The Temperature and Heat combustion

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1 Introduction

The heat of combustion is the energy liberated when a substance undergoes complete combustion. Usually at constant pressure into the environment with excess Oxygen. The heat of combustion is used to check the performance of a fuel in a combustion system such as aircraft engines or power generation turbines. The heat of combustion is typically presented in the form of a heating value. The heating value is the amount of energy released during combustion and can be referenced as a higher or lower heating value.

The higher heating value (HHV) accounts for heat od combustion and any energy released to bring the combustion products back their pre-combustion temperatures. To bring the combustion products back to pre-combustion temperatures, the water component of the combustion condeses and the latent water vaporisation's heat is incorporated in the higher heating value.

The lower heating value (LHV) assumes that the combustion products are not breaking back to pre-combustion temperatures and equals essentially the higher value minus the heat of vaporisation of water product.

Correletion

$$\mathrm{HHV} = \mathrm{LHV} + H_v(\frac{n_{H2O,out}}{n_{fuel,in}}) \tag{1}$$

2 Model

The model measures the temperature of combustion for two different fuels. Model is using a reactor with three different pressures and three different fuel to oxygen ratios. Temperature is saved in every 0,00001 second from 0 to 0,3 second. The results are shown on plots were X asis is time and Y asix is a temperature.
Intial conditions:

- $$p_1 = 101325Pa, \quad T_1 = 298K \quad Ratio_1 = 1:1 \tag{2}$$

- $$p_2 = 202650Pa, \quad T_2 = 450K \quad Ratio_2 = 2:1 \tag{3}$$
- $$p_3 = 506625Pa, \quad T_3 = 600K \quad Ratio_3 = 3:1 \tag{4}$$

Fuels

-
- Methane (CH4)
$$CH_4 \tag{5}$$
-
- Hydrogene (H2)
$$H_2 \tag{6}$$

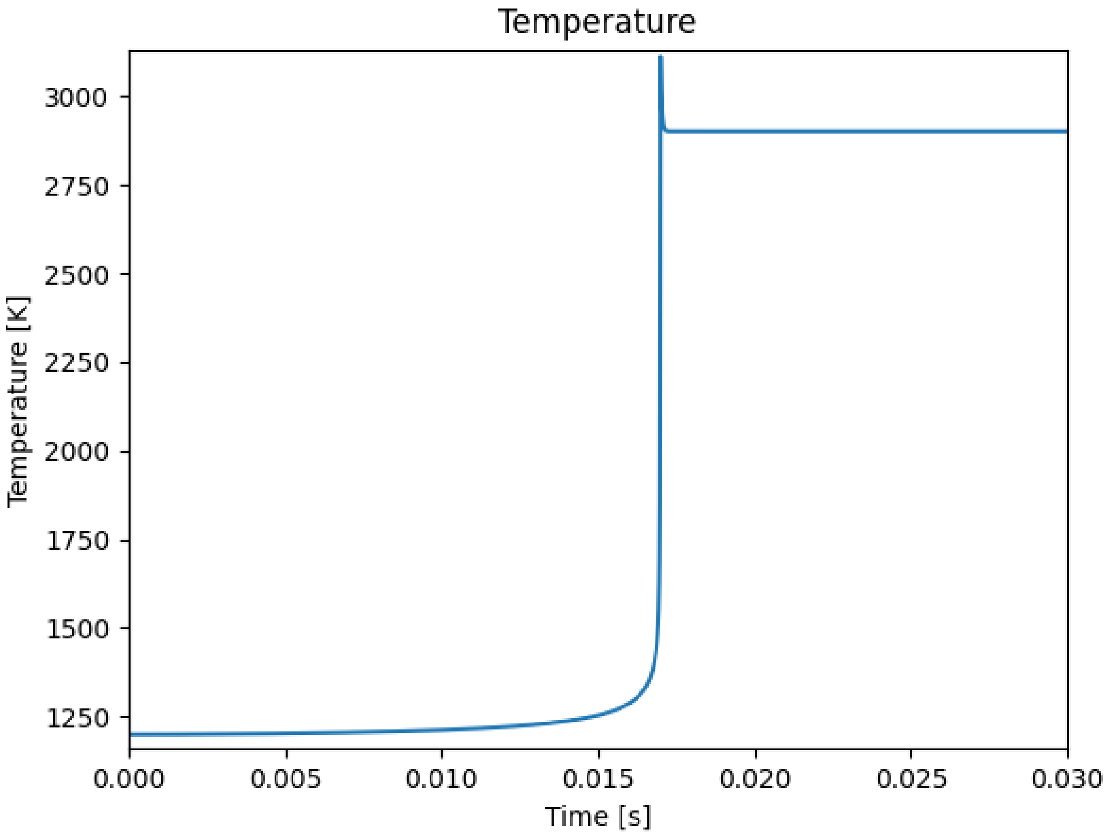
To measure the heating values model is using a enthalpy mass of substrate and products, developed into cantera mechanism caled giri30. Result is achieved by dividing enthalpy mass between products and substrates.

