Pulse Detonation Engine Research

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Motivation

Stanford University's Pulse Detonation Engine research aims, in part, at optimizing the performance of this new technology in order to be competitive with conventional propulsive techniques. Deflagration to detonation transition, time-varying thrust, fuel-filling dynamics and heat transfer all need to be well understood.

Overview

In Figure 1 we see the trajectory and velocity of the detonation wave in the pulse detonation engine as measured by pressure transducers and ionization probes. Notice the short initial region characteristic of a slow flame. This quickly leads to a detonation wave after approximately 30 cm. Information like this is extremely important in determining how well the engine is able to create a detonation wave. If a detonation is not formed, the engine loses thrust dramatically.

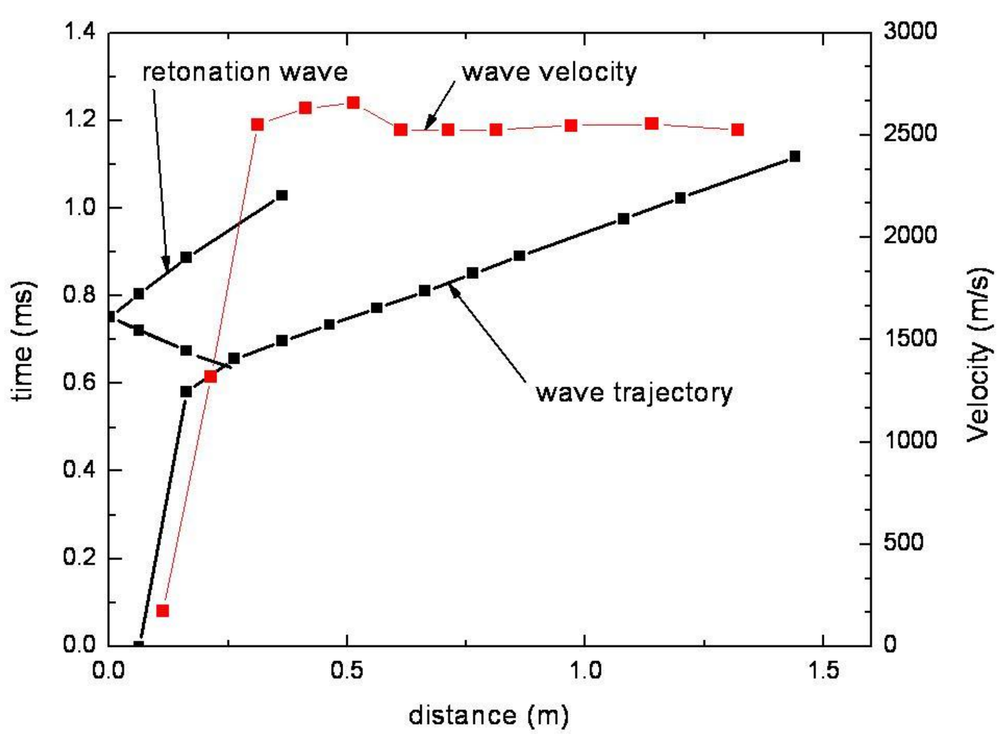

Figure 1: Wave trajectories and velocities in pulse detonation engine

Figure 2 compares the pressure acting on the thrust plate of a standard straight-tube engine and that of an engine with a converging-diverging nozzle. The nozzle increases impulse by both creating a reflected wave pattern as well as by prolonging the blowdown process.

