Destratification of thermally stratified water columns by air diffusers

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Abstract

This study aims at improving the understanding in order to optimise an aeration system for artificial destratification to control cyanobacteria growth in the reservoirs. Previous applications for artificial destratification in reservoirs were based on installations based on computational methods, where neither the effect of air bubble size and configuration nor the effect of air density in the bubble plume could be investigated. This study seeks for an optimized design with the help of experimental and numerical analyses. In order to perform experimental studies, a novel water tank enabling the heating/cooling of the water column as desired and a diffuser system were manufactured. During the experimental studies, effect of bubble size, bubble slip velocity, and other parameters of air diffuser on destratification efficiency were investigated. Based on the nondimensional parameters, a new destratification efficiency formula is obtained by the Genetic Algorithm (GA) approach. Additionaly, the hydrodynamics of the water tank during the mixing process by air diffuser was simulated via 3D numerical model and validated with experimental results. The Eulerian multiphase model with the 'degassing' boundary condition and k-ω turbulence model are found to be suitable for the purposes of the study. Based on the error analysis of comparisons of the model and observations, the best configuration of air diffuser is proposed, and the numerical model is found to be successful in simulating the destratification of thermally stratified water columns by air diffuser.