JTC JOULE-THOMSON CRYOSTAT COOLING SYSTEM

Operating Instructions

TELEDYNE
JUDSON TECHNOLOGIES
A Teledyne Technologies Company

PB 219

The Teledyne Judson JTC System is designed to cool Teledyne Judson InSb and HgCdTe detectors to 77° K without the inconvenience of liquid nitrogen. This product bulletin describes the operation of the cooling system, including the following components:

P/N J42902-2	Demand Flow Joule-Thomson Cryostat
P/N J9169	Tubing and Fitting Assembly
P/N J8994	Reducer
P/N J5684	Molecular Sieve Filter

The above components, part of a JTC-cooled Teledyne Judson detector package, may also be purchased separately. This product bulletin provides operation instructions and specifications for these components and should be read carefully before using the JTC system or any of the components.

DESCRIPTION:

Infrared detectors with Joule-Thomson Cryostat Systems have been used extensively in military applications due to their small size, fast cool down time, low maintenance and automatic operation. The Teledyne Judson JTC System offers this high technology in an easy-to-use package for commercial applications.

The JTC system consists of a high-quality detector mounted with a silicon diode temperature sensor in a miniature glass dewar. The cryostat and dewar are permanently fixed in a compact aluminum housing to reduce potential mishandling of the cryostat or glass dewar.

The cryostat has no moving parts and requires no electrical power. It operates from bottled high pressure nitrogen gas. A single 14,000 (STP) liter, 6,000 psi bottle can supply 230 continuous hours of operation.

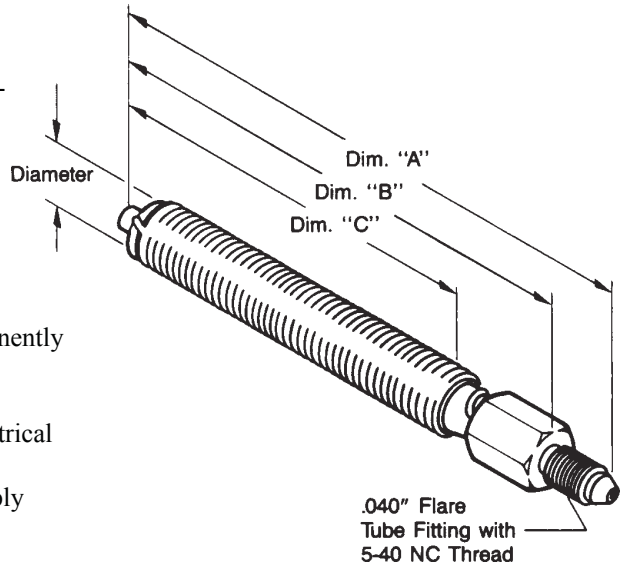


Figure 1: Miniature Joule-Thomson Cryostat

FEATURES:

- Continuous, maintenance-free operation.
- Compact size.
- No liquid nitrogen pour fill required.
- Reliable.
- Suitable for automatic on/off operation.
- No electrical power requirements.
- Intrinsically safe.

APPLICATIONS:

- Airborne thermal mapping.
- Automated infrared instruments.
- Thermal imaging at remote sites.
- IR detector for hazardous areas.

Simple and rapid cooldown of detector elements is offered by Teledyne Judson miniature Joule-Thomson cryostats in an appropriately designed dewar. The cryostats convert pressurized gas to cryogenic liquid at the cryostat tip which is positioned behind the dewar cold finger. The cryostats have no electrical power requirements and can be operated in any position. (Complete inversion reduces performance.)

Teledyne Judson cryostats operate with high-purity nitrogen gas for 77°K detector temperature. They are capable of operating with detector/dewar heat loads up to 2 Watts in ambient temperatures of -55°C to 70°C. Cryostats for use with Argon gas (87°K) are also available.

