

Small scale sCO₂ compressor impeller design considering real fluid conditions

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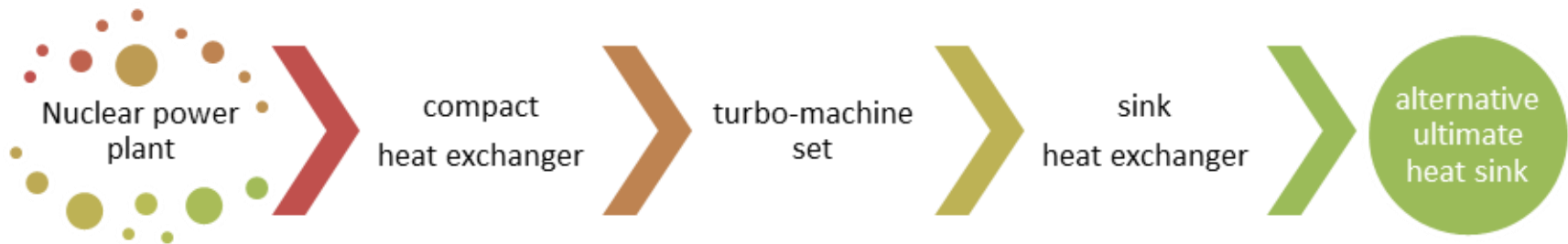
Overview

- Introduction
- Primary Design
- Implementation of real fluid properties
- Numerical Simulation
- Summary

