Micro-GASS™

Gas Analysis Sampling System

Installation, Operation and Maintenance Manual

PERMA PURE INCORPORATED • 8 Executive Drive • Toms River, NJ 08754
Ph: (800) 33-PERMA • (732) 244-0010 • FAX (732) 244-8140

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I. *INTRODUCTION*

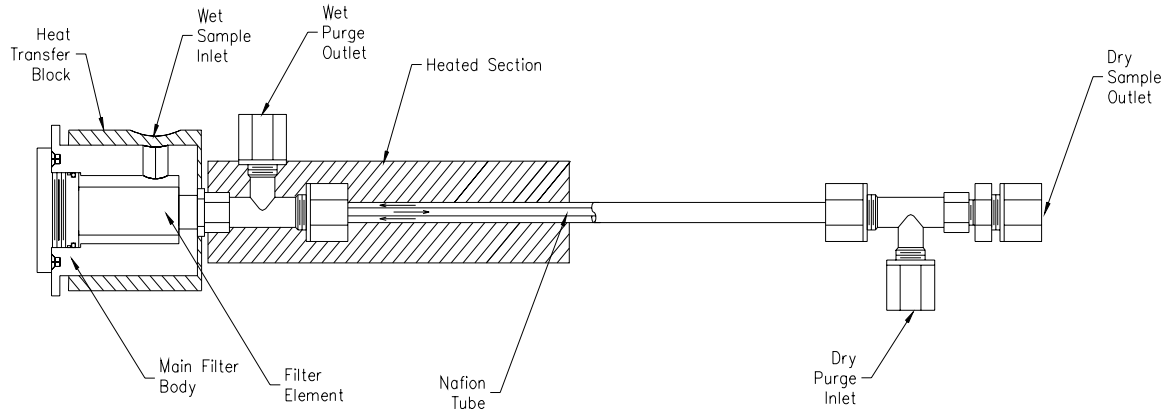
A. <u>Micro-GASS System</u> - The Perma Pure Micro-GASS is designed to reduce the humidity of gas samples to 20% to 80% RH, the optimal humidity for Electrochemical Sensors. The Micro-GASS system will remove particulate matter and water vapor from a gas stream without removing the compounds being monitored. The system consists of: a heated particulate filter, a partially heated Perma Pure Nafion® gas dryer, a sample pump, and controls for temperature and sample flow, assembled in a 12" x 12" x 7" NEMA3R enclosure.

B. <u>Nafion Technology</u> – Nafion is similar to Teflon in that it is highly resistant to chemical attack, but the presence of exposed sulfonic acid groups confers unique properties to the polymer. The sulfonic acid has a very high water-of-hydration, consequently Nafion absorbs up to 22% of its weight in water. When a gas containing water vapor comes into contact with the Nafion membrane the water is absorbed by and moves through the walls of the tubing, evaporating into the surrounding air by a process called perevaporation. Since the absorption is a specific chemical reaction with the water molecule, other analyte gases are not affected. The reaction is driven by the humidity gradient across the membrane, stopping when equilibrium is reached. Water vapor is carried away by the purge gas, and the sample is dried without being exposed to condensate that absorbs common analyte gases.

II. *OPERATION*

A. <u>Heated Filter</u> – The first step in conditioning the sample is filtering out particulate. The standard Micro-GASS system filter is a disposable 1µ "encapsulated micro-fiber" filter element housed in a Kynar filter body for corrosion resistance. Surrounding the filter body is a heated aluminum shell. The filter is thermostatically controlled at 95°C to prevent aerosols from forming in the sample stream. The heated filter and the MD-Series Nafion membrane dryer together form the Micro-GASS Module.

