JERN RU

Cryogenic High-speed Exhaust High-Vacuum Cryo-Pump

From -120°C to -170°C (-184°F to -274°F) 153°K to 103°K

Excellent helper to the vacuum industry
Energy-saving technology & cooler system

The Pioneer and Leader in Wide Range of Temperature Technologies.
We Plan, Design and Manufacture from +100°C to -262°C.

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Why Installation of an Extreme Cryogenic -JR- Cryopump with High-speed Exhaust and Hhigh Vacuum is Needed for a Vacuum Apparatus?

[From -120°C to -170°C (-184°F to -274°F) 153°K to 103°K]

The water vapor is the biggest barrier to the exhaust speed of vacuum apparatus in the vacuum system.

- -JR- cryogenic high-speed exhaust cycle vacuum cryopump is able to effectively catch the remaining 65%~95% in the air. [Water vapor is the most commonly seen source of contamination, and the biggest barrier to the exhaust speed of vacuum apparatus.
- In a high vacuum system, it is able to cryo-condense the water molecules from dehumidification and shorten the time spending in pumping out the water vapor to achieve efficiency as high as up to 75%.
- In an readymade system, an additional installation of JR- cryogenic high-speed exhaust vacuum cryo-pump can increase the capacity by 20%~100% and upgrade the operation-handling quality.

Water vapor is the most commonly seen source of contamination in vacuum system

- When processing a higher thin-film quality, a processing approach by producing a further lowered partial vapor pressure of vapor is able to obtain a better adhering performance and a superior reproduction is to process a higher.
- Further enhanced reflective effect to the aluminum-finished deposition.
- The surface at corner will be deposited at a smooth & level state during the deposition process for plastic substrate.
- The reflective rate of surface is very stable during the deposition process of glass lens.
- ITO transparent conductive films have no phenomenon of fractional distillation for its deposition process during the sputter deposition process.
- The adhesive strength of the substrate, such as the plastic films or wire coil, with richly contained water molecules will be strengthened along with thereof dehydration & drying during the deposition process.
- There will be no presence of aberration when coloring variety of decorative materials during the deposition process.

Relation between the pressure and the volume expansion of water vapor in vacuum system

Boyle's Law: $P_1V_1 = P_2V_2$

Example:

When vacuumed to (10^{-4} torr), the volume expansion of 1L ice at a pressure of (760 torr) in vacuum chamber is = (1L) x 760 torr/10^{-4} torr = 7,600,000L water vapor.

	Vacuum pressure	Volume variation at different vacuum pressure
1L ice at 760 torr	0.1(1x10^{-1})Torr	7,600L water vapor
	0.01(1x10^{-2})Torr	76,000L water vapor
	0.001(1x10^{-3})Torr	760,000L water vapor
	0.0001(1x10^{-4})Torr	7,600,000L water vapor
	0.00001(1x10^{-5})Torr	76,000,000L water vapor

Example: Theoretical value

It takes about 16 minutes for [oil-diffusion pump or molecular pump at a vapor-extracting rate 8,000 (L/sec)] to extract 7,600,000L water vapor from a vacuum chamber under (1x10^{-4}) Torr state. Instead, it takes about [0.63 minutes + cooling time 3~5 minutes = 3.63~5.63 minutes] when used the -JR-150-100 cryogenic high-speed exhaust high-vacuum cryo-pump [vapor-extracting rate (200,000L/sec)] for extraction.

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Characteristics of -JR- Cryogenic High-speed Exhaust High-vacuum cryo-pump

[From -120°C to -170°C (-184°F to -274°F) 153°K to 103°K]

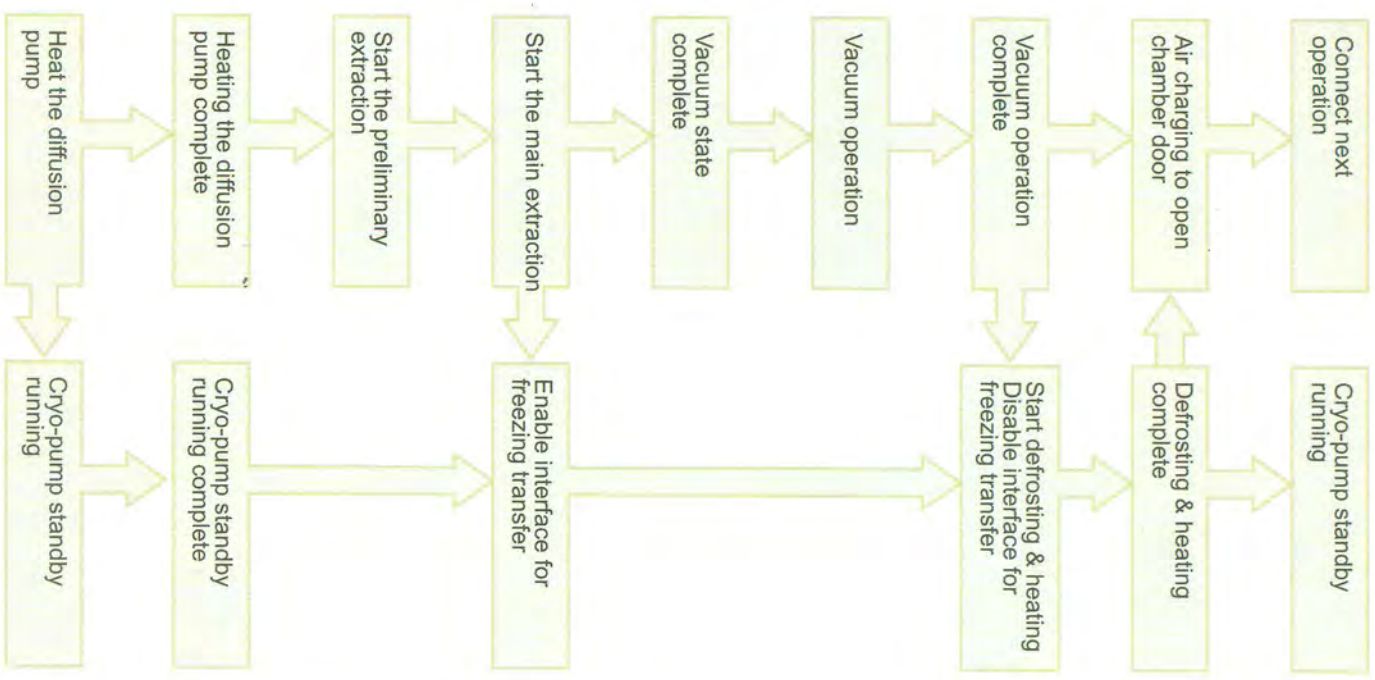
A cryogenic cold-trap interface to place the water vapor and gases onto the cold-trap interface through three reacting mechanisms: (1) cryo-condensation, (2) cryo-trapping (3) cryo-sorption, thus the fundamental principle of vapor-extraction to quickly reduce the vapor pressure inside the chamber is achievable.

For a vacuum system, the vapor pressure of internal substance determines the performance of vacuum degree while this vapor pressure is closely related to the temperature. Since the gaseous molecules will migrates toward the low-temperature place under a vacuum state, the lower the temperature the lower the vapor pressure of substance.

