The Rising Air Bubble Technique for Streamflow Measurement

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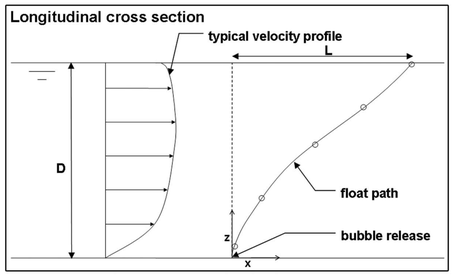
Applying the technique

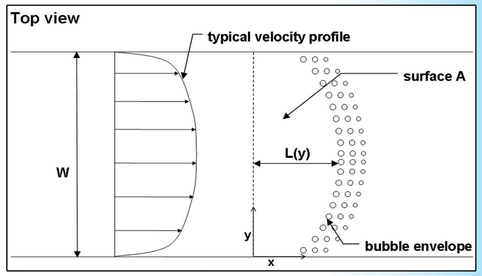
Research questions

- Can we perform accurate measurements with the Rising Air Bubble Technique?
- How can modern techniques improve the RABT?

Method

Assuming that the bubble rising velocity v_z is constant, we can determine the discharge per unit width (q) from the displacement L. Integrating over the width results in a stream discharge Q (Sargent, 1982).





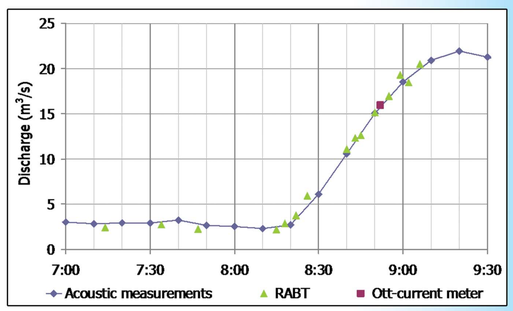
$$q = v_z L$$

$$Q = v_z \int_0^W L(y)\,dy = v_z A$$

The development of the bubble envelope is captured with a digital photo camera.

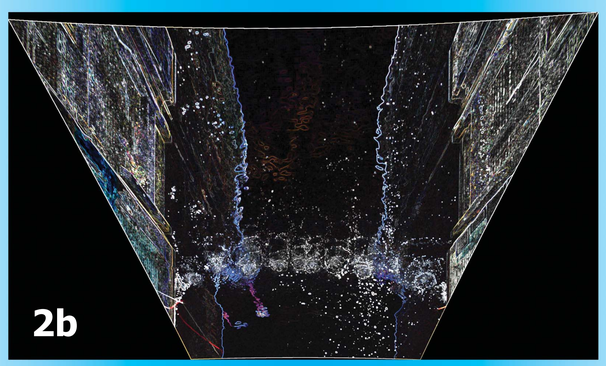
Results

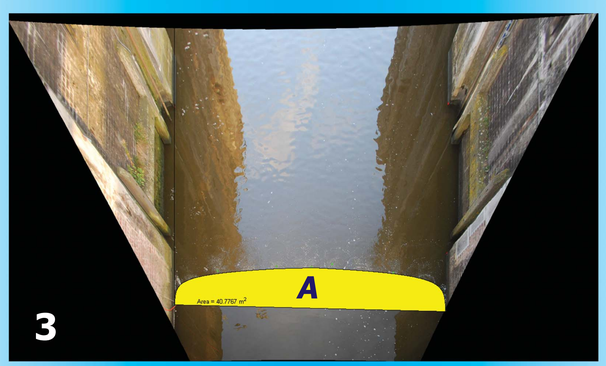
The RABT was applied in a lock (width: 9 m; depth: 4 m) with moderate, variable flow velocities. Air bubbles were released from a steel pipe across the stream. Images were corrected for lens distortion and reprojected using the Image Processing Toolbox of Matlab® (see the pictures 1 to 3).



Conclusions

Modern image processing techniques facilitate the RABT to a large extent. Accurate measurements were performed by using a single photo camera. We expect that applying pattern recognition techniques to the processed images (picture 2b) could automatize this method.





Determining the bubble's rising velocity

Research questions

- Under what circumstances can we create air bubbles that rise with an almost constant velocity?
- What is the rising velocity in that case?

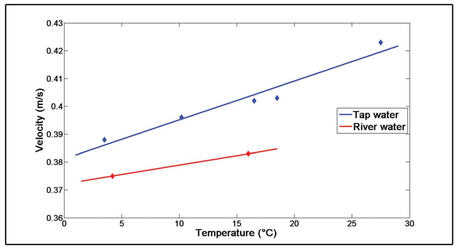
Method

Lab experiments were performed to assess the influences of:

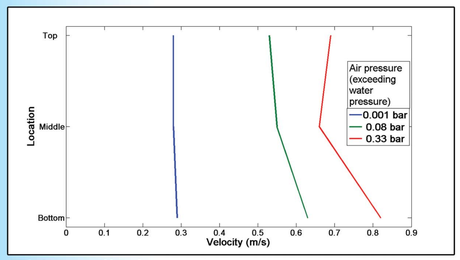
- air pressure
- nozzle size
- water contamination
- water temperature

Results

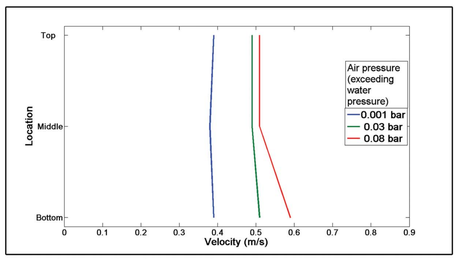
The rising velocity appeared dependent on temperature. However, the velocity varied less in the contaminated river water as compared to tap water. With thick walled nozzles, the velocity was less sensitive to pressure variations.



Temperature influence on velocity



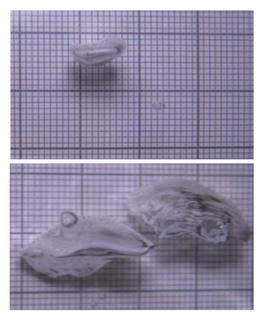
Thin walled nozzle



Thick walled nozzle

Conclusions

The air bubbles can best be released from thick walled nozzles. With a nozzle diameter of 1.1 mm, ellipsoidal air bubbles are produced. These bubbles have a more constant rising velocity. We recommend to calibrate the nozzles in a laboratory situation for the water temperature at which they are applied in the field.



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