Hall C Expert Howto

Drift Chamber Gas System Operation

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Abstract

This document provides detailed setup information for the drift chamber gas mixing system, as well as the correct procedure for refilling the alcohol supply and changing gas bottles. This information is intended for use by **gas system experts only.** For day-to-day shift worker instructions, refer to the corresponding *user* howto document.

1 Overview

The drift chamber gas is composed of 50% Argon and 50% Ethane (by volume), bubbled through isopropanol at 1° C. This results in gas containing approximately 1% alcohol vapor. The mixing system that produces this gas is housed in the gas shed. The bottles supplying the gas to the mixing system are attached to two two-bottle manifolds outside the gas shed, within the fenced-in gas bottle yard.

2 Gas Interlock System

The flow of gas from the supply bottles may be automatically shut off by normally-closed solenoid valves installed in the primary argon and ethane manifolds. Several conditions such as overtemperature, fan failure, gas leak, and fire alarm must all be in the non-alarm state before these valves will open. Alarm conditions are indicated on the gas system alarm panel on the lower-left side of the center counting-house console.

When any of the required conditions is not satisfied the sounder on the panel will make an annoying noise and both solenoid valves will close. The audible alarm may be silenced by a toggle switch on the panel. Be certain to return it to the "on" position as soon as the fault is cleared.

The most confusing, but most common alarm condition is "Low Pressure". The solenoid valves will not remain open unless there is already ample pressure on the output side of both valves. This prevents us from flowing, for example, pure ethane to the drift chambers when the argon bottle is empty. The way to clear this condition is to make sure there are no other faults and that both argon and ethane manifolds are properly pressurized and fitted with non-empty bottles; then press and hold the "override" button for several seconds. This button forces the solenoid valves to open even if there are fault conditions present. If all is well, gas will flow through the valves and clear the "low pressure" condition so that the button many be released.

3 Settings for Normal Operation

Refer to the gas system flow diagram, Fig. 1

For normal operation, with the alcohol systems in use, the valves should be set as follows:

For The HMS:

Open - 3, 4, 11, 14; Closed - 12, 13, 17, 18, 19, 20.

The nominal flows set in the mass flow controller are:

- Channel 3 (Argon): 0.3 slpm (standard liters per minute)
- Channel 4 (Ethane): 0.3 slpm

Unless the gas #3 Mass flow control valve is installed, valve #6 should always be closed.

For the SOS:

Open - 1, 2, 7, 10; Closed - 8, 9, 15, 16, 19, 21.

- Channel 1 (Argon): 0.15 slpm
- Channel 2 (Ethane): 0.15 slpm

Unless the gas #3 Mass flow control valve is installed, valve #5 should always be closed.

