Comparison of MKS and Honeywell Zephyr Series Mass Flow Sensors for Hall A GEM Detectors

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This note presents the mass flow measurement tests conducted to compare the performance of the Honeywell Zephyr mass flow meter (MFM) to the MKS mass flow controller (MFC).

The Detector Support Group has implemented gas control and monitoring systems [1, 2] for several, different detectors in the Physics Division. One common element of these systems is the mass flow controller (MFC), which controls and transmits the measured gas flow to the external hardware.

MKS MFCs (Fig. 1), which are the standard, offer a variety of communication methods—analog and MODBUS/TCP are the commonly implemented options, and have high accuracy.

Most detector systems have a few gas lines to be controlled and monitored, hence, are instrumented with MKS MFCs. However, Hall A's BigBite and Super BigBite spectrometers require gas monitoring of ~50 lines, which makes using MKS MFCs cost-prohibitive.

An alternate to the MKS MFC was researched and the Honeywell Zephyr MFM, Fig. 1, was found. The Honeywell Zephyr uses Microelectronic and Microelectromechanical System (MEMS) technology sensing die to provide the response to flow changes, along with an ASIC compensation providing I²C output, which makes an extremely small and cost-effective sensor. The Honeywell has smaller packaging (43x20x20 mm) than the MKS MFM (110x140x37 mm) and is about twenty times cheaper ($75 : $1500).

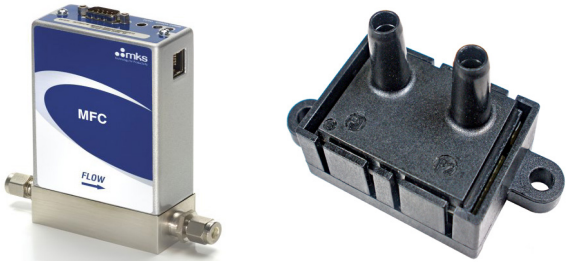

FIG. 1. MKS MFC on the left; Honeywell Zephyr on the right.

The downside of the Honeywell Zephyr MFM is that the housing is made of plastic so these MFMs cannot be used at high pressures or handle flammable gases. Due to the silicon die on the sensor, the radiation hardness of the MFMs has to be determined for use in high radiation environments.

Figure 2 shows the test setup used to compare an MKS MFC (200 sccm N2, GE50A) vs. a Honeywell Zephyr (±200 sccm). The pump was used as a flow source along with a needle valve that could be used to adjust the flow, a buffer volume smoothed the flow output from the pump, and finally the flow went through the MKS MFC, whose valve was kept open at 100%, i.e. worked in the MFM mode, which was followed by the Honeywell Zephyr MFM.

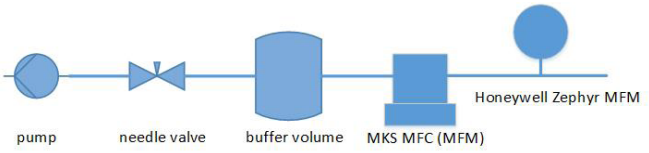

FIG. 2. Diagram of test setup.

Figure 3 shows the comparison of the flows over the full test range. The peak over 250 sccm is where the limit of the Honeywell Zephyr MFM was reached (though it is specified as ±200 sccm, the Honeywell Zephyr MFM goes up to 250 sccm), but the MKS MSM has more range available (so the peak). Also visible is the faster response to flow changes by the Honeywell sensor. Once both sensors had stabilized they read to within 1–2 sccm of each other.

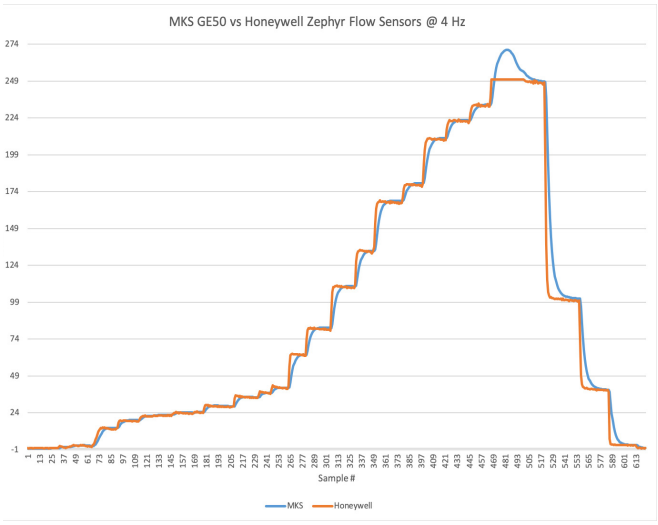

FIG. 3. MKS vs Honeywell flow comparison.

In summary, for high channel counts where accurate, cost effective sensors are needed, the Honeywell Zephyr series is a good choice, provided they work in high radiation environments, which is mandatory for Hall A instrumentation.

[1] G. Jacobs, et al. *Design of the Gas System for Hall A's Heavy Gas Cerenkov Detector*, DSG Note 2018-29, 2018.
[2] M. McMullen, et al. *Gas Controls and Monitoring for Testing the Radial Time Projection Chamber*, DSG Note 2019-23, 2019.