PRODUCT DATA SHEET

POLYCOLD® MAXCOOL CRYOCHILLERS

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Polycold® MaxCool Cryochillers are closed loop cryogenic refrigeration systems that provides up to 4,000 watts of cooling. They can be used to capture water vapour and other condensable substances on a cold surface such as a cryocoil or chevron baffle. The MaxCool Cryochillers are also used to cool objects to very low temperatures such as electrostatic chucks used in semiconductor wafer processing.

Water vapour pumping

Polycold® MaxCool Cryochillers effectively capture water vapour, which comprises 65% to 95% of the residual gas in high vacuum systems. Water vapour is typically the most reactive contaminant present. With our MaxCool Cryochillers you can expect an increase in product throughput in your existing system of 20% to 100% and an improvement in the quality of deposition.

The MaxCool advantage

- High-vacuum pumpdown time cut by up to 75%
- High-speed pumping of water vapour: typical pumping speeds of 164,000 to 328,000 l/sec based on the model
- Increased product throughput of 20% to 100%
- Lower water vapour partial pressure during processing for higher film quality, better adhesion and more reproducible deposition
- Superior in cost/performance to liquid nitrogen cooled Meissners
- Minimise cost of ownership with power management
- High capacity cooling and heating for a wide variety of processes

When added to your vacuum system, MaxCool Cryochillers can dramatically reduce pumpdown times and increase product throughput. The MaxCool will pump water vapour within minutes from start and can defrost in less than four minutes, giving true fast-cycle capability and enabling your system to perform more production cycles per shift.

Using patented Polycold® refrigerant mixtures, the MaxCool works on the principle of Meissner trapping. Water vapour is captured by condensation on a cryogenically cooled surface, called a Meissner coil.

The cryocoil is mounted directly in the vacuum chamber so conductance is not limited by ports, manifolds, valves and baffles. The cryocoil is easy to install and can be adapted to fit any system. It does not need a high vacuum valve.

MaxCool Cryochillers are the most cost-effective upgrade that you can add to any diffusion-pumped, turbo-pumped, or helium-cryopumped system.

The Polycold® MaxCool Cryochillers are compliant with European Application Refrigerants ((EU) No 517/2014) and the US EPA SNAP

Features and Benefits

- Cooling from-98°C (175 K) to-145°C (128 K)
- Heat Removal up to 4,000 watts
- Cryocondenses water vapor in vacuum systems with typical pumping speeds up to 329,000 l/ sec vacuum levels to 8 x 10-10 torr (1 x 10-9 mbar)
- Option for power management to minimise cost of ownership
- Patented Green refrigerant charge is globally compliant, non-toxic and nonflammable
- Based on Polycold®s proven, innovative, dependable mixed gas refrigeration
- Third party certified to EU PED, MD, and RoHS
- TÜV Rheinland Listed to NRTL/CANADA Safety Standards
- ISO 9001:2015 certified manufacturer

Features

All MaxCool Cryochiller models have the following features in common:

Ethernet and USB 2.0: Standard communications on each model to allow users to easily interface with each MaxCool.

HMI: Includes a manual interface with a display and a keypad for navigation and selection.

Rapid Balance Pressure Check: This feature enables the MaxCool unit to give a balance pressure reading in about 20 minutes, rather than the 48-hour warm-up required by the previous PFC models. This improvement maximises tool uptime.

Self-Diagnostics: All MaxCool Cryochiller models include self-diagnostics to assist the user.

Footprint: Most service access is needed only from the front, making the unit easier to position.

Compliance: MaxCool Cryochillers are compliant to EU PED, MD and RoHS. TUV Rheinland listed to NRTL/Canada safety standards. Semi S2 and Semi F47compliance are dependent on system configuration.

Options

VCR fittings: Optional VCR fittings for cyrocoil connection. Parker-compatible fittings are standard.

