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CFD of a Herschel-Bulkley fluid in turbulent flow within a circular pipe

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This research concerns the hydraulics of concentrated domestic slurry (by minimising the use of water) that promotes better nutrient and biomass recovery, while saving water. Our experiments suggests that at higher concentrations, domestic slurry behaves as non-Newtonian Herschel-Bulkley fluid [1]. Based on experimental data on the pressure losses incurred by such a slurry in turbulent flow through circular pipes and bends, we propose a computational fluid dynamics-based methodology to simulate Herschel-Bulkley fluids in turbulent flow using Reynolds-Averaged Navier-Stokes models. This is aimed at finding a simpler engineering model of such a turbulent flow, to support the industrial design and implementation of a sewerage that could efficiently transport concentrated domestic slurry.

The standard $\kappa - \epsilon$ and Reynolds-stress models are used for our simulations. However, to improve the accuracy with which the wall-shear stress (and ultimately the pressure losses) are predicted, a **specified-shear approach** has been developed to correctly model the transition of turbulent to laminar flow near the walls of the pipes carrying the Herschel-Bulkley slurry. In effect, this is a rough extension of the original wall function proposed by [2] for Newtonian fluids in turbulent flow.

The results indicate improved accuracy in predicting the pressure losses (comparison against our experiments and other existing literature) not only through straight pipes but also through bends in the pipe. The intention now is to extend this methodology to the modelling of a two-phase mixture of air and concentrated domestic slurry.

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