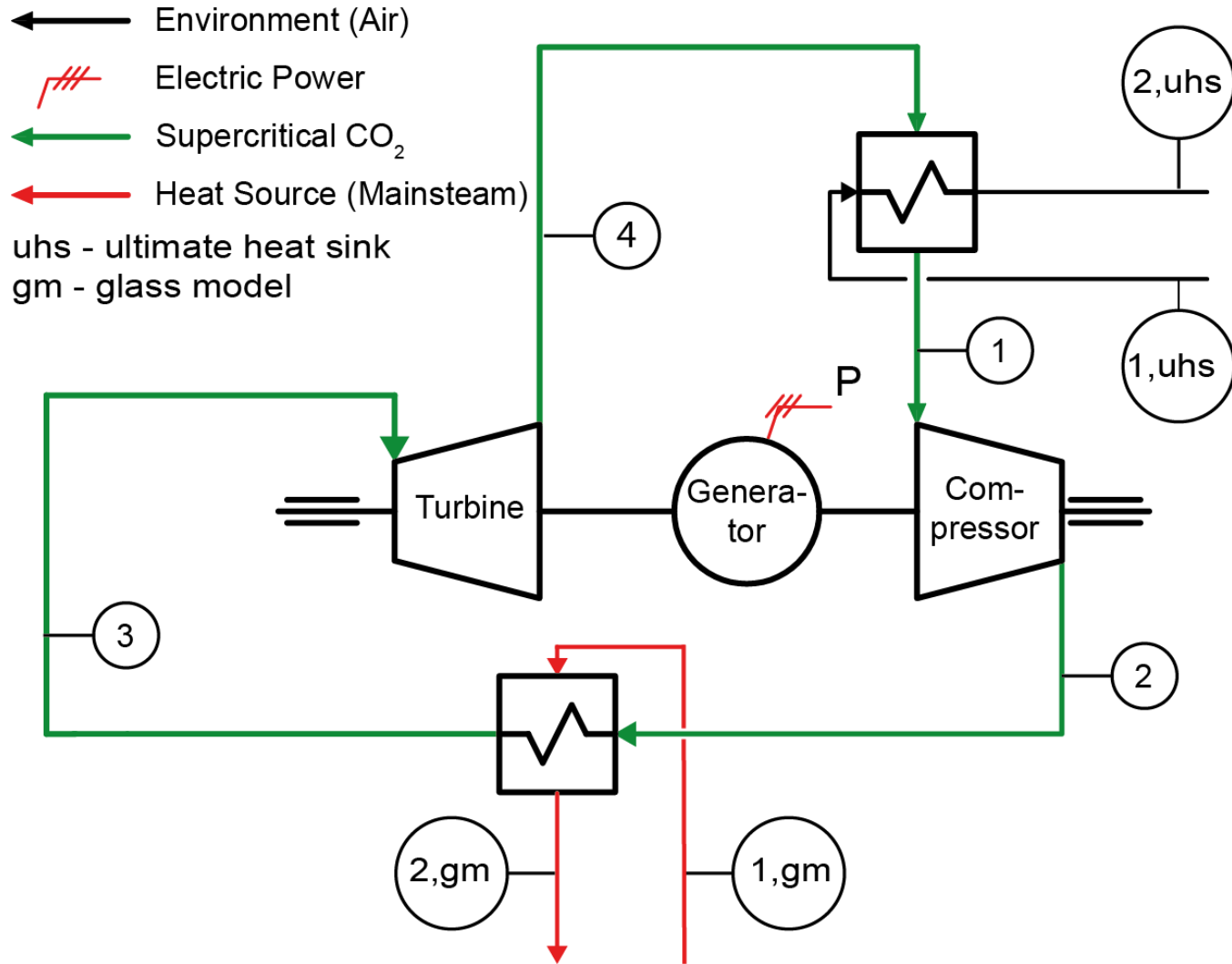
Introduction



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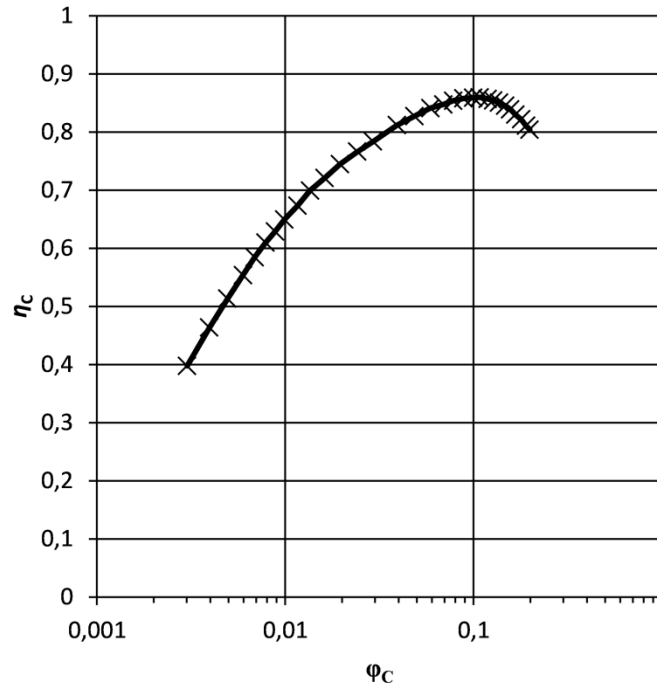


Introduction



Primary design procedure of the compressor impeller

- $a = u_2 * C_{u_2} - u_1 * C_{u_1} \implies u_2 * C_{u_2} \implies u_2^2$
- Flow coefficient considered as 0.1
- Rotational speed constrained by frictional losses



$$\phi_c = \frac{4 \dot{V}}{\pi * d_2^2 * u_2}$$

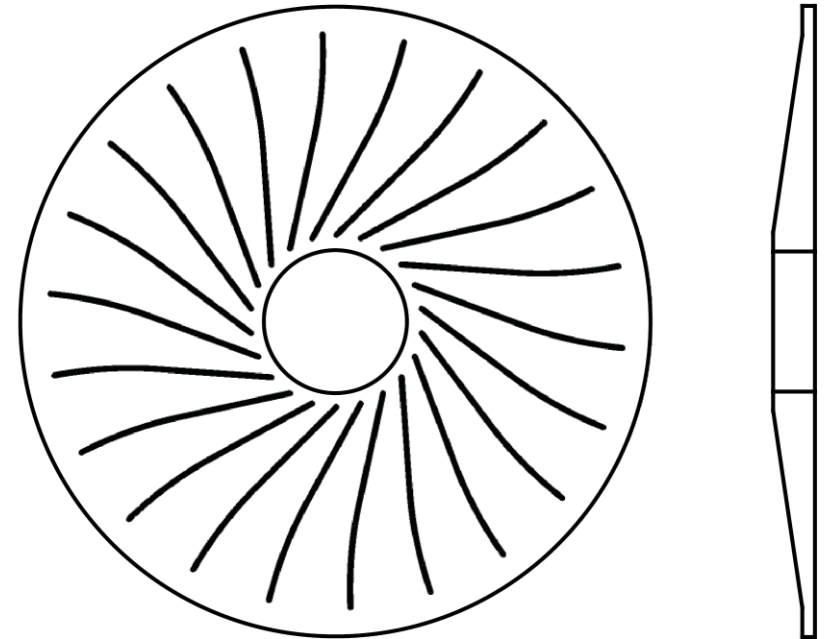
Compressor efficiency (R. Aungier, Centrifugal Compressors)

