Abstract

Fires in the built environment typically consist of diffusion flames with inefficient mixing of fuel and oxygen, resulting in a degree of incomplete combustion and the generation of carbon monoxide. Fire suppression systems, used to control the growth and spread of fire, influence the combustion reaction process. Water droplets interacting with the gas phase chemistry of fire interrupt combustion processes and promotes generation of carbon monoxide.

Past research into mist suppression primarily focuses on optimal droplet size for heat release rate reduction, and notes a significant increase in carbon monoxide concentrations with this approach. The aim of this experimental study was to contribute to the knowledge of the interaction of water droplets on the gas phase chemistry of fire and assess the factors that influence the generation of carbon monoxide.

The experimental set-up was designed to minimise the effect of the mist spray on the heat release rate of the fires. Laboratory-scale fires, having heat release rates of 40-70 kW, and consisting of gaseous, liquid and solid fuels, were subjected to mist suppression sprays. The sprays applied consisted of droplets having characteristic diameters (D_{v50}) of 163-287 μm, and water flow rates of 1.5-3.5 L/min. The concentration of carbon monoxide produced by fires subject to mist suppression increased by up to 250%, with minor reductions to the heat release rate.

This study represents a proof of concept to a currently largely under explored phenomenon. The findings indicate a need for closer examination of how water sprays influence toxic species production. The results raise uncertainly on the applicability of typical applied species yields when fires are partially suppressed through fine water sprays. It is recommended that fire safety engineers consider the adoption of more conservative safety factors where it could be anticipated that the suppression systems would not result in extinguishment.