Detonability of Hydrocarbon/Air Mixtures Using Combustion Enhancing Geometries for Pulse Detonation Engines

Authors: Neil G. Sexton; NAVAL POSTGRADUATE SCHOOL MONTEREY CA SOFTWARE ENGINEERING AUTOMATION CENTER

Abstract: This research studied combustion enhancing geometries and shock reflection on generating a hydrocarbon/air detonation wave in a combustion tube. Ethylene was used as a baseline fuel to determine the preferable geometries. Propane was then used in later testing because of its combustion similarities with heavy hydrocarbon fuels such JP5, JP8, and JP10. Three criteria were used to measure the effectiveness of the combustion enhancing geometries: ability to generate a detonation, wave speed, and time for shock formation. The evaluated geometries included flow-restricting orifice plates and a Schelkin spiral. The shock reflection was accomplished by a vertical fence (large orifice) placed in the last fourth of the tube length. The optimum geometry was found to be the orifice plate used in conjunction with the spiral. Detonations occurred when using ethylene in this configuration, but did not develop when using propane. Because propane's overall reaction rate is slower than that of simpler fuels, more large- and small-scale turbulence to further enhance combustion needs to be generated to create a detonation wave in a short distance when using complex hydrocarbons, such as propane.

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