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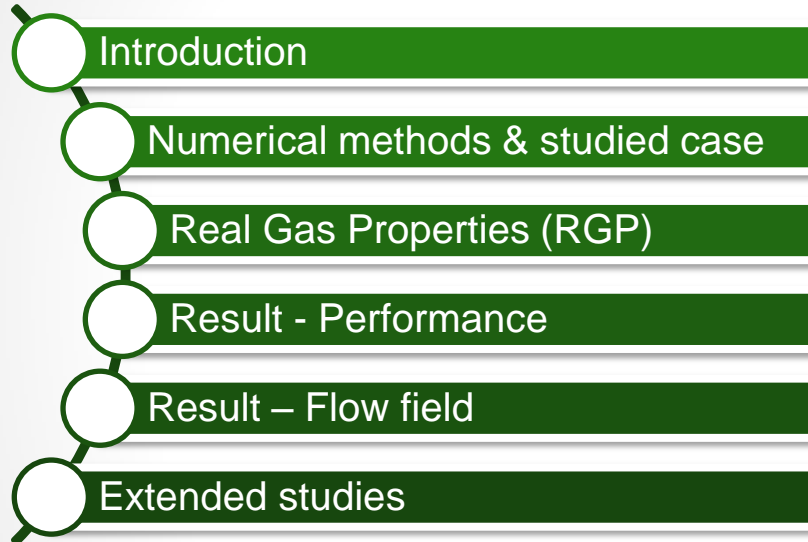


Numerical Sensitivity Analysis for Supercritical CO₂ Radial Turbine Performance and Flow Field

Alireza Ameli, Antti Uusitalo, Teemu Turunen-Saaresti, Jari Backman



Outline





- Motivation
- Present study

Introduction

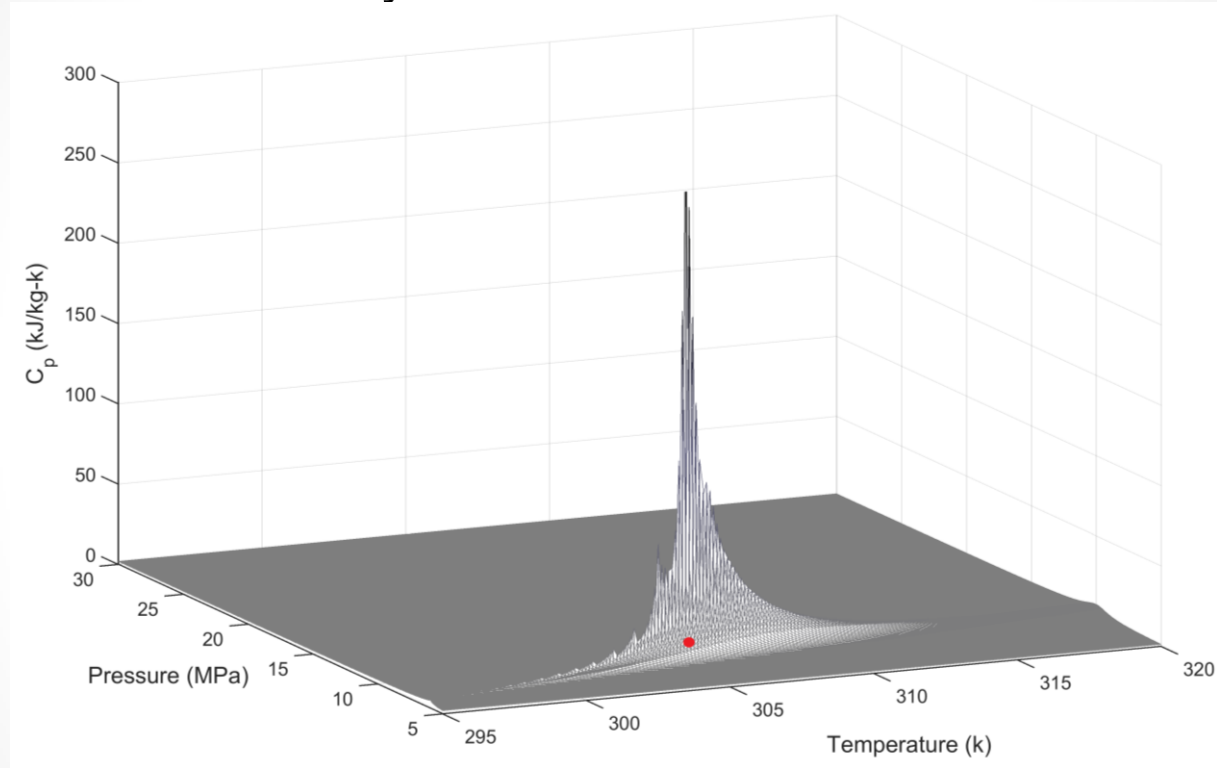
Numerical methods & studied case

Real Gas Properties (RGP)

