FEM Analysis of Flamelet Wrinkling in a Diffusion Flame

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Abstract

One can hardly get the exact analytic solution of a full time-dependent convection-diffusion equation, for describing the dynamics of a non-premixed flamelet. The analytic solution of the linearized form with such a model was studied by MATLAB®. And also, a numerical computation was made with the linearization model by COMSOL Multiphysics® software, to provide a perfect accordance with the analytical solution. As well as giving a validation to the linearization flamelet model, the results reveal the characteristics of the flamelet positions and wrinkling originated from a harmonic disturbance on the velocity of reactants at the inlet. It is shown that the more closer to the two ends of the flame, the larger are the amplitudes of the wrinkling. The mixture fraction along the axial of the flame damps generally in an exponential law. The paper would provide principal data for deeply understanding with the thermo-acoustic instabilities of non-premixed combustion.

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Figures used in the abstract

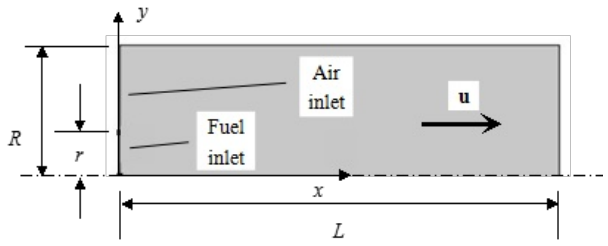

Figure 1: Geometry of the Combustor.

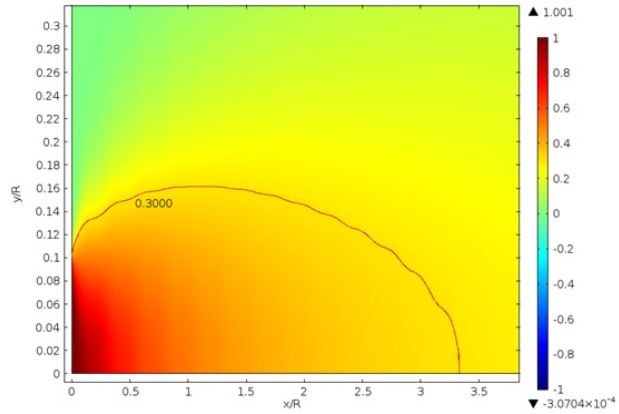

Figure 2: Wrinkling of the Flamelet.

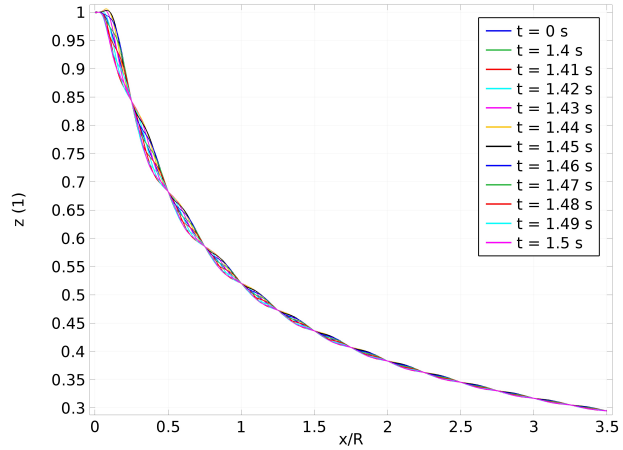

Figure 3: Time-dependent Variation of the Mixture Fraction along the Flame Axial.

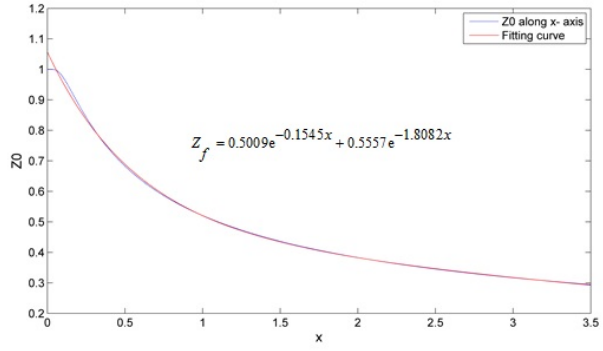

Figure 4: Exponential Fitting of the Steady-state Mixture Fraction along the Flame Axial.