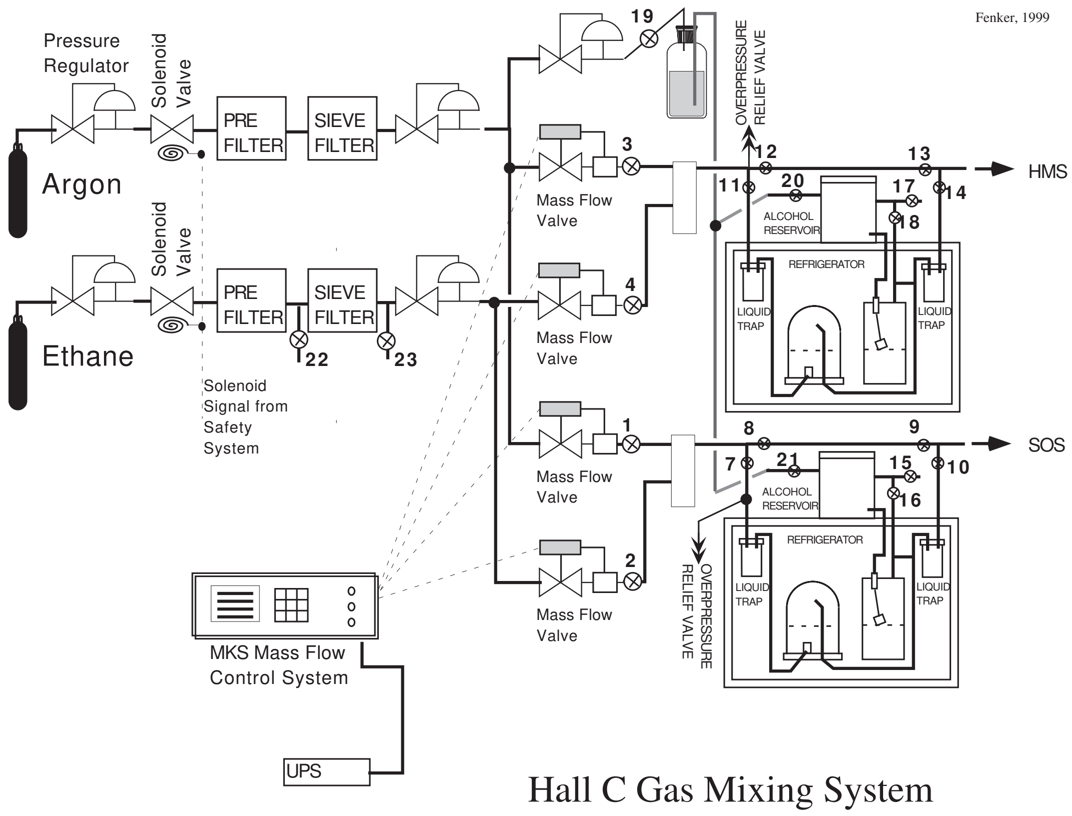

Figure 1: Diagram of Hall C Gas Mixing System

4 Operating the Mass Flow Controller.

The gas flow is controlled by a MKS 647 controller and mass flow control valves. The 647 is menu driven from a CRT in the front panel and with a keypad with cursor controls. The 647 features a non-volatile memory so settings are retained even if the unit is unpowered. The initial menu upon startup is the Command Menu. For normal operation use either the User Display menu (Command menu item #1) or the Extended Display menu (Command menu item #2). The User Display menu shows actual flow in each channel and the total flow in all channels. The Extended Display menu shows actual flow, flow set point, units, valve full scale range, gas calibration factor, whether that channel is enabled, and whether each channel is operating in master, slave, or independent mode.

4.1 To set flow rates:

The flow rate set points are adjusted from the Extended Display menu. There are two methods to change valve flow rate set point. If you want to enter a specific value you must first turn off the flow in that channel or all of the channels. Using the cursor keys move the cursor to the desired channel. Enter the desired flow rate.

The flow rate set point can be changed with gas flowing using the cursor keys. In the Extended Display mode move the cursor to the desired channel using the left/right cursor keys. The set point can then be adjusted up or down using the cursor up/down keys.

4.2 To turn gas flow on or off:

The gas flow can be turned on or off while in any menu. When any of the mass flow valves are open the green LED labeled "GAS ON" on the 647 is lit. When none of the gas flow valves are open the red "STAND BY" LED will be flashing. In the Extended Display menu the bottom line displays on or off, by channel, to show which mass flow valves are enabled. The green LED must be lit and an "ON" must be displayed in the bottom row of the Extended Display menu for gas to be flowing in a particular channel.

Turning the gas on or off is done in two steps which can be done in either order. Each channel must be enabled by pressing "ON" and then that channel number. The command input must be enabled by pressing

"ON" and then "ALL" from the keypad. This allows a single channel or all of the enabled channels to be turned on or off at once. Both steps must be performed initially, but thereafter only one of the steps need be performed to cycle the gas flow on or off.

To turn gas off in a single channel press "OFF" and then the desired channel. If you want to close all the valves simultaneously, press the "OFF" key and then the "ALL/0" key. To turn gas back on you must reverse whichever sequence you used to stop the gas flow. For example if you turned the gas off by pressing "OFF" and then the channel number, it must be turned back on by pressing "on" and then the channel number. If you turn off all the channels by pressing "OFF" , "ALL" you must turn it back on by pressing "ON" , "ALL."

5 To Change a Gas Bottle

The argon and ethane supply bottles should be replaced by new (full) bottles when the bottle content drops below about 10% of its capacity. For argon, the bottle content is directly indicated by the bottle pressure: a new bottle usually contains 2000 to 3000 psig. Argon bottles should be changed whenever the bottle pressure is found to be below about 200 psig. Ethane bottles, on the other hand, contain liquified ethane. Thus the bottle pressure is just the vapor pressure of ethane at whatever the current temperature happens to be. At 70° F this is about 544 psig. The pressure guage will not tell you how much ethane is left in the bottle until it reads zero! Instead, we measure the ethane content by observing the weight of the bottle and comparing it to the weight when the bottle was full. A standard B-size cylinder contains about 32 pounds of ethane. Thus, when the bottle weight is about 30 pounds less than its full weight, the bottle should be replaced. Recent (as of April 2003) experience indicates that full bottles weigh $165 \pm 1 lbs$.

Handling and connecting bottles of compressed gas require special knowledge. The high pressure gas stored in the cylinders (bottles) constitutes significant stored energy. Mishandling of a gas bottle can pose a lethal hazard! Refer to the JLab EH&S Manual [1] for safe handling practices. If you do not already know how to safely manipulate compressed gas hardware, have a knowledgeable person train you.

