User Manual

Oxford Instruments Austin, Inc.

Cryogenic Water Pump

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Cryogenic Water Pump

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support@oxinst.com

For contact information and a complete listing of Direct Sales, Distributor, and Sales Representative contacts, visit the Oxford Instruments Austin, Inc. Web site at:

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http://www.oxford-instruments.com/businesses/industrial-products/austin

Oxford Instruments Austin, Inc.
1340 Airport Commerce Dr.
Bldg. 1 Suite 175
Austin, Texas 78741 USA
TEL. +1 512 441 6893
FAX +1 512 443 6665
Email: cryo-sales@oxinst.com

Cryogenic Water Pump

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Revision History

Date	Version	Reason
December 2013	1.0	Initial Release

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1.1 About Oxford Instruments Austin

Oxford Instruments Austin, Inc., a wholly-owned subsidiary of Oxford Instruments, specializes in the manufacture and repair of cryogenic vacuum pumps, cryocoolers (refrigerators) and helium compressors for semiconductor, optical coating, linear accelerators, medical equipment, and R&D applications.

You can find just what you need from our range of products and support services.

• New equipment - cryopumps, such as the cryogenic water pumps described in this manual, compressors, cryocoolers, and cryopump controllers.

• Comprehensive range of accessories for the installation of whole systems and a complete range of spare parts to repair cryopumps and compressors.

1.2 Other Services from Oxford Instruments Austin

Oxford Instruments Austin, Inc. offers a broad range of additional services:

• *Repair and refurbishment services* - Whatever brand of cryo-components you have, we offer fully warranted refurbishment, often with off-the-shelf availability.

• *Exchanges* - We offer our own quality products, as well as most makes of cryopumps and helium compressors, which are refurbished and fully warranted.

• *Technical Suppor*t - Our support engineers will help determine if your cryopump system is operating correctly so that you can get your system back to optimum efficiency as soon as possible.

To contact Oxford Instruments Austin, Inc. Technical Support:

Email: support@oxinst.com

• Telephone: 1-512-441-6893 or Toll Free: 1-800-404-1055

• *Installation* - On-site installation services are available to guarantee performance and save you time.

• *Training* - We offer on-site training to help you and your staff to know more about your cryopump and compressor systems. Our training will give you confidence and the ability to maintain a highest possible uptime for your system.

1.3 About this Manual

The purpose of this manual is to provide our customers using the Cryogenic Water Pump with information needed to safely and efficiently operate the cryogenic water pump when operating as part of a cryogenic refrigeration system. Such a system is often comprised of the following equipment:

• Helium compressor unit such as the Model 600 compressor from Oxford Instruments Austin

• Coldhead/cryopump/cryogenic water pump

• Connecting helium lines

This manual describes the design, operation and maintenance of a cryogenic water pump unit.

1.4 Compatibility

The Cryogenic Water Pumps described in this manual are designed for use with Oxford Instruments Austin, Inc. helium compressors (M125, M400, M600, and M700 etc.).

Safety Warnings 2

2.1 Safety Warnings

2.1.1 Standards for the Use of Warnings and Cautions

Warnings are noted when there is a possibility of injury or death to persons operating the equipment or performing specific tasks or procedures noted in this manual. Cautions are noted when there is a possibility of damage to equipment if the caution is ignored.

2.1.2 Warnings Applicable to All Aspects of the Operation of Cryogenic Water Pump Cryopumps

Warning

If a Cryogenic Water Pump has been used to pump any toxic or dangerous materials, such information must be listed on shipping container and associated paperwork before the equipment is returned to Oxford Instruments Austin, Inc. for service.

Warning

When pumping any toxic, corrosive, or flammable gases, a vent pipe must be connected to the cryopump relief valve and vented to a safe location.

Warning

Do not install a hot filament vacuum gauge on the cryopump side of the hi-vac gate valve as this could be a source of ignition.

Warning

Helium gas can cause rapid asphyxiation and death if released in a confined area.

Warning

Use a pressure reducing regulator when withdrawing helium gas from a high pressure cylinder

Warning

Detaching the helium flex lines with the compressor load (coldhead, cryopump, etc.) at low temperature can cause the pressure rise in the system beyond the permissible level therefore creating a safety hazard.

2.1.3 Operator Instructions

Follow standard Cryogenic Water Pump operating procedures as described in this manual. If after reading this manual, you still have questions regarding the safe operation of the equipment, please contact Oxford Instruments Austin, Inc. Technical Support using the contact information found in Chapter 1, Section 1.2.

