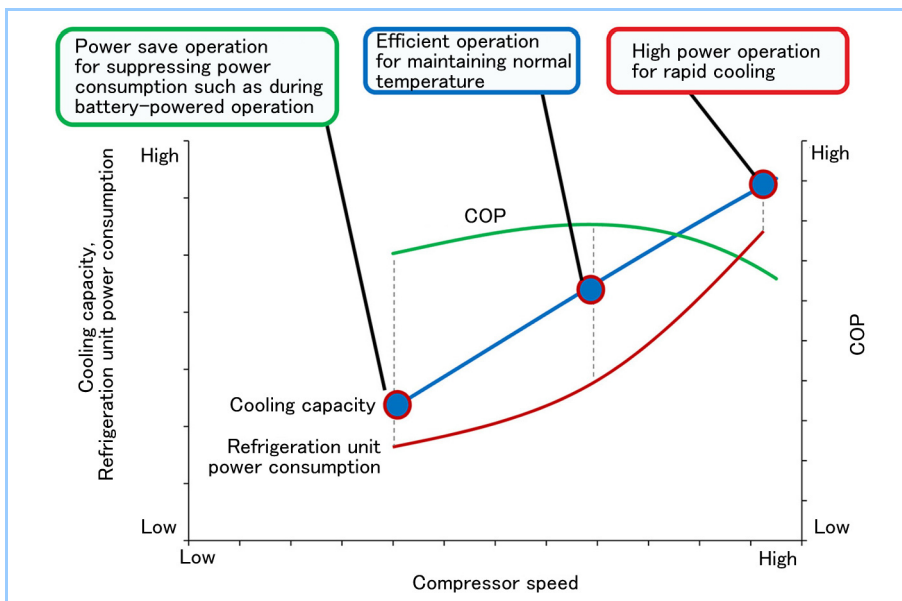


Figure 2 Power control and compressor speed control

(2) Visibility and operability improvement

The temperature in the refrigerated cargo room and the remaining battery level are always displayed on the controller LCD so that they can be seen at a glance (**Figure 3**). The driver can easily check the refrigeration unit operating condition and the temperature of the cargo.

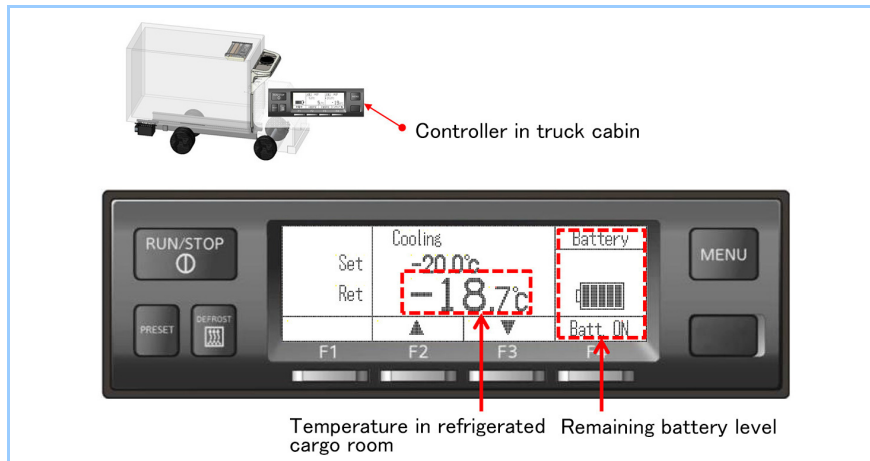


Figure 3 Easy-to-see display of temperature in refrigerated cargo room and remaining battery level

2.2 Reduce environmental impact and improvement of economy

(1) Improvement of energy saving performance

Due to the generator dedicated to the refrigeration unit, the battery is charged during vehicle running when the engine efficiency is good, and the refrigeration unit operation during vehicle stops is powered by the battery, so that the stored energy of the vehicle engine can be used more efficiently. In addition, as shown in Figure 2, when maintaining the temperature of the refrigerated cargo room, the refrigeration unit is operated at a high-efficiency operating point using an inverter, thereby further improving the energy saving performance.

