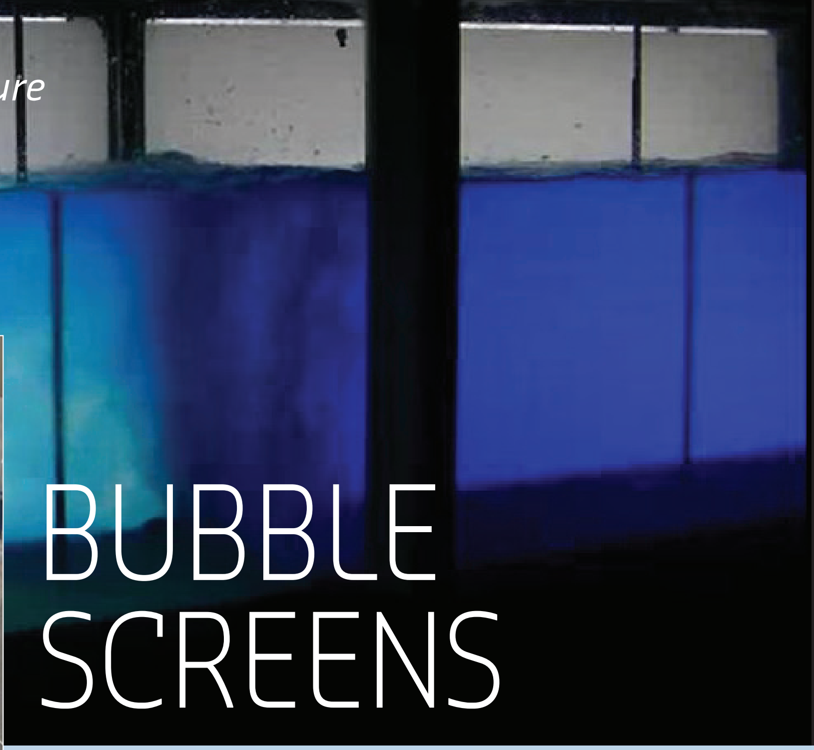
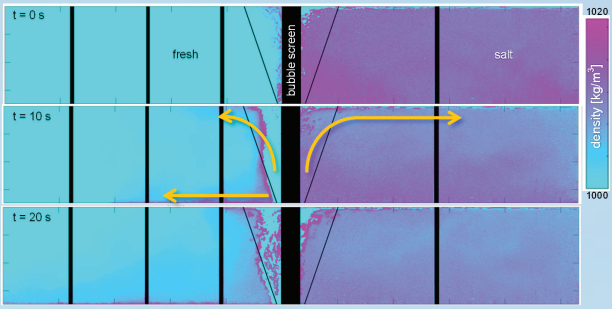


BUBBLE SCREENS

▲ *Exchange of salt (blue, on right) and fresh water (transparent, on left)*

◀ *Yachts and a bubble screen in the Krammer recreational lock, the Netherlands*



"t" indicates the time in seconds after the opening of the lock door

Bubble screens are exactly what the name suggests: screens of bubbles in water. They are used, for example, to mix water in lakes or to collect plastics from rivers. They are also used in locks between salt and fresh water bodies to reduce the amount of salt intrusion during passages. This maintains the quality of the fresh water, not only for ecological reasons and but also to ensure that the water can be used for agriculture and for drinking.

The use of bubble screens in shipping locks has been a subject of research for some time. Several studies have demonstrated their effectiveness. Unless appropriate mitigation measures are taken, recent shipping traffic developments, such as increasing shipping intensity and the enormous size of modern locks, will lead to a rise in salt intrusion.

Bubble screens generally require a large air flow rate and therefore significant compressor size. The design must be optimised to reduce salt intrusion effectively while minimising the use of energy. Modern locks are very large and deep and they therefore represent a challenge for bubble screen technology. The Dutch government recently granted subsidies for fundamental research on this topic.

Physical scale-model measurements were made in a flume in the facilities at Deltares in 2017. They generated highly accurate data with a high spatial resolution. The performance of the bubble screen at varying air flow rates was assessed and high accuracy was required to detect potentially subtle differences. The experimental flume had two compartments of equal size that were separated by a metal sheet representing a lock door. One compartment contained saline water; the other contained fresh water. A lock exchange was simulated by lifting the door, with the effects being attenuated by the bubble screen. A dye was added to the saline compartment before the door was lifted in order to visualise the mixing of the water bodies.

The effects were monitored using two optical measurement techniques: particle-image velocimetry (PIV) measurements of the flow induced by the bubble screen and a calibrated video recording of the mixing induced by the screen. Two bubble generators were tested that created either large or fine bubbles and several air flow rates were used.

The experiments provided high-spatial-resolution pictures of the mixing achieved with the bubble screen and quantitative data for the exchange flow. It was concluded that higher air-flow rates may reduce the effectiveness of the bubble screen in terms of salt intrusion mitigation. The results help to understand better how bubble screens can be used in practice. This is useful for Rijkswaterstaat and market parties for the purposes of bubble screen use or design. The physical scale-model results will be used in a follow-up study to validate numerical computations for this application.

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