

Principles of Refrigeration Air Dryers

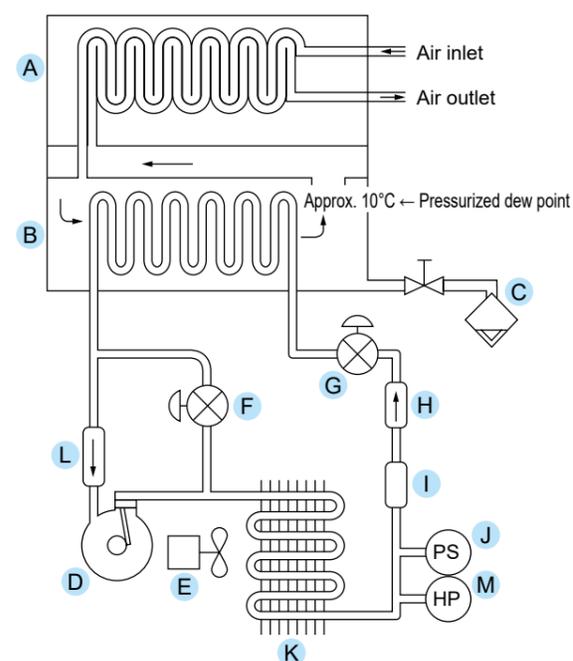
Air Circuit

Warm moist compressed air is pre-cooled by cold dehumidified compressed air in the air equalizer (A) (precooler). Pre-cooled compressed air is directed to the cooling chamber (B) (evaporator), where it is cooled to a pressurized dew point of 10°C by the vaporization heat of the cold CFC gas. Water vapor in the cooled compressed air condenses and accumulates as water droplets (drain), which are automatically discharged outside by the automatic drain (C). Compressed air cooled in the cooling chamber (B) re-enters the air equalizer (A) (reheater), is reheated by warm compressed air from the inlet, and exits through the air outlet as warm dry air.

Refrigerant Circuit

The high-temperature, high-pressure CFC gas discharged from the refrigeration compressor (D) is led to the condenser (K), where it is cooled at ambient temperature by the cooling fan (E) and condensed into a warm high-pressure liquid. The warm, high-pressure CFC liquid is led to the filter dryer (H), which captures dust and moisture in the refrigerant, and is then throttled and expanded by the temperature-type automatic expansion valve (G) (or capillary tube) to a specified low-pressure, low-temperature liquid, which is then led to the cooling chamber (B) (evaporator). Low-pressure, low-temperature liquid (mist) entering the cooling chamber evaporates by heat exchange with warm, moist compressed air and is sucked into the refrigeration compressor as gas. The capacity control valve (F) bypasses the refrigerant gas and returns it to the refrigeration compressor inlet when the heat load in the cooling chamber is reduced. This suppresses the amount of refrigerant that flows into the cooling chamber, and prevents freezing from over-cooling. When the refrigerating compressor suction pressure drops to the set pressure or lower, the valve opens automatically, and high humidity/high pressure gas is bypassed. As a result, it allows the refrigeration compressor to operate continuously even under no-load conditions. The fan control switch (J) is used to turn the cooling fan (E) ON and OFF to keep the high-pressure pressure (condensation pressure) within a certain range, and is a pressure switch that detects and operates the high-pressure pressure.

(System diagram)



Function of service parts

No.	Name	Operation
(A)	Heat exchanger	Exchanges heat between high temperature/high humidity compressed air and low temperature compressed air.
(B)	Evaporator	Cools compressed air with liquid refrigerant evaporative latent heat and condenses water vapor to remove moisture.
(C)	Auto-drain (drain discharger)	Automatically discharges drain.
(D)	Refrigerating compressor	Compresses low pressure refrigerant vapor to turn it to high pressure refrigerant vapor.
(E)	Cooling fan	Sends cold air to condenser.
(F)	Capacity regulator valve	When air flow drops, flows high temperature refrigerant gas to prevent overcooling.
(G)	Automatic expansion valve	Depressurizes high pressure liquid refrigerant to turn it to low pressure/low temperature liquid.
(H)	Filter dryer	Filters out foreign matter from the refrigerant circuit (water, foreign materials).
(I)	Receiver	Collects refrigerant liquefied by the condenser, separates it into air and liquid, and feeds only liquid refrigerant to the automatic expansion valve.
(J)	Fan control switch	The cooling fan operates when refrigerant pressure on the high pressure side rises to the specified pressure and stops when the pressure drops to the specified level. This controls refrigerant temperature.
(K)	Condenser	Cools high temperature/high pressure refrigerant vapor to turn it to high pressure liquid refrigerant.
(L)	Accumulator	Separates liquid refrigerant from vapor so that liquid refrigerant is not sucked into the refrigerating compressor.
(M)	High pressure switch	Stops refrigerating compressor operation when high pressure side refrigerant pressure rises to a specified pressure.

