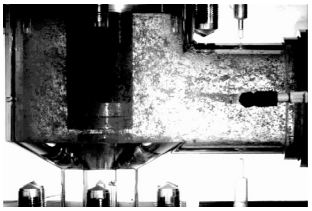
MULTIPHASE FLOWS

Two-phase and free surface flows encountered in engineering and industrial processes constitute a major field of research in the EA department. Experimental and CFD tools have been developed to study several types of these complex flows.

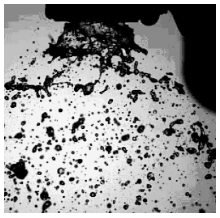
Gas-evolving electrodes are systems in which gas bubbles are produced by heterogeneous reaction as encountered in electro-chemical processes. The formation of micro-bubbles in such reactors has been modelled to describe their influence on the net mass transfer and the occurrence of gas film formation leading to reaction shut down.

Lance bubbling technique, widely used to enhance the chemical reaction in the manufacturing of materials used in advanced technologies has been experimentally and numerically investigated. Unsteady phenomena associated to bubble growth have been modeled and the correlations for bubble detachment frequency has been established and validated.

Experimental simulation of lance bubbling

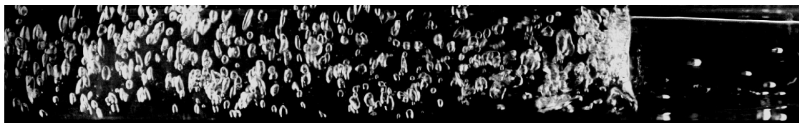


Bubbly flow in safety relief valve



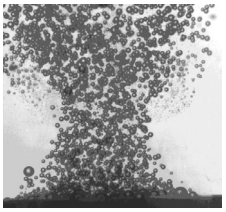
Instantaneous visualization of liquid spray formation

The performance of safety valves used in nuclear and chemical industry is not yet well estimated under two-phase flow conditions. That issue has been deeply explored in close collaboration with the French company CETIM. The methodology adopted consists in studying first bubbly flows in divergent, convergent and bend ducts to derive robust pressure drop correlations and to establish two-phase flow regime map. Then a detailed analysis of two-phase flow in a transparent model of relief valve has been undertaken.

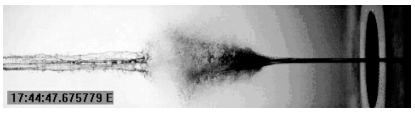


Bubbly to slug flow transition

A dedicated facility instrumented with Phase Doppler Interferometer is continuously operating to provide diagnosis of liquid spray behavior in different operating conditions. Single and multiple nozzle configurations have been tested with Newtonian and non Newtonian liquids, respectively. The knowledge of the droplet size distribution and mass flux mapping allow relevant design of water curtains for mitigation of industrial hazard consequences and cooling units for metal strip treatment.



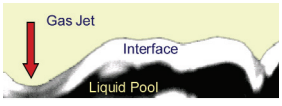
Micro-bubble formation in electrochemical reactor



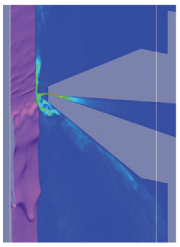
Instantaneous visualization of liquid flashing jet

When a liquid stored at a high-pressure in a reservoir is suddenly flowing through an opening to the atmosphere experiencing superheated condition, the resulting liquid jet boils rapidly. This mechanism called flashing jet has been extensively experi-mentally and numerically studied at the VKI in the frame of the European Flashing Liquids in Industrial Environments (FLIE) project. The research proceeds further analyzing the occurrence and characteristics of such phenomenon in liquid fuel reservoir of satellites.

Free surface flows resulting from the impingement of a turbulent gas jet onto a liquid pool or thin film as found in jet wiping process and water entrainment in automotive air conditioning lines are currently studied at the VKI. Dedicated facilities have been developed where high speed visualization combined with the Level Detection and Recording (LeDAR) technique, two-phase PIV and light absorption method are applied. In parallel numerical 3D simulation relying on LES and VOF approaches are conducted.



Impingement of gas jet on liquid pool LEDAR technique



3D LES-VOF simulation of jet wiping

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