Extravehicular Activity Technology Development – Oxygen Subsystem

Colin Campbell, *Johnson Space Center*
Grant Bue, *Johnson Space Center*

The extravehicular activity (EVA) technology development team is devising critical oxygen (O_2) subsystem components to support the development of the Constellation Program (CxP) lunar spacesuit. The O_2 subsystem of a spacesuit Portable Life Support System provides the crew member with gaseous oxygen for metabolic consumption, a pressurized environment, and the ability to supply open-loop purge flows for carbon dioxide washout or supplemental cooling. The primary components of the O_2 subsystem are tanks and regulators. Additional components include quick disconnects, purge valves, and relief valves.

Primary variable regulator

The shuttle and International Space Station environmental mobility units have O_2 regulators with only two mechanically fixed set points. In contrast, the CxP requires a variable-pressure regulator. This regulator must perform the function of decreasing the pressure from 3,000 psia in the O_2 tank to a nominal suit pressure of approximately 4.8 psia (figure 1). Making the regulator capable of varying the pressure setting provides added functionality because it can be used to regulate the suit pressure to (1) match different vehicle pressures, (2) perform procedures to prevent or treat decompression sickness, or (3) minimize pre-breathe durations prior to going EVA. This project will develop an electronically driven regulator with a minimum of five set points and a goal of making the regulator continuously variable. Currently, this regulator (built by Carleton Technologies Inc., Orchard Park, N.Y.) has a stepper motor to adjust the compression of a spring that then mechanically sets the regulator. The current development not only includes the mechanical operations of the regulator, but also the electronics that drive the regulator and the control logic. The Johnson Space Center designed and built a test stand to evaluate candidate regulators for future spacesuit development (figure 2).

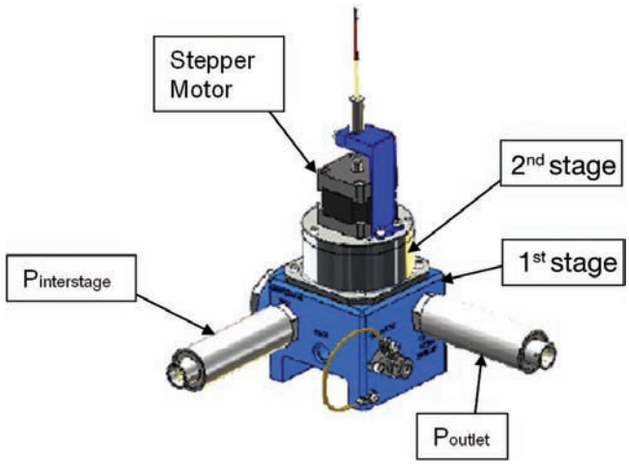

Fig. 1. *Primary variable regulator.*

Fig. 2. *Regulator test stand.*

Variable electronic regulator

The variable electronic regulator (VER) (figure 3) is an alternative to a variable pressure regulator. Instead of using a stepper motor and a spring to mechanically set the pressure of the regulator, the VER uses a variable orifice control valve and a feedback control scheme to actuate the valve. A pressure transducer within the VER measures the pressure and changes the valve position to control to the desired set point.

Oxygen subsystem component performance in dusty or dirty environments

Components such as quick disconnects, relief valves, and purge valves are all key components of the O_2 system. These precision fluid systems components are expected to be very sensitive to contamination by lunar regolith. A dust box, the lunar regolith environment simulator (LRES) (figure 4), tests these components. The LRES can deposit regolith and dust onto O_2 system components through direct spray, indirect spray, electrostatic deposition, and immersion, and by simply pouring the regolith on the components. Oxygen system components are exposed to contaminants in this facility, and their performance is then evaluated to quantitatively determine whether any degradation has occurred. The typical performance degradation for these types of components is an increased leakage rate.

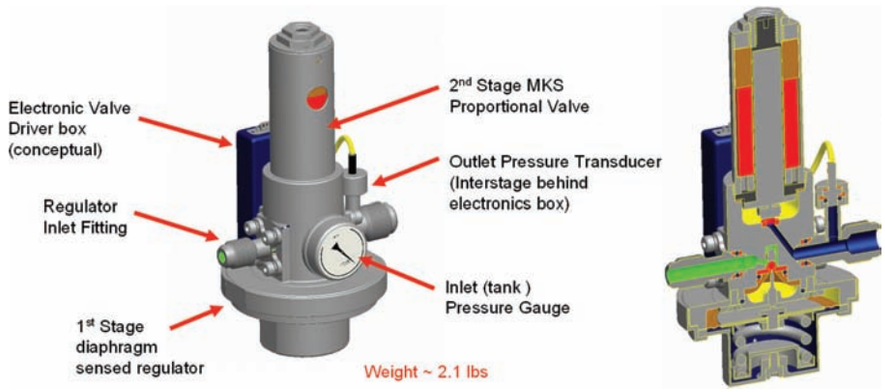

Fig. 3. *Variable electronic regulator.*

Fig. 4. *Lunar regolith environment simulator.*

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