Result Performance

Result Flow fields

Extended studies





- Numerical simulations with ANSYS CFX 17.0
- Structured mesh by using Turbo Grid (about 1.4 million cells)
- $k - \omega$ SST Turbulence model
- Sandia radial turbine (main)*
- Boundary conditions: p_t, T_t & $p_s - p_t, T_t$ & \dot{m}
- Unsteady state simulation (Time Transformation)

Introduction

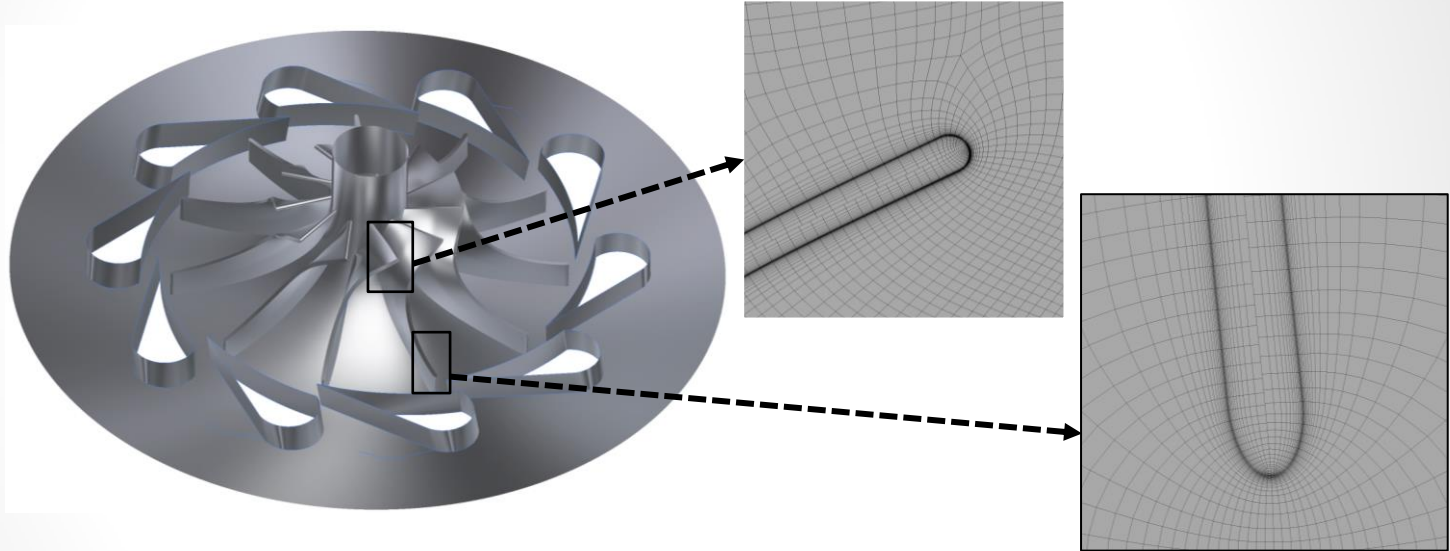
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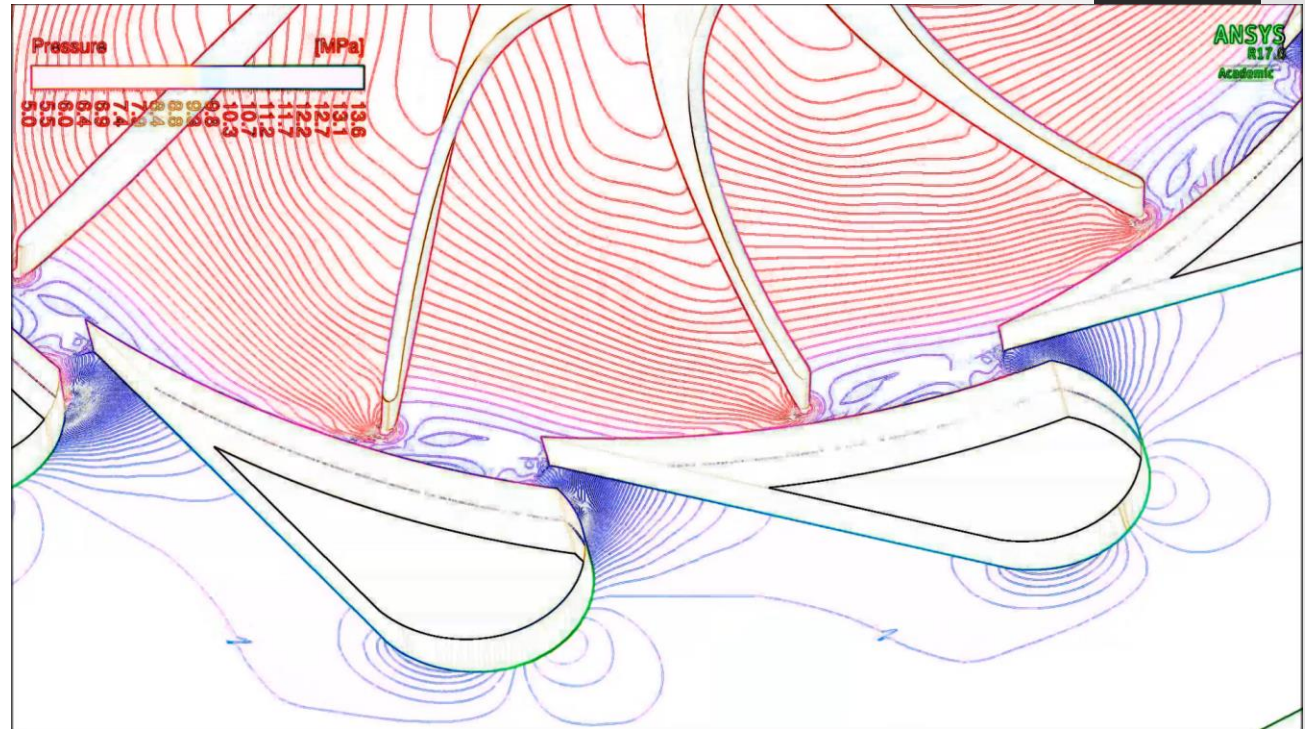