Mixtures

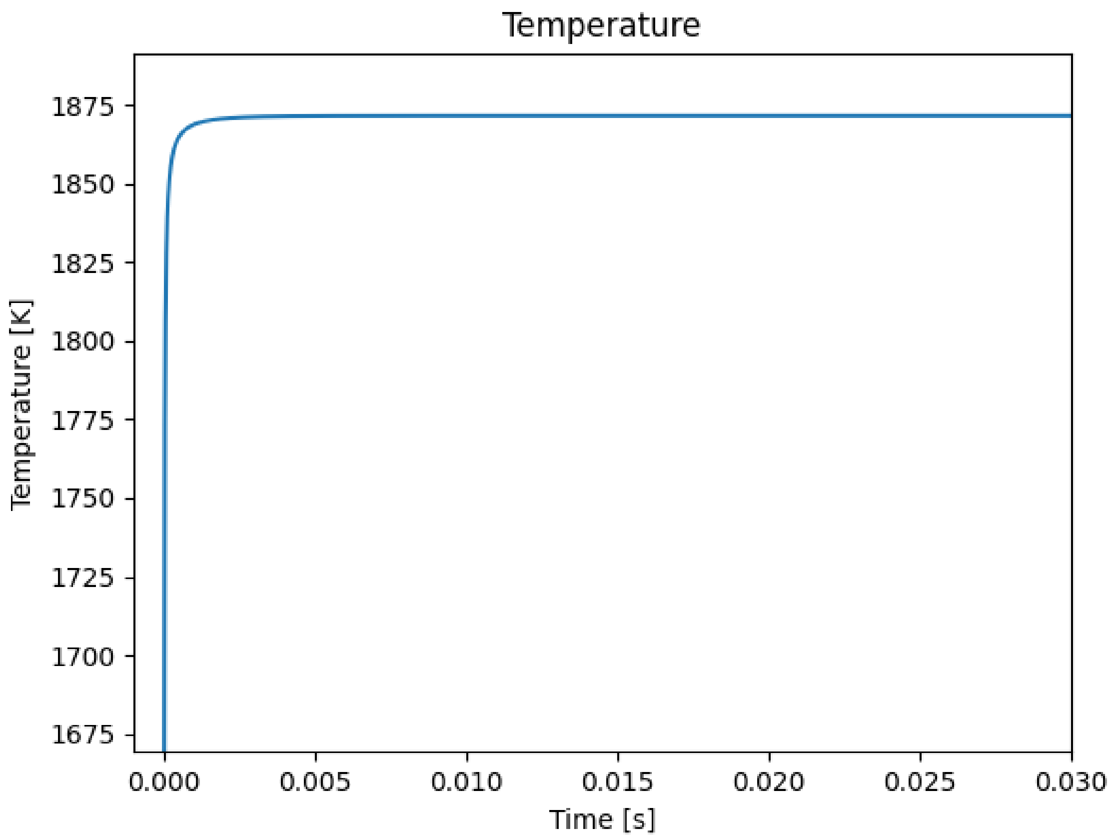
- $$\text{Methane (CH}_4\text{)} \quad CH_4 + 2 \cdot O_2 \rightarrow CO_2 + 2 \cdot H_2O (7)$$
- $$\text{Hydrogene (H}_2\text{)} \quad 2 \cdot H_2 + 0_2 \rightarrow 2 \cdot H_2O \quad (8)$$

