Refrigeration air dryer

Principle of refrigeration air dryer

Pneumatic circuit

Warm wet water is precooled by compressed air chilled and dehumidified by air balancer (A) (precooler). Precooled compressed air is led to cooling chamber (B) (evaporator) and cooled to a pressured dew point of 10°C (min. 3°C) by cold Freon gas vapor. Water vapor in cooled compressed air condenses and changes into water drops (drainage). This drainage is automatically drained by automatic drain (C). Compressed air cooled in cooling chamber (B) is led to air balancer (A) (reheater) again, and is heated again by warm compressed air from the inlet. This becomes warm dry air and is discharged from the air outlet.

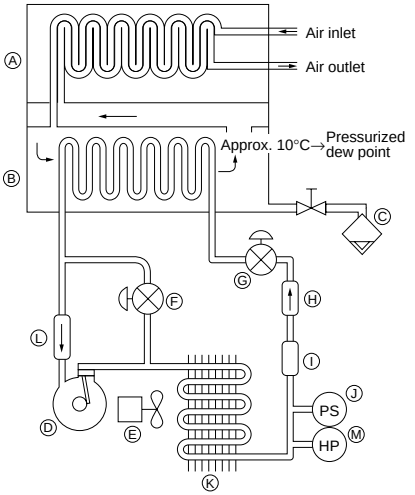
Refrigerating circuit

Hot, high-pressure Freon gas discharged from refrigeration compressor (D) is led to condenser (K), and is cooled from ambient temperature to condensed warm high-pressure liquid by condenser cooling fan (E). Warm high-pressure Freon liquid is led to filter dryer (H) where dirt and water in the refrigerant are caught. It is then compressed and expanded into specified low-pressure, low-temperature liquid (mist) by temperature automatic expansion valve (G) (or capillary tube), and led to cooling chamber (B) (evaporator). Low-pressure, low-temperature liquid (mist) led to the cooling chamber is thermally converted into warm wet compressed air, and is sucked into the cooling compressor as evaporated gas. (Capacity control valve (F) bypasses refrigerant gas when thermal load in the cooling chamber is lowered, and returns gas to the refrigeration compressor inlet. This suppresses the amount of refrigerant that flows into the cooling chamber, and prevents freezing from overcooling.

When refrigeration compressor suction pressure drops below the set pressure, the valve opens automatically, and hot, high-pressure gas is bypassed. Thus, the refrigeration compressor can be continually run even in a no-load state.

Fan control switch (J) is used to turn condenser cooling fan (D) ON and OFF and maintain high pressure (condensed pressure) at a constant range. This pressure switch activates when high pressure is detected.

(System diagram)



Functions of service parts

No.	Name		Operation
Ⓐ	Heat exchanger	Precooler/reheater	Exchanges heat between hot, high-moisture compressed air and low-temperature compressed air.
Ⓑ		Evaporator	Cools compressed air with liquid refrigerant evaporative latent heat, and condenses water vapors to remove moisture.
Ⓒ	Automatic drain		Automatically drains drainage.
Ⓓ	Refrigeration compressor		Compresses low-pressure refrigerant vapors and creates high-pressure refrigerant vapor.
Ⓔ	Condenser cooling fan		Sends cold air to condenser.
Ⓕ	Capacity control valve		When air flow drops, flows hot refrigerant gas to prevent overcooling.
Ⓖ	Automatic expansion valve		Depressurizes high-pressure liquid refrigerant to create low-pressure, low-temperature liquid.
Ⓗ	Filter dryer		Filters out foreign matter from the refrigerant circuit. (Water, dirt)
Ⓘ	Receiver		Collects refrigerant liquefied by the condenser, separates it into air and liquid, and feeds only liquid refrigerant to the automatic expansion valve.
Ⓙ	Fan control switch		When high-pressure refrigerant pressure rises to the specified pressure, the cooling fan operates, and stops when pressure drops to the specified level. This controls refrigerant temperature.
Ⓚ	Condenser		Cools hot, high-pressure refrigerant vapor to create high-pressure liquid refrigerant.
Ⓛ	Accumulator		Separates liquid refrigerant from vapor so liquid refrigerant cannot be sucked into the refrigerant compressor.
Ⓜ	High-pressure switch		Stops refrigerant compressor operation when high-pressure side refrigerant pressure rises to a specified pressure.