Distinctive vacuum-cooling exhaust system

- -JR- cryogenic high-speed exhaust vacuum cryo-pump can be started its [COOL] mode after having been enabled the [STANDBY] mode for 30 minutes; thus the cryogenic cold-trap interface can quickly to extract the water vapor out quickly in few minutes; a initiation of [DEFROST ACTIVE] process will follow right after the vacuum operation that has been finished in shortest period; and after the completion of defrost mode [DEFROST COMPLETE], carrying out the next operating stroke is available after elapsing the [STANDBY] mode for 5 minutes. The system is capable of performing quick circulation to the existing operation system that heightens a higher capacity by 20% ~100% for every operation shift and shortens the extraction-separation time by 25% ~75% approximately.
- Using the JR- cryogenic high-speed vacuum cryo-pump system for process operation is mainly to take the advantage of the principle to capture the water molecules from cryogenic freezing. The water vapor can be captured from the cryogenic freezing surface, and this is the so-called cold-trap interface module. The cold-trap interface module can be mounted directly in the vacuum cabin, for example: vacuum chamber, connecting port, manifold, valve and partitioning board, etc. Ease of installation, the control functions of this cold-trap interface module can be relayed to the readymade controller or processor.
- The JR- cryogenic high-speed vacuum cryo-pump is the most cost-effective vacuum-exhaust system of higher version. Integration to mount any diffusion vacuum pump, turbine vacuum pump or helium cryogenic pump for operation is available.
- The JR- cryogenic high-speed vacuum cryo-pump can offer a lot of operating functions and assembly methods for cold-trap interface module. Mounting two cold-trap interface, or one cold-trap interface with a set of partitioning board.
- For more details about the mode, please refer to the product specification table and the related options.

Connecting method between the vacuum apparatus and the cryo-pump



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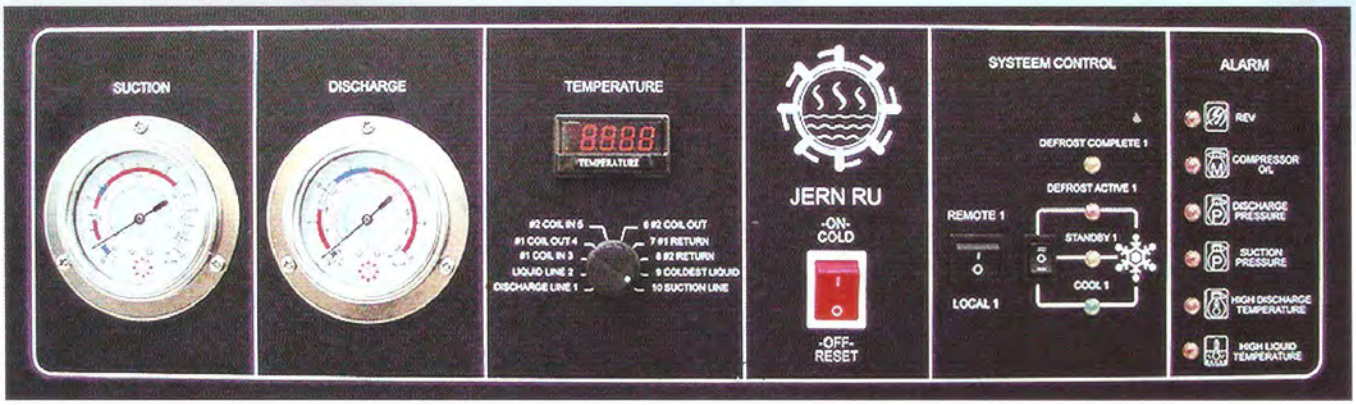
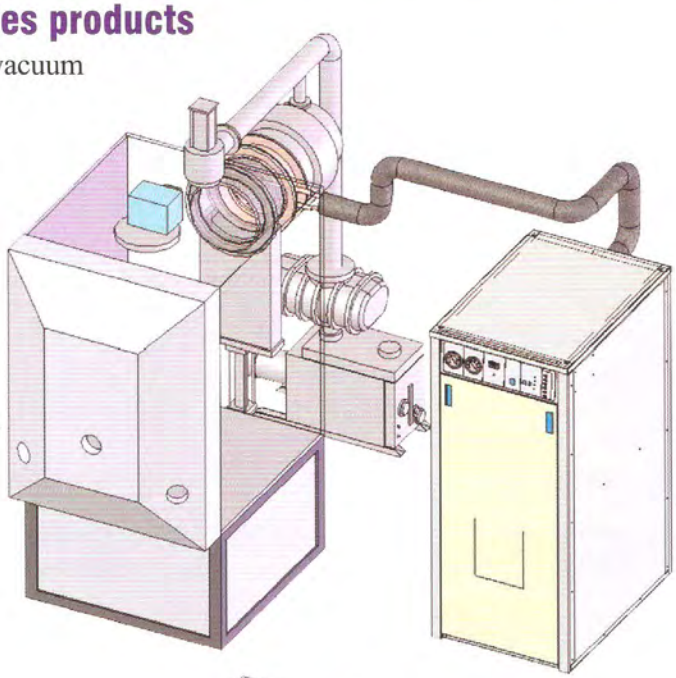
JR-D-Series Complete Detection and Control System

(JR-050/ 075/ 100-D Series)



Characteristic applications of JR-D-Series products

- Able to mount a set of cold-trap interface inside the vacuum chamber of vacuum system to perform a high-speed cryogenic vacuum suction and defrost exhaust.
- Able to mount a set of cold-trap interface inside the cooling chamber of cryogenic system to perform a high-speed cooling and defrosting & heating.
- Able to mount a set of cold-trap interface in the volatile gases VOC recovery condensation tank to perform the cryogenic recovery and defrost.
- Able to mount a set of cold-trap interface inside the condensation tank of vacuum-drying equipment to perform the high-speed cryogenic drying and defrost.

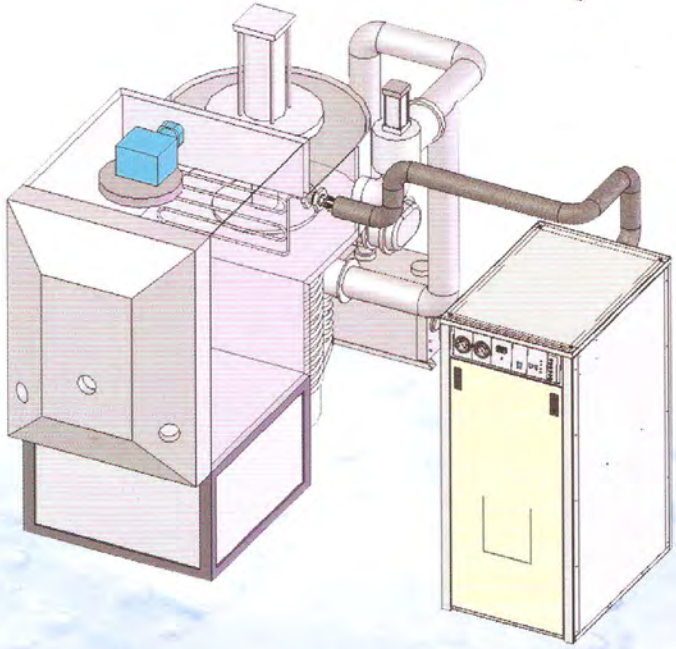


JR-D- An integral display of operating interface

- DISCHARGE/SUCTION pressure indication
- 10-stage temperature indication
- Cryo-pump COLD ON/OFF, abnormality RESET
- REMOTE/ LOCAL selector switch
- DEFROST/ STANDBY/ COOL changeover switch and indication

JR-D- 6-Stage double safety protection system

- Under phase and phase reversal of power supply
- Overload/overheating compressor indication
- Too high discharge pressure indication
- Too low suction pressure indication
- Too high discharge temperature
- Too high condensing temperature