3 Results

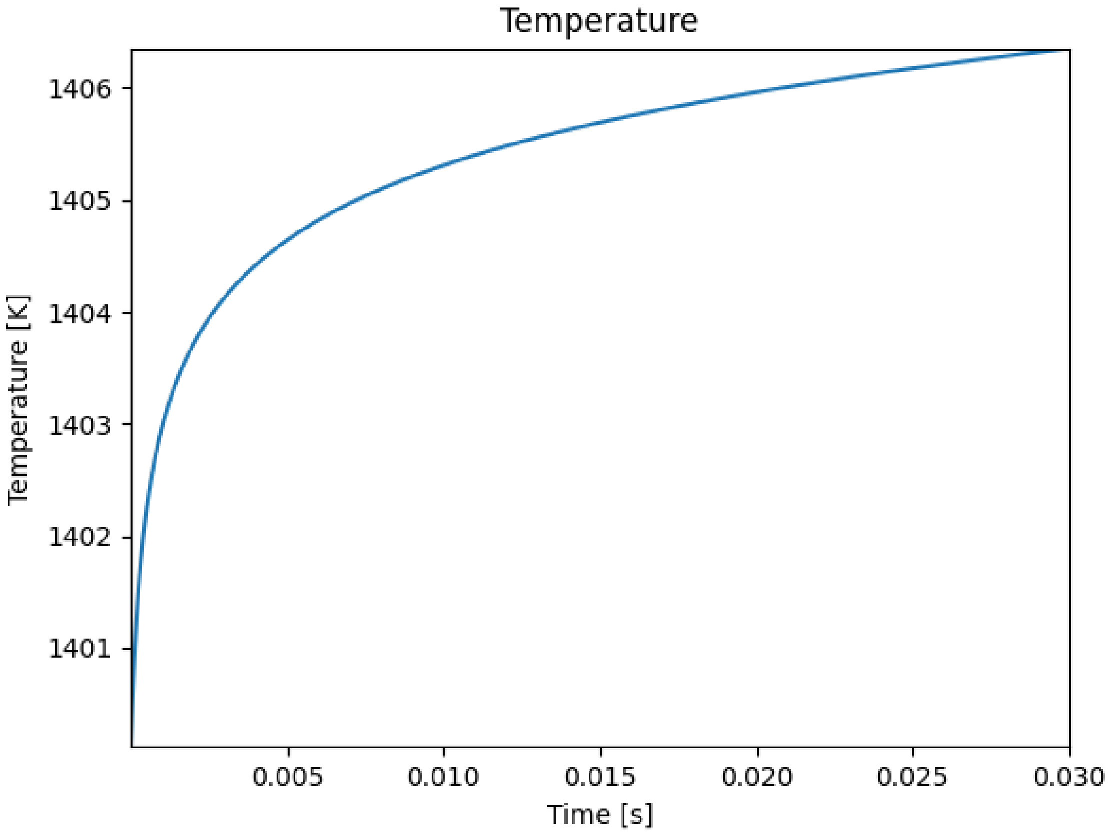
3.1 Graphs



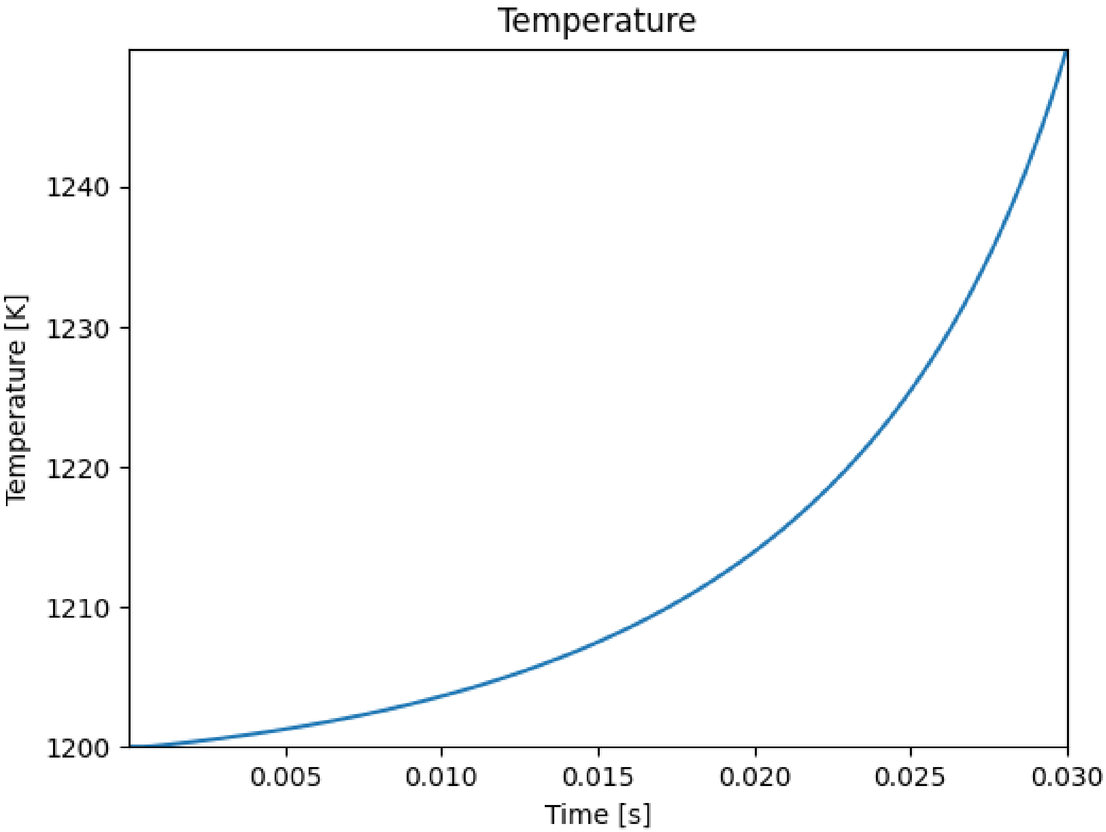
CH4 1-1 T1 p1


Temperature
Temperature [K]
1675
1700
1725
1750
1775
1800
1825
1850
1875
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

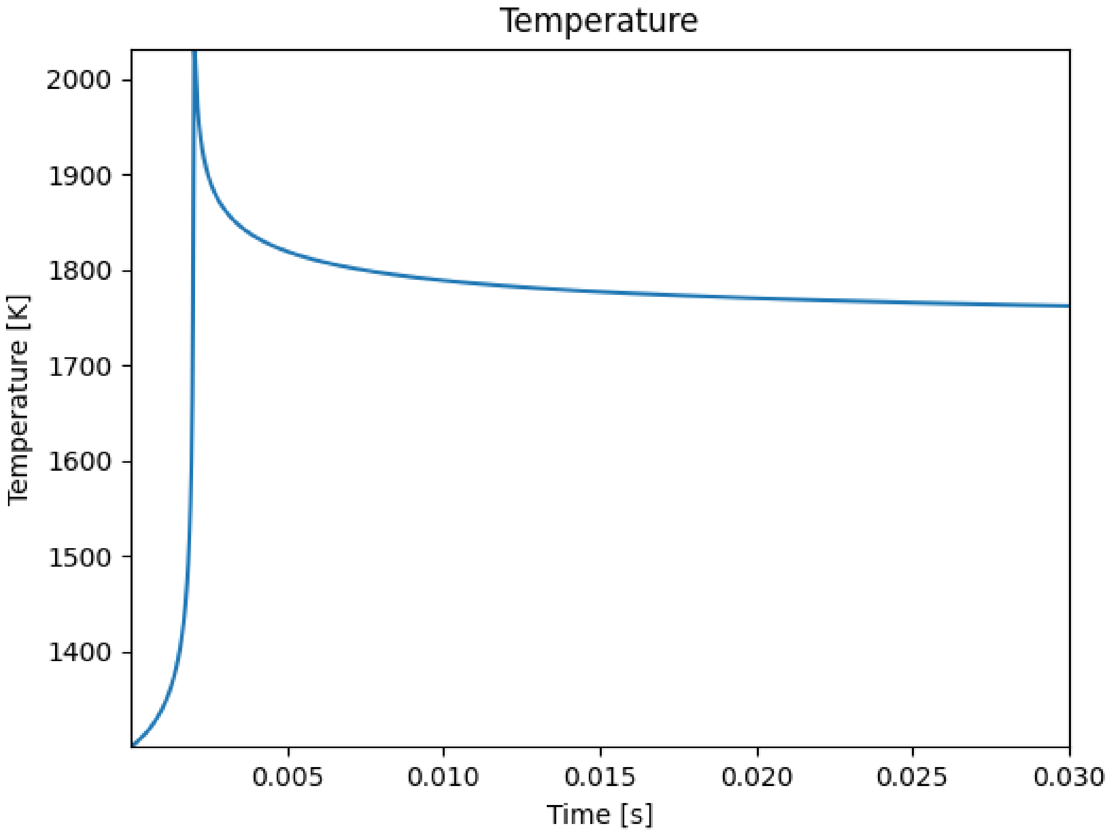
CH4 1-1 T2 p2


Temperature
1406
1405
1404
1403
1402
1401
Temperature [K]
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

