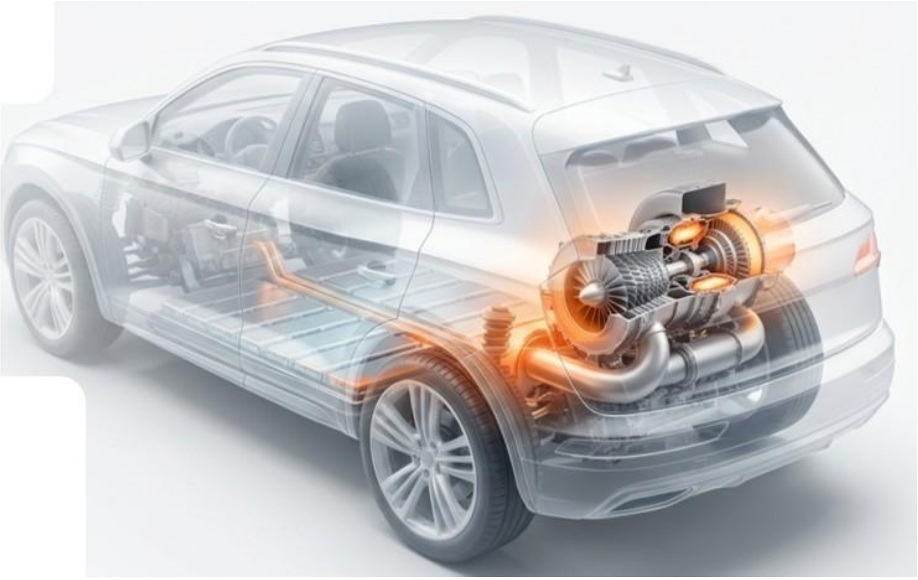
Modelling of 1D Micro Gas Turbine For Range Extender Electric Vehicles



5. INTERNATIONAL GAZİANTEP SCIENTIFIC RESEARCH CONGRESS

27/12/2025

Dr. Harun Güçlü

BURSA ULUDAG UNIVERSITY 1975

50th year

Towards greater goals...

Towards greater goals...

Outline

- Motivation
- Simple Brayton Cycle
- 1D Model of MGT
- Results
- Future Work
- Acknowledgement

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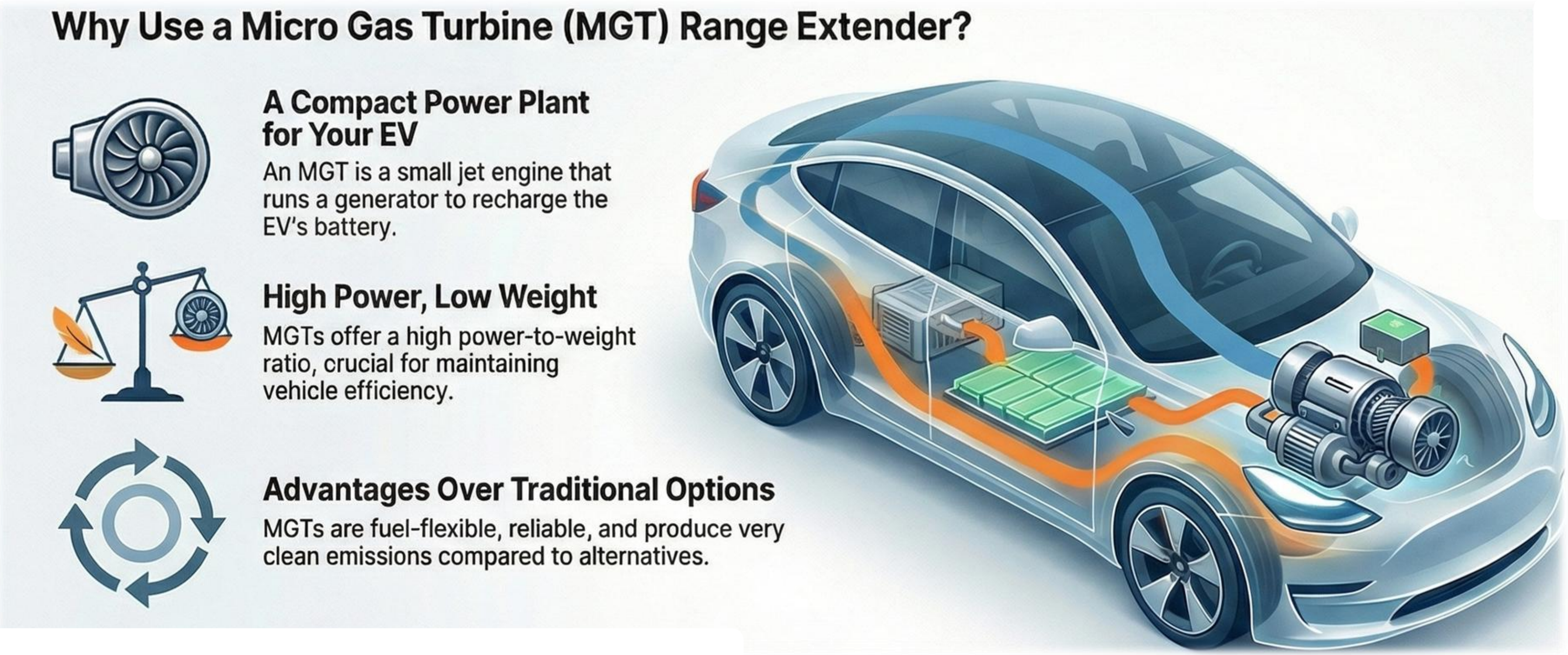
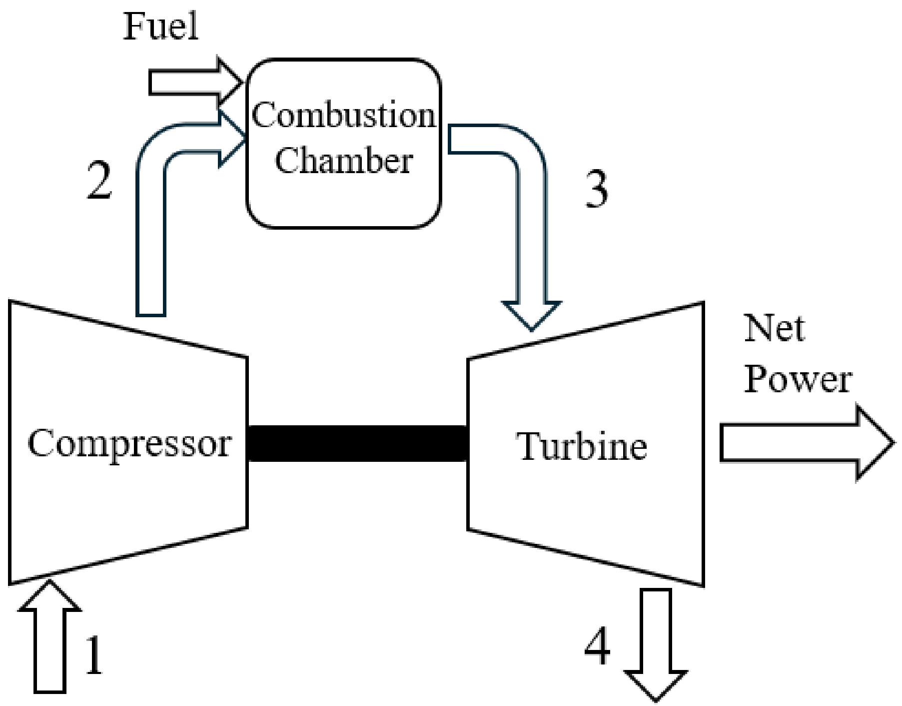
Motivation