Dual Circuit: Enables the MaxCool to cool two cryosurfaces (two cryocoils, coil and baffle or two baffles) which can be cooled or defrosted separately.

Power Management: The Power Management option allows additional savings up to 15% in standby and 25% while cooling, as long as the full cooling capacity is not needed.

24V Remote: The MaxCool has an option for a 24V remote, which allows for direct wiring of inputs to and outputs from the unit in a manner similar to earlier PFC models. The 24V remote may be Isolated or Non-Isolated and may be for a Single Circuit or Dual Circuit system. Two setpoint relays are included.

Advanced I/O: EtherCAT, PROFINET, Profibus or DeviceNet.

Casters: Allow for ease of unit installation and removal.

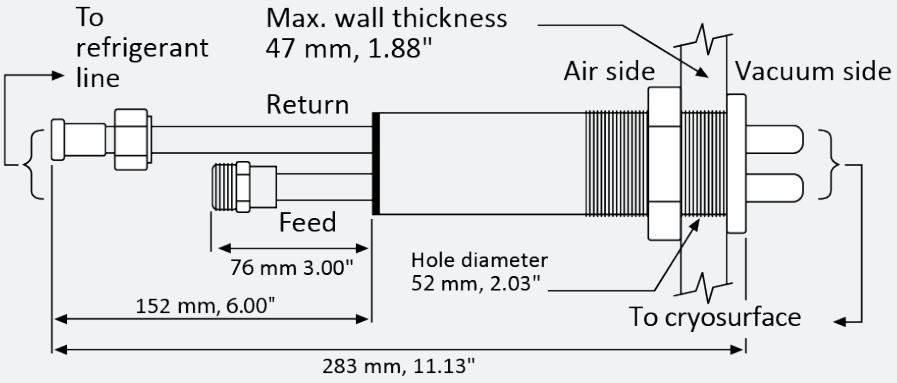
Lifting rings: Allow for ease of unit movement.

Sound attenuation option: Reduce unit sound through additional insulation.SEMI S2/F47: Includes remote EMO and DC Contactor.

System Accessories

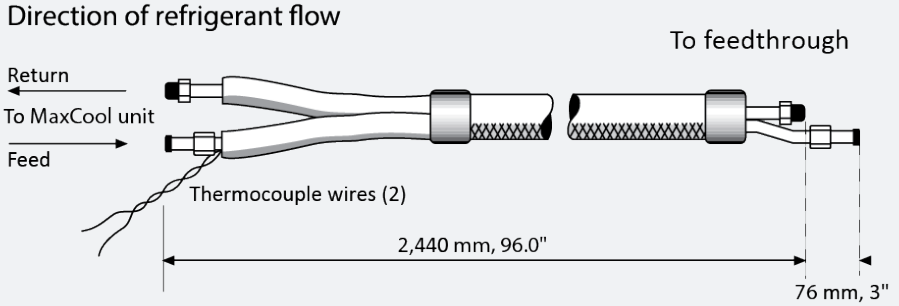
Feedthrough

The standard cryogenic feedthrough provides thermal isolation between the feed/return tubes and the O-ring seal. The dual-pass feedthrough requires a two inch diameter hole in the vacuum chamber. Couplings on the feedthrough mate with the refrigerant line. Optional feedthroughs fit one-inch diameter holes, but two are required (one for each tube).



Refrigerant Line

A standard refrigerant line set consists of a copper feed and return line, each with stainless steel couplings on both ends for connection to the MaxCool unit and to the feedthrough. Longer lengths of refrigerant line (more than the standard 8 feet/2.44 m) can be ordered from the factory, but will require our applications review.



Frequently asked applications questions

How do I select the right model of MaxCool to trap water vapour in my vacuum chamber?
Determining the appropriate MaxCool system depends upon the desired water vapour pumping speed and the ability of the chamber to accommodate the required amount of cold element (cryocoil) surface area. The larger the cryocoil, the greater the pumping speed. Typically, we recommend an increase in chamber net speed of four times the existing (net in-chamber) water vapour pumping speed. This typically results in a pumpdown time reduction from 25% to 75%. Once the approximate unit size and cryocoil surface area have been established, the equired temperature and cooling capacity of the system are reviewed against the presence of any additional heat load (long refrigerant lines, process heat, etc.).

