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Non-Catalytic Rayleigh-Taylor Assisted Combustion Adapted to Exploit Non-Catalytic Rayleigh-Taylor Instability

Combustion processes are essential to engines and power generation. Many combustion devices operate under large, induced forces by arranging the combustion flow path to follow a partially circular geometry that induces centripetal acceleration on the reactants and products flowing through the combustor. These combustors mix the cold reactants and hot combustion products through Rayleigh-Taylor Instability (RTI), a chemical instability that occurs when two fluids of different densities mix due to gravity or other external forces. Current advances in RTI-assisted combustion rely on strategically-placed catalyst strips that leverage RTI-driven mixing. However, impurities in the fuel and/or reactants may render a catalyst useless (catalyst poisoning). To mitigate catalyst poisoning in combustion systems, scientists are now looking towards designing a similar combustion system without the need for catalysts strips.

Researchers at ASU have designed a combustor flow path promoting Rayleigh-Taylor Instability (RTI) that does not rely on a catalyst. The flow path takes advantage of the density difference between the heavier incoming reactants and the lighter combustion products to enhance RTI within the combustor, improving mixing and combustion and reducing large total pressure losses. Low-loss microflameholders (small passages that trap and cause low-density hot product gases to act as an ignition source for incoming high-density reactant gases) replace the catalyst elements in previous mechanisms, producing expanded blowout limits and higher combustion efficiency. Overall, the enhanced design of the RTI-assisted combustor does not rely on a catalyst to promote RTI-based mixing and improves the performance and reliability of the combustor, making it an easy replacement for essentially all combustion processes.

Potential Applications

- Gas turbine engines
- Aeropropulsion, green energy, and power generation systems
- Industrial burners and furnaces
- Waste and hazardous materials incineration

Benefits and Advantages

- Lower Cost and Effective - the simplified design functions without potentially expensive catalysts or large-scale flameholders, making manufacturing easier
- Efficient - microflameholders replace catalysts to enhance RTI, reducing total pressure losses while improving mixing and combustion efficiency
- Increased Functional Range - microflameholders expand flame blowout limits, allowing amplification of the incoming reactants

For more information about the inventor(s) and their research, please see:

Dr. Werner Dahm's directory webpage