TELEDYNE
JUDSON TECHNOLOGIES
A Teledyne Technologies Company

221 COMMERCE DRIVE
MONTGOMERYVILLE, PA 18936-9641
PHONE: 215-368-6901
FAX: 215-362-6107
www.teledynejudson.com

Demand Flow or Fixed Orifice Operation

Demand flow cryostats automatically regulate the flow of gas into the cryostat to maintain operating temperature with fluctuations of less than ±1°K. This throttling effect reduces gas consumption and increases the operating time of the gas supply bottle.

Fixed orifice cryostats have a constant gas flow, with more than twice the gas consumption rates of demand flow cryostats, but with faster cooldown times and reduced temperature fluctuations.

High-Pressure Gas Supply Components

Teledyne Judson high-pressure gas supply components are designed for use with miniature Joule-Thomson cryostats for cooling of Teledyne Judson detectors for customer's military or commercial systems.
The J5026 Pressure Regulator accepts a standard CGA 667 fitting from a 6,000 psi nitrogen gas supply bottle. (CGA 680 fittings for 3,000 psi bottles are also available.) Gas supply should be >99.995% pure; bottles are available from vendors of scientific gases.
The molecular sieve gas filter, reducer and miniature tubing and pressure fittings are described in this product bulletin.

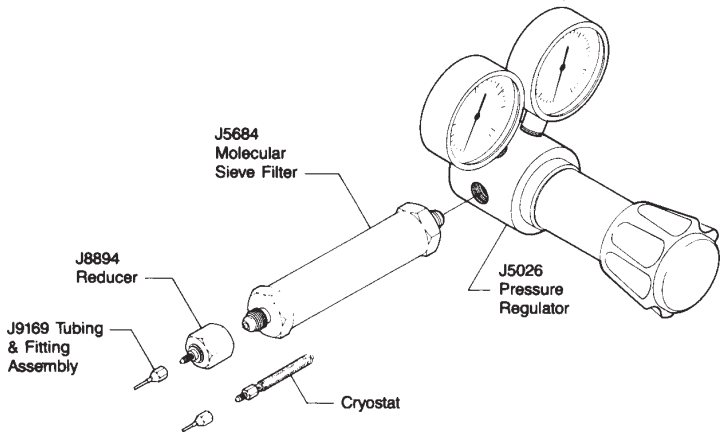


Figure 2: Complete High-Pressure Gas Supply Assembly for Joule-Thomson Cryostat Operation

Specifications for Joule-Thomson Cryostats

Model Number	Diameter (Inches)	Dimension A	Dimension B	Dimension C	Type of Operation	Suggested Inlet Gas Pressure
J42902-2	0.204	2.65"	2.25"	2.10"	Demand Flow	3500 psi
J43610-2	0.326	2.69"	2.29"	1.88"		
J9159	0.204	2.60"	2.20"	2.00"	Fixed Orifice	1000 - 2000 psi
J9174	0.326	2.47"	2.07"	1.88"		

Figure 3 shows the suggested set up for operation of the JTC system. Figure 4 shows the detector/dewar/cryostat assembly in greater detail. Items A thru H are supplied by Teledyne Judson. Items I thru K must be provided by the customer.

A) Infrared detector in glass dewar

B) Outer protective metal jacket

C) Silicon Diode Temperature Sensor

D) Demand Flow Joule-Thomson Cryostat (P/N J42902-2)

E) Coaxial cable for detector output

F) Tubing and Fitting Assembly (P/N J9169)

G) Reducer (P/N J 8994)

H) Molecular Sieve Gas Filter (P/N J5684)

I) Main supply line (Not supplied by Teledyne Judson). Type 304 seamless stainless steel tubing 0.25" O.D. X .028" wall. Tank end 1/4" Gyro-Lok fitting. Molecular sieve end Parker Triple-Lok outlet option of 4TXS sleeve for flare tubing.

J) High pressure regulator (Not supplied by Teledyne Judson). Pressure regulator and valve for operation of cryostat must mate with type of gas bottle selected (see item 'K'). Sources: Airco model 30 regulator for 6,000 psi gas tank, Matheson Gas Products model 4 regulator with cylinder valve outlet CGA 580 for 2,490 or 3,500 psi gas bottle. 1/4" Gyro-Lok outlet option of stainless steel is suggested for all regulators.

