(SD2023-006) Gas delivery and purification system for continuous monitoring of atmospheric helium and other trace gases: applications to the global carbon cycle, verifying reported natural gas emissions, and predicting earthquakes

Tech ID: 33168 / UC Case 2021-Z08-1

ABSTRACT

Researchers from UC San Diego have developed an invention that allows the continuous monitoring of atmospheric He, Ne, and H2 at unprecedented precision. This enables important new applications including in the understanding of the global carbon cycle, verifying reported natural gas emissions, and predicting earthquakes.

TECHNOLOGY DESCRIPTION

The invention is a cryogenic gas purification and flow-stabilizing system that is interfaced with a mass spectrometer for the high-precision analysis of these gases. Air from a sample or a reference gas alternatingly flows at a precisely stabilized flow rate through the purification system which concentrates the species of interest in the gas stream to the mass spectrometer. To allow continuous operation, the purification system consists of two switchable cryo-traps that each can be regenerated independently by a heating cycle such that one trap is used for purification while the other is regenerating.

In contrast to previous designs, the cryogenic trap can be regenerated automatically and with two identical traps operating in parallel, continuous measurements of the gases of interest can be achieved. Previous designs used a chemical purification system that had to be manually replaced which was labor intensive and required breaking vacuum leading to substantial down time, risks of leaks and contamination.

APPLICATIONS

High-precision measurements of atmospheric helium levels in situ and in sample flasks, enabled by the cryo-enrichment method presented here, have great potential to improve our understanding of the anthropogenic carbon cycle, to which helium is intimately connected through co-emission of He and CO_2. The validation experiments and semi-continuous measurements of He/M" role="presentation"> during local pollution events at Scripps Pier shown here demonstrate that the new method further improves precision and overcomes previous ease-of-use limitations of the “getter-helium” method employed by Birner et al. (2022a, 2021), thereby paving the way for establishing He as an important part of the trace-gas toolkit in carbon cycle studies.

ADVANTAGES

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OTHER INFORMATION

KEYWORDS

cryogenic gas purification, mass spectrometer, cryo-traps, high-precision measurement, anthropogenic carbon cycle, trace-gas toolkit, carbon cycling, field-deployable, He anomalies, Helium anomaly, earthquake forecasting

CATEGORIZED AS

- **Energy**
  - Hydrocarbon
- **Environment**
  - Sensing
- **Sensors & Instrumentation**
  - Analytical
  - Environmental Sensors

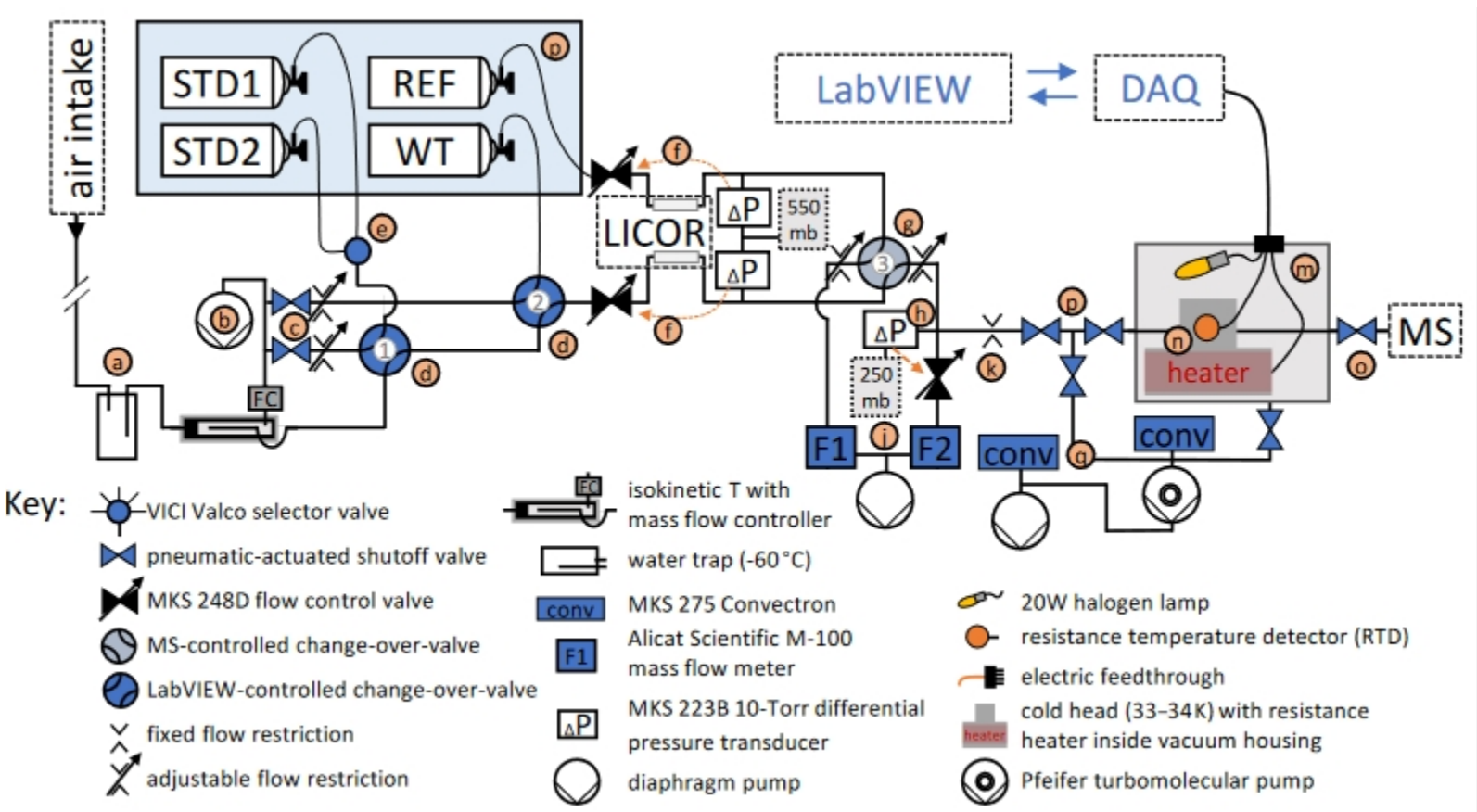
RELATED CASES

2021-Z08-1

The cryo-trap system for He, Ne, and H2 measurements potentially field-deployable. This unprecedented capability is of particular interest for the prediction of earthquakes because previous studies have demonstrated the existence of He anomalies in natural gases and ground water associated with faulting. However, so far no continuous monitoring system exists that is capable of detecting these He changes and use them as a tool to forecast earthquakes.

Another technical advantage of the cryo purification system is that removes not only N2, O2, and CO2 from the air like the chemical purification system but also argon, which allows a stronger preconcentration of the gases of interest and thus the system can achieve higher precision with smaller samples than previously possible. This enables the integration of the system into a flask measuring network which will provide previously unavailable information about spatial gradients of these gases that can be used to verify reported natural gas emissions.

STATE OF DEVELOPMENT



INTELLECTUAL PROPERTY INFO

This patent-pending technology is available for commercialization. Please contact UCSD's Office of Innovation & Commercialization for licensing terms.

RELATED MATERIALS

- Short-term variability of atmospheric helium revealed through a cryo-enrichment method B Birner, E Morgan, RF Keeling Atmospheric Measurement Techniques 16 (6), 1551-1561. - 03/24/2023

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