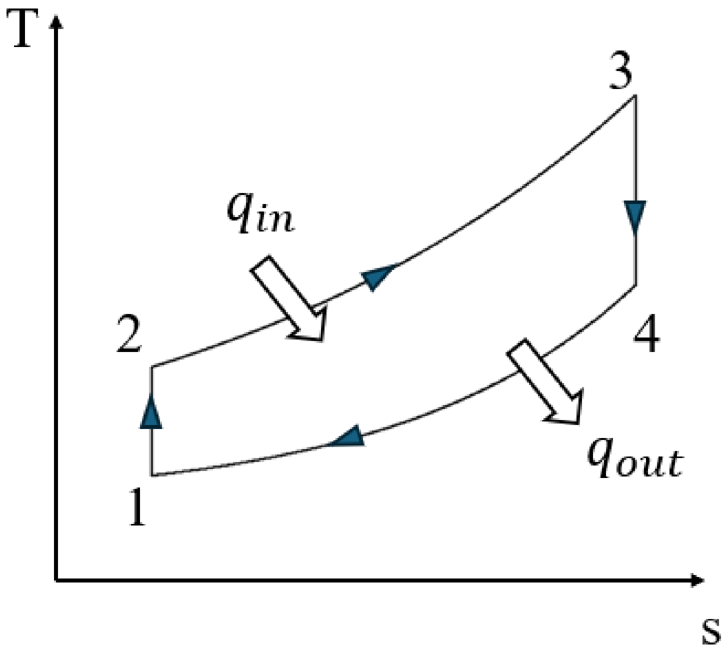
Solving Range Anxiety: The Micro Gas Turbine Solution



Simple Brayton Cycle



1-2 Isentropic compression (in a compressor)
2-3 Constant-pressure heat addition
3-4 Isentropic expansion (in a turbine)
4-1 Constant-pressure heat rejection

