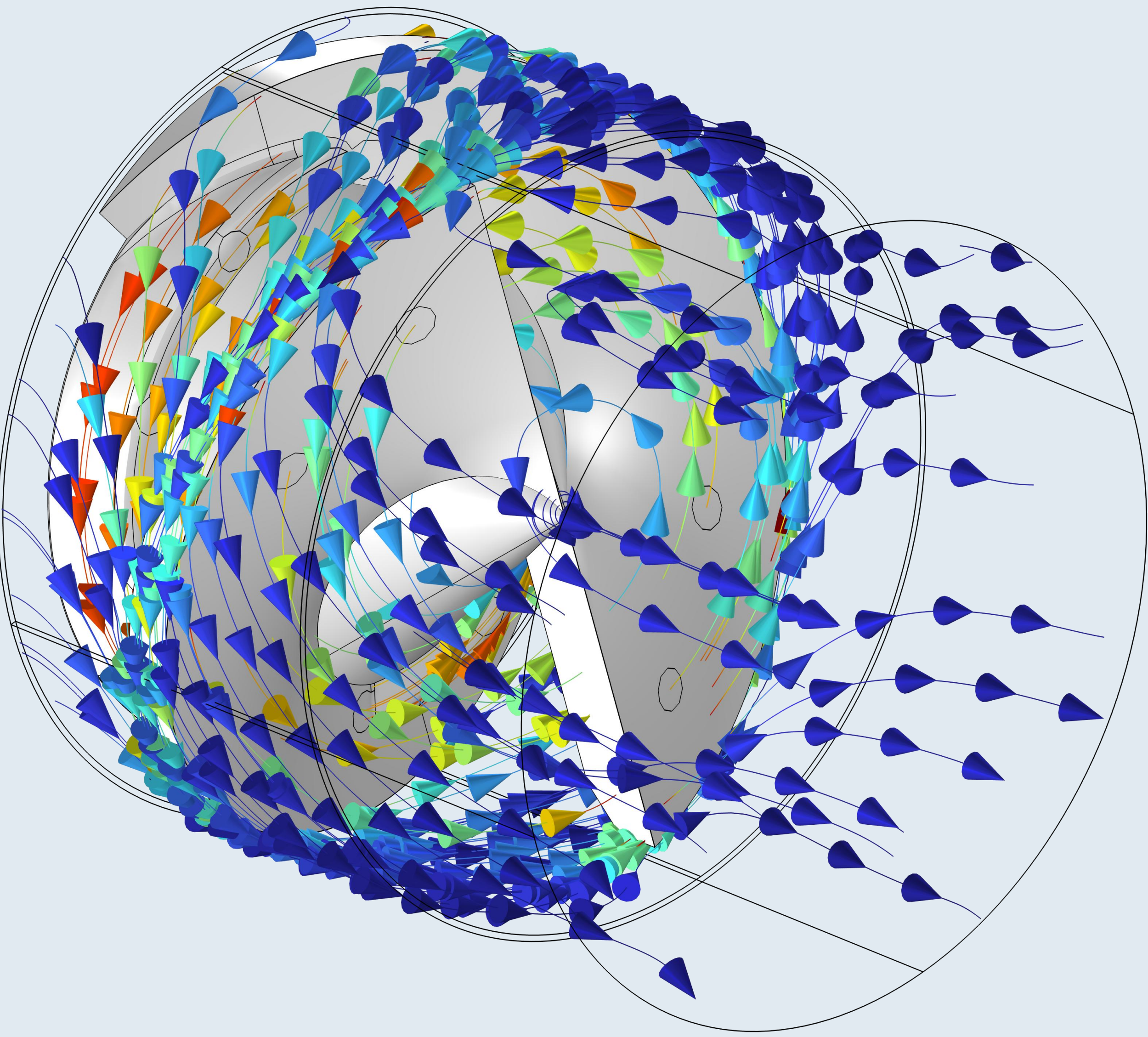




Simulation of Single Screw Extrusion

Understanding the effect of the geometry of the screw tip on the flow field for process optimisation

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Introduction

Single screw extrusion is a manufacturing method used to produce catalytic active extrudates. The understanding of the flow field within the extruder is fundamental to optimise the shape of the screw to obtain high-quality extrudates. In fact, the screw tip has the task to transport the paste from the inlet ring to the centre of the stator between the screw tip and the extrusion tool. If the paste is not well redistributed, the extrudate usually shows

cracks/holes at the centre. Due to the complex geometry of the screw and to the paste exhibiting a non-Newtonian behaviour, numerical simulations are fundamental to study the system, hence the single screw extrusion process was simulated in COMSOL Multiphysics®.

