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Evaluation of floc settling velocity models through image analysis for ballasted flocculation

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ABSTRACT

The outstanding performance of ballasted flocculation (BF) can be attributed to the enhanced velocity of settling flocs, which is significantly increased by the attachment of ballast particles. It is important to determine the mechanism by which the settling velocity of an individual floc changes with ballast size and density under BF. Many researchers have developed models to predict floc settling velocity, which is correlated with the size and density of flocs, but these existing models underestimate the floc settling velocity because model parameters are not obtained from flocs of BF. Therefore, the purpose of this study is to improve the accuracy of model prediction of floc settling velocity by modifying existing regression models based on experimental observations. For this purpose, an image analysis method was used to determine the settling velocity and size of individual flocs generated through laboratory BF experiments, and then floc density was calculated using Stokes' law with flow condition-based drag coefficient. These velocity and density values were used to compare and modify the velocity models. The predictions of modified models and the experimental observations were then tested through analysis of variance and Pearson's correlation. The modified density model of Lau and Krishnappan was found to be the most appropriate for predicting individual floc density, but velocity models as linear or power function of floc size were inappropriate for predicting the settling velocity of ballasted flocs. Various statistical tests revealed that the modified velocity model is effective. In addition, the model predictions were found to be in agreement with 75% of experimental velocity observations, whereas other velocity models showed only 30% agreement. Thus, we propose the combination of the Stokes' velocity model with the modified density model of Lau and Krishnappan as the most suitable approach for predicting settling velocity.

Keywords: Ballasted flocculation; Floc density; Settling velocity modelling; Magnetic ballast; Image analysis

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