VISUALIZING DYNAMIC FLOW TRANSPORT OF A CENTRIFUGAL PUMP

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ABSTRACT: In this work we present our results for applying specially designed unsteady flow visualization methods to a simulation of a centrifugal pump. The simulation has been performed on a high-resolution grid (Figure 1) for 80 time steps using three different turbulence methods (SAS, DES, SST [1]) with special focus on the analysis of the so called *rotational stall* phenomenon. This causes large areas of recirculation and significantly affects the efficiency and life time of the device. We provide a comparative visual analysis using common local vortex detectors as λ_2 and the Q criterion, and recent local methods as Sujudi & Haimes [2], and Cores of Swirling motion [3]. Such local methods are shown to fail on representing the actual size, functional impact and structural importance of the relevant features over time. To efficiently visualize stall cells we applied a set of global and time-dependent measures to convey size, structure and temporal evolution of important transport effects and large-scale turbulent flow structures. Our analysis provides qualitative statements about the application of Lagrangian methods as FTLE [4], integral pressure, arc length of path lines and texture advection (Figure 1) revealing recirculation zones and blocked channels.

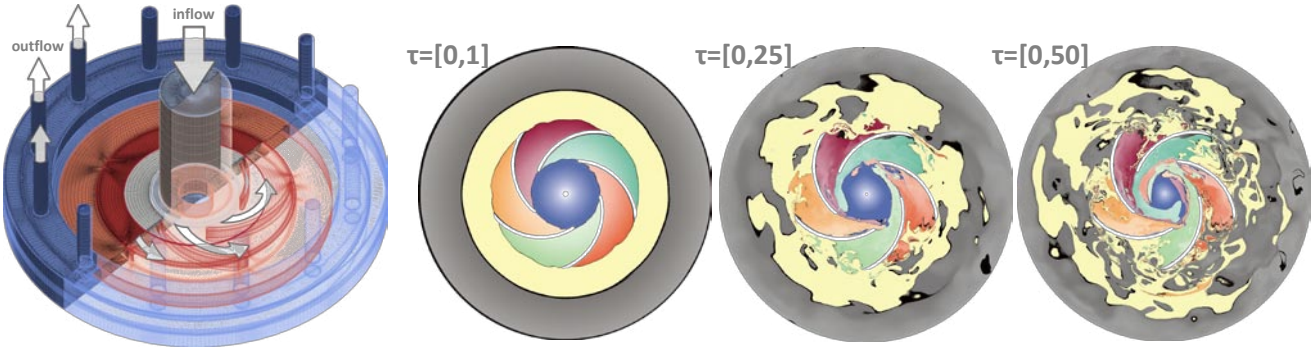

Fig. 1: Grid representation of the pump and three slices of the texture advection method. The advected channel information contains information about the transport efficiency of the individual channels and reveals areas of stagnating flow over the whole specified time interval τ delivering a compact and intuitive visualization.

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