Study of the reverse vortex fluid flow dependence on the reactor geometry

One of the key challenges for today is reducing the CO₂ emissions level. There are several ways, which have been under research. One of the solutions is to produce green-energy source, i.e. H₂, from methane. In order to convert methane into hydrogen, plasma can be used for activating and driving the reaction. Therefore, possible plasma pyrolysis reactor concepts are of great interest.

As it is known, CFD simulations have been widely used in the chemical engineering field. Through the usage of the CFD simulation tools, new reactor designs can be evaluated and optimised for the targeted heat and mass transfer behaviour. Performing such simulations reduces the costs involved in running experiments, especially with the plasma reactors.

The aim of this thesis work is to study the influence of the possible alterations of the existing plasma reactor on the fluid flow behaviour. The changes can involve the smoothening of the corners, change of the inlet tube diameters, and the length ratio of the reactor body to the outlet tube, etc. Since the flow is turbulent, the level of the flow representation by the turbulent model approximations can be compared for the considered reactor geometries. Based on the fact that the turbulence approximation equations have been tuned for the specific applications, their compatibility with different reactor geometry alterations should be assessed. One of the aspects of the work is also to observe the computation time needed for each of the different geometries. Since it can drastically increase when the plasma chemistry and heat transfer will be further included into the simulation.

For the work a base case model built in OpenFOAM® will be provided, see Fig. 1. OpenFOAM® is the open source CFD simulation software. This software allows for the simulation of the complex geometries and turbulence at the relatively high speed.

Fig. 1: 2D cutout plane: surface vector plot of the gas velocity

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