Introduction 3

3.1 General Information about the Cryogenic Water Pump

Oxford Instruments Austin, Inc. provides both custom and industry standard cryogenic solutions at highly competitive prices. Cryogenic vacuum pumps providing clean, oil-free high vacuum with high pumping speeds are the pump of choice for sputtering, electron beam evaporation, accelerator beam lines and many aerospace and coating applications. Cryogenic Water Pump are available in various standard inlet flange configurations -ANSI, ISO, CF and complete UHV, with temperature sensors either in diode or hydrogen-vapor-bulb (HVB) configurations.

3.1.1 Cryogenic Water Pump Features

Cryogenic water pumps, as seen in Figure 3-1, are typically used in the following applications:

• Sputtering tools

• Ion implanters

• R & D bell-jar systems

• Surface analysis

• Accelerators

• Beam lines

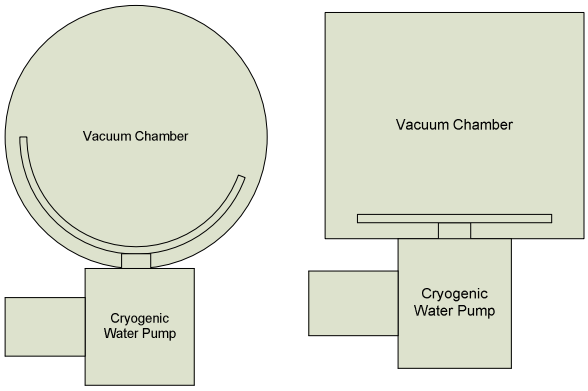
• Any vacuum system or process where water vapor could cause degradation in system vacuum level and/or product qualities

The pump-down time to achieve proper base vacuum level in a vacuum chamber is a critical cost element in a production environment. This is especially true for a large vacuum chamber which will require significant amount of pumping time to reach its desired base vacuum before production can begin. At 10E-3 torr or better vacuum level, about 97% of the residual particles in the chamber are water vapors. Using cryogenic water pumps would therefore significantly reduce the overall vacuum pump down time and improve the productivity of the process equipment. It is also a cost-effective way of upgrading existing vacuum chambers that are equipped with turbo-molecular pumps (TMPs) or diffusion pumps (DPs).

Cryogenic water pumps can generally be configured in three different ways to maximize their effects. Each configuration has its own distinct advantages and in the case of upgrading a vacuum chamber, they may be selected based on characteristics of the chamber and its existing TMP/DP pumping system designs. The followings are brief descriptions of these three configurations.

1. In-Situ Configuration

In this configuration, the cryo-panel or the so-called sail of a cryogenic water pump is located inside the vacuum chamber, while the coldhead and its drive motor are mounted on a vacuum chamber port. Figs. 1a and 1b present two variants of such a configuration. The picture on the cover of this manual shows an in-situ cryogenic water pump without its sail.



Figs. 1a & 1b Cryogenic water pump mounted in-situ on a vacuum chamber.

The main advantage of this configuration is that the sail of the pump can be custom designed to fit the geometry inside the chamber, with largest achievable cryo-pumping surface area (hence highest achievable water pumping speed). However, this configuration does need sufficient clearance within the chamber and access to the inside of the chamber for maintenance, etc.

When using this configuration to upgrade a chamber that has installed TMP or DP pumping system, it has no impact on the pumping speeds of other process gases if the pump is mounted on its own port.

2. In-line Configuration

When a chamber has no spare port to mount a cryogenic water pump independently, the in-line configuration can be used to take advantage of the benefit of a cryogenic water pump without significant change to the existing chamber equipment design and setup. In this configuration, a cryogenic water pump is inserted in between the existing TMP or DP and the mounting port, as shown in Fig. 2. The cylindrical cryo-panel of the pump is situated inside the pump vessel that connects the inlet of the TMP or DP to the vacuum chamber port, and does not protrude into the chamber itself.

The addition of the cryogenic water pump in front of the existing TMP or DP will somewhat impact the pumping speed of the later. The change can be described as:

$$1/S_{eff} = 1/S_{ini} + 1/C_{wp}$$

With S_{ini} being the TMP or DP pumping speed of a particular gas at the mounting port without the cryogenic water pump, and C_{wp} being the water pump conductance of the same gas. S_{eff} is then the effective TMP or DP pumping speed of this particular gas with the in-line cryogenic water pump installed. Generally, this could result in reduction of the TMP or DP pumping speed.