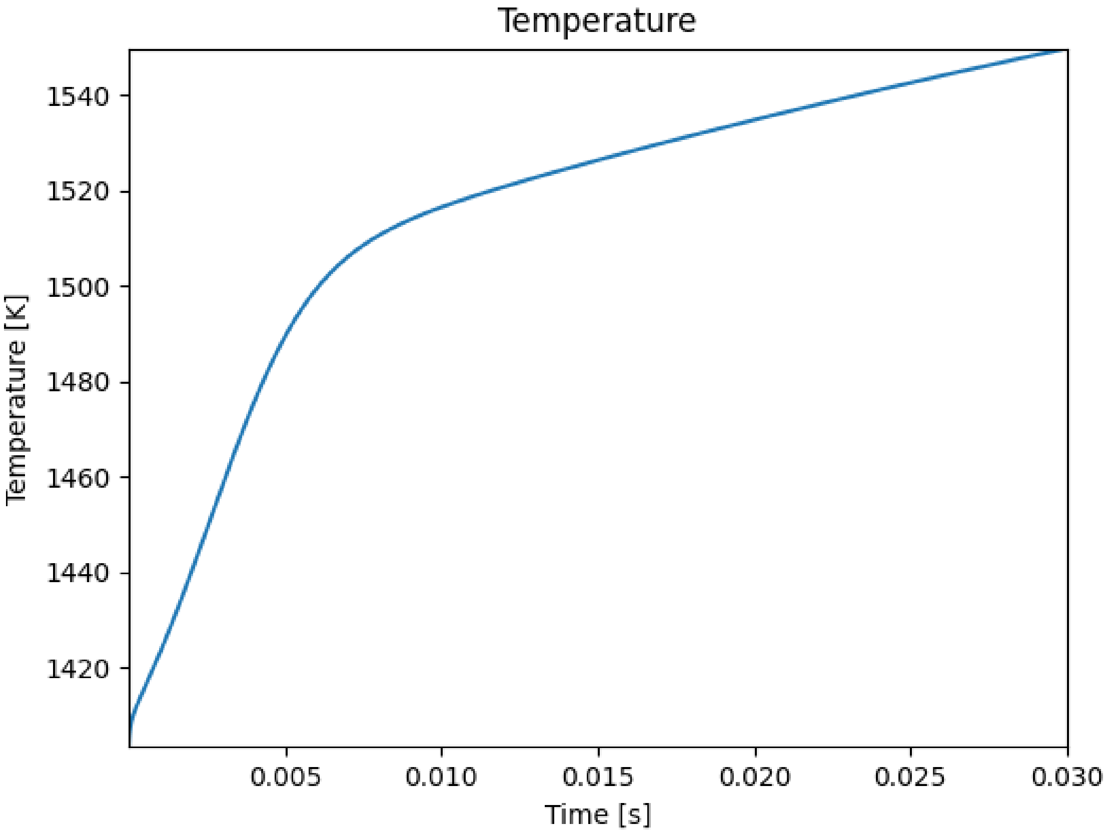
CH4 1-1 T3 p3


Temperature
Temperature [K]
1200
1210
1220
1230
1240
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

CH4 2-1 T1 p1

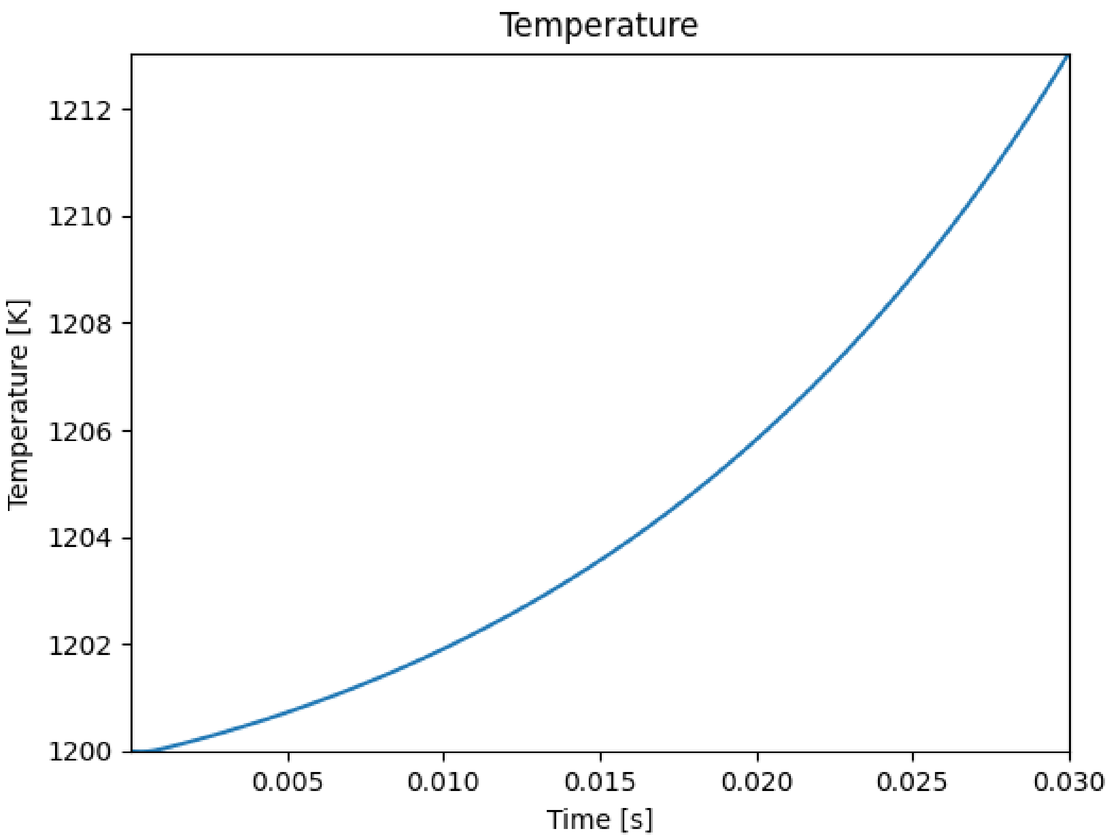

Temperature
2000
1900
1800
1700
1600
1500
1400
Temperature [K]
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

