The MVT Gas Mixing System

Introduction

The MVT gas mixing system supplies mixed gas to the micromegas detectors of CLAS12. This includes the MVT and FT.

The gas mixing system performs 3 main functions;

- 1) Mix the gas in the correct ratios
- 2) Maintain the gas delivery pressure between 12-16 psi.
- 3) Supply argon gas for system purge

There are two independent gas mixing systems in order to produce two different gas mixtures, Mix #1 is 10% C4H10 (isobutane) in argon and Mix #2 is 10% CF4 (carbon fluoride) 10% C4H10 (isobutane) in argon.

These mixtures are sent to the MVT and FT gas controls chassis in Hall B. The MVT gas chassis is supplied with both flammable mixtures. The FT chassis is supplied with a single gas mixture, 10% C4H10 in argon.

The Gas Supply

Argon is supplied from the boil off of the 1500 gallon liquid argon (LAr) dewar at the 96B gas shed. A pressure regulator is used to reduce gas to 40 psi to supply the mixing system.

Isobutane, C4H10, is a Flammable Gas with explosive limits of 1.4% to 8.3% in air. C4H10 gas has a low vapor pressure, necessitating the use of a cylinder heater blanket to maintain sufficient gas output pressure. C4H10 is supplied from an FX type gas cylinder containing 116 lbs (52.6 kg) of gas at saturation temperature and pressure. A gas cylinder heater blanket is used to maintain cylinder temperature at 89F resulting is pressure of 55 psi. Pressure is reduced to 40 psi by a pressure regulator attached to the gas cylinder. Cylinder fill levels are periodically monitored by weight using a scale.

Carbon tetrafluoride, CF4, is supplied from high pressure K size cylinders containing 65 lbs (29.5 kg) of gas at saturation temperature and pressure. Pressure is reduced to 40 psi by a pressure regulator attached to the gas cylinder. Cylinder fill levels are periodically monitored by weight using a mechanical scale.

The Mixing System

The MVT gas mixing system consists of two independent mixing systems, one for each of the gas mixtures produced.

Mix #1 - 10% C4H10 (isobutane), balance Argon

Mix #2 – 10% C4H10 (isobutane), 10% CF4 (carbon tetraflouride), balance Argon

These systems operate continuously to maintain mixed gas supply pressure in the 12-16 psi range.

MKS mass flow controllers meter the gas at the programmed ratios and flow rates. The gas pressure in the mixing buffers is monitored by the control system. The gas mixing flowrate is adjusted to maintain mixed gas supply pressure within the proper range.

MIX 1-10% C4H10 balance Argon



Mix 1 Maximum Flow Rates

Argon MFC - 2820 sccm

C4H10 MFC - 210 sccm

10% C4H10 in Argon – 2000 sccm



MIX 2 – 10%CF4 10% C4H10 balance Argon



Mix 2 Maximum Flow Rates

Argon MFC - 2820 sccm

C4H10 MFC - 210 sccm

CF4 MFC – 210 sccm

10% C4H10 10% CF4 in Argon - 2000 sccm

Pressure Control

Mixed gas pressure is controlled by varying mixing flow rates to maintain pressure within the 12-16 psi operating band. A pressure transducer monitors pressure in the volume of the mixed gas buffer tanks. When pressure falls to the low level setpoint, the mixing gas flow rates are increased to raise pressure. When pressure increases to the high level setpoint, the mixing gas flow rates are flow rates are decreased in order to reduce pressure. If the mixed gas pressure reaches the high high setpoint, the mass flow controllers shut, preventing any further increase in pressure.

System Operation

Normal operation of the gas mixing system is automatic. System operation is controlled by the software running on the cRIO. System startup and shutdown is controlled from the 96B gas shed.

A manual inert gas purge of the system must be performed at startup, shutdown, and prior to and after maintenance to prevent air mixing with the flammable gas.

System operating parameters, mixed gas pressure, flow rates, and mix ratios are monitored by EPICS. EPICS system alarms for high and low pressure, high and low flow rates, and incorrect mix ratios alert shift personnel to mixing system errors.

The gas supply for isobutane (C4H10) and carbon flouride (CF4) must be monitored periodically during operation and changed out as required. Spare cylinders of C4H10 and CF4 are kept on site due to the 4 week lead time for ordering these gasses.

Future System Upgrades

There following are system upgrades available to reduce the man hours required to operate and monitor the system;

The addition of an argon purge line at the distribution system inlet to purge the distribution system and detectors in the hall to eliminate the need to purge the mixing system in order to purge the detector volumes. This will eliminate the 2 hours required to purge the mixing system with argon and then re-purge the mixing system with mixed gas prior to operation

The addition of scales with digital readout and analog output to monitor liquid gas cylinders C4H10 and CF4.

The addition of a 2nd set of cylinders of C4H10 and CF4 to permit normal mixing system operation while replacing empty cylinders.