MODELING ON-BOARD MIST SUPPRESSION – A SOLUTION TO TACKLE RAPID GROWTH FIRE

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KEYWORDS

Computational Fluid Dynamics (CFD), On-Board Mist Suppression, Smoke Management, Fire Dynamics Simulator (FDS), Fire Dynamics

ABSTRACT

Smoke management in confined settings like tunnels and underground stations is a challenge. It is especially critical when the origin of fire is shielded inside a train car in a tunnel. In order to adhere to NFPA 130 evacuation requirements to tackle rapidly growing fires, rail and transit agencies impose the same design criteria on designers. To minimize loss of life, the best strategy to adopt given the availability of short response time in such cases is to consider on-board mist suppression system. In this study, we discuss the underlying assumptions and the modeling technique for mist suppression along with suppression results on rapidly growing fires. The Fire Dynamics Simulator (FDS) developed by NIST is used to perform the Computational Fluid Dynamics (CFD) modeling. Traditional smoke management systems in stations and tunnels rely on strategically designed ventilation systems combined with sprinkler system activation in some cases to improve tenability until the firefighters arrive to tackle the fire. However, the response time of ventilation systems is high and the traditional train station sprinkler system is not effective when the fire is shielded. In the current computational model, the fire is detected on-board the train and the mist

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suppression system is activated. The effectiveness of the mist suppression system is shown by the comparison of the heat release rate with and without the activation of mist suppression system. The heat release rate is a function of many important parameters such as the type of fuel, availability of oxygen, and the initial accelerant in the case of rapidly growing fires. The fire dynamics involved in the development of the heat release rate in this study for mist suppression is also discussed. It is important to note that suppression is a control mechanism targeted at lowering the heat release rate and not necessarily aimed at extinguishing the fire. Based on the results, the mist suppression system is effective in reducing the heat release rate by a significant factor.