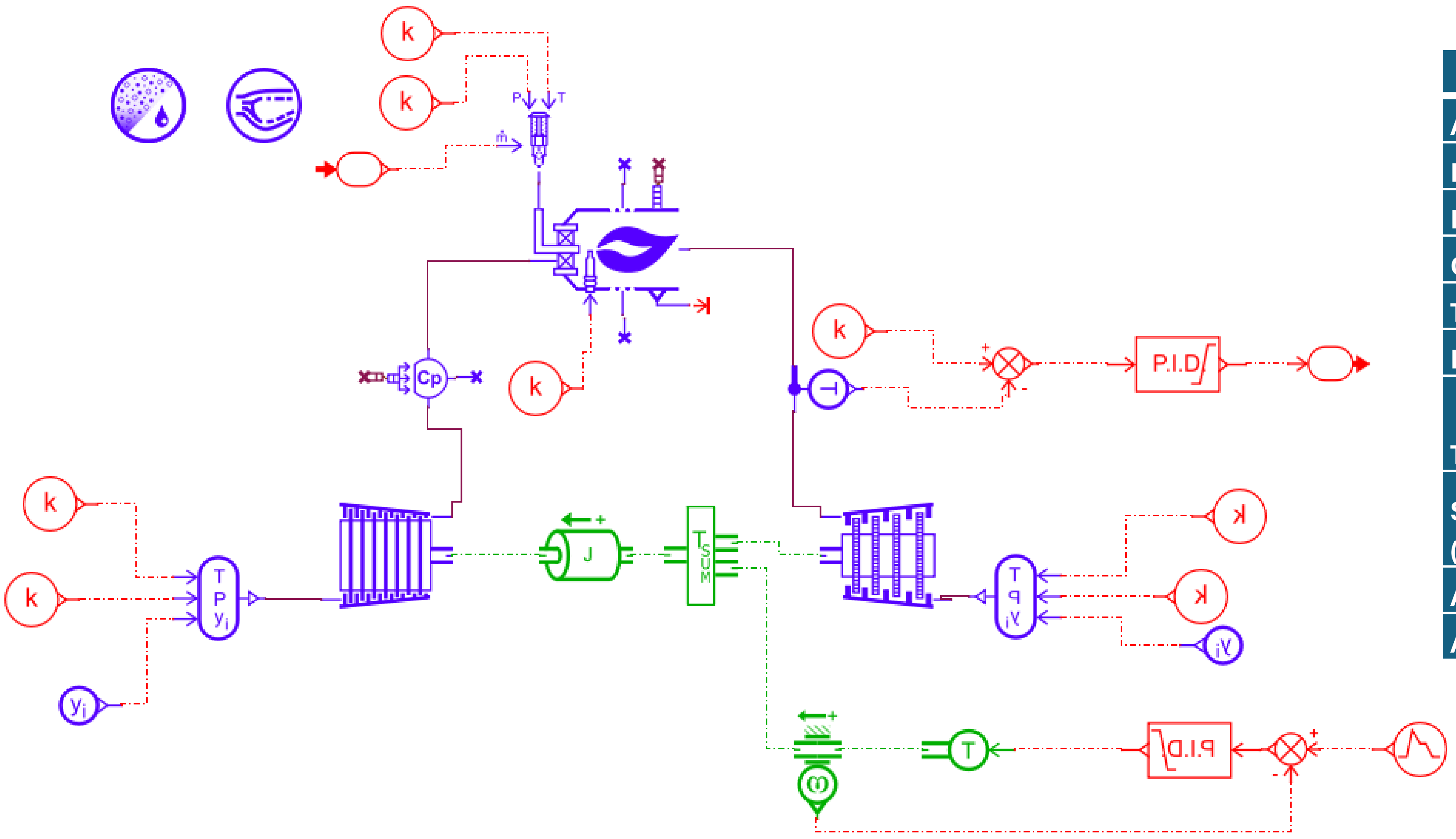


$$P_{net} = (T_t - T_c).\omega$$

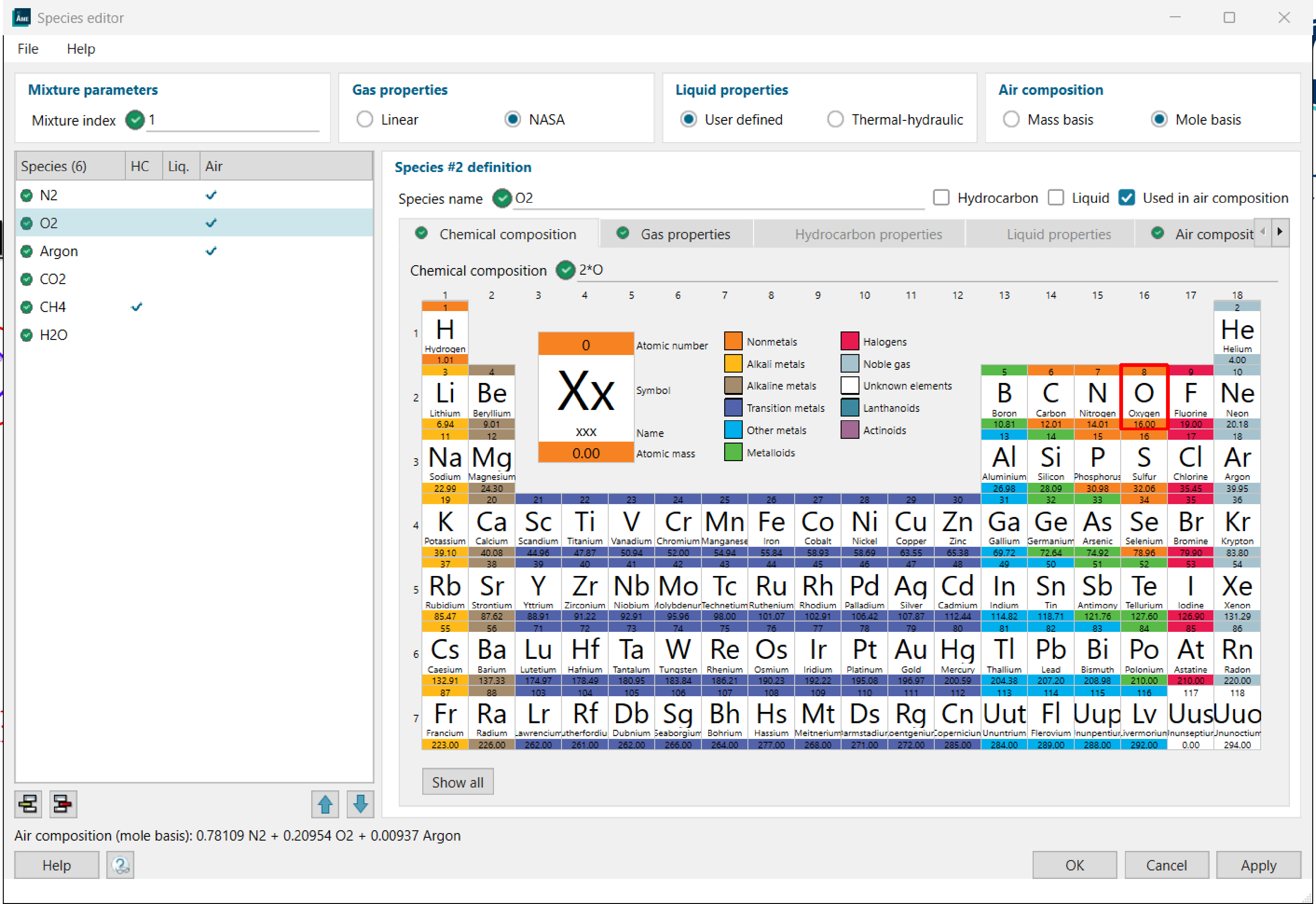
$$Q = \dot{m}_f.LHV$$

$$\eta_t = \frac{P_{net}}{Q}$$

1D Model of MGT



	Unit	Value
Air flow	kg/s	0.85
Design point of shaft	rpm	90 000
Net Power	kW	182
Compressor efficiency	-	0.786
Turbine efficiency	-	0.879
Pressure ratio	-	5
Turbine Inlet Temperature (TIT)	K	1275
Specific fuel consumption (SFC)	kg/kWh	0.318
Ambient Pressure	barA	1.013
Ambient Temperature	K	288.15


Species editor
File
Help
Mixture parameters
Mixture index 1
Gas properties
Linear
NASA
Liquid properties
User defined
Thermal-hydraulic
Air composition
Mass basis
Mole basis
Species (6)
HC
Liq.
Air
N2
O2
Argon
CO2
CH4
H2O
Species #2 definition
Species name O2
Hydrocarbon
Liquid
Used in air composition
Chemical composition
Gas properties
Hydrocarbon properties
Liquid properties
Air composit
Chemical composition 2*O
Atomic number
Symbol
Name
Atomic mass
Nonmetals
Alkali metals
Alkaline metals
Transition metals
Other metals
Metalloids
Halogens
Noble gas
Unknown elements
Lanthanoids
Actinoids
Show all
Air composition (mole basis): 0.78109 N2 + 0.20954 O2 + 0.00937 Argon
Help
OK
Cancel
Apply

