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The high-flow sampling technology is an effective way of measuring fugitive and vented emissions. Phase 1 of the project required a prototype of the high flow sampler to be developed by CSU. We are currently in phase 2 of the project. In phase 2, a test matrix is developed to test the functional block or subsystems of the high-flow samplers. Eight tests will be conducted to assess these functional blocks in isolation and the overall performance of the high-flow samplers. These tests are:

i. Air Flow testing
ii. Air/Gas flow testing
iii. Sensor response to methane
iv. Sensor response to Methane, Ethane, and Propane blends
v. Limit of Detection/Quantification
vi. Accuracy Over Range
vii. Gas Composition Sensitivity
viii. Performance on real-world equipment

The commercial high flow samplers available for testing for phase 2 of this project use different technologies in developing the high flow samplers. A careful review of the specifications of these high flow samplers as specified by the manufacturers is made. The test matrices are developed within and sometimes slightly beyond these specifications to verify these suggested claims. To ensure that there is a fair assessment made, all the devices are tested under similar conditions. For instance, if a particular test would take a week, all the devices would be tested within the same test point under the same conditions before the next test is conducted.

The tests are done in a laboratory setting and on the field tests. In evaluating the performance of these tests, any issue associated with the usage of the devices during calibration, or field use of any of the devices is reported. This in addition to the performance of the devices, will enable the manufacturers to fix such problems and ultimately improve user experience with the high flow sampling.[1]

Project Progress

The air flow testing, sensor response to methane, sensor response to methane, ethane, and propane blends, and accuracy over range tests have been conducted.

Air Flow Testing

Methane was used as the tracer gas for the air flow testing. The concentration and volumetric flow rate of the tracer gas were confirmed by Aerodyne QC – TLDAS and a volumetric prover respectively. Using these parameters, the bulk air volumetric air flow measurements were calculated and compared to the volumetric flow rates of each instrument.