Primary design procedure of the compressor impeller

Design Parameters

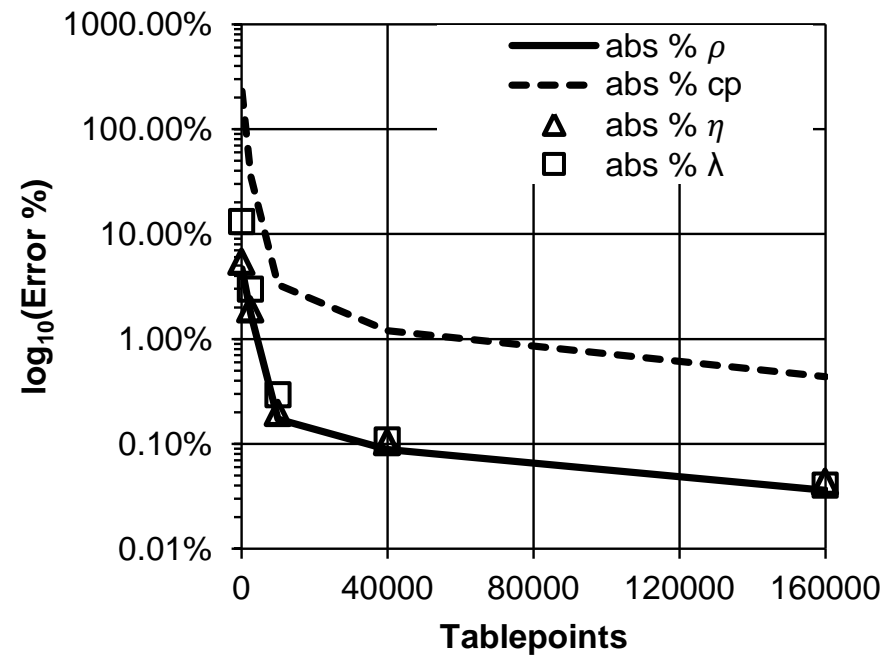
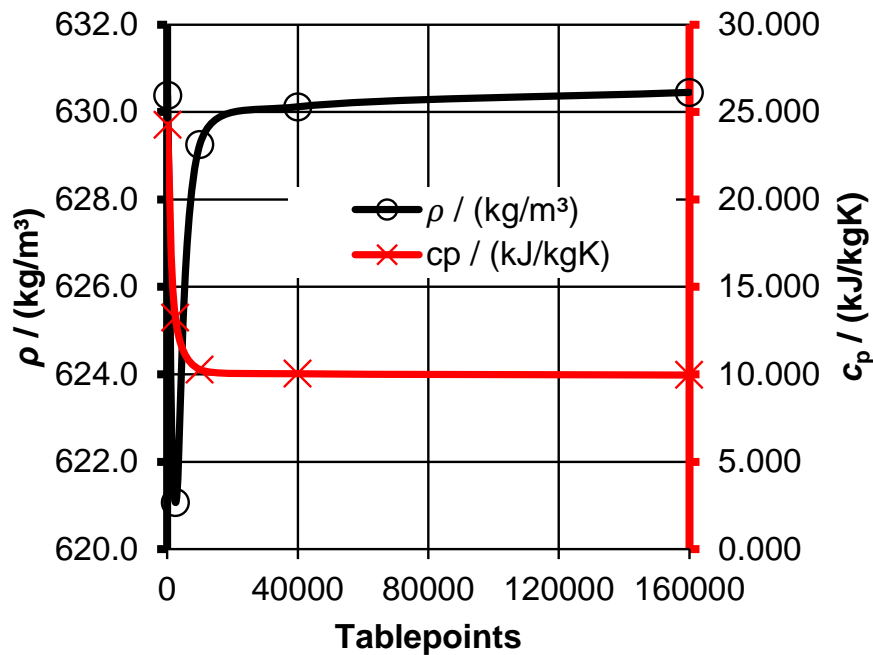
Parameter	Symbol	Value	Unit
Rotational Speed	n	50000	rpm
Number of impeller blades	n_{Blade}	22	-
Mass flow	\dot{m}	0.65	kg/s
Isentropic Power	P_{is}	5.046	kW
Impeller outlet diameter	d_2	40	mm