CH4 2-1 T2 p2

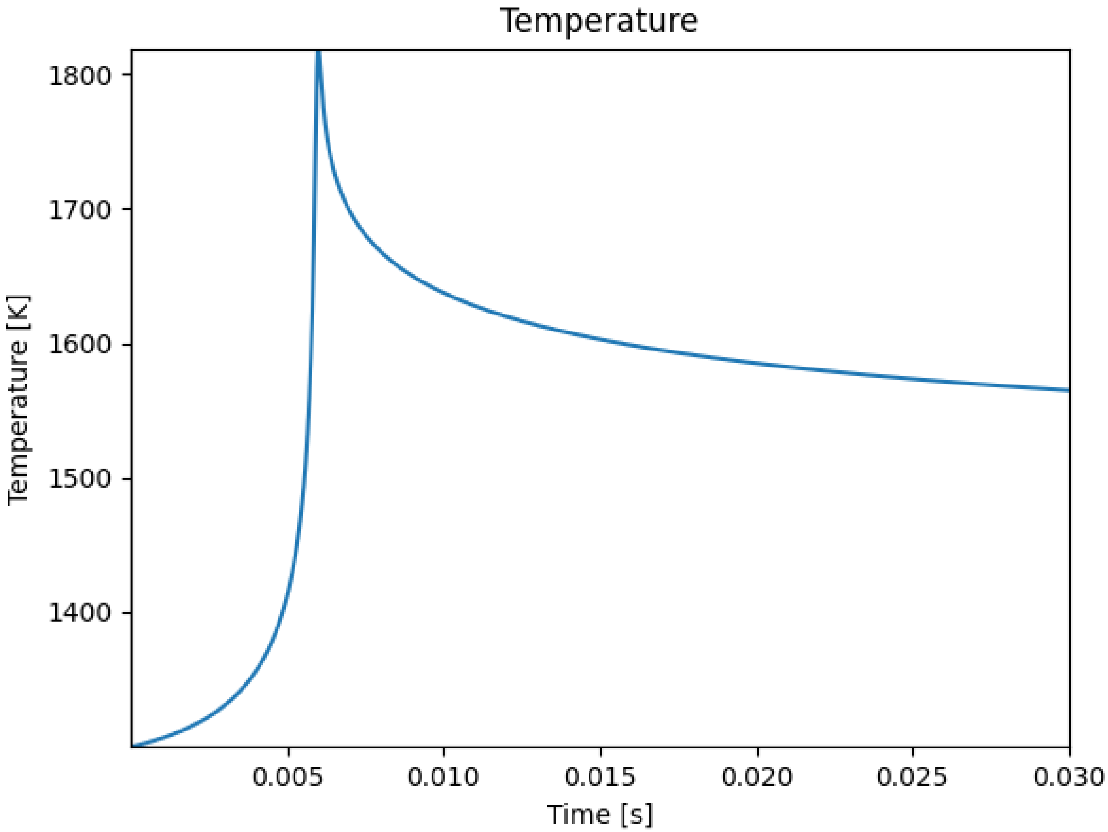


Temperature
1540
1520
1500
1480
1460
1440
1420
Temperature [K]
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

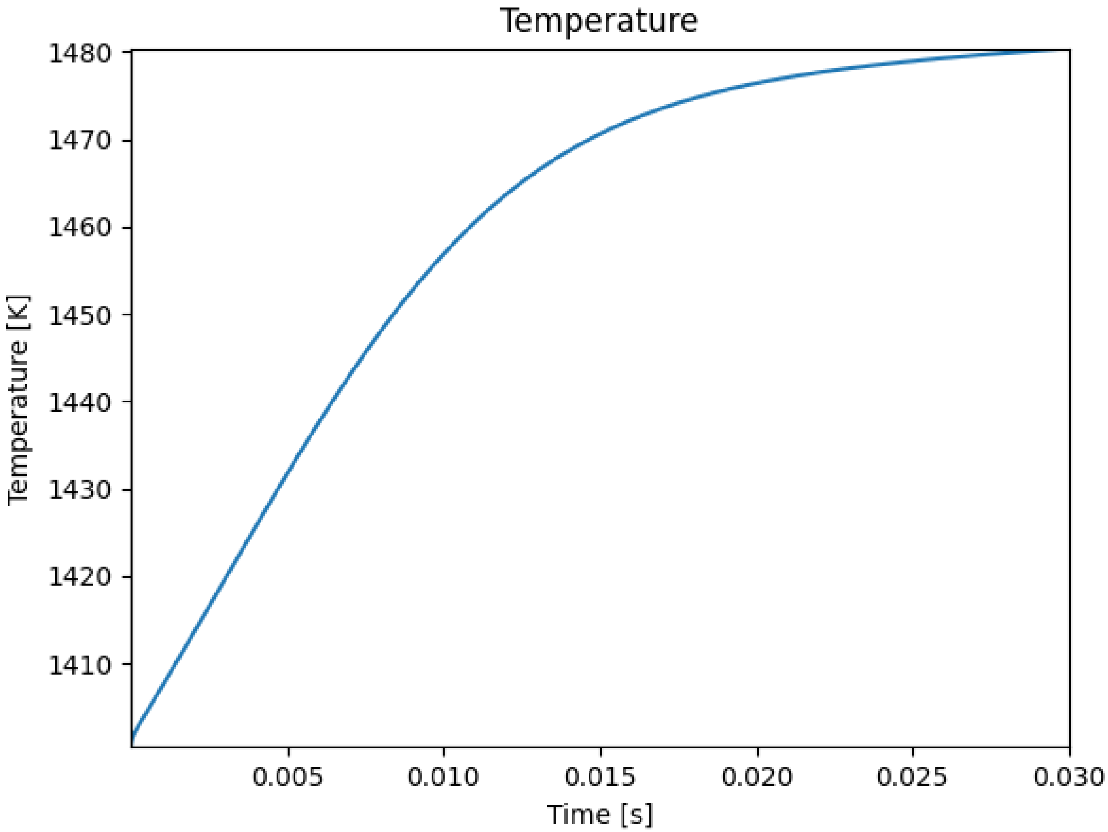
CH4 2-1 T3 p3


Temperature
Temperature [K]
1200
1202
1204
1206
1208
1210
1212
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