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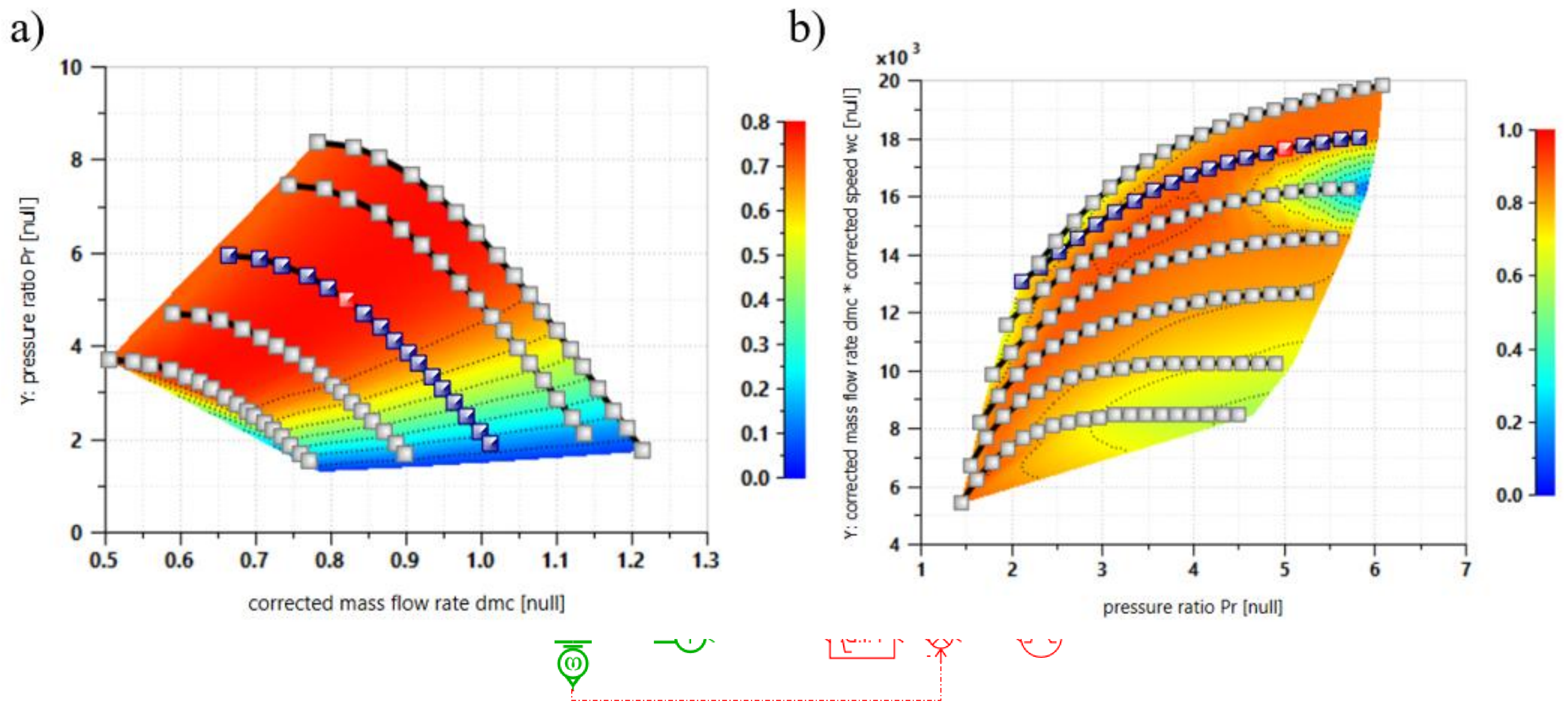
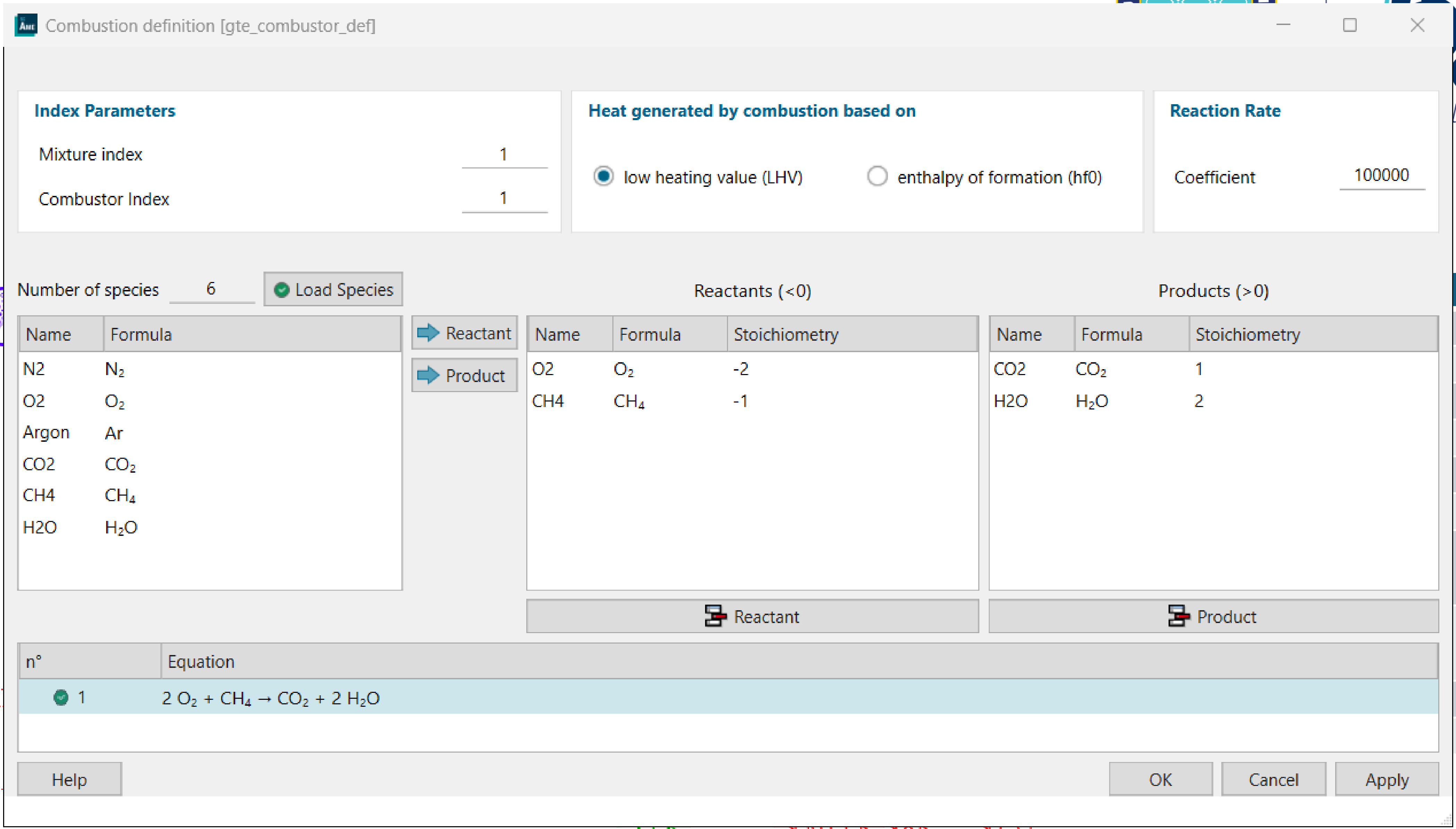
1D Model of MGT





