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Visualization of the Rise of a Bubble in a Two-Dimensional Air-Fluidized Bed

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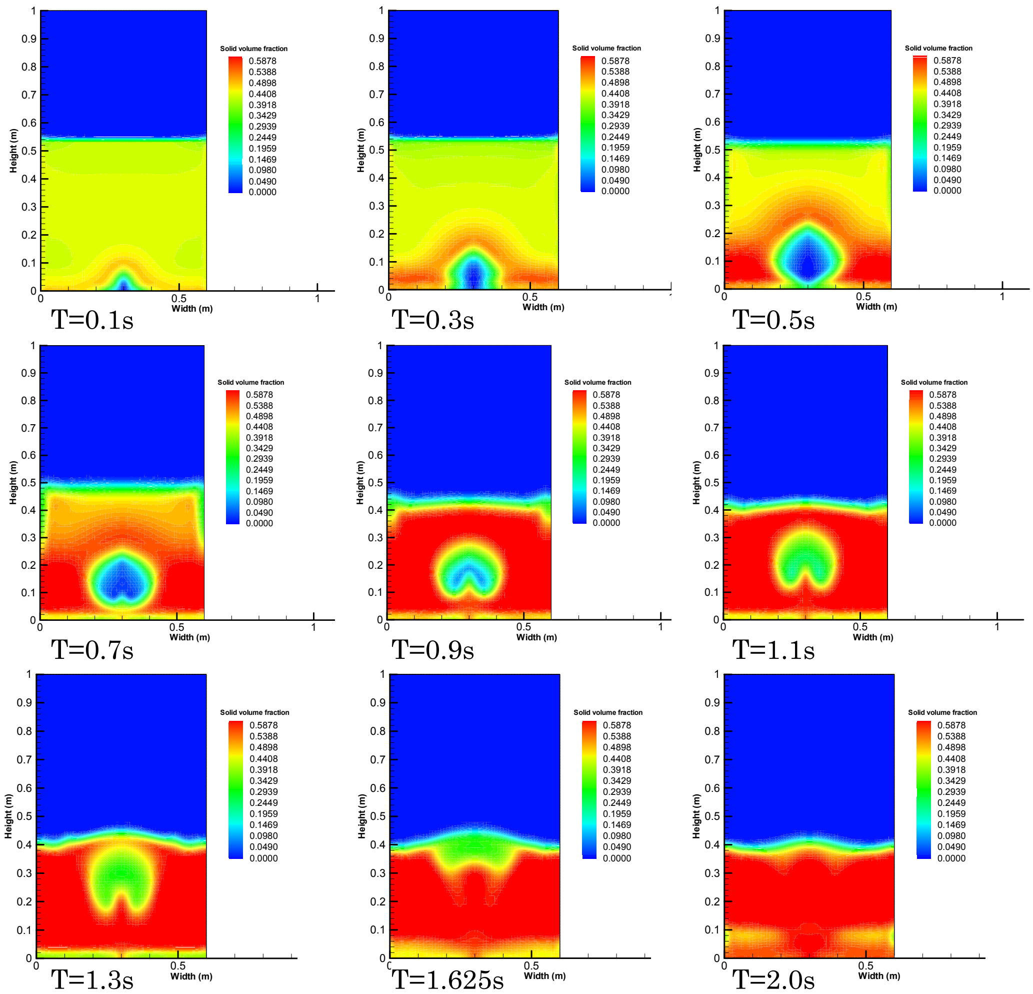

Fig. 1. The numerical results of the formation, rise and cracking of a bubble.

A two-dimensional air-fluidized bed of 600 mm width and 1000 mm height was studied to investigate the formation, rise and cracking process of a bubble. The particles were assumed to be regular round particles of diameter 4 mm. The RNG k-ε model was employed for the turbulence, and the time integration scheme is the first order implicit difference with the time-step 0.0001 s. The equations were spatially discretized by the finite volume method, and the SIMPLE algorithm was used to solve the pressure-velocity of fluid.

It is found in Fig. 1 that when the bubble rises, part of the gas remains inside the bubble, while some other gas escapes from the bubble at the top arch, then passes through the emulsification layer surrounding the bubble, and finally returns into the bubble at the bottom side to form a cycle around the bubble. The motion and mixture of particles in the air-fluidized bed are mainly caused by the motion of bubble.