Figure 1 – The Micro-GASS Module



B. <u>Nafion® Membrane Dryer</u> –

1. The MD-Series dryer is installed downstream of the filter. The dryer is a shell-in-tube configuration in which the sample gas flows in the inner tube, or "element", with the purge gas in the shell flowing counter to the sample. O-ring seals isolate the sample from the purge gas. As the sample flows through the dryer water is continually removed, reducing the sample dew point as it travels from inlet to outlet. The water vapor is evacuated with the purge exhaust.
2. The sample inlet portion of the dryer is heated to provide rapid removal of the water and to prevent condensation. Nafion transfers water vapor with a higher efficiency at elevated temperatures. Yet, not all of the water-of-hydration molecules can be removed, and the Nafion always retains some water. The amount of water retained is greater at higher temperatures. Since water is removed only to the extent that the membrane is dry, the dryer should be kept at the lowest temperature possible without causing the sample to condense. As the sample dew point constantly drops as it travels through the dryer, a temperature gradient that is just above the sample dew point is the most desirable. This is achieved by heating only the sample inlet, where the sample dew point is highest, and cooling the sample outlet with purge air where the sample dew point is the lowest. Efficiency throughout the dryer is achieved by using this process.
3. If liquid water is introduced into the dryer, efficiency will decline and the dryer could fail to perform altogether. The Nafion tube when wet will elongate approximately 10% over its dry length. This elongation will cause the element to kink inside the dryer housing, creating a restriction in the flow.

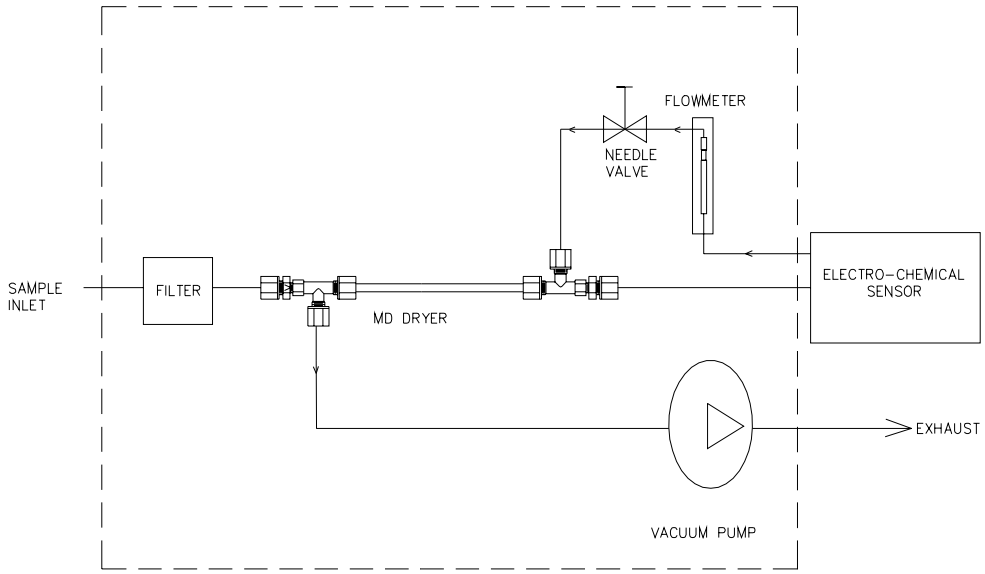


Figure 2 – Micro-GASS Schematic

C. Dry Sample as Purge Gas – The dry sample is piped to the sensor and back to the Micro-GASS for use as the purge gas. It is expanded through a needle valve in the flow meter and placed under slight vacuum. The vacuum increases the difference in partial water vapor pressure between the sample and purge gas and enhances the drying efficiency of the system. The purge flow enters the dryer at the sample outlet end of the dryer and performs two functions: First, it provides a medium for the water vapor to be carried away. Second, the cool gas creates a temperature gradient along the length of the dryer. The purge gas is heated as it traverses the heated section of the dryer, reaching its maximum temperature at the purge exhaust port. It is in the purge exhaust that the dryer temperature is monitored and controlled.

D. Temperature Control – The operating range of the Micro-GASS is from 45^{O}C to 65^{O}C. To maintain the proper operating temperature the purge gas exhaust is monitored and controlled by the electronic temperature controller. Dry sample gas returns to the system at ambient conditions, cooling the outlet end of the dryer. As the purge gas passes through the dryer it is heated to the desired sample inlet temperature, creating a temperature gradient along the dryer. This gradient allows for both rapid water removal and decreased final dew point.

E. System Pump – The system pump draws sample from the source through the dryer and analyzer, and re-circulates the sample through the purge side of the dryer under vacuum. Pump has capacity is up to 1 lpm and is made from materials highly resistant to chemical attack. The pump power is controlled by the temperature controller in order to prevent drawing the wet sample into the system when the system is cold.

III. *CONTROLS*

A. System Power – The system power switch controls power to the temperature controller, and the filter, dryer, and heated-line heaters. System power is on a 2 Amp fuse, located on the front panel.

