Testing of a Wedge-Plasma Torch Combination as a Supersonic Flameholder

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Scope and Justification of Document

My document for ME 5984 is an excerpt from my master's thesis, which is a study of the use of a plasma torch-wedge combination as a flameholder for supersonic combustion. The purpose of my study is to determine how well the wedge-plasma torch combination works by both qualitative and quantitative measures of the flame.

Supersonic combustion is becoming a more important topic as the speeds of aircraft, both airplanes and missiles, are pushed above Mach 5. Above Mach 5, normal methods of propulsion, such as turbofan and turbojet engines, do not perform well. Rocket engines have typically been used at these flight speeds, but come with a large weight penalty. In a rocket engine, one must carry not only the fuel, but also the oxidizer. A way to eliminate the need for the onboard oxidizer is to use an air-breathing engine. Typically, scramjets are used at these high speeds. A scramjet, which is an engine with no moving parts, works by using the momentum of the inlet air stream to compress the air before fuel is injected and burned. This flow through the engine is then accelerated through a nozzle to produce thrust. The real difficulty in scramjet engines is that the burning takes place in an air stream that is still supersonic. In this environment, it is extremely difficult to produce a flame, and generally some sort of flameholder-igniter combination is needed.

Plasma torches in conjunction with various flameholders have been studied to determine their effectiveness in establishing a flame in supersonic air streams. Compared with currently used igniters, plasma torches offer a couple of advantages. For instance, plasma torches are a source of thermal energy and combustion enhancing radicals. The thermal energy from the plasma torch serves as an ignition source for the fuel. An even more important benefit is the combustion enhancing radicals produced by the plasma torch. These radicals increase the rate of reaction of the fuel with the air, which helps decrease the size of combustor needed for complete combustion in the engine. The purpose of my work is to test a wedge-plasma torch combination as a supersonic flameholder.

Analysis of Constraints

The primary audience for my thesis will primarily be my committee members who are familiar with supersonic combustion, but may not be familiar with the problems associated with plasma torches. A secondary audience would be research professionals interested in supersonic combustion. In regard to the format for the thesis, that will follow the Electronic Thesis and Dissertion guidelines at Virginia Tech:

http://etd.vt.edu/guidelines/format.html