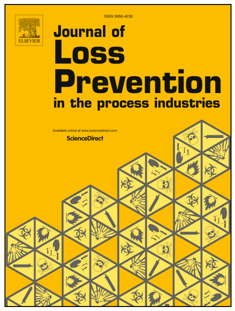

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Abstract

The thermal radiation impact of organic peroxide fireballs is experimentally assessed using an infrared camera. Fireballs are generated while liquid peroxide filled steel drums are subjected to gas burner fire at different heating rates. Three large burning clouds are observed with varying flame characteristics. Thermal radiation properties are assessed by infrared images with the presented methods. Despite of the two-dimensional temperature fields, the flames are treated and characterized as three-dimensional objects. Fireball diameters and heights are calculated based on a representing radiating sphere with the same cloud volume. By the use of the solid flame model and assumptions for emissivity and transmissivity, heat fluxes and thermal radiation doses against distance are predicted. Thermal safety distances are presented based on the maximum irradiance and the allowed exposure time. The validation of the maximum and time-dependent radiation fields is achieved through heat flux sensors in varying distances to the fireball. The results prove the use of an infrared camera and a volume based size calculation to fully assess the thermal radiation hazards of fireballs.

Keywords: fireball, thermal radiation, infrared camera, organic peroxide, safety distances

1. Introduction

Thermal radiation hazard assessment from industrial fires has been a matter of great interest in the past. The investigation of pool fire, jet fire and fireball incidents and their prevention mainly focus on the prediction of the thermal radiation impact on people and objects and the calculation of appropriate safety distances (Hailwood et al., 2009; Palacios et al., 2012; Planas et al., 2015; Bariha et al., 2016). Often, incident consequence modelling is based on semi-empirical equations and on several assumptions since experimental data for real scale are not available. Recordings from security cameras or videos made by eyewitnesses are often the only source of information to handle with available models, e.g. models for estimating fireball consequences (Casal et al., 2002; Mannan, 2005).
All evaluation models are based on experimental work where the flame characteristics can be recorded. The best way for characterizing flames is to capture the experiment with infrared cameras and measure the thermal radiation over distance using heat flux sensors simultaneously. By evaluating the data concerning flame sizes and temperatures, as well as the Surface Emissive Power (SEP) and the radiation impact are calculable.
Infrared cameras were used in the past for the assessment of jet fire radiation (Palacios et al., 2012; Zhang et al., 2015). Flames were characterized by means of temperature and shape to predict irradiances with distances to the fire. From a two-dimensional (2D) infrared image a three-dimensional (3D) flame represented by a cylinder was assumed (Palacios et al., 2012). Using the solid flame model for cylindric fires (Mudan, 1984; Hailwood et al., 2009) the shape specific view factor was calculated and used for the irradiance prediction.
In an analysis of hydrocarbon pool fires, a 2D approach was used for the view factor calculations (Muñoz et al., 2004). The flame was treated as a plane and the view factor was calculated for each pixel of the infrared images. In summation a total view factor was achieved and the irradiance over distance predicted. In this approach the radiation close to the fire is generally under-predicted. The image plane is in the middle of the pool and hence the radiation decreases towards the pool rim

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