



TECHNICAL MANUAL

AIR TO WATER HEAT PUMP

Q-ton Natural refrigerant CO₂ water heater

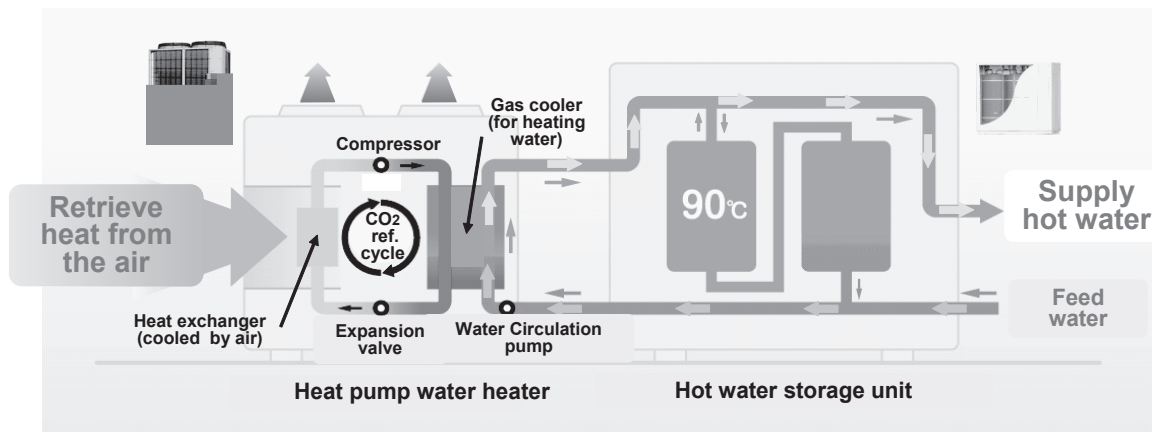
Including hot water recirculation system

ESA30EH2-25

1. GENERAL DESCRIPTION

1.1 Mechanism of CO₂ heat pump water heater for commercial use

- The CO₂ heat pump water heater for commercial use is a water heater that is composed of a heat pump unit with natural refrigerant such as CO₂ which can produce hot sanitary water with heat pump technology and a hot water storage unit which can store hot water. A touch panel type remote control applied to this heat pump water heater can control up to 16 units of heat pump units.
- The way to produce hot water with this heat pump water heater is that the heat energy retrieved from the outdoor air through the air to refrigerant heat exchanger of heat pump unit heats up the refrigerant and such refrigerant is increased its temperature and its pressure much higher through the compressor and is transferred to the gas cooler (the refrigerant to water heat exchanger). In the gas cooler, the refrigerant releases its heat to increase the water temperature and is returned to the air to refrigerant heat exchanger after depressurized through expansion valve in order to evaporate easily.
On the other hand, the water stored in the hot water storage unit is circulated by the water circulation pump to the heat pump unit through the connection pipe between the hot water storage unit and the heat pump unit. In the gas cooler, the water exchanges the heat from the high temperature refrigerant and is heated up to higher temperature. Such hot water is returned to the hot water storage unit and stored in the hot water storage unit.
The hot water in the hot water storage unit is distributed to the end of hot water supply system for utilizing.
- The power actually consumed is the power supplied to the compressor, fan and water circulation pump only. However the total energy added to produce hot water is the power actually consumed and the heat retrieved from the outdoor air so that the consumed energy efficiency (COP=Coefficient of Performance) can be more than 1 (one). In other words, this system allows very high efficiency operation. As for this unit, the nominal COP can achieve 4.3 under the condition of outdoor air temperature 16°C DB/12°C WB, water inlet temperature 17°C and water outlet temperature 65°C.
- This heat pump water heater does not need any acceptance of notification by local authority due to exempt of regulation.



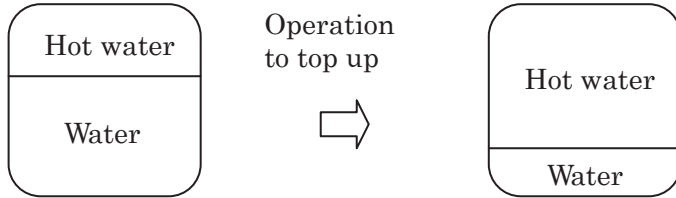
<Merit of CO₂ as refrigerant>

- The global warming potential (GWP)=1 (it is good for ecology)
*R410A : GWP=1975 (Based on Regulation (EC) No.842/2006)
- It has following advantage.
 - Hot water at 90°C can be produced efficiently.
 - The size of hot water cylinder can be minimized.
 - The storage of heat can be controlled by adjusting storage water temperature.
 - The hot water can be used for washing.

