# NUMERICAL SIMULATION OF OSCILLATORY INSTABILITY IN THE IRREGULAR PACKED BED OF PARTICLES

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**Abstract:** Pore-scale numerical simulation of oscillatory instability formation and development during stoichiometric methane combustion in the packed bed of particles is performed. The flame front has a cellular structure with anchoring on the particle surface. The mechanism of the oscillatory instability relates to the flames with repetitive extinction and ignition in pore channels with the temperature gradient. Decreasing of the flow velocity below the critical value leads to the stability loss of some flame front fragments. The less the flow velocity, the larger the part of the front which becomes unstable till the moment of instability of the whole computational region. Existence of such a transitional regime is defined by the local flow and heat transfer conditions. During unstable combustion, the mutual hydrodynamic influence of the flame front fragments in adjacent channels takes place that leads to the random frequency characteristics.

**Keywords:** porous media combustion; flame instability; porous media; combustion wave; oscillations; FREI; numerical simulation; heat recuperation

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## Figure Captions

**Figure 1** Schematic diagram illustrating the computational domain generation procedure. The ratio between the particles and container dimensions was artificially increased for better legibility

**Figure 2** Schematic diagram of the computational domain with notations of the domains and boundaries: $\Omega_f$ — fluid region; $\Omega_s$ — solid region; $\Gamma_{\mathrm{in}}$ — inlet boundary; $\Gamma_{\mathrm{out}}$ — outlet boundary; $\Gamma_{f,\mathrm{sym}}$ and $\Gamma_{s,\mathrm{sym}}$ — symmetry boundaries of $\Omega_f$ and $\Omega_s$ domains, respectively; and $\Gamma_{f-s}$ — interphase boundary

**Figure 3** Temperature profiles of the fluid ($T_f$) and solid ($T_s$) regions

**Figure 4** Propagation of the flame front fragment in the channel where the oscillating instability forms by the sequence of the methane consumption contours

**Figure 5** Diagram of the transition from the stable flame to the fully developed oscillatory instability as a function of the inlet flow velocity

**Figure 6** Frequency characteristic of flame oscillations in some channels of the considered packed bed

**Figure 7** Dependency of the oscillation's frequency on the inlet flow velocity

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