Value
0.85
90 000
182
0.786
0.879
5
1275
0.318
1.013
288.15

Title	Value	Unit	Tags	Name
integral part	0	null		ipart
controller type	PID			outputtype
limit output	**yes**			outlim
proportional gain	**0.1**	null		Kp
integral gain	**0.5**	null		Ki
derivative gain	0	null		Kd
time constant for first order lag used to est...	0.001	null		tau
saturation				
maximum permitted output value	**15**	null		outmax
minimum permitted output value	**-100**	null		outmin
anti windup method	back calculation and tracking			antiwind
backtracking gain	1	null		Ks

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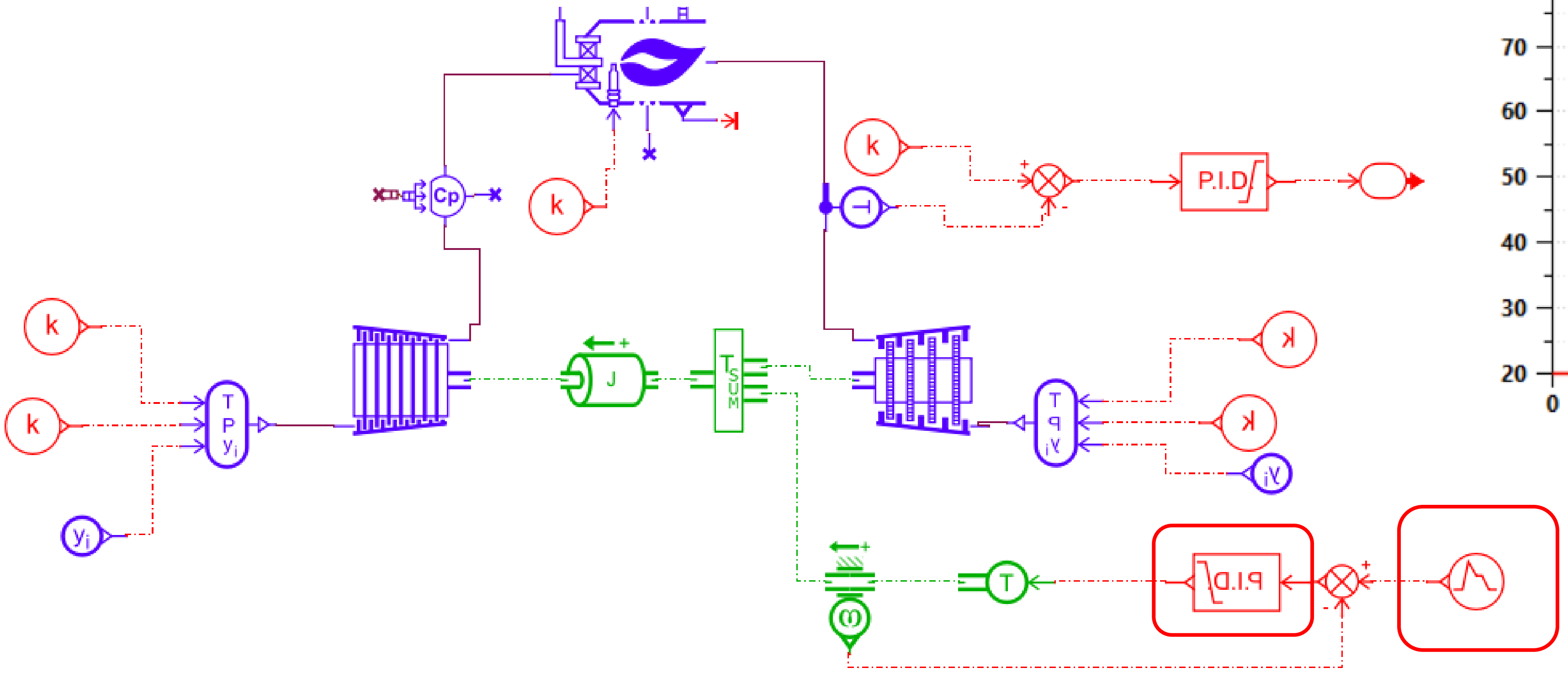
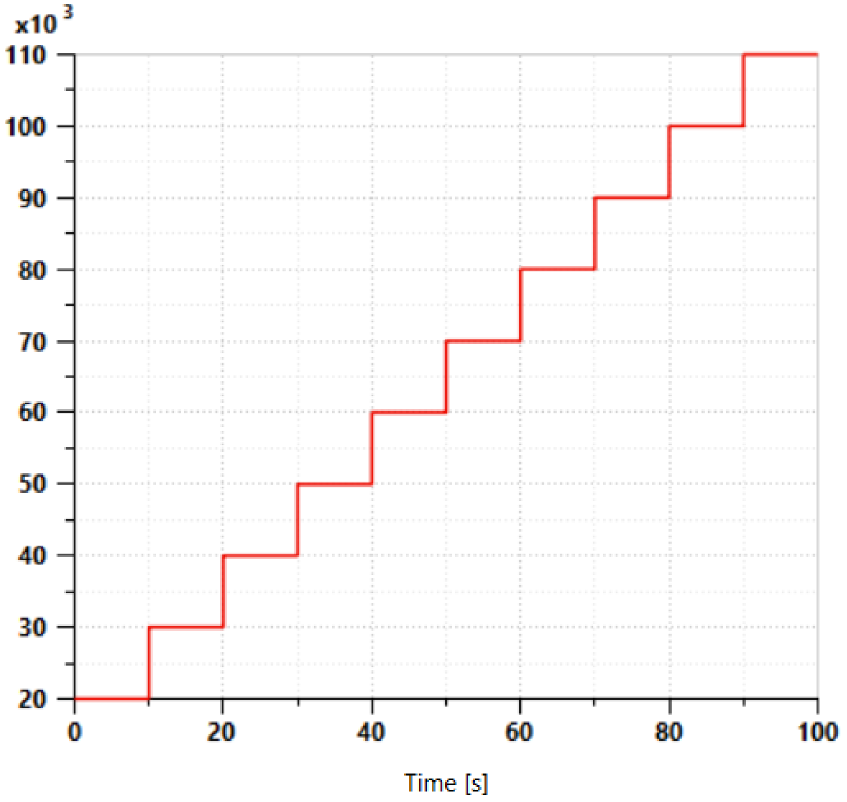
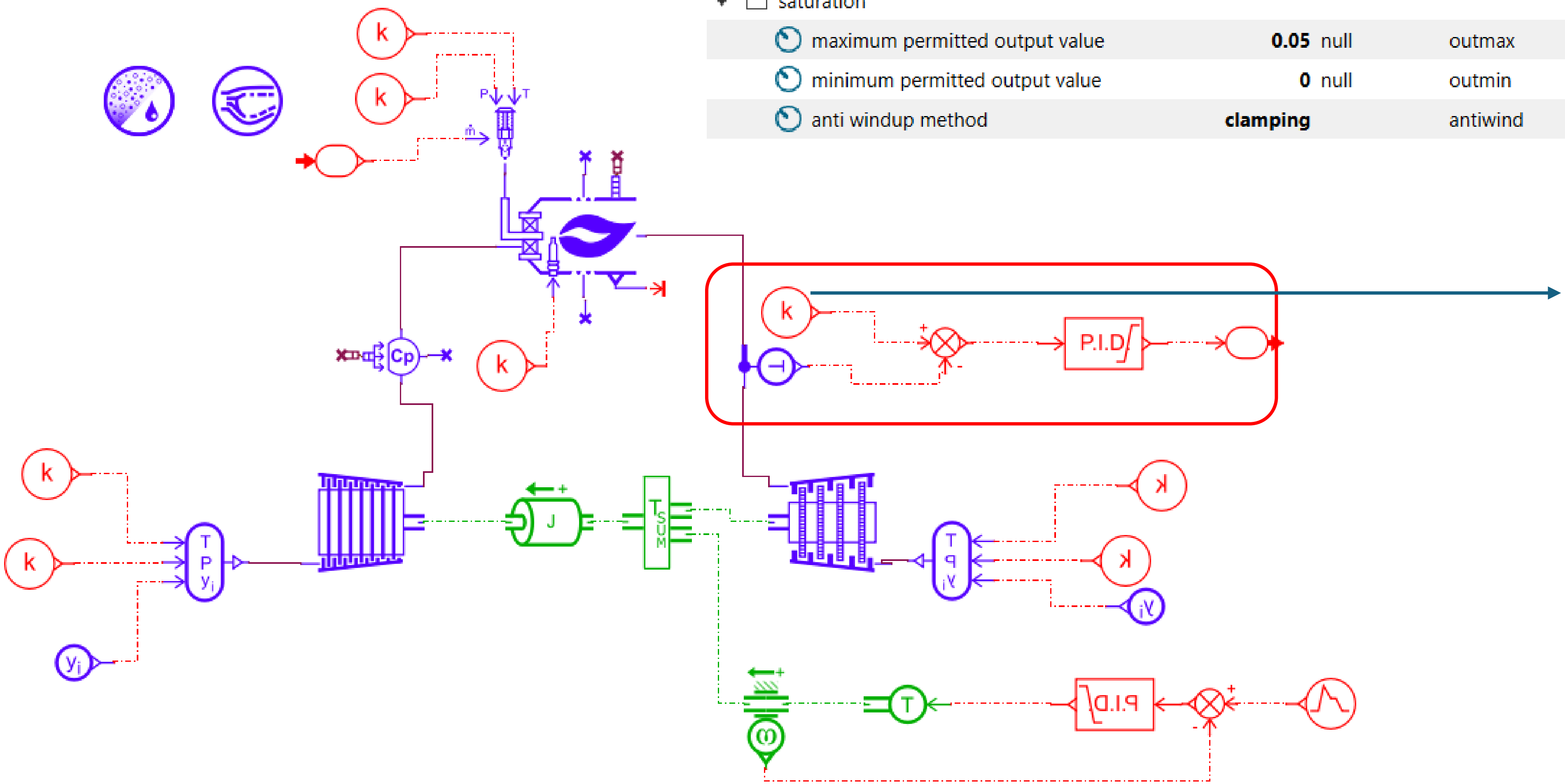
1[





