Resistance to jet fires of passive protection materials: numerical evaluation of thermal loads

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ABSTRACT

Jet fires from high pressure leakages represent a severe hazard on petroleum, petrochemical and gas plants, especially in offshore structures. These fires give rise to high convective and radiative heat fluxes, and high erosive forces when the jet impinges an element. The solicitations imparted to the tested products cannot be reproduced in conventional furnaces to evaluate its fire performances.
Thus, the jet fire facility according to the ISO 22899-1 Standard [1] was adopted. It allows the simulation of a large scale jet fire on full size elements, but smaller than typical items of structure and plant. This test is designed to give an indication of how passive fire protection materials will perform.

The aim of this study is to propose and validate a numerical model of the testing facility designed with the CFD code FDS [5]. Because of the low Mach number approximation and the limitations of the code, the model focuses only on thermal loads close to the tested elements. Therefore, the main hypothesis assumed for the simulations is to focus only on the prediction of thermal loads near the target and the second part of the jet downstream the lift-off area, where combustion takes place and where the Mach number of the flow is coherent with the incompressible formulation of FDS. Typical external and internal configurations described in the reference Standard are modeled and the resulting flame characteristics and thermal loads are compared with experimental results 000.
In this study, only results for the internal configuration and external configuration with a fire protection coating section are presented. The thermal solicitations for tested specimen in terms of heat flux, velocities and temperatures are compared with experimental results. A fairly good agreement is found for each quantity. Once thermal solicitations on the specimen are calculated, boundary conditions are evaluated and applied on the exposed side of the material, considering a mapping due to thermal loads inhomogeneity. A thermal transfer analysis into the element is performed with the finite element code SAFIR [6]. The temperature evolution in the protection material is then assessed and optimizations for the protections can be investigated.

The virtual jet fire model can then be used to optimize a protection material configuration. However, no mechanical loads are considered in this study. This will be a next step for the jet fire facility modeling.

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