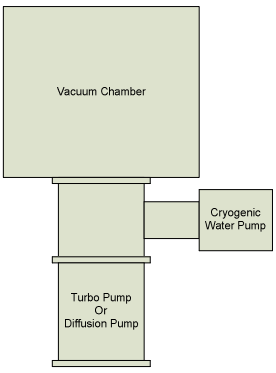


Fig. 2 In-line "series" connection of a cryogenic water pump used in conjunction with a turbo or diffusion pump.

3. Appendage Configuration

Fig. 3 illustrates a so-called Appendage configuration of a cryogenic water pump. For a vacuum chamber that has extra ports available, this configuration will allow adding significant water vapor pumping capability to the chamber without interfering with the existing vacuum equipment setup and performance.

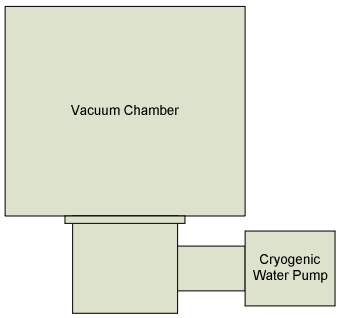


Fig. 3 Appendage configuration of a cryogenic water pump on a vacuum chamber.

This configuration does not affect the pumping speed of the existing TMPs or DPs.

Oxford Instruments Austin designs and manufactures cryogenic water pumps of all three configurations, at sizes of 4", 6", 8", 10" and 16", and with different type of flanges (CF, ISO, ANSI, etc.). Oxford Instruments Austin can also design and manufacture custom configuration of cryogenic water pumps. Table 1 lists the water pumping speed and other info of the ASC cryogenic water pump product line.

In addition, Oxford Instruments Austin has an automatic cryogenic water pump controller (Model E1000) that provides highly customer configurable automatic control of the water pumps.

For more detailed information of these products, please contact Oxford Instruments Austin at 1-512-441-6893 or 1-800-611-8871.

3.2 Specifications

This section describes the specifications for the Cryogenic Water Pump cryopumps.

Table 3-1 Pumping Speed of Cryogenic Water Pumps

Pump Size	4"	6"	8"	10"	16"
Water Vapor Pumping Speed [liter/sec]	1,100	2,500	4,000	7,000	16,000
Conductance* (N_2, in-line configuration)	450	1,000	1,800	2,800	7,800

*For in-line configuration only.

Note: Cryogenic water pumps can operate safely in any mounting orientation.

Figures 3-1a through 3-1f shows main dimensions of several configurations of Oxford Instrument Austin cryogenic water pump.

Figure 3-1a. Dimensional Drawing of a 6" In-Line Cryogenic Water Pump with Rotatable CF Inlet Flanges, both Standard and UHV versions (with a Custom RGA Port)

