FORCED DISPERSION OF HEAVY GAS CLOUDS BY WATER CURTAINS EXPERIMENTAL & NUMERICAL APPROACHES

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Water curtains efficiency in dispersing a heavy gas cloud is investigated as a mitigation tool typically applicable in petro-chemical and gas industries.

A water curtains action on a gas cloud may be threefold: the mechanical dispersion due to the air entrainment within the sprays, the dilution by chemical absorption and the buoyancy effects by heat exchange. This thesis emphasize on the mechanical dispersion induced by the sprays in terms of air entrainment.

The objectives are to evaluate the water curtain efficiency with respect to the operating conditions, and define the critical parameters required. For this purpose, three different approaches are undertaken. First, field tests are performed to simulate under real conditions, gas cloud behaviour in front of a water curtain. In this manner three dimensional effects are accounted for. Secondly, Wind Gallery experiments simulate the same problematic in two dimensions. This is needed to perform some parametrical investigations that are to complex to carry out on the field. At last, numerical methods are tested in order to evaluate their capability to simulate the gas cloud behaviour in front of a water curtain.

In this manner, a comparative investigation leads to a clear understanding of the gas cloud behaviour under forced dispersion. First, it is highly related to the water-to-wind momentum ratio. The higher the ratio, the more the water curtain will behave as a moving obstacle in front of the cloud. The cloud is then blocked and affected by an air flow that obliges it to recirculate upwind the water curtain. In this manner, the forced dispersion of the cloud is enhanced with low wind velocities and high water flow rates in the water curtain. This effect is observed in the three approaches. In fact, efficiencies of 90% are achievable for water-to-wind momentum ratios close to 10.

The water curtain to gas cloud height ratio is found as an essential parameter for an optimal effect. The dispersion is enhanced if the entrained gas by the water curtain also consists of fresh air and not only pollutant gas. As a practical rule, water curtains more than twice the height of the gas cloud are recommended.

By numerical simulations, the evolution of the dilution factor with respect to the distance to the source demonstrates that the peak value actually takes place between the source and the water curtain. Next, it constantly decreases with the distance. Again, the higher the water-to-wind momentum ratio, the more efficient is the water curtain; the protected area also increases with the same ratio.

At last, a simple wind model is introduced and fitted to field test results. It demonstrates that high efficiencies are difficult to reach for wind speeds larger than 6 m/s.

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