gunt
HAMBURG

HM 132 Vertical visualisation of flow fields

✓ Patented

Fine gas bubbles are perfectly suited to visualising flow fields. Due to analogies, many flow processes that occur in air can also be demonstrated by experiments in water.

The trainer consists of a vertical experimental section in which an interchangeable model is inserted. Water flows from bottom to top through the experimental section. Electrolytically generated hydrogen bubbles rise with the flow, flow around the model and visualise the flow.

Movement detection

Flows can be visualized by floating particles or gas bubbles. These particles or gas bubbles must be so small that they follow the flow without distortion.

For good visualisation of the flow fields it is important to have a good contrast between the fluid and the particles or gas bubbles. As gas bubbles reflect the light well owing to their spherical shape this allows for an excellent contrast.

Electrolytically produced
hydrogen bubbles
as contrast medium.

Learning objectives / experiments

- streamline course in flow around and through models
- flow separation
- vortex formation, demonstration of Karman vortices
- qualitative observation of the velocity distribution in laminar flow
- analogy to air flow
- in conjunction with a special camera (i.e. PCO Pixelfy) and suitable software (i.e. ImageJ):
  - image processing evaluation of the experiments (particle image velocimetry, particle tracking velocimetry)

Optional accessory: high-sensitivity camera

HM 132 Vertical visualisation of flow fields

Working with exposure times t_E

There are various possibilities for detecting a movement process. Exposure time controls the duration of a recording. The intensity and duration of the exposure determines how the movement processes in the photograph are displayed.

Short t_E: Standing image

Long t_E: Motion blur occurs

Exposure time t_E variable. Lighting constant.

v = 7 cm/s

t_E = 1/200 s

t_E = 1/5 s

t_E = 1/1 s

Snapshot with single bubbles

Clarification of vortex structures

Visualization of the affected area

With a camera with adjustable exposure time t_E, the flow state can be kept as an image in a simple manner. Individual bubbles can smear to lines. If the lines are still clearly separated, the velocity of the bubbles can be calculated by reproduction scale, length/width of lines, and exposure time.

Particle Tracking Velocimetry – PTV

Motion blur gets directional information by decreasing illumination intensity

Exposure time t_E variabel. Lighting dimming.

By dimming the illumination within the exposure time, the bubbles produce lines in the image. The fading of the lines shows the flow direction. The length of the lines is proportional to the velocity.

v = 7 cm/s

Particle Image Velocimetry – PIV

Double image. Usually applied in two image files.

Picture 1

Picture 2

Exposure time t_E short, double. Lighting short, intense.

Software compares two images taken one after the other, quickly. The direction of motion and magnitude of the bubble patterns are calculated. With the reproduction scale and the time offset between the images, the speed can be determined.

Image created with ImageJ, PIV

Image created with ImageJ, PIV