A Clean Gas System with Closed Loop for a Large Gaseous Detector Operating at High Rates

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The gas system of the Outer Tracker (OTR) of HERA–B produces the desired gas mixture (standard mix is $Ar/CF_4/CO_2$ 65:30:5) and circulates the counting gas through the detector at a flow rate of 22 m^3/h, i.e. 1 vol/h. It controls flows and regulates pressures in all 26 OTR half–superlayers, purifies the gas upon return from the detector, and automatically performs a quantitative analysis of main and trace (O_2, N_2, H_2O) gas components for the common input and the outputs of all half–superlayers. We report on constructing such a large system with major gas purification stations ($\approx$ 60 kg of purifying agent per station) using only non–outgassing, "clean" materials and devices, e.g. stainless steel, PEEK, baked Viton, and metal bellows pumps; the experience of running the system for over a year is also discussed. We review the extensive use of an epoxy glue as a non–outgassing sealing material in applications with up to 100 bar pressure.

Summary of Poster: The system has been supplying all OTR chambers with gas since the beginning of the HERA–B commissioning run in January 2000. Fresh gas has been continuously added at rates of 0.5 – 2%/h by the mixing station. The monthly gas consumption of CF_4 – by far the most expensive gas component at about 70 DM/kg – was about 400 kg/month. The pressure regulation of the chambers worked well keeping them at slight over-pressures of 0.3 – 0.6 mbar relative to ambient air pressure. A system of safety valves successfully prevented all chambers from becoming dangerously over-pressurized or under-pressurized while preventing air from entering the chambers during pressure alarms. For most of the run period the gas system was able to keep the variation of the main gas concentrations within the range allowed by design: (65$\pm$1)% for Argon, (30$\pm$1)% for CF_4, and (5$\pm$0.2)% for CO_2. A variation of Argon concentration by 1% corresponds to a change in gas gain of $\approx$15% under nominal operating conditions. The purification system for removal of oxygen and water was commissioned by mid-April 2000. During commissioning it was observed that the regenerable oxygen purifier absorbs not only oxygen, but also significant amounts of CO_2 and water. Appropriate CO_2 conditioning procedures after regeneration were successfully established to ensure a stable CO_2 concentration in the counting gas. Due to the water absorption by the oxygen purifier the detector was operated with very dry gas ($c(H_2O) < 20$ ppm) for most of the 2000 run even after the water purifier had been excluded from the system. One regenerated purifier could keep the oxygen content at levels below 200 ppm for about 10 days giving the gas crew considerably more than the needed minimum of 3 days to regenerate the second oxygen purifier in parallel. An operational problem was that leaks occurred repeatedly in the bellows of the metal bellows pumps that circulate the gas. The leakage is most likely due to grease, metal shavings and/or dust getting wedged in the outside of the moving bellows and finally causing a rupture; the possible influence of fluorine compounds or radicals in these ruptures is currently under study. To prevent further leaks 5 pumps were lifted up from the floor of the pump house and an air filter was installed. A leak detection system is being installed for the pumps using an oxygen meter and valve system to pinpoint any future pump leaks very quickly.