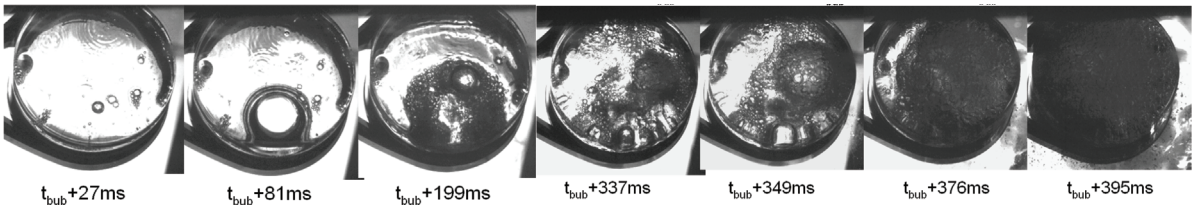
EXPERIMENTAL CHARACTERIZATION AND MODELLING OF HAZARDS: BLEVE AND BOILOVER

Nowadays, more and more industrial sites include storage facilities of tanks filled with hydrocarbons or compressed liquids that can be either toxic or flammable. In case of an accident, these vessels can rupture explosively and lead to generation of BLEVE or Boilover phenomenon depending on the type of reservoir and liquid.

Allowing secure small scale experiments, the VKI BABELs facility (**B**leve **A**nd **B**oilover **E**xperimenta**L** **s**etup) consists of a cylindrical chamber of 2m diameter and 3m high, with round shape flanges, made out of steel with a rated pressure of 0.5 MPa. It has 3 series of 7 optical accesses, an entrance door, and an optional air venting system.

BABELs

BOILOVER



Bottom visualization of evaporation front at Boilover onset for lamp oil experiment

A Boilover is a violent ejection of fuel due to the vaporization of a water sublayer, resulting in an enormous fire enlargement and formation of fireball and ground fire. Small scale experiments with cylindrical reservoirs of 0.08 to 0.3m diameter in glass or metal, filled with a mixture of diesel and oil have been performed.

At Boilover onset, high speed visualizations in glass reservoir show that the growth of one big vapour bubble leads to a water boiling front that spreads radially all along the fuel-water interface. That results in the ejection of the fuel layer and the increase of the flame size. Such an experimental finding confirms that the vaporization of the water layer is homogeneous and produces a piston effect.

Flame enlargement during Boilover (Dt=0.2s)

BLEVE

A BLEVE (or Boiling Liquid Expanding Vapour Explosion) is an explosion resulting from the catastrophic failure of a vessel containing a liquid at a temperature significantly above its boiling point at normal atmospheric pressure. BLEVE accidents appear mostly when the tank is engulfed in fire. The heat increases wall temperature and internal pressure and induces wall-thinning and/or formation or fissures. The vessel then fails; vapour is ejected and the pressure drop caused by the rupture is superheating the liquid that boils rapidly and violently. This rupture generates a blast wave and if the liquid is flammable, it could ignite and form a fireball.

BLEVE phenomenon (Wikipedia)

The study is based on small scale experiments performed with cylinders of propane, laid horizontally and heated from the bottom by an electrical resistor. A weakening of the reservoirs on the upper part allows better reproducibility of the rupture. High speed visualisation and shadowgraphy techniques help the tracking of the rupture and content release. These experiments show that the fluid behaviour during rupture depends on the size of the weakened part and therefore on the rupture pressure.

Shadowgraph of BLEVE rupture with 80mm weakness (left), 40mm (middle) and 10mm (right)

This research project is carried out in the frame of a collaboration between the von Karman Institute (VKI), the École des Mines d'Allès (EMA) and the CEA Gramat.

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