K) Pure dry nitrogen gas supply (Not supplied by Teledyne Judson). Not oil pumped, with dew point lower than -90OF and purity higher than 99.995%. Cryostat requires at least 2,000 psi for operation. High pressure gas bottles are recommended for most efficient use. Sources: Aicro 6,000 psi nitrogen cylinder type 500, CGA 677, 99.995% purity. Matheson nitrogen 2,490 or 3,500 psi, 99.998% purity. Linde Co. 3500 psi, cylinder 667, 99.997% purity. Equivalents also available from Victor Equipment Co., Air Reduction Co., etc.

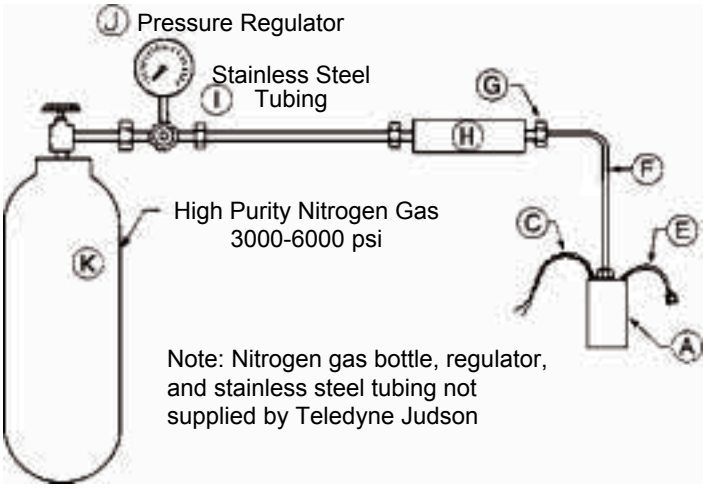


Figure 3: Suggested operating setup for the JTC system

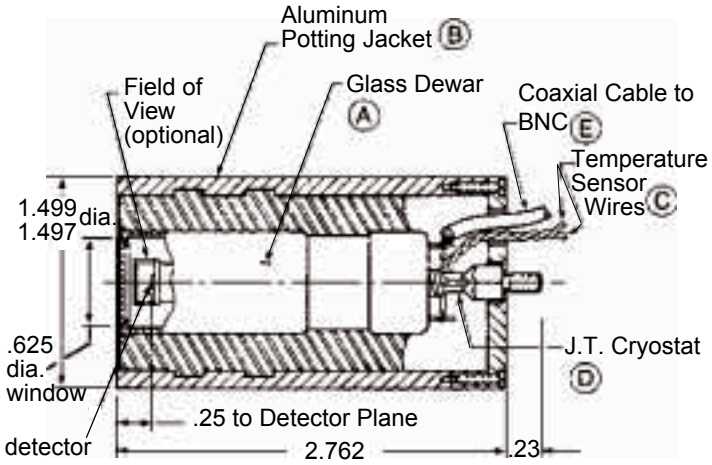


Figure 4: Detector/Dewar/Cryostat assembly

SYSTEM ASSEMBLY AND OPERATION

Assemble the components as shown in Figure 3. Carefully tighten all fittings. Tighten miniature flare fittings to 10 inch-ounces of torque, equivalent to a strong finger tightness. Check the seal. If necessary, tighten to a maximum of 50-60 inch-ounces. If more torque is required to provide a seal, the tube or fitting may be damaged. (Examine the fittings and the flared tube ends under 30x magnification for evidence of damage.)

Anchor the supply tubing at several points. Check for leaks, using soapy water or leak detector solution such as Heck-Check Type III (The Heckerman Corp., 814 W. Hyde Park Blvd., Inglewood, CA).

Purging

At initial installation of the cryostat system, the connecting lines must be completely moisture free. Make all plumbing connections to the cryostat and purge with 100 psi nitrogen for 10 minutes to allow the molecular sieve filter to remove moisture from the gas.

