

High-Performance Gas Heat Pump ECO7



ATSUSHI YOSHIMURA*1

TAKUYA OKADA*1

SATOSHI SOBURI*2

AKIRA ITO*2

YASUSHI WATANABE*2

SATOSHI WATANABE*2

To meet customers' mounting needs for economy and environmental protection, commercial air-conditioners of gas heat pump type noted for energy saving and comfort have been improved. Consumption of gas and energy has been reduced and the product power has been enhanced by improving energy efficiency, reducing noise and vibration, improving ease of installation and meeting renewal needs.

1. Introduction

Gas heat pumps which drive engines fueled by natural gas (city gas) or LP gas with low environmental impact, and operate a compressor are known to have high heating performance in winter. This is because, unlike electric heat pumps, exhaust heat of the engine is utilized, resulting in low power consumption of about 1/10 that of electric heat pumps. Accordingly, these products are expected to achieve smoother energy demand, reduce contracted power, and lower the load of electric power receiving facilities.

A new ECO7 series using refrigerant R410A has been developed by greatly improving efficiency as compared with the existing model (Fig. 1).



Fig. 1 Appearance of outdoor unit of gas heat pump

2. Features of ECO7 series

The ECO7 series uses R410A as refrigerant, operates a newly developed high-performance scroll compressor (Fig. 2), and has been substantially enhanced in coefficient of performance (COP) through improved engine thermal efficiency and air-conditioning technology, achieving COP = 1.59 at 13 horsepower, the highest in the industry. Apart from reduced gas consumption, DC motors are used to drive the outdoor fan and cooling water pump, and total power consumption is cut by more than 30%.

The series includes a 24 horsepower outdoor unit for the first time in the industry, and is applicable to higher capacity. In addition, since existing piping can be utilized, it easily meets the market's renewal demand. The main specifications of the ECO7 series are given in Table 1.



Fig. 2 Appearance of high-efficiency scroll compressor

*1 Air-Conditioning & Refrigeration Systems Headquarters

*2 Nagoya Research & Development Center, Technical Headquarters

Table 1 Main specifications of ECO7 series

Outdoor unit capacity	(HP)	13	16	20	24
Cooling capacity	(kW)	35.5	45.0	56.0	67.0
Heating capacity	(kW)	40.0	50.0	63.0	71.0
Low-temperature heating capacity	(kW)	42.5	53.0	67.0	75.0
Cooling gas consumption	(kW)	22.4	30.5	41.5	58.7
Cooling consumption power	(kW)	1.12			
Heating gas consumption	(kW)	22.7	29.1	38.0	46.4
Heating consumption power	(kW)	1.21			
Cooling and heating average COP		1.59	1.54	1.46	1.31
Overall dimensions	(mm)	2250 (H) × 1750 (W) × 1080 (D)			

3. Enhancement of performance

Conventional machines have two heat exchangers. The new machine has four heat exchangers in L-profile, and with no increase in the unit width, the front surface area of heat exchangers is increased by about 50%, the air flow rate is increased by about 18% by using a newly developed long-chord fan, and the performance of the heat exchanger is enhanced. This improved performance of the heat exchanger not only contributes to enhancement of COP but also enables stable operation at high temperature in mid-summer with ample allowance (**Fig. 3**).

The compressor comprises two newly developed high-efficiency scroll compressors. Compared with conventional compressors, the compression efficiency of the new compressor has been improved by 20% at 20 horsepower cooling rating point through use of the original high-efficiency scroll profile and development of low-loss bearing. In a region of partial load with decreased room load, the efficiency has also been enhanced as compared with conventional machines. This compressor includes a capacity control mechanism, and is flexibly applicable to cooling and heating load changes through optimization of the number of running compressors and capacity load mechanism. The compressor operation time has also been equalled out by rotation start of the two compressors.

The engine driving the compressors has a piston of short skirt and a low-tension piston ring, resulting in lower friction loss, and higher engine efficiency has also been realized by newly developing an exhaust gas heat exchanger of low pressure loss type. By the use of lean limit control for detecting the combustion state from engine speed information, the air-fuel ratio can be kept near the lean combustion limit. The exhaust gas re-circulation (EGR) mechanism required in conventional machines is not used, and low NOx operation is realized.

As a result of improvement of efficiency, energy consumption for cooling is reduced by 24% as compared with conventional machines at 13 horsepower.

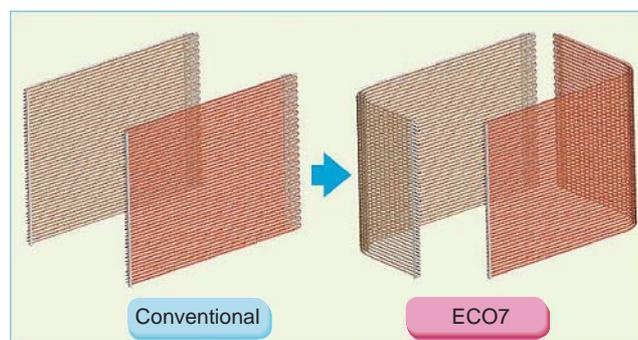


Fig. 3 Structure of four heat exchangers

Comparison of structure of conventional heat exchangers and ECO7 heat exchangers.

