

MASTER

Numerical study of bubble curtains in a two-layer stratified lock-exchange configuration

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Public Summary

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Climate change creates new challenges that we need to tackle. In the Netherlands, we are facing frequent and prolonged periods of droughts during which salt intrusion in estuaries and shipping locks can become a serious threat to our drinking water sources. One way of mitigating salt intrusion is the use of bubble curtains. Bubble curtains use the vertical momentum of the injected air along with its the natural buoyancy of air bubbles to block the salt intrusion. Since they consume a significant amount of energy, they must be used optimally. This can be assessed using the effectiveness, which quantifies the amount of salt that is blocked by the bubble curtain. The ratio between the strength of the bubble curtain and the strength of the gravity current is expressed using the deflection modulus. From previous research it is known that two regimes can be distinguished: a breakthrough regime, where the gravity current breaks through the bubble curtain and a curtain driven regime, where the bubble curtain limits the salt intrusion significantly. The transition between these two regimes, which we call the intermediate regime, results in an optimum effectiveness. Until recently, this effectiveness has only been determined for non-stratified lock-exchange configurations. In this study, the effect of a two-layer stratification lock-exchange configuration is investigated using numerical simulations. The numerical simulations are performed using OpenFOAM, where an Euler-Euler multi-phase solver with Boussinesq approximation is used, and Large Eddy Simulations (LES) is used to model the turbulence. It is found that the effectiveness in a two-layer stratification is affected significantly as a result of stratification. The value of the deflection modulus for which the optimum value of effectiveness is achieved is shifted significantly to higher values. Furthermore, when the value of the deflection modulus is large, the effect of the stratification on the results is diminished, as mixing breaks up the stratification.