1D Model of MGT

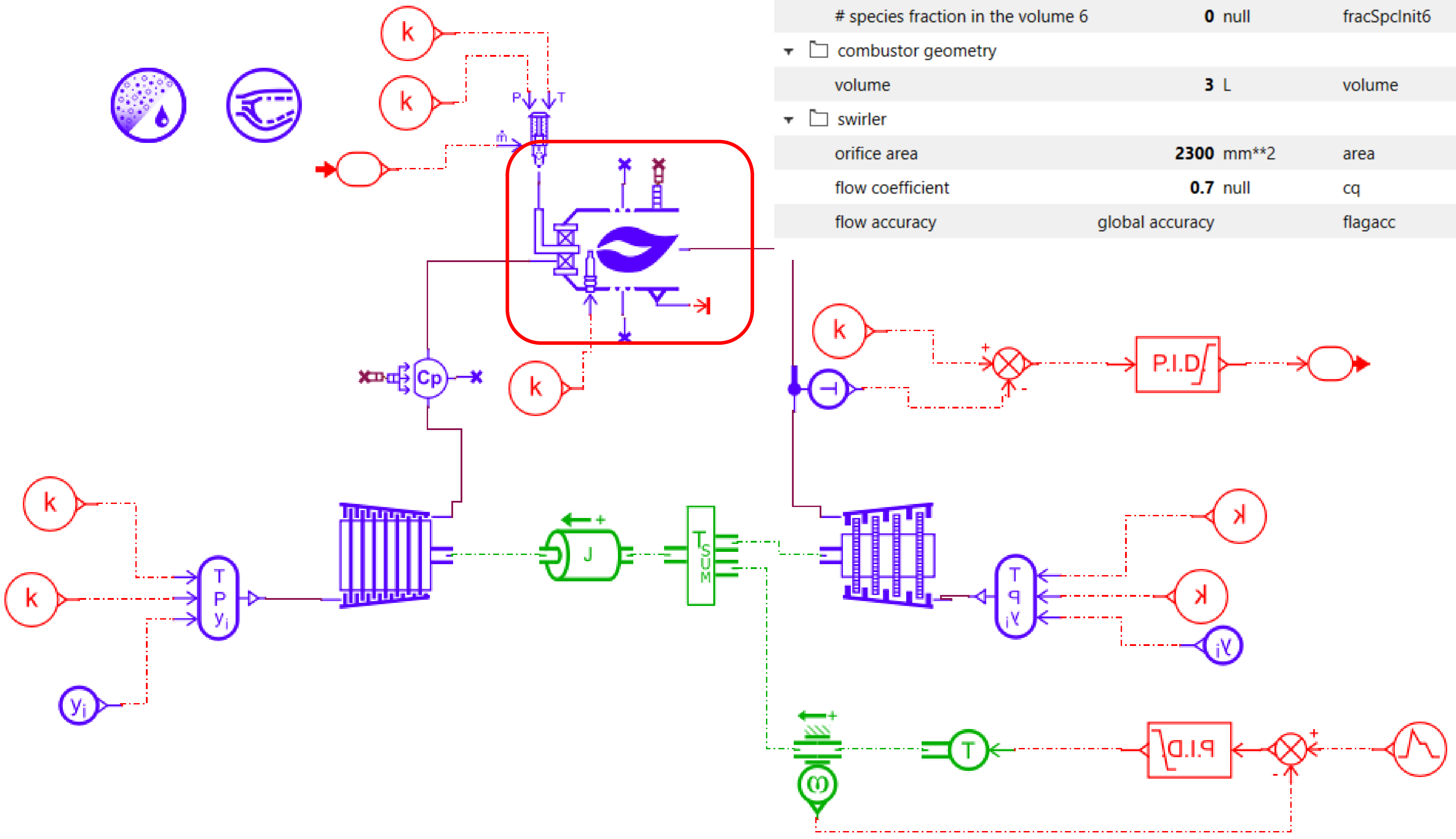
dummy state variable for estimating derivative ...	0	1/s	w
integral part	0	null	ipart
controller type	PID		outputtype
limit output	**yes**		outlim
proportional gain	**0.0001**	null	Kp
integral gain	**0.0005**	null	Ki
derivative gain	0	null	Kd
time constant for first order lag used to estimat...	0.001	null	tau
saturation			
maximum permitted output value	**0.05**	null	outmax
minimum permitted output value	**0**	null	outmin
anti windup method	**clamping**		antiwind