4. Noise of operation

In the ECO7 series, engine vibration is suppressed, bottom plate rigidity is increased to improve sound insulation performance, and a newly developed low-noise fan is used. In total, the noise level has been lowered by 2 dB as compared with conventional machines, and the operation noise level of the 20 horsepower model is 58 dB.

5. Installation

The refrigerant is high-density R410A. An overcooling heat exchanger is newly installed, and the piping length limit has been extended to 160 m, the longest in the industry. The total extension length is 510 m and the piping size has been reduced. By extension of the piping length, indoor units can be installed in a limit area and installation space is saved. Reduction of the piping size results in lower cost of piping and refrigerant (**Table 2**).

The series includes a 24 horsepower outdoor unit for the first time in the industry, and the conventional installation of 8 horsepower + 16 horsepower units can be replaced by one unit of 24 horsepower. Alternatively, three units of 16 horsepower can be replaced by two units of 24 horsepower. Installation space, weight, and size of piping system can be reduced (**Fig. 4**).

In the unit power source specification, single-phase power and three-phase power specification machines are commonly used. The single-phase power and three-phase power can be easily changed over at the site simply by connecting the power cable and without need for a particular setting.

Table 2 Reduction of piping size

Outdoor unit capacity	Conventional unit: RC07C		ECO7 Refrigerant: R410A	
	Liquid piping	Gas piping	Liquid piping	Gas piping
13 HP	φ 15.88	φ 31.8	φ 12.7	φ 25.4
16 HP		φ 34.92		(φ 28.58)
20 HP	φ 19.05	φ 38.1	φ 12.7 (φ 15.88)	φ 28.58
24 HP	-	-		(φ 31.8)

() denotes actual length of 90 m or more.

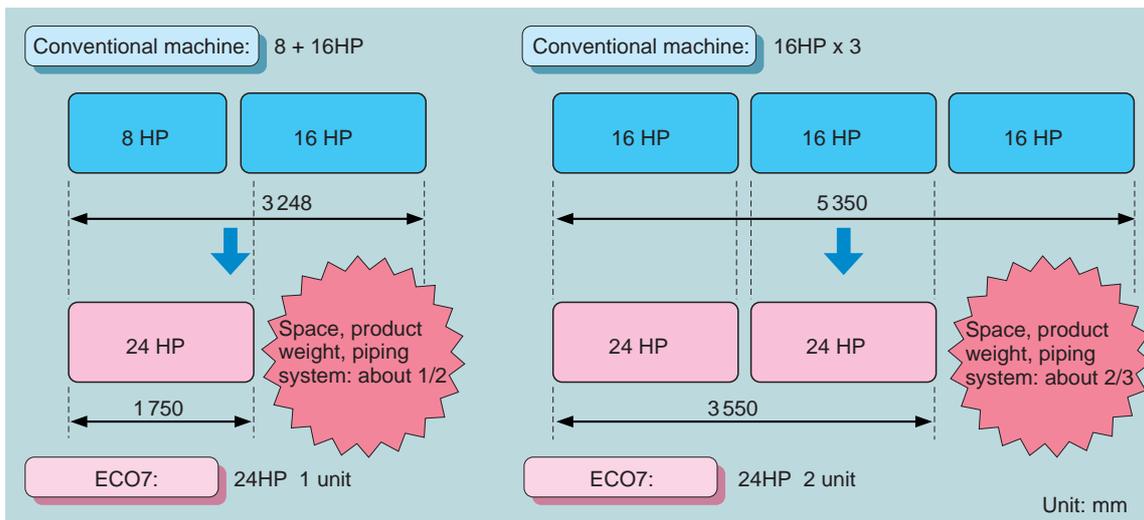


Fig. 4 Comparison of installation space
Comparison of installation space of conventional machine and ECO7.

6. Renewal needs

A renewal model of the ECO7 series can be installed with the existing piping. The renewal model has the same width as the conventional model, and the overall size is applicable to exchange of the outdoor unit only. To clean the existing piping, two methods are possible. In one method, when the existing unit can be operated, the existing unit is put into cooling operation for more than 30 minutes as a simple cleaning operation, and the existing piping can be cleaned. In the other method, when the existing unit cannot be operated, a piping cleaning kit is connected to the new unit, and the piping is cleaned. The new unit and piping cleaning kit can be easily connected with a flange using flexible piping, and it can also be easily detached.

The renewal series is also applicable to different piping sizes: a conventional system of two units of 10 horsepower can be replaced by one unit of 20 horsepower, or a system of three units of 8 horsepower can be replaced by one unit of 24 horsepower. Freedom of installation of renewal is thus assured.

7. Conclusions

The ECO7 includes a large-capacity outdoor combination series using two outdoor units, cooling and heating free multi-series capable of cooling and heating simultaneously in one refrigerant system, and a generator series that reduces power consumption by the generator built in the outdoor unit. These varied products are well suited to market needs for reduction of environmental impact, improved efficiency and increased capacity. From now on, new products contributing to growth of the gas heat pump market will be further researched and developed.



Atsushi Yoshimura



Takuya Okada



Satoshi Soburi



Akira Ito



Yasushi Watanabe



Satoshi Watanabe