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Radiative attenuation by water sprays for fire safety.

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ABSTRACT. Since the late1980's and the Montreal protocol on substances that deplete the ozone layer, fire safety has to replace halon compounds used for fire protection systems. As water is a well-known candidate, a significant amount of research has been carried out since and especially from present authors on water sprays/mists for radiative shielding [1-3]. Usually, the radiation comes from fire flames or high temperature walls and water curtains are then used for either firefighting or for protection of equipment and people. The present study is part of this framework and aims at assessing the radiative attenuation provided by various sprays investigated in the frame of French-Ukrainian cooperation.

For the present work three different spraying devices were used: a full cone nozzle TG-1 (delivering 0.86 $L.min^{-1}$ under 4 bars) and two equivalent "sprinklers" with respective nozzle discharge coefficient (K-factor) of 4.45 and 13.6 $L.min^{-1}.bars^{-1/2}$. An experimental system was built up for the radiative attenuation investigations. It includes an extended blackbody used as the radiation source, a coupled FTIR spectrometer / IR camera for the infrared analysis and a pressurized vessel for the water delivery to the nozzle. The incident radiation coming from the blackbody crosses the water curtain and is then attenuated (due to absorption and scattering by droplets and vapour in air) during its path through the spray. The transmitted signal is finally recorded by the camera and the spectrometer. Nozzles were tested at various pressures suitable and flow rates. Attenuation measurements were conducted at several distances from the injection point.

Experimental results were then compared to numerical results provided by the BERGAMOTE code developed by the authors. This code is used for the prediction of the radiation attenuation throughout a water spray by combining (1) an Eulerian-Lagrangian approach to simulate the two phase flow made of droplets and air, and (2) a Monte Carlo method to calculate the radiation attenuation by the resulting participating medium. A series of parameters and phenomena is involved in the simulation as input data, including droplet size distribution, flow rate, radiative properties of the spray, evaporation, turbulence and heat transfer. Therefore, the characteristics of the nozzles were determined first in terms of velocity and droplet size distribution using a two-dimensional PDPA device and an optical microscopy.

The communication will present all the results obtained during our experimental campaign and the analysis of the attenuation ability of the present water mists in relation with their characteristics.

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