* S. A. Wright, P. S. Pickard, M. E. Vernon, R. F. Radel and R. Fuller, "Description and Test Results from a Supercritical CO2 Brayton Cycle Development Program," in *7th International Energy Conversion Engineering Conference*, Denver, Colorado, 2-5 August, 2009.



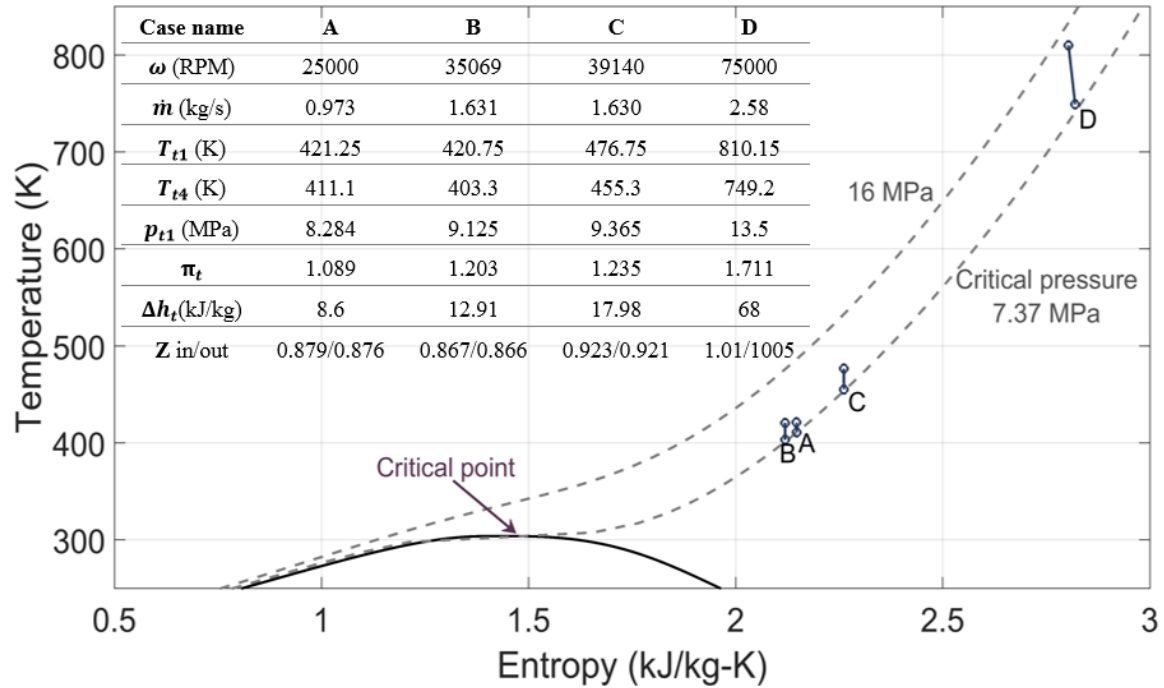
1. Improved cubic EOS models Peng-Robinson (PR)
2. Soave-Redlich-Kwong (SRK)
3. Span & Wagner (SW)
4. Ideal

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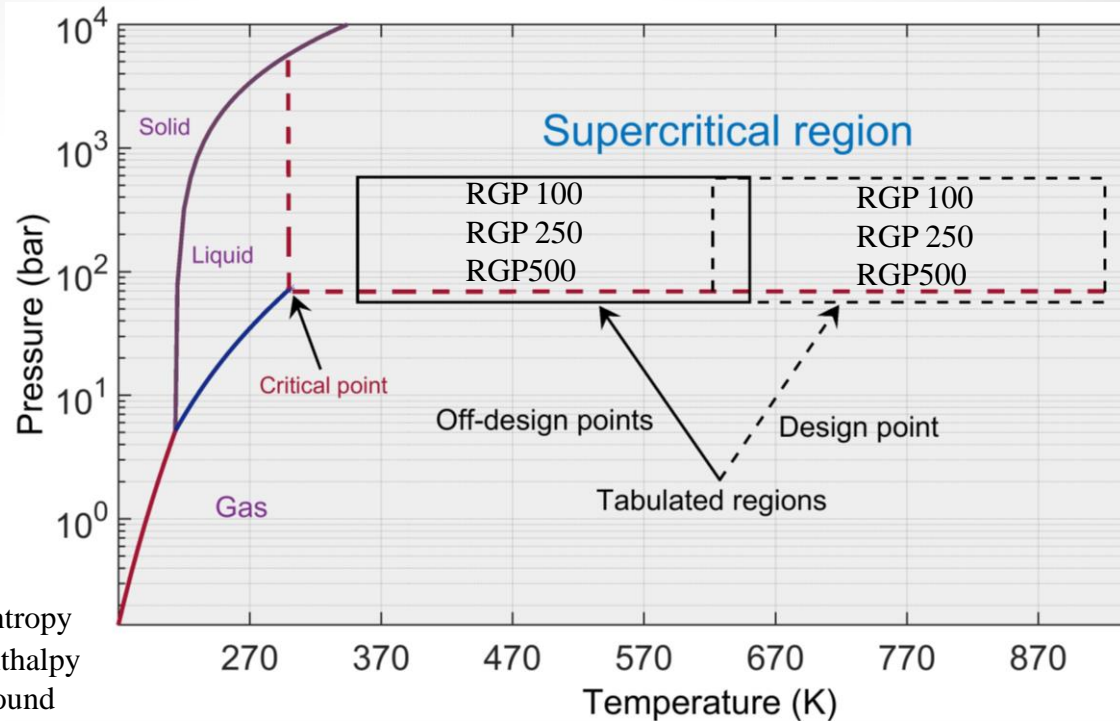


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- 1- Specific entropy
- 2- Specific enthalpy
- 3- Speed of sound
- 4- Specific volume
- 5- Specific heat at constant pressure
- 6- Specific heat at constant volume
- 7- Dynamic viscosity
- 8- Thermal conductivity
- 9- Partial derivative of pressure with respect to specific volume at constant temperature.



