Effect of Confinement due to Parallel Vapor Barriers on Vapor Cloud Overpressures

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Abstract

Two of the main components that affect the overpressure produced from a vapor cloud explosion (VCE) are congestion and confinement - congestion being created by smaller obstacles (e.g. piping) that create turbulence and flame acceleration, and confinement being due to larger obstacles (e.g., walls) which limit venting of gases and combustion products.

Within the context of LNG facility siting applications, concerns have been recently raised regarding the potential for overpressures being produced if a flammable vapor cloud is confined between parallel rows of vapor barriers and ignited. The concern is that the vapor barriers, which are used to impede flammable vapor from dispersing offsite or to other sensitive areas, may allow the vapor to accumulate and, in case of ignition, may provide enough confinement to produce potentially dangerous overpressures.

In order to study the effect of this confinement on VCE overpressure, a parametric study has been performed using the CFD software FLACS. Idealized clouds of a flammable hydrocarbon and a reactive hydrocarbon mixture have been considered while varying the gap between vapor barriers, the congestion levels within the gap, the cloud ignition locations, and the strength of the barriers (i.e., the yield pressure). The scope of the parametric study was to predict whether the overpressures from the confined scenarios could pose higher threat to the public than the overpressures from identical, unconfined clouds.

Simulation results show that the overpressures resulting from an uncongested VCE confined by vapor barriers are unlikely to cause a threat to public safety, in each case failing to penetrate barriers of even light sturdiness. The congested cases show that the overpressures are only marginally affected by the confinement due to the vapor barriers. This is presumably due to the yield pressure of the barriers causing the confinement to succumb to the explosion pressure, relieving the confinement before the overpressures become too high.