Brandenburgische
Technische Universität
Cottbus - Senftenberg

Possible Topic for a MASTER THESIS OR STUDY PROJECT

at Brandenburg University of Technology (BTU) in Cottbus, Germany

Heat transfer evaluation in rotating cylindrical reactors

Synopsis – Rotating reactors are used in several process engineering units. Early research in Reynolds-Averaged Navier-Stokes (RANS) turbulence modeling [1] showed that the introduction of the rotational effects in the flow rendered the use of traditional simplified models, such as the RANS $k - \epsilon$ model, unusable. Nowadays, the use of turbulence modeling has been partially avoided by Direct Numerical Simulations (DNSs) for low Reynolds number flows [2]. However, some process engineering units may have considerable large dimensions and span a large range of operating temperatures, which spans a large parameter space, at the very least in terms of Reynolds and Prandtl numbers. Preliminary investigations have also shown that at large heat flux regimes, variable thermal inertia effects may become relevant [3]. A more extensive parametric investigation is desired for the regime of rotating pipe flows, such that a modeling approach for rotating reactors can be formulated in a consistent way. In order to make the large parameter investigation feasible, a reduced order stochastic turbulence model is suggested for the purpose of the numerical flow simulation. To that extent, this investigation may be carried out in one of the following modalities:

- **a) Master Thesis (1 semester):** In this case the student should focus on the evaluation of heat transfer in rotating pipe flows considering negligible thermal inertia effects in air. A stand-alone in-house developed stochastic turbulence model will be used for this purpose.
- **b) Study Project (2 semesters):** Same as a), but the student will resort to the use of both the stand-alone in-house developed stochastic turbulence model and the open source software OpenFOAM using standard Large Eddy Simulation (LES) or RANS turbulence closure models.
- **c) Study Project and Master Thesis (3 semesters):** Same as b), but the student will also evaluate the effect of non-negligible variable thermal inertia for both air and carbon dioxide as working fluids.

[1] Speziale (1998), *AIAA Journal* **36**(2), 173-184 — [2] Satake, Kunugi, (2002), *Int. J. Numer. Methods Heat Fluid Flow* **12**(8), 958-1008 — [3] Medina Méndez, Klein and Schmidt (2019) *Int. J. Heat Fluid Flow* **80**:108481

Tasks

- Review of relevant literature and theoretical foundations
- Code development, compilation and testing
- Visualization, post-processing, and data analysis of numerical simulation data
- Comparison of simulation results with relevant reference data

Desired skills and requisites

- Solid knowledge of fundamentals of fluid mechanics
- Affinity to programming (preferably Python, Matlab, C/C++, or Fortran)
- Scientific attitude (curiosity, self-motivation, and critical reasoning)
- Experience with data analysis, numerical simulation and modeling, or CFD is an asset
- **For the intended take of the Master Thesis:** The student must have approved the modules of Turbulence Modeling and CFD 1.
- **For the intended take of the Study Project:** The student is required to take the modules of Turbulence Modeling and CFD in parallel to the project time frame.

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