



المؤتمر الدولي للطاقات الحفريّة والمتجددة

International Conference on Fossil and Renewable Energies
18th – 19th November 2025, ICFRE'2025

Numerical Evaluation of $R_{152a}-Al_2O_3$ Nanorefrigerant for Energy Efficiency Enhancement in Vapour Compression Refrigeration Systems

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Plan



Introduction

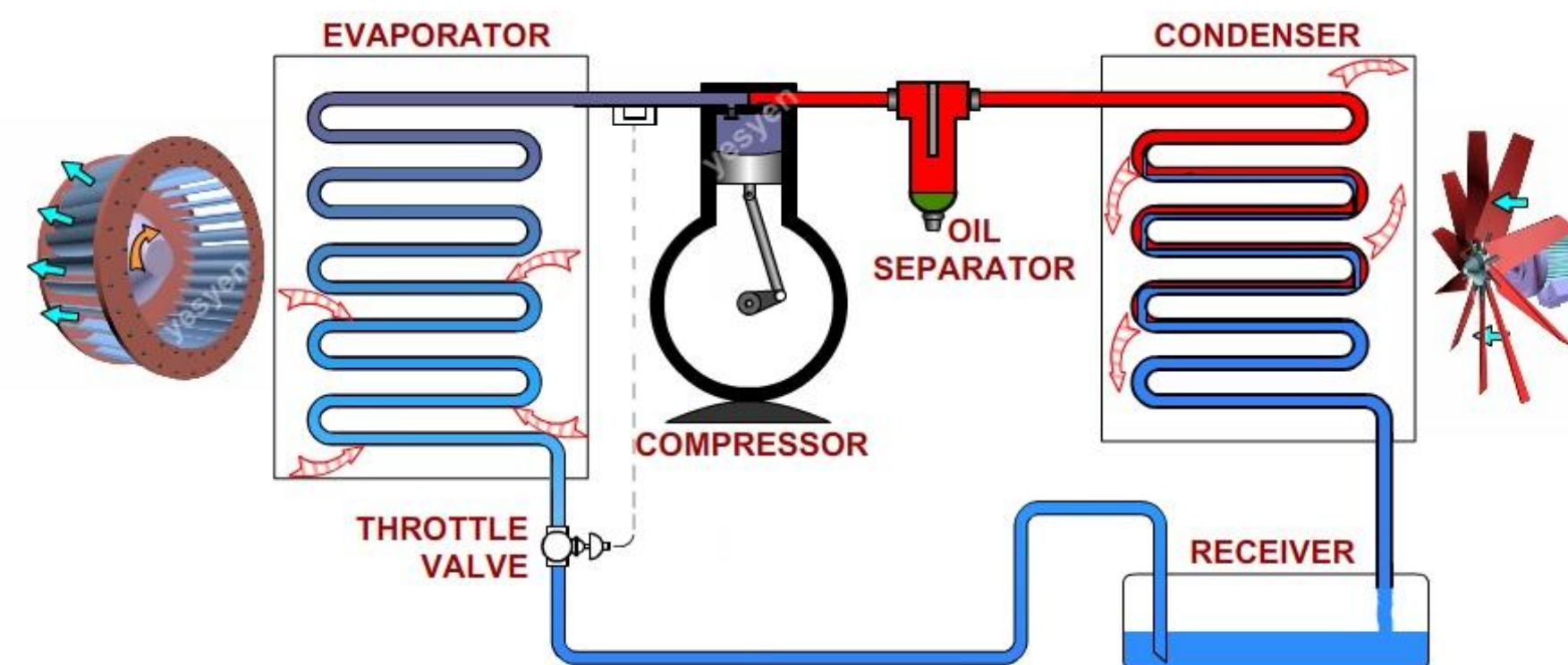
Vapour compression refrigeration systems (VCRS) are widely used in cooling technologies.

Resulting

R134a is common but has high Global Warming Potential (GWP ≈ 1430)

Our work is focused on:

- ➔ The use of R152a as a next-gen refrigerant with very low GWP
- ➔ Examination of Al_2O_3 -enhanced R152a compared to R134a.

