Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Lean premixed reacting flows with swirl and wall-separation zones in a contracting chamber YUXIN ZHANG, ZVI RUSAK, Rensselaer Polytechnic Institute, SHIXIAO WANG, U. Auckland, New Zealand — Low Mach number lean premixed reacting swirling flows with wall-separation zones in a contracting circular finite-length open chamber are studied. Assuming a complete reaction with high activation energy and chemical equilibrium behind the reaction zone, a nonlinear partial differential equation is derived for the solution of the flow stream function behind the reaction zone in terms of the inlet total enthalpy for a reacting flow, specific entropy and the circulation functions. Bifurcation diagrams of steady flows are described as the inlet swirl level is increased at fixed chamber contraction and reaction heat release. The approach is applied to an inlet solid-body rotation flow with constant profiles of the axial velocity, temperature and mixture reactant mass fraction. The computed results provide predictions of the critical inlet swirl levels for the first appearance of wall-separation states and for the size of the separation zone as a function of the inlet swirl ratio, Mach number, chamber contraction and heat release of the reaction. The methodology developed in this paper provides a theoretical feasibility for the development of the technology of swirl-assisted combustion where the reaction zone is supported and stabilized by a wall-separation zone.

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Date submitted: 24 Jul 2017 Electronic form version 1.4