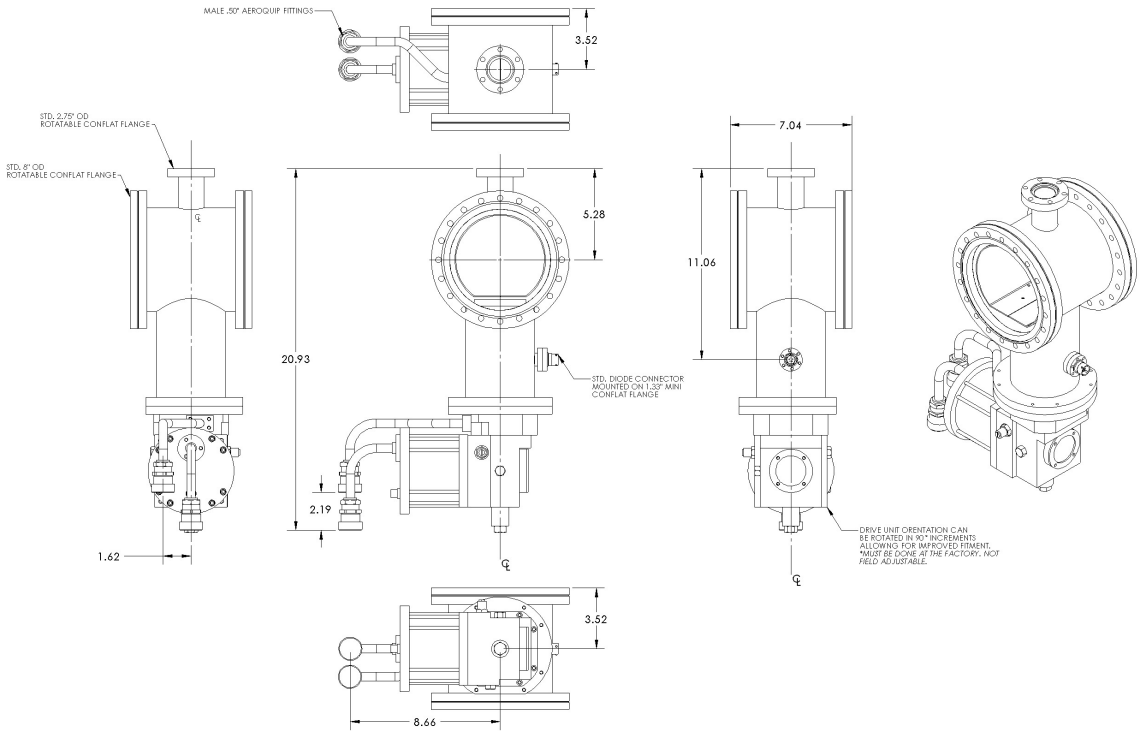


Figure 3-1b. Dimensional Drawing of an 8" In-Line Cryogenic Water Pump with Rotatable CF Inlet Flanges, both Standard and UHV versions (with a Custom RGA Port)

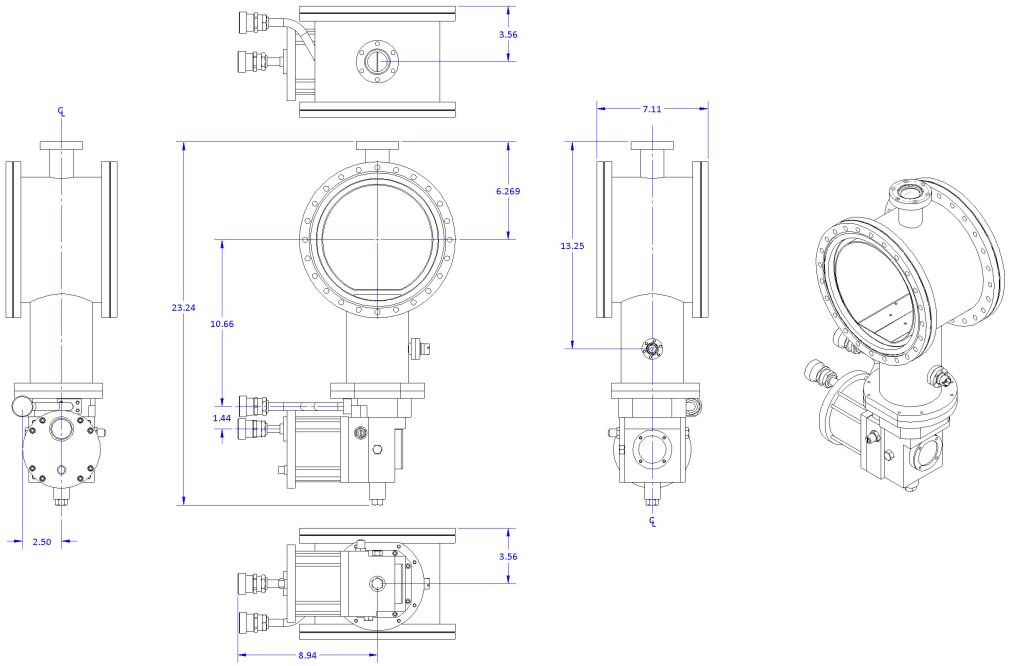


Figure 3-1c. Dimensional Drawing of a 4" In-Line Cryogenic Water Pump with Rotatable CF Inlet Flanges, both Standard and UHV versions

