SIMULATING VENUS WITH AVEC: THE APL VENUS ENVIRONMENT CHAMBER. M. Lessis[1,2], N. R. Izenberg[1], R. Osiander[1], [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD (noam.izenberg@jhuapl.edu), [2]Notre Dame Preparatory School, Towson, MD.

Introduction: The APL Venus Environment Chamber (AVEC) is a reactor vessel designed to simulate surface temperature, pressure, and atmospheric composition conditions of the surface of Venus, and potentially other planets, in the laboratory.

AVEC is part of the Instrument, Concept, Evaluation Laboratory (ICElab) at the Applied Physics Laboratory. It is designed to create a small volume of analog atmosphere at Venus surface temperature (450 °C) and atmospheric pressure (92-95 bar) to enable testing of materials and simple sensors at ambient Venus surface conditions. Tolerances of the chamber are designed to be ample (4000+ PSI and 500+°C). Temperature is monitored by a thermocouple located in a thermowell, and pressure by an integrated transducer. The AVEC body (Figs 1, 2) is composed of Inconel with internal diameter of 2.5" and depth of 9" (thermowell depth of 6"). The chamber has an port for a feed-through for two wires to enable external monitoring of simple devices or prototype sensors inside the chamber.

AVEC can be filled with custom gases to mimic the atmosphere of Venus at different altitudes, and temperature and pressure can be adjusted accordingly. The set temperature and pressure can be maintained for prolonged times (weeks to months). Samples for reaction experiments, and prototype simple instruments can be held in the chamber in a variety of appropriate holders (*e.g.*, ceramic), and instruments may be monitored in real time. AVEC is controlled by the Parker Autoclave "Universal Reactor Controller" (URC-II). The controller allows the user to adjust the temperature and pressure within the vessel tolerances.

Pilot Tests:

Basic function and a "warm" test of AVEC (Fig. 3) in ambient atmosphere is complete. In this first test, chamber wall temperature reached 86°C bringing well temperature was steadily rising, reaching 38°C over tens of minutes before it was powered off. The rate of temperature change is a controllabler parameter, and will be relatively slow in early tests.

Progressive pilot tests will follow initial connection and functionality tests.

1) Venus Temperature test: Seal and heat 450°C beginning with 1 bar nitrogen purge.
2) Venus P/T test, inert CO_2 atmosphere. Fill with about 38 bar of lab grade CO_2 and bring to 450°C, monitoring pressure. Pressure at target temperature should be about 92 bar.
3) Custom Venus Atmosphere test with trace gases (no sulfur)
4) Custom Venus Atmosphere test with trace gases including SO_2.

Planned tests will include witness chips of mineralogically and compositionally charcterized materials, observed in SEM before and after tests for change, and comparison to control chips not subjected to the tests.

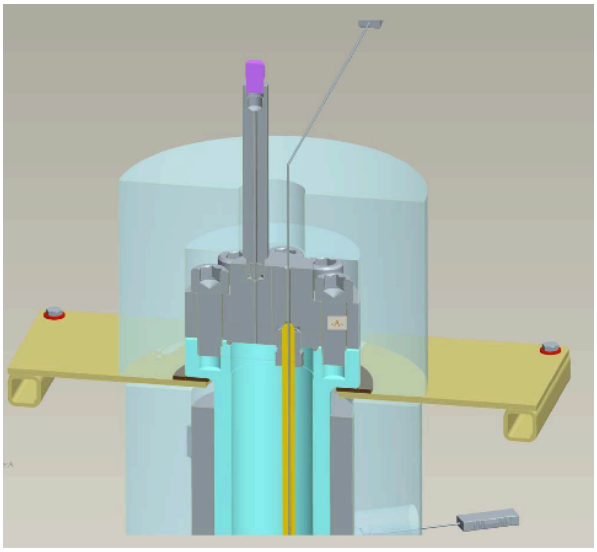

Fig 1. AVEC body (grey) and well (blue) cross-section diagram with insulating cover (translucent blue).

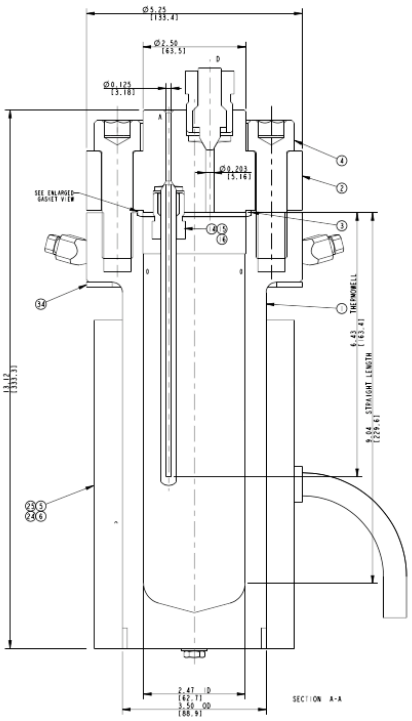

Fig 2. Engineering drawing of the AVEC reactor, with an extended F250C adapter. A 1/4" NPT on top will fit with a 3/32" drill through.

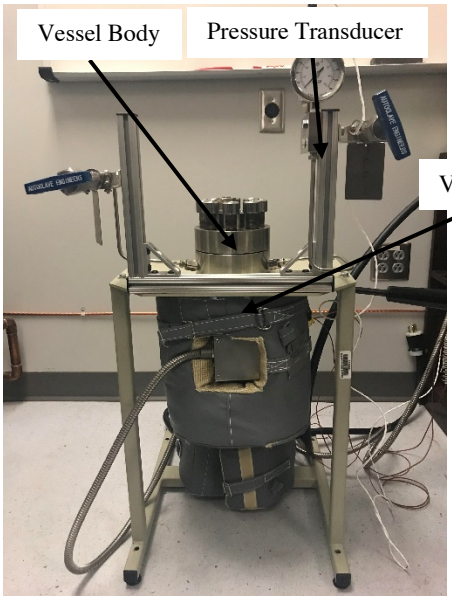

Fig. 3 AVEC in the Lab with the top insulation cover removed .

Future Plans:

AVEC will be utilized as a device for experimentally further expanding the knowledge of Venus. Simulting the Venusian environmental conditions and experimenting with materials will lead to new or aid in current scientific research regarding the planet.

Experimenting with various minerals in AVEC, after thouroghly analyzing their composition and properties, will help improve understanding of geochemical, compositional, and physical changes of rock-forming minerals on the surface of Venus. AVEC is a smaller, less capable, but easier and quicker to run experimental venue than the NASA Glenn Extreme Environment Rig (GEER) [1], which has been used for similar experiments. Different custom gas mixtures can be created or purchased to enable a variety of gas-solid reaction and rate experiments [2].

Conducting simple, high temperature sensor tests for observations and measurements of partial pressures of oxygen will be helpful for further research into the atmosphere composition. By placing oxygen fugacity sensors like FirefOx in the vessel, new information can be discovered regarding the planet's geochemistry [3].

The ultimate goal for AVEC is to be open to the community for scientists interested in experimenting and using it as an experimental tool for experimental planetary research.

References:

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[3] N. Izenberg et al., (2015) *EPSC2015-130. Vol. 10.*