# OPTICAL DENSITY AND VELOCITY MEASUREMENTS IN CRYOGENIC-GAS FLOWS


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The widespread storage and transport of chemicals and liquefied gases like propane can result in the accidental release of dense gases into the environment. Examples of such releases include the accidents in Flixborough in England (1974) and Mexico-City (1984) with thousands of casualties. Therefore, understanding the behavior of these released dense gases is still of major concern in current safety studies.

Gases are called heavy or dense gases when their density is higher than the density of the ambient air. The spreading behavior of gases strongly depends on the density ratio of the gas to the ambient air. With a density close to the one of the ambient air the behavior is mostly passive, i.e. the gas moves with the prevailing flow conditions of the surrounding air. Contrary to this behavior, gases with a density higher than the ambient air are driven by gravity along the ground.

The propagation behavior of cryogenic gas clouds in a heavy-gas channel is studied with image correlation velocimetry (ICV) and background oriented Schlieren (BOS) in combination with supplemental thermocouple measurements. These cryogenic gas clouds are generated by evaporation of liquid nitrogen. The release scenario is based on the continuous release of cryogenic nitrogen evaporated by electrical heating over a time interval of up to five minutes. This release scenario is investigated in the context of the propagation over a horizontal surface. With the implemented diagnostics the two most important parameters velocity and temperature are determined for the different propagation scenarios at several positions in the channel.

The velocity measurements are conducted with a planar velocimetry system. It makes the extraction of two-dimensional velocity-vector maps possible. Ice-particles, which are generated during the evaporation process of the liquid nitrogen, are used as markers. Additionally, the surrounding flow is seeded with talcum powder.

The combination of a background oriented Schlieren (BOS) system and thermocouples allows the extraction of two-dimensional temperature profiles that are averaged over the width of the heavy-gas channel.

Both measurement methods for velocity and temperature are implemented and evaluated for their performance in the experimental context encountered in the heavy-gas channel. The results obtained with both systems are used to quantify the dilution behavior of the propagating cloud through a global entrainment parameter $\beta$. Its value agrees well with the results obtained by earlier studies.