Books & Reports

Development of Vapor-Phase Catalytic Ammonia Removal System

A report describes recent accomplishments of a continuing effort to develop the vapor-phase catalytic ammonia removal (VPCAR) process for recycling wastewater for consumption by humans aboard a spacecraft in transit to Mars. The VPCAR process is implemented by a system of highly integrated design in which some power consumption is accepted as a cost of minimizing the volume and mass of a wastewater-processing system and eliminating the need to resupply water. The core of the system is a wiped-film rotating-disk (WFRD) evaporator, which removes inorganic salts and nonvolatile organic compounds from the wastewater stream and concentrates these contaminants into a recycle-and-bleed stream. The WFRD evaporator is also part of a subsystem that distills water from the wastewater stream. This subsystem operates in a vacuum-vapor/compression distillation configuration in the temperature range from 20 to 65 °C. Volatile organic compounds and ammonia, distilled along with water, are oxidized to CO_2, H_2O, and N_2O in a packed-bed, high-temperature catalytic reactor placed at the outlet of the vapor-phase compressor of the distillation subsystem. A VPCAR engineering demonstration unit is expected to be included in a human-rated simulation of a mission to Mars.

This work was done by Michael Flynn, John Fisher, and Mark Kliss of Ames Research Center; Bruce Borchers of Orbital Sciences Corp.; Badawi Tleimat and Maher Tleimat of Water Reuse Technology Inc.; and Gregory Quinn, James Fort, Tim Nalette, Gale Baker, and Joseph Genovese of Hamilton Sundstrand Space Systems International, Inc. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-2954. Refer to ARC-14607-1.

Several Developments in Space Tethers

Five reports address different aspects of development of tethers to be deployed from spacecraft in orbit around the Earth. The first report discusses proposed optoelectronic tracking of retroreflective objects located at intervals or of retroreflective coats along the entire length of a tether to measure lateral motions. The second report describes digitally controlled spooling machinery that retracts or extends a tape tether at controlled speed and tension in the spool isolated from uncontrolled tension on the outside. The third report discusses part of this machinery that pivots to accommodate misalignments between the deployed and spooled portions of the tether and contains rollers used to exert tension and speed control. The fourth report discusses aspects of designs of proposed electrodynamic tethers, which would be electrically conductive and would interact with the magnetic field of the Earth to exert forces to modify orbits of deploying spacecraft. The fifth report discusses electrical aspects of designs of electrodynamic tape tethers, including the use of solar cells or motional electromagnetic force to generate currents in tethers and the use of electron emitters and electron and ion collectors at opposite ends of tethers to make electrical contact with the thin plasma in surrounding space.

This work was done by Andrew Santangelo and Rich Sturmfels of The Michigan Technic Corp. and Neal Rothwell of Double R Controls for Marshall Space Flight Center. Further information is contained in a TSP (see page 1).
MFS-31822/4/6/7/30

Design Concept for a Nuclear Reactor-Powered Mars Rover

A report presents a design concept for an instrumented robotic vehicle (rover) to be used on a future mission of exploration of the planet Mars. The design incorporates a nuclear fission power system to provide long range, long life, and high power capabilities unachievable through the use of alternative solar or radioisotope power systems. The concept described in the report draws on previous rover designs developed for the 2009 Mars Science laboratory (MSL) mission to minimize the need for new technology developments.

The surface fission power system that would be used consists of a 15 kW (thermal) heat-pipe-cooled reactor coupled with a Stirling generator to provide 3 kW of electrical power. This power system would be compact enough to fit readily into prior rover chassis concepts, allowing further adaptation of previously designed MSL elements, including the aeroshell and pallet lander system, with modifications to support the significant mass added by the nuclear reactor and its associated shielding. The estimated mass of the fission power system, including its mission-specific shielding, is 1,169 kg.

This work was done by John Elliott of Caltech, Dave Poston of Los Alamos National Laboratory, and Ron Lipinski of Sandia National Laboratory for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-30865

Formation-Initialization Algorithm for *N* Spacecraft

A paper presents an algorithm to initialize a formation of *N* distributed spacecraft in deep space. Such formations will enable variable-baseline interferometers in future NASA missions designed to study the structure and origin of the universe. The algorithm described in the paper reflects some basic assumptions:

1. Each spacecraft is capable of omnidirectional radio communication with any other spacecraft,
2. Each spacecraft is equipped with a limited field-of-view sensor relative position sensor (RPS) to measure the relative positions and velocities of other formation members, and
3. Spacecraft maneuvers must satisfy Sun-angle pointing constraints to shield sensitive optical equipment from direct sunlight.

The formation initialization algorithm proceeds by first dividing the spacecraft into two groups with anti-parallel RPS sensor boresights. Next, the spacecraft perform a three-phase (in-plane, out-of-plane, and near-field) sky search involving synchronized maneuvers to ensure full sky coverage while maintaining front-to-front, simultaneous RPS sensor lock. During the sky search, the spacecraft are grouped into two classes of sub-formations. The initialization problem is then reduced to the simpler problem of joining the sub-formations. The paper includes an analytical