CKD Features of Refrigeration Air Dryers

- 1 Highly efficient
- 2 Environment-friendly new refrigerants R-134a, R-410A, and R-407C in various sizes (capacities) from compact to super large are adopted
- 3 Energy saving
 - ① Energy-saving operation with 50% decreased power by limiting the number of refrigerating compressors (GT9300 (W) to GT9450 (W))
 - ② Energy-saving operation with 60% decreased power through inverter control (GT9000WV2 Series)
- 4 Stainless steel is used as standard for compact to super large heat exchange vessel (container)
- 5 Dust filter is standard for air cooling condenser

Air cooling and water cooling

- Refrigerated air dryers are generally categorized into air cooling and water cooling types. Refer to the following explanation to select a model according to required applications and performance.
 - Refrigeration air dryers use evaporative latent heat of the refrigerant to cool compressed air, and condense and remove the moisture content.
 - In a set closed circuit, the refrigerant repeatedly changes: high temperature/high pressure gas → high temperature/high pressure liquid → low temperature/low pressure liquid → low temperature/low pressure gas → high temperature/high pressure gas. When evaporating and changing from low temperature/low pressure liquid to low temperature/low pressure gas, the heat is drawn from the surroundings. It means that the compressed air loses heat and cools. This part is called the evaporator in the refrigerating cycle.
 - Conversely, the section to liquefy high temperature/high pressure gas is called the condenser. High temperature/high pressure gas discharged from the compressor must be changed to high temperature/high pressure liquid. So the refrigerant is forced-cooled.
 - There are two types of forced cooling methods: air-cooled and water-cooled.

Air-cooled type (Compact to Super Large)

Ambient air is fed by a fan to cool refrigerant piping, to which fins are installed for improving conductivity. Since it is cooled by the air surrounding the dryer, it is greatly affected by the air temperature. During summer, the place where the dryer is installed (compressor room) gets very hot, so this method is not effective for cooling. The fan runs continually, but is still insufficient for cooling. By contrast, the air temperature is low during winter, so the fan starts and stops to adjust the state to avoid overcooling.

Advantages: (1) Easy maintenance. The condenser's dust filter must be cleaned for clogging once every several months, but this only involves blowing with air. Little technical knowledge is required. (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. Affected by installation work.No.

Disadvantages: (1) The refrigerant's high pressure is adjusted by turning the fan ON/OFF, so it is hard to stabilize the high pressure side and cooling the water. Compared to water-cooled type, it is also difficult to stabilize the dew point.
 (2) Cooling performance is often insufficient in the summer, and the overload state occurs easily.
 (3) A large amount of air is fed by the fan, so the noise level is high and dust is raised. Heat exhaust (ventilation) may be required.

Water-cooled type (Medium to Super Large)

The refrigerant pipe is cooled with water in this method. A plate or double pipe condenser is often used. The cooling water rate is adjusted by the water regulating valve on the 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 structure.

Advantages: (1) Cooling water is adjusted variably so high pressure stability is high, and it is easy to stabilize the dew point.
 (2) A stable cooling effect is obtained in summer so the system does not fail easily. Stable dew point performance is achieved throughout the year.
 (3) The installation environment is not affected. Dust is not raised. There is no fan noise. There is no heat by discharged wind, so the room temperature does not rise.

Disadvantages: (1) Accompanying work, such as water piping, is required.
 (2) The condenser must be back-washed by qualified personnel once every 6 months to 1 year.

