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Final Project Abstract

**Optimization of 2D Scramjet Combustor Geometry**

Consider a scramjet aimed to operate at an altitude of 30 km and at Mach 6. The inlet and isolator provides the combustor with 150kg/s of air at Mach 3 with a 64% pressure recover factor. The combustor comprises of 20 fuel injector segments on the top and bottom surfaces, each approximated as a flat plate at some angle to the combustor’s axis. The combustor length is 3 meters, and across its entire length, fuel is added according to the function:

The combustor entrance has an aspect ratio (w / h) = 7. Assume hydrogen fuel is injected and burns at its injection point. Assume constant air properties along the length of the combustor. The combustor feeds into a nozzle which perfectly expands to static conditions. At any point along the combustor, static temperatures are not to exceed 2700 K, static pressure should not exceed 300 kPa, and the flow velocity at any point must be at least 1.05 Mach. Sequential injector plates should have a difference in angle no greater than 2 degrees. Determine the optimal combustor and nozzle geometry that produces the greatest jet thrust for the given flight conditions.

**Approach:**

The design variables are the angles of each fuel injector plate, and the objective function (jet thrust) is designed as follows:

u

u: Nozzle exit velocity

: Total mass flow

All constraints are inequalities, and flow field constraints (such as Mach, pressure, and temperature) will be evaluated at their corresponding maximum or minimum values as appropriate. This should be feasible, as property maximum and minimum values are typically restricted to a choke point that tends not to move significantly as the design changes. The calculation for all flow fields, and thus the objective and constraint equations, will be handled by a solver in Matlab. The SQP optimization algorithm, using Matlab’s “fmincon” function, will be used for a multitude of reasons. With the combustor taking significant computation to solve, the fast nature of SQP will make the problem more feasible. There is a significant chance the optimization procedure will venture into unfeasible territory easily, which SQP can handle. Finally, the non-linear nature of the flow field constraints will be better represented by SQP than other strictly linear methods.