Distinguished Lecture Series

Inaugural Lecture
"Fueling the Future of Aerospace"
by
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Wright-Patterson Air Force Base, OH

Kettering Engineering Building KL-221
Tuesday, 20 January 2004 3.00 PM

Aerospace (Jet) Fuels

William (Bill) Harrison, III of Air Force Research Laboratory gave an exciting and thought-provoking presentation entitled, "Fueling the Future of Aerospace," at the University of Dayton's von Ohain Fuels and Combustion Center (VOFCC). This lecture marked the opening of the VOFCC Distinguished Lecture Series that will offer scholarly presentations in fuels, combustion, and related areas from distinguished individuals. This inaugural event was co-sponsored by the University of Dayton Chapter of Sigma Xi. Approximately 70 students, faculty, and professionals attended this lecture. The audience included researchers from the Air Force Research Laboratory, UD faculty, and numerous graduate and undergraduate students.

Dilip Ballal, VOFCC director introduced the speaker. **Bill Harrison** is a distinguished individual with many years of experience in fuel science and technology. He is the Chief of Fuels Branch and also Director of National Aerospace Fuels Research Complex of the Turbine Engine Division, Propulsion Directorate, Air Force Research Laboratory, WPAFB, OH. He has also served as the Acting Deputy Commander of the Air Force Petroleum Office. Bill Harrison's Fuels Branch has an AFOSR Star Team Status and provides technical and administrative leadership in the fuels area for the DoD/DoE/NASA/Industry VAATE program, hypersonics and low cost access to space as part of National Aerospace Initiative, and solves warfighter field problems.

Harrison pointed out that the development of advanced aircraft has hinged on the development of fuels that enable improved propulsion system performance. From the development of Grade X fuel for the Wright Flyer through the development of tetra ethyl lead for high octane gasoline's for the high performance piston engines of World War II, aviation gasoline's were key to air superiority. In the Jet age, fuel again became a key factor in the performance of jet aircraft. As we move to the future, the need for fuels that provide high heat sink, operate without freezing at high altitudes and fuels that produce less pollutant emissions will be needed.

Fuel is an important part of weapon system design. Fuel is approximately 50% of an aircraft take-off gross weight (TOGW) and is a $4 Billion per year expense for the Department of Defense. Advanced hydrocarbon based fuels are important to advanced rocket launches and low cost access to space. Fuel provides cooling for aircraft and engine subsystems as well as provides the propulsive energy for flight. Integrated aircraft thermal management using fuel as the primary heat sink is a key part of advanced aircraft design.

Harrison stated that the challenge to fuels research is real fuels are complex and produced to a specification that allows for the use of many different crude oil sources and many refining techniques. Fuel degrades at high temperature via reactions with dissolved oxygen in the fuel to

form gums, varnishes and coke. Coking can plug fuel nozzles and distort the spray pattern of fuel in the combustor. Fouling can lead to engine damage such as the cracks in this turbine blade. High heat sink fuels are being developed by the Air Force for use in advanced engines. These engines will use fuel cooling of cooling air and operate at very high temperatures improving thrust to weight and fuel efficiency.

Advanced engines enable higher altitude flight and aircraft that can stay at altitude for long periods of time. Unmanned air vehicles are becoming a key asset in our arsenal. Fuels exposed to low temperatures can form wax crystal and at very low temperatures gel and stop flow. Research is being conducted to study the low temperature behavior of fuels and to develop advanced fuel additives to allow fuel flowability at very low temperatures.

Pollutant emissions are a concern to aviation. Advanced fuel additives and fuel formulations are being developed to reduce soot. Fuel additives designed to reduce fouling and coking such as the JP-8+100 additive have been shown to reduce smoke/soot emissions.

Harrison summarized by pointing out that advanced fuel technologies are key to the future of aerospace; the approach must be flexible enough to meet the expeditionary nature of today's Air Force and enable the migration to space in the future.

William E. Harrison, III

Harrison receiving the VOFCC Plaque from Ballal