RE-DEPENDENT DRAG COEFFICIENT OF FINITE CYLINDER

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In papermaking the modelling of fibre suspensions is of great importance. When the properties of final product are to be predicted the knowledge about fibres behaviour, in particular fibres orientation, is required. With Lagrangian approach, the most adequate simulation technique, single fibre is modelled as a chain of segments, which may be represented by either cylinders or prolate spheroids or, in the simplest case, spheres. The choice of element shape is determined by the desired fibre model properties as well as computational performance. When spheres are used to discretize the fibre, drag force distribution may be easily implemented from literature. However, with this segment shape one may expect huge computational cost (proportional to the number of segments) as well as the problems with fibres overlapping and collision detection. These problems may be overcome when fibre is constructed from cylinders. However, for isolated cylindrical particle drag force coefficient becomes a function of orientation angles (see Fig. 1) and these relationships are unknown, expect for creeping flow conditions, i.e. Re<<1.

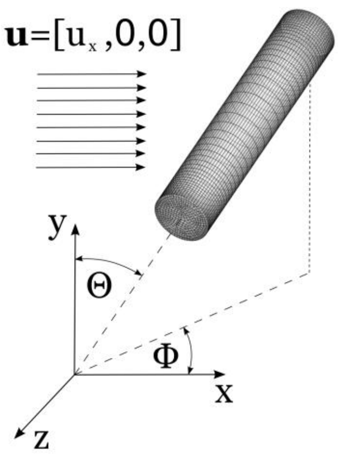

Fig.1. Orientation angles definition

In present paper numerical algorithm has been developed enabling for detailed studies of drag force coefficient as a function of orientation angles, cylinder aspect ratio and Reynolds number. Automatic procedure allowed to generate numerical grid (Gambit) and then to conduct CFD calculations (Ansys Fluent). A sample distribution of drag force coefficient c_D for Re=5 is shown in Fig. 2. The results were found to be fully consistent with available reference data (Vakil and Green, 2009).

Drag force and torque coefficients distributions were implemented to the Lagrangian fibre model being developed and tested in a simple shear flow. Results of simulations revealed good consistency with reference data indicating increased relevance of the model.

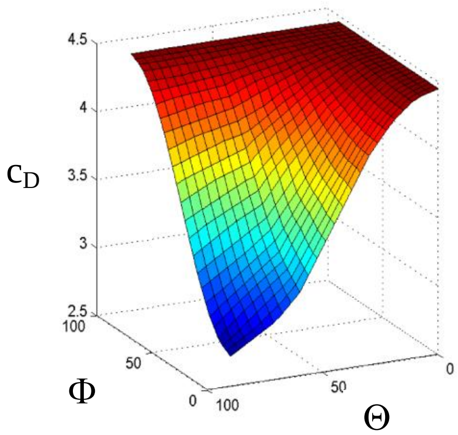

Fig.2. Drag force coefficient vs orientation angles

References

Vakil, A., Green, S. I. (2009): *Drag and lift coefficients of inclined finite circular cylinders at moderate Reynolds numbers*, Computers & Fluids, vol. 38, pp. 1771–1781