Impeller Geometry

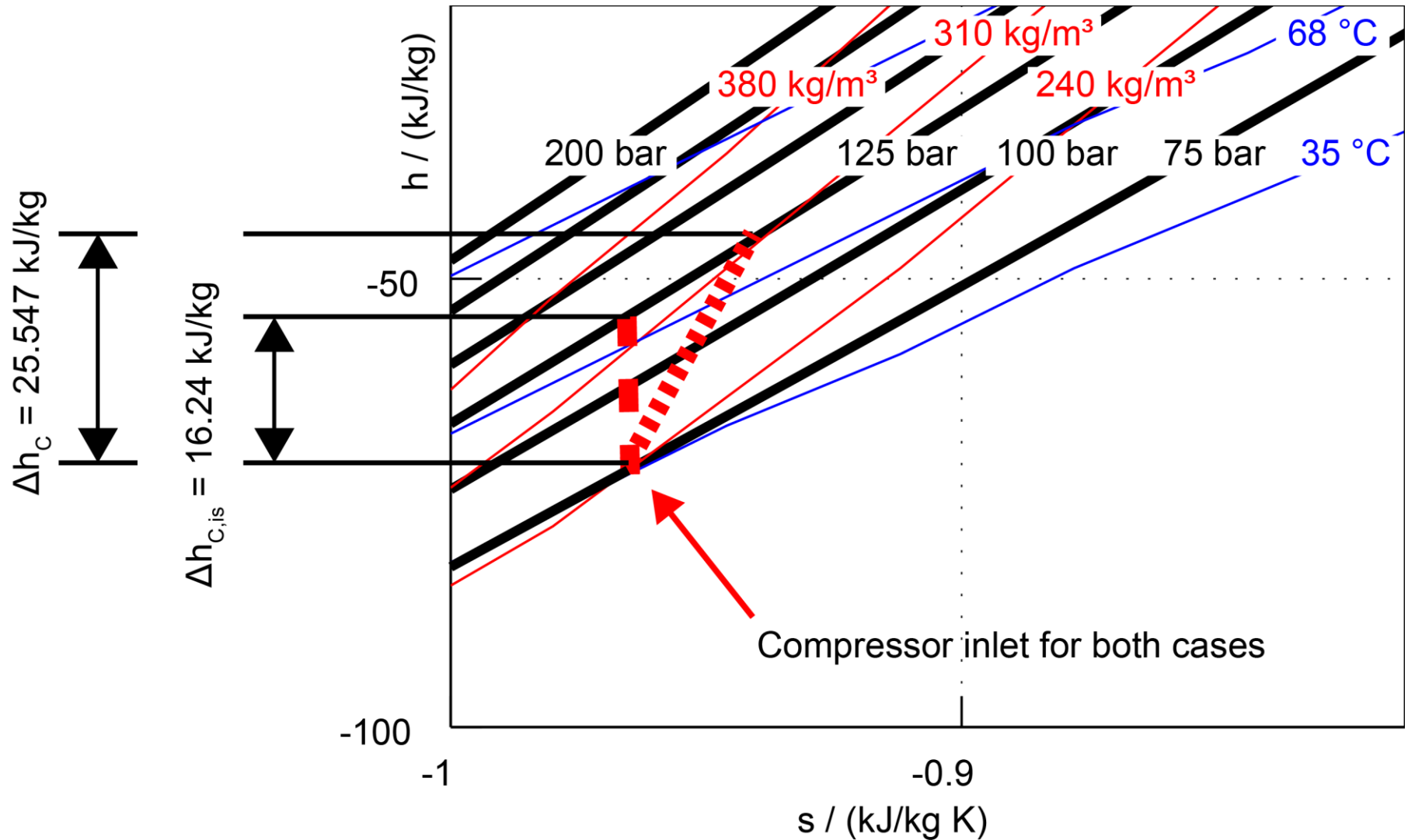


Implementation of real fluid properties

- ANSYS CFX, Menter-SST turbulence model
- Need for real fluid properties
- Investigation of resolution of real fluid properties table

