The MVT Gas Mixing System for Hall B

Overview

The MVT tracking detector in Hall B uses two different gas mixtures. The first is 10% isobutane, C4H10, in argon. The second is 10% isobutane, C4H10, 10% carbon tetrafluoride, CF4, in argon. These gasses are mixed in the Hall B gas shed, bldg. 96B, and travel 300ft to Hall B in individual temperature controlled lines. The lines terminate at the MVT gas distribution panel located on the forward carriage in Hall B.

The gas mixing system performs 3 main functions;
1) Mix the gas in the correct ratio.
2) Maintain the gas delivery pressure between 12-16 psi.
3) Supply argon gas for system purge

There were several major goals of this system design in how it performs the 3 main functions.

- Prevent detector damage due to improper gas mixture.
- Minimize any required operator actions.
- Minimize human errors.
- Automate system startup and shutdown.
- Prevent any flammable gas mixture during maintenance or down times.
- Prevent HV operations with improper gas mixtures.
- Integration with EPICS and the alarm handler.
- Easy to adjust system operating parameters via a GUI.

The Gas Supply

C4H10 and CF4 gas are supplied from individual cylinders located along the outside wall of the Bldg 96B gas shed. Argon gas is supplied via the boil off from the 1500 gallon liquid argon dewar at the same location.

C4H10 has a low vapor pressure and is supplied in 116 lb liquid cylinders. Cylinder pressure follows ambient temperature necessitating the use of a heater blanket to maintain sufficient gas output pressure. A scale is used to monitor cylinder fill level.

CF4 is supplied as a liquid. A scale is used to monitor cylinder fill level.

Argon is supplied from the 1500 gallon liquid argon dewar located at the bldg. 96B gas shed.

The Gas Mixing System

The individual gas flows are metered using Mass Flow Controllers, MFCs. The MFCs are controlled by a cRio controller. The program running on the cRio controls the gas supply pressure to the MVT gas distribution system between 12-16 psi by varying the gas flow rate.

The mixed gas travels to the hall from the gas shed in temperature controlled lines to prevent the C4H10 from condensing due to low ambient temperatures. The lines enter the hall through a penetration at space frame level 3 south where the lines descend to level 1. New lines direct the gas to the MVT gas distribution system from the current termination on level 1 south space frame.

Mixing System Controls for System Operations

The MVT gas mixing system is controlled by a program running on the 96B cRio controller. The program controls the mass flow controllers. The control GUI has two main buttons, Startup and Shutdown, for the 2 modes of operation. A HV system interlock is required to prevent damage to the detector due to an incorrect gas mixture. The HV cannot be turned on until the startup process in complete.

Mixing System Startup

When the startup button is clicked, the cRio controller opens the HV interlock preventing HV operation. The startup in progress indicator on the GUI lights up, and the argon gas purge commences.

For the 10% C4H10 in argon gas mixing system, the argon purge displaces the gas currently in the system volume, including the detectors and gas lines. Argon gas flows at 650 sccm* for 4 hours. The startup program then switches to mixed gas at 650 sccm* and flushes for 2 hours. The startup program then switches to operational mode which reduces the mixed gas flow rate, switches to pressure control operation, and closes the HV interlock to permit HV operation.

For the 10% CF4 10% C4H10 in argon gas mixing system, the argon purge displaces the gas currently in the system volume, including the detectors and gas lines. Argon gas flows at 325 sccm* for 4 hours. The startup program then switches to mixed gas at 325 sccm* and flushes for 2 hours. The startup program then switches to operational mode which reduces the mixed gas flow rate, switches to pressure control operation, and closes the HV interlock to permit HV operation

Pressure Control

There are 2 independent mixing system, 10% C4H10 in Argon and 10% CF4 10% C4H10 in argon. Gas supply pressure for the MVT gas distribution must be maintained 12-16 psi. The program running on the cRio varies the mixing flow in order to maintain pressure within the required band. Normal flows for the systems are 500 sccm and 250 sccm respectively.

For the 10% C4H10 in argon supply, the mix flow rate is varied between 600 sccm and 400 sccm in order to maintain supply pressure between 12 and 16 psi. When the pressure reaches 16 psi, flow is reduced to 400 sccm. When the supply pressure reaches 12 psi, flow is increased to 600 sccm. In the case that pressure reaches 17.2 psi, the cRio controller closes the mass flow controllers to prevent any further pressure increase. When the pressure decreases to 12 psi, mixing flow restarts at 600 sccm.

For the 10% CF4 10% C4H10 in argon supply, the mix flow rate is varied between 300 sccm and 200 sccm in order to maintain supply pressure between 12 and 16 psi. When the pressure reaches 16 psi,

flow is reduced to 200 sccm. When the supply pressure reaches 12 psi, flow is increased to 300 sccm. In the case that pressure reaches 17.2 psi, the cRio controller closes the mass flow controllers to prevent any further pressure increase. When the pressure decreases to 12 psi, mixing flow restarts at 300 sccm.

The EPICS alarm handler will have alarms for out of normal system parameters. Alarms for the following; high or low pressures, high or low flow rates, improper mixing ratios, and low gas cylinder weights.

Mixing System Shut Down

When the shutdown button is clicked, the cRio controller opens the HV interlock preventing HV operation, and the argon gas purge commences. The argon purge displaces the gas currently in the system volume, including the detectors and gas lines.

For the 10% C4H10 in argon mixing system, argon gas flows at 650 sccm* for 4 hours. For the 10% CF4 10% C4H10 in argin mixing system, the argon flows at 325 sccm* for 4 hours. Then the cRio controller turns off the mass flow controllers and the shutdown complete indicator on the GUI lights up.

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. *Maximum gas flow may be reduced due to pressure control restrictions.

Integration with the Sacley PLC Controls

In order for the system to operate as described, the cRio controls and Saclay PLC controls require integration.

Conclusion

The system design incorporated the following goals into how it performs it's three main functions.

- Prevent detector damage due to improper gas mixture.
- Minimize any required operator actions.
- Minimize human errors.
- Automate system startup and shutdown.
- Prevent any flammable gas mixture during maintenance or down times.

The system hardware selection and cRio control programming permitted these goals to come to fruition.