Maintain 100 psi pressure during the purge. Higher pressures will cool the cryostat below 0°C, freezing the moisture and stopping the purge operation.

Operation

The J42902-2 cryostat is designed to give a rapid cool down and provide good gas economy. The fiber deflector on the cold end of the cryostat retains a film of liquid cryogen adjacent to the detector, allowing operation in any attitude.

To ensure satisfactory operation it is necessary that the supply gas be free of contaminants. Solids such as dust and metal particles, liquids such as water and oil, and gasses such as carbon dioxide can clog the cryostat. Recommended gas supplies are listed on page 3, item 'K'.

The minimum operating pressure is the inlet pressure that allows the cryostat to maintain liquid production. Decreasing the inlet pressure from this point will not support liquification of the gas. Suggested operating pressure is 2,000 to 3,500 psi.

To start, open the tank valve. The detector should cool in about 30 seconds with a 3,000 psi gas supply. The cool down time will vary depending on the thermal mass of the detector and dewar cold end.

The cryostat will throttle the gas flow automatically after liquifying the incoming gas. Thereafter it will cyclically vary the gas flow so that the flow is intermittent. Cool down time and average gas consumption rates of the J42902-2 cryostat are shown in Figure 5.

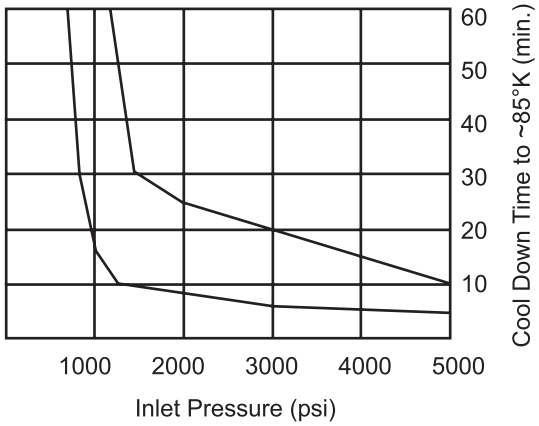


Figure 5: Cool down time and gas consumption for J42902 Cryostat

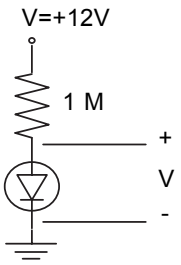
Temperature Monitoring

Most JTC units come equipped with a built-in silicon diode temperature sensor (twisted pair cable). The voltage measured between the sensor anode (white wire) and ground (yellow wire) should be 0.6 V maximum at room temperature and 1V minimum at 77 °K for the suggested test circuit of Figure 6.

During cool down, monitor the silicon diode temperature sensor and verify that final voltage across the sensor is at least one volt.

As the cryostat cycles, the temperature will normally vary over several °K. The temperature fluctuation will be greatest with low ambient temperatures, moist gas, poor dewar vacuum, large detector bias powers, high radiation loads, or inverted operation. Excessive cycling outside the range shown on the data sheet is evidence of cryostat contamination or malfunction.

Figure 6: Silicon Diode Temperature Sensor



Using the Detector

For detector electrical setup, testing and operating procedures, refer to the Teledyne Judson Detector Testing Guide, Product Bulletin #211 for InSb detectors and Product Bulletin #212 for HgCdTe detectors.

Molecular Sieve Filters

Teledyne Judson molecular sieve filters remove moisture and contaminants larger than 5µm in diameter from high pressure gas and inter-connecting components to ensure reliable operation of miniature Joule-Thomson cryostats.

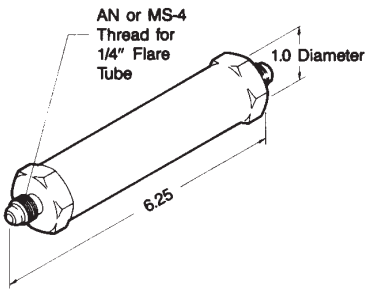
The J5684 Molecular Sieve Filter is rated for 3,000 psi operating pressure. The J8994 Reducer connects the filter to Teledyne Judson miniature pressure fittings.