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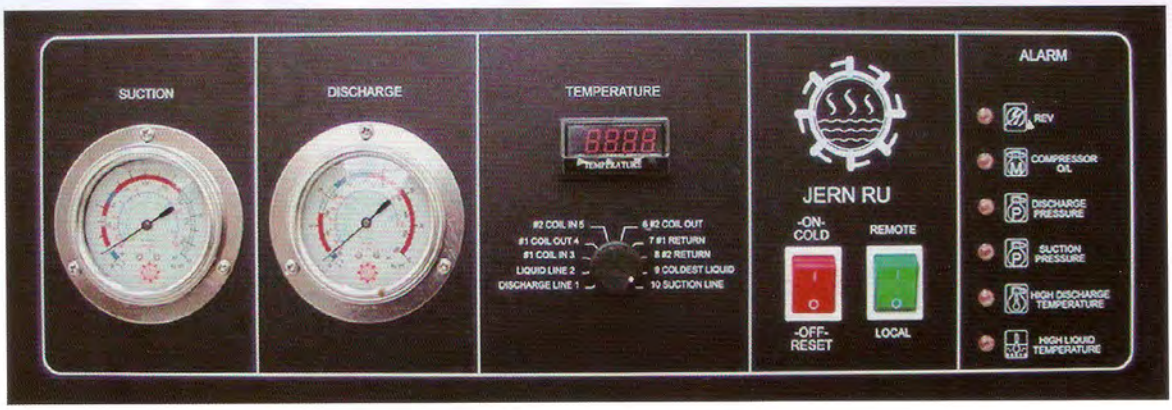
JR-C-Series Complete Detection and Control System

(JR-050/ 075/ 100-C- Series)



Characteristic applications of JR-C-Series products

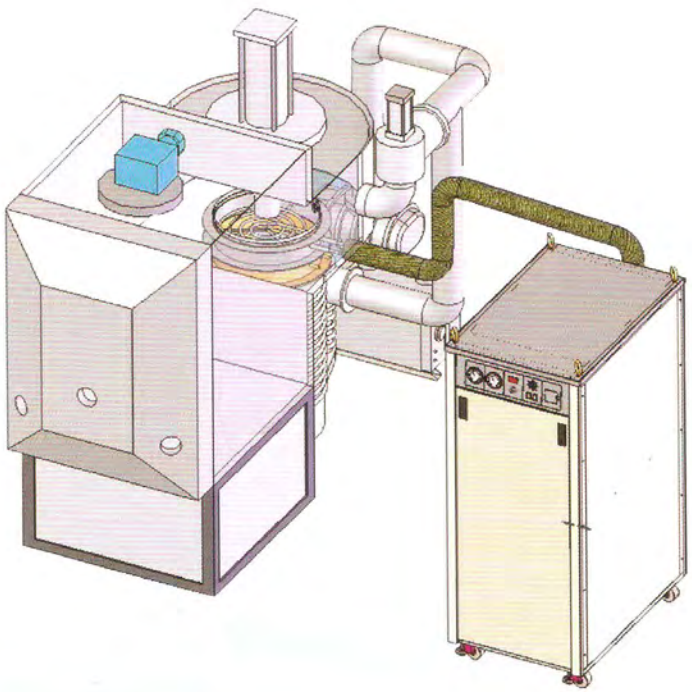
- Can be mounted a cold-trap interface with partitioning board device in the extraction chamber for the diffusion of water vapor in the vacuum system, where the whirling airstream in the extraction chamber of pump can be controlled to increase the extracting speed of water vapor.
- Can be mounted a set of cold-trap interface inside the cooling chamber of cryogenic system to perform a high-speed cooling.
- Can be mounted a set of cold-trap interface in the volatile gases VOC recovery condensation tank to perform the cryogenic recovery.

JR-C- An integral display of operating interface

- DISCHARGE/SUCTION pressure indication
- 10-stage temperature indication
- Cryo-pump COLD ON/OFF, abnormality RESET
- REMOTE/ LOCAL selector switch
- Cooling switch and indication

JR-C- 6-Stage double safety protection system

- Under phase and phase reversal of power supply
- Overload/overheating compressor indication
- Too high discharge pressure indication
- Too low suction pressure indication
- Too high discharge temperature
- Too high condensing temperature



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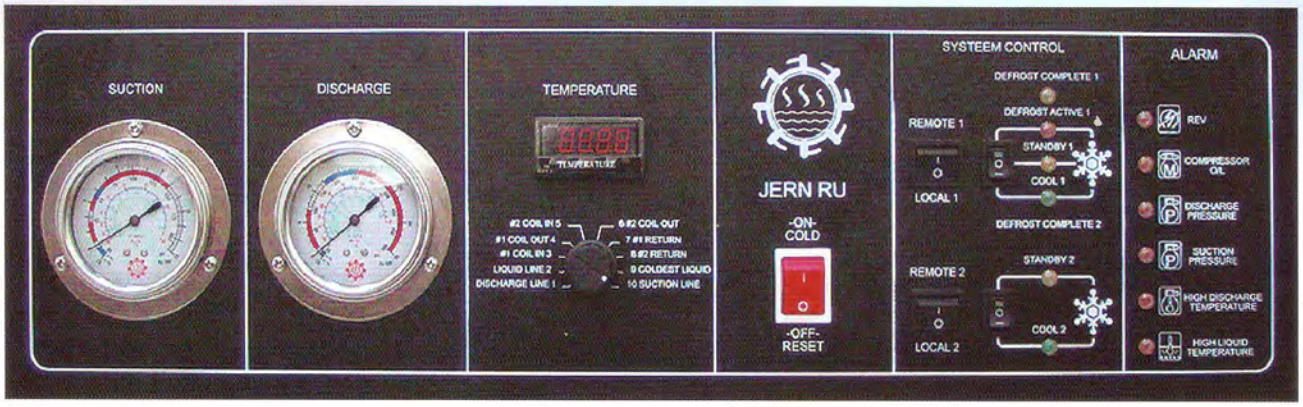
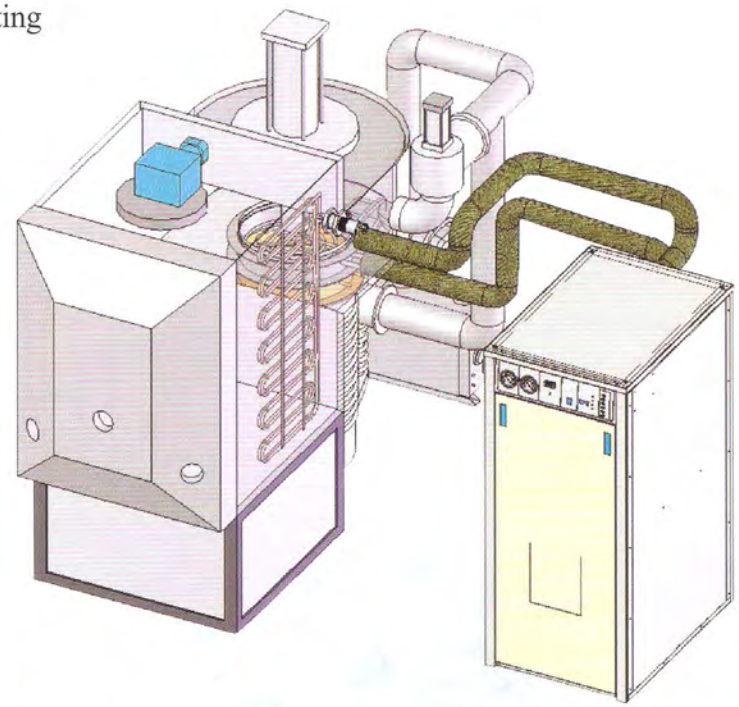
JR-DC-Series Complete Detection and Control System

(JR-050/075/100-DC- Series)



Characteristic applications of JR-DC-Series products (Can offer a set of D- model cooling system and a set of -C-model cooling system)

- (1) Can be mounted a set of cold-trap interface inside the vacuum chamber of vacuum system to perform high-speed cryogenic vacuum suction and defrost exhaust.
- (2) Can be mounted a cold-trap interface with partitioning board device in the extraction chamber for the diffusion of water vapor in the vacuum system, where the whirling airstream in the extraction chamber of pump can be controlled to increase the extracting speed of water vapor.



