NUMERICAL SIMULATION OF THE HEAT TRANSFER IN LIQUID SPRAYS

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It is very common practice in industry to store chemicals in pressurized and often abnormally cold liquid phase as to significantly reduce their volume. In case of the industrial accident with a leakage of the chemical, the evaporating gas is usually heavy and forms a creeping dense cold cloud, which has very poor mixing with the surrounding air under calm stable atmospheric conditions ($U < 2\ m/s$). The ground concentration of the gas exceeds health risk limits and therefore the forced dilution has to be used.

The water spray curtain is often used as a barrier to the slowly advected gas cloud. The water spray curtain is a multiphase flow, where water is sprayed in air from a rake of nozzles. Inside the water spray curtain strong momentum, heat and mass exchange exists between phases. The exchange of momentum and heat provides significant forcing to the dense cold gas cloud, which in turn becomes mixed with surrounding air.

The water spray and the water spray curtain have been simulated numerically by means of the numerical package Fluent. The numerical simulation of the single axisymmetric water spray curtain has shown the importance of droplet phase changes. Several ambient conditions have been taken into account including freezing temperatures. In order to model the heat exchange under droplet freezing conditions, the User Defined Function with accurate phase change physics of droplets has been developed. Numerical simulation of the single spray has been validated by comparing predicted gas entrainment with published data.

The two dimensional water spray curtain in cross wind has been simulated with four different mass flow rates. Two gases for the cloud have been selected (Liquid Natural Gas LNG, Chlorine Cl_2) so as to simulate dilution and heating of various clouds. The cold LNG gas cloud has been found to be diluted better than the dense gas cloud of Chlorine. Satisfactory comparison of the dilution factor with field test data and Wind Gallery WG1 experiments has been found and is shown in figure 1.

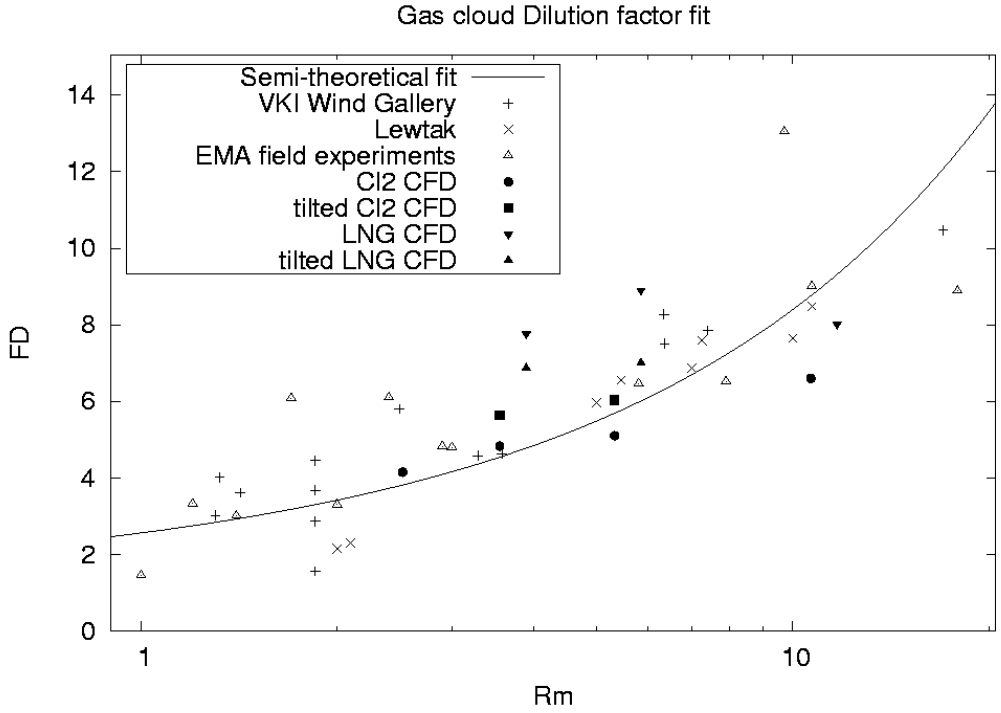

Figure 1: Dilution factor FD correlation to the water spray curtain momentum ratio Rm