



## Structure of Cylindrical Quasi-Detonation in Ultra-Rich Fine Coal Char Suspensions

Juntang Zhang<sup>1</sup>, Huangwei Zhang<sup>1, \*</sup>

\*lead presenter: [juntang.zhang@u.nus.edu](mailto:juntang.zhang@u.nus.edu)

<sup>1</sup> Department of Mechanical Engineering, National University of Singapore, 9 Engineering Drive 1, Singapore 117576, SINGAPORE

Direct initiation and propagation of cylindrical detonation in fine coal char particle suspensions with varying concentrations are investigated using the Eulerian-Lagrangian method. Heterogeneous and homogeneous reactions are modeled via a kinetic/diffusion surface reaction model and GRI-Mech 3.0, respectively. The results show that stable detonation occurs at initial particle concentrations from 40 to 620 g/m<sup>3</sup>, while quasi-detonation can be observed when the concentration exceeds 620 g/m<sup>3</sup>, characterized by reduced detonation speed and overpressure. These findings have implications for coal mine safety and hazard mitigation. In the quasi-detonations, a series of azimuthally detonation wavelets (ADW) exist along the leading shock front, with localized subsonic regions behind them. This results in different hydrodynamic structures compared to that of conventional detonations with multiple transverse waves. As the wave expands, ADWs increase in number, with their collisions sustaining quasi-detonation and forming cellular trajectories. It is also shown that near-stoichiometric concentrations intensify and accelerate the wave, producing small, regular cells, whereas high concentrations lead to large, irregular cells due to oxygen depletion. Furthermore, strong shear-induced flow jets and vortices lead the particle non-uniformity, with sparse and aggregated regions consequently resulting in highly uneven reaction zones. In quasi-detonation, sparse regions exhibit higher temperatures due to lower energy absorption, while aggregated regions experience significant interphase heat transfer, distinct from the behavior observed under near-stoichiometric conditions.