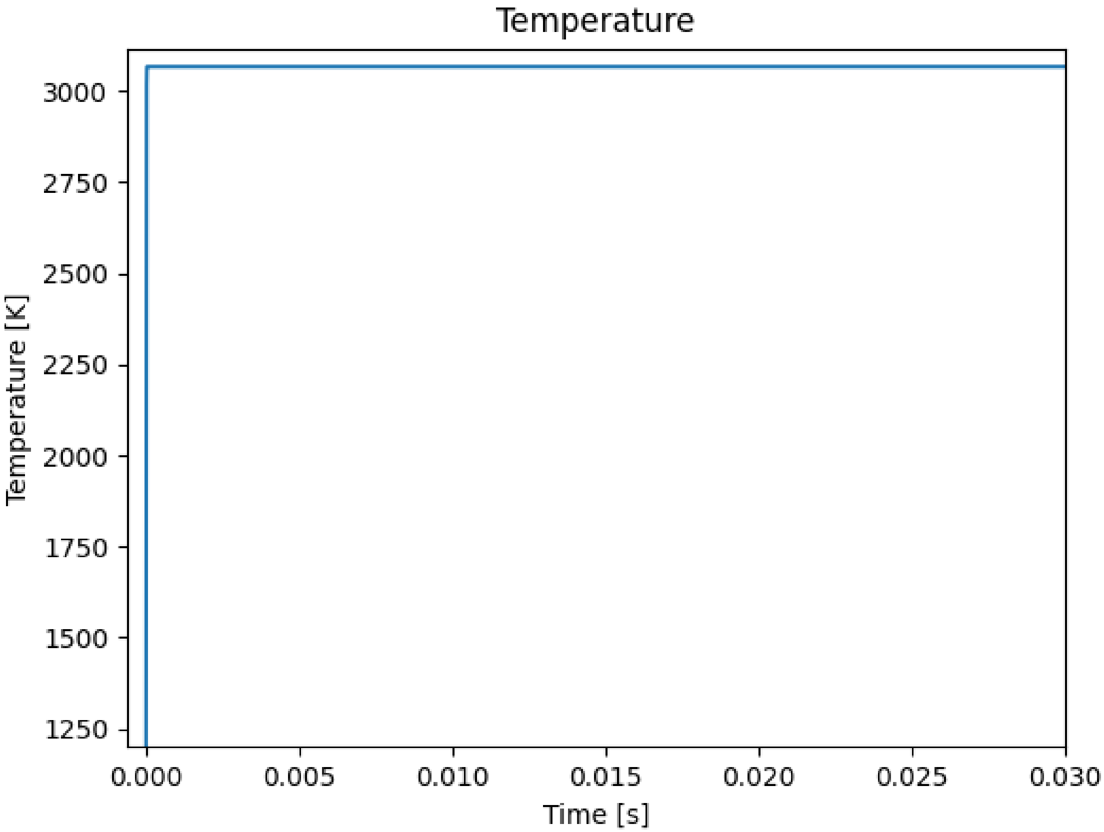
CH4 3-1 T1 p1


Temperature
1800
1700
1600
1500
1400
Temperature [K]
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

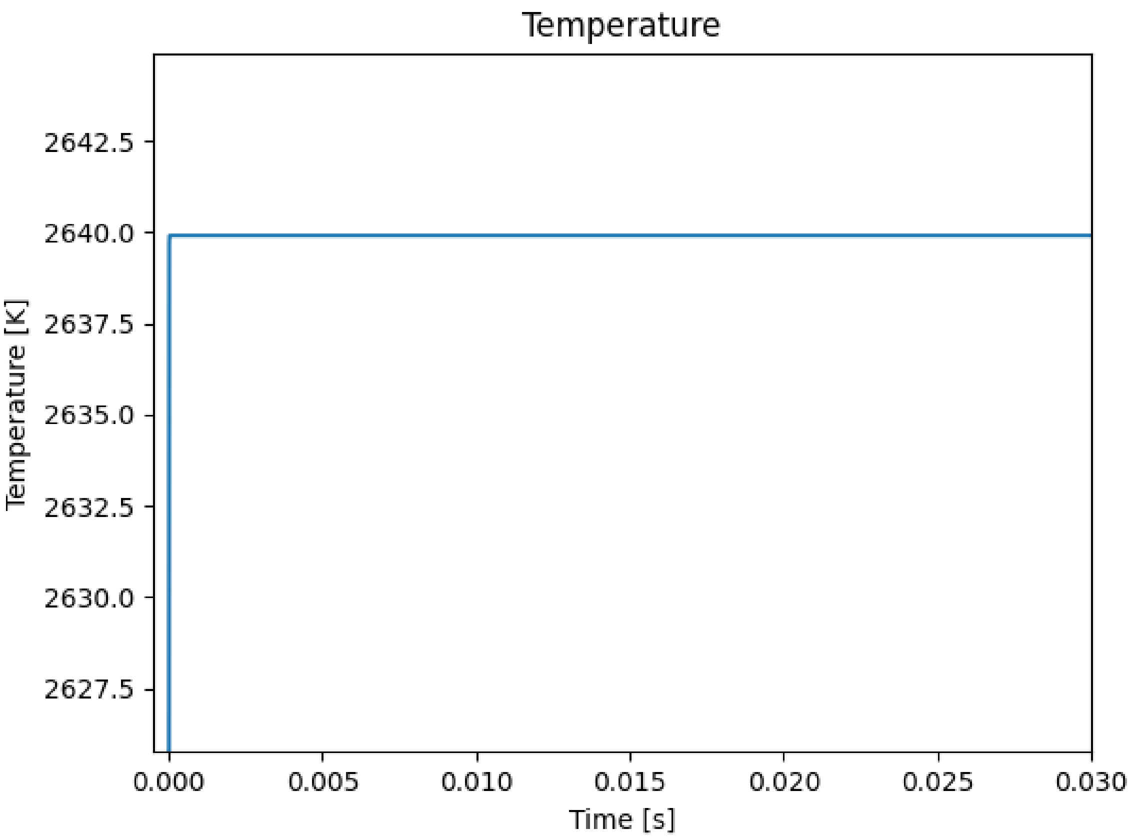
CH4 3-1 T2 p2


Temperature
1480
1470
1460
1450
1440
1430
1420
1410
Temperature [K]
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

