



## Temperature Drop Through Multi-Stage Supercritical CO2 Turbines with Recuperation

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<https://infinityturbine.com/temperature-drop-through-multi-stage-sco2-turbines-with-recuperation-by-infinity-turbine.html>

A detailed analysis of temperature reduction across single, double, triple, and four-stage supercritical CO2 turbines operating with recuperation. Explains how temperature drop, expansion ratio, and recuperator design interact to affect overall system efficiency.



This webpage QR code

**PDF Version of the webpage (maximum 10 pages)**

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## Temperature Drop Through Multi-Stage Supercritical CO2 Turbines with Recuperation

### Introduction

In a supercritical CO2 (sCO2) Brayton cycle, turbine expansion converts the thermal and pressure energy of supercritical CO2 into mechanical shaft work. During this expansion, the CO2 temperature drops as enthalpy is converted to work.

Understanding how temperature decreases across single-stage and multi-stage turbines is essential for cycle design, especially when combined with recuperation, which recovers waste heat from the turbine exhaust to preheat the compressed CO2. The number of turbine stages, total pressure ratio, and degree of recuperation determine the exit temperature profile and overall cycle efficiency.

### The Thermodynamic Foundation

The turbine temperature drop is governed by the isentropic expansion relation:

$$T_{out,isen} = T_{in} \cdot \left( \frac{P_{out}}{P_{in}} \right)^{\frac{\gamma - 1}{\gamma}}$$

where

$(T_{in})$  = turbine inlet temperature (K)

$(P_{in}, P_{out})$  = inlet and outlet pressures

$(\gamma)$  = specific heat ratio (~1.3 for CO2 in the supercritical region)

The actual exit temperature is higher than the isentropic value due to turbine efficiency:

$$T_{out,actual} = T_{in} \cdot \eta_t \cdot (T_{in} - T_{out,isen}) + T_{out,isen}$$

with typical sCO2 turbine isentropic efficiencies between 80–90%.

### Typical Conditions for Analysis

Let's assume a representative sCO2 Brayton turbine setup:

Turbine inlet temperature (TIT): 600°C (873 K)

Turbine inlet pressure (TIP): 10 MPa

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