EFFECTIVENESS OF WATER MIST DROPLET SIZE ON FIRE SUPPRESSION IN AIR CRAFT CABIN AND CARGO COMPARTMENT USING A MULTI-ZONE COMPUTER MODELING

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Over the past few years several research projects and studies have been conducted for replacing halogen based (Halon) suppressants by water mist in the aircraft cabin and cargo compartment. Using experimental and theoretical results, it has been shown that the droplet size plays a critical role in fire suppression as well as other parameters such as; fuel type, enclosure, introduction of the mist and droplet size distribution. A detailed analysis shows that thermodynamic cooling and oxygen displacement are two mechanisms that compete. Better understandings of these competing mechanisms are necessary for developing a model to optimize the droplet size and distribution.

Using conservation of mass and energy, a multi-zone model has been developed using Matlab. This model introduces four distinct zones; a. Upper layer, b. Plume, c. Flame and d. ambient zone. Different parameters such as; fire source, water mass flow rate, droplet size distribution have been introduced to the program as an input. Fire and plume characteristics are calculated by empirical relations; however, upper layer development has been computed by mass and energy conservation equations. The results from the code include; average temperature at each zone, layer height, water consumption, droplet distribution as well as oxygen displacement. These parameters have been calculated by using different numerical techniques (Forward difference, backward difference, and Crank-Nicholson) in order to compare the convergence rate of the results. Changing the droplet size has a reasonable effect on thermodynamic cooling and oxygen displacement in each zone. Moreover, decreasing the droplet size reduces the total amount of suppressant. This is very important for air craft cabin and cargo compartment systems due to aircraft weight limitations.