1.2 As for hot water storage unit

Heat pump water heater can be connected to an unvented hot water storage cylinder and it is applicable to various type of hot water supply system.

Unvented hot water storage cylinder



What is the unvented hot water storage cylinder?

The storage cylinder is unvented and is pressurized by fully filled hot water.

- The hot water can be supplied by the pressure in the cylinder.
- It is sanitary because the hot water is not exposed to the air.
- It is good for retaining heat
- It is good for supplying hot water to upper floors.

1.3 About ECO MODE

Q-ton provide "ECO MODE" for the solution of energy saving.

The hot water in the storage tank is used effectively to limit the time to start filling up.

This function can be canceled if it does not suit the user's condition.

This function is automatically canceled from next time, when fill up operation start after the HW lower amount limit is reached.

How to cancel "ECO MODE"

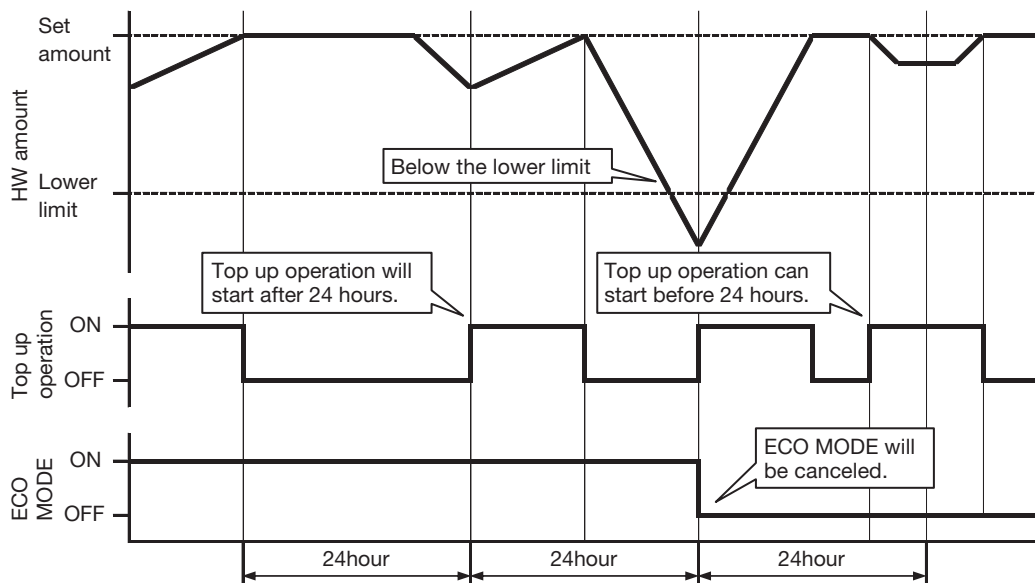
Change software switch setting [P99] from "1" to "0".

How to change the lower HW amount limit

Change software switch setting [P07] to suitable value (%).

About the procedure of changing software switch setting, please see the "INSTALLATION MANUAL for DHW system" 8-(4).

• Operation image of ECO MODE



1.5 Feature of natural refrigerant CO₂

(1) General characteristics

The general characteristics of CO₂ is as follows.

Under the atmospheric pressure, since CO₂ is gaseous state and has following characteristics, be careful to handle it.

- It is colorless and odorless gas, but when interacting with water, it produces mild acidity and irritating odor.
- When dissolving it with water, it will be mild acidic and may cause metal to corrode.
- It is heavier than air and remains on the floor in the unvented room.
- In case of high density, it may have a risk for addiction or suffocation.
- Carbon oxide gas is effective for fire extinction because of noncombustible and nonflammable gas.
- Liquefied carbon oxide is ordinarily stored in the bomb at -20°C under the pressure of 2MPa. It is clear and colorless and when releasing it into the air, it will be solid “Dry Ice Snow (frozen carbon oxide)” and CO₂ gas.
- Solid carbon oxide is so called “Dry Ice” which is solidified “Dry Ice Snow” mentioned above. Since it has very low temperature of -78.5°C under the atmospheric pressure, it may have a risk for frostbite when touching it with one’s bare hands. And if it gets into someone’s eye, it may have a risk for loss of one’s eyesight. Therefore when releasing it, especially be careful to handle it.

