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Numerical Assessment of Fire Characteristics with Bodies Engulfed in Hydrocarbon Pool Fire

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Abstract : Fires accident becomes even worse when the hazardous equipment like reactors or radioactive waste packages are engulfed in fire. In this work, large-eddy numerical fire simulations are performed using fire dynamic simulator to predict the thermal behavior of such bodies engulfed in hydrocarbon pool fires. A radiatively dominated 0.3 m circular burner with n-heptane as the fuel is considered in this work. The fire numerical simulation results without anybody inside the fire are validated with the reported experimental data. The comparison is in good agreement for different flame properties like predicted mass burning rate, flame height, time-averaged center-line temperature, time-averaged center-line velocity, puffing frequency, the irradiance at the surroundings, and the radiative heat feedback to the pool surface. Cask of different sizes is simulated with SS304L material. The results are independent of the material of the cask simulated as the adiabatic surface temperature concept is employed in this study. It is observed that the mass burning rate increases with the blockage ratio (3% ≤ B ≤ 32%). However, the change in this increment is reduced at higher blockage ratios (B > 14%). This is because the radiative heat feedback to the fuel surface is not only from the flame but also from the cask volume. As B increases, the volume of the cask increases and thereby increases the radiative contribution to the fuel surface. The radiative heat feedback in the case of the cask engulfed in the fire is increased by 2.5% to 31% compared to the fire without cask.

Keywords : adiabatic surface temperature, fire accidents, fire dynamic simulator, radiative heat feedback
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