JR-DC- An integral display of operating interface

- DISCHARGE/SUCTION pressure indication
- 10-stage temperature indication
- Cryo-pump COLD ON/OFF, abnormality RESET
- REMOTE/ LOCAL selector switch
- DEFROST/ STANDBY/ COOL 1 changeover switch and indication
- STANDBY/COOL 2 changeover switch and indication

JR-DC- 6-Stage double safety protection system

- Under phase and phase reversal of power supply
- Overload/overheating compressor indication
- Too high discharge pressure indication
- Too low suction pressure indication
- Too high discharge temperature
- Too high condensing temperature

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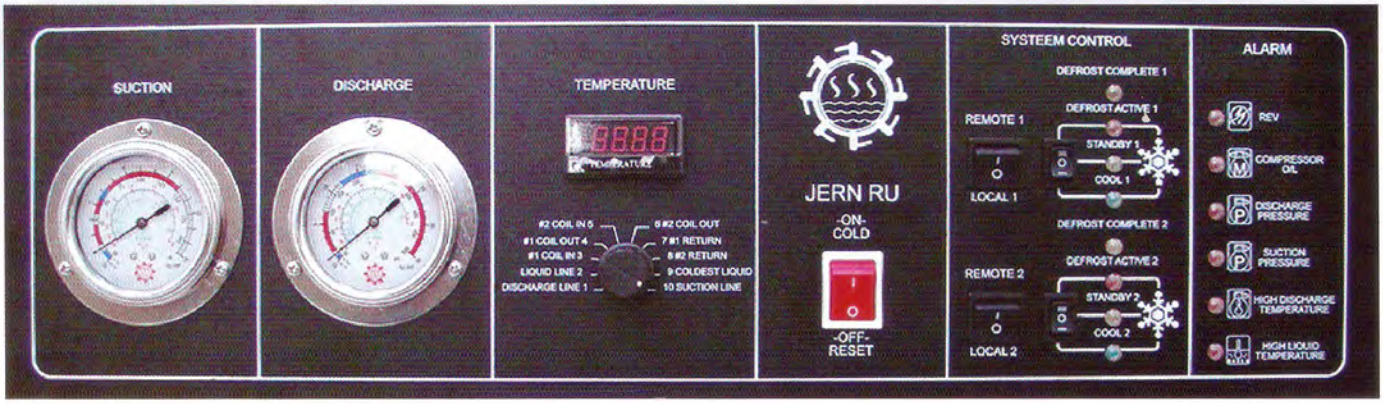
JR-DD-Series Complete Detection and Control System

(JR-050/ 075/ 100-DD- Series)



Characteristic applications of JR-DD-Series products (Can offer two sets of D- model cooling system)

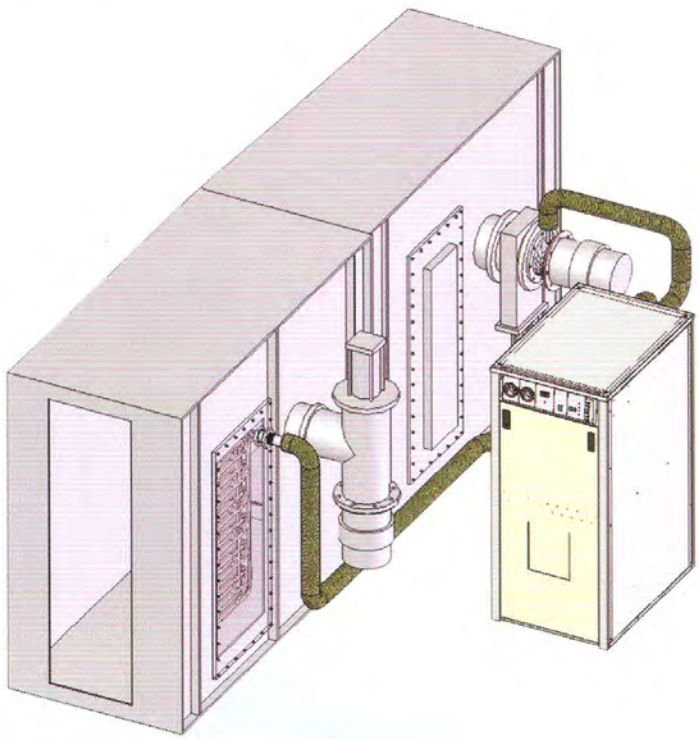
- (1) Can be mounted a set of cold-trap interface each in two vacuum system to perform high-speed cryogenic vacuum suction and defrost exhaust.
- (2) Can be mounted a cold-trap interface with partitioning board device in front of the molecular pump in the vacuum system, where the whirling airstream in the extraction chamber of pump can be controlled to increase the extracting speed of water vapor.

JR-DD- An integral display of operating interface

- DISCHARGE/SUCTION pressure indication
- 10-stage temperature indication
- Cryo-pump COLD ON/OFF, abnormality RESET
- REMOTE/ LOCAL selector switch
- DEFROST/ STANDBY/ COOL 1 changeover switch and indication
- DEFROST/ STANDBY/ COOL 2 changeover switch and indication

JR-DD- 6-Stage double safety protection system

- Under phase and phase reversal of power supply
- Overload/overheating compressor indication
- Too high discharge pressure indication
- Too low suction pressure indication
- Too high discharge temperature
- Too high condensing temperature



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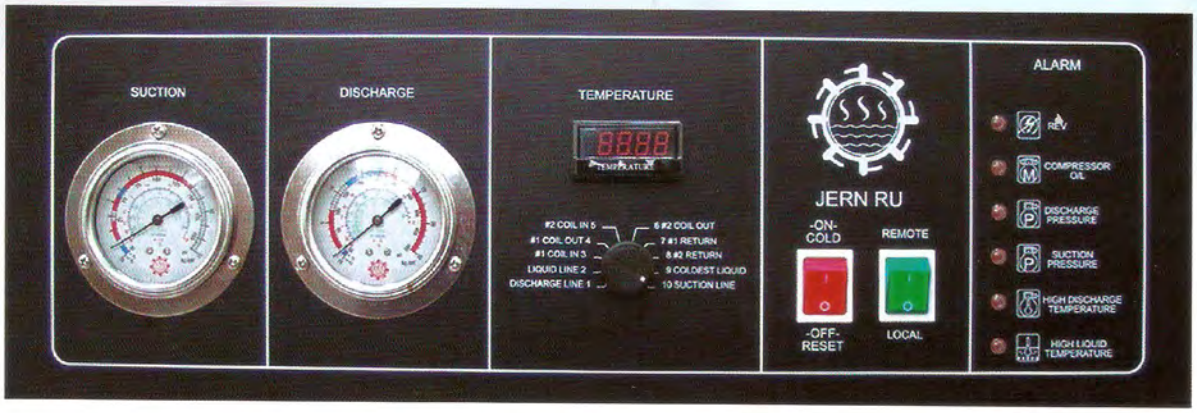
JR-CC-Series Complete Detection and Control System