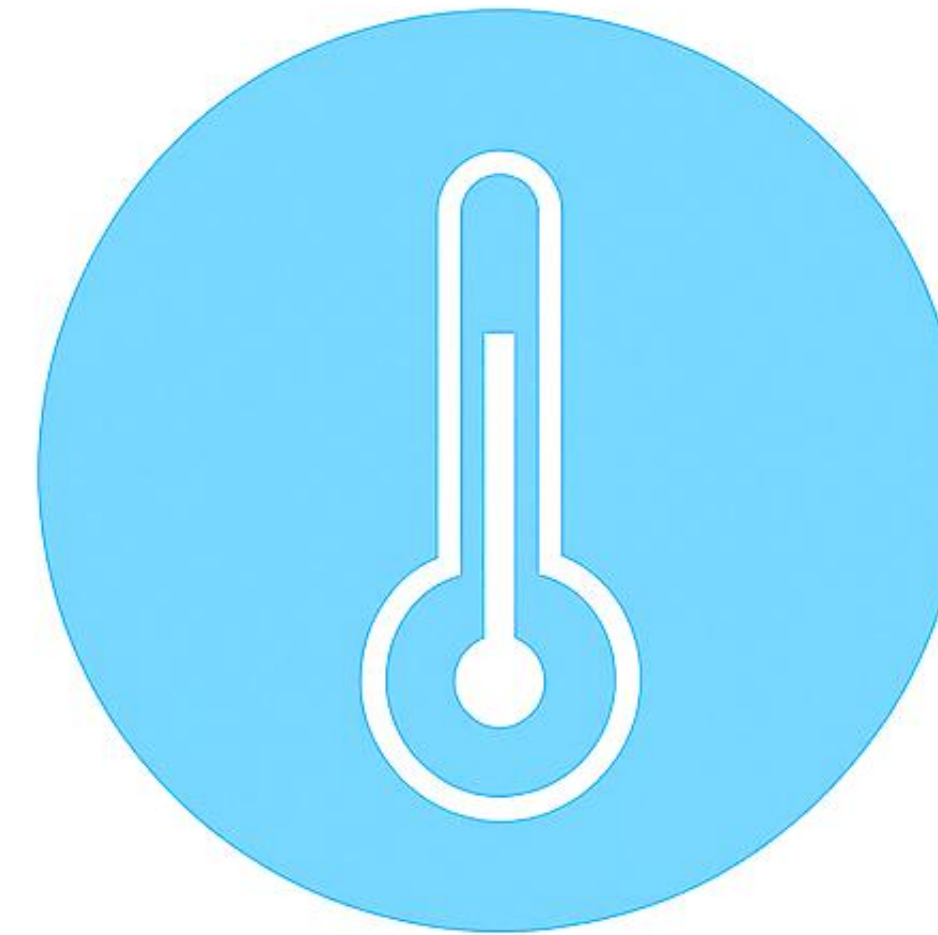


Problematic and Objective of Work

Problematic



Environmental concerns urge replacement of high-GWP refrigerants



Thermal performance must not be compromised during replacement

Objective

Evaluate the effect of 5 wt% Al_2O_3 nanoparticles on:

- ◆ COP (Coefficient of Performance)
 - ◆ Compressor power consumption
 - ◆ Cooling capacity
- Compare R152a-based nanorefrigerant to R134a



**Examination
of the
technology**

The Use of Nanorefrigerants

Nanorefrigerants: The Future of Cooling

Nanorefrigerants = Refrigerants
+ Nanoparticles



Al₂O₃ Enhanced
Conductivity

Benefits of Nanorefrigerants:

1.  Enhanced Heat Transfer
2.  Reduced Energy Consumption
3.  Potential Reduction in Refrigerant Mass Flow

Focus: R152a + 5 wt% Al₂O₃ Nanofluid

Steps involved in our study



Develop simulation code
in MATLAB



Couple code with
REFPROP...



Set baseline: pure
R134a and R152a



Inject 5 wt% Al_2O_3 ...
 Al_2O_3 ...



Al_2O_3 Enhanced
Conductivity

Compare key performance indicators:



- Compressor power

- COP



- Heat absorption

- Economic impact



How it works ?



