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Application of scale-resolving simulation to a hydraulic coupling, a hydraulic retarder, and a hydraulic torque converter

Key words: Scale-Resolving Simulation; Hybrid RANS/LES; Hydraulic coupling; Hydraulic retarder; Hydraulic torque converter

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Objectives

- Providing a brief description of flow mechanism of three hydrokinetic devices based on the computational fluid dynamics (CFD) method.
- Employing scale-resolving simulation (SRS) to improve the accuracy of performance prediction and to provide understanding of the flow structures, instead of Reynolds-averaged Navier–Stokes (RANS) simulation.

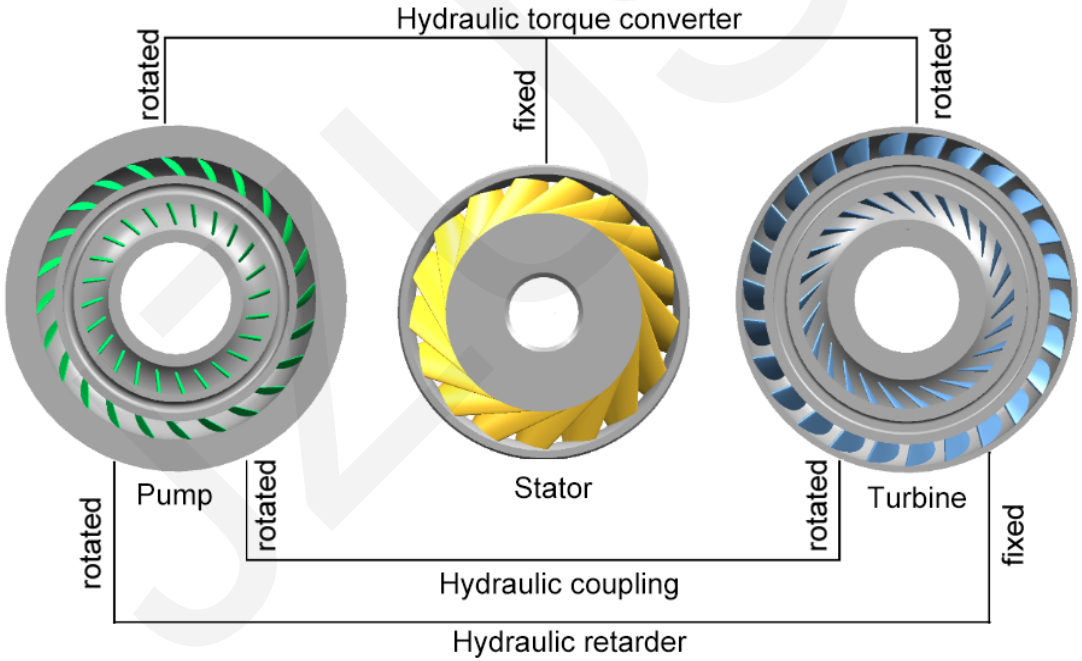

Fig 1. Classification and relationship of three hydrokinetic devices

Three Representative Cases

Hydraulic coupling

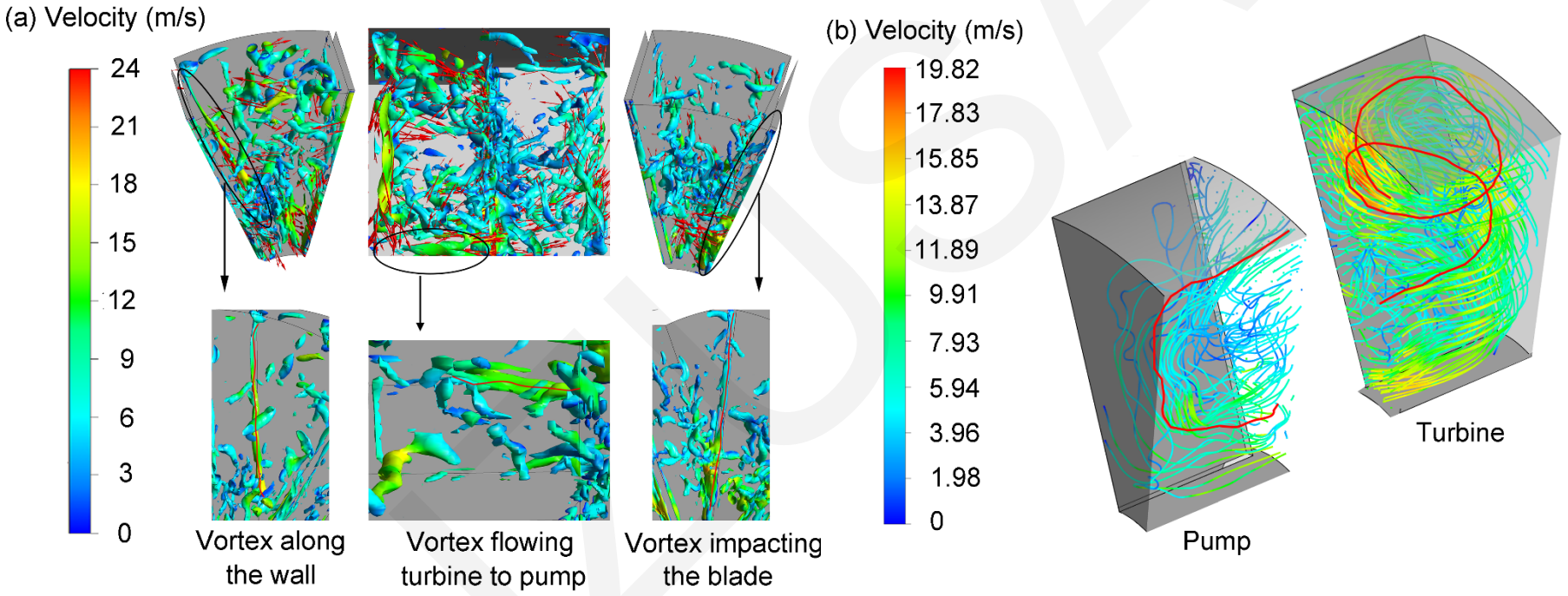

Fig. 2 Fluid flow behavior at pump and turbine channels

Three Representative Cases