900 K
1000 K
1100 K
1275 K

1D Model of MGT

Title	Value	Unit	Tags	Name
efficiency definition	constant			effDef
combustion efficiency	0.99	null		effCombConst
initial values				
pressure at port 4	5	barA		press4
# temperature in the volume	480	K		temp0
initial fraction mode	mass basis			initFracMode
# species fraction in the volume 1	0.78109	null		fracSpcInit1
# species fraction in the volume 2	0.20954	null		fracSpcInit2
# species fraction in the volume 3	0.00937	null		fracSpcInit3
# species fraction in the volume 4	0	null		fracSpcInit4
# species fraction in the volume 5	0	null		fracSpcInit5
# species fraction in the volume 6	0	null		fracSpcInit6
combustor geometry				
volume	3	L		volume
swirler				
orifice area	2300	mm**2		area
flow coefficient	0.7	null		cq
flow accuracy	global accuracy			flagacc



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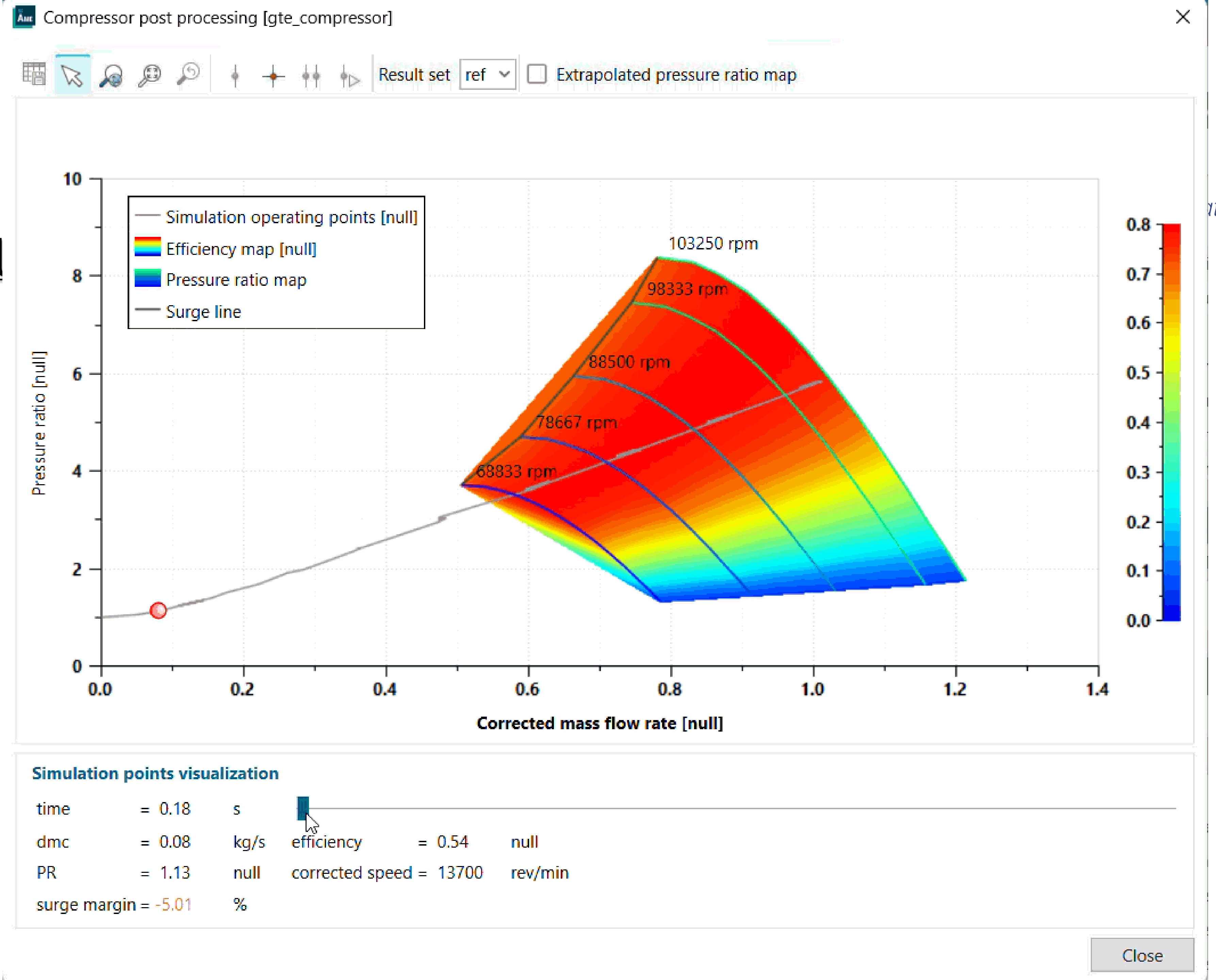
Resul



ater goals...