Case study

Determination of the different parameters and data of the case study



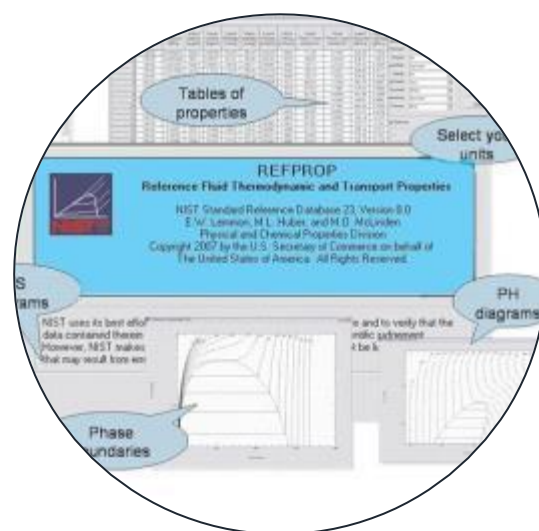
MATLAB

Writing an code for the simulation of the desired technology



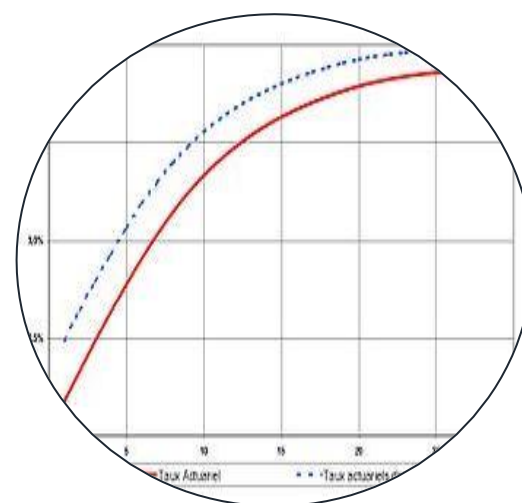
REFPROP & Coolprop

Linked the Matlab code with REFPROP

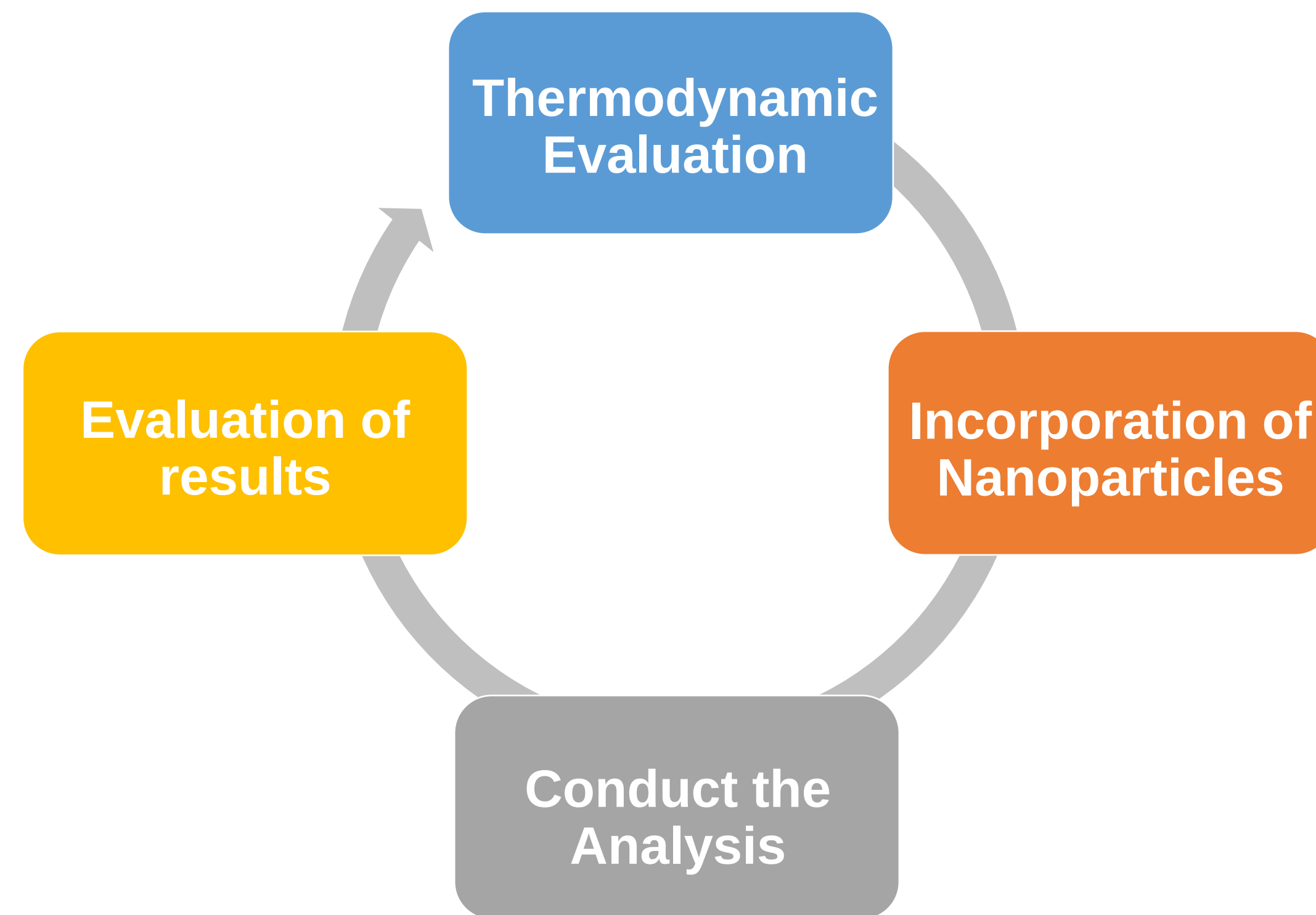


Results