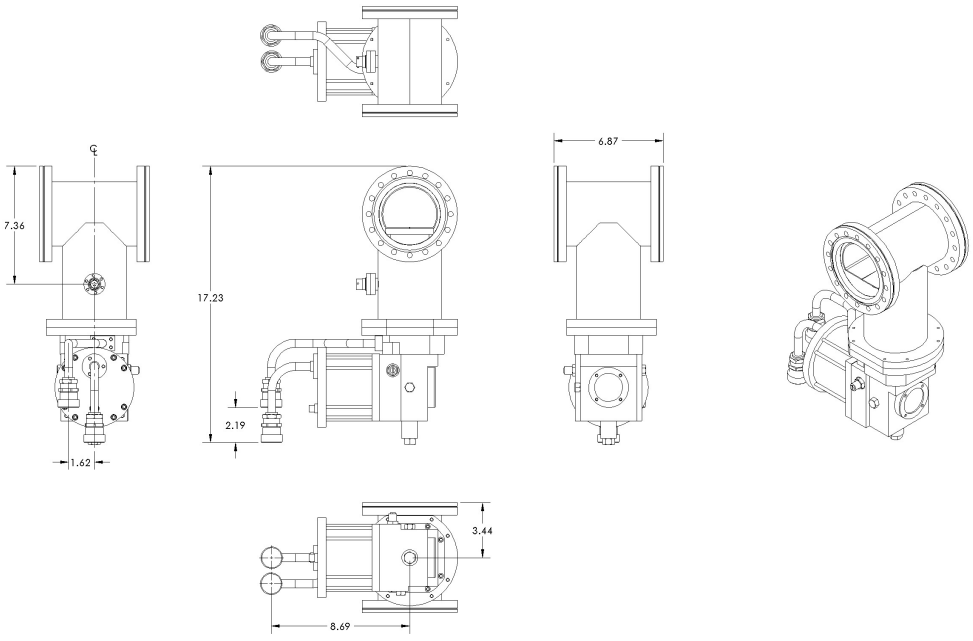


Figure 3-1e. Dimensional Drawing of a 16" In-Line Cryogenic Water Pump with ISO Inlet Flanges

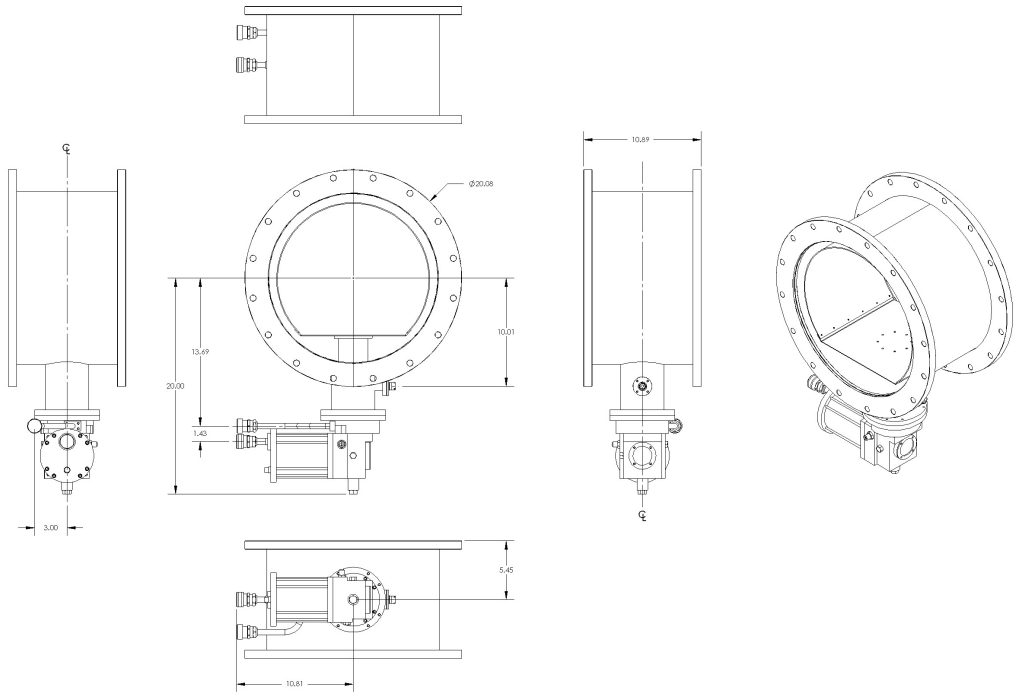


Figure 3-1f. Dimensional Drawing of a 6" (ISO160) In-Situ Cryogenic Water Pump with ISO Inlet Flanges (MK-50 Equivalent)