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Vortex Pairing

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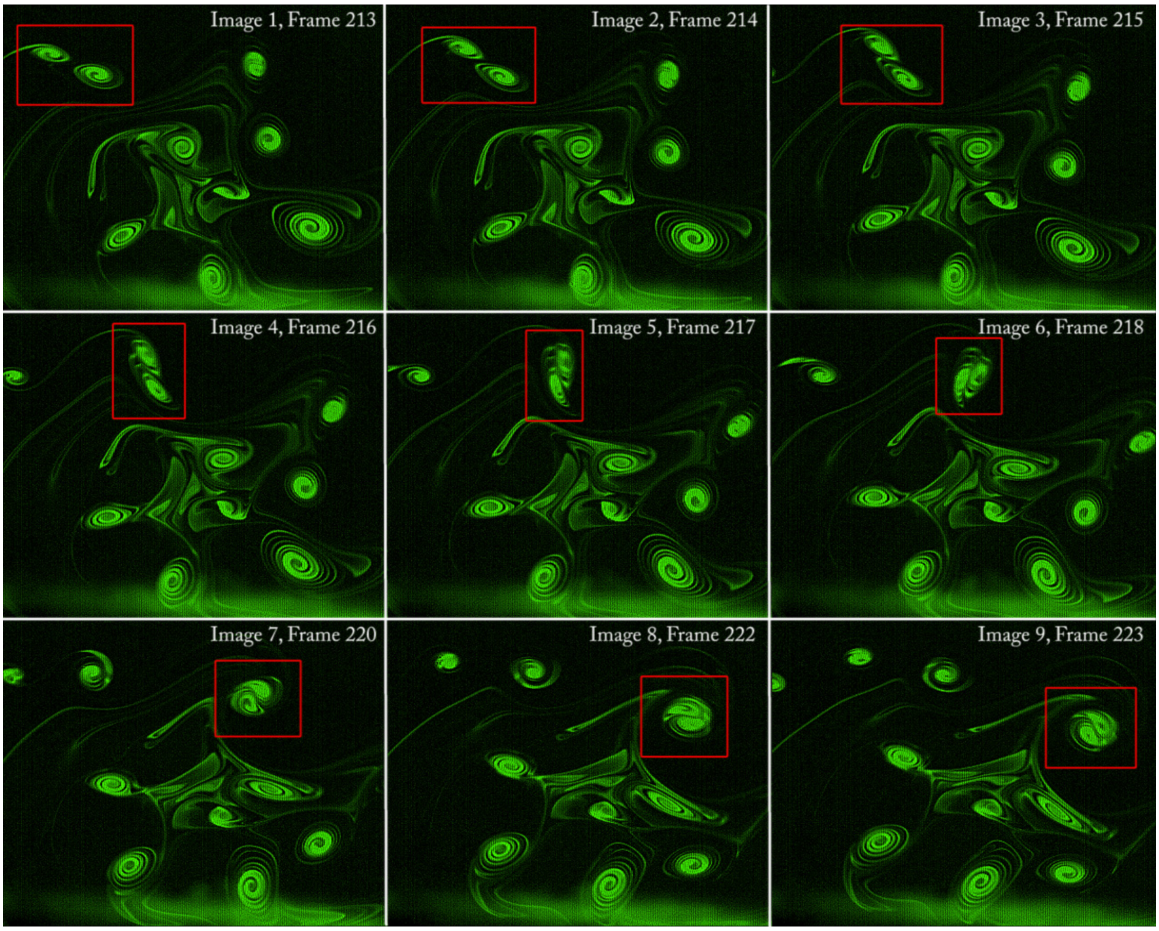

The progression of images represents transient airflow over a 5.08 cm (2.00 in) high fence. The flow images were acquired within a two-dimensional aircraft nacelle simulator. This simulator is 0.23 m high and 1.83 m wide (0.75 ft and 6.00 ft respectively). The main flow direction is left to right. Each image is labeled with the number of frames from the flow startup and with a number designating the order. The images progress from one to nine. Smoke was generated using incense sticks placed at the upstream corner of the fence. A 1000 W tungsten light and a high-speed digital camera were used to illuminate and acquire the smoke images at 240 frames per second (4.17 ms between frames).

Shear layer vortices can be seen forming and rolling up in the recirculation region behind the fence. The fence is located 2.54 cm (1.00 in) to the left of each image. This image sequence highlights within the red box the motion of two vortices undergoing a pairing interaction.