Introduction

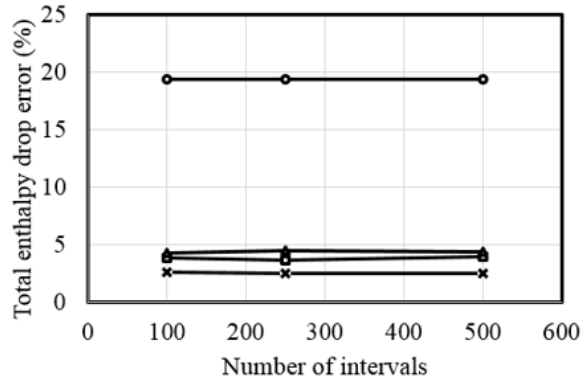
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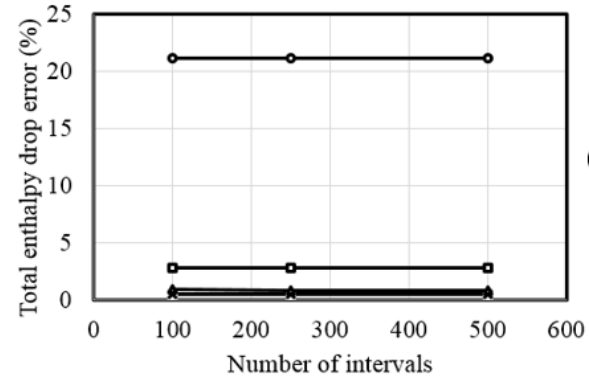
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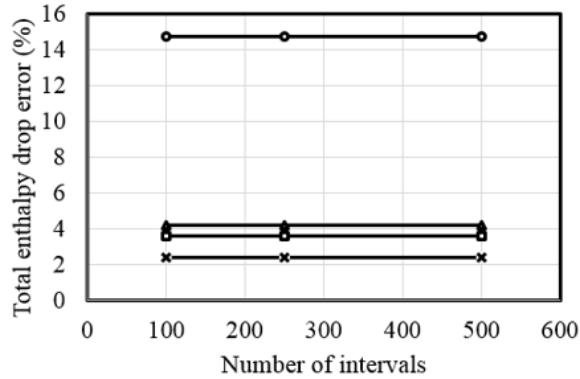
Extended studies



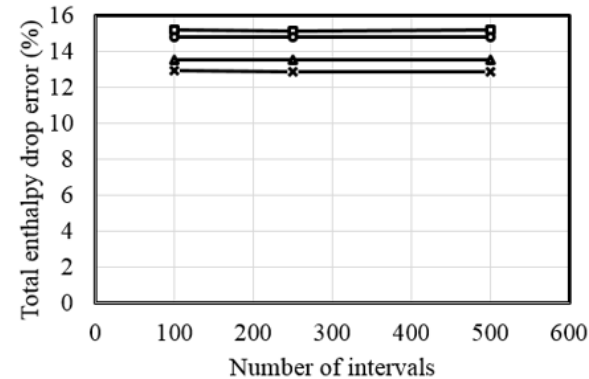
(A)



(B)



(C)



(D)