B. Pump Power – The pump power is wired through the temperature controller. In order for the pump to engage the system must be heated to 40°C, and the pump power switch must be in the on position. Sample flow is controlled by the flow meter.

C. Temperature Control - The dryer heaters are controlled by a PID electronic temperature controller. Set-point adjustment is made by pressing the "★" key and either the up arrow key or the down arrow key simultaneously. When the desired temperature is displayed, release both keys. The allowed set-point range and the pump cut-off temperature are pre-programmed by PPI. Refer to APPENDIX C for the temperature controller configuration, or to the manual included with the documentation package.

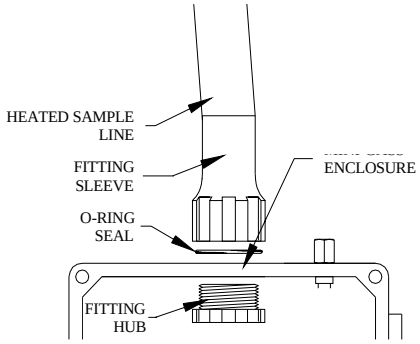
D. Flow Control – System flow is measured after the analyzer in the dry sample at atmospheric pressure and temperature. The flow meter should be adjusted to provide a flow of between 0.5 to 1.0 lpm, depending on the water content of the sample. Lower flow-rates result in dryer samples.

IV. *INSTALLATION*

A. <u>Enclosure Mounting</u> – The Micro-GASS enclosure is rated NEMA4, but the system is intended for indoor installation. For mounting, choose a location to avoid exposure to direct sunlight as it may raise the internal temperature above the operating limits, nor should the system be subjected to extreme cold (< 10°C). Vertical orientation of the system is required for proper operation of the flow meter. A set of four mounting feet are supplied for mounting the system on 12 ¼" centers.

B. <u>Sample Connections</u>

1. Sample Inlet and Heated Line Connection – To prevent condensation of the sample gas a heated line may be required. The Micro-GASS is supplied with a heat shrink sealing heated-line fitting sleeve or "boot". Connect the boot to the enclosure with the fitting hub inside the enclosure and the o-ring seal on the outside, as shown in the figure, tighten to secure. The heated sample line passes through the sleeve into the enclosure. Remove the insulation from the heated line and connect the sample line to the ¼" compression fitting at the inlet to the filter body. Heat-shrink the boot sleeve to the heated line:



a. Before heat shrinking the boot connect the sample line to the filter and ensure that it is in its final and ultimate position. The sleeve is adhesive lined and the heated line cannot be removed after shrinking.
b. Provide adequate ventilation. Fumes from burning can cause eye, skin, nose and throat irritation.
c. Using a low intensity heat source; such as a hot air heat gun, or infrared heat source, heat the boot evenly until the sleeve shrinks into place. Allow extra heating time to ensure that the adhesive melts and flows for proper adhesion.
d. Keep the heat source 1" away from the heated line. Keep the heat source moving; do not concentrate the heat in one place. If charring or burning to occurs stop heating immediately.

2. Dry Sample and Purge Connections – ¼" Bulkhead compression fittings located on the side of the enclosure are for these connections. Connect the "Dry Sample Outlet" port on the Micro-GASS enclosure to the inlet port of the sensor. Connect the sensor exhaust/outlet back to the "Dry Sample Return" on the Micro-GASS. No heated line is required for these connections unless the lines will be exposed to cool temperatures (< 10°F).

3. Sample Exhaust – The sample exhaust can either vent freely, or can be piped away from the Micro-GASS. This gas is "wet" and condensation in the line is likely.

4. Calibration Gas Connection – ¼" Bulkhead compression fitting is located on the enclosure bottom. The port must be plugged when not in use, a cap is provided.

C. Electrical Connections - 60 Watts, 110 or 220 Volts

1. **Standard 110VAC** receptacle is provided. For 220-volt systems, a pigtail cord is provided for connection to the appropriate 220-volt plug (not provided).
2. **Heated Line** – For connection to the heated line two female and one male bullet connectors; for neutral, line, and ground connections respectively, are provided. An in-line fuse holder is provided for a fuse not to exceed 10 amps.

V. ***START-UP*** **-** Once all sample, purge, and electrical connections have been made the system is ready for operation. Start with the sample flowmeter closed and system and pump power switches in the off position.

