Applications of a Supercritical CO2 Test Bed for Miniature Expanders and Turbines

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https://infinityturbine.com/infinity-turbine-applications-of-supercritical-co2-test-cart-for-developers.html

Exploring the applications of a supercritical CO_2 test bed for miniature expanders and turbines, including Tesla turbine designs, reversed centrifugal pumps, radial and impeller models, and advanced 3D printed metal prototypes.

This webpage QR code

PDF Version of the webpage (maximum 10 pages)

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Introduction

Supercritical carbon dioxide is increasingly viewed as a game-changing working fluid for energy conversion systems. Its high density and favorable thermodynamic properties make it suitable for compact turbines, expanders, and heat recovery systems. A cart-mounted supercritical CO_2 test bed with small tubing and interchangeable test fixtures provides an ideal platform for evaluating prototype expanders and turbines on a laboratory scale.

Applications in Turbine and Expander Development

Tesla Turbine Concepts

The Tesla turbine, with its smooth rotor discs and boundary layer operation, is a candidate for supercritical CO_2 systems where compact size and simplicity are desired. A small test rig allows rapid iteration of disc spacing, diameter, and nozzle designs to optimize efficiency with dense working fluids.

Reversed Centrifugal Pumps as Expanders

High-efficiency centrifugal pumps can often be reversed to function as radial expanders. With supercritical CO_2 as the working fluid, a miniature test bed can validate flow characteristics, pressure ratios, and mechanical loading when these off-the-shelf pumps are operated in reverse as expanders.

Radial and Impeller Designs

Radial inflow turbines and impeller-style expanders are widely used in high-pressure applications. A compact supercritical CO_2 test bed can be configured to test variations in blade geometry, flow passages, and bearing arrangements. These experiments are vital for understanding performance under high density and moderate temperature ranges typical of supercritical CO_2.

3D Printed Metal Prototypes

Additive manufacturing enables rapid prototyping of intricate turbine geometries that would be difficult to machine traditionally. Materials such as stainless steel, Inconel, or titanium can be printed with precise cooling channels, blade designs, or seal interfaces. A modular test system allows engineers to insert these prototypes, measure efficiency and durability, and refine the designs quickly.

Benefits of a Modular Test Bed

Flexibility: The ability to swap different turbine and expander designs without reconfiguring the entire system.
Scalability: Data from small-scale tests can be scaled up to inform larger power generation systems.
Innovation: Facilitates experimentation with unconventional geometries such as Tesla turbines, mixed-flow impellers, or hybrid expanders.
Rapid Prototyping: Seamless integration with 3D metal printing technologies for accelerated design cycles.