The J50309-10 High Pressure Molecular Sieve Filter is rated for 10,000 psi operating pressure. The J52386 High Pressure Adapter connects the high pressure filter to Teledyne Judson miniature pressure fittings.

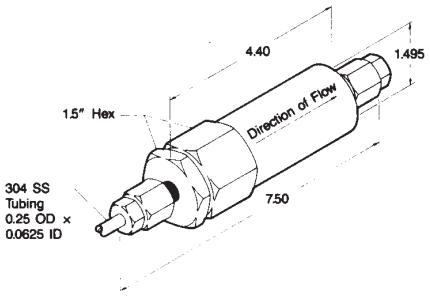
The J5684 and J50309-10 filters are re-chargeable using J8890 filter refills.
The J5034 Mini Filter is a non-rechargeable filter for use in military or commercial systems.

It connects directly to Teledyne Judson miniature pressure fittings.

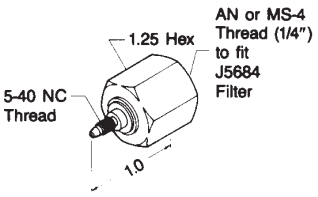
J5684 Molecular Sieve Filter



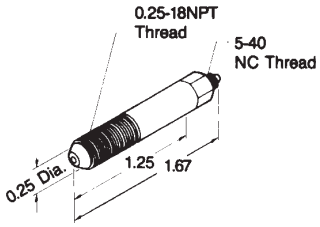
J50309-10 High Pressure
Molecular Sieve Filter



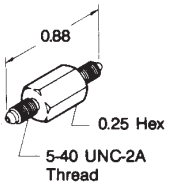
J8994 Reducer



J52386 High Pressure Adapter



J5034 Mini Filter



Miniature Tubing and Fitting Components and Assemblies

Teledyne Judson tubing and miniature pressure fittings permit safe operation of Joule-Thomson cryostats with high pressure gases.

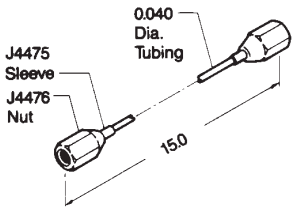
The 1mm diameter copper-nickel tubing with 0.1mm wall is flexible to reduce the stress on glass dewars from the high pressure plumbing. Burst pressures are in excess of 20,000 psi. The tubing ends have doublewalled flares for pressure-safe seals with Teledyne Judson fittings.

The J9169 Tubing and Fitting Assembly includes 15" of tubing with a nut and sleeve at each end for connection to Teledyne Judson cryostats or adapters. Other lengths of tubing are available. The J4476 Nut and J4475 Sleeve are also sold separately.

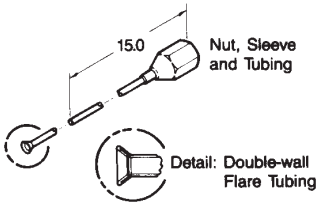
The J5121 Adapter connects a tubing and fitting assembly directly to a standard 2-56 NC thread. (This setup bypasses a molecular sieve filter and is generally not recommended for long-term operation.)

The J4474 Union Body connects two tubing and fitting assemblies.

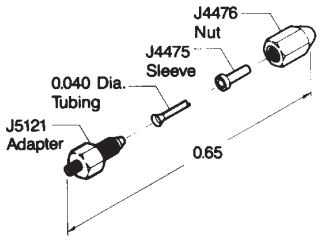
J9169 Tubing and Fitting Assembly



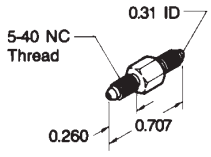
J9181 Tubing and Fitting Assembly
(single end)