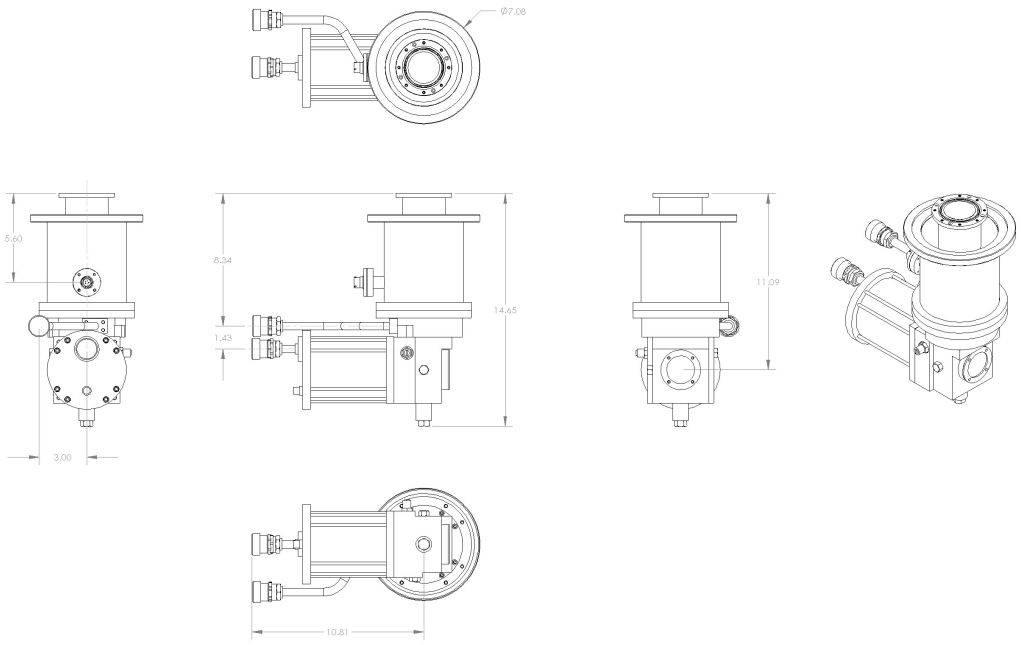


Figure 3-1g. Dimensional Drawing of a 10" In-Line Cryogenic Water Pump with ISO Inlet Flanges

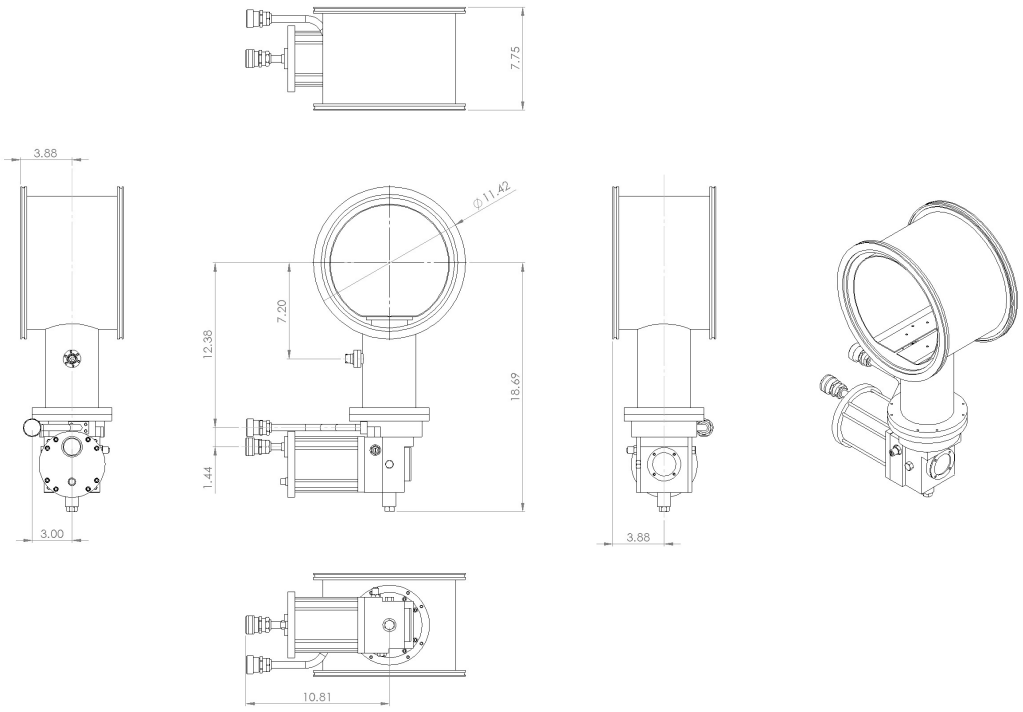


Figure 3-1h. Dimensional Drawing of a 10" In-Line Cryogenic Water Pump with CF & ISO Inlet Flange

3.3 Ordering Information

Call 1-512-441-6893 or 1-800-611-8871, or email to cryo-sales@oxinst.com for ordering of cryogenic water pump and other OI-AUSTIN products.

3.3.1 Standard Equipment and Accessories

Table 3-2 contains the ordering information for the cryogenic water pumps.

Table 3-2. Cryogenic Water Pump Ordering Information

Pump Type	Pump Inlet Flange Size	Inlet Flange Type	Part number
In-Line	4"	CF (Rotatable) x 2	92-00700-000
In-Line	6"	CF (Rotatable) x 2	92-00100-000
In-Line	6"	CF (Rotatable) x 2; Full UHV	92-00300-000
In-Line	8"	CF (Rotatable) x 2	92-00200-000
In-Line	8"	CF (Rotatable) x 2; Full UHV	92-00400-000
Appendage	6" (ISO160)*	ISO	92-00008-000
In-Line	10"	CF (Rotatable) & ISO	92-00600-000
In-Line	10"	ISO-LFB x 2	92-00600-001
In-Line	10"	ISO x 2	92-00600-002
In-Line	16"	ISO x 2	92-00800-000

*CTI MK-50 water pump equivalent

3.3.2 Optional Accessories and Replacement Parts

The customer can order the optional accessories and replacement parts listed in Table 3-3.

