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Title: Modeling large-scale thermoplastic fires

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Fire growth models require an accurate treatment of heat and mass transfer, pyrolysis, combustion, and turbulence. Thermoplastic fire growth models are further complicated by the tendency of thermoplastics to deform and melt during combustion. Melting leads to the formation of a pool fire on the ground which can accelerate fire growth. Deformation leads to large-scale geometry changes that impact radiative heat transfer, entrainment, and liquid transport. For these reasons, traditional fire growth models that use static meshes and do not represent molten fuels are inadequate for modeling thermoplastic fires.

Here, a model is presented in the large eddy simulation framework capable of capturing these phenomena at industry-relevant scales. This is achieved by building upon existing multi-region and multi-phase functionality within the FireFOAM solver, and by adapting and extending dynamic mesh, thermal baffle, and Lagrangian particle implementations.

The target plastic commodity consists of a stack of eight plastic pallets constructed from reinforced high density polyethylene (HDPE). The geometry of commodity is complex, including thin 'lattice' shaped sections with small thermal inertia, exposed to heating on all sides. Full-scale experiments have shown that these elements readily melt and deform, significantly altering the geometry and producing a pool fire on the ground, substantially altering the fire growth behavior.

A simplified model was developed to represent this complex behavior. The thin plastic elements are modeled with psuodo-1D equations for heat transfer and pyrolysis. The geometry change is realized by modifying the attach-detach dynamic mesh functionality in OpenFOAM, and the molten plastic film and dripping is modelled in a Lagrangian framework. The resulting model can capture the essential fire growth dynamics for a target, standardized plastic commodity. Preliminary comparisons are made with experimental results and a roadmap is outlined for incorporating water suppression physics.