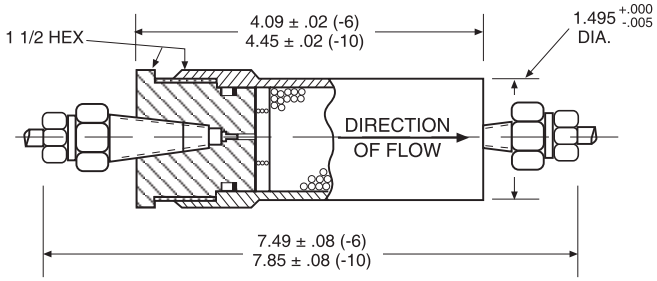
Assembly of Nut, Sleeve and Tubing
with J5121 Adapter (optional)



J4474
Union Body



Molecular Sieve Filter Operating Instructions



J50309-10

1. Tubing connection: Use 1/4" OD x .083" ID 304 stainless steel tubing only. Thread collar onto tubing (left hand thread). Slide gland over collar and tighten firmly in fitting (10-15 ft-lbs).

2. Tubing and similar tube fittings may be purchased from High Pressure Equipment Co., Erie, PA 16505.

3. Filter should be regenerated or recharged after drying 2,000 cu. ft. of gas or upon evidence of insufficient gas dryness.

4. Regenerating Procedure:
A. Connect inlet line and place in oven with at least one foot of line in oven to warm the gas. Purge filter at atmospheric pressure with 2 to 3 liters/minute of -40°C or dryer gas (commercial dry nitrogen is acceptable). Raise oven temperature to 190/200°C and hold at temperature for 2 to 3 hours. Turn off the purge gas and cap the filter while cooling to prevent water absorption.

or

B. Place filter in vacuum oven, heat to 190/200°C at 10-1 torr or better and hold for 2 to 3 hours. Valve off vacuum pump to prevent oil backstreaming and cool in oven under remaining vacuum.

5. Recharging Procedure:
A. Remove end fitting and spring assembly and discharge molecular sieves.

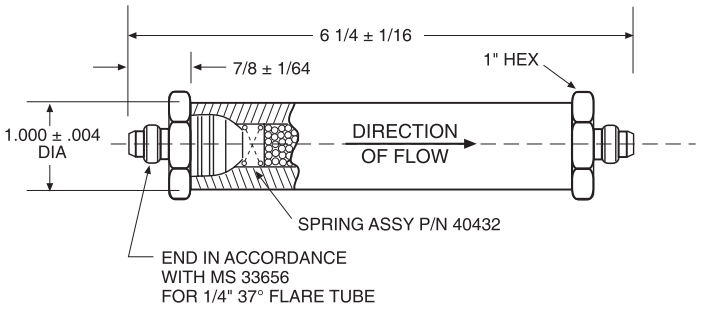
B. If oil contamination is suspected, wash only the metal parts in trichlorethylene, heat to 200°C, cool to room temperature and reinstall the o-ring and backup ring.

C. Fill cavity with Linde molecular sieve 8 x 12 beads #4A so that spring assembly when installed is compressed to 0.2" length. Teledyn e Judson J8890 molecular sieve refill is recommended to

D. Insert spring assembly as shown, replace fitting and tighten to 15 to 20 ft-lbs torque.

6. Cap ends when filter is not in system.

7. Working pressure: 50309-6 6,000 psi max.
50309-10 10,000 psi max.



J5684

1. Filter should be regenerated or recharged after two months of daily operation (approximately 2,000 cu. ft. of gas).

2. Regenerating Procedure:
A. Connect inlet line and place in oven with at least one foot of line in oven to warm the gas. Purge filter at atmospheric pressure with 2 to 3 liters/minute of -40°C or dryer gas (commercial dry nitrogen is acceptable). Raise oven temperature to 190/200°C and hold at temperature for 2 to 3 hours. Turn off the purge gas and cap the filter while cooling to prevent water absorption.

or

B. Place filter in vacuum oven, heat to 190/200°C at 10-1 torr or better and hold for 2 to 3 hours. Valve off vacuum pump to prevent oil backstreaming and cool in oven under remaining vacuum.

