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

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Sizing study for a six inch supercritical CO2 turbine. Estimated net power in kilowatts and realistic heat rate ranges in BTU per kilowatt hour are provided for four turbine inlet temperatures.

This webpage QR code

PDF Version of the webpage (maximum 10 pages)

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Overview

Scaling a purpose designed supercritical CO2 micro turbine from small diameters up to a six 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 approximately linearly with radius. This article provides first pass net power estimates for a six inch radial inflow sCO2 turbine meant to drive a compact generator, and it includes cycle heat rate guidance for context.

Design Basis and Scaling Notes

Turbine outside diameter: 152.4 mm (six inches)
Inlet radius: 76.2 mm
Inlet blade height: about 0.5 mm (kept the same as the smaller studies for clean scaling)
Inlet annulus area equals 2 times pi times radius times height. Holding height and inlet velocity constant, mass flow and power scale with radius.
Inlet total pressure: about 150 bar
Representative turbine isentropic efficiency: about 70 percent for a carefully designed stage
Whole cycle allowances for leakage, pressure losses, generator, and controls are included in the quoted net figures
Heat sink: about 40 C

Reference scaling: the one inch study yielded about 6, 7, 8, and 8.5 kW net at 100 C, 300 C, 500 C, and 700 C respectively. A six inch rotor has six times the radius of the one inch case, so first order power scales by about six when blade height and inlet velocity are unchanged.

Estimated Net Power Output

100 C inlet: about 36 kilowatts net
300 C inlet: about 42 kilowatts net
500 C inlet: about 48 kilowatts net
700 C inlet: about 51 kilowatts net

Notes

1. These values assume passages, volute, and diffuser are purpose designed for sCO2 with tight clearances and good surface finish.
2. Final allowable speed is set by rim stress and tip Mach limits; those constraints are respected by carrying over the same throughflow velocities used in the smaller studies.
3. Larger diameter reduces relative leakage and eases manufacturability, which can yield modest real world gains beyond simple linear scaling. The estimates above stay conservative.

Heat Rate Guidance in BTU per Kilowatt Hour