NUMERICAL MODELLING OF LIQUID SPRAYS

Robert Lewtak, Poland
Supervisors: J.-M. Buchlin & P. Rambaud

The objective of the project was thoroughly numerical study of the mitigation of industrial hazards caused by release of toxic substances like chlorine. Usually water spray curtains are used in industrial applications to decrease the concentration of the release substance.

If spray-to-spray overlapping is neglected, the dynamic around and in a water spray curtain is equivalent to the one belonging to a single spray. So, the detailed single spray numerical simulation has been carried out to learn how to correctly simulate various real parameters for the single spray. The spray has been modelled as a discrete phase in Eulerian-Lagrangian model. Using the discrete phase in Fluent, one has to set the spray as injections of the discrete phase. The numerical results of this stage were validated with experimental results what shows reasonably good agreement. Figure 1 shows the air velocity profiles to calculate the air entrainment into the spray. The problem of distribution of the spray injection and mass flow rate per one injection was successfully solved.

Next, the dilution of heavy highly-concentrated cold gas release by the water spray curtain has been numerically simulated as shown in Figure 2. The numerical simulation was compared to measurements previously performed at the VKI, showing a remarkable agreement. The numerical simulations were conducted for different values of the curtain-to-wind momentum ratio. The effectiveness of the dilution is given in terms of the dilution factor. The dilution factor has been plotted as a continuous function of the distance from the curtain. Finally, the comparison of the dilution factor obtained from the current numerical simulations with other results shows coherence of all the results.
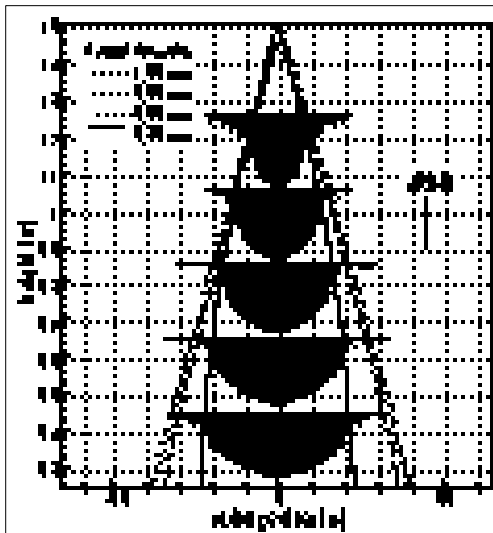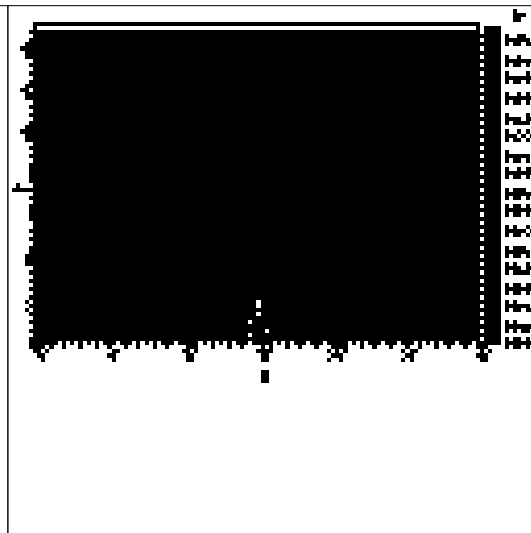

Figure 1: Air velocity profiles in the spray

Figure 2: Contour in Cl_2 concentration for the dilution of heavy gas release by the water spray curtain