1. Turn on the System Power switch on the front panel. This supplies power to the heated line, the filter and dryer heaters, and the temperature controller. Allow 10-15 seconds for the system to come fully on-line. The temperature controller will display the dryer temperature.
2. Adjust the dryer set-point temperature to 35°C, or ten Celsius degrees above the maximum anticipated dewpoint temperature, whichever is higher. Refer to section III.C. for the temperature controller instructions.
3. Switch on the Pump Power. To prevent wet sample gas from entering the unheated dryer the sample pump is powered via the temperature controller. A relay in the temperature controller remains open until the system reaches 40°C. The system requires 10-15 minutes before the operating temperature is reached; and the pump then becomes energized. There will be a temperature spike associated with the start of sample flow. This is acceptable provided the temperature stabilizes within a few minutes.
4. Open the flow meter, adjust the flow to the desired rate (0.5 to 1 lpm). Lower flows result in dryer gas samples. Samples with a dewpoint of greater than 35°C should be run at not more than 0.5 lpm.

VI. ***SHUTDOWN*** **-** Do not permit wet gases to condense in the Nafion dryer. Follow this procedure to purge wet sample gas from the system before shutting down.

1. With system and pump power switches in the ON position remove the filter cap from the bottom of the enclosure. (Check the condition of the filter element.)
2. Allow the pump to run for at least two minutes.
3. Turn the power switches to the OFF position and replace the filter cap.

VII. *MAINTAINENCE*

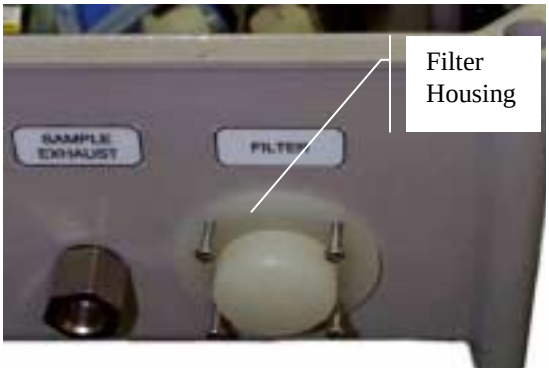
A. <u>Flow Rate</u> The system should be checked daily for proper flow rate.

B. <u>Coalescing Filter Element</u> - The filter element should be checked regularly to ensure that the element is in good condition. If the filter is dirty or causing a flow restriction replace the filter element.

a. Remove the filter cap and element.
b. Inspect the o-ring for damage and replace if necessary.
c. Fit the new filter element to the raised portion of the filter cap and replace the filter cap.
d. Tighten until snug, do not overtighten.

C. <u>Dryer Element Replacement</u> - Under the operating conditions specified the Nafion dryer element could last for several years. However, should the element become wet, clogged, or dirty it may require replacement.

1. Removal Element



a. *Disconnect the system power source*.
b. Remove four (4) screws from filter housing flange as shown here.
c. Open cover and lift control panel to gain access to the system components.
d. Remove two (2) nuts from the sample inlet tee fitting as shown in Figure 3.
e. Rotate the tee fitting counterclockwise and remove it from the heater sleeve..
f. While holding the filter heater sleeve from the inside of the enclosure, remove the Kynar filter housing from the outside by turning counterclockwise until it can be pulled out.
g. Remove nut and union from the outlet end of the dryer as shown in Figure 4.
h. From the outlet end, carefully push the element into the housing until the end of the element clears the "O" ring.
i. Remove the "O" ring. (Replace with a new o-ring.)
j. Grab the element from the filter end of the dryer and gently pull until the element is free of the housing. See Figure 5. Remove the "O" ring from the housing with the element.

