Marshall Problem/Project Statement - Senior Design Topic

Problem/Project Title: Planetary Water Recovery System

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Indicate which discipline(s) is/are most appropriate to work on this problem (e.g., aerospace, mechanical, electrical, chemical, industrial, civil, computer, physics, materials, test, nuclear, earth science, other)

Chemical, Environmental

Marshall Problem Statement

Background: The big picture with references to previous work (Why would a senior design student be excited about this work?)

NASA will be embarking on missions beyond ISS in the next decade, including planned missions to the lunar surface in preparation for a mission to Mars. For long-term missions (beyond approximately 60 days), water recycling is required. NASA is currently evaluating various architectures for a planetary water treatment system.

Recent/on-going research on the problem (What resources, if any, are available to the senior design team, such as equipment, software, facility utilization)

NASA is currently developing planetary water recovery and treatment architectures.

Waste streams required for evaluating a water treatment systems can be generated at any academic institution. Any hardware required for a test program would be specific to the concept developed by the institution.

Details of the problem; design constraints, requirements (if any), outcome expected. One semester Senior Design course lasts 15 weeks; two semester course lasts 30 weeks. (What do you expect the senior design team to accomplish?)

Requirements:
The system shall be compatible with standard launch loads from earth, and landing loads on Mars.
The system shall be functional after a nine month mission, including exposure to space radiation
The system shall be capable of establishing functionality within 48 hours of crew arrival
The system shall be compatible with an operational duration of 1 year on the surface followed by up to two years of dormancy before the next operational cycle, with this cycle repeating for up to 15 years.
The system shall process waste water for 6 crew, including a daily rate of 0 to 11.7 L of condensate, 0 to 12 L of urine + flush water, 0 to 40 L of hygiene waste (including shower, handwash, and wet shave), 0 to 16 L of laundry waste (2 day cycle), and 0 to 0.6 L of oral hygiene waste.
The ISS treatment process implements an agrees urine pretreatment to prevent microbial growth in crew urine, including residual urine (~100 ml) maintained in the urine separator required for microgravity. For this design project, the system architecture must also address microbial control of the urine in a partial gravity application.

This project should assume urine collection separate from fecal collection, but the project should provide a conceptual design for the urinal that defines how the urinal will address microbial control to ensure hardware functionality throughout the system operation. In addition, the system shall accommodate urine storage for up to one week in response to system maintenance.
The system shall produce potable water with a Total Organic Carbon concentration less than 3 mg/L and a conductivity less than 1 μS prior to addition of a biocide.
Optimum system architectures must minimize launch mass (including mass for spare parts and consumables) while maximizing system reliability.

Outcome Expected:

Students shall provide final report defining an architecture and how each requirement is met. The estimated system mass (including consumables) should be defined, as well as technical risks associated with their concept.

Senior Design Project Rules:

1. Weekly telecons will be scheduled to maintain proper progress and prevent dead-end ventures.

2. Deliverable(s) required (e.g., one semester course – a written final report; two semester course – written final report and a prototype/model (if practical))

Deliverables expected:

1. For a one semester course – a written final report and presentation that must include an introduction, methods, results, discussion, conclusions, and raw data appendix.

2. For a two semester course – a written final report and presentation that must include an introduction, methods, results, discussion, conclusions, raw data appendix, and physical prototype delivered.