Can I use the MaxCool Cryochiller for thermal management?
The MaxCool Cryochiller cools components in a wide variety of process steps in diverse markets such as semiconductor, flat panel display, data storage and space simulation. Applications include refrigerant-cooled chucks r platens that regulate the temperature of substrates during manufacturing processes. The MaxCool Cryochiller can also cool an external heat exchanger for open-loop or closed-loop gas chilling processes.

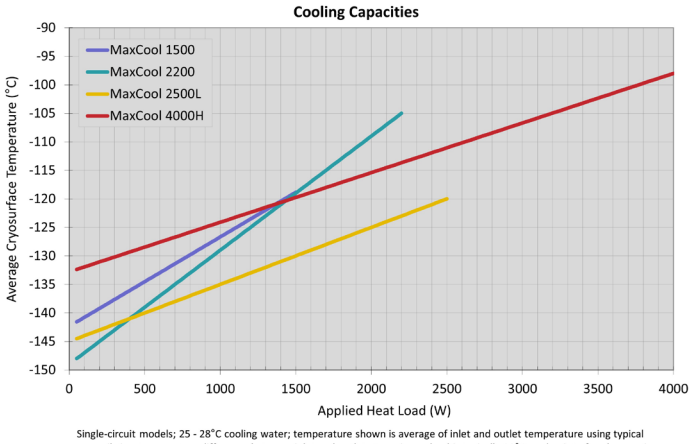
What is the best temperature to trap water vapour effectively?
To find the cryosurface temperature that is best for your vacuum system, look for the ltimate base pressure of your system in the table below. This temperature provides 90% water vapour trapping efficiency.

Helpful Information for Sizing Systems

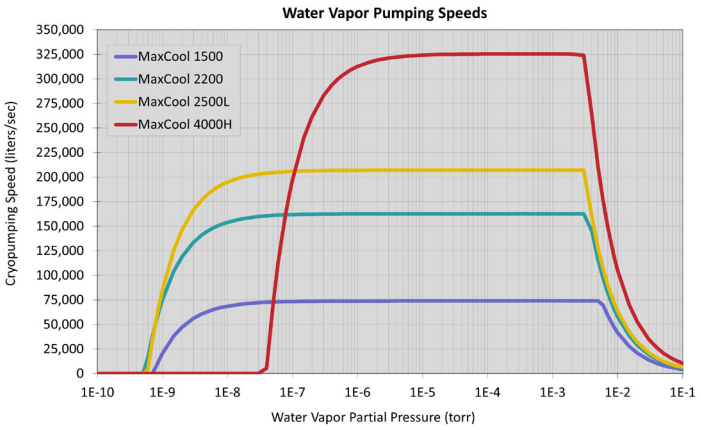
- Radiation Heat Load on Cryocoil At 25°C
- At 25°C Ambient Conditions: 376.6 watts/m2 (35 watts/ft2)
- Refrigerant Line Heat Load: 26.3 watts/m (8 watts/ft)
- Vacuum Jacketed Line Heat Load: 1.0 watts/m (0.3 watts/ ft)
- Water Vapour Pumping Speed: 149,000 l/s/m2 (13,842 l/s/ft2)
- Liquid Nitrogen Cooling: approximately 45 watts/litre/hour