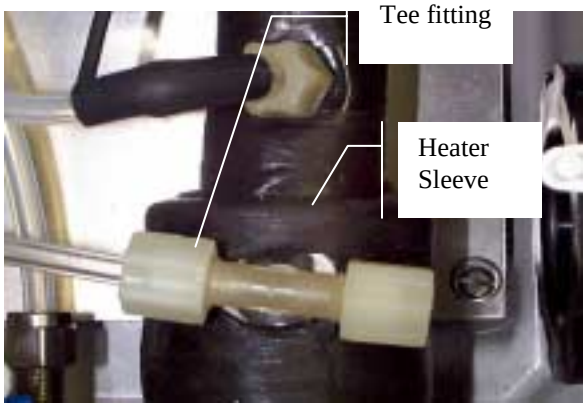


Figure 3

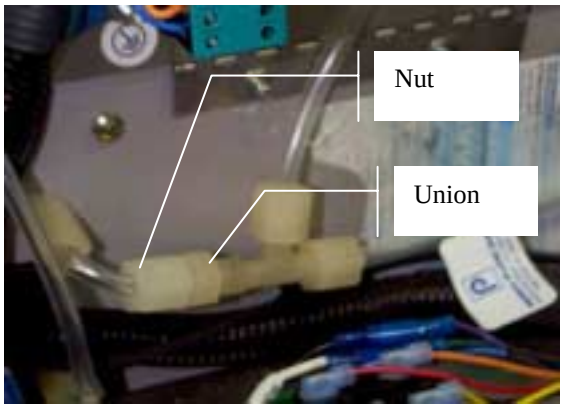


Figure 4

2. Element Installation

a. *Always wear gloves when handling the element to prevent skin oils from contaminating the membrane surface.*
b. Remove the nut from the tee fitting at the outlet end of the dryer.
c. Remove the bend clips from the dryer housing tube and straighten the tube to allow the element to slip in more easily.
d. Slip two of the new "O" rings onto one end of the new element.
e. Install the other end of the element into the filter side of the dryer housing by gently pushing the element into the housing. Be careful not to kink the tubing. As the element approaches the end of the dryer, it may be necessary to flex the dryer housing to line up the end of the element with the hole in the tee fitting. Allow about ¼" to protrude from the end of the tee fitting. See Figure 6.
f. Install the third "O" ring seal around the end of the element and gently push it into the recess of the tee fitting.
g. Install the union and hand tighten, followed by a ¼ turn with a 5/8" wrench.
h. Install the two (2) nuts on the tee fitting and tighten by hand.
i. Replace the tube bend clips.
j. Install the filter housing by again holding the filter heater sleeve from the inside of the enclosure and lining up the union threads with the element and tee fitting end of the dryer. Some flexing of the dryer heater sleeve may be necessary to line up the threads. *Do not cross thread the union! When the threads are lined up properly, virtually no resistance will be felt until the union contacts the "O" ring seal.* Turn the filter housing until tight and the purge port is visible through the hole in the heater sleeve.
k. *Apply new Teflon tape to the tee fitting and thread it into the purge port. Do not cross thread the port!*
l. Install the two (2) nuts on the tee fitting and tighten by hand.
m. Install the four (4) screws in the mounting flange.

Figure 5

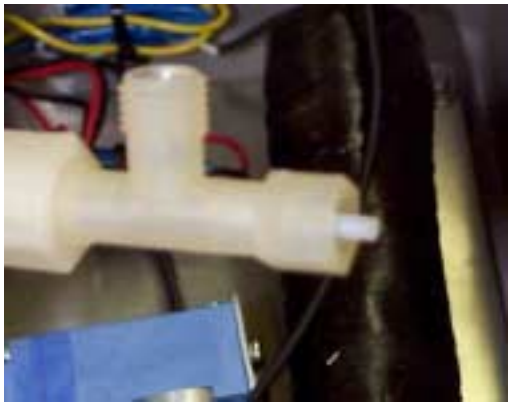


Figure 6

***APPENDIX A* – Specifications**

TEMPERATURE	65°C (150°F) Max.	
PRESSURE	30 PSIG Max. -5 in. Hg Min.	
SAMPLE FLOW RATE	0.5 to 1.0 LPM	
ELECTRICAL REQUIREMENTS	110VAC, 0.6A, 60 Watts 220VAC, 0.3A, 60 Watts	
GAS INLET/OUTLET FITTINGS	¼" TUBE Compression Fittings	
OPERATING ENVIRONMENT	10°C to 40°C Ambient 0 to 95% R.H.	
NAFION TUBE INNER DIAMETER	0.060" +/- 10%	
WATER VAPOR CONTENT by SAMPLE DEW POINT	55°C (130°F) Max.	
WATER VAPOR CONTENT by PERCENT	15% (by Volume) Max.	
SAMPLE GAS RELATIVE HUMIDITY @ 5 lpm	INLET Dew Point	OUTLET %R.H. @ 20°C
	35°C 40°C 45°C	27% 29% 33%
SOLUABLE GAS REMOVAL RATES	GAS	% LOSS
	NO, NO2 SO2 CO, CO2 H2S, HCl	0 0 0 0

