SIMULATION OF SURFACE INSTABILITY OF A LIQUID POOL SUBJECTED TO A SHEAR FLOW

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In this theoretical and numerical project, the physical mechanisms leading to the production of surface waves generated at the interface of two fluids (liquid/gas or liquid/liquid) are investigated. A particular attention is devoted to the Kelvin-Helmholtz type instability appearing in the area of high shear located at the fluid-fluid interface. The subsequent disturbances in velocity and pressure associated with the wave motion are assumed 2D and sufficiently small to justify the linearization of the equations of the motion. Navier-Stokes, Orr-Sommerfeld, Kelvin-Helmholtz Darcy (KHD) equations are mainly considered to investigate the surface instability.

During the project, the main characteristics of surface instability such as wavelength, amplitude, wave speed and growth rate are investigated according to various physical parameters (density, surface tension, dynamic viscosity) of the fluids. The effect of the gravity is analysed through 2D simulations configurations of horizontal flow as well as vertical co- and counter flow configurations (See figures below).

FFT analysis is providing the values of the dominant frequency and wavelength. This last quantity is compared when the fluids are in the linear instability regime with KHD theory.

In spite of difficulties to extract the FFT contents, the results are matching well with the theory for horizontal case. Prediction of the unstable region characteristics is possible with this methodology together with the correct prediction of the transition of the waves from linear to non-linear regime.

For vertical flow, the representation of the gravity field with the periodic assumption is presenting a numerical difficulty to keep a constant mass flow rate for each individual phase.

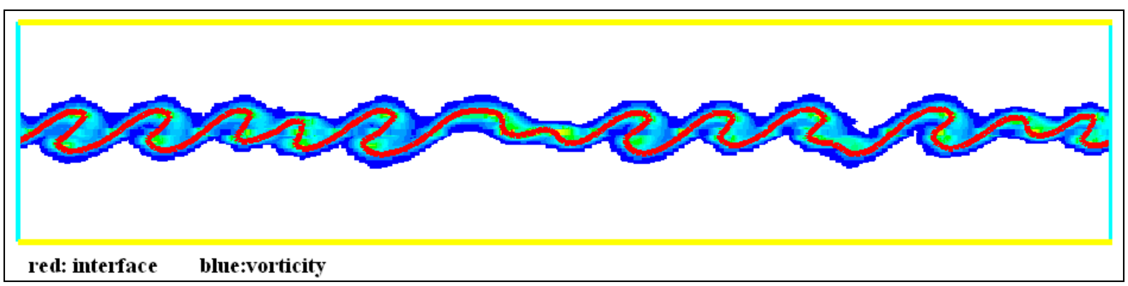

Figure1: Illustration of the interface (in red) with iso-contours of major vorticity (in blue) at time 0.17s.

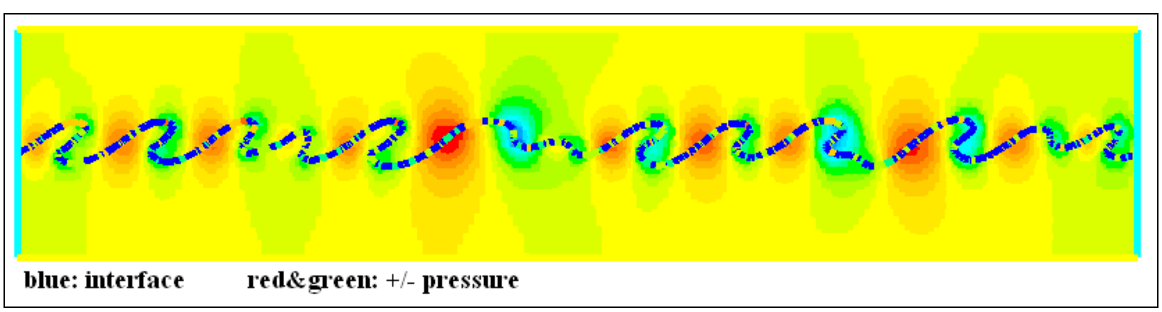

Figure 2: Illustration of the interface (in blue) with iso-contours of the 'periodical pressure' (red & green) at time 0.17s.