—x— SW —▲— PR —◻— SRK —○— Ideal



Introduction

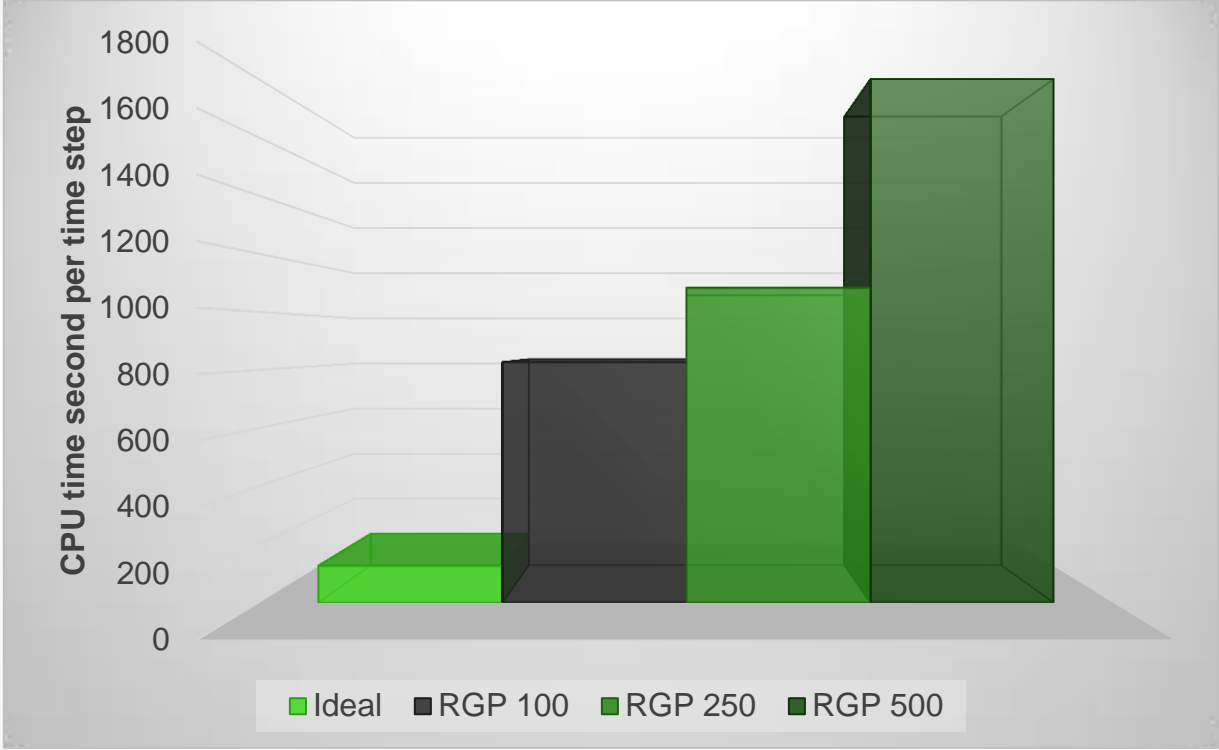
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