$$P_{net} = (T_t - T_c).\omega$$

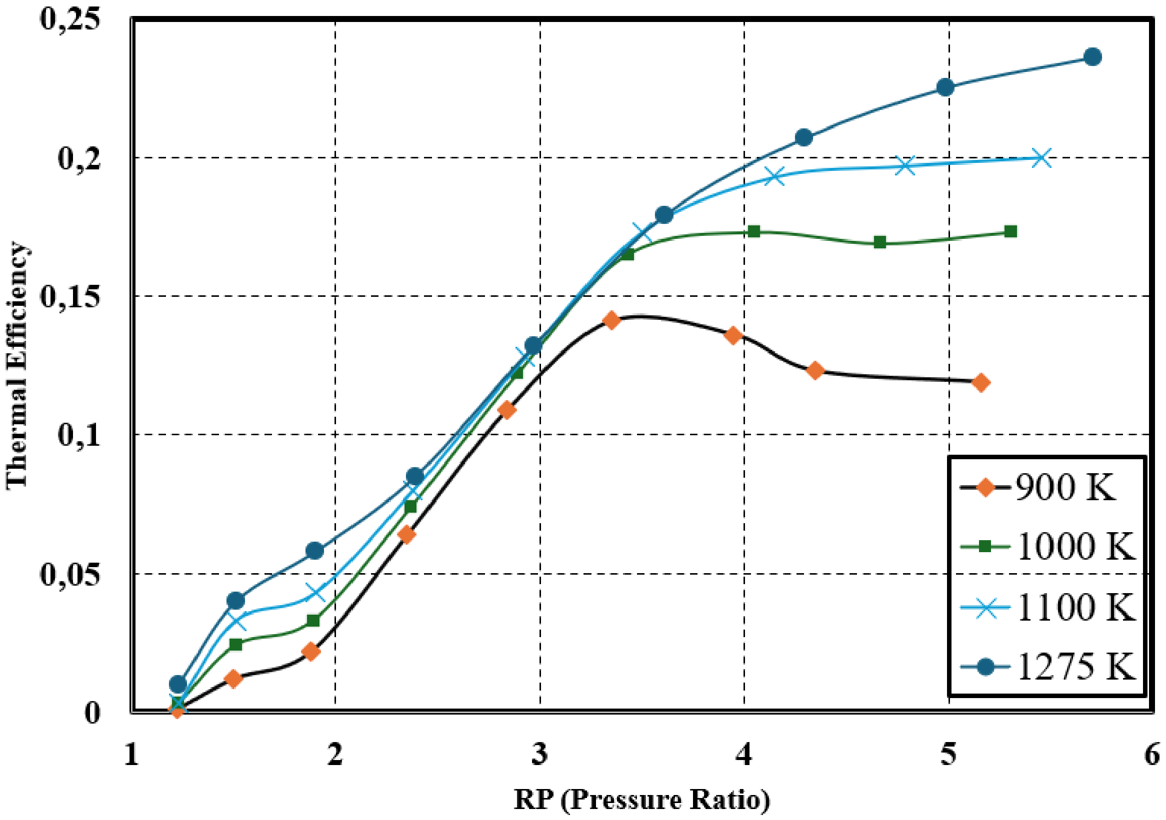
$$Q = \dot{m}_f.LHV$$

$$\eta_t = \frac{P_{net}}{Q}$$

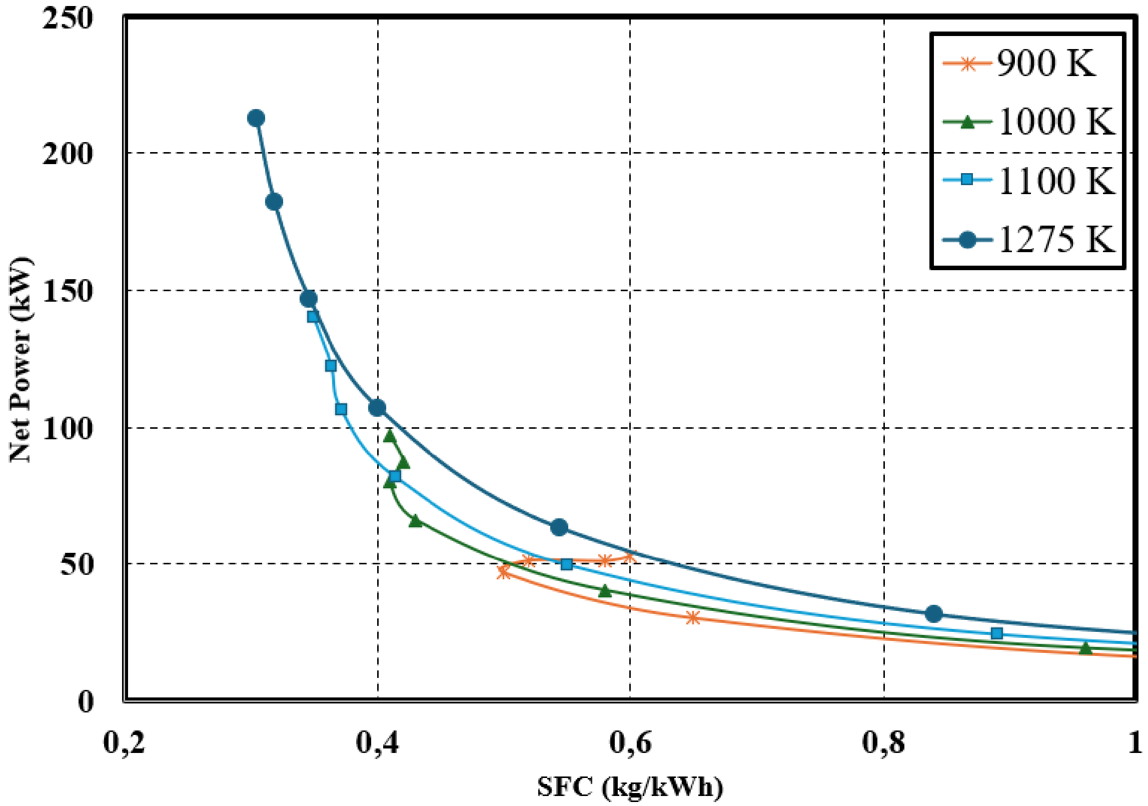
$$SFC = \frac{\dot{m}_f}{P_{net}}$$

Results

a)



b)



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Acknowledgement

SIMOFIS®

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