Extravehicular Activity Technology Development – Ventilation Subsystem

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The ventilation subsystem performs the functions of providing oxygen circulation, carbon dioxide (CO_2) removal, trace contaminant removal, and humidity control. The extravehicular activity (EVA) technology development team is devising critical ventilation subsystem components to support the development of the Constellation Program (CxP) lunar spacesuit.

Rapid cycle amine swing-bed

A rapid cycle amine swing-bed is the CxP baseline for spacesuit CO_2 and humidity control. This swing-bed operates by flowing gas in the ventilation loop through beds of aluminum foam packed with small polymer beads. The beads are coated with an amine that adsorbs both CO_2 and water vapor. Once the beds are saturated, a valve is actuated to expose the bed to the vacuum of space and desorb the CO_2 and water vapor. The swing-bed contains two sets of beds, one set of which is always adsorbing while the other set is always desorbing, thus allowing continuous regeneration during EVA (figure 1). The beds are thermally coupled so that a minimal net thermal load exists on the ventilation subsystem heat exchangers. Recent technology development efforts focused on packaging this swing-bed into a low-mass, cylindrical housing that rotates back and forth against a faceplate to cycle the beds. We built and tested several subscale test articles, including a flow visualization test article (figure 2), a test article to evaluate the rotating seal on the faceplate (figure 3), and a four-bed unit. A full-sized, 10-bed unit was designed.

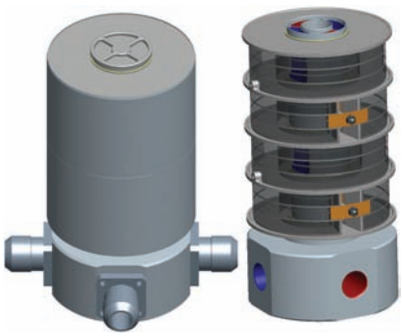

Fig. 1. *Rapid cycle engine conceptual design.*

Fig. 2. *Flow visualization testing.*

Fig. 3. *Face seal test article.*

Ventilation fan

Fan development for the ventilation subsystem focused on minimizing mass and power while providing adequate flow over a wider range of flow rates and pressure drops. After comparing numerous commercial fans, compressors, and blowers, we tested several units to generate reasonable power and determine whether the fans met mass and performance requirements. Hamilton Sundstrand (Hartford, Conn.) is designing and fabricating a fan for these tests (figure 4).

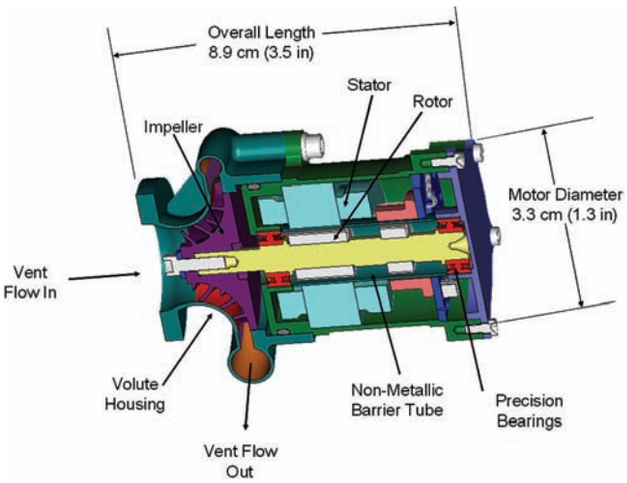

Fig. 4. *Fan cross section.*

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Humidifier

The humidifier in the ventilation loop needs to control the humidity level to within an acceptable range. We tested two commercial off-the-shelf (COTS) humidifiers units (figure 5) that operate by evaporating water across a membrane into the ventilation loop. We also tested a custom unit. Additional development efforts will optimize the size of the unit and develop a control scheme.

Fig. 5. *COTS humidifiers.*

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