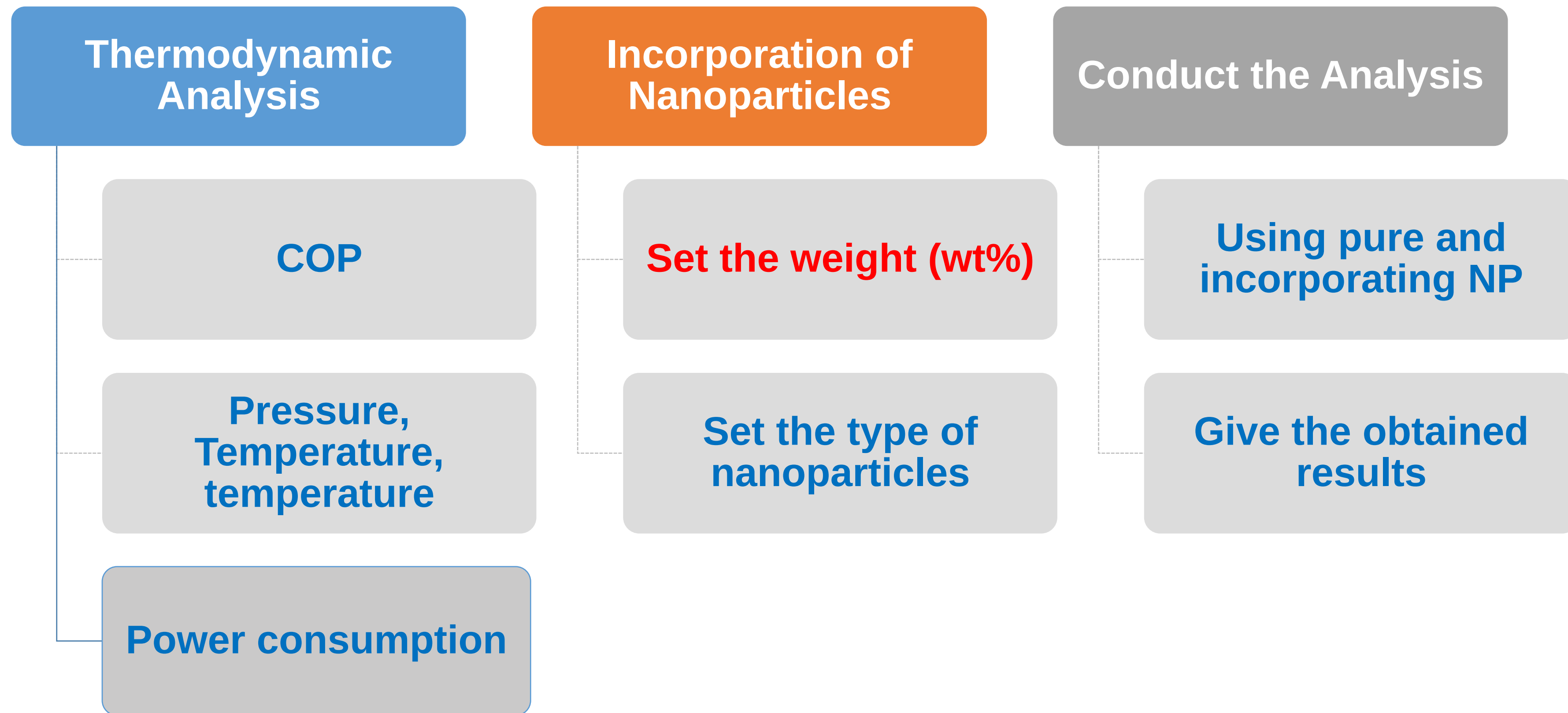
Simulations results



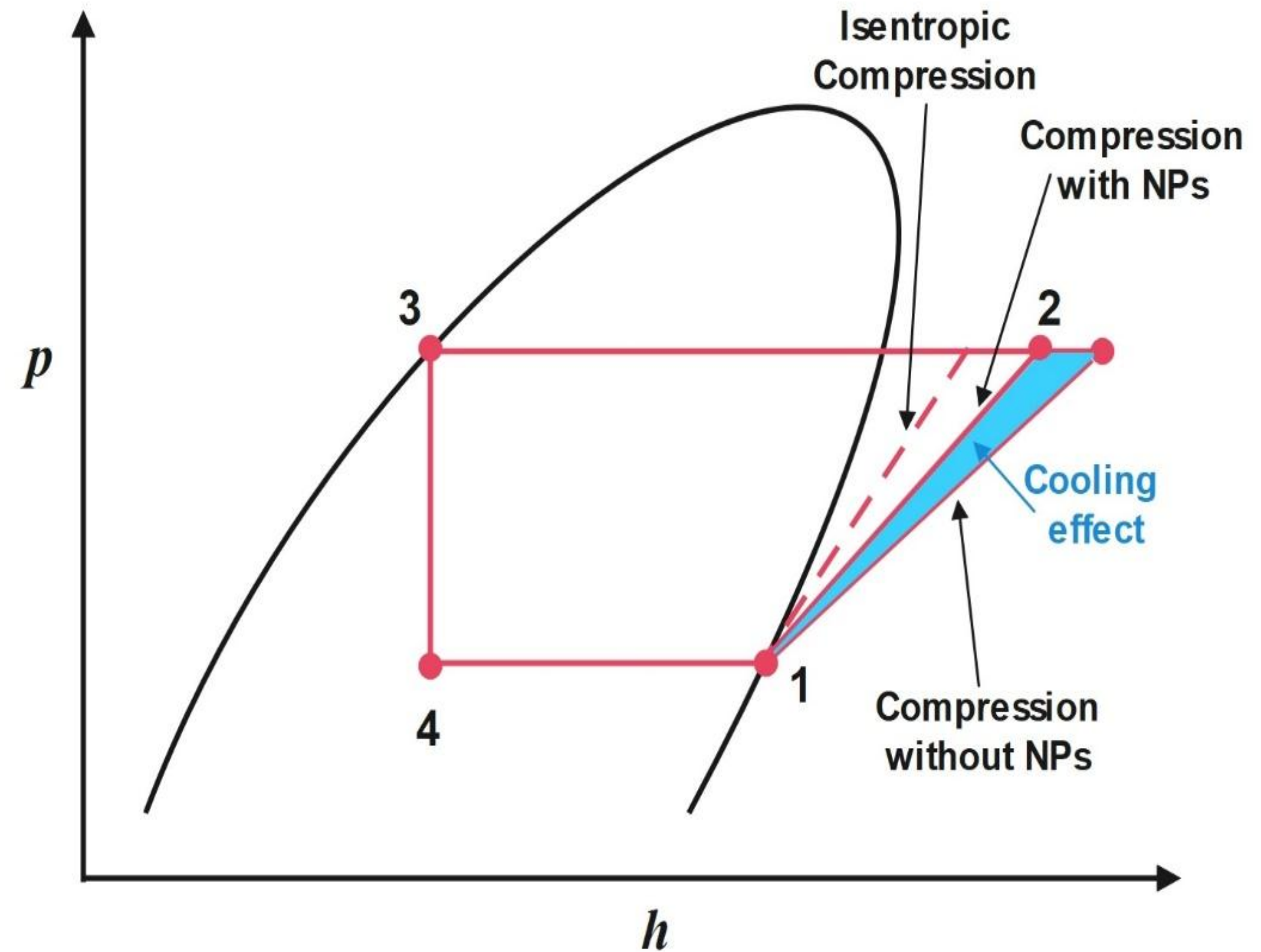
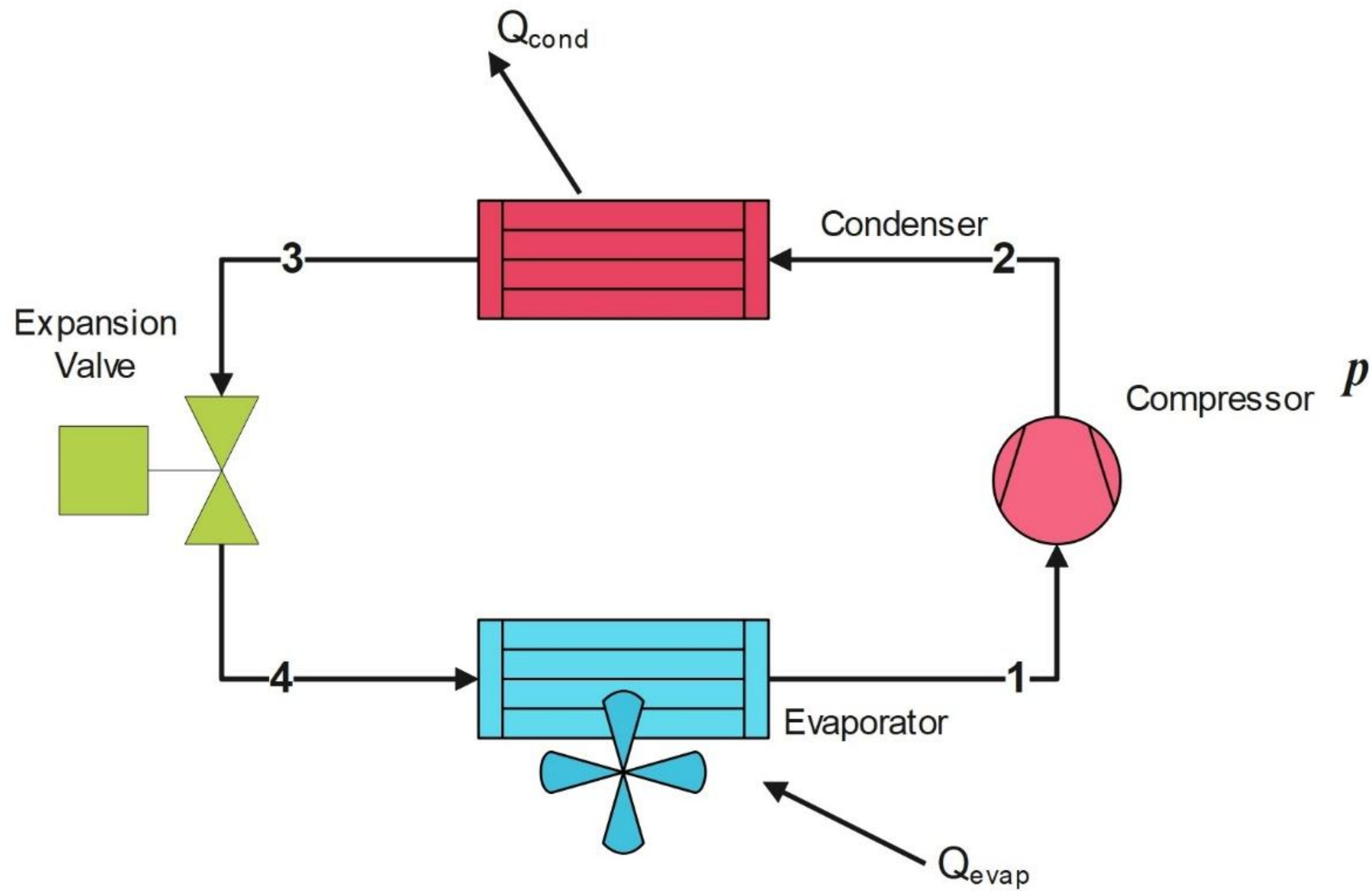
What can the code do ?