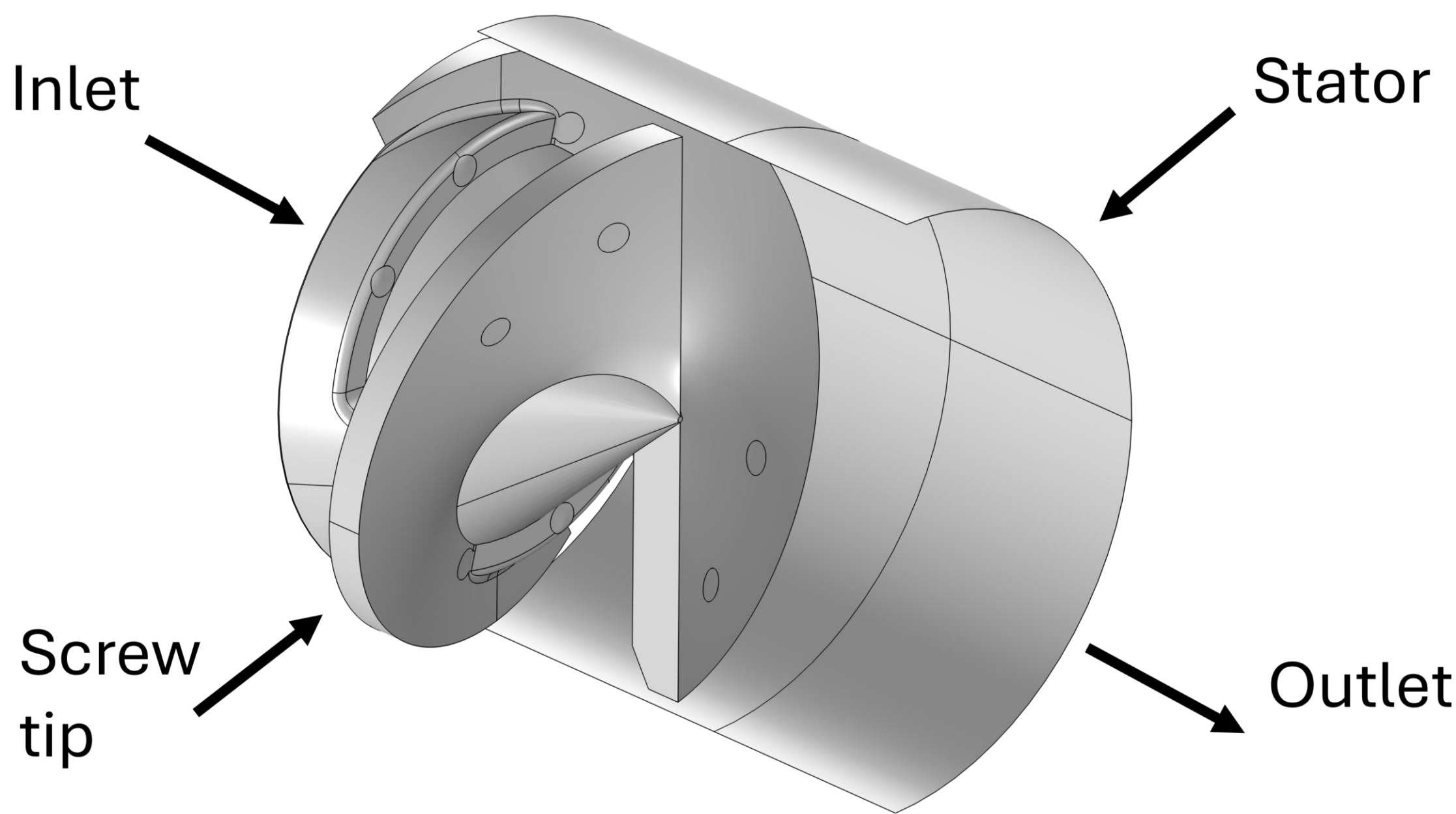


FIGURE 1. Geometry of the screw and the stator for the simulation of the single screw extrusion process

Methodology

Boundary conditions at both the inlet and the outlet were provided in terms of pressure. A no-slip boundary condition was assigned at the walls. Revolutions per time was specified for the rotating domain under the Moving Mesh interface. The rheology of the paste was implemented using the Herschel-Bulkley-Papanastasiou non-Newtonian model. First, a Frozen Rotor stationary study was carried out, which provided a good estimate of the velocity field and pressure distribution into the domain under investigation. Results were then used as initial condition for a time dependent study to improve the convergence of the simulation and obtain a more accurate prediction of the flow field during the rotation of the screw.

