Twelve Inch Supercritical CO2 Axial Multi Stage Turbine Performance at 100 C, 300 C, 500 C, and 700 C

Infinity Turbine LLC

[TEL] 1-608-238-6001

[Email] greg@infinityturbine.com

https://infinityturbine.com/infinity-turbine-sco2-12-inch-micro-turbine-performance-at-100-300-500-700-c.html

Recalculated performance for a twelve inch supercritical CO2 axial multi stage turbine. Estimated net power in kilowatts and heat rate in BTU per kilowatt hour are provided for four turbine inlet temperatures.

This webpage QR code

PDF Version of the webpage (maximum 10 pages)

Twelve Inch Supercritical CO2 Axial Multi Stage Turbine Performance at 100 C, 300 C, 500 C, and 700 C

Overview

This article scales our earlier micro turbine studies up to a twelve inch outside diameter axial flow turbine using multiple stages and high efficiency blading for supercritical CO2. The goal is maximum practical net power for a compact generator while keeping realistic cycle and mechanical assumptions. Results are shown for turbine inlet temperatures of 100 C, 300 C, 500 C, and 700 C.

Design Basis and Scaling Logic

Reference baseline

One inch radial inflow single stage supercritical CO2 turbine results from the earlier study
100 C about 6 kW net
300 C about 7 kW net
500 C about 8 kW net
700 C about 8.5 kW net

Key upgrades for this design

Diameter increased from one inch to twelve inches
Axial flow multi stage layout to raise overall pressure ratio and specific work while improving blading efficiency
Target turbine stage isentropic efficiency about 85 percent versus 70 percent used in the one inch baseline
Recuperated cycle with a 40 C sink, inlet total pressure near 150 bar, passages sized to keep relative Mach numbers subsonic with supercritical CO2 properties

Scaling method in plain text

Mass flow is proportional to annulus area at the inlet. For the same blade height and inlet velocity, annulus area and mass flow scale with radius. Diameter grows by twelve, radius grows by twelve, so mass flow scales by about twelve.
Turbine efficiency improvement factor equals 0.85 divided by 0.70 which is about 1.21.
Multi staging allows higher overall pressure ratio and specific work than the single stage baseline. We use a conservative specific work factor that rises with temperature because higher turbine inlet temperature allows higher pressure ratio at acceptable Mach numbers.
100 C specific work factor about 1.2
300 C specific work factor about 1.3
500 C specific work factor about 1.4
700 C specific work factor about 1.5

Net power scaling in plain text

Net power equals baseline power multiplied by diameter factor multiplied by efficiency factor multiplied by specific work factor.