Numerical simulation of axial blood pumps: Challenges and rotation modelling approaches

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Abstract

This presentation presents an in-house developed workflow for the design and assessment of axial rotary blood pumps. At its core lies a parametric CAD model that is connected to numerical simulations, optimization strategies, and automated documentation tools. The framework was built to support iterative design exploration, enabling both systematic performance evaluation and geometry refinement.

Particular attention is devoted to rotational modelling, with a direct comparison between the Multiple Reference Frame (MRF) approach and fully transient rotating mesh simulations. The trade off between computational efficiency and the ability to capture rotor-stator interaction with sufficient accuracy will be discussed.

The broader objective is to provide a reproducible benchmark environment that can be expanded towards advanced analyses, including hemocompatibility assessment, blood damage prediction, and thrombosis modelling.

Keywords: Parametric CAD design, geometrical constructions, ventricular assist device, axial blood pump, incompressible Navier-Stokes, OpenFOAM, optimalization, shape optimalization, automated design workflow, biomedical, MRF, transient