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UTSI receives $175K contract to study rocket motor design

The University of Tennessee Space Institute has been awarded a $175,000 contract to provide an intensive analysis of an innovative rocket engine design that promises high performance, longevity and low cost.

The contract was awarded by ORBITEC, an aerospace research and product development company headquartered in Madison, Wisc.

ORBITEC is working on a liquid-fueled rocket motor design in which the fuel forms an outer cooling layer while the engine burns, thereby preventing extreme heat from reaching and damaging the combustion chamber walls.

"While the chamber walls are subject to the radiant heat transfer, one of the propellants provides effective wall cooling to prevent heat from damaging the chamber," Dr. Joe Majdalani, UTSI professor and principal investigator for the contract with the Wisconsin firm, said.

"This extends the lifetime of the chamber and allows for simple, lightweight, low-cost engine designs."

Further expected benefits include simplifying the manufacture of the engine and lowering operational costs.

"Second and third generation launch vehicles will benefit from an available computational model during their developmental stages," Majdalani said. "Computational fluid dynamics provide a feasible method for simulating combined-cycle engines, liquid propellant rocket motors, and air-breathing engines such as ramjets and scramjets."

The concept can also improve performance from commercial and military perspectives, the professor noted.

Aside from the propulsive applications, he said understanding the vortex combustion field, with minor changes, may have "significant benefits" in the energy sector.

"For example," Majdalani continued, "it could be applied to swirl burners and furnaces that employ vortex technology. It can also be applied to model gas and hydrocyclone separators and de-dusters. Potential

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results include improved combustion efficiency, extended lifetime, and potentially reduced emissions."

The ultimate goal of the UTSI project is to improve ORBITEC's computer-based computational and theoretical capabilities in modeling heat transfer, lifetime, reusability, and thrust-to-weight ratio for a liquid propelled rocket engine, according to Majdalani.

"Our theoretical study aims at better understanding the fundamental behavior of cyclones and their inner workings," Majdalani added. "We also hope to better understand and quantify the wall-cooling characteristics attributed to cyclonic combustion."

Since 1996, Majdalani has been engaged in a partnership with ORBITEC. The first NASA Phase II project was on the Vortex Injection Hybrid Rocket Engine. Since that time, the professor and his students have developed analytical solutions that "capture the essence of the gaseous motion inside the vortex-driven hybrid rockets."

They have provided both theoretical solutions and numerically simulated assessments to the first NASA/ORBITEC vortex-driven liquid rocket engine.

"Now, our focus is switching to modeling an improved version of the ORBITEC engines," said Majdalani, "including lab scale, full scale, and workhorse engines sanctioned by the U.S. Air Force."

Majdalani said his lengthy collaboration with Dr. Martin J. Chiaverini, principal propulsion engineer at ORBITEC, "has enabled us to solve several problems of key importance — specifically those pertaining to the vortex engine development — to ORBITEC, NASA, the U.S. Air Force and Army. We are extremely grateful for Marty's efforts to support UTSI and for his contributions in promoting vortex engine technology."

Chiaverini chairs the Wisconsin Section of the American Institute of Aeronautics and Astronautics and the AIAA Hybrid Rocket Technical Committee.