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A Parametric Study of Unsteady Rotor-Stator Interaction in a Simplified Francis Turbine[1] ALEX WOUDEN, JOHN CIMBALA, BRYAN LEWIS, Pennsylvania State University — CFD analysis is becoming a critical stage in the design of hydroturbines. However, its capability to represent unsteady flow interactions between the rotor and stator (which requires a 360-degree, mesh-refined model of the turbine passage) is hindered. For CFD to become a more effective tool in predicting the performance of a hydroturbine, the key interactions between the rotor and stator need to be understood using current numerical methods. As a first step towards evaluating this unsteady behavior without the burden of a computationally expensive domain, the stator and Francis-type rotor blades are reduced to flat plates. Local and global variables are compared using periodic, semi-periodic, and 360-degree geometric models and various turbulence models (k-omega, k-epsilon, and Spalart-Allmaras). The computations take place within the OpenFOAM® environment and utilize a general grid interface (GGI) between the rotor and stator computational domains. The rotor computational domain is capable of dynamic rotation. The results demonstrate some of the strengths and limitations of utilizing CFD for hydroturbine analysis. These case studies will also serve as tutorials to help others learn how to use CFD for turbomachinery.

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