Desired water vapour partial pressure		Average cryosurface temperature needed
torr	mbar	°C
1 × 10-3	1.3 × 10-3	-89.6
5 × 10-4	6.7 × 10-4	-93.4
2 × 10-4	2.7 × 10-4	-98.2
1 × 10-4	1.3 × 10-4	-101.6
5 × 10-5	6.7 × 10-5	-104.9
2 × 10-5	2.7 × 10-5	-109.1
1 × 10-5	1.3 × 10-5	-112.2
5 × 10-6	6.7 × 10-6	-115.1
2 × 10-6	2.7 × 10-6	-118.1
1 × 10-6	1.3 × 10-6	-121.5
5 × 10-7	6.7 × 10-7	-124.1
2 × 10-7	2.7 × 10-7	-127.5
1 × 10-7	1.3 × 10-7	-129.9
5 × 10-8	6.7 × 10-8	-132.2
2 × 10-8	2.7 × 10-8	-135.2
1 × 10-8	1.3 × 10-8	-137.3
5 × 10-9	6.7 × 10-9	-139.5
2 × 10-9	2.7 × 10-9	-142.1
1 × 10-9	1.3 × 10-9	-144.1

MaxCool Performance



Single-circuit models; 25 - 28°C cooling water; temperature shown is average of inlet and outlet temperature using typical cryocoil size; temperature difference between inlet and outlet at maximum load is typically 20°C; end point of each curve is maximum load for that model; performance at 50Hz can be 3 - 5°C warmer than 60Hz performance shown.



Single-circuit models; 25 - 28°C cooling water; 2.4m refrigerant line; advertised cryocoil surface areas only (larger cryocoils will give greater pumping speeds and can be used in some applications); 25°C temperature in line of sight with cryocoil; 60Hz.

