

'MSV2' Air-Cooled Heat Pump Module Chiller Realizes Top-class High-efficiency and Adopts R32 Refrigerant



Mitsubishi Heavy Industries Thermal Systems Ltd.

In recent years, along with global demand for the reduction of carbon dioxide emissions, refrigerants with a lower global warming potential are being increasingly used in air conditioning products. The adoption of such refrigerants is necessary not only for residential air conditioners and packaged air conditioners, but also for air-cooled heat pump chillers used for air cooling/heating in buildings or water chilling/heating in factories. Because installation space is limited, it is desirable to realize both larger capacity and better efficiency at the same time.

Adopting a refrigerant that can contribute to curbing global warming, Mitsubishi Heavy Industries Thermal Systems, Ltd. (MTH) has developed the highly-efficient MSV2 series of air-cooled heat pump chillers featuring the industry's largest class 70 horsepower (HP) model. This report presents the product characteristics and specifications.

1. Characteristics

1.1 Reduced the impact to global warming and realization of extensive operating range

(1) Adoption of R32 refrigerant and reduced refrigerant charge volume

To curb global warming, the Kigali Amendment to the Montreal Protocol calls for a reduction in the consumption of alternative fluorocarbons (HFCs^{*1}). As a refrigerant for use in our chillers, we therefore adopted R32 because its GWP^{*2} is roughly 1/3 of the conventionally-used R410A. A refrigerant circuit with two different flow rate control systems is employed to divide the flow rate control depending on the operation mode (cooling/heating), thereby optimizing the refrigerant charge volume. As a result, the volume was successfully reduced by approximately 28% from earlier models, thus contributing to mitigating global warming as shown in **Figure 1**.

*1 Hydro Fluoro Carbon *2 Global Warming Potential

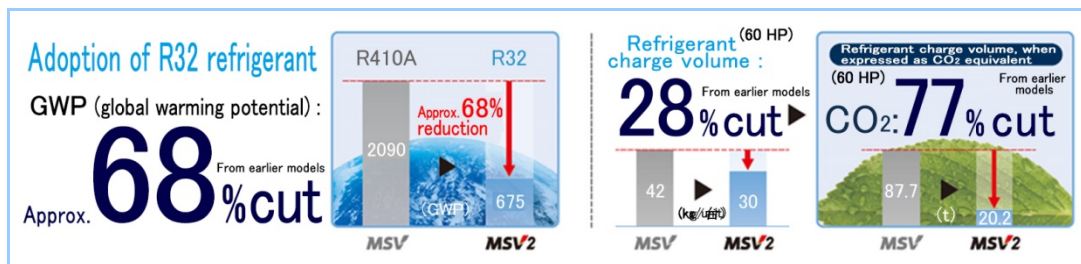


Figure 1 Global warming mitigating effect

(2) Adoption of e-3D scroll compressor with new cooling mechanism

Because of its specific heat ratio of R32 being greater than that of the earlier R410A, R32 when used results in an increase in the refrigerant gas temperature during the compression process of the compressor. Cooling is therefore required to protect the compressor and the parts of the refrigerant circuit. As the e-3D scroll compressor is incorporated in new models is

equipped with a cooling mechanism enabling a liquid refrigerant to be directly supplied to the intake port in the compressor, the increase in refrigerant gas temperature can be suppressed by utilizing the vaporization of liquid refrigerant. Thus, it has become simultaneously possible to utilize the same parts as previously used with R410A and expand the heating operation range.

1.2 Increased capacity to save space and improved efficiency

The development of the “e-3D scroll” compressor, air-side heat exchanger and small lightweight controller with a large capacity has realized 70-HP class chillers, helping to make the installation footprint smaller. Specifically, four 70-HP chiller units application for a property where conventionally seven 40-HP chillers were required, which means space saving of roughly 33%.

(1) Larger capacity and higher efficiency enabled by our proprietary technology, the “e-3D scroll” compressor

The increased capacity and the reduced leakage loss of the “e-3D scroll” compressor have been enabled by employing a compression chamber with a wall height that continuously changes like a slope as compression progresses as shown in **Figure 2**. As a result, the IPLV^{*3} of 60-HP class model was improved by approximately 25% from the earlier model, achieving an IPLV^c of 5.5.

^{*3} Integrated Part Load Value, Cooling

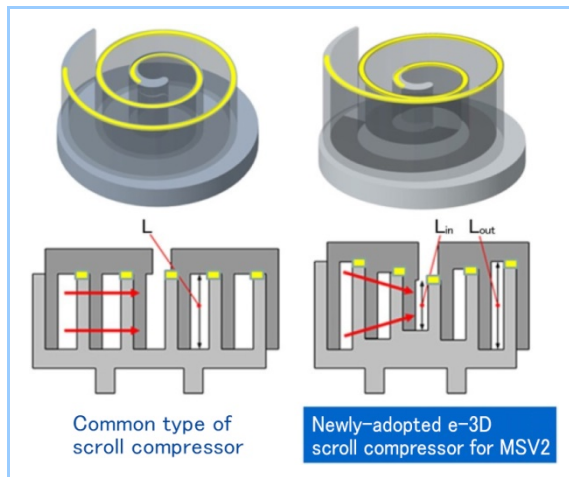


Figure 2 Schematic illustration of the “e-3D scroll” compressor

(2) Improved performance of air-side heat exchanger

The use of small-diameter hairpin tube realized an air-side heat exchanger with a higher density than earlier models, reducing the size of the air heat exchanger. Employing a propeller fan of an increased size and optimization air flow path by a long bell-mouth shape as shown in **Figure 3** can improve the performance.

