Pore-scale numerical simulation of flame stabilization in two-layer porous burner

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Porous media burners are one of the most prospective devices in the energy industry due to its unique advantages following from heat recuperation mechanism. Such energy feedback from the combustion product to the fresh mixture leads to enhanced flammability limits, large effective flame speed, and low pollutant emission as well. In porous media burners, the flame can be stabilized at the external radiating surface, using cooling tubes, in the divergent flow. Different stabilization technique has been proposed by Trimis and Durst [1] based on the idea to close the flame between two different upstream and downstream porous sections with sub- and supercritical Péclet number respectively.

In the previous pore-scale simulations [2] it was shown that the flame stabilization mechanism is a complex interplay of heat recuperation, stretching effect, and flow hydrodynamics. In this work, the model two-dimensional two-layer porous burner was studied numerically within the framework of the pore-scale approach, principles and mathematical formulation are presented in the paper above.

Figure 1 shows the flame structure with the superficial flow velocity of 1.7 m/s when the front is stable and located at the interface between upstream and downstream layers. It can be noticed that the front is highly curved and stretched by the flow. During that, it anchors the particles and locates at the separating layer behind them. Similar flame behavior has been observed in many studies, devoted to flames near bluff bodies [3]. In spite of the difference in shapes and circular particles section, the stabilization mechanism is similar, considering solid-to-solid heat transfer via radiation.

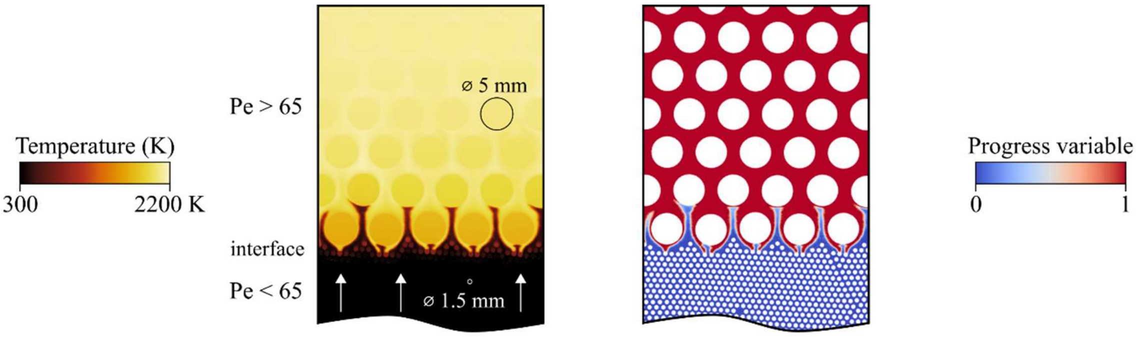

Fig. 1. Flame structure in two-layer porous burner

The pore-scale approach in some manner allows us to consider different effects on the local flame behavior. It can be seen, that physics of the flame stabilization at pore scale is more complicated than heat or velocity balance, but includes flame front deformation by non-uniform flow field and local configuration of particles packing.

References

1. D. Trimis, F. Durst, *Combust. Sci. Technol.* **1996**, 121, 153–168.
2. I. Yakovlev, A. Maznoy, S. Zambalov, *Combust. Flame.* **2021**, 231, 111468.
3. K.S. Kedia, A.F. Ghoniem, *Combust. Flame*. **2015**, 162, 1304–1315.