CH4 3-1 T3 p3

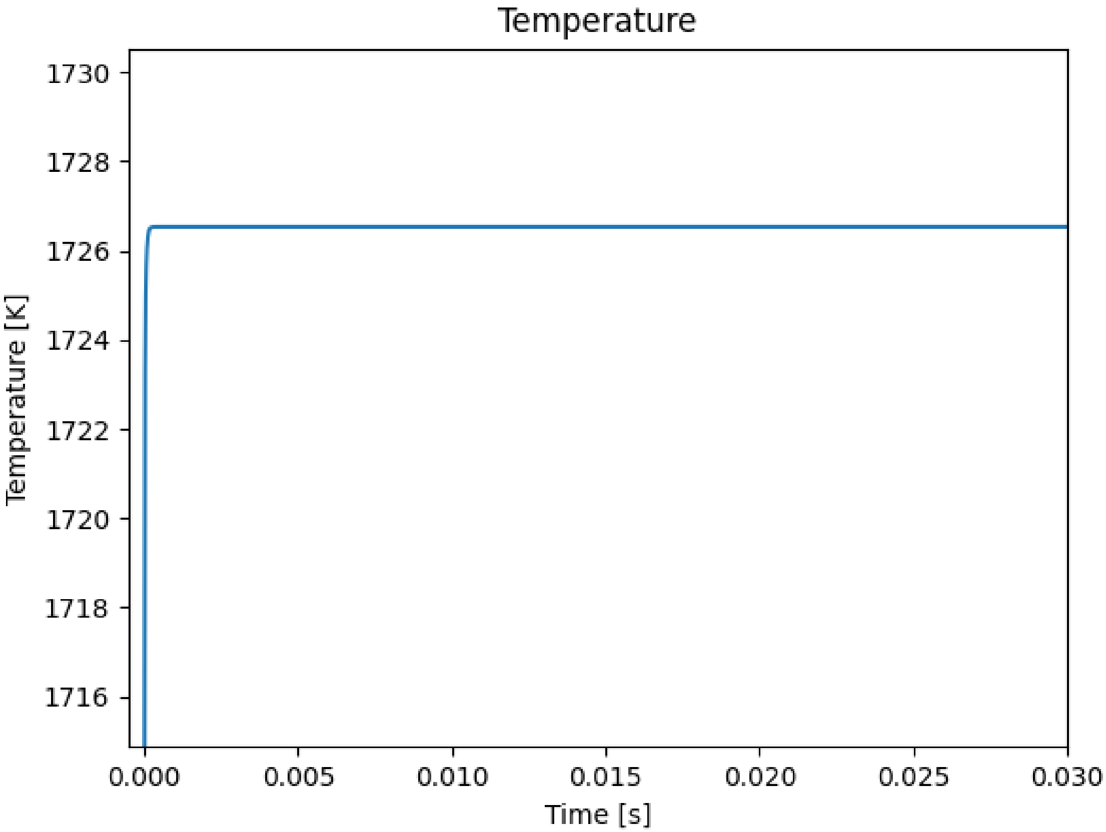

Temperature
3000
2750
2500
2250
2000
1750
1500
1250
Temperature [K]
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

H2 1-1 T1 p1

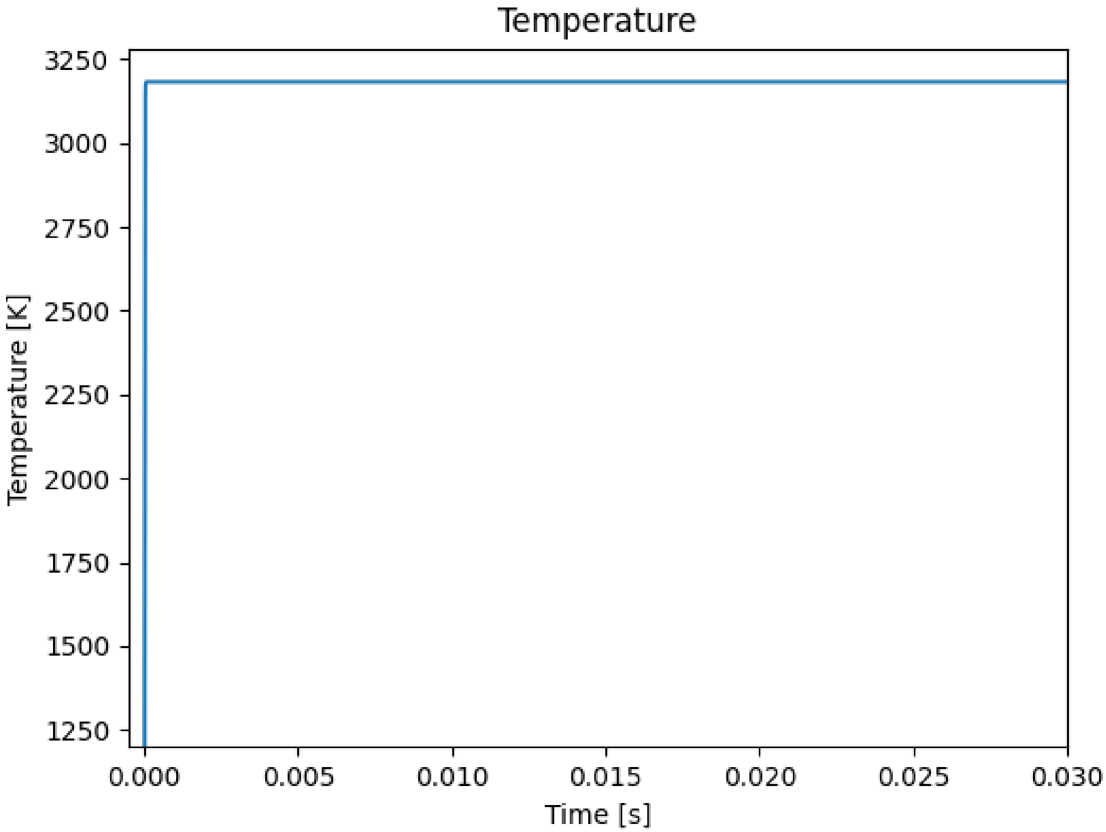


Temperature
2642.5
2640.0
2637.5
2635.0
2632.5
2630.0
2627.5
Temperature [K]
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

