Sensitivity Analysis of a Real Gas Conical Diffuser using Uncertainty Quantification

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Abstract

The Organic Rankine Cycle (ORC) has become a leading thermodynamic technique for generating electricity from low-to-medium temperature geothermal resources, as it is capable of extracting more energy compared to other conventional cycles by benefiting from the application of high-density fluids. As the connecting component to the ORC turbine outlet, real gas conical diffusers are key components designed to improve the efficiency of ORC. However, investigations in the robust optimal design of real gas diffusers are lacking, which restricts the improvement of overall ORC efficiency. An advanced and robust framework coupling an Uncertainty Quantification (UQ) approach with Computational Fluid Dynamics (CFD) and NIST REFPROP is proposed to effectively implement sensitivity analysis of real gas conical diffusers. R143a, a potential real gas fluid for radial-inflow turbines in ORC, is employed in this analysis. Both operating and geometric parameters have significant impact on the performance of conical diffusers, and thus a performance analysis is conducted using the proposed framework. This paper is the first attempt to quantify the influence of coupled and multiple uncertain parameters on a conical diffuser using R143a as working fluid. It is shown that the swirl velocity has more impact than inlet axial velocity on pressure recovery under various extreme geometric conditions regarding length and angle of the real gas conical diffuser. This study highlights the need to achieve a robust optimal real gas diffuser design in order to improve overall ORC efficiency.

Keywords: **Conical Diffuser, generalized Polynomial Chaos (gPC), Uncertainty Quantification (UQ)**