What can the code do ?



Configuration of VCERS



Simulation Results

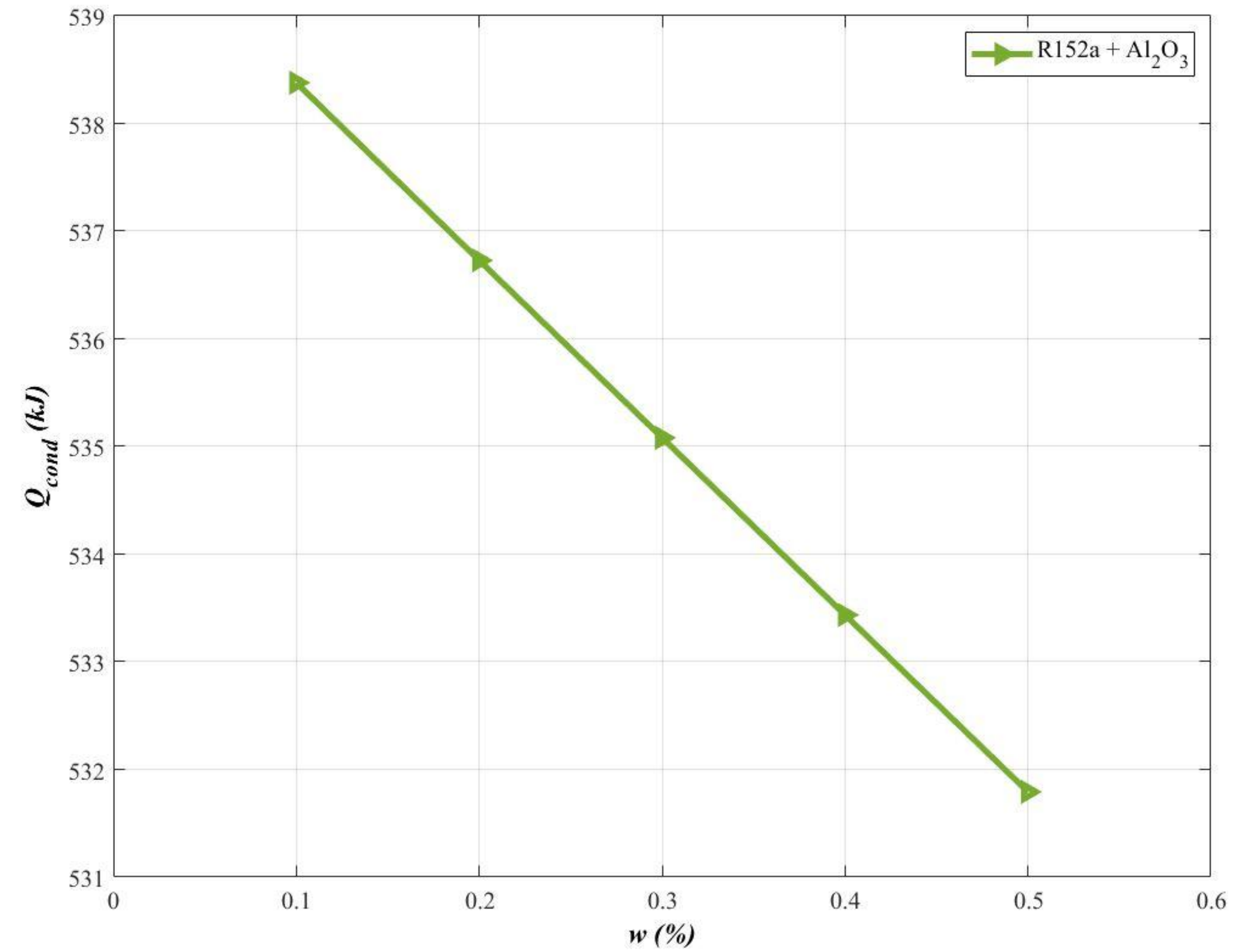
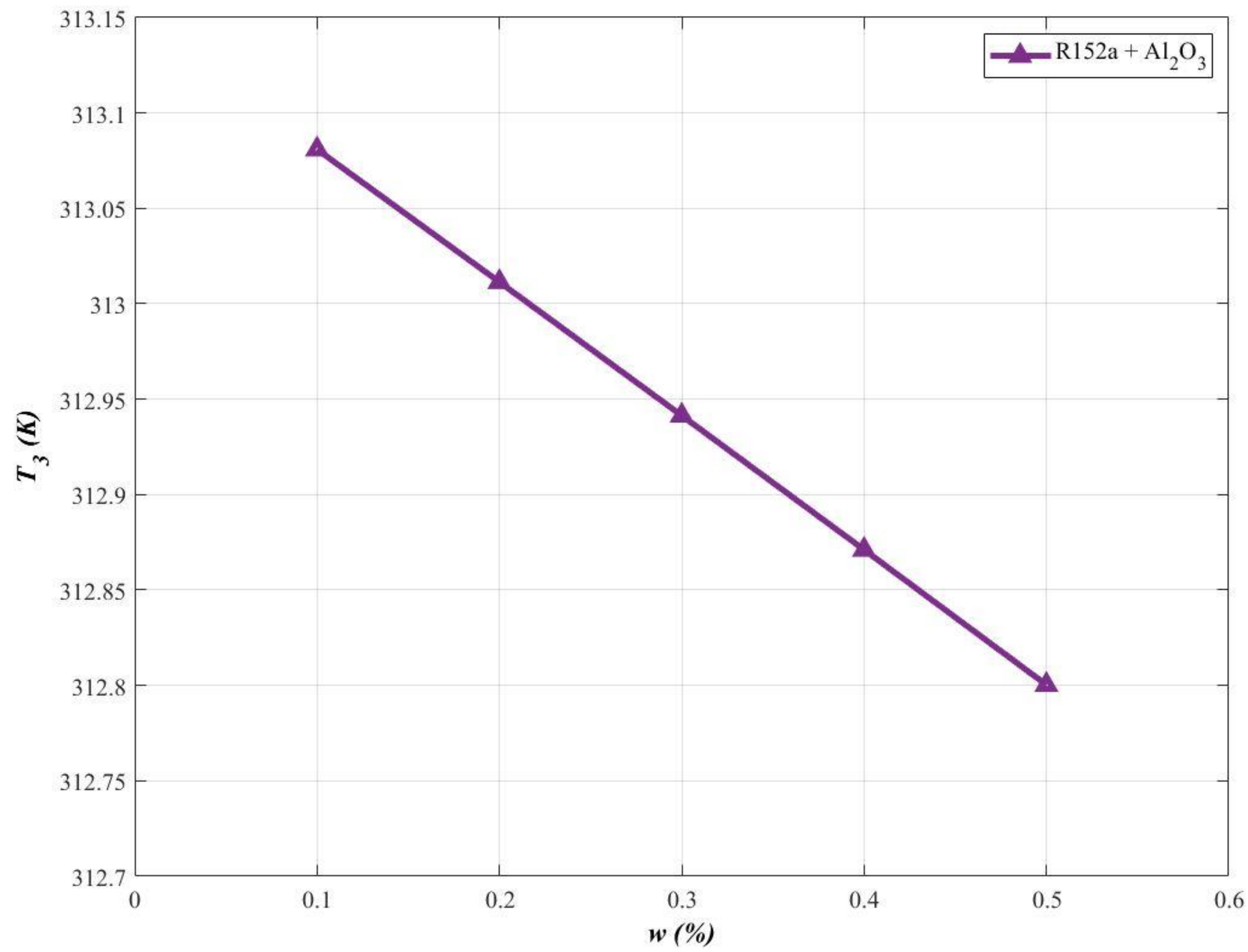
Validation of the developed code

