Effect of ultrafine water mist on methane/air explosions in a close vessel with obstacles

Jingjie Ren[1], Mingshu Bi[1] and Xingyan Cao[1]
[1]Dalian University of Technology, Dalian, China.
Presenting author email: RenJJ@dlut.edu.cn

Abstract

[*Background*] The research of suppressing fires and gas explosions using ultrafine water mist has been motivated due to the phase-out of the halon extinguishing agents. Due to the complex interactive mechanism between the combustion process and the mist, there are many works need to be done to reveal the suppressing law. [*Objective*] This study mainly focused on the suppression process of methane/air explosions in a confined space with obstacles, which was a frequent accident form. [*Method*] A multi-phase computational model has been developed to study the interaction of the ultrafine water mist and the explosion flame of methane/air in a closed vessel with obstacles. The large eddy numerical model was used to analyze the explosion flow field and the partially premixed combustion model was adopted to calculate the combustion reaction of methane and air. The transfers of the mass, momentum and energy between explosion flame and water mist were calculated using discrete phase model. [*Results*] The results show that there formed obvious vortexes at the rear of the obstacle in the explosion flow field (Fig.1), and the turbulence intensity of the explosion flame front was enhanced gradually with progressing upward. The suppression effect of ultrafine water mist on explosion flame was achieved mainly through latent heat, then by sensible heat and momentum absorption (Fig.2). Under this condition, more concentrated mist would be needed to suppress the explosion. [*Main conclusions and recommendations*] For effective inhibiting the gas explosion with water mist in reality, the following suggestions are proposed: (1) the presence of obstacles should be avoid in confined space; (2) in order to achieve an outstanding inhibition effect, the spraying concentration should be adjusted with the increasing of the number of obstacles.

KEYWORDS: ultrafine water mist, methane/air explosions, confined space, obstacles.

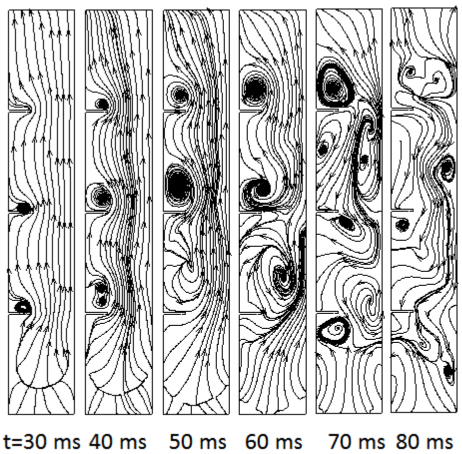

Fig.1 Effect of obstacles on the flow flied

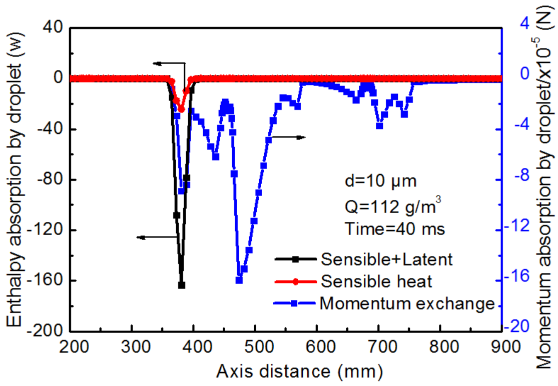

Fig.2 Comparison of energy absorptions