Refrigeration Air Dryers

⚠ Cooling water of a water cooling air dryer

Observe the following cautions for cooling water for the water-cooled condenser in the refrigerating compressor. If the following water quality standards are not met, performance may be compromised, and the service life of the condenser could be reduced significantly.

- 1 The cooling water quality should be as per the "Guideline of Water Quality for Refrigeration and Air Conditioning Equipment" provided by the Japan Refrigeration and Air Conditioning Industry Association.

Japan Refrigeration and Air Conditioning Industry Association			CKD Water cooling For dryer Cooling water	Japan Refrigeration and Air Conditioning Industry Association For refrigeration/air conditioning components Guideline of Water Quality Cooling water system I Circulating type (I) Circulating water (JRA-GL-02-1994)
Item	Chemical formula	Unit	Water quality standard	Water quality standard
Beher	-	pH(25°C)	6.5 to 8.2	6.5 to 8.2
Electrical 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 (pH 4.8)	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
Ionized 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)	Not detected	Not detected
Ammonium ion	NH4+	mg/L(ppm)	1.0 or less	1.0 or less
Residue chlorine	Cl	mg/L(ppm)	0.3 or less	0.3 or less
Free carbonic acid	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	
Nitric acid 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 degrees or less	

- Cooling water containing many elements that could accumulate or precipitate in the condenser/cooling water piping, or containing many corrosive elements must not be used.

- Soften hard water before use.

- 2 Install a strainer of approximately 20 mesh at the cooling water inlet.

- 3 Wash the condenser on a periodic basis.

⚠ Installation environment and air quality

Refrigeration air dryers use copper pipes (phosphorus deoxidized copper pipes) for the refrigerant gas pipes and pipes within the heat exchanger. When corrosion causes a hole in these copper pipes, the refrigerant gas will leak and make it impossible to operate the unit, or cause failure such as water leaking from the compressed air outlet side of the air dryer. Copper is also used as a conductive material for electrical wiring, etc., and corrosion can lead to malfunctions that can cause safety problems such as electrical leakage accidents. In addition, copper is also used as conductive materials for the electrical wiring, etc. Corrosion thereof may cause failures which may lead to safety problems such as electrical leakage accidents. Failures caused by corrosion are not covered by the warranty. Plant exhaust may contain NOx (nitrogen oxides), SOx (sulfur oxides), CO2 (carbon dioxide), and other substances that may promote corrosion, and consideration must be given to the installation location of air dryers and air compressors to ensure that they are not affected by factory exhaust. In rare cases, if chlorine-based organic solvents (trichloroethylene, etc.), aldehyde or alcohol (formaldehyde generated from building materials or methanol in the chemicals used) are absorbed by the air dryer and hydrolyzed, the copper piping could corrode (like an ant nest). Caution is required in these cases.

MEMO



This list is for selection guide. Refer to the appropriate page for selection, and select a model after checking installation conditions.