Validation of results using R134a + Al₂O₃

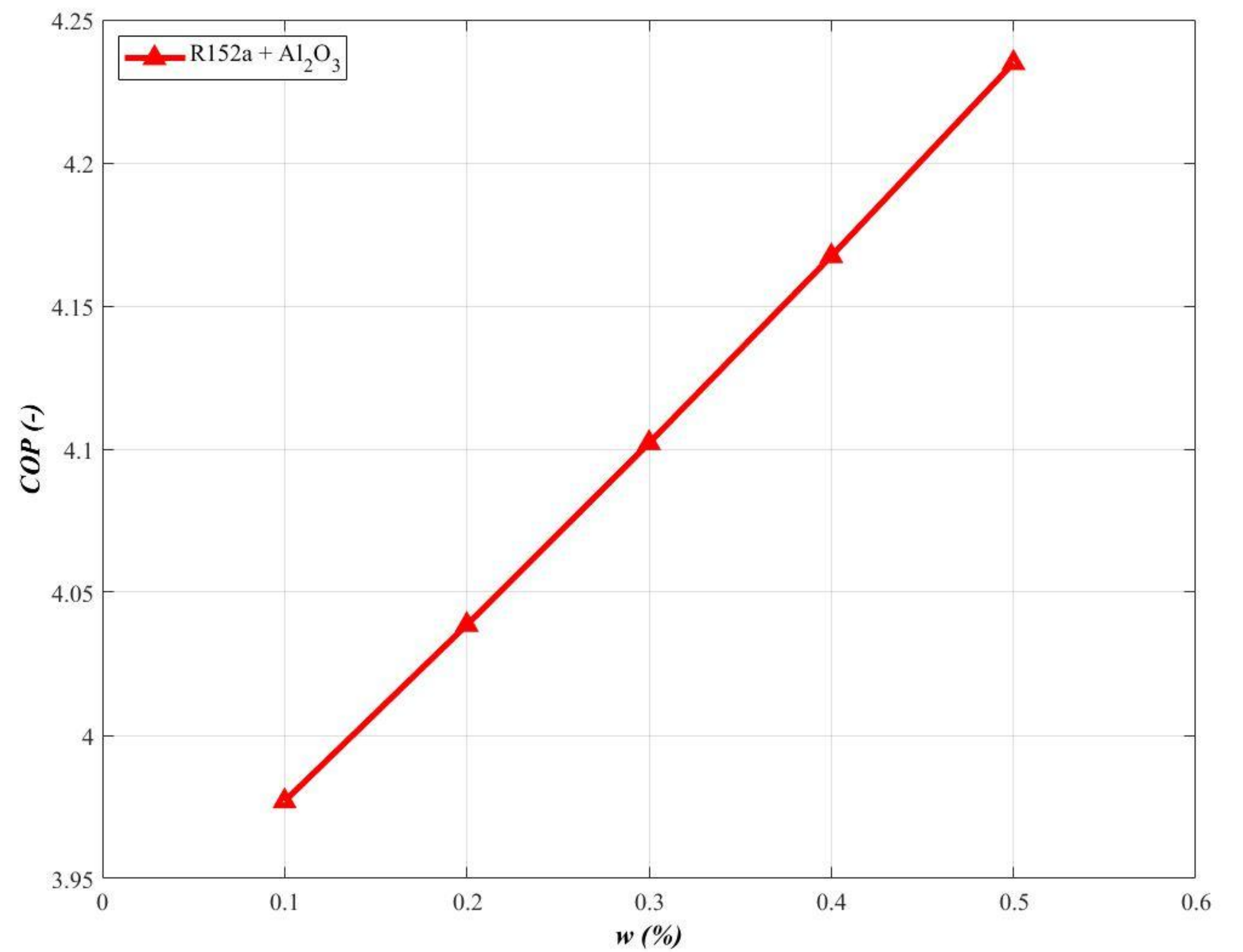
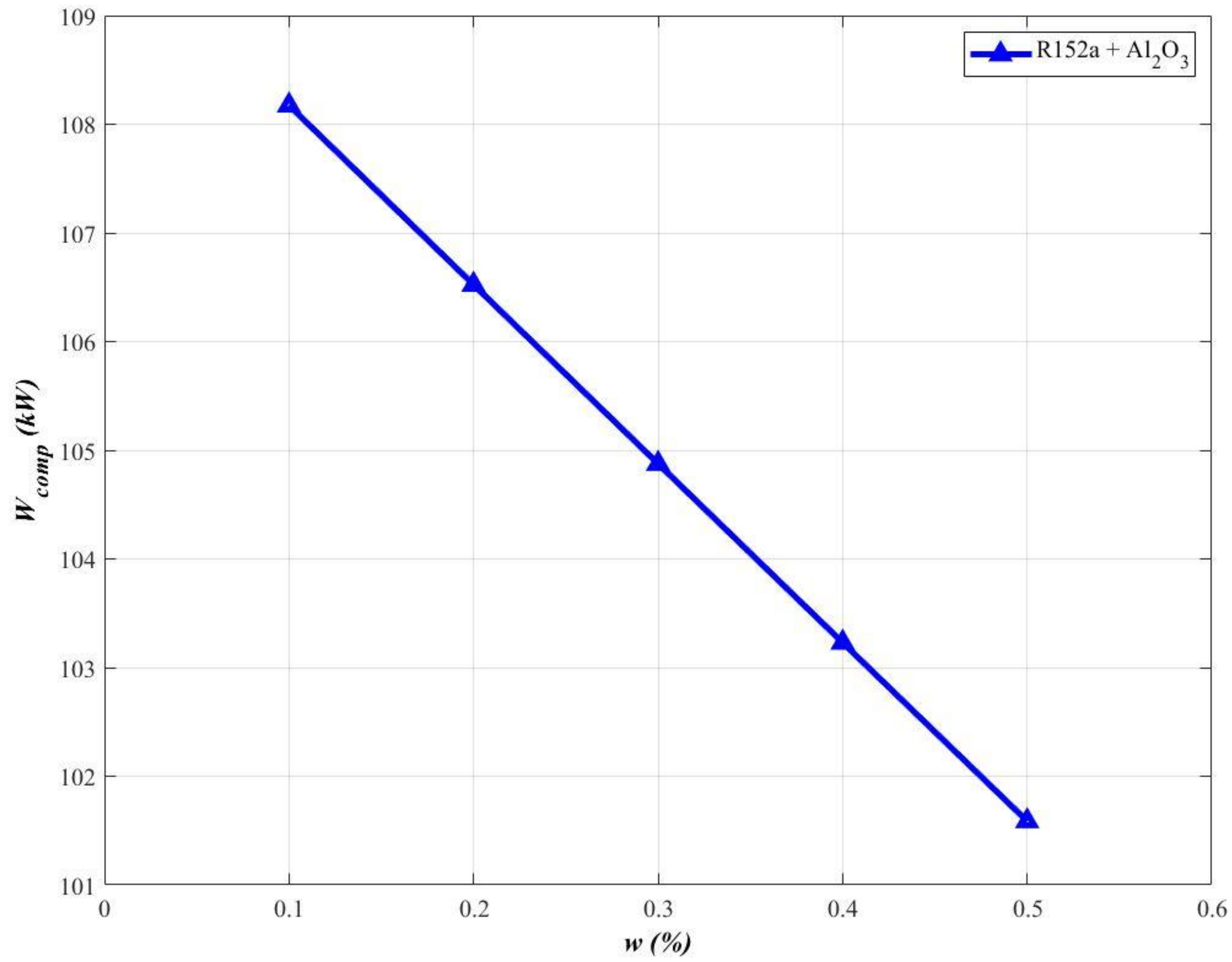
Parameter	R134a [Ref]	This simulation	Deviation (%)	This Simulation	Deviation (%)
ω (%)	0	0	0.1	0.1	0
T_1 (°K)	273.15	273.15	0.1	279.178	0
T_2 (°K)	334.78	334.76	0	333.63	0.01
p_1 (°K)	313.15	318.77	0	317.97	0
h_1 (kPa)	396.6	398.6	0.5	393.11	0
h_1 (kJ.kg ⁻¹)	440.36	440.36	0	439.2	0.033
h_3 (kJ.kg ⁻¹)	253.94	430.34	0	263.67	0.035
φ_1 (%)	0	0	0	123.67	0
COP	3.233	3.243	0	1125.66	3.33