Table 3-3. Optional Accessories and Replacement Parts

Accessories/Replacement Parts	Part Number
E1000 Remote Temperature Controller (Controller Only)	81-00040-000
Kit, E1000 Remote Temperature Controller (10ft Compressor Input Cable)	99-00079-000
Kit, E1000 Remote Temperature Controller (15ft Compressor Input Cable)	99-00079-015
Kit, E1000 Remote Temperature Controller (20ft Compressor Input Cable)	99-00079-020
Cable, Diode, Dual Pump, 10ft	81-00038-010
Cable, Diode, Dual Pump, 20ft	81-00038-020
Cable, Diode, Dual Pump, 25ft	81-00038-025
Coldhead Drive Unit Power Cable (10 ft.)	10144-10
Helium Line, 0.5"ID, 10ft	10418-10
Single Pump Installation Kit	10251

Custom length cables/helium lines are available, please contact Oxford Instruments Austin at 1-512-441-6893 or 1-800-611-8871.

Installation & Operation 4

4.1 Safety Warnings

Review the safety warnings found in Chapter 2 before starting any installation activities.

4.2 Inspect Equipment before Installing

Remove the cryopump from the box and inspect for any damage during shipping. Notify the shipping company and Oxford Instruments Austin immediately if any damage was found. Take photographs of the damages when possible.

4.3 Tools Needed for Installation

The Installation Kit for is offered as an optional accessory that can be ordered from Oxford Instruments Austin. Refer to Chapter 3, Section 3.3 for the part number and ordering information.

4.4 Installing the Cryogenic Water Pump Cryopump

Follow these steps to install a cryogenic water pump:

1. Clean all sealing surfaces, install inlet flange gasket(s) or o-ring(s). Before installing an o-ring, lightly apply a thin film of vacuum grease to it.

2. To mount the cryogenic water pump -

- For an appendage or in-line cryogenic water pump, mount and secure the pump to the chamber gate valve;
- For an in-line cryogenic water pump, mount the original TMP/DP/CP to the other flange of the pump;
- For an in-situ cryogenic water pump, mount and secure the pump to a chamber port (no gate valve).

3. For an in-situ cryogenic water pump, install the sail to the coldhead from the chamber side.

4. Remove dust plugs from any Aeroquip self sealing couplings and inspect gasket seals.

5. Connect helium flexible lines in the following order -

- Use one helium flex line to connect the “Return” ports on both the cryogenic water pump and the compressor;
- Use another flex line to connect the “Supply” ports on both the cryogenic water pump and the compressor.