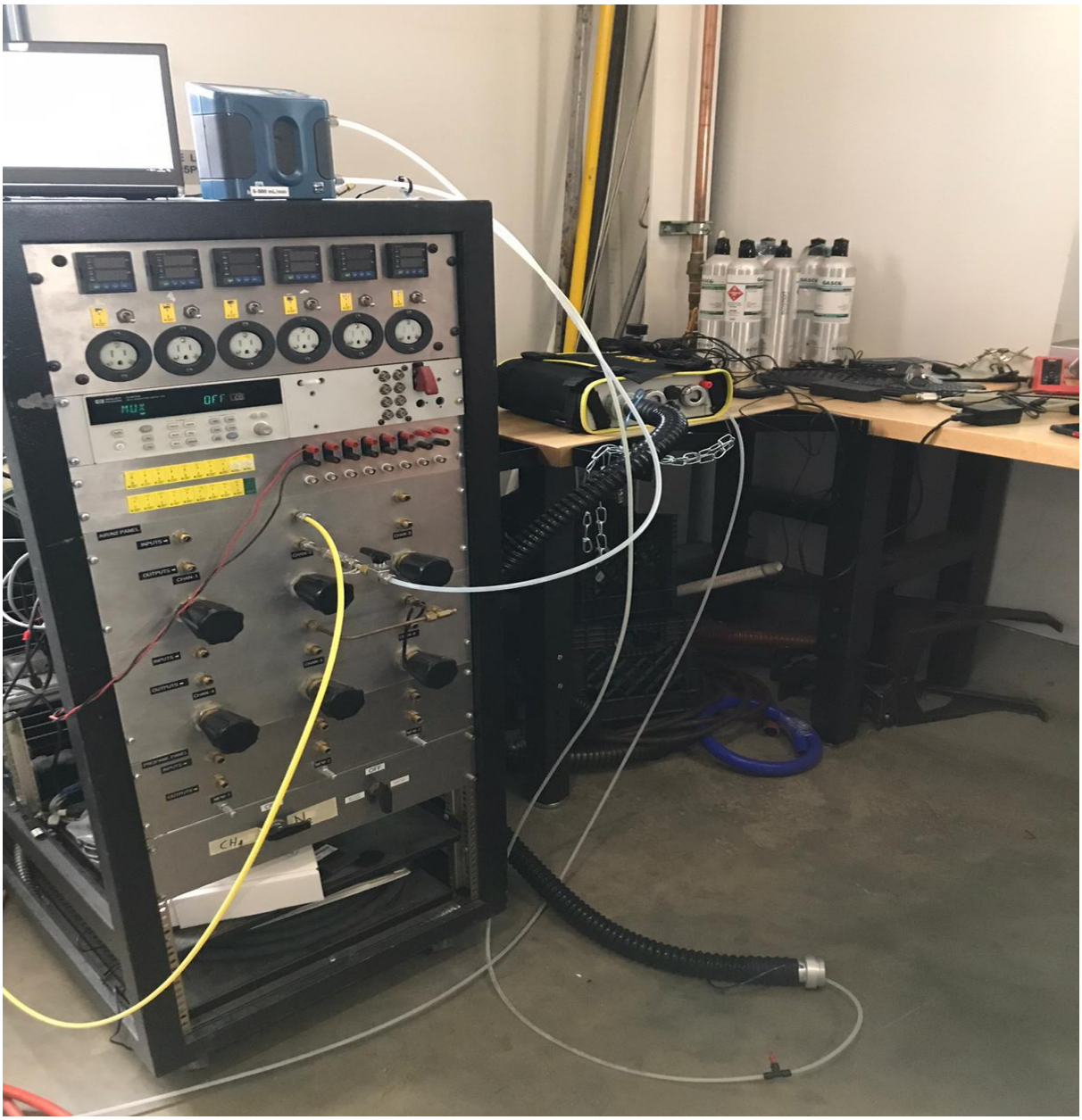

Figure 1: Air Flow testing of Gas Flow Meter 2.0 at the Powerhouse Energy Campus.

Accuracy Over Range Test

Different ranges of controlled natural gas leaks were released at METEC. The recorded leak measurements of each instrument were compared to these controlled releases.

Figure 2: Accuracy Over Range test at METEC Facility with Colorado State University Open Source High Flow Sampler

Sensor Response to Methane

Test points spanning from 6ppm to 100% methane were selected for the tests. Metered air and methane were measured with precision using volumetric provers. A uniform methane-air mixture was achieved through a static mixer. This mixture was then delivered to a manifold, the central distribution point where each instrument drew in the gas blend.

The calculated concentrations derived from the volumetric provers and the known methane concentration in the shop air serve as benchmarks for evaluating the accuracy of the concentration readings obtained from each sampler.

Figure 3: Sensor response to methane of HI-FLOW 2 Fugitive Methane Sampler, Gas Flow Meter 2.0, and Colorado State University Open Source High Flow Sampler at the Powerhouse Energy Campus

Sensor Response to Methane, Ethane, and Propane Blends

Different methane, ethane, and propane compositions representing pipeline, midstream, and upstream gas compositions were chosen for this test. A static mixer was used to ensure a uniform mixture of the gas blends before being delivered to a manifold. Each sampler drew samples from the manifold and their respective concentrations were compared to the calculated concentrations from the volumetric provers and the release rig.

Figure 4: Sensor response to methane, ethane, and propane blends of HI-FLOW 2 Fugitive Methane Sampler, Gas Flow Meter 2.0, and Colorado State University Open Source High Flow Sampler at the Powerhouse Energy Campus.

Research Plans.

i. Complete the four other tests and analyze the data from all the tests.
ii. Write a report for phase 2 of the project, which will highlight the performance of the high flow samplers and problems identified with the calibration and usage of the high flow samplers.

Literature Cited

[1] T. Vaughn, “Final Report: Evaluation of High Flow Sampler Technologies”, April 2023.