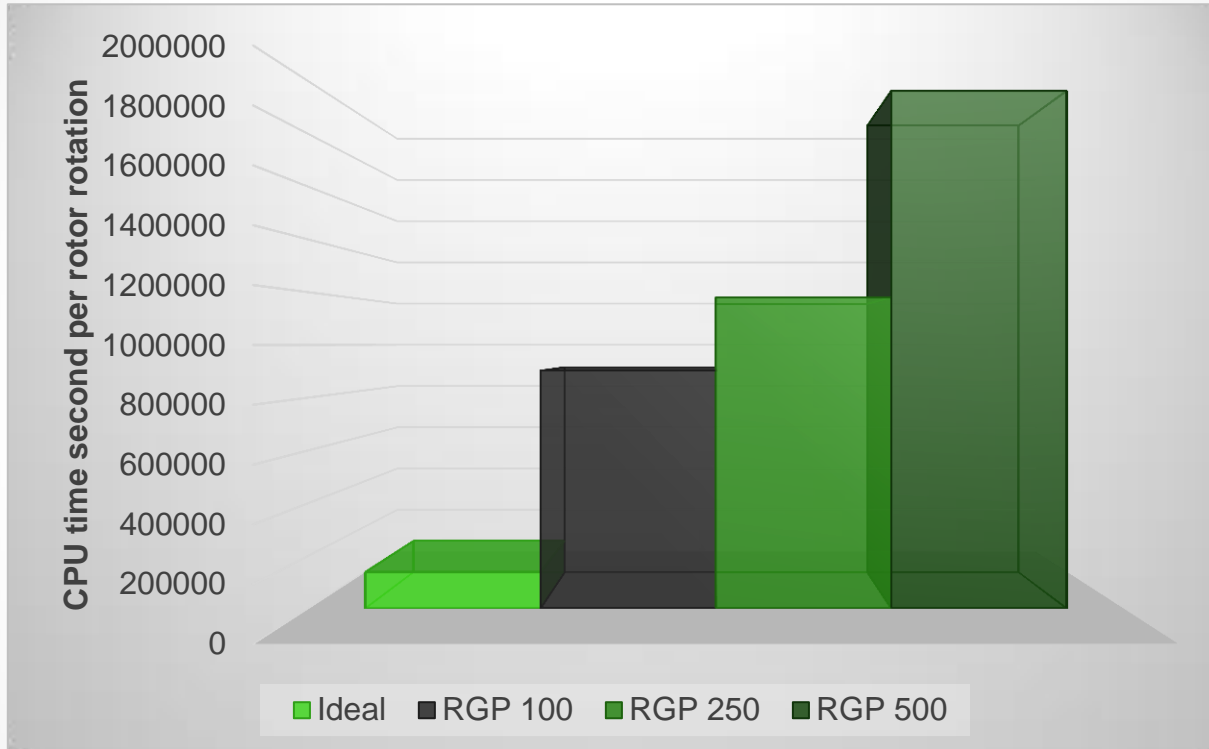
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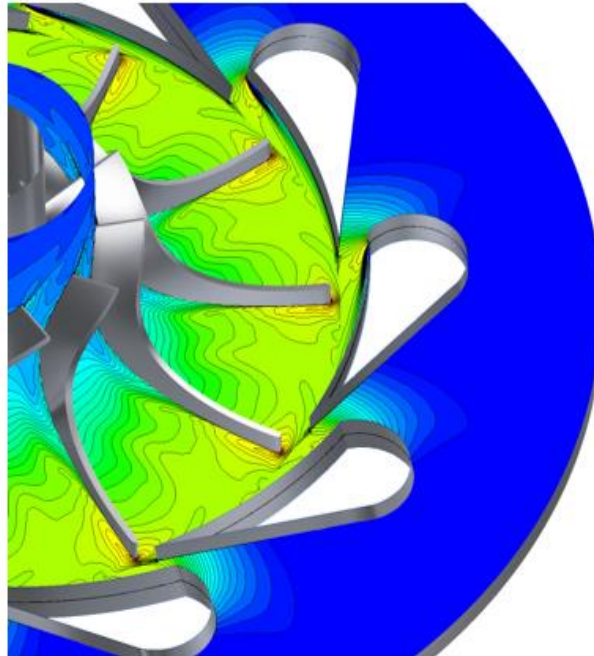