6. Check gas pressure gauge per compressor specifications. Charge or discharge compressor if necessary.

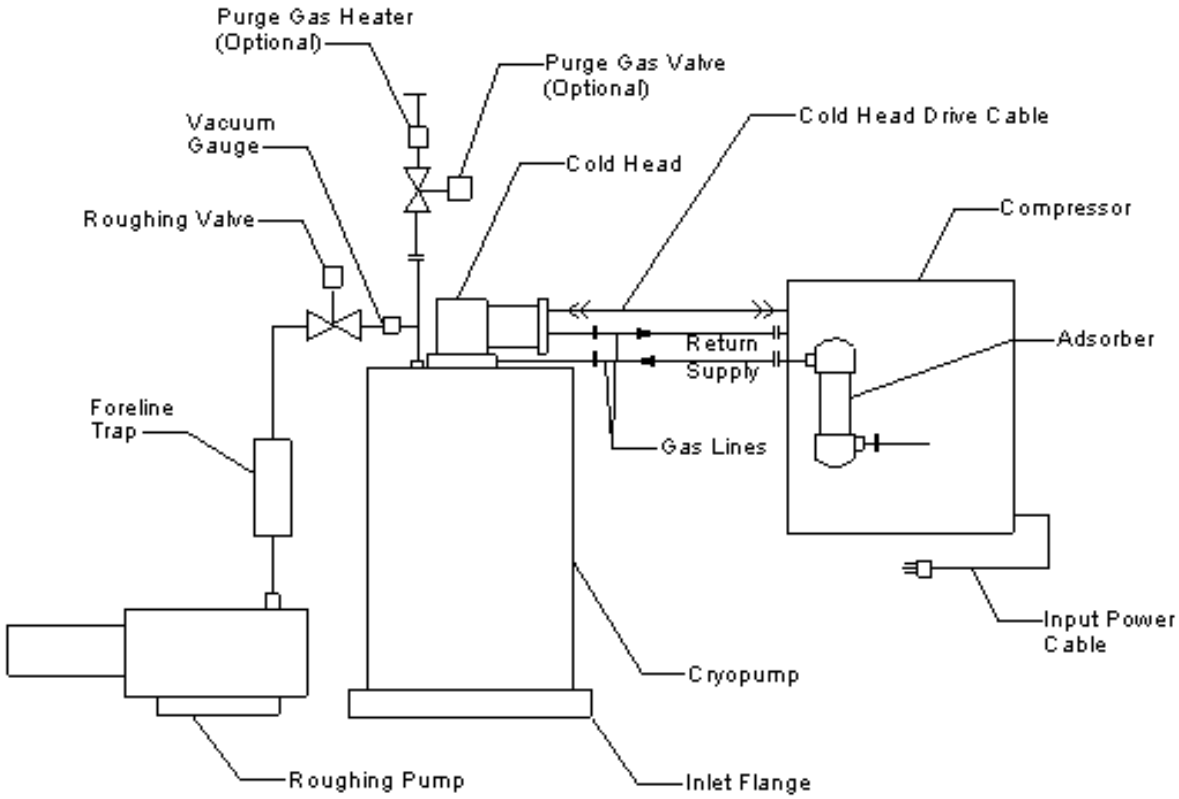
7. Connect cold-head drive cable from compressor to the pump drive unit.

8. Connect diode cable(s) between the pump diode connector(s) and a temperature monitor/controller (such as an E1000 controller) if applicable.

9. Connect main power cable per compressor specifications.

Figure 4.1 shows a typical installation diagram when making connections.

Figure 4-1. A Typical Cryogenic Water Pump (In-Line Configuration) Connection Diagram



4.5 Cryogenic Water Pump Operations

To start a cryogenic water pump operation:

1. For an in-line or appendage cryogenic water pump, make sure the chamber gate valve is closed.

2. Turn on the mechanical roughing pump and rough to 10E-3 torr or better pressure level within the pump vessel.

3. For an in-situ cryogenic water pump that has its sail located inside the vacuum chamber, make sure the chamber pressure reaches 10E-3 torr or better.

3. Turn on the compressor that runs the cryogenic water pump and start the cool down process.

4. When the pump is operating properly, it usually takes about 15~30 minutes to reach between 104K to 108K.

5. Make sure the pressure level within the pump vessel reaches at least the crossover of the vacuum chamber before opening the gate valve.

Cryogenic Water Pump

To stop a cryogenic water pump operation:

1. For an in-line or appendage cryogenic water pump that is separated from the main vacuum chamber through a gate valve, close the gate valve

2. Turn off the compressor that runs the cryogenic water pump.

3. The pump will then be warmed up to ambient temperature.

Troubleshooting 5

5.1 Troubleshooting

Table 5-1 describes some problems that users might encounter while operating a cryogenic water pump and provides solutions to those problems.

Table 5-1. Troubleshooting Procedures

Problem	Possible Cause	Corrective Action
Temperature of cryogenic water pump does not reach required operating temperature	The sail is loose, thereby preventing good thermal contact with its cold station on the cold head. Excessive thermal load. Decrease in water pump cold head performance.	Warm the waterpump to ambient temperature, and retighten the sail to about 15 to 20 in-pounds. Reduce the thermal radiation load by (1) shielding the pump or (2) lowering the temperature of the radiating surface. If the helium pressure gauge reads well above or below the normal operating pressure, release or add helium gas as described in the compressor manual. Warm up and then re-cool down the water pump. If the temperature remains high, the problem may be within the cold head. Contact Oxford Instruments Austin.
Pump fails to cool down to the required operating temperature or takes too long to reach temperature.	Incorrect helium supply pressure. Vacuum leak in vacuum system or cryogenic water pump. Compressor problem.	Add or release helium gas as described in the compressor manual. a. Check vacuum system for leaks. b. Check cryogenic water pump for leaks. Contact Oxford Instruments Austin.
Cryogenic water pump has intermittent noise during operation, a ratcheting or thumping sound.	Helium contamination.	Contact Oxford Instruments Austin.

Call 1-512-441-9258 or 1-800-404-1055, or email to support@oxinst.com for Technical Support of any Oxford Instruments Austin products.

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