Turbocharger Flow Computations with the Space–Time Isogeometric Analysis (ST-IGA)

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ABSTRACT

We focus on turbocharger computational flow analysis with a method that possesses higher accuracy in spatial and temporal representations. In the method we have developed for this purpose, we use a combination of i) the Space–Time Variational Multiscale (ST-VMS) method [1, 2], which is a stabilized formulation that also serves as a turbulence model, ii) the ST Slip Interface (ST-SI) method [3], which maintains high-resolution representation of the boundary layers near spinning solid surfaces by allowing in a consistent fashion slip at the interface between the mesh covering a spinning surface and the mesh covering the rest of the domain, and iii) the Isogeometric Analysis (IGA) [4], where we use NURBS basis functions in space and time. In this method, which we call ST-IGA [5], the basis functions are spatially higher-order in all representations, and temporally higher-order in representation of the solid-surface and mesh motions. The ST nature of the method gives us higher-order accuracy in the flow solver, and when combined with temporally higher-order basis functions, a more accurate representation of the surface motion, and a mesh motion consistent with that. The spatially higher-order basis functions give us higher-order accuracy in the flow solver, a more accurate, in some parts exact, representation of the surface geometry, and better representation in evaluating the second-order spatial derivatives. Computations presented for a turbocharger turbine show the effectiveness of the ST-IGA method.

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