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Numerical Modeling of Premixed Combustion and Flame Acceleration of Li-ion Battery Thermal Runaway Gases

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Li-ion battery safety is linked to fire and explosion hazards, due to flammable gases produced by the thermal runaway reactions that can accumulate in a confined environment.
To represent large-scale problems, typically a deflagration inside a Battery Energy Storage System container and its potential transition to detonation, the strategy relies on a numerical model relying on the knowledge of laminar flame speed depending on local pressure and temperature, turbulence, and flame wrinkling. The methodology consists of revisiting existing correlations, established in the specific case of H2/air premixed combustion, extending them to more complex mixtures as typical battery thermal runaway gases may contain. The case study is a premixed flame/shock interaction in a 2D semi-closed channel, with obstacles after the shock has interacted with the flame and accelerated it to enhance the generation of vortices. A comparison of the large-scale simulation model with a reference accurate solver shows a correct agreement between the estimated flame speeds despite the inherent limitations of correlation models in flame propagation and biases on flame speed estimation induced by the test case.

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