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Velocity and Temperature Fields Measurement Using Thermochromic Liquid Crystals

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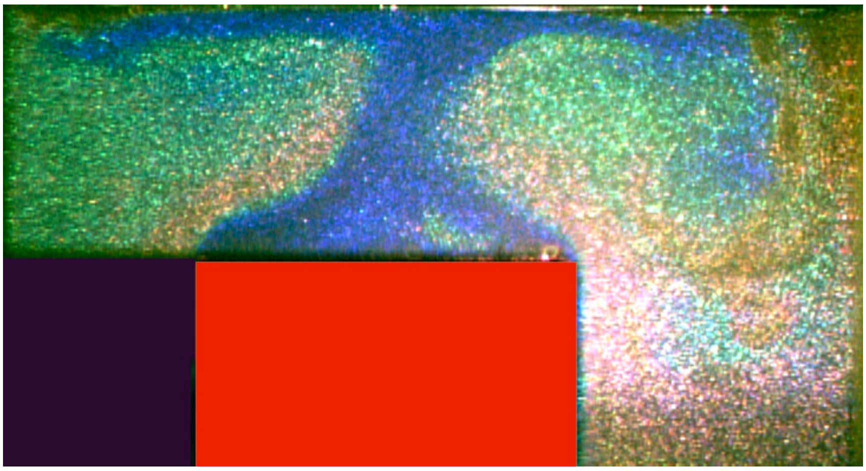

Fig. 1. Flow visualization.

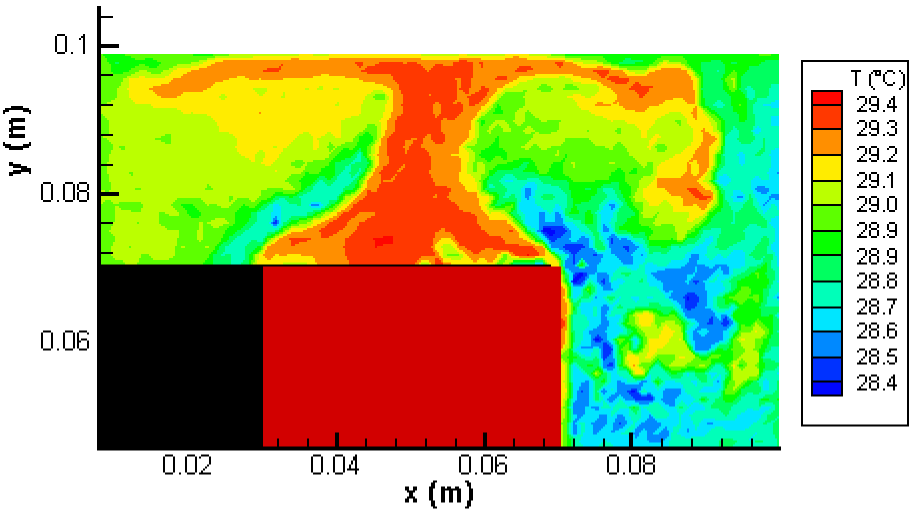

Fig. 2. Temperature field.

Based on a particular property of some liquid crystal to reflect a specific wavelength for a specific temperature, Particle Image Velocimetry and Thermometry (PIVT) is a method allowing to measure simultaneously velocity and temperature fields. The studied flow is seeded with Thermochromic Liquid Crystals (TLC) and illuminated with a white light sheet. In front of this light plane, a CCD color camera records particle images. The color of particles provides the temperature fields whereas, the particle displacement between two images gives the velocity field.

Formation of Vortex Systems on Soaring Interfaces Inside Attached Internal Waves Past Horizontal Cylinder Starting to Move Uniformly in a Linearly Stratified Fluid