(2) Improved total cost of ownership

Conventional electrically-driven refrigeration unit systems mainly use high-cost batteries such as lithium ion batteries and high-efficiency permanent magnet generators. In contrast, due to the adoption of the high-efficiency converter technology with a high conversion voltage ratio, the charge/discharge monitoring that greatly extends the battery life and the inverter control, this product realizes a refrigeration unit that combines a low-cost and general-purpose lead-acid battery and an alternator for commercial vehicles, improving both the initial cost as well as running cost of refrigeration unit.

3. Specifications and configuration

The TE30GA is a refrigeration system that control the temperature of one refrigerated cargo room with one evaporator unit.

On the other hand, the TE20AM is a system that can operate two cargo rooms in different temperatures such as chilled and frozen with two evaporator units.

Figure 4 shows the system configuration of the TE30GA. **Table 1** lists the specifications of the TE30GA and TE20AM.

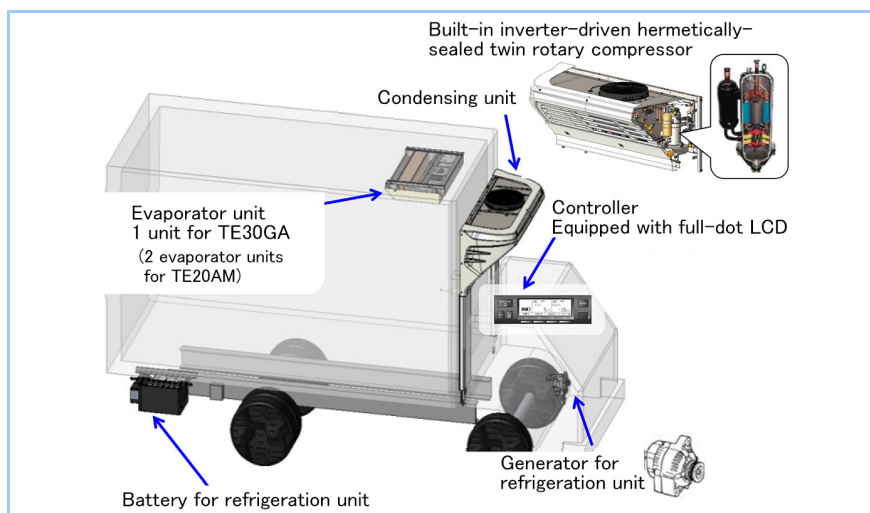


Figure 4 Refrigeration unit and system configuration of TE30GA

Table 1 Specifications of TE30GA and TE20AM

Model type		TE30GA	TE20AM	Remark	
Operating temperature range	Cargo room temperature	°C	-20 to +30	-20 to +30	*1 At maximum capacity operation with inverter control
	Ambient temperature	°C	-20 to +40	-20 to +40	
Cooling capacity	Evaporator for compartment A	W	3000W* ¹ (Ambient temperature 30°C /Cargo room temperature 0°C)	2400W* ^{1,2} (Ambient temperature 35°C /Cargo room temperature 0°C)	*2 Evaporator for freezing, in-house test value
	Evaporator for compartment B	W	—	1650W* ^{1,2} (Ambient temperature 35°C /Cargo room temperature 0°C)	*3 Evaporator for cooling, in-house test value
Refrigerant		kg	R410A, 1.3kg	R410A, 1.3kg	*4 Excluding battery and generator
External dimensions* ⁴	Condensing unit	mm	1585×580×725	1585×580×725	
	Evaporator for compartment A	mm	960×620×151	882×300×390	
	Evaporator for compartment B	mm	—	882×300×390	
Weight* ⁴	Condensing unit	Kg	88	88	
	Evaporator for compartment A	Kg	20	10.8	
	Evaporator for compartment B	Kg	—	7.9	

4. Future development

We will continue to improve the performance of electrically-driven refrigeration units for delivery trucks and expand the product line for various types of vehicles, in order to contribute to the improvement of people's lives by reducing the environmental impact in the cold chain, relieving driver burden, and improving transportation quality.