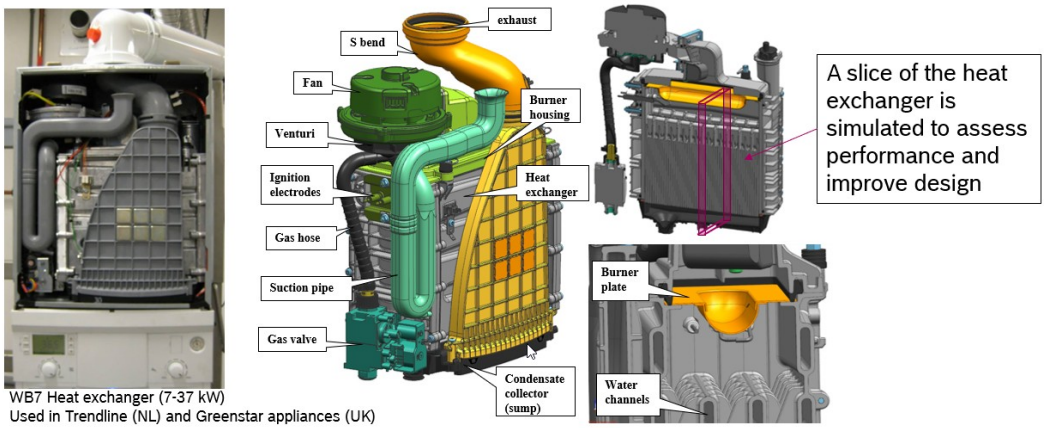
Extension of a turbulence wall function model for wall roughness model

MSc Project Proposal
November 2023

Problem description

Turbulence modeling is one of the fundamental topics in CFD. Surface irregularities like roughness, and erosion can have significant effects on the flow either by changing the performance or contributing to aeroacoustic noise. These effects can be determined by a direct numerical simulation or modeled by using a large eddy simulation model, but these methods are computationally expensive. In a previous study a surface roughness model is developed and coupled with existing SA and SST turbulence models that are implemented in the open-source CFD suite SU2[1,2]. In some applications the details of the turbulent flow field is not needed, and the effect of the viscous sub-layer can be modeled by a so-called wall-modeled turbulence model. Recently, on a separate project, such a wall-modeled turbulence model is implemented into SU2 where turbulence is not resolved but modeled near the surface[3].

Within this project, the goal is to merge the wall-modeled turbulence model and the roughness model to be able to simulate the effect of surface irregularities without resolving the turbulence near the wall.



Your tasks

Possible sub-tasks of the project:

- Merge pressure-based incompressible Navier-Stokes (N-S) implementation with develop version of SU2.
- Compare the results with preconditioned (density-based) N-S solver.
- Analyze the current status of roughness model and turbulence wall function.
- Combine the roughness model with the wall function: extend the turbulence wall function model to include the wall roughness model (the implementation is in C++).

- Validate for turbulent flow inside a sand-cast aluminum heat-exchangers (staggered cylindrical heat exchangers)

Your Profile

- Basic knowledge of fluid dynamics
- Knowledge of CFD and/or aeroaouctics is a pre.
- Knowledge of numerical analysis and algorithm development
- Knowledge of a programming language C++ (or a similar language)

Project Details

- Work will be carried in collaboration with BOSCH (nl.bosch.com).
- Project duration will be 6 to 12 months (in mutual agreement with the student).
- A possible internship position at BOSCH.

References

[1] SU2, https://su2code.github.io

[2] Ravishankara A.K. Ozdemir H., Weide E.T.A van der, Analysis of leading edge erosion effects on turbulent flow over airfoils, Renewable Energy Journal, 172, pp. 765-779, 2021.

[3] Beishuizen N., "Turbulence modeling near the wall simulating wall bounded flows in SU2", 3rd annual SU2 Conference, 2022 https://drive.google.com/file/d/16al4x0VIk9tDepSBjrJf0YTqaEu9QHDn/view?usp=sharing

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