MaxCool Specifications

Model	MaxCool 1500	MaxCool 2200	MaxCool 2500L	MaxCool 4000H
Typical Performance (a)				
Maximum Load	1500 W	2200 W	2500 W	4000 W
Average Temperature at Maximum Load	-118°C	-105°C	-120°C	-98°C
Coldest Temperature at Maximum Load	-141°C	-149°C	-145°C	-133°C
Typical Water Vapor Pumping Speed (from Typical Cryocoil Surface Area)	74,500 l/s	163,900 l/s	208,600 l/s	327,800 l/s
Maximum Pump Start Pressure (b)	1 atm	1 atm	1 atm	1 atm
Ultimate Operating Pressure (c)	1E-9 torr	8E-10 torr	7E-10 torr	5E-8 torr
	1.3E-9 mbar	1E-9 mbar	9.3E-10 mbar	7E-8 mbar
	1.3E-7 Pa	1E-7 Pa	9.3E-8 Pa	7E-6 Pa
Time to Defrost (d)	4 minutes	3 minutes	4 minutes	5.5 minutes
Cryocoils and Refrigerant Lines				
Typical Cryocoil Surface Area	0.5 m^2 (5.4 ft^2)	1.1 m^2 (11.8 ft^2)	1.4 m^2 (15.1 ft^2)	2.2 m^2 (23.7 ft^2)
Conservative Maximum Cryocoil Surface Area (e)	1.0 m^2 (10.8 ft^2)	1.5 m^2 (16.1 ft^2)	2.0 m^2 (21.5 ft^2)	2.8 m^2 (30.1 ft^2)
Typical Refrigerant Line Length	2.4 m (8 ft)	2.4 m (8 ft)	2.4 m (8 ft)	2.4 m (8 ft)
Typical Single Circuit Cryocoil Tube OD	12 mm (1/2 in)	16 mm (5/8 in)	16 mm (5/8 in)	16 mm (5/8 in)
Typical Single Circuit Cryocoil Tube Length	13.3 m (41.1 ft)	21.9 m (72.4 ft)	27.9 m (92.1 ft)	43.8 m (144.7 ft)
Typical Dual Circuit Cryocoil Tube OD	12 mm (1/2 in)	12 mm (1/2 in)	12 mm (1/2 in)	16 mm (5/8 in)
Typical Dual Circuit Cryocoil Tube Length	6.6 m (20.6 ft)	14.6 m (45.5 ft)	18.6 m (57.6 ft)	21.9 m (72.4 ft)
Utilities				
Cooling water flow for 13 °C (55 °F)	6.8 l/min	6.8 l/min	15.1 l/min	15.1 l/min
Cooling water flow for 18 °C (65 °F)	9.1 l/min	9.1 l/min	18.2 l/min	18.2 l/min
Cooling water flow for 24 °C (75 °F)	13.6 l/min	13.6 l/min	27.3 l/min	27.3 l/min
Cooling water flow for 29 °C (85 °F)	27.6 l/min	27.6 l/min	54.1 l/min	54.1 l/min
Maximum Power Input	11.7 kW	11.7 kW	19.2 kW	19.2 kW
Typical Power Input (at Maximum Rated Load)	7.8 kW	8.6 kW	11 kW	14 kW
Typical Power Input (with Cool Mode and Low Load)	5 kW at 0 to 150 watts	5 kW at 0 to 150 watts	8.0 kW at 0 to 300 watts	8.0 kW at 0 to 300 watts
Typical Standby Power	4.5 kW	4.5 kW	8.0 kW	8.0 kW
Nominal Power Requirements (f)	200-3-50	200-3-50	200-3-50	200-3-50
	208-3-60	208-3-60	208-3-60	208-3-60
	230-3-60	230-3-60	230-3-60	230-3-60
	380-3-50	380-3-50	380-3-50	380-3-50
	400-3-50	400-3-50	400-3-50	400-3-50
	460-3-60	460-3-60	460-3-60	460-3-60
	480-3-60	480-3-60	480-3-60	480-3-60
Safety and Compliance				
Certified by an Independent Third Party for European PED-Compliance	Yes	Yes	Yes	Yes
Nontoxic Refrigerant Blends	Yes	Yes	Yes	Yes
Nonflammable Refrigerant Blends	Yes	Yes	Yes	Yes
Minimum Room Volume per EN 378 (g)	20 m^3 (706 ft^3)	20 m^3 (706 ft^3)	39 m^3 (1377 ft^3)	43 m^3 (1519 ft^3)
Minimum Room Volume per ASHRAE-15 (g)	15.3 m^3 (540 ft^3)	15.3 m^3 (540 ft^3)	40 m^3 (1400 ft^3)	34 m^3 (1200 ft^3)
Maximum Operating Sound Level (h)	72 dB(A)	72 dB(A)	78 dB(A)	78 dB(A)
Maximum Operating Sound Level with Sound Attenuation Option (h)	64 dB(A)	64 dB(A)	69 dB(A)	69 dB(A)
Refrigerants used in the blend (see product I.D. label for amounts)	R-245fa, R-125 R-23, R-14, Argon	R-245fa, R-125 R-23, R-14, Argon	R-245fa, R-125 R-23, R-14, Argon	R-245fa, R-125 R-23, R-14, Argon
Total CO_2 equivalent emission (metric tons)	35.32	35.32	56.00	55.00

Footnotes: a) Under standard test conditions with a single-circuit model, 25°- 28°C cooling water, a 2.4m refrigerant line, a typical cryocoil surface area, 25°C temperature in the line of sight with the cryocoil, and 60Hz operation. b) Recommended cryopump start pressure is near normal "crossover." Mechanical roughing pumps and blowers are generally more effective for moisture removal above 1torr. c) Typical cryocoil at twenty five percent (25%) of maximum pumping speed. d) Many applications use smaller cryocoils and achieve significantly shorter defrost times. e) Larger cryocoils give greater pumping speeds, and can be used in some applications. Contact Edwards Vacuum for application details. f) For nominal power requirements not in the table, please contact Edwards Vacuum. Please refer to the manual for allowable voltage ranges. For 480 volt operation the maximum voltage is 506V. g) To comply with EN-378 or ASHRAE-15, the cryochiller should be located in a room no smaller than listed. h) Units were tested in a manufacturing environment while under maximum load in the COOL mode.

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