Numerical studies on fire behavior inside the confined area

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Abstract

Fire hazard is one of the major cause of fatalities in the industries and residential areas. The fire hazard in corridor/chambers is caused by rapid rise of temperatures, presence of high concentrations of toxic gases like CO and smoke. Corridors are common in industries and residential areas, and propagation of smoke, during the fire accident, is fast through corridors as of their narrow and long shape, which can show the way to catastrophic results. Safety of person is a critical factor whenever a fire accident take place in underground station or corridor types areas because of limitation of ventilation systems to provide a safer indoor environment and extraction of the smoke and hazardous gasses.

In FDS, Smagorinsky form of LES (Large Eddy Simulation) and Combustion Model is based on mixture fraction (of fuel and air) concept is used to predict the extent of combustion and turbulent mixing in under-ventilated spaces. [1]

Further, pyrolysis model is incorporated to study the rate of evaporation of liquid fuels on burning. Clausius-Clapeyron relation is used to correlate the volume fraction of the fuel vapor above the surface with liquid boiling temperature [2]

$$X_f = \exp\left[-\frac{h_v W_f}{\mathcal{R}}\left(\frac{1}{T_s}-\frac{1}{T_b}\right)\right]$$

The present work is proposed to study the behavior of fire inside the corridor/ chamber. The dimensions of the model corridor/ chamber is 10.0 (length) m × 2.0 m (width) × 3.5 m (height) and the cross ventilation is provided to study the effect of ventilation. The present research work is focused on the travelling of fire under different fire condition inside the chamber/ corridor

Parameters measured for the study are:

- Heat release rate (HRR) and Mass burning rate
- Temperature at the different locations at ceilings and at vent
- Heat fluxes at different locations

The results will be useful in the design of fire protection systems, i.e. sprinkler, fire detector, alarm and evacuation system inside the industries and residential areas.

References

[1] McGrattan et al, Fire Dynamics Simulator Technical Reference Guide Volume 1: Mathematical Model, Sixth Edition, NIST Special Publication, 2010.

[2] D. Sahu, S. Kumar, S. Jain and A. Gupta, *Full scale experimental and numerical studies on effect of ventilation in an enclosure diesel pool fire*, Building Simulation. 10.1007/s12273-016-0328-x (2016).