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Fluid Dynamics and Transport Phenomena

An integrated model for predicting the flame propagation in crimped ribbon flame arresters☆

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Abstract:

Crimped ribbon flame arresters are important safety devices in the chemical industry, especially for the dangerous situations. Although proper design of arresters by the numerical simulation method is promising, its reliability and accuracy are dependent upon the mathematical model. In this work, an integrated mathematical model for the microchannel in the crimped ribbon flame arresters was set up; the fluid flow behavior and the sensitivities of four chemical kinetics mechanisms of propane-air on the accuracy were analysed. It is shown that turbulence is predominant in the microchannel of the crimped ribbon flame arresters under the deflagration and detonation conditions, and a new quenching criterion for the numerical simulation is proposed. The kinetics mechanism of Mansouri *et al.* [1] among the four ones is the most accurate due to the best agreement of the predicted outlet temperature at the experimental flameproof velocity with the autoignition temperature of propane-air. The species mass fraction profiles and the temperature distribution, which are too difficult to measure due to the tiny dimension of the microchannel in experiments, are captured. The fundamental insights into chemical reactions and heat loss are well portrayed. It can be concluded that the integrated mathematical model established in

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