Better combustion through plasma

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Mix together air, fuel, and heat and you get combustion, the chemical reaction that powers most engines in planes, trains and automobiles. And if you throw in some ionized gas (plasma), it turns out, you can sustain combustion even in conditions that would otherwise snuff out the reaction: at low air pressure, in high winds or when there's low fuel.

Such plasma-assisted combustion can potentially give an efficiency boost to high-performance aircraft. The technology could help military jets fly at high altitudes, passenger planes and unmanned drones cruise for long distances while conserving fuel, and supersonic jets maintain ignition at breakneck speeds that would normally suffocate flames with fast-flowing air.

Scientists know that by introducing plasma to the reaction – near or at the location where the flame ignites – new chemical species are produced that catalyze combustion. But no one knows precisely what species are involved, what the reactions are, and what their rates are. "It's not well understood at all," said Igor Adamovich of Ohio State University.

To better understand plasma-assisted combustion and to develop future technology, researchers are conducting experiments and creating computer models to determine which chemical processes are involved.

Adamovich will discuss some of his and his colleagues' recent experimental results and computer models at the meeting of the American Physical Society's Division of Fluid Dynamics, held Nov. 24 –

26 in Pittsburgh. The researchers studied reactions and reaction rates at air pressures that represent high-altitude flight and at temperatures between 200 and 400 degrees Celsius—below ignition temperature and where data and reliable models are particularly lacking. The researchers found that for simpler fuels – such as hydrogen, methane and ethylene – the models agreed fairly well with experimental data, while for propane, the agreement was much worse.

Just over five years ago, relatively little was known about how plasma-assisted combustion works, Adamovich said. But since then, scientists have made significant progress toward identifying the mechanism behind the plasma assisted combustion chemistry. "We hope in a few years, such a mechanism might emerge," he said.

More information: The presentation "Kinetic Modeling of Low-Temperature Plasma Assisted Combustion," is on Tuesday, November 26, 2013 in the David L. Lawrence Convention Center, Room 317. ABSTRACT: meeting.aps.org/Meeting/DFD13/Event/204268

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