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Copenhagen, Denmark

Tuesday 18:00 Marselisborg & Rosenborg PO79

Effect of lift force on dense gas-fluidised beds of non-spherical particles

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Particle aggregates are frequently processed in industrial apparatus such as pneumatic conveyors, bed gasifiers and fluidised bed reactors. In numerical models of these processes, particles have traditionally been represented as spheres, thus limiting complexities associated with drag or lift forces. However, spherical particles are not representative of the entities encountered in real systems. For example, non-spherical biomass particles of varying aspect ratios are used in the production of biomass fuels. Thus far, there is limited literature in relation to hydrodynamic forces experienced by non-spherical particles under fluidised conditions. In fluidised beds, particles will experience varying lift force conditions dependent on the orientation of the particle relative to the direction of the fluid velocity.

In this study, we investigate numerically the effect of differing lift force coefficient correlations on spherocylindrical particles of varying aspect ratios. We employ correlations derived from previous simulations on non-spherical particles [1] and aerofoil dynamics [2] in simulations. Particle interactions are modelled using the Open Source engine CFDEM, which uses the OpenFOAM computational fluid dynamics (CFD) solver to describe the fluid component and LIGGGHTS to implement discrete element method (DEM) calculations [3]. We investigate the importance of lift forces on non-spherical particles under dense fluidised conditions and compare results to the case of spherical particles where lift forces are often neglected.

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Tuesday 18:00 Marselisborg & Rosenborg PO80

Practical mapping of the draw resonance instability

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In film casting and fiber spinning processes, molten material is extruded through a die and taken up by a rotating chill roll, with the so-called draw ratio, i.e., the ratio of the inlet to the take-up velocity. Exceeding a critical draw ratio leads to oscillations of flow velocity and film thickness and width or, respectively, fiber diameter, which is commonly known as draw resonance.

In this work, we present a mapping strategy which enables a quick and practical oriented analysis of the draw resonance behavior for film casting and fiber spinning. For this purpose, film casting and fiber spinning models including gravity and inertia as well as the effects of neck-in in film casting and surface tension in fiber spinning are examined by means of linear stability analysis. Besides Newtonian models, the simplified PTT model is applied to account for viscoelastic effects as well. Proper scaling of the system variables reveals dimensionless control parameters with strong correlation to practical application, e.g., the inlet velocity and the fluidity.

The stability maps visualize isolines of constant critical draw ratio in the parameter space. This enables, besides a comprehensive overview of the stability behavior, the identification of distinct dynamical regimes, within which one or several effects can be neglected, as for instance parameter regions of unconditional stability in the case of dominating inertia or unconditional instability in the case of dominating surface tension in fiber spinning.

Tuesday 18:00 Marselisborg & Rosenborg PO81

Observation of jet buckling instabilities for various non-Newtonian fluids

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Jet buckling instabilities are found in multiple industrial applications, such as dairy products containers filling or rocket boosters loading. The way the filling goes is critical as it will affect end-use properties. For high viscosity products or high filling rates, the jet of fluid will spread or form different types of coils depending on its velocity and diameter. Regarding the case of Newtonian fluids, the diameter of this coil, the winding frequency and the jet radius at impact are well known for a large range of flow rates and falling heights [1]. Multiple regimes were found, depending on the balance of gravity, inertial and viscous forces (and thus fluid characteristics as viscosity or density). However, a few questions arise:

Does a non-Newtonian fluid follow the same kind of physics (eventually re-scaled by a modified viscosity function)?

Once the fluid coil reaches a certain height, how does it collapse (entrapping gas bubbles)?

What happens on a tilted (slipping) plane?

In order to answer these questions, different materials were used, including transparent non-Newtonian fluids. Buckling is observed thanks to a high speed camera and coiling parameters (frequencies and diameters, as discussed before) are measured. The amount of air trapped during the filling is also addressed with regard to the collapse frequency of the coils and their internal volume. Comparisons between existing models on Newtonian fluids and our results are then discussed. In addition, direct observations on how the liquid "rope" forms the coil (local flexion or torsion at the impact point) are made using a few amounts of particles as markers in the various fluids.