(JR-050/075/100-CC- Series)



Characteristic applications of JR-CC-Series products (Can offer two sets of -C-model cooling system)

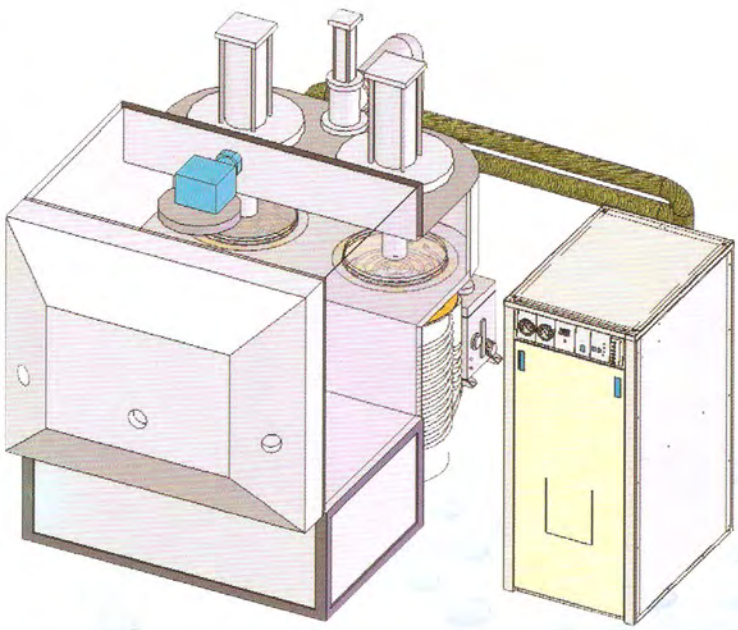
- Can be mounted a cold-trap interface with partitioning board device in the extraction chamber for the diffusion of water vapor in the vacuum system, where the whirling airstream in the extraction chamber of pump can be controlled to increase the extracting speed of water vapor.

JR-CC- An integral display of operating interface

- DISCHARGE/SUCTION pressure indication
- 10-stage temperature indication
- Cryo-pump COLD ON/OFF, abnormality RESET
- REMOTE/ LOCAL selector switch
- Cooling switch and indication.

JR-CC- 6-Stage double safety protection system

- Under phase and phase reversal of power supply
- Overload/overheating compressor indication
- Too high discharge pressure indication
- Too low suction pressure indication
- Too high discharge temperature
- Too high condensing temperature



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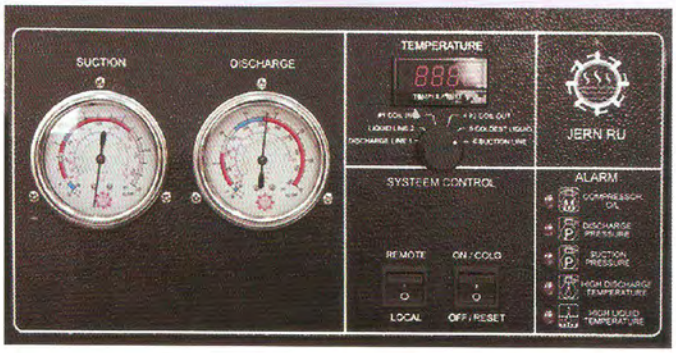
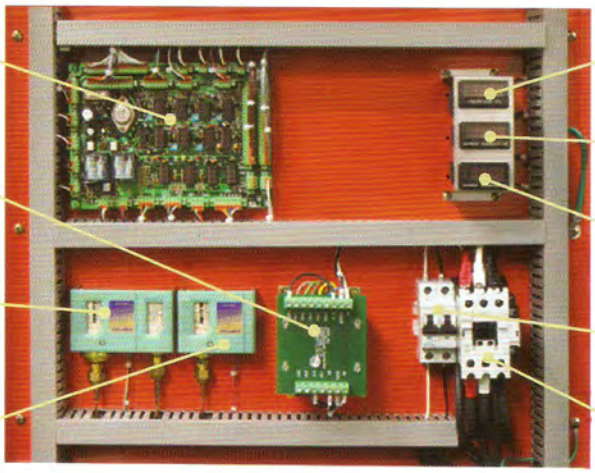
Small size JR-D/ C-Series Complete Detection and Control System

JR-010/020/030-D- Series JR-010/020/030-C- Series

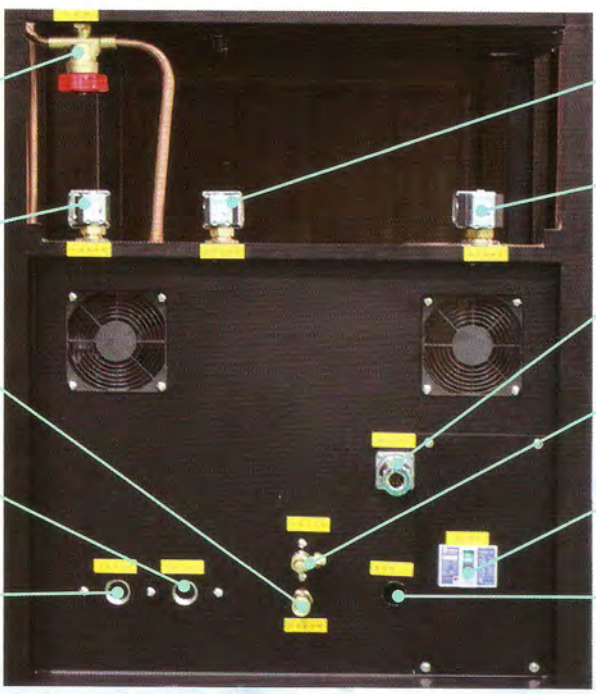


Electric Control System



- Main electronic control terminal block
- 24V transformer for electric control
- High-low pressure switch
- High-pressure relief switch
- Electronic thermostat for water temperature
- Electronic thermostat for defrost 1
- Electronic thermostat for defrost 2
- 24V circuit breaker for electric control
- Overload relay contactor for compressor

Cooling water and power input system



- Defrost feed isolation valve
- 1st set of hot gas feed solenoid valve
- Discharging outlet of safety valve
- Cooling water outlet
- Cooling water inlet
- 2nd set of hot gas feed solenoid valve
- Balance solenoid valve
- Junction box for remote control
- Vapor extracting and charging valve
- Power supply circuit breaker
- Power supply inlet

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Specifications of Cryogenic High-speed Exhaust Vacuum cryo-pump