Table 1.1 General characteristics of CO₂

Appearance	Gas: Colorless Liquid: Clear and Colorless Solid: Milky white If releasing the liquid CO ₂ into the air, it will be a low-temperature solid. (Dry Ice)
Smell	Odorless (When interacting with water, it produces mild acidity and irritating odor.)
Absolute vapor pressure	1.967MPa (-20°C) 3.485MPa (0°C) 5.733MPa (20°C)
Density of gas	1.977kg/m ³ (0°C, 0.1013MPa abs) Since it is heavier than air, it remains on the floor or in the dimple.
Density of liquid	1.030kg/liter (-20°C, 1.967MPa) When varying to gas from liquid, it will expand its volume to roughly 500 times. (At purging to the air)
Density of solid	1.566kg/liter (-80°C) Solid CO ₂ (Dry Ice) has extremely low-temperature at -78.5°C.
Flash point	None
Ignition point	None
Explosion characteristics	None Since it is noncombustible and nonflammable, it can be used as fire extinguishing gas.
Solubility into water	1.713 literCO ₂ /liter H ₂ O (0°C, 0.1013MPa abs) 1.194 literCO ₂ /liter H ₂ O (10°C, 0.1013MPa abs) 0.878 literCO ₂ /liter H ₂ O (20°C, 0.1013MPa abs) CO ₂ is easily dissolved into water and carbonic water can be made by dissolving 1 liter of CO ₂ into 1 liter of water.
Others	The liquid CO ₂ is subject to control by the High Pressure Gas Saving Act.

(2) Characteristics of CO₂ refrigerant

CO₂ refrigerant is so called R744 and its physical property and saturated vapor pressure at each temperature are shown in table 1.2.

For comparison purpose, it is shown in contrast with those of R410A refrigerant generally using for current air-conditioners.

Table 1.2 Physical property and saturated vapor pressure of refrigerant

Item		CO ₂ (R744)	R410A
Composition		CO ₂	R32/R125 (50/50%) Pseudo azeotropic mixed refrigerant
Ozone Depletion Potential (ODP)		0	0
Global Warming Potential (GWP)		1	1975*1
Saturated vapor pressure (MPa absolute)	-20°C	1.97	0.40
	0°C	3.49	0.80
	20°C	5.73	1.44
	25°C	6.40	1.65
	30°C	7.21	1.88
Boiling point (°C)		-78.4	-51.4
Critical temperature (°C)		31.0	71.4
Critical pressure (MPa absolute)		7.38	4.90

*1 Based on Regulation (EC) No.842/2006

The feature of CO₂ refrigerant is natural refrigerant and is the environment-friendly refrigerant whose ODP is 0 and GWP is as low as 1. On the other hand, regarding R410A, its ODP is 0 but GWP is much higher than CO₂. This point of R410A is inferior to CO₂.

However the pressure of CO₂ refrigerant at normal temperature is as high as 6.4MPa that is about 4 times higher than 1.65MPa of R410A. And the critical point of CO₂ refrigerant is 31°C or higher. Therefore even if increasing pressure, it has a property not to be liquefied.

Above features are suitable for producing hot water by heating up water from low temperature to high temperature at once and are utilized widely for this purpose.

The pressure of CO₂ refrigerant at the temperature above the critical point is decided by the refrigerant temperature and refrigerant charged amount to the heat pump unit and generally is 12 to 15MPa at the highest. Therefore the attention about safety to high pressure is needed much more than that for R410A.

(3) Handling precaution of CO₂ refrigerant

Regarding the safety considerations to high pressure, be careful not to give any damage on the refrigerant circuit piping of heat pump water heater during servicing, and to purge a small amount of the refrigerant gradually by adjusting valve opening properly to a place where there is no person. (See 4.1 (2) Method to purge CO₂ refrigerant)

CO₂ refrigerant itself is harmless, but if sucking the high concentration CO₂ refrigerant, it may exert various influences on the human body.

The influence on the human body exerted by the concentration of CO₂ gas in the atmosphere is shown in the table 1.3.

Table 1.3 The influence on the human body exerted by the concentration of CO₂ gas in the atmosphere

Concentration of CO ₂ gas (vol%)	Influence on human body
0.036	Normal air
0.5	Long-term safety limit (Critical concentration by weighted time average calculated with 8 hours of averaged permissible time)
1.5	It is still endurable for long term without any influence on workability and basic physiological function, but it may exert influence on the metabolism of calcium and phosphorus.
3.0	Workability comes down and alternation of physiological function will emerge as the alternation on weight, blood pressure and heart rate.
4.0	Breathing becomes deeper and breathing rate is increased. It will be the state of slightly gasping that is considerably discomfort feeling.
5.0	Breathing becomes difficult and it will be the state of heavily gasping that will be unendurable for all persons and make them to feel nausea. Exposure for 30 minutes results symptoms of poisoning.
7 to 9	It is the allowable limit. It will be the state of severely gasping and leads to unconsciousness within about 15 minutes.
15 to 20	It produces more serious symptoms, but it is not fatal within 1 hour.
25 to 30	It produces slow respiration, blood pressure reduction, coma, loss of reflex action and paralysis. It leads to death within a few hours.