Series		General Purpose							
		GX3200D	GX5200D		GT9000(D)	GT9000W(D)	GT9000WV2		
Installation Application	Features Main specifications	Terminal installation in plant, device integrated			Compressor direct connection				
		General	Air cooling compressor directly connected		Air cooling air compressor directly connected	Water cooling air compressor directly connected	Water cooling air compressor directly connected		
Applicability Air Compressor kW	Applications	• Ambient temperature Max. 45°C • Inlet air temperature 35°C (40°C for GX3255D)		• Ambient temperature Max. 45°C (48°C for GX5255D and GX5275D) • Inlet air temperature 55°C		• Ambient temperature Max. 40°C (48°C for GT9075D, 9090D, 9120D, 9100D, and 9190D) • Inlet air temperature 40°C		• Inlet air temperature 40°C	
		0.75		●		●			
1.5		●		●					
2.2		●		●					
3.7		●		●					
5.5		●		●					
7.5		●		●					
11		●		●					
15		●		●					
22		●		●					
37		●		●					
55		●		●					
75				●					
90									
120									
150									
190									
240									
300									
380									
450									
710									●
960									●
Digital dew point monitor		x		x		● Standard (GT9300 and higher)		● Standard (GT9300W and higher)	● Standard Equipment
Medium pressure		x		x		x		x	x
CE Compliant		x		x		x		x	x
New refrigerant (R-134a, R-410A, R-407C)		● Standard Compliance		● Standard Compliance		● Standard Compliance		● Standard Compliance	● Standard Compliance
Stainless steel heat exchanger		● Standard Equipment		● Standard Equipment		● Standard Equipment		● Standard Equipment	● Standard Equipment
Drain forcible discharge method		x		x		x		x	● Standard Equipment
Multi-voltage (transformer integrated)		Contact CKD Option for GX5255D and 5275D				● Option		● Option	● Option
Copper tube rust proof coating		● Option		● Option		● Option		● Option	● Option
Bypass piping set		● Accessory		● Accessory		x		x	x
Remote control		● Option (standard for GX3215D and higher)		● Option (standard for GX5211D and higher)		● Standard Equipment		● Standard Equipment	● Standard Equipment
External signal		● Option		● Option (standard for GX5255D and GX5275D)		● Standard Equipment		● Standard Equipment	● Standard Equipment
Outdoor specifications		x		x (Contact CKD for GX5255D and GX5275D)					● Contact CKD for details.
Instantaneous power failure		● Standard Compliance (GX3215D and higher)		● Standard Compliance (GX5211D and higher)		● Standard compliance (except for GT9240)		● Standard compliance (except for GT9240W)	● Standard Compliance
Dust filter for condenser		● Standard Equipment		● Standard Equipment		● Standard Equipment		-	-
Anchor bolt		● Accessory		● Accessory		● Accessory		● Accessory	● Accessory
Companion flange		-		-		● Accessory (GT9120D and higher)		● Accessory (GT9120WD and higher)	● Accessory
Stainless steel nameplate		● Option		● Option		● Option		● Option	● Option
English Language Specifications		● Standard Equipment		● Standard Equipment		● Standard Equipment		● Standard Equipment	● Standard Equipment
Product Photo		Contact CKD for details.				Contact CKD for details.		Contact CKD for details.	
Listed page		90		96		114		122	130

Main Line Components

Refrigeration Dryers

Desiccant Dryers

High Polymer Membrane Dryers

Main Line Filters

Drain discharger, etc.

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Periodic inspection items

Conduct the following inspections periodically to use devices over a long period.

Inspection Item	Inspection Term				Inspection Point	Inspection Method	Judgment Reference
	Daily	Every week	Every month	Every 6 months			
Operation confirmation	<input type="radio"/>				Operation lamp	Visual inspection	• This should be lit at operation
	<input type="radio"/>				Operation sound of refrigerating compressor	Listening to the sound	• No abnormal noise
	<input type="radio"/>				Fan rotation	Visual inspection Listening to the sound	• Smooth rotation without abnormal noise • ON and OFF operation or turned ON
Dew point (cooling) temperature	<input type="radio"/>				Refrigerant pressure gauge	Visual inspection	• It should be in the green zone
Inlet air pressure		<input type="radio"/>			Air pressure gauge	Visual inspection	• It should be within product specifications (should be specification pressure)
Drain discharge	<input type="radio"/>	<input type="radio"/> (Cleaning)			Drain trap	Visual inspection	• Drainage should be discharged • Air should not be left blowing
Ambient temperature	<input type="radio"/>				Near condenser inlet	Measuring with thermometer	• It should be within specifications
Condenser Clogging			<input type="radio"/>	<input type="radio"/> (Cleaning)	Air Cooling Condenser fin section	Visual inspection	• Foreign materials and dust should not be accumulated. • Condenser inlet section should not be plugged. • Condenser inlet section should not be exposed to hot air.
					Water Cooling Refrigerant high pressure gauge		• 1.95MPa or less (cleaning is required for 2.15MPa and over)
Power supply voltage			<input type="radio"/>		Power supply	Measuring with a tester	• Rated voltage of specifications within ±10%
Operating current			<input type="radio"/>		Power supply	Measuring with a tester	• Rated voltage of specifications within ±20%

Guide to Recommend Replacements for Refrigeration Dryers

As of November 2024

Production and sales of the "Old Products" listed in the table below have been discontinued. Please select a replacement model from the "Current Products."

Note: The comparison table given below shall only be used as a guide. When selecting a replacement, consider the current operating pressure, inlet air temperature, ambient temperature, required dew point, etc., to ensure adequate performance.

