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FINITE ELEMENT LES OF A WAVE-ENERGY AIR TURBINE USING DISCONTINUITY-CAPTURING DIRECTIONAL DISSIPATION

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We present a computational fluid mechanics technique for modeling of wave-energy air turbines, specifically a Wells turbine conceived for Mediterranean sea operations, designed and manufactured in the framework of Poseidone Project (Italian Ministry of Environmental Protection). In this type of energy conversion, the wave motion is converted to an oscillating airflow in a duct with the turbine. The turbulent flow physics involved in the complex, unsteady flow is governed by non-equilibrium phenomena, and we use a stabilized formulation to address the related challenges in the context of a Large-Eddy Simulation approach.

Here the discontinuity-capturing directional dissipation (DCDD) stabilization, in combination with the SUPG and PSPG stabilizations, is applied to computation of unsteady turbulent flow in the wave-energy turbine. We demonstrate how the DCDD stabilization takes effect where there is a sharp gradient in the velocity field and introduces dissipation in the direction of that gradient, as such providing a mechanisms for the distribution of an effective viscosity comparable to hybrid LES simulation.

Finally, we compare the numerical performance of the formulation to the available experimental data.