As shown in the table 1.3, when the concentration of CO₂ becomes 3% or more, it leads to the alternation of physiological function and at 7 to 9% it leads to unconsciousness within about 15 minutes and at 25 to 30% it leads coma and then to death. Therefore be careful for handling it.

Since CO₂ refrigerant is heavier than air and is likely to remain at the lower place, when CO₂ refrigerant may leak or is released, be careful to work with taking a measure to prevent from remaining CO₂ on the floor by ventilating or such ways.

The emergent measures at following states are mentioned below.

- a) When sucking high concentration CO₂ gas.
 Move the victim immediately to the place filled with fresh air and warm up him and keep him at rest.
 If he is unconscious, loosen his clothing, clear his air way and give artificial respiration and then make him received treatment by medical doctor promptly.
- b) When liquid CO₂ stays on the skin
 In case of mild frostbite, it is OK to rub down the affected area. However in case of severe frostbite, warm up the affected area with lukewarm water and wrap it with gauze softly and then make him received treatment by medical doctor promptly.
- c) When liquid CO₂ gets into one's eye
 Flush the eye with freshwater immediately and then make him receive treatment by medical doctor promptly.

2. SPECIFICATIONS

2.1 Specifications of product

(1) Heat pump water heater

Item		Model	ESA30EH2-25
Power source		—	3 Phase 380V±5%, 400V±5%, 415V±5%, 50/60Hz
Operation to top up (In intermediate season)* ¹	Heating capacity	kW	30.0
	(Water amount)	L/min	8.97
	(Power consumption)	kW	6.98
	COP	—	4.30
Operation to top up (In cold season)* ²	Heating capacity	kW	30.0
	(Water amount)	L/min	5.06
	(Power consumption)	kW	10.73
	COP	—	2.80
Operating sound pressure (In intermediate season)* ^{1, 3}		dB(A)	58
Operating sound power (In intermediate season)* ¹		dB(A)	70
Exterior dimensions	Height	mm	1690
	Width	mm	1350
	Depth	mm	720 + 35 (Water pipe connection)
Current	Max	A	21
	Starting	A	5
Unit weight		kg	375 (During operation 385)
Color			Stucco white (4.2 Y 7.5/1.1 approx.)
Compressor	Type×Pcs.		Hermetic inverter compressor×1
	Nominal output	kW	6.4
Refrigerant	Type		R744 (CO ₂)
	Charged amount	kg	8.5
Refrigerant oil	Type		MA68
	Charged volume	cc	1200
Crankcase heater		W	20
Anti-freezing heater	for water pipe	W	21×3
	for drain pan	W	40×2
	for drain hose	W	16×3
Heat exchanger ,Air side			Copper pipe straight fin type
Heat exchanger ,Water side (Gas cooler)		Type	Copper pipe coil, indirect heat exchanger
		Possession quantity of water	kg
			10
Fan	Type		Axial flow type (direct coupled motor)×2
	Output×Pcs	W	386×2
	Air volume	m ³ /min	260
	External static pressure	Pa	50
Water pump	Type×Output		Non-self-suction spiral type inverter pump×95W
	Materials contacting to water		PPS, SUS 306
	Actual pump head	m (kPa)	5m(49kPa) @17L/min
Usage temperature range	Outdoor air temperature	°C	-25 to+43
	Feed water inlet temperature	°C	Top up 5-35, Warm up 35-63
	Hot water outlet temperature	°C	60-90
Water pressure range		kPa	500 or lower (Keep water pressure more than 0kPa at the inlet of heat pump water heater)
Defrost			Hot gas type
Vibration and sound proofing devices			Compressor ;placed on anti-vibration rubber and wrapped with sound insulation
Protection devices			High pressure switch, over current protection, power transistor overheat protection and anomalous high pressure protection
Pipe connection	Feed water inlet		Rc3/4 (Copper 20A)* ⁴
	Hot water outlet		Rc3/4 (Copper 20A)* ⁴
	Drain water outlet		Rc3/4 (Copper 20A)* ⁴
Electric wiring	Earth leakage breaker		30A, 30mA, 0.1sec
	Power cable size		□8mm ² ×4 (Length70m)
	Molded-case circuit breaker		Rated current 30A, switch capacity 30A
	Grounding wire size		M6
	Remote control wire size		0.3mm ² ×2 cores shielding wire (MVVS)
Design pressure		MPa	High pressure; 14.0 Low pressure; 8.5
IP code			IP24

AIR TO WATER HEAT PUMP



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