University of Dayton Research Institute

CAPABILITIES

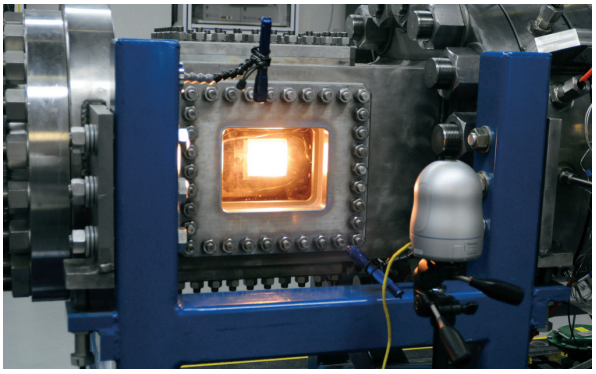
FUELS & COMBUSTION

Research and Testing

EFFORTS IN THE AREA OF ADVANCED FUELS AND COMBUSTION INCLUDE:

- Development and evaluation of alternative fuels and fuel technologies
- Improved high temperature thermal stability fuels and additives
- Improved low temperature flowable fuels and additives
- Development and testing of fuels and additives for reduced combustion particulate and gaseous emissions
- Advanced chemical analyses of fuels and additives
- Chemical kinetics and fluid dynamics modeling of fuels and combustion
- Development and testing of advanced combustion concepts
- Detection, identification, and mitigation of fuel biocontamination

UDRI is a pioneer in **testing and evaluation of alternative jet fuels**. Our researchers conducted many of the detailed laboratory evaluations and supported field trials of Fischer-Tropsch, HEFA, and ATJ fuels and fuel blends which resulted in ASTM and military certification. We also coordinate the FAA D4054 Clearinghouse for ASTM certification and qualification of alternative jet fuels. Developed AFRL/engine OEM certified “referee combustor” for alternative fuel combustor operability.



UDRI has significant experience in **identification and mitigation of biocontaminants** for ground and aircraft fuel systems. We pioneered DNA sequencing methods for identification and quantification of microbial contamination. We have studied the role of fuel composition (e.g., alternative fuel species) on the growth of fuel microbes. We continue to study the development of non-toxic advanced fuel antimicrobial molecules and the molecular mechanisms of fuel species metabolism.

UDRI is a world leader in studies of **jet fuel thermal stability** in both oxidative and pyrolytic environments. Our researchers have many years expertise in thermal stability additive testing, evaluation, and formulation. We have pioneered the development and interpretation of thermal stability tests such as:

- Quartz crystal microbalance (QCM)
- Near isothermal flowing test rig (NIFTR)
- Phoenix & ECAT thermal stability rigs
- AFRL fuel system simulator (FSS)
- Endothermic fuel pyrolytic and catalytic reactor systems

UDRI is a leader in the development of **unique analysis techniques** for the identification and quantification of important fuel species. We specialize in difficult analyses which require custom preseparation methods, as well as quantification of fuel species classes. Preseparation techniques pioneered by UDRI researchers for use for fuel include solid-phase extraction and high performance liquid chromatography. These techniques are then combined with gas chromatography with various detectors or with multi-dimensional gas chromatography (GCxGC). Our researchers also employ unique derivatization techniques which greatly improve difficult analyses, such as silylation for analysis of metal deactivator additive and triphenylphosphine for analysis of hydroperoxides.

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UDRI is the primary U.S. Air Force technical contractor responsible for the development, testing, and evaluation of the advanced **high temperature thermal stability additive package** JP-8+100 and the improved low temperature flowable fuel JP-8+100LT. These improved fuels have saved the Air Force millions of dollars per year in maintenance and logistics costs.

UDRI has expertise in improving the **low temperature flowability of fuels** via development of flow improving additive packages. We have developed numerous techniques to study low temperature fuel crystallization and flowability including:

- Scanning Brookfield viscometry
- Cold-stage optical microscopy
- Differential scanning calorimetry
- Custom fuel waxing and icing system simulators
- Custom additive screening tests

In addition we have developed numerous **computational fluid dynamic models of test devices and aircraft fuel system components** to better understand fuel tank temperature profiles and the effects of viscosity, heat transfer, and solidification. These models have supported the conversion of the U.S. Air Force from JP-8 to Jet A fuels at CONUS locations.

UDRI researchers are actively involved in performing measurement of **combustion particulates and gaseous emissions** for test rigs as well as actual gas turbine engines. Our AFRL transportable laboratory is used for on-wing testing of engine emissions and the effects of alternative fuels. We employ numerous methods for characterization of emissions including particle number density, particle size distribution, particle mass concentration, and particle count using instruments such as:

- Condensation nuclei counter
- Scanning mobility particle sizer
- Differential mobility analyzer
- Tapered element oscillating microbalance
- Laser particle counter

In addition, we have pioneered the evaluation and development of emissions reducing additives.

UDRI researchers are pioneering techniques for **prediction of thermal-oxidative fuel deposition.** A methodology has been developed, which employs a combination of unique chemical kinetic mechanisms with computational fluid dynamics techniques which will allow the prediction of fuel deposition and oxidation for various fuels as a function of temperature and time in complex fuel system geometries. Such models can be used to improve fuel system design, more efficiently use the fuel heat sink, predict nozzle lifetime, and improve reliability and time between maintenance.

UDRI has a **Cooperative Research and Development Agreement (CRADA) with AFRL which allows use of their one-of-a-kind facilities for third party research and testing.** Your organization gains the dual benefits of research and testing using these unique facilities along with analysis and interpretation of results by UDRI's fuel experts.

For additional information please contact:
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