LI. S, and Lu.,I.A Theoretical Comparative Study of Vapor-Compression Refrigeration Cycle using Al₂O₃ Nanoparticle with Low-GWP Refrigerants: *Entropy* 2022, <https://doi.org/10.3390/entropy20220624121920>

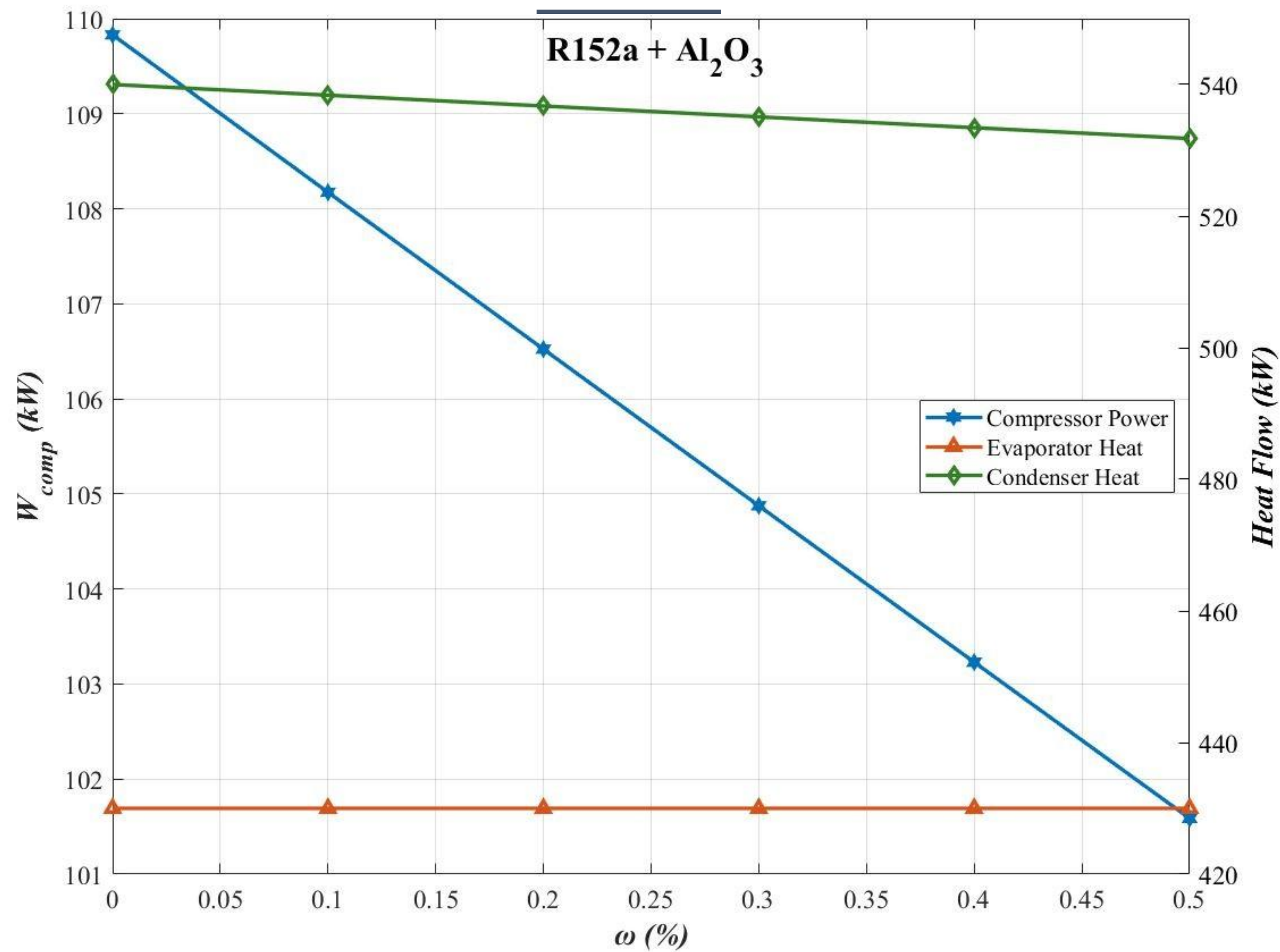
Simulation results



Simulation results



Simulation results



Questions