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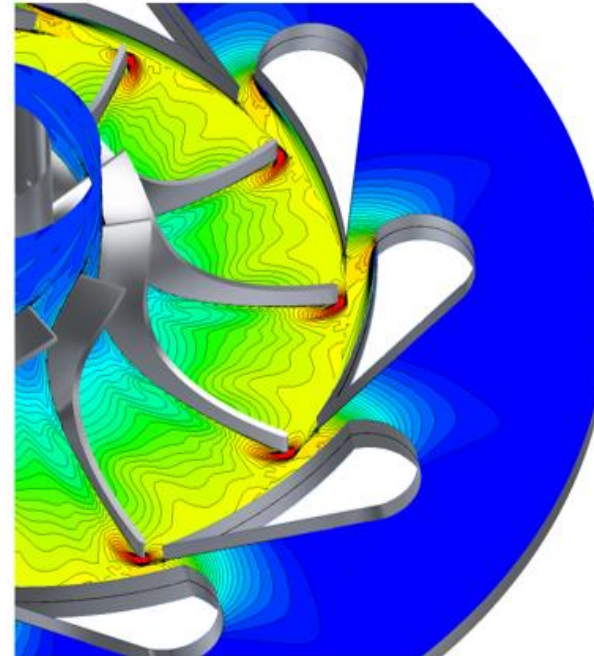




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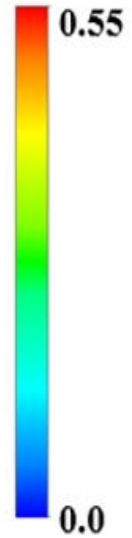


