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A mathematical tool for describing the behaviour of a dense effluent discharge

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ABSTRACT

In many cases a dense effluent has to be discharged in the environment with possible harmful consequences. The preferred design for the relevant discharge unit is that of a simple or multi-port diffuser issuing jets at a given inclination above the horizontal. This work presents the follow-on developments of a model previously proposed to predict the behaviour of inclined dense jets issuing in a stagnant environment. It consists of a set of three ordinary differential equations that can be solved by standard numerical methods. Model outputs include information on the trajectory, spreading and dilution of inclined dense jets, return point position and concentration. Interestingly the model also predicts velocities along the trajectory and values of return point velocity which can be of great importance in the design and monitoring of dense effluents diffusers. Model predictions are compared with experimental data from several sources and in all cases a good agreement is found. For user convenience, model implementations in the form of an Excel® spreadsheet or Matlab® routine have been made available as open access material upon request to the authors. Finally, dimensional analysis considerations are made that enlighten the use of the densimetric Froude number as the major, though not the sole, correlating parameter for dense jet behaviour.

Keywords: Dense effluents; Modelling; Inclined dense jets; Diffusers design tool; Return point dilution; Return velocity

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