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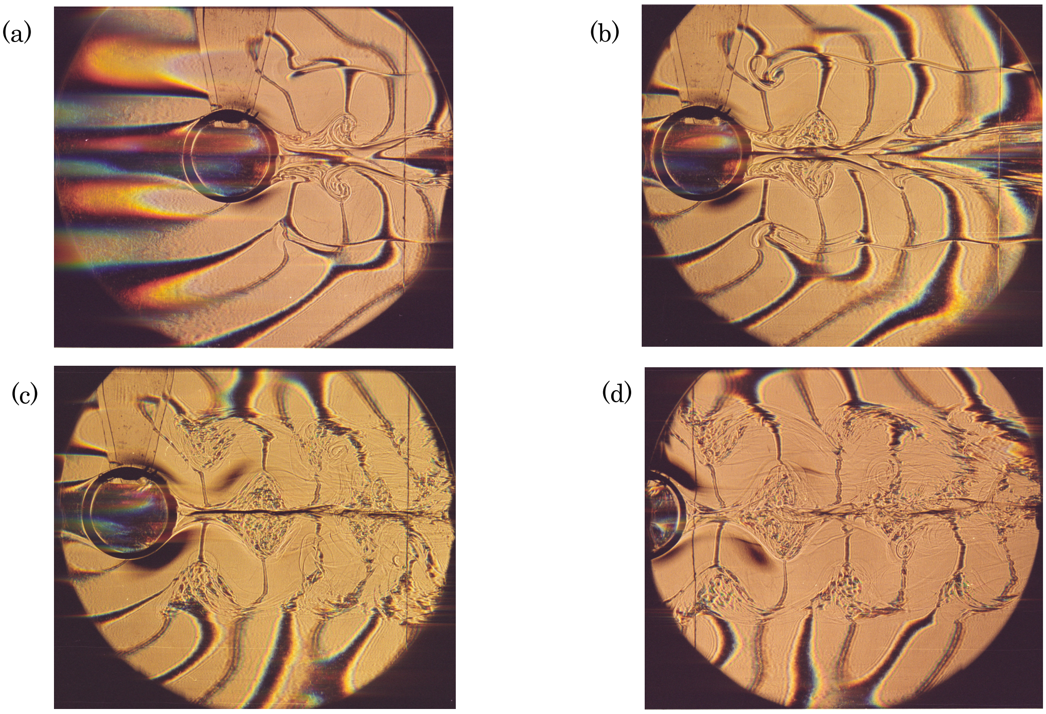

Schlieren images of flow induced by starting horizontal cylinder in a continuously stratified liquid (buoyancy period is $T_b = 13$ s). Method is “vertical slit-thin thread in focus”, colouring of image is caused by natural dispersion of light in the salt brine, and diameter of view field is 23 cm (Chashechkin, 1999). The cylinder of diameter $D = 5$ cm is towed with velocity $U = 0.35$ cm/s; the internal Froude number is $\mathrm{Fr} = U/ND$ = 0.14, the Reynolds number is $\mathrm{Re} = 175$. Evolution of the flow with time after beginning of the motion: (a) – forming soaring interfaces, time from start of the motion, normalized on the buoyancy period, is $\tau = t/T_b = 3.9$; (b) – gradual formation of vortex pairs on leading edges of soaring interfaces, $\tau = 5.8$; (c, d) – vortex systems in phases of formation $\tau = 25$ and stabilization of the flow, $\tau = 28$.

Note : The motion is from right to left, sloping rays of transient internal waves ahead of the body bound upstream disturbance on the horizon of the cylinder. Downstream wake with embedded vortices is bounded by thin interfaces. Curved black lines visualise crests and double grey lines are troughs of waves. Positions of embedded vortices as well as crests and troughs of attached internal waves are synchronised. In Fig. (a) crests and troughs come to the same point on different sides of interfaces opposite large vortex bubble embedded inside downstream wake. Internal waves deform the density wake and soaring interfaces. New vortex structures are placed between embedded vortex bubbles. Distinctive vortex pair in Fig. (b) shows that the vortices are produced by incoming fluid interacting with external opposite flow. Soaring vortices distort shapes of internal waves in Fig. (c, d).

Reference : Chashechkin, Yu.D., Schlieren Visualization of a Stratified Flow around a Cylinder, J. of Visualization, 1999, 1-4, pp. 345-354

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The Vibration of Flexible Plate Caused by Vortices Using Fluid-Solid Coupled FEM