Results

The model was validated against the flow rate of the paste derived by experimental measurements. The post processing tool in COMSOL Multiphysics® was used to investigate both the velocity and the pressure fields, which are of fundamental importance to assess the quality of the flow and the presence of any stagnant zone. The latter usually leads to a maldistribution of the paste after the screw tip and therefore to defects into the extrudate. This model represents a tool to investigate the effect of the geometry of the screw on the flow and pressure fields. This is extremely valuable to optimise the geometry of the screw to improve the quality of the extrudate and reduce costly experimental trials in the future.

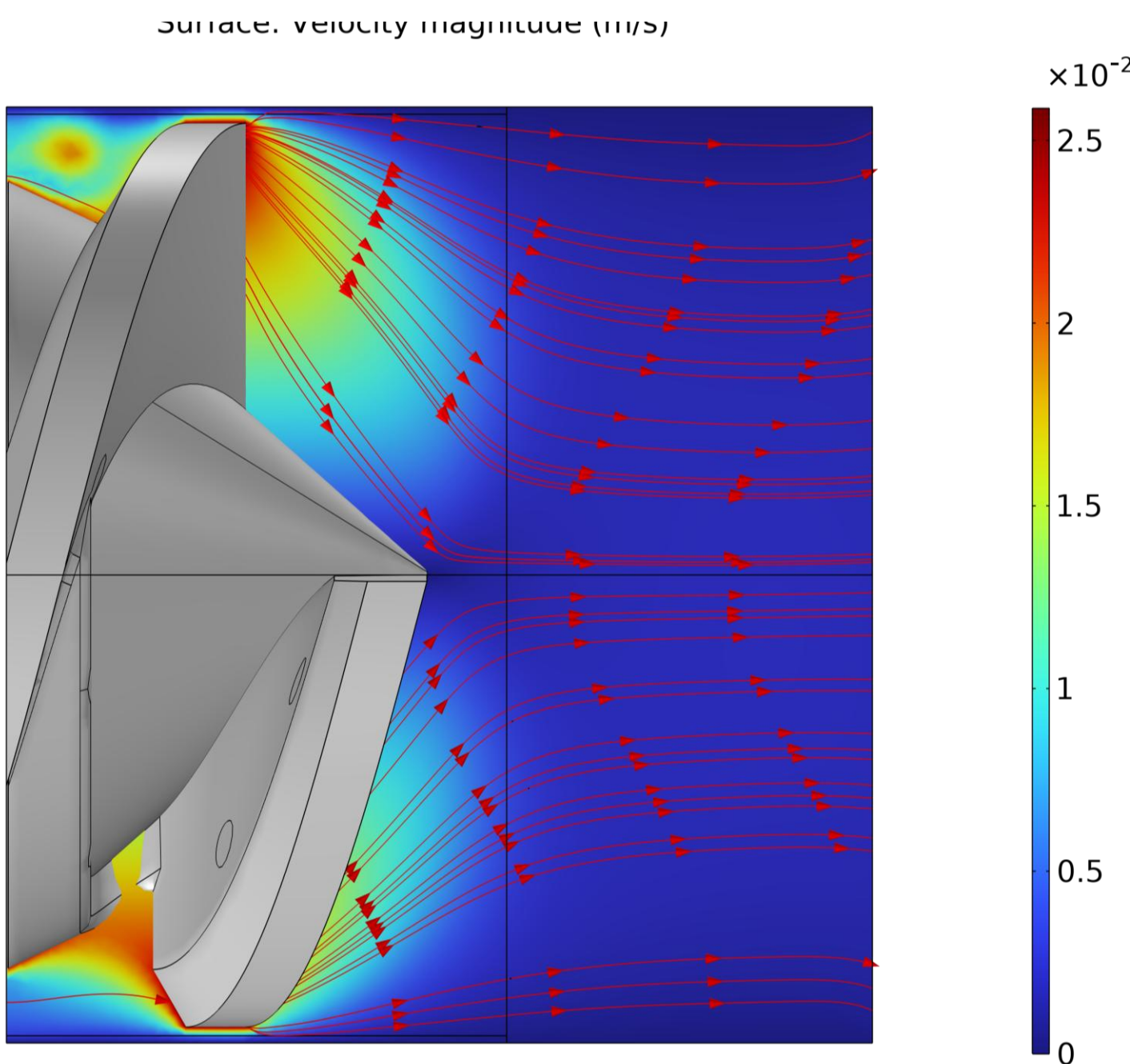


FIGURE 2. Velocity field at the mid-plane of the screw

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