The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

MODELING AND SIMULATION OF A BINGHAM FLUID IN A RHEOMETER WITH THE CUMULANT LATTICE BOLTZMANN METHOD

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Key Words: *Non-Newtonian Fluid, Bingham Fluid, Lattice Boltzmann Method.*

Modern building construction is now experiencing a boom in new technologies, one of which is additive manufacturing. 3D printing provides many new options, e.g. the ability to reproduce complex structures or to print directly from the digital model of the object, bypassing additional steps and reducing construction time and production costs. A crucial factor in the implementation of a 3D printing process is the printing material. In civil engineering construction this is mainly concrete. The successful development of this technology is inherently connected to the existence of accurate numerical models for fresh concrete [1].

The Bingham fluid model represents a yield stress model with linear flow behaviour [2]. In this model, the fluids only go into a flow state beyond a certain shear stress level. Fresh concrete can be described by a Bingham model. In our previous work [3], we described the modelling and implementation of Bingham fluid with the Cumulant lattice Boltzmann method.

A general problem for the numerical modelling of complex building materials like concrete is the acquisition of the required model parameters which are highly dependent on the specific composition of the material used. The rheological behaviour of these material is *a priori* unknown and assessed by measurements with rheometers. In this research a digital twin of the actual rheometer is implemented with the Cumulant lattice Boltzmann method using Newtonian and non-Newtonian fluids. Our focus is the effect of the mixing tool on the relation between the rotational velocity and the torque, from which the rheological properties can be directly calculated.

REFERENCES

[1] Kloft, H., Hack, N., Mainka, J., Brohmann, L., Herrmann, E., Ledderose, L. and Lowke, D. (2019) Additive Fertigung im Bauwesen: Erste 3-d-gedruckte und bewehrte Btonbauteile im shotcrete-3-d-printingverfahren (sc3dp). Bautechnik, 96, 929-938.E.

[2] Bingham, E. (1916) An Investigation of the Laws of Plastic Flow. Bulletin of the Bureau of Standards, 13, 309-353. https://doi.org/10.6028/bulletin.304

[3] Geier, M., Kutscher, K. and Krafczyk, M. (2021) A Direct Effective Viscosity Approach for Modeling and Simulating Bingham Fluids with the Cumulant Lattice Boltzmann Method. Open Journal of Fluid Dynamics, 11, 34-54. doi: 10.4236/ojfd.2021.111003.