Model			Unit	JR-150-015	JR-150-020	JR-150-030	JR-150-050	JR-150-075	JR-150-100
Max. load (W at highest temperature)			w	270	360	540	1260	2520	3600
The highest ideal extracting speed			l/sec	22,350	29,800	44,700	104,300	208,600	298,000
Reserved extracting speed (in operating room)			l/sec	15,000	20,000	30,000	70,000	140,000	200,000
Max. operating pressure			torr	5 x 10^{-8}	5 x 10^{-8}	5x 10^{-8}	5x 10^{-8}	1.5 x 10^{-8}	1.5 x 10^{-8}
Highest start pressure of pump			atm	1.0					
Defrosting time			min	3 minutes ~ 5 minutes (The defrosting time is proportional to the piping length of cold-trap interface)					
Cold-trap interface temperature			°C	-100°C~-150°C (The refrigerating temperature and speed are proportional to the piping length of cold-trap interface)					
Cryo coils and refrigerant pipelines	Standard length of refrigerant connection pipe		m(ft)	2.4 (8)					
	Total surface area of coils		$m^2(ft^2)$	0.1m^2(0.11ft^2)	0.2 (2.2)	0.3 (3.1)	0.7 (7.2)	1.4 (14)	2 (21.6)
	Single loop	Pipe O.D.	mm(in)	6.35(1/4)	7.95 (5/16)	9.5 (3/8)	12.7 (1/2)	15.88 (5/8)	15.88 (5/8)
		Pipe length	m(ft)	5(16.4)	8 (26)	10 (33)	17 (56)	28 (92)	40 (132)
	Dual loops	Pipe O.D.	mm(in)	N/A			9.5 (3/8)	12.7 (1/2)	12.7 (1/2)
		Pipe length	m(ft)				11 (36)	17 (57)	25 (82)
Overall dimensions		H	mm	990	1200	1200	1420	1620	1720
		W		485	500	500	700	700	700
		D		700	700	700	850	950	1050
Wheel height			mm	70	120				
Cooling water flow rate		13°C (55°F)	l/min (gal/ min)	N/A	3 [0.8]	3 [0.8]	4.9 [1.3]	6.8 [1.8]	13.6 [3.6]
		26°C (79°F)		N/A	9 [2.4]	9 [2.4]	12.3 [3.2]	17.3 [4.6]	33.8 [8.9]
		29°C (85°F)		N/A	15 [4]	15 [4]	19.7 [5.2]	27.6 [7.3]	54.1 [14.3]
Diameter of cooling water pipe			in	1/2				1/2	3/4
Weight			kg	122	164	185	265	370	430
Max. operating sound level			dB	70	72	72	72	81	81
Min. operating room space			$m^3(ft^3)$	75(2,650)	100 (3,530)	155.7 (5,500)	212 (7,500)	340 (12,000)	354 (12,500)
Max. load of power supply input			kw	2	2.5	3.7	6.6	9.8	13.2
Rated power supply specifications Running/ current		200-240v 3p/50/60hz	A	7(1p14A)	6.1	9.2	16.3	24.5	32.8
		380-480v 3p/50/60hz	A	N/A	3.6	5.3	9.5	14	18.7
Refrigerant				JR-HFC environment-friendly natural refrigerant					

Model No. for optional purchase JR - [ ] - [ ] - [ ]

- JR: **Company code**
- [ ]: **Cryogenic code**
- [ ]: **Compressor HP code**
  - 010=1HP
  - 020=2HP
  - 030=3HP
  - 050=5HP
  - 075=7.5HP
  - 100=10HP
- [ ]: **Model code**
  - D=1 set of cooling/defrost/heating system
  - C=1 set of cooling system
  - D/C=Cooling system + cooling/defrost/ heating system
  - D/D=2 sets of cooling/defrost/heating system
  - C/C=2 sets of cooling system

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Specifications of Cryogenic High-speed Exhaust Vacuum cryo-pump

Model			Unit	JR-165-050	JR-165-075	JR-165-100
Max. load (W at highest temperature)			w	230	400	550
The highest ideal extracting speed			l/sec	30,000	50,000	75,500
Reserved extracting speed (in operating room)			l/sec	20,000	35,000	50,000
Max. operating pressure			torr	2×10^{-11}	1.5×10^{-12}	1.5×10^{-12}
Highest start pressure of pump			atm	1.0		
Defrosting time			min	2 minutes ~ 3 minutes (The defrosting time is proportional to the piping length of cold-trap interface)		
Cold-trap interface temperature			°C	-130°C~-165°C (The refrigerating temperature and speed are proportional to the piping length of cold-trap interface)		
Cryo coils and refrigerant pipelines	Standard length of refrigerant connection pipe		m(ft)	2.4 (8)		
	Total surface area of coils		$m^2(ft^2)$	0.25 (2.7)	0.35 (3.6)	0.5 (5.4)
	Single loop	Pipe O.D.	mm(in)	9.5 (3/8)	12.7 (1/2)	12.7 (1/2)
		Pipe length	m(ft)	7 (23)	9 (30)	13 (39)
	Dual loops	Pipe O.D.	mm(in)	N/A		9.5 (3/8)
		Pipe length	m(ft)			7 (23)
Overall dimensions		H	mm	1420	1650	1720
		W		700	700	700
		D		850	950	1050
Wheel height			mm	120		
Cooling water flow rate		13°C (55°F)	l/min (gal/min)	4.9 [1.3]	6.8 [1.8]	13.6 [3.6]
		26°C (79°F)		12.3 [3.2]	17.3 [4.6]	33.8 [8.9]
		29°C (85°F)		19.7 [5.2]	27.6 [7.3]	54.1 [14.3]
Diameter of cooling water pipe			in	1/2	1/2	3/4
Weight			kg	265	370	430
Max. operating sound level			dB	72	81	81
Min. operating room space			$m^3(ft^3)$	212 (7,500)	340 (12,000)	354 (12,500)
Max. load of power supply input			kw	6.6	9.8	13.2
Rated power supply specifications Running/ current		200-240v 3p/50/60hz	A	16.3	24.5	32.8
		380-480v 3p/50/60hz	A	9.5	14	18.7
Refrigerant				JR-HFC environment-friendly natural refrigerant		

(a) Standard conditions for performance test:

1. Inside the vacuum chamber at 1 Torr vacuum.
2. Temperature of cold-trap interface is 20°C.
3. Recommended cold-trap interface and piping length.
4. Cooling water temperature 20°C~25°C.

(b) For a bigger cooling interface, a higher extracting speed can be applied to the operation of multiple models of machine. Please contact our sales representative for details of machine model for application.

(c) The extracting speed of standard cold-trap interface is 25% of maximum speed.

(d) Recommended the normal operating should be the start pressure for cryo-pump. Normally, the pressure above 1 torr can effectively extract the water vapor.

(e) For those power supply specifications other than the tablutaed specifications of normal power supply, please contact the Factory and refer to the operating manul for voltage specifications.

(f) The machine unit has been performed the cooling mode test before exfactory.

(g) In order to meet the mechanical safety regulations, ANSI and ASHRAE-1994 regulations, the unit shall be installed in an operating room with a good ventilation, heat dissipation and a safe distance maintained.

= Cooling Water Specifications =

※ Verify the water quality of cooling water, short of temperature and flow rate & volume or rise of water temperature will cause failure; therefore, a precheck is a must before start each time.

※ The water quality shall be stringently monitored in order to prevent the condenser from being corroded or the water tubes from being attached by the fouling scale.

※ Only the cleaning agent incorrosive to stainless steel and steel can be applied to clean the condenser.

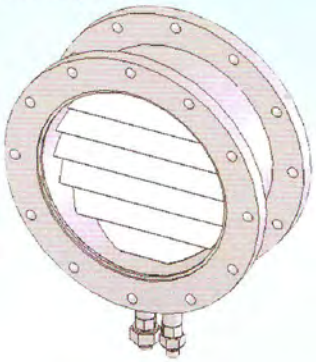
※ Please use a chiller when the cooling water temperature is above 30°C.

※ For an application at a cooling water temperature lower than 13°C, a mounting of water thermostat controller is recommened to maintain a water temperature of 20°C.

1. Variety of cold-trap interfaces (optional part)

The cryogenic interface can be designed and mounted in a particular extracting chamber according to the requirement; a specially customized cryogenic interface is available as well. Generally, the refrigerating coils are designed in spiral form, vortex form and other simple design. Using a refrigerating plate design is not recommended for thus design will increase the element mass and thermal volume, counteract the function of cryo-pump at pipe end and extend the cooling and defrosting time.

