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Portfolio

Visualization of Nonpremixed Hydrogen Jet Flame in a Vitiated Coflow by DNS(1)

Wang, Z.*, Zhou, J.* and Cen, K.*

* State Key Laboratory of Clean Energy Utilization, Institute for Thermal Power Engineering, Zhejiang University, Hangzhou, 310027, P. R. China.

E-mail: wangzh@zju.edu.cn

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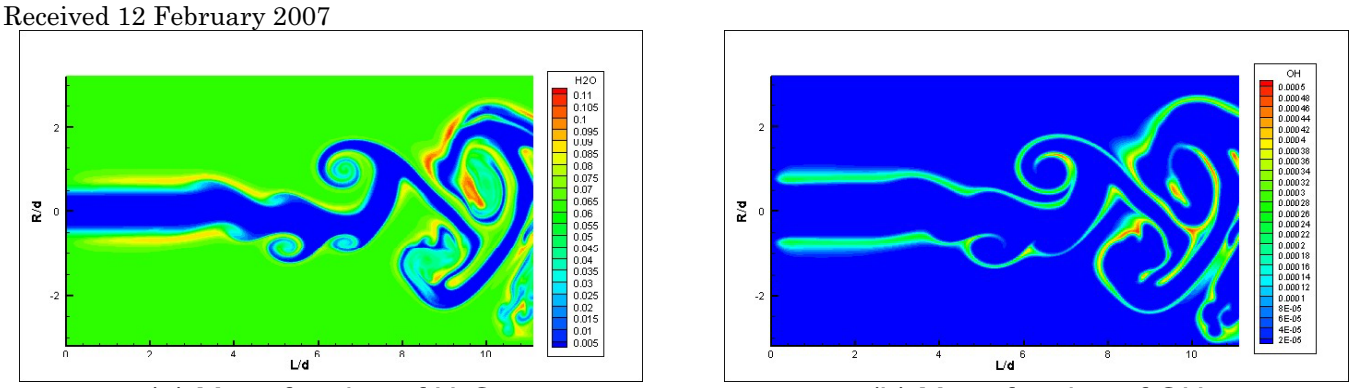
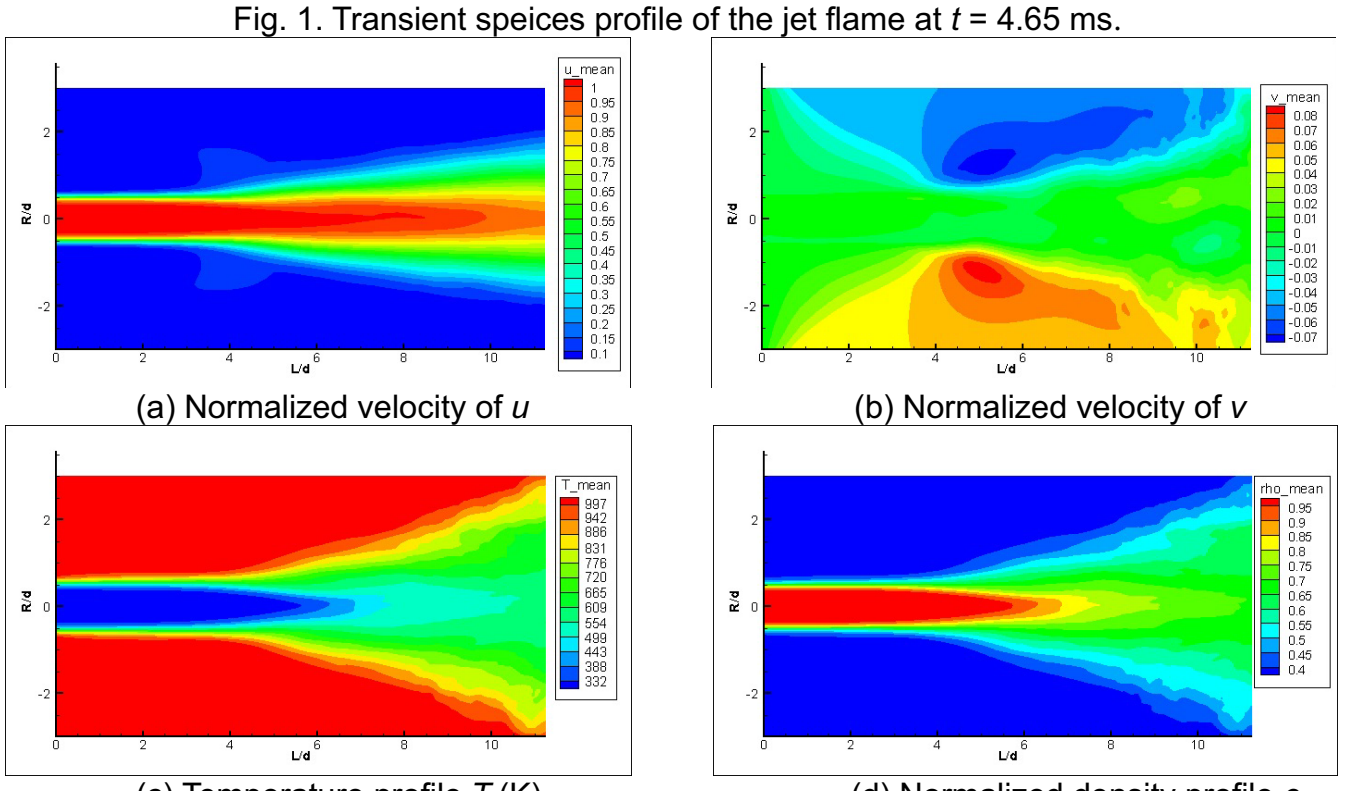


(a) Mass fraction of H_2O (b) Mass fraction of OH

Fig. 1. Transient speices profile of the jet flame at t = 4.65 ms.



(a) Normalized velocity of u (b) Normalized velocity of v

(c) Temperature profile T (K) (d) Normalized density profile ρ

Fig. 2. Faver averaged flow field of the jet flame. The reference values used here are: velocity u_r = 103.5 m/s; density ρ_r = 0.856 kg/m^3

These figures show the simulation results of hydrogen jet flame in a vitiated coflow, which were realized by 2D DNS (Direct Numerical Simulation) method with 9 species and 16 steps chemical kinetic mechanism. The diameter of the jet is d = 4.57 mm. The jet fuel is a mixture of 25 % H_2 and N_2 as dilution, by volume. The velocity of the jet is U_1 = 107 m/s at 305 K. The coflow consisted of products from a lean premixed H_2/air flame with a velocity of U_2 = 3.5 m/s at 1045K. The composition is 15 % O_2, 9.9 % H_2O and 75 % N_2, by volume. Based on the velocity of U_1-U_2, jet diameter d and inlet fuel jet properties, the Reynold's number of the jet flame is 23000, Pr = 0.71. The autoignition phenomenon can be well captured and visualized. Figure 1 shows the transient mass fraction profiles of H_2O and OH in the flow field, which were considered as the indicator of reaction as well as the heat release rate. The combustion mainly appears at the edge of the large scale vortex structures. At the end of the noncontinuous flame sheet or the positions with large curve rate, the combustion are always enhanced, as shown in Fig. 1(b). By accumulation of this kind of flame points, the fuel jet will be ignited automatically. Figure 2 shows the Faver-average results of velocity u, v, temperature and density in the flow field.

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