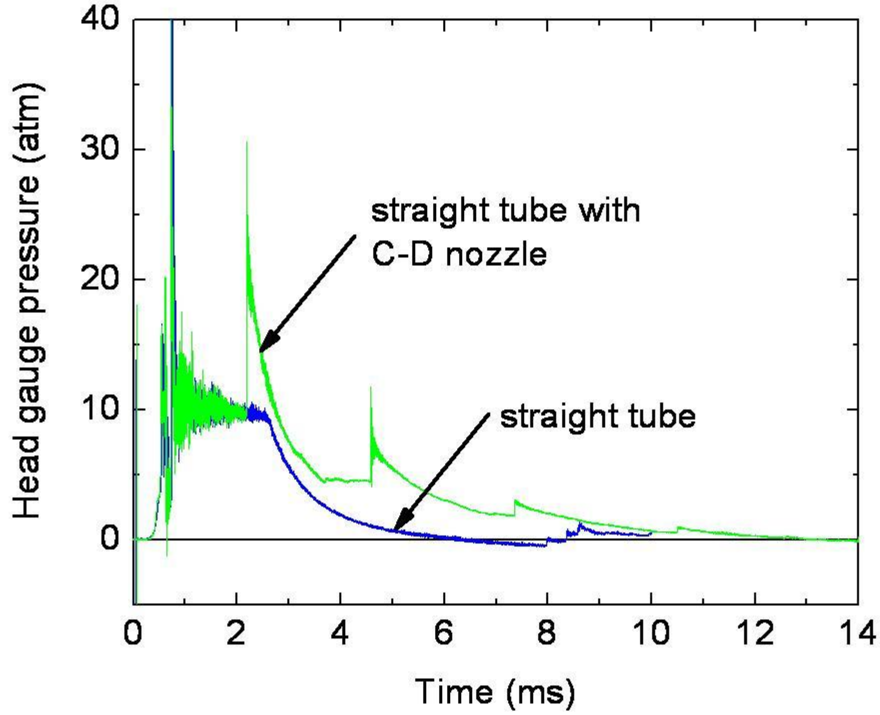

Figure 2: Thrust plate pressure

The pressure data in Figure 2, along with additional pressure data from the nozzle, are integrated to give time-varying thrust, presented for the engine with nozzle in Figure 3. These results are plotted along with predictions from two numerical models, the first of which assumes an adiabatic engine; the second incorporates heat losses. We see that heat losses are important for two reasons: 1) thrust is significantly reduced and 2) a heat loss model is required to predict wave arrival times.

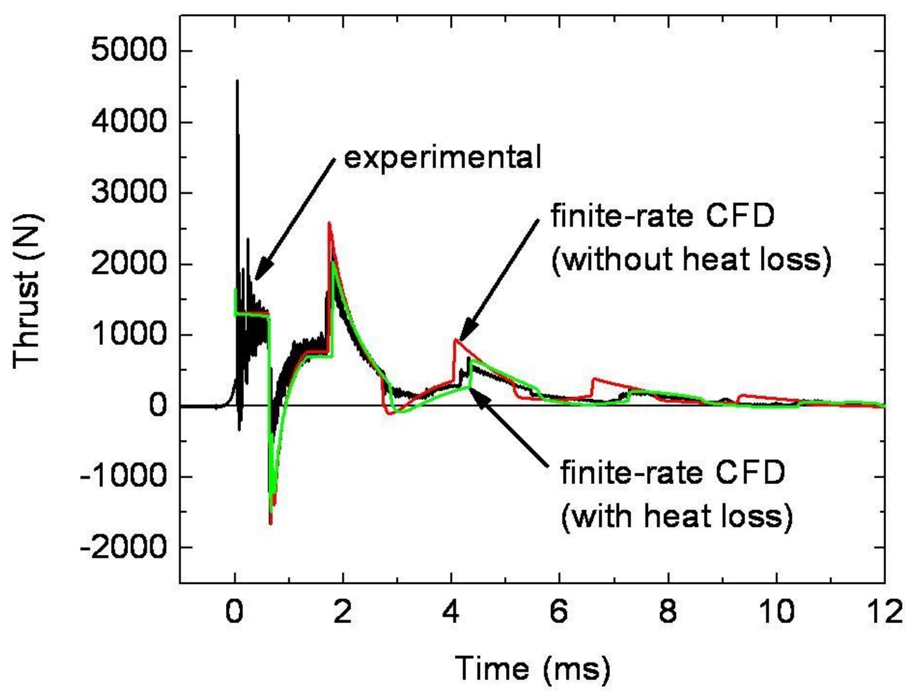

Figure 3: Time varying thrust for engine with nozzle