

Simulation of Non-Newtonian Fluids using Modelica

Pooyan Jahangiri Rita Streblow Dirk Müller
RWTH Aachen University - E.ON Energy Research Center
Mathieustr. 10, 52074 Aachen, Germany
pjahangiri@eonerc.rwth-aachen.de

Nowadays, many different fluids in different applications such as in food industries and energy distribution systems show a non-Newtonian behavior. In order to simulate this behavior, various approaches exist but are not fully implemented in a simulation program. One of the problems with these kinds of simulations is the lack of compatibility with existing models. This makes the modeling very time consuming.

Non-Newtonian fluids are fluids in which the viscosity changes with respect to the applied stress. Many available fluids can fully or partly be described by Ostwald-de Waele relationship. In this paper, a simple approach is shown that provides a general set of equations which can then be used to model both Newtonian as well as non-Newtonian behavior of fluids according to this relationship. Since the implementation is in the base models, existing components can be easily used to simulate non Newtonian fluids without sacrificing the simulation times.

This is done by adding a new function to describe the flow behavior index which represents the degree of non-Newtonian behavior in each fluid in the base medium model in Media library in the standard library. The equations for the calculation of pressure drop in the flow model are adapted to use the new flow behavior index function for calculation of pressure drop for both Newtonian as well as non-Newtonian fluids in the same model according to [1] (see Figure 1).

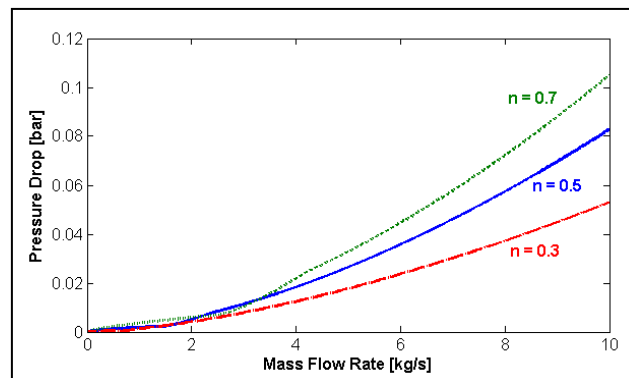


Figure 1: Comparison between different pressure-drops in fluids with different flow behavior indices

Grateful acknowledgement is made for the financial support by BMWi (Federal Ministry of Economics and Technology), promotional reference 032747B.

References

- [1] Metzner, A.B. und Reed, J.C.; Flow of Non-Newtonian Fluids - Correlation of the Laminar, Transition, and Turbulent-flow Regions; A.I.Ch.E. Journal. December 1955, pp. 434-440.