COMPREHENSIVE VENUS SURFACE ENVIRONMENT SIMULATION WITH THE GLENN EXTREME ENVIRONMENT RIG. J. A. Balcerski[1], S. T. Port[2], T. Kremic[2], G. W. Hunter[2], L, M. Nakley[2], K. G. Phillips[3]. [1]Ohio Aerospace Institute (jeffreybalcerski@oai.org. 22800 Cedar Point Rd, Cleveland, OH 44142), [2]NASA Glenn Research Center (Cleveland, OH 44135), [3]HX5 Sierra, LLC (Cleveland, OH 44135).

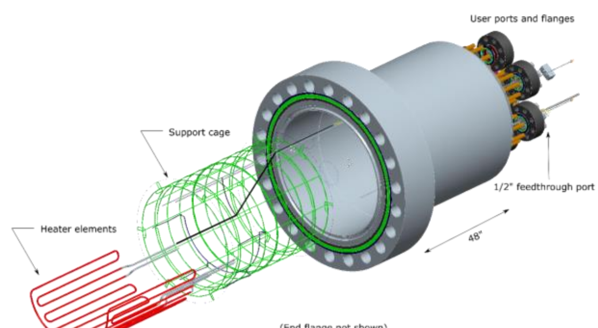
Introduction: NASA's Glenn Research Center (Cleveland, OH) maintains and operates the Glenn Extreme Environment Rig (GEER), a 800 l heated pressure vessel capable of simulating the atmospheric conditions at the surface of Venus, amongst others. GEER successfully completed its inaugural long-duration experiments in 2013, in which it demonstrated continuous thermochemical simulation of Venus' reference surface environment for more than 30 days(1). Shortly thereafter, GEER demonstrated continuous operation for 80 days at the target conditions. GEER has the ability to precisely control 8 independent minor gas streams in addition to the CO_2 carrier gas (in this case, N_2, SO_2, H_2O, CO, COS, H_2S, HCl, and HF) to the sub-ppm level, thereby simulating the chemical environment of Venus' surface atmosphere with as high fidelity as the thermal and pressure conditions. Inclusion of minor gas species has been demonstrated to be absolutely necessary for accurately reproducing geochemical interactions of Venus' atmosphere with its surface and with technology intended to operate in that environment. The combination of large volume, precision-controlled supply gas mixing, constant analytical monitoring of physical and chemical test conditions, and long-duration operation make GEER unequaled among current Venus environment test facilities. This facility is made available for use by public, private, and non-profit researchers for scientific experiments and technological advancement.

Pressure Vessel Description: GEER is a 36" interior diameter pressure vessel (Figure 1), constructed of 304 stainless steel (selected due to having a combination of corrosion resistance and strength characteristics surpassing that of either of 316 stainless or Inconel™) and is capable of operating at a maximum of 475 °C and 94 bar. Full access to the 36" diameter interior vessel (e.g., for large test articles) is provided through a 56" diameter roll-away head flange, with access also provided through multiple 3" and 4" "user ports" on both ends for smaller test articles. These ports can each support multiple ¼" ,½" , and ¾" feedthroughs, to accommodate active experiments that require power and/or data connections.

Facility Analytical Support: In addition to the nine internal thermocouples and dual pressure transducers present in the chamber, the facility-operates a mass spectrometer and a multi-column gas chromatograph that provide quantitative tracking of targeted gas species during operation, via a combination of manual and automated sampling. True in-situ analytic capabilities, to allow for zero-loss, continuous monitoring of gas concentrations, are currently being added and expected to be operational by early 2022. Results from these analytic instruments are compared to upstream, high-precision gas flow meters to verify the composition and monitor changes over time.

Collaborative Research and Development:

The GEER facility is available for researchers proposing to a variety of opportunities including NASA ROSES solicitations. GRC is able to provide test condition data (including temperature and pressure tracking and selected gas quantities), sample preparation and handling, custom support and interface hardware, electrical feedthroughs, and custom temperature, pressure, and composition profiles, as well as expertise to help plan and conduct desired experiments or tests. To date, GEER has been utilized for several competitively awarded science research efforts, including experiments on surface-atmosphere interaction, rock weathering, and atmospheric dynamics (1–4). The facility has also been successfully used for testing suitability of a wide range of engineering materials for use at Venus' surface and for maturing exploration instruments and technology(5–8).



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