EXPERIMENTAL CHARACTERIZATION AND MODELING OF HAZARDS: BLEVE AND BOILOVER

Delphine Laboureur, Belgium
Supervisors: Prof. P. Rambaud & Prof. J.-M. Buchlin
Promoters: Prof. J.-M. Buchlin (ULB, Belgium) &
Prof. G. Dusserre (Ecole des Mines d'Alès, France)

Nowadays, more and more industrial sites include storage facilities of tanks filled with hydrocarbons or compressed liquids that can be either toxic or flammable. The objective of this thesis is to study the criteria of apparition and the consequences of an accident involving a container of pressure liquefied gas (BLEVE phenomenon) or liquid fuels (Boilover phenomenon). After a bibliographic research on the two phenomena, an experimental study in laboratory scale is performed and from the results, a modeling of the phenomena and their hazards is ongoing. Small scale experiments are performed in the BABELs facility (Bleve And Boilover ExperimentaL setup) that 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.

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. Instrumentation of the measurements consists of thermocouple rakes, Medtherm radiometers, a load cell and a CCD camera with a fisheye. At Boilover onset, high speed visualizations in glass reservoir (see Figure 1) show that the growth of one big bubble leads to a boiling front that propagates radially all along the fuel-water interface, ejecting the upper fuel layer and leading to the increase of flame size, as observed during Boilover phenomenon.

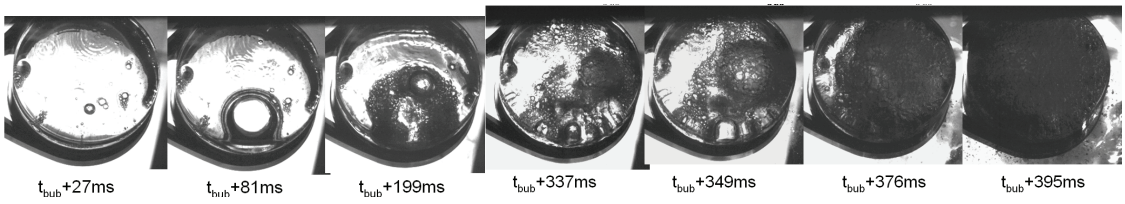

Figure 1: High speed visualization of Boilover onset (80mm reservoir and lamp oil)

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. Small scale experiments are performed with cylinders of 42g of propane, laid horizontally and heated from below by an electrical resistor. A weakening of the reservoirs on the upper part allows better reproducibility of the rupture. High speed visualization and shadowgraphy are helping in visualizing the rupture and the content release. Thermocouples and PCB are also used to measure respectively the temperature and the blast wave. These experiments show that the fluid behavior (as observed in the shadowgraph image in Figure 2) during rupture differs with the size of the weakened part and therefore with the rupture pressure and that the rupture pressure and temperature are supercritical, leading to the definition of a new type of BLEVE since there is no distinction between liquid and vapor prior rupture.

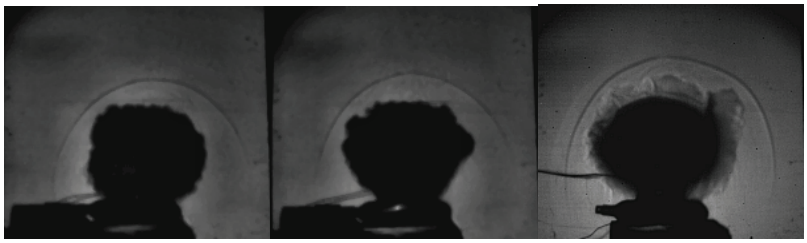

Figure 2: Shadowgraph of BLEVE rupture: 80mm weakness (left), 40mm (middle) and 10mm (right)

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