(1) Air Cooling (standard inlet air temperature)

Old product Group A	Old product Group B	Old product Group C	Old product Group D	Old product Group E	Current Product
	RD(A)1003(A) RDA-3(E)	GK3103	GK3103D	GX3203D	GX3203D
	RD(M)1004(A) RD(M)1006(A) RDA-6(E)	GK3106	GK3106D	GX3206D	GX3206D
4304-25PD	RDA-12(E) RD(M)1008(A)	GX3108	GK3108D	GX3208D	GX3208D
4304-35PD	RDA-12(E) RD(M)1011(A)	GX3111	GK3111D	GX3211D	GX3211D
	RD-15D(E) RD(M)1015(A) GX3015	GX3115	GX3215	GX3215D	GX3215D
4308-50PD 4308-75PD	RD-22D GX3022	GX3122	GX3222	GX3222D	GX3222D
4308-100PD 4308-125PD 4310-150PD	RD-37D GX3037	GX3137	GX3237	GX3237D	GX3237D
4316-250PD 4316-375PD	RD-55D RD-75D	GT7055 GT7075	GX3255	GX3255D GT9075	GX3255D GT9075D
		GT7095		GT9090	GT9090D
4332-575PD	RD-120D	GT7120		GT9120	GT9120D
4332-700PD	RD-150D	GT7150(D)		GT9150	GT9150D
4332-1000PD	RD-190D	GT7200(D)		GT9190	GT9190D
4332-1200PD	RD-240D	GT7250(D)		GT9240	GT9240D
4332-1500PD	RD-300D(E,F)	GT7300(D)		GT9300	GT9300D
4332-1750PD	RD-360D(E,F)	GT7400(D)		GT9380	GT9380D
	RD-450D(E,F)	GT7480(D)		GT9450	GT9450D

(2) Air Cooling (high temperature inlet air temperature)

Old product Group A	Old product Group B	Old product Group D	Old product Group E	Current Product
RD(M)2001(A) RD(M)2002(A) RD(M)2003(A) GX5003	GX5103	GK5103	GX5203D	GX5203D
RD-3.7(E)-AC RD(M)2004(A) GX5004	GX5104	GK5104	GX5204D	GX5204D
RD-5.5(E)-AC RD(M)2006(A) GX5006	GX5106	GK5106	GX5206D	GX5206D
RD-7.5(E)-AC RD(M)2008(A) GX5008	GX5108	GX5208	GX5208D	GX5208D
RD-11(E)-AC RD(M)2011(A) GX5011	GX5111	GX5211	GX5211D	GX5211D
RD-15(E)-AC RD(M)2015(A) GX5015	GX5115	GX5215	GX5215D	GX5215D
RD-22D-AC GX5022	GX5122	GX5222	GX5222D	GX5222D
RD-37D-AC GX5037	GX5137	GX5237	GX5237D	GX5237D
RD-55D-AC RD-75D-AC	GT5055 GT5075D	GX5255 GX5275	GX5255 GX5275	GX5255D GX5275D

(3) Water Cooling

Old product Group A	Old product Group B	Old product Group C	Old product Group D	Current Product
4310-150PDW	RDW-37D	GT7055W	GT9075W	GT9075WD
4316-250PDW	RDW-55D	GT7055W	GT9075W	GT9075WD
4324-375PDW	RDW-75D	GT7075W	GT9075W	GT9075WD
		GT7095W	GT9090W	GT9090WD
4332-575PDW	RDW-120D	GT7120W(D)	GT9120W	GT9120WD
4332-700PDW	RDW-150D	GT7150W(D)	GT9150W	GT9150WD
4332-1000PDW	RDW-190D	GT7200W(D)	GT9190W	GT9190WD
4332-1200PDW	RDW-240D	GT7250W(D)	GT9240W	GT9240WD
4332-1500PDW	RDW-300D(F)	GT7300W(D)	GT9300W	GT9300WD
4332-1750PDW	RDW-360D(F)	GT7400W(D)	GT9380W	GT9380WD
	RDW-450D(F)	GT7480W(D)	GT9450W	GT9450WD
	RDW-680D(F)	GT7710W(D)	GT9710WV	GT9710WV2
	RDW-900D(F)	GT7960W(D)	GT9960WV	GT9960WV2

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