Structural Dynamic Performance Analysis of a Radial Turbine Operating with Butane

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Abstract

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This study investigates the structural dynamic behavior of a radial turbine operating with butane as the

working fluid. Emphasis is placed on rotating machinery performance under varying inlet pressures and the

resulting impact on structural loading. The objective is to assess how internal fluid flow affects stress

distribution, energy transfer, and flow rate within the turbine.

A three-dimensional model of the radial turbine was created and simulated using SIMFLOW (based on

OpenFOAM). Simulations were carried out under steady-state laminar flow conditions for different inlet

pressures ranging from 100,000 Pa to 160,000 Pa. A hexahedral mesh with localized refinement around the

blades was used to accurately capture the flow features.

Post-processing was conducted using PARAVIEW, and results were analyzed to determine the influence of

pressure on the turbine's performance. The study evaluated delivered power and mass flow rate variations

across multiple cases. These variations correspond to pressure-induced forces that significantly affect blade

loading and may trigger dynamic responses such as vibration or stress concentration.

The results underline the importance of accounting for fluid-induced structural effects in

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rotating

machinery design, especially when using alternative working fluids like butane. This work contributes to

the broader understanding of fluid–structure interaction in compact turbines and supports the integration of

structural dynamics into their performance analysis.

Keywords:

Radial turbine, Rotating machinery, Structural dynamics, CFD, Butane, Pressure variation,

Flow rate, SIMFLOW