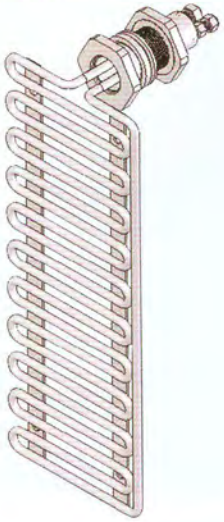
Type 1: Cold-trap interface for molecular pump (optional part)



Type 2: Cold-trap interface for diffusing pump (optional part)

Type 3: Cold-trap interface inside the vacuum chamber (optional part)

Type 4: Cold-trap interface inside the vacuum chamber (optional part)



Remarks

※: For a high vacuum system → downsize the cold-trap interface and area.

※: For a substrate with high water content → enlarge the cold-trap interface and area.

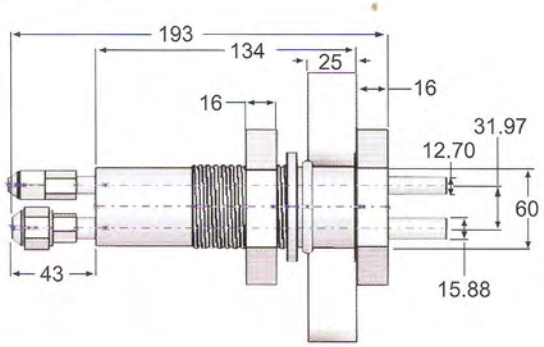
※: For a high-temperature heating vacuum apparatus → downsize the cold-trap interface and area.

※: A too-long distance for mounting the refrigerant connection tube will result in a reduction of refrigerating efficiency and cooling speed; the longer the tube length the harder the minimum temperature will reach; therefore, shorten the distance as far as possible.

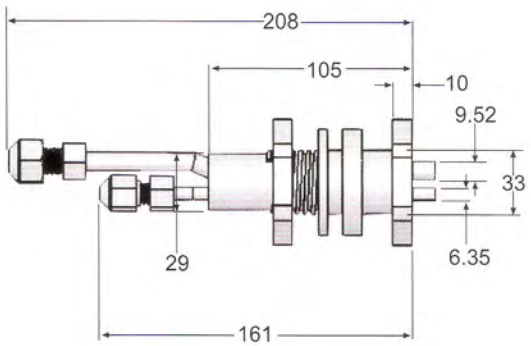
2. Feedthrough for vacuum chamber (optional parts)

The standard feedthrough is to provide insulation from vacuum temperature between the refrigerant line and the cold-trap interface inside the vacuum chamber. Special design for customization is available.

2.1: -JR-60 feedthrough for vacuum chamber (optional part)

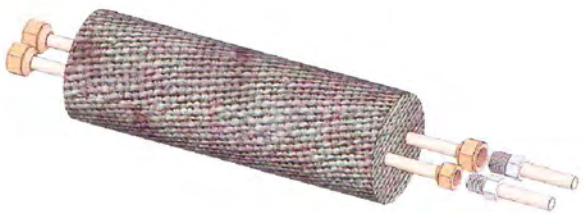


2.2: -JR-34 feedthrough for vacuum chamber (optional part)



3. Refrigerant line (standard part)

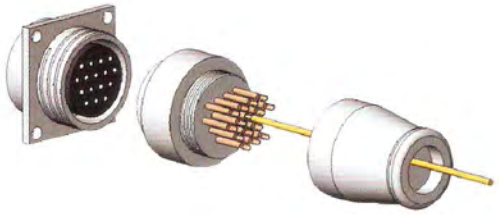
The refrigerant line at a standard length of [8 feet (2.4m)] is to be connected from the cooling tube outside the vacuum chamber to the tube connector output from the cryo-pump with a T# temperature-sensing wire; for a tube length longer than the standard length [8 feet (24m)], please order it from factory.



4. Remote control connector (standard part)

4.1: 24P-35S remote control connector JR-100/JR-075/JR-050 (Standard part)

4.2: 16P-28S remote control connector JR-030/JR-020/JR-010 (Standard part)



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How to select a suitable specification for Cryo-pump cooling module to perform the capturing and removal operation of water vapor from a vacuum chamber?

Cooling module is determined according to the extracting speed of water vapor and the performance of cooling elements' surface (cold-trap interface). Generally speaking, the longer the cooling pipeline, the higher the extracting speed will be. Normally, increasing the net extracting speed in the operating room to four times of the water vapor-extracting speed can reduce the extracting operation time by 25% ~ 75%. Once selected the suitable cooling module and the dimensions & specifications of cold-trap interface, the extra temperature load can be referred to evaluate the operating temperature and the cooling operation performance (length of cooling pipeline, disposal of thermal energy, etc. factors).

What is the optimal temperature for capturing the water vapor?

When fining the optimal cooling surface temperature in vacuum system is desired, just follow the following contents to locate the optimal pressure condition in system, and then find the optimal temperature from the right column while the temperature can offer 90% efficiency in capturing water vapor.

Desired Water Vapor Partial Pressure			Average Cryosurface Temperature Neededt	Desired Water Vapor Partial Pressure			Average Cryosurface Temperature Neededt
Torr	Pascal	mbar	°C	Torr	Pascal	mbar	°C
5×10^{0}	7×10^{2}	7×10^{0}	-25.4	5×10^{-5}	7×10^{-3}	7×10^{-5}	-104.9
2×10^{0}	3×10^{2}	3×10^{0}	-34.4	2×10^{-5}	3×10^{-3}	3×10^{-5}	-109.1
1×10^{0}	1×10^{2}	1×10^{0}	-40.8	1×10^{-5}	1×10^{-3}	1×10^{-5}	-112.2
5×10^{-1}	7×10^{1}	7×10^{-1}	-46.8	5×10^{-6}	7×10^{-4}	7×10^{-6}	-115.1
2×10^{-1}	3×10^{1}	3×10^{-1}	-54.3	2×10^{-6}	3×10^{-4}	3×10^{-6}	-118.1
1×10^{-1}	1×10^{1}	1×10^{-1}	-59.7	1×10^{-6}	1×10^{-4}	1×10^{-6}	-121.5
5×10^{-2}	7×10^{0}	7×10^{-2}	-64.8	5×10^{-7}	7×10^{-5}	7×10^{-7}	-124.1
2×10^{-2}	3×10^{0}	3×10^{-2}	-71.2	2×10^{-7}	3×10^{-5}	3×10^{-7}	-127.5
1×10^{-2}	1×10^{0}	1×10^{-2}	-75.8	1×10^{-7}	1×10^{-5}	1×10^{-7}	-129.9
5×10^{-3}	7×10^{-1}	7×10^{-3}	-80.1	5×10^{-8}	7×10^{-6}	7×10^{-8}	-132.2
2×10^{-3}	3×10^{-1}	3×10^{-3}	-85.6	2×10^{-8}	3×10^{-6}	3×10^{-8}	-135.2
1×10^{-3}	1×10^{-1}	1×10^{-3}	-89.6	1×10^{-8}	1×10^{-6}	1×10^{-8}	-137.3
5×10^{-4}	7×10^{-2}	7×10^{-4}	-93.4	5×10^{-9}	7×10^{-7}	7×10^{-9}	-139.5
2×10^{-4}	3×10^{-2}	3×10^{-4}	-98.2	2×10^{-9}	3×10^{-7}	3×10^{-9}	-142.1
1×10^{-4}	1×10^{-2}	1×10^{-4}	-101.6	1×10^{-9}	1×10^{-7}	1×10^{-9}	-144.1

