

“Development of a Multi-Cascade Refrigeration Electronics Thermal Control System for Application to Venus Lander Payload Missions”

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UC, Irvine Mechanical Engineering Seminar

The surface of Venus has been explored by previous missions. Russia's Venera 13 lander is reported as the longest lived mission lasting 127 minutes. Short-lived mission durations are due to extreme Venus surface environments, where the temperature is 740K (467 °C, 872 °F) with a pressure of 9.3 MPa. This presentation discusses a cascaded hybrid refrigeration system, which is being proposed so that future science instruments may survive this harsh environment for durations spanning several weeks, and perhaps months. The cascaded refrigeration cycle is composed of four stages, with the working fluids i) NH₃, ii) Transcritical CO₂, iii) Supercritical CO₂, and iv) Methyl Linoleate (MLL) Fatty Acid Methyl Ester (FAME). The MLL-FAME working fluid is a biofuel usually obtained from vegetable oils by transesterification. It will be used in the topping cycle and will experience the highest temperature at 773 K (500°C, 932°F). The system is design to lift 100W of thermal energy while maintaining a payload environmental temperature of 100°C. The presentation will focus on the following challenging engineering aspects of the project: Optimization of the cycle for input power and heat lift. Thermodynamic characterization of the MLL-FAME working fluid. Development of a high temperature compressor. Key to the above cascaded thermal control system's ability to function is the compressor. The compressor serves to increase the working fluid's pressure allowing it to reject heat to the environment. The presentation will outline the development of a reciprocating compressor unit, including an appropriate seals and lubrication system that will be able to handle working fluids in excess of 500°C while maintaining operational longevity and reliability.

SPEAKER BIO:



Dr. Kevin Anderson is a Professor of Mechanical Engineering and Director of the Solar Thermal Alternative Renewable Energy Laboratory at California State Polytechnic University. Dr. Anderson received his BSME, Cal Poly Pomona, 1991, MSME CU Boulder, 1994, and Ph.D. in Mechanical Engineering, CU Boulder, 1998. Dr. Anderson holds over 25 years of private industry and consulting experience, and has published over 30 peer reviewed journal articles, and over 50 conference proceedings. Dr. Anderson is currently a Faculty Part Time Senior Thermal Engineer at NASA Jet Propulsion Lab (JPL) Dr. Anderson's research lies in the areas of spacecraft thermal control, SCO₂ power systems, solar powered desalination, solar powered aquaponics and solar thermal research. A self-titled modern day renaissance man, Dr. Anderson continues to teach a wide variety of courses and laboratories including Machine Design, Control Systems, System Dynamics, Thermal Systems Design, Heat Transfer, Solar Thermal Engineering, Renewable Energy, Engineering Measurements, Mechanical Vibrations, Fluid Mechanics, Computer Programming and Engineering Mathematical Analysis. Dr. Anderson also holds an active Mechanical Engineering P.E. license.