Real gas assumption



Ideal gas assumption

Mach Number in Stn Frame

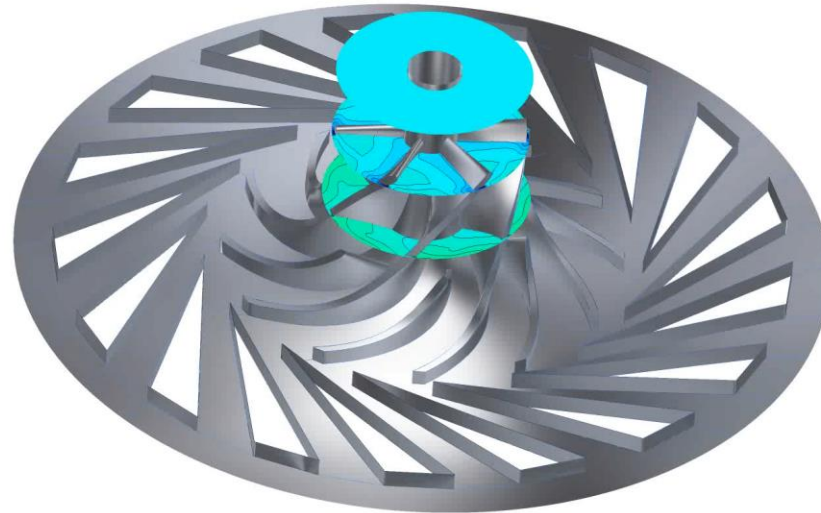
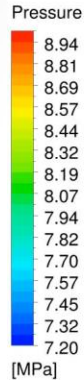


Undergoing researches:



- Design a centrifugal compressor with current and modified loss models.

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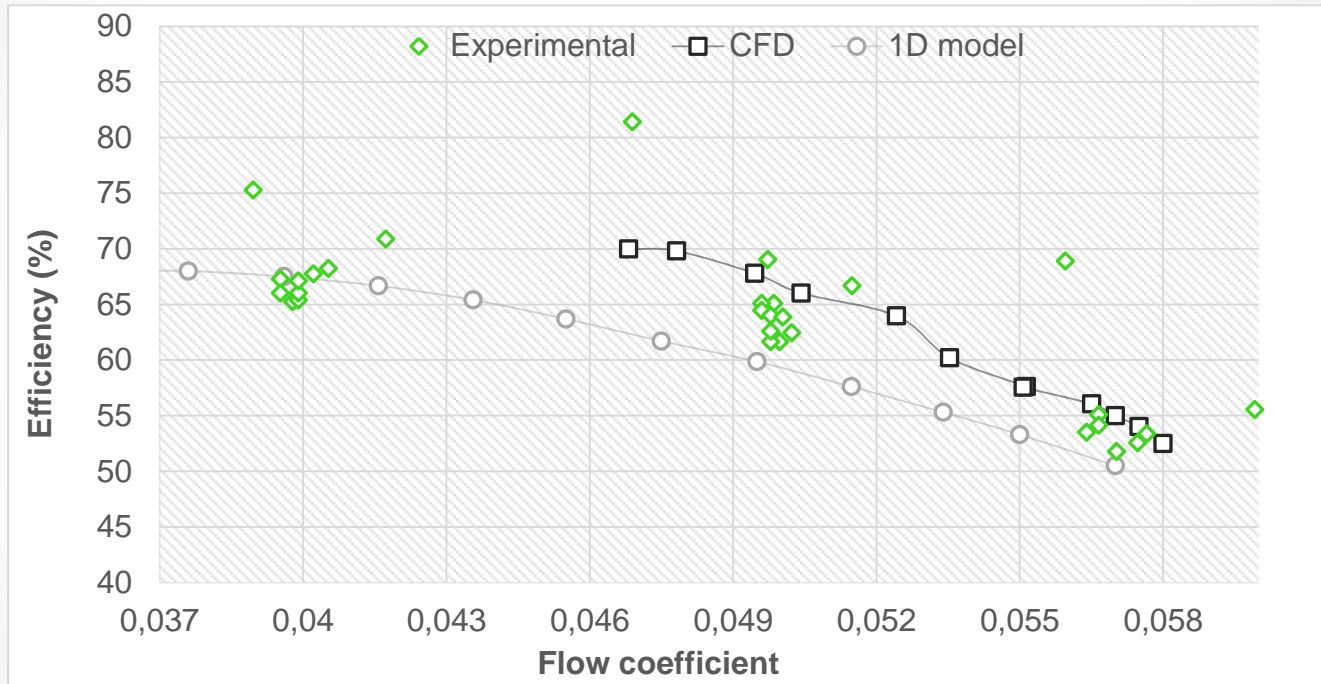
ANSYS
R17.0
Academic

❖ Sandia Supercritical CO₂ Radial compressor

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Thank you for your attention!