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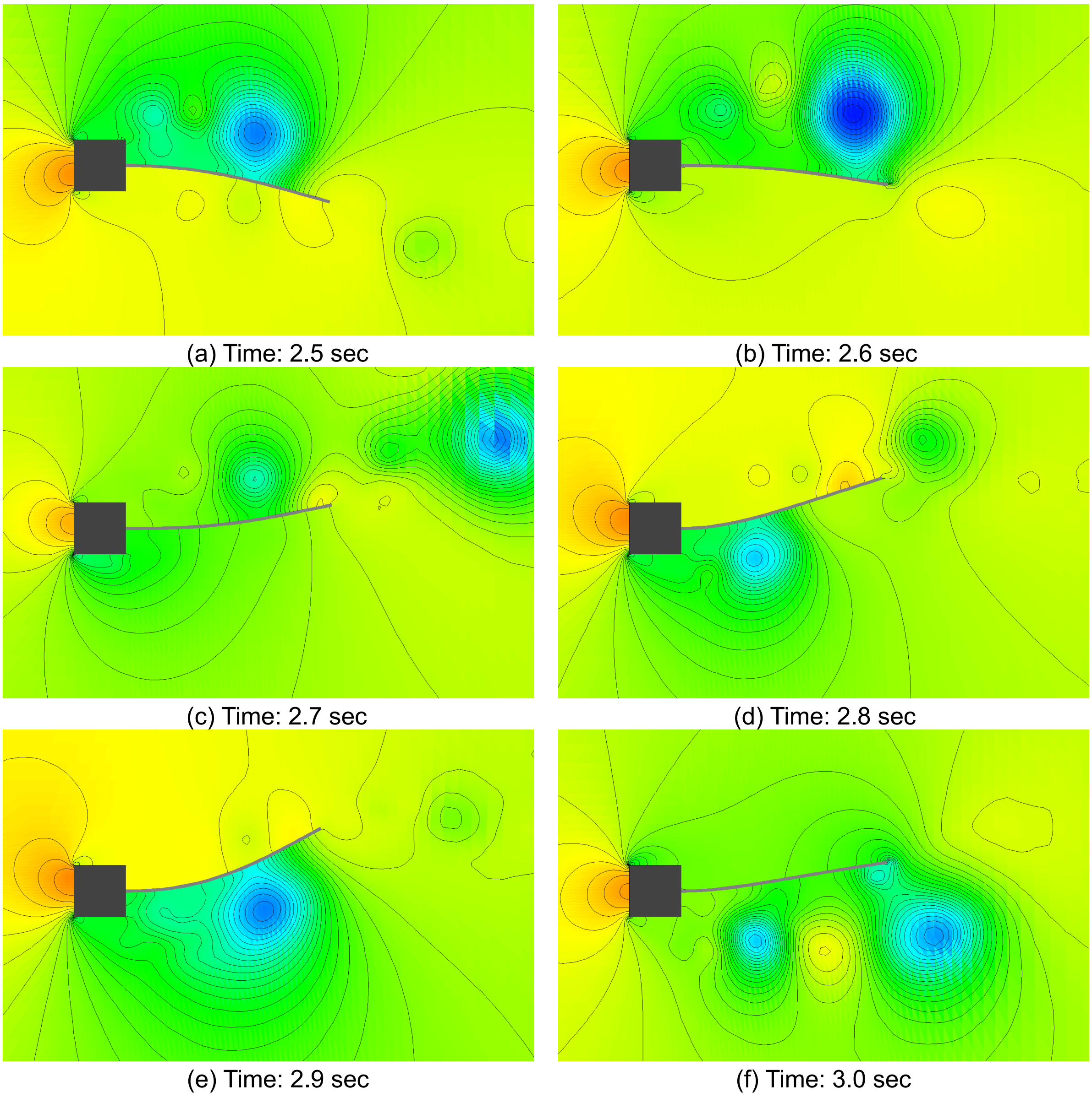

(a) Time: 2.5 sec (b) Time: 2.6 sec (c) Time: 2.7 sec (d) Time: 2.8 sec (e) Time: 2.9 sec (f) Time: 3.0 sec

Fig. 1. The appearances of plate vibration and pressure contours.

In recent years, much attention has been paid to a fluid-solid coupled analysis. The deformation of solid wall which is caused by flow is one of important mechanical problems. Because solid wall influences the flow field, the phenomenon becomes very complex. We simulated the flexible plate vibration caused by shedding Karman vortices. A rubber-like plate joined to a rigid quadrilateral prism locates in air flow. We simulated this phenomenon using ALE (Arbitrary Lagrangian-Eulerian) GSMAC (Generalized-Simplified Marker and Cell)-FEM. Figure 1 shows the appearances of plate vibration and pressure contours for a period. The difference of fluid force by shedding vortex on both sides of the plate begins the vibration.