Hydraulic retarder

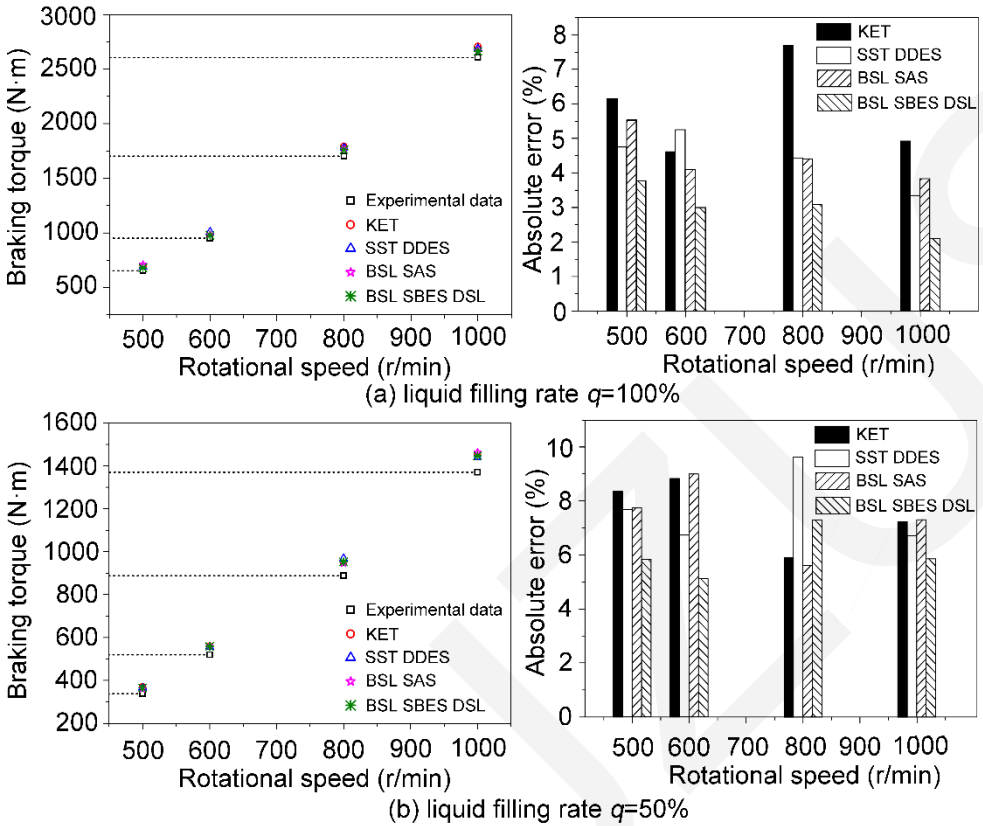

Fig. 3 Comparison between experimental and predicted results for braking torque

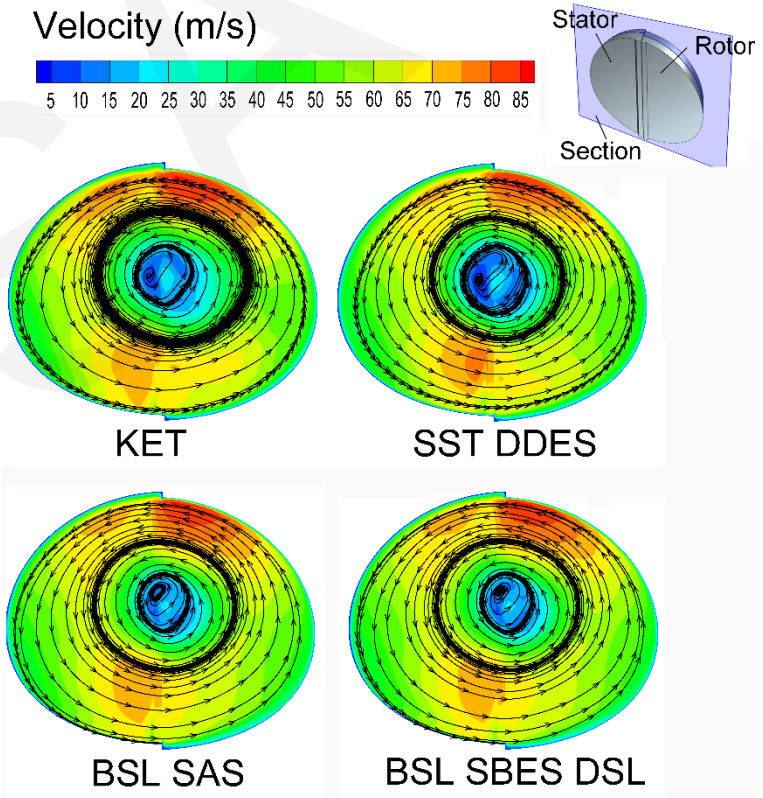

Fig. 4 Velocity distribution under different turbulence models

Three Representative Cases

Hydraulic torque converter

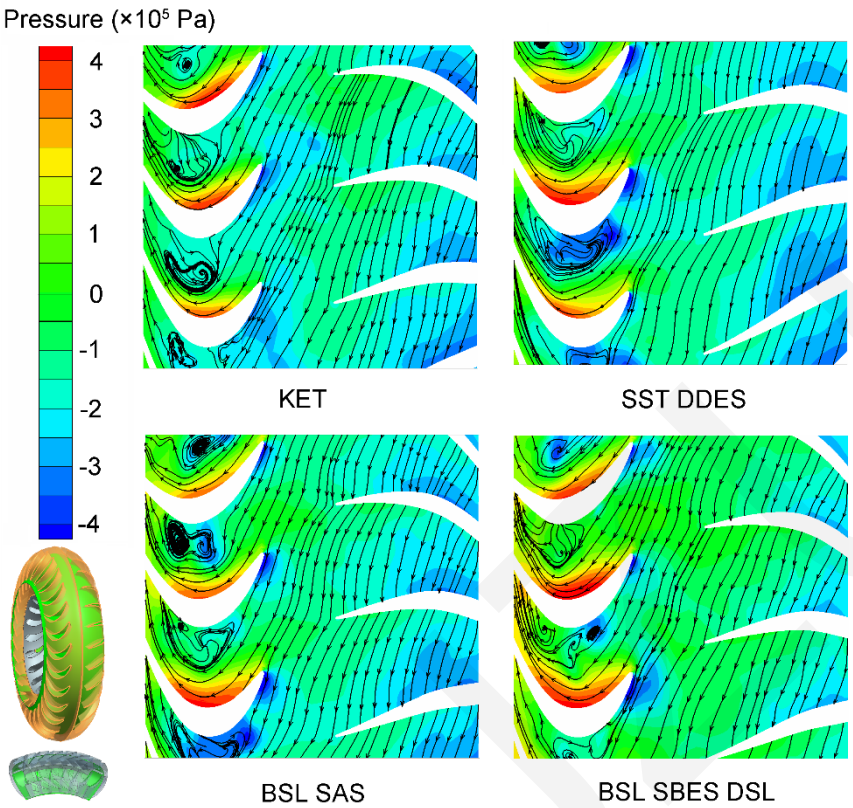

Fig. 5 Pressure-velocity streamline in the pump–turbine interface

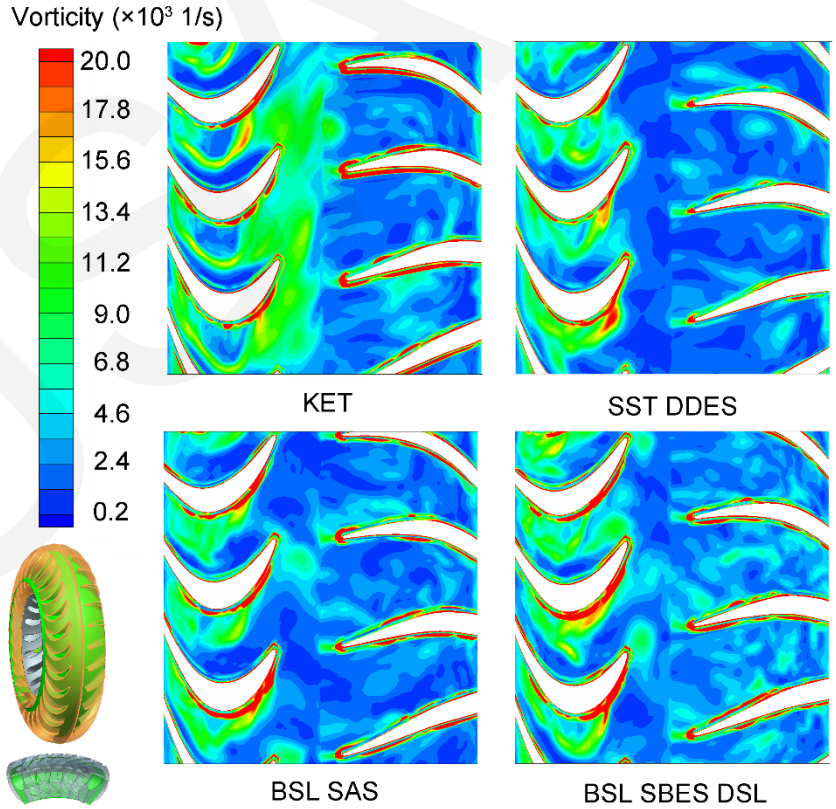

Fig. 6 Vorticity distribution in the pump–turbine interface

Conclusions

- According to the literature review, the prediction errors of RANS simulation are mainly between 10% and 15%. By SRS approaches, the maximum errors are reduced below 10%. It is found that a remarkable improvement in external performance is achieved.
- The improvement of performance prediction is based on the capture of the flow field. For certain transient unsteady flow simulations, SRS models can give additional flow information compared to RANS models.