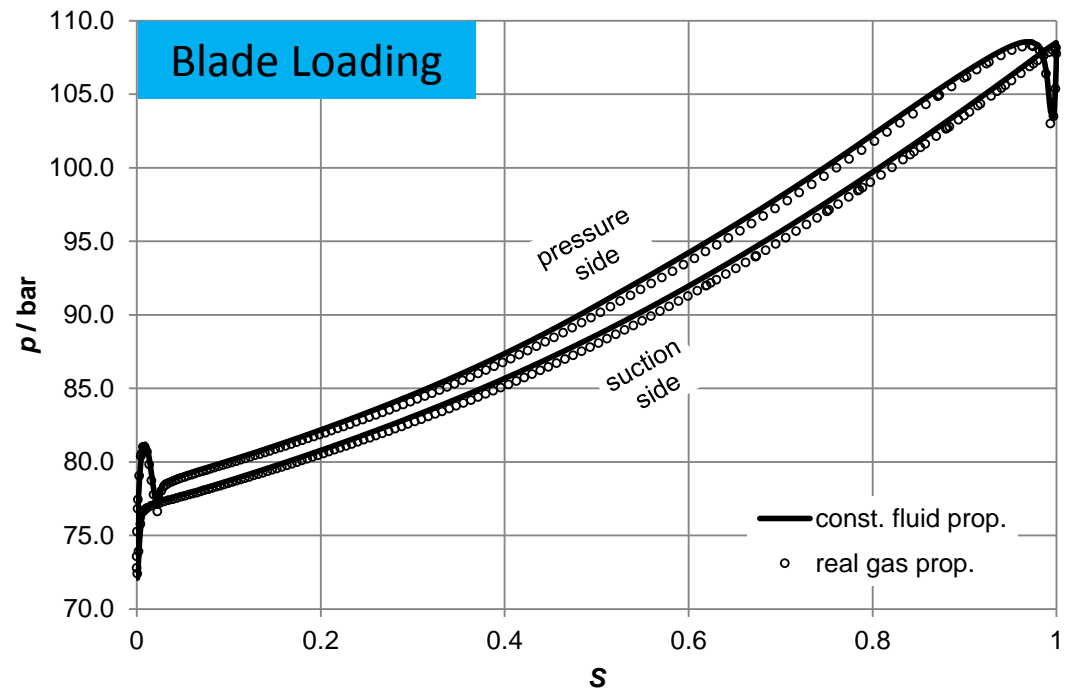
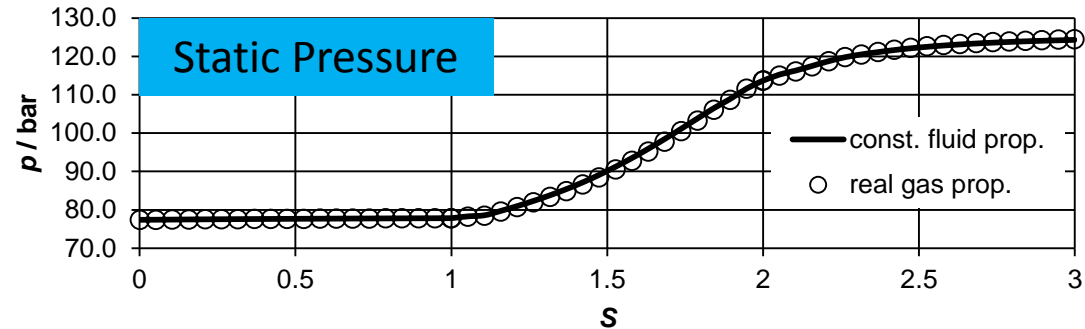


