A closed-circuit gas system for an RPC-based neutron detector

D. Rossi[1], K. Boretzky[2], H. Simon[2] for the R^{3}B collaboration
[1]Institut für Kernchemie, Johannes Gutenberg-Universität, D-55128 Mainz, Germany; [2]GSI, D-64291 Darmstadt

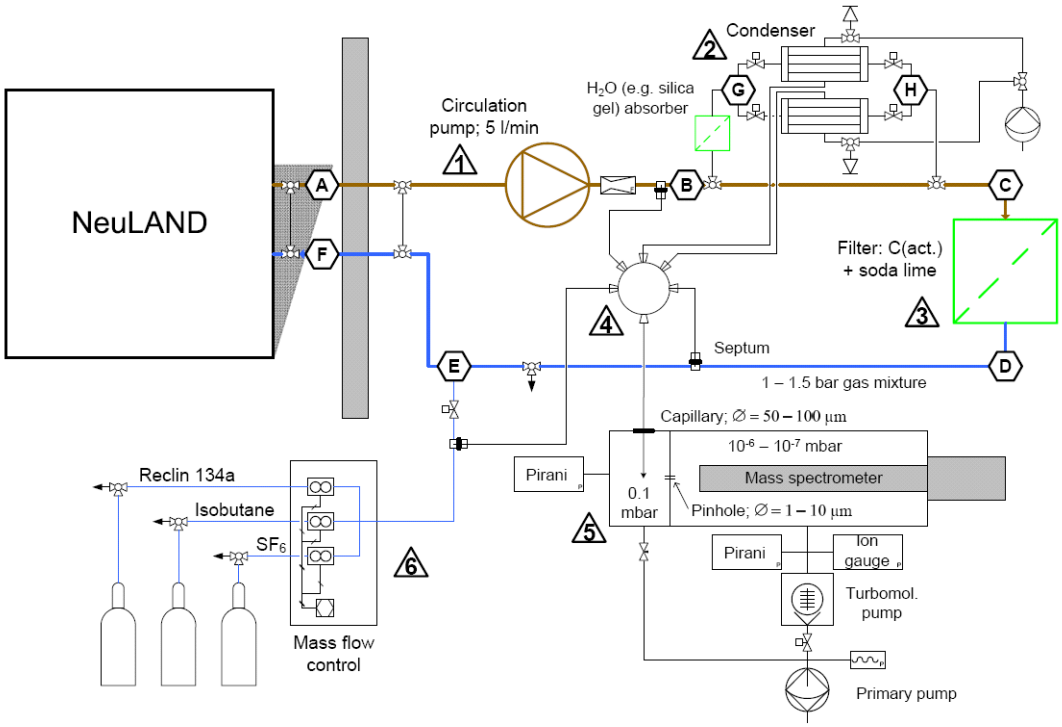

Figure 1: Proposed closed-circuit gas system for the NeuLAND neutron detector. For description, see text.

As a core component of the R^{3}B experimental setup [1] in the future FAIR facility, a new neutron detector – NeuLAND – is currently under development at GSI. It is foreseen that NeuLAND will be based on a resistive plate chamber (RPC) concept. RPCs are gas detectors running on a gas mixture of approximately 85% Reclin 134a (1,1,1,2-tetrafluoroethane), 10% SF_6 and 5% Isobutane. Reclin 134a and SF_6 are both greenhouse gases, whose emission will be subject to emerging legal constraints. Even though a detector system such as NeuLAND is a negligible emitter of such gases, a closed-circuit gas system also improves the long-term stability of the gas mixture inside the detector, and reduces the total running cost of the detector, since only a limited amount of fresh gas needs to be supplied to the system.

The proposed closed-circuit gas system, as shown in fig. 1, would be located outside the experimental area, allowing maintenance even during an ongoing experiment. It consists of a main recirculation circuit (1), a condensation and storage sub-circuit (2), an analysis system (5) and an injection sub-circuit (6). Under normal operation (path: ABCDEF), the gas flow is driven by a circulation pump through a chemical filter (3) filled with activated charcoal and soda lime, removing gas contaminants produced by the RPCs.

One of the central issues in this closed-circuit gas system is the continuous monitoring of the composition of the gas. This is achieved by using a quadrupole mass spectrometer (5) linked to a multi-port valve (4) with capillary tubes running to various locations in the gas circuit. In a scanning mode, the mass spectrometer is able to determine precisely the mixing ratio of the three working gases, as well as to detect various contaminants.

The gas pressure in the RPCs and the recirculation circuit is chosen to be slightly higher than atmospheric pressure, to avoid contamination of the detector gas with air. Due to inevitable leaks, this also means that a small amount of fresh gas must be supplied continuously through the injection branch (6), where the total flow and composition of fresh gas is adjusted to be introduced into the main circuit at point E.

To clean the gas, e.g. during filling of the detector system, the gas can be collected by condensation (in 2). Contaminated gas runs into one of the two condenser units (path: ABG), while the other unit releases the gas into the main circuit again (path: HCDEF). All three gas species used in RPCs condensate before nitrogen and oxygen do, meaning that several cleaning cycles can be used to remove all air from the detector.

With the injection branch (6) existing already, it is foreseen to build a pilot system consisting of a circulation pump and mass spectrometer, and to investigate the gas composition on-line with a working RPC.

References

[1] R^{3}B technical proposal; http://www-land.gsi.de/r3b

Acknowledgements

This work was financially supported by BMBF grant 06MZ222I.