Congress on Numerical Methods in Engineering CMN2017
Valencia, 3-5 July, 2017

CFD analysis of a pool fire in an offshore platform

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ABSTRACT

Offshore platforms have been widely used in offshore oil and gas exploitation. Super-structures (topside) in most cases are common features associated with the various types of offshore platforms. Topside consists of a number of modules that host different equipment (gas turbine, pumps, gas flare stack, living quarters with hotel). Most of these modules are highly congested with the presence of obstacles in the form of pipelines, cables and other equipment necessary for process operations. The level of risk in such conditions is very high. Explosions followed by hydrocarbon fires are the most frequently reported incidents on offshore platforms. These fires predominantly occur in well-ventilated open decks, involving burning oils and gaseous components with an enormous release of energy.

Most of available research work on fires in these conditions was not conclusive because the heat flux calculation in open fire compartments is still very difficult to characterise. EC1-1-2 presents a simplified calculation model performed by Heskestad. However, this method shows some limitations: only the temperature in the plume is calculated and, if the wind effect is considered, this method is no longer applied.

In this paper, the study case corresponds to a "fictitious" fixed offshore platform, which dimensions are based on the typical offshore platforms. It is defined as an open structure, composed by three main decks and two intermediate decks in between, everything supported by steel frames. The fire loading reproduces an accidental crude oil release, which spreads on the first level of the topside (left side) and results in a localised pool fire. A full-scale model of the topside platform is constructed in FDS6.3.2 software, in order to analyse the development of smoke and temperature. To decrease the run time symmetry was introduced to the model. The dimension of the computational domain is 44.0 m by 22.8 m by 23.6 m, which is slightly bigger than the half of the offshore platform. Appropriate boundary conditions are considered for simulating the symmetry plane. Several fire scenarios are studied; the difference between them is embedded in the fire area and the wind conditions. The characteristic fire diameter (D*) ranges between 2.2 m and 7.9 m. Simple pyrolysis model is used by defining a gas burner with a specified heat release rate per unit area (HRRPUA). For the case with no wind HRRPUA = 1920 kW/m^2; while for 5 m/s wind velocity, Blinov and Khudiakov proposal is considered: HRRPUA = 2050 kW/m^2.

Results are presented in terms of heat flux, temperature, heat release rate and smoke layer. In addition, a comparison with analytical methods is proposed in relation to the main outputs.