Features of CKD Refrigeration Air dryer (excluding models such as RD-PRT)

1 Highly efficient

2 New environmentally friendly refrigerant R407C integrated in all sizes (capacities) from small to extra-large units.

3 Energy saving
(1) Low pressure loss - highest in the industry
(2) Lower power consumption compared to conventional product even while using new refrigerant R407C

4 Stainless steel heat exchanger vessel (container) incorporated as standard from small to extra-large units.
Small stainless steel plate heat exchanger incorporated

5 Forced discharge for accurately discharging drainage integrated as a standard from small to extra-large units

6 Dew point monitor allowing operation state to be confirmed quickly integrated as a standard from small to extra-large units

7 Dust filter provided as a standard on air-cooled condensers

Refrigerant (Freon)

R22 refrigerant commonly used currently has a very low ozone depletion potential of 0.055, but is not zero. An international agreement has agreed to reduce the rate by 35% from 2004, and to completely abolish use by 2020.
In some European countries, use has already been completely abolished. (Table 1)

Table 1

Sweden	Completely abolished by end of 1997
Germany	Completely abolished by end of 1999
Norway	Completely abolished by end of 1999
Netherlands	Completely abolished by end of 1999
Denmark	Completely abolished by end of 2001
Belgium	Completely abolished by end of 2004
Italy	Completely abolished by end of 2008
USA (new devices)	Completely abolished by end of 2010
Entire EU	Completely abolished by end of 2015
Worldwide	Completely abolished by end of 2020

As of Sept. 1999

Table 2 New refrigerant to be used as replacement

Application	Regulated refrigerant	New refrigerant
Car air-conditioner	R12	R134a
Electric refrigerator	R12	R134a
Room air-conditioner	R22	R410A
Package air-conditioner	R22	R407C
Low-temperature freezer	R502	R404A, R507A

Refrigeration air dryer

Air-cooled type and water-cooled

- Refrigeration air dryers are generally categorized into air-cooled and water-cooled.
  Refer to the following explanation and select the model according to required applications and performance:
  - The refrigeration air dryer uses evaporative latent heat of the refrigerant to cool compressed air and condense and remove moisture content.
  - The refrigerant repeatedly changes from hot high-pressure gas to hot high-pressure liquid, low-temperature low-pressure liquid, low-temperature low-pressure gas, and to hot high-pressure gas while circulating within a set closed circuit.
    When evaporating and changing from a low-temperature low-pressure liquid to a low-temperature low-pressure gas, surrounding heat is lost, i.e., compressed air loses heat and cools. This is called the evaporator in the refrigerating cycle.
  - Conversely, the cooling section is called the condenser. High-temperature high-pressure gas discharged from the compressor must be changed to hot high-pressure liquid. The refrigerant is forced-cooled to do so.
  - Either air-cooled or water-cooledis used for forced cooling.

Air-cooled

(small to extra-large capacities)

Air (outer air) is fed by a fan to refrigerant piping, to which fins are installed to improve conductivity, and is cooled.
Air is cooled with air around the dryer, so efficiency is generally affected by air temperature.
During summer, the place where the dryer is installed (compressor room) becomes very hot, so this method is not effective for cooling. The fan runs continually, but is still insufficient for cooling.
In winter, air temperature is low, so the fan starts and stops to adjust the state so that air is not overcooled.

Merits: (1) Maintenance is easy.
The condenser's dust filter must be cleaned once every several months, but this only involves blowing with compressed air and does not require expertise. If the filter is heavily contaminated, it must be washed or replaced.
(2) Only space required for taking in and exhausting air must be secured. Other installation work is not affected.

Disadvantages: (1) The refrigerant's high pressure is adjusted by turning the fan ON and OFF, so it is hard to stabilize the high pressure side.
It is also harder to stabilize the dew point compared to the water-cooled method.
(2) Cooling performance is often insufficient in summer, and overloads easily occur.
(3) A large amount of air is fed by the fan, so noise is high and dust often prsent.
Heat exhaust (ventilation) may be required.

*** With the GT Series, the above disadvantages are improved by stabilizing the dew point using the variable control of the cooling fan. In addition, the refrigerating circuit has been strengthened to secure a maximum ambient temperature of 43°C.**

Water-cooled

(medium to extra-large capacities)

This cools refrigeration pipes with water, often using a plate or double pipe condenser. All CKD dryers have a stainless steel plated condenser having outstanding heat efficiency and durability.
The cooling water rate is adjusted by the check valve on top of the cooling water pipe. The high pressure value of the refrigerant is detected, and valve opening is automatically adjusted by the pressure balance mechanical mechanism.

Merits: (1) Cooling water is adjusted variably so high pressure stability is high, and it is easy to stabilize the dew point.
(2) Cooling may be stabilized in summer so the system does not fail easily. Stable dew point performance is achieved through the year.
(3) The installation environment is not affected.
Dust does occur. The fan does not make noise. Heat is not discharged with discharged wind, so room temperature does not rise.

Disadvantages: (1) Ancillary facilities, such as water piping, are required.
(2) The condenser must be back-washed by qualified personnel once every 6 to 12 months.

Cooling water for water-cooled air dryer

The following precautions must be observed for cooling water used for the water-cooled condenser in the refrigeration compressor.
If the following water quality standards are not satisfied, performance may drop and condenser life could be reduced significantly.

