Technische Universiteit Delft

Offshore & Dredging Engineering

Horizontal Slurry Transport on a Large Laboratory Scale

The first head loss prediction methods for hydraulic transport of solids in pipes, date back to the years '50 of last century. The principles are still applied today. Although it is observed that obtained results may differ from reality, when the circumstances do not represent the situation of the original experiment. To investigate this, the performance of various prediction models is analysed on a large scale laboratory test set-up.

In recent publications, several researchers observed disturbances in their expected flow patterns. Described as either 'unsteady flow', 'instability' or 'unexpected mechanism'. Talmon developed the theory that the occurrence of these events could be explained by transient processes in the pipe flow. It is recommended to use a test pipe with great length. To verify, by longitudinal pressure profile measurement, that equilibrium is measured, and that indicated transients are captured by the measuring system.

A laboratory test set-up is provided by the CCCC National Engineering Research Center of Dredging Technology and Equipment Co., Ltd. In a joint research program with Delft University of Technology: the pressure drops for water and mixture flow over the pipeline length are analysed. This is done for horizontal hydraulic transport. The focus is on comparing test results with existing theories and find explanations to deviating results. If instabilities are observed, the gathered data can be used for further research on density waves in pipelines.

In the liquid flow experiment, three prediction methods derived from the Colebrook-White equation are analysed: Darcy-Weisbach, Swamee & Jain and RangaRadju & Garde. Considering the pipeline to be smooth, the predicted values are similar. The difference between them is almost nil. Furthermore, the result shows good correspondence with the data acquired on the test set-up.

In the mixture experiment, four prediction methods are analysed: Durand, Führböter, Jufin & Lopatin and Wilson. They are compared with laboratory data of test conducted in a heterogeneous flow regime. With a velocity ranging from three to six meter per second and concentrations of: 4.4, 8.1, 12.3 and 14.6 percent. In a general approach, considering all transport velocities and concentrations. It is observed that the theoretical principle described by Durand shows the closest resemblance with the experimental data. When only the concentrations are considered, a distinction has to be made. For the two lowest mixture densities, the Führboter method gives the best fit. For the highest two, the best correlation is according to the Durand theory. The principles of Jufin & Lopatin and Wilson underestimate the pressure loss. Where the difference of the former is significantly larger in comparison to the latter.

For the lowest velocities of the twelve and fifteen percent slurry experiments, stationary waves over the pipeline length are observed. Due to the length of the test set-up, the transition to equilibrium flow is clearly visible. It demonstrates that longer flow loops give opportunity to conduct further research into the extent of waves.

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