Relevant data regarding the cold-trap interface, the size of connecting pipeline and the radiant heat of system

(At 25°C temperature) 37.6 Watts/m^2 (35Watts/ft^2)
Thermal load of cooling circuit 26.3 Watts /m (8 Watts/ft)
Thermal load of vacuum connection device 1.0 Watts/m (0.3 Watts/ft)
Extracting speed of water vapor (theoretical value) **1m^2=149,000 L/sec (1ft^2 = 13,842 L/sec)**
Refrigerating value of liquified nitrogen (45 Watts/liter/hour)

Simple form of specifications
Final standard temperature _____ required temperature _____
Thermal load cryo coil _____
Thermal load refrigerating circuit _____
Extra thermal load (operating thermal energy) _____
Total thermal load _____

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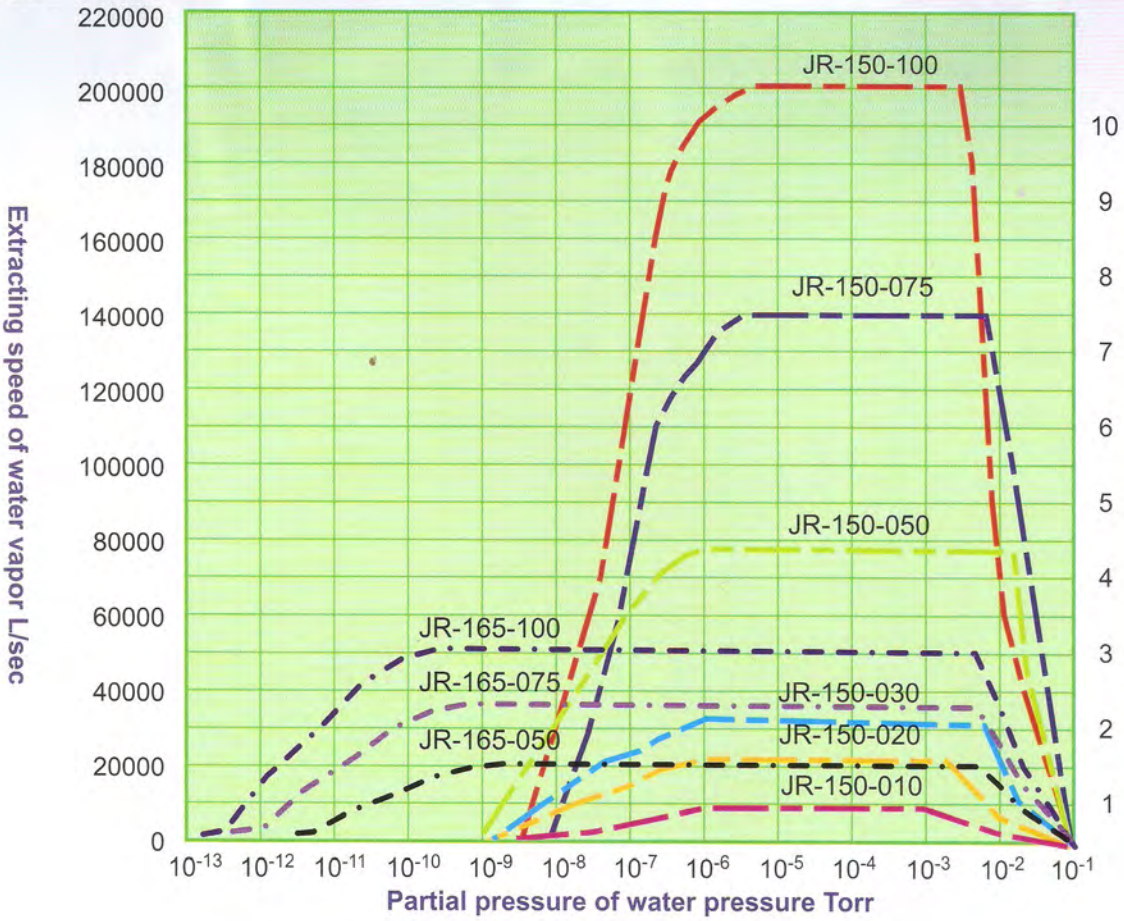
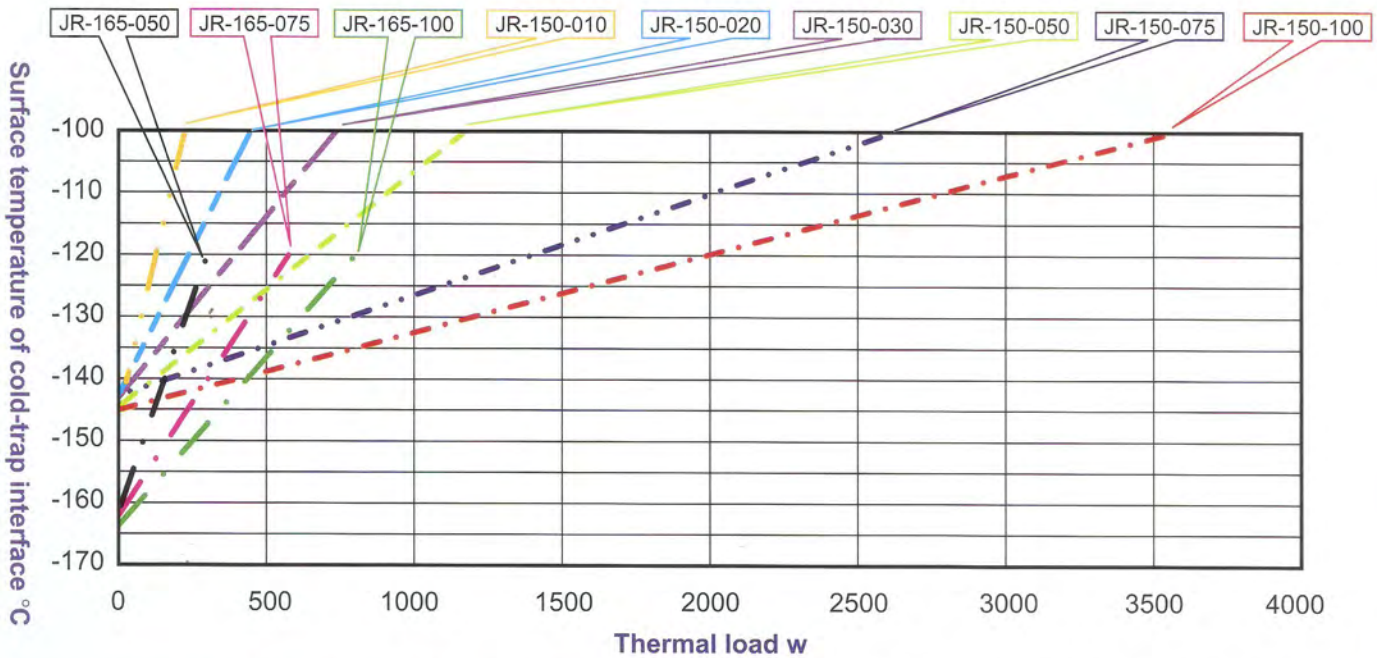
Comparison Between the Extracting Speed and the Pressure of Water Vapor in Cryo-pump



Comparison between the surface temperature and thermal load of cold-trap interface



(a) It is recommended that refrigerant line should be mounted a temperature indication at the inlet/outlet of vacuum chamber.

(b) At the maximum load, the typical temperature difference between inlet and outlet is 20°C. The end point of each curve is the maximum load of this model.

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