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Numerical Study of Upward Flame Spread over Discrete Fuels

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Previous studies indicate that flames tend to spread faster in some discrete fuel configurations than in continuous configurations. While these previous experiments identified this phenomenon, there are few, if not zero, numerical studies that offer comprehensive investigation of what causes it. In this study, upward flame spread over thin solid fuel is numerically examined in discrete and continuous fuel configurations using Fire Dynamic Simulator. In the discrete configuration, fuel segments (1cm in length) are separated by air gaps of various sizes (0.25-3cm in length). The numerical results show that the flame spread rate increases with increasing gap size. Heat fluxes distributions on the fuel surfaces and the flow profiles for continuous and discrete configurations were compared in details. It shows that the presence of the gaps has two effects. First, it forces the flame base to jump to the next fuel segment when the upstream one burns out. Second, it reduces the flame standoff distance at the gaps, and in some configurations, breaks the flame into multiple flamelets. The shorter standoff distance and intense burning at each flamelet base result in a larger total burning rate for the discrete fuel array, compared with continuous fuel. These two effects contribute to the faster flame spread over discrete fuel configurations.