3. Recharging Procedure:
A. Remove end fitting(s) and spring assembly and discharge molecular sieves.

B. If oil contamination is suspected, wash only the metal parts in trichlorethylene, heat to 200°C, cool to room temperature and replace the o-rings.

C. Replace downstream fitting, if removed, and fill tube with 11.5 ± 0.5 grams of Line molecular sieve 8 x 12 beads #4A. Teledyne Judson J8890 molecular sieve refill is recommended to provide exact quantity and assure clean, dry sieve material.

D. Insert spring assembly P/N 40432 with the screen against the molecular sieves.

E. Replace inlet fitting and tighten both ends to 15 to 20 ft-lbs torque.

4. Replace plastic shipping caps when filter is not in system.

5. O-rings may be purchased from Porter Seal Co., Glendale, CA as P/N 3-8 Silicon Compound S613-60.

6. Working pressure: 3,000 psi max.

CAUTIONS

· All connecting tubing and fittings must be clean and dry.

· Tighten the miniature flared fittings with extreme care. Excessive torque will damage the flare on the tubing.

· If the flare is damaged, the tubing must be re-flared with special tooling to produce a double-wall flare. ***Single flares made in the field are not suitable for safe high-pressure seals.***

· High-pressure gas exhausted at high velocity can cause serious skin injury. Tubing should be securely anchored at several points to constrain a broken line from violent whipping.

· The cryostat is push-fit to one pound in the dewar . The jacket back plate should remain in place during operation to prevent the cryostat from working loose. Do not remove the cryostat from the dewar unnecessarily.

MAXIMUM PRESSURE RATINGS

Part #	Description	Maximum Pressure
J5684	Molecular Sieve Filter	3,500 psig
J8994	Reducer	3,500 psig
J9169	Tube and Fitting Assembly	3,500 psig
J42902-2	Demand Flow Cryostat	7,500 psig
J50309-10	High Pressure Molecular Sieve Filter	6,000 psig

SIEVE FILTER RECHARGING

The J5684 Molecular Sieve Filter is designed to remove excess moisture and contaminants from a pure, dry gas supply. It should be recharged or regenerated after two months of daily operation (approximately 2,000 cubic feet of gas).

Regenerating Procedure:

Place the filter in a vacuum oven. Heat to 190 or 200 °C at 10^{-1} Torr or better. Hold for 2 to 3 hours. Valve off the vacuum pump to prevent oil backstreaming and cool the filter in the oven under remaining vacuum.

Recharging Procedure:

Remove the end fittings and spring assembly from the filter and discharge the old molecular sieve beads.

Wash only the metal parts in trichlorethylene, heat to 200°C and cool to room temperature. Replace the o-rings. (P/N 3-8 Silicone Compound 5418-6 o-rings are available from Porter Seal Co., Glendale, CA.)

Replace the downstream fitting and fill the tube with clean molecular sieve beads, available as Teledyne Judson P/N J8890 Filter Refill. Re-install the spring assembly with the screen against the molecular sieve beads.

Replace the inlet fitting and tighten both ends to 15 to 20 ft-lbs torque. Keep the plastic shipping caps in place when the filter is not in the system.

PROBLEMS

Cryostat Fails to Cycle:

If after 30-60 seconds the gas flow rate continues at the same high rate as during cool down, then the cryostat is not cycling properly. This can be caused by water vapor or other contaminants. Allow the system to warm up and blow out contaminants by purging for 2 to 5 minutes at 100 psi. Try again. If the dewar window feels very cold or frosts over, then a dewar failure may have occurred. Contact factory for advice.

Excessive Temperature Cycling:

If the cryostat cycles, but with very large temperature swings, then the cryostat may be contaminated. Purge as described above. Verify that a proper nitrogen gas supply is being used.

221 COMMERCE DRIVE
MONTGOMERYVILLE, PA 18936-9641
PHONE: 215-368-6901
FAX: 215-362-6107
www.teledynejudson.com