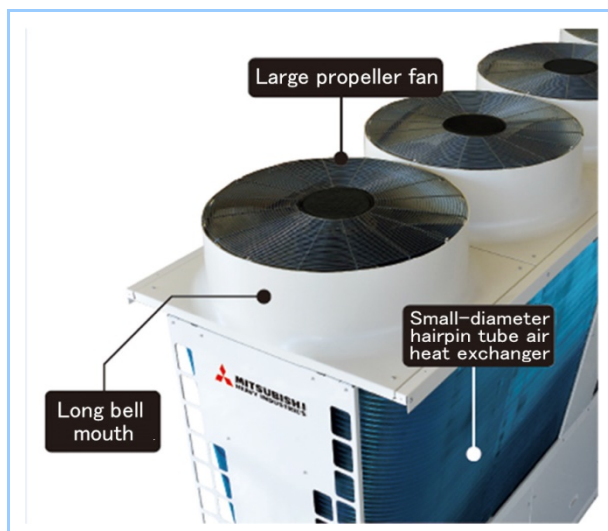


Figure 3 Newly adopted technologies

(3) Development of light weight controller

An increased capacity increases the weight of the chiller, so to offset this increase, a new controller was introduced to realize a weight reduction of approximately 36% compared with earlier models. Separately provided boxes were combined together, which improved the serviceability.

1.3 Other points

(1) Harmonic current controller installed as standard feature

In terms of the issues of harmonics for which control is prescribed as necessary in the guidelines, active filters, which were optional in earlier models, are installed in all new models as a standard feature. By predicting the current waveforms that should be addressed, the performance to reduce harmonics has been improved.

(2) Optimal operation control

Figure 4 shows how startup proceeds after the unit is turned on. The time required from the start of operation until the steady state has been shortened to 1/3 of that of earlier models. Quick startup, which is necessary after power outages, is also possible. If one of the compressors in the unit is broken, the backup operation function will kick in to allow the operation to continue in an optimal manner using the remaining compressors.

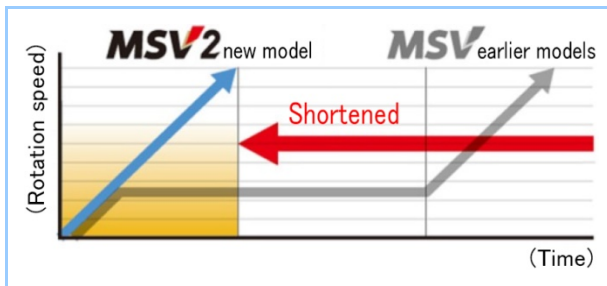


Figure 4 Startup control comparison with earlier models

(3) Cooling/heating concurrent operation system

The MSV2 series is equipped with an unprecedented concurrent operation system by which both cold- and hot-water loads can be handled simultaneously. In accordance with cold- and hot-water loads, the respective numbers of operating units can be easily changed using a touch remote controller as shown in **Figure 5**. The standard features also include Modbus communications that are used for machine-to-machine communications in factories, which contributes to visualizing factory energy supply and demand and energy-saving effects, as well as easing maintenance work.

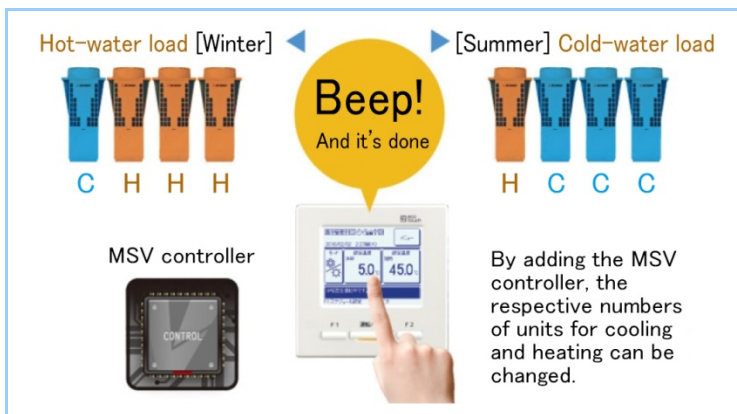


Figure 5 Schematic illustration of the cooling/heating concurrent operation system

2. Specifications

Table 1 lists the major specifications.

Table 1 Main specifications of the MSV2 series (Heat pump standard model)

Item		40 HP	50 HP	60 HP	70 HP
Model		MSV1182F	MSV1502F	MSV1802F	MSV2002F
Cooling	Capacity (kW)	118	150	180	200
	COP $\Delta T: 7^{\circ}\text{C}/5^{\circ}\text{C}$	3.85/3.80	3.70/3.60	3.41/3.32	3.23/3.13
Heating	Capacity (kW)	118	150	180	200
	COP $\Delta T: 7^{\circ}\text{C}/5^{\circ}\text{C}$	3.87/3.78	3.62/3.55	3.39/3.34	3.29/3.26
Refrigerant		R32			
Compressor		4 inverter-driven scroll compressor units			
Dimensions (mm)		2350 (H) \times 1050 (W) \times 3400 (D)			
Registration under Japan's High Pressure Gas Safety Act		Not necessary			Necessary

3. Future prospects

Space-saving modular chillers with better environmental performance, space saving and higher efficiency have been launched in the Japanese market. We will promote the series in Europe and Asia (in Southeast Asia in particular).