Implementation of real fluid properties



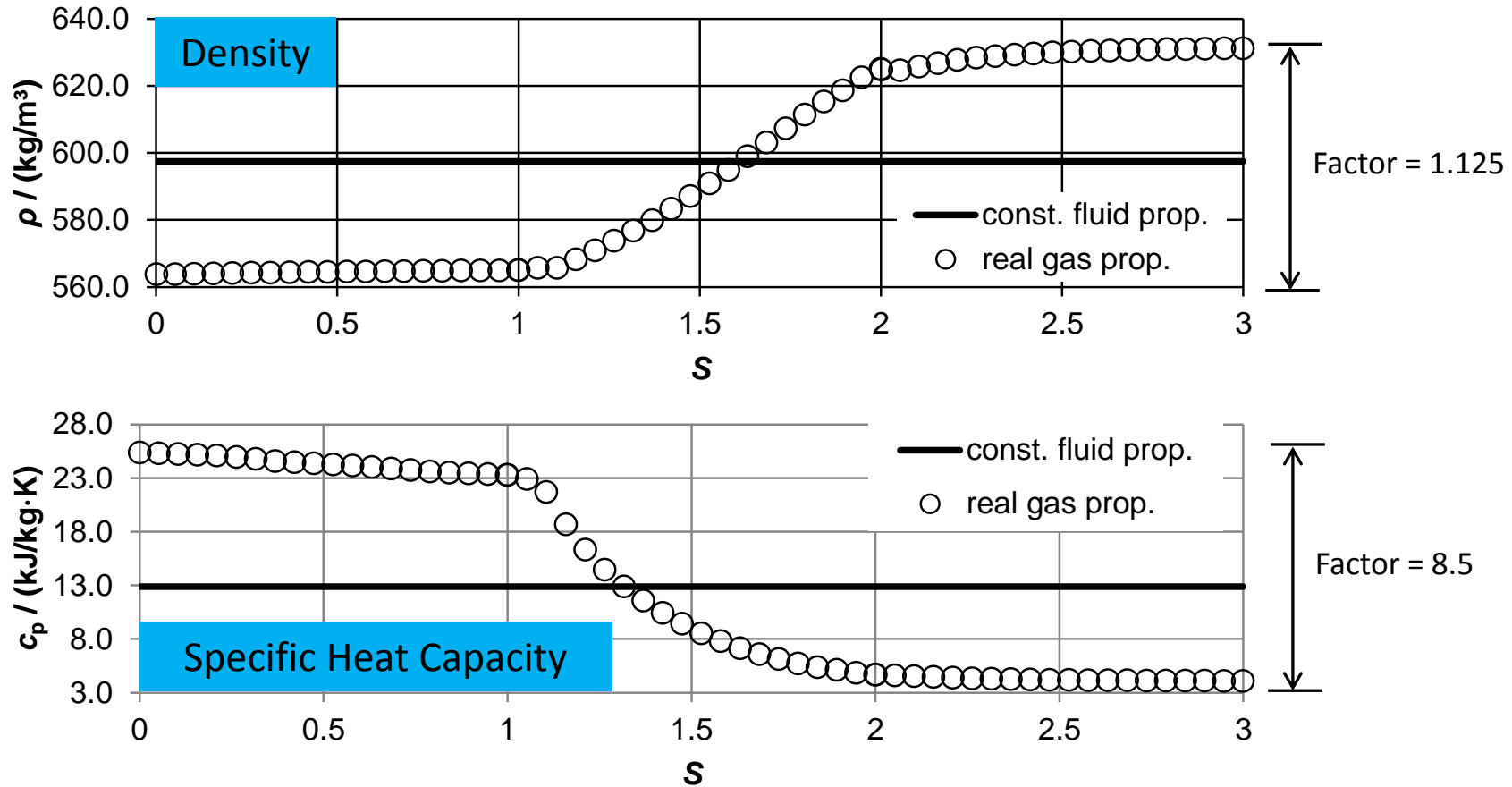
Numerical Simulation

- Two numerical simulations – Real gas properties and constant properties
- Inlet b.c. – total pressure, total temperature
- Outlet b.c. – Mass flow rate



Numerical Simulation

- Variation in results for density and specific heat capacity



Summary

- Primary design of compressor impeller presented
- Real fluid properties match well with the analytical values computed from the equations of state
- Acceptable efficiency achieved
- Influence of real fluid properties on the flow solution is negligible

Thank You For Your Attention