6 To by-pass the alcohol system

For the HMS:
Open valves 12 & 13, then close valves 11 & 14, in that order!
For the SOS:
Open valves 8 & 9, then close valves 7 & 10, in that order!

7 The Alcohol Bubblers

To reduce the rate of aging of the wire chambers, the operating gas contains a small quantity of alcohol vapor. The vapor is added by bubbling the argon/ethane mixture through liquid alcohol. The temperature of the alcohol controls the alcohol vapor pressure, which determines the amount of vapor added to the gas. The alcohol content also affects the electron dirft velocity in the wire chambers, so it must be held approximately constant.

7.1 To refill the alcohol bubblers:

The alcohol bubbler system features a refill system that allows filling directly from the bottle, minimizing exposure of the alcohol to air and reducing the possibility of a spill. **The reservoirs should be refilled before they become empty to maintain a head of liquid over the float valve which will prevent air from entering the system.** In the back of the gas system rack is a holder for gallon sized alcohol bottles and a cap with dip tube. Place a new bottle in the bottle holder and replace the cap with the cap with dip tube.

7.2 Step-by-Step Instructions for Refilling the SOS Alcohol Bubbler

These steps must be individually completed in the order listed!
Refer to Fig. 1.

1. *If needed, install a full bottle of alcohol in the back of the gas racks as mentioned in the preceeding paragraph.*

2. Open valves 8,9. Close valves 7,10 *to Put the SOS alcohol bubbler in BYPASS.*

3. Close valve 16 *to isolate the warm reservoir gas from the bubbler.*

4. Open valve 15 *to bleed off the warm reservoir gas pressure.*

5. *Certify that the pressure feeding valve 19 is 1 psi or less so that you do not cause the alcohol bottle to explode when you pressurize it.* Wear safety glasses!!

6. Open valve 19 *to pressurize the alcohol bottle.*

7. Open valve 21 *to flow alcohol into the warm reservoir.*

8. *When the alcohol level in the sight-glass is within 2cm of the top, stop the flow of alcohol:* Close valve 21.

9. Close valve 19.

10. Open valve 16.

11. Close valve 15.

12. Open Valves 7 and 10. Close Valves 8 and 9.

13. *Record what you did in both the gas logbook and the electronic logbook.*

7.3 Step-by-Step Instructions for Refilling the HMS Alcohol Bubbler

These steps must be individually completed in the order listed!
Refer to Fig. 1.

1. If needed, install a full bottle of alcohol in the back of the gas racks as mentioned in the preceeding paragraph.

2. *Open valves 12,13. Close valves 11,14* to Put the HMS alcohol bubbler in BYPASS.

3. *Close valve 18* to isolate the warm reservoir gas from the bubbler.

4. *Open valve 17* to bleed off the warm reservoir gas pressure.

5. *Open valve 19* to pressurize the alcohol bottle.

6. *Open valve 20* to flow alcohol into the warm reservoir.
7. When the alcohol level in the sight-glass is within 2cm of the top, stop the flow of alcohol: *Close valve 20.*
8. *Close valve 19.*
9. *Open valve 18.*
10. *Close valve 17.*
11. *Open Valves 11 and 14. Close Valves 12 and 13.*
12. Record what you did in both the gas logbook and the electronic logbook.

7.4 Alcohol Temperature Control

To keep the alcohol temperature (and thus the vapor pressure) constant, the alcohol bubblers are housed in refrigerators which are controlled by electronic temperature regulators having 1 C° sensitivity. Both controllers are located on a shelf in the left rack of the gas mixing system. Normally, the actual temperature in each refrigerator is indicated on the front panel of the controller. Both controllers should be set to maintain a temperature of 1° C.

8 Gas Filters Maintenance

There are gas filters on the argon and ethane supply lines just inside the gas shed. These filters should be replaced on a regular schedule. See Bill Vulcan for details.

9 Secure Pressure Regulators

The gas mixing system is protected from failure or mis-setting of the primary pressure regulators (the ones mounted on the manifolds on the exterior of the gas shed – near the bottles) by *hidden* regulators mounted just inside the gas shed. It is these regulators which actually set the maximum supply pressure to the mixing valves. These regulators should *never* be adjusted by other than a gas system expert! The nominal secondary pressure supplied by both the argon and ethane secure regulators is 15 psig.

10 Related *Howtos*

- MKS 647 Mass Flow Controller Howto [?]
- Flammable Gas Detector System [?]
- Gas System Interlock Panel [?]
- Base Equipment Shift Checklist Items [2]

References

[1] Jefferson lab environment, health, & safety manual. Jefferson Laboratory. `http://www.jlab.org/ehs/manual/EHSbook.html`.

[2] H. Fenker. Hall-c base equipment checklist. `http://hallcweb.jlab.org/document/howtos/HKS/base_equip_checklist/`. HKS User Howto.