1 Cooling water quality must comply with Refrigerating and Air Conditioning Device Water Quality Guidelines set forth by the Japan Society of Refrigerating and Air Conditioning Engineers.

Japan Society of Refrigerating and Air Conditioning Engineers			CKD water-cooled dryer cooling water	Japan Society of Refrigerating and Air Conditioning Engineers Refrigerating and Air Conditioning Device Water Quality Guidelines Cooling water system - circulation - circulation water (JRA-GL-02-1994)
Item	Chemical formula	Unit	Water quality standards	Water quality standards
pH	—	pH (25 °C)	6.5 to 8.2	6.5 to 8.2
Electric conductivity	—	mS/m (25 °C) {μS/cm (25 °C)}	0.2 to 80 {2 to 800}	80 or less (800 or less)
Chloride ion	Cl-	mg/ℓ(ppm)	200 or less	200 or less
Sulfate ion	SO4--	mg/ℓ(ppm)	100 or less	200 or less
Acid consumption (pH4.8)	CaCO3	mg/ℓ(ppm)	100 or less	100 or less
Total hardness	CaCO3	mg/ℓ(ppm)	200 or less	200 or less
Calcium hardness	CaCO3	mg/ℓ(ppm)	150 or less	150 or less
Ionic silica	SiO2	mg/ℓ(ppm)	50 or less	50 or less
Iron	Fe	mg/ℓ(ppm)	0.5 or less	1.0 or less
Copper	Cu	mg/ℓ(ppm)	0.3 or less	0.3 or less
Sulfide ion	S--	mg/ℓ(ppm)	No detection	No detection
Ammonium ion	NH_4+	mg/ℓ(ppm)	1.0 or less	1.0 or less
Residual chloride	Cl	mg/ℓ(ppm)	0.3 or less	0.3 or less
Free carbon	CO2	mg/ℓ(ppm)	4.0 or less	4.0 or less
Stability index	—		6.0 to 7.0	6.0 to 7.0
Matson rate	HCO3-/SO4--		1.0 or more	
Hydrogen carbonate ion	HCO3-	mg/ℓ(ppm)	—	
Oxygen rate		mg/ℓ(ppm)	0.1 or less	
Aluminum	Al	mg/ℓ(ppm)	0.2 or less	
Manganese	Mn	mg/ℓ(ppm)	0.1 or less	
Nitrate ion	NO3-	mg/ℓ(ppm)	100 or less	
Sodium ion	Na+	mg/ℓ(ppm)	20 or less	
	PO4---	mg/ℓ(ppm)	2.0 or less	
	NH3	mg/ℓ(ppm)	0.5 or less	
	Mn++	mg/ℓ(ppm)	10 or less	
	H2S	mg/ℓ(ppm)	0.05 or less	
Evaporation residue		mg/ℓ(ppm)	50 or less	
Turbidity			2° or less	

- Cooling water containing many elements that could accumulate or sediment in the condenser or cooling water piping, or containing many corrosive elements must not be used.
- Soften hard water before using.

2 Install a strainer on the cooling water inlet.

3 Wash the condenser once or twice a year.

Refrigerating type air dryer

Periodic inspection descriptions

Please conduct following inspections periodically.

Inspection descriptions	Inspection term				Inspection points	Inspection method	Judgment standard
	Every day	Every week	Every month	Every 6 months			
Operation confirmation	○				Operation light	Visual inspection	• To be lighting at operation.
	○				Operating sound of compressor for refrigeration	Hear the sound.	• To be no abnormal noise
	○				Fan rotation	Visual inspection Hear the sound.	• To be no abnormal noise, and smoothly rotated. • To be ON - OFF operation, or turned ON.
Dew point (cooling) temperature	○				Dew point monitor	Visual inspection	• To be in the green zone.
Inlet air pressure		○			Air pressure gauge	Visual inspection	• To be within product specifications.
Drainage	○			Cleaning	Automatic drain (For forcible discharge type)	Press the manual button. Hear the sound.	• Fizz drain discharge noise or air blow noise must be heard during pushing manual button (GX, GT series)
Ambient temperature	○				Near capacitor intake	Measure by a thermometer	• To be within specifications range.
Capacitor Clogging			○	Cleaning	Air cooling Capacitor fin section	Visual inspection	• Foreign matter or dirt must not be accumulated. • Capacitor intake section must not be plugged. • Capacitor intake section is not to be exposed to hot air.
					Water cooling Refrigerant high pressure gauge		• To be 1.6 MPa or less (Washing is required for 1.8 MPa and over.)
Power voltage			○		Power supply	Measure by a tester	• To be within ±10% of specified rated voltage.
Operating current			○		Power supply	Measure by a tester	• To be within ±20% of specified rated current.