***APPENDIX B* – Parts List**

REPLACEMENT FILTER ELEMENTS (5)	UG-FE
FILTER HOUSING ASSEMBLY	UG-F
FILTER HEATER	UG-FH
DRYER, ELEMENT ONLY	UG-MD-070-24E
DRYER	UG-MD-070-24F
DRYER ASSEMBLY	UG-DA-070-24F
PUMP	UG-1212-PUMP
FLOW METER	UG-FM
HEATED LINE (110 or 220)	UG-HL-(10 or 20)
HEATED LINE SEAL	UG-HL-BOOT
HEATED LINE ASSEMBLY CHARGE	UG-HL

APPENDIX C – CAL 3300 Temperature Controller Configuration

1) *For all Micro-GASS systems with the CAL3300 Temperature controller, perform the following setup procedures.*

   a) **Power Up** - Apply power to the system and wait for the controller to perform its self test routine. The display will then be alternately flashing "**nonE**" and "**inPt**".

   b) **Input sensor type** - Press and hold ✱ key. Press ▲ key repeatedly to select the "**tc K**" option for K type thermocouple. Release both keys.

   c) **Input unit type** - Press the ▲ key once. The display will then be alternately flashing "**unit**" and "**nonE**". Press and hold the ✱ key. Press ▲ key repeatedly to select the "^{O}**C**" unit. Release both keys.

   d) **Input setpoint 1 type** - Press the ▲ key once. The display will then be alternately flashing "**SP1.d**" and "**nonE**". Press and hold the ✱ key. Press ▲ key once to select the output device "**SSd**". Release both keys.

   e) **Input the maximum temperature setpoint** - Press and hold the ▼ key until "**LEVL**" appears. Press and hold the ✱ key. Press the ▼ key to move to level 2. Release the two keys. Press and hold the ▲ key until "**hi.SC**" appears. Press and hold the ✱ key. Press the ▼ key until "**65**" appears. Release the two keys.
   f) **Input the minimum temperature setpoint** Press the ▲ key once. "**Lo.SC**" appears. Press and hold the ✱ key. Press the ▲ key until "**45**" appears. Release the two keys.

2) Configure the low temperature alarm.

   a) **Configure SP2 relay as alarm -** Press and hold ▲ and ▼ keys simultaneously for 3 seconds to enter the program mode. Release the two keys. The display will then be alternately flashing "**tunE**" and "**oFF**". Press the ▼ key once. The display will then be alternately flashing "**LEVL**" and "**1**". Press and hold the ✱ key. Press the ▲ key once to move to level **2**. Release the two keys. Press and hold the ▲ key until "**SP2.A**" appears. Press and hold the ✱ key. Press the ▲ key until the display reads **FS.Lo**. Release the two keys. The display will then be alternately flashing "**SP2.A**" and "**FS.Lo**".

   b) **Save configuration into memory** - Press and hold ▲ and ▼ keys simultaneously for 3 seconds. The display will then be alternately flashing the process temperature and "**PArK**" indicating that no setpoint temperature has been entered.

3) *Set the control setpoint and auto-tune the controller*.

   a) **Input the control setpoint temperature** - Press and hold the ✱ key. Hold the ▲ key until the display goes from **0** to **55**.

   b) **Auto-tune the controller -** Press and hold ▲ and ▼ keys simultaneously for 3 seconds to enter the program mode. Release the two keys. The display will then be alternately flashing "**tunE**" and "**oFF**. Press and hold the ✱ key. Press the ▲ key until "**At.SP**" appears. Release the two keys. Press and hold ▲ and ▼ keys simultaneously for 3 seconds to exit the program mode. The display will then be alternately flashing "**tunE**", "**At.SP**" and the actual process temperature. Allow the controller time to auto-tune. *When tuning* is complete the display will show **only** the actual process temperature. This process may take up to an hour.

4) Enable low temperature alarm.

   a) **Input the alarm setpoint** - Press and hold the ▼ key until "**LEVL**" appears. Press and hold the ✱ key. Press the ▼ key to move to level 1. Release the two keys. Press and hold the ▲ key until "**Set.2**" appears. Press and hold the ✱ key. Press the ▲ key until "**40**" appears. Release the two keys. This alarm will control the sample pump so that it will automatically turn off at any time that the temperature is below 40^{O}C.