Three Inch Supercritical CO2 Micro Turbine Performance at 100 C, 300 C, 500 C, and 700 C

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https://infinityturbine.com/infinity-turbine-sco2-three-inch-micro-turbine-performance-at-100-300-500-700-c.html

Updated sizing for a three inch supercritical CO2 turbine. Estimated net power in kilowatts and cycle heat rate guidance are provided across four turbine inlet temperatures.

This webpage QR code

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Overview

Scaling the previously sized one inch supercritical CO2 turbine to a three inch outside diameter increases inlet annulus area and mass flow in proportion to radius when blade height and throughflow velocity are held constant. With similar stage loading and efficiency, shaft power scales about linearly with radius. This article provides first pass net power estimates for a purpose designed three inch radial inflow sCO2 micro turbine intended to drive a compact generator. Heat rate guidance is included for context and remains governed primarily by temperature lift and cycle quality rather than rotor size.

Design Basis and Scaling Notes

Turbine outside diameter: 76.2 mm (three inches)
Inlet radius: 38.1 mm
Inlet blade height: about 0.5 mm (same as the one inch study)
Inlet annulus area equals 2 times pi times radius times height. Tripling radius from one inch to three inches increases area and mass flow by about three times for the same inlet velocity.
Inlet total pressure: about 150 bar
Representative turbine isentropic efficiency: about 70 percent for a carefully designed micro stage
Whole cycle allowances for leakage, pressure losses, generator, and controls are included in the quoted net figures
Heat sink: about 40 C

Because blade height and inlet velocity are unchanged, net power scales to roughly three times the one inch results. Minor additional gains are possible from lower relative tip leakage at the larger diameter, but the values below keep to conservative scaling.

Estimated Net Power Output

100 C inlet: about 18 kilowatts net
300 C inlet: about 21 kilowatts net
500 C inlet: about 24 kilowatts net
700 C inlet: about 26 kilowatts net

Notes

1. These figures assume passages, volute, and diffuser are purpose designed for sCO2 and clearances are tight.
2. Final allowable speed is set by rim stress and tip Mach limits; those constraints are respected by carrying over the same flow velocities used in the smaller studies.
3. The larger diameter tends to reduce relative leakage and improve manufacturability, which can provide modest real world gains beyond simple scaling.