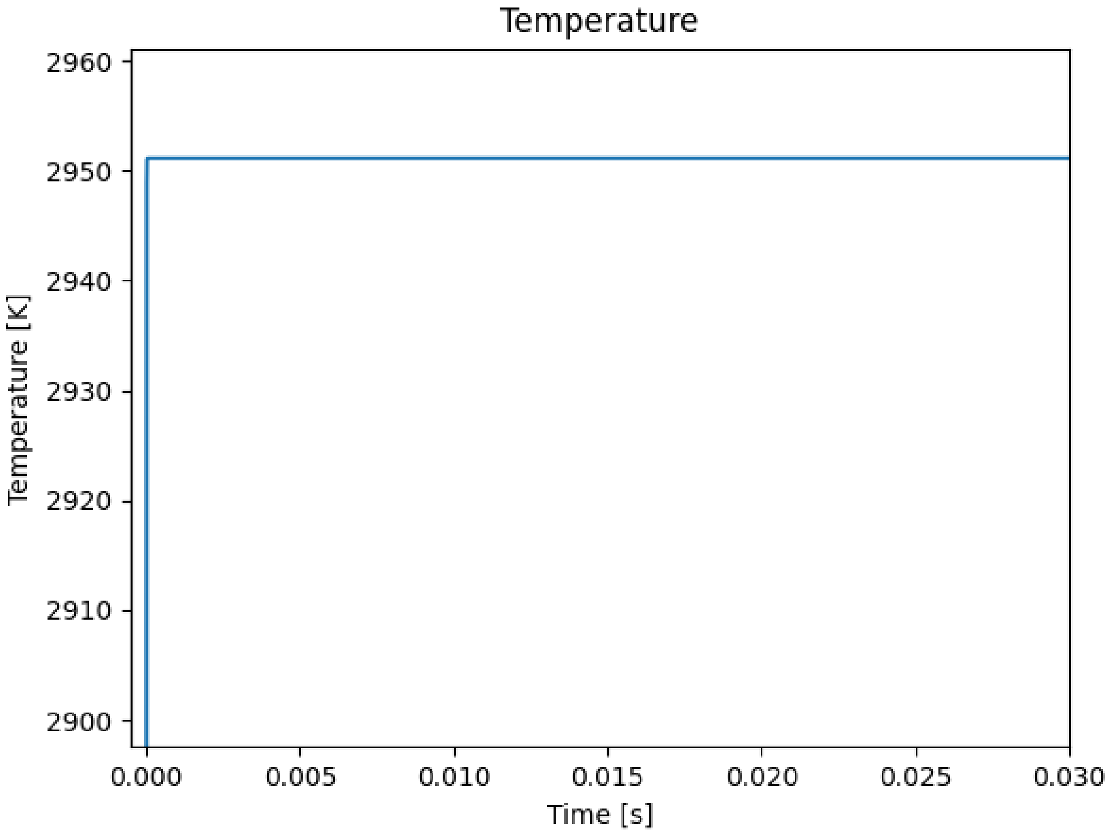
H2 1-1 T2 p2


Temperature
1730
1728
1726
1724
1722
1720
1718
1716
Temperature [K]
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

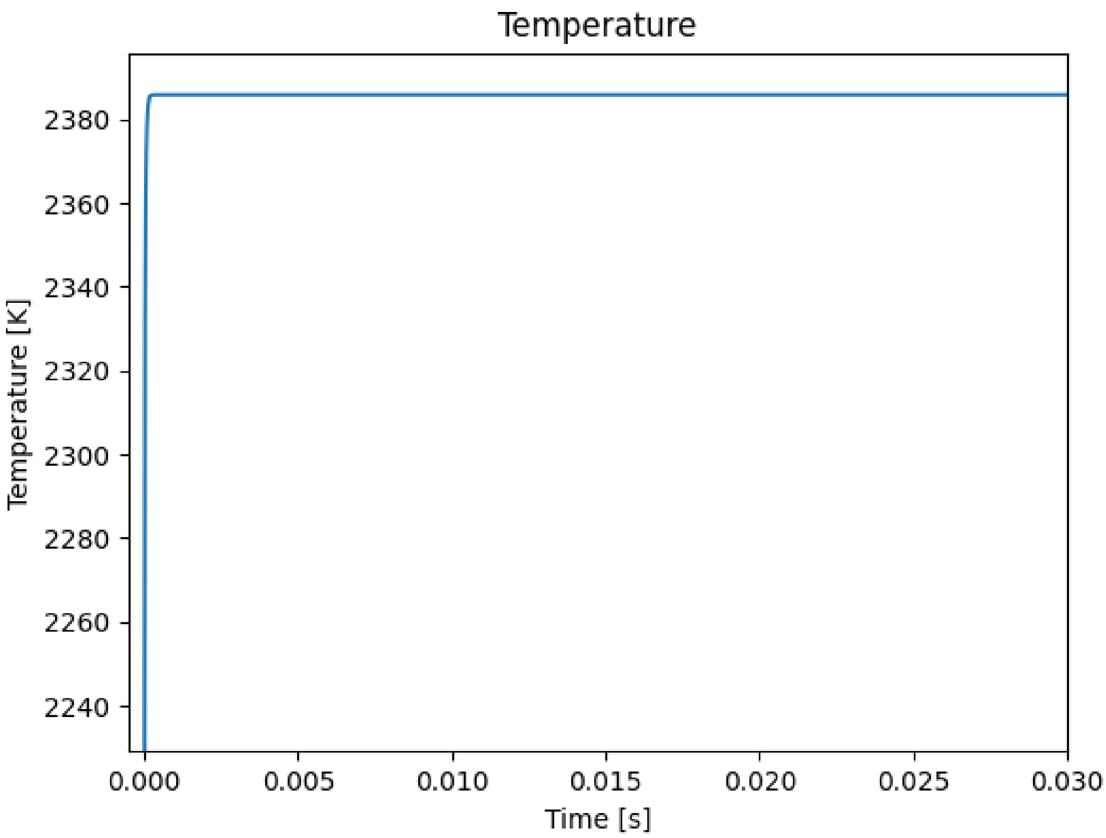
H2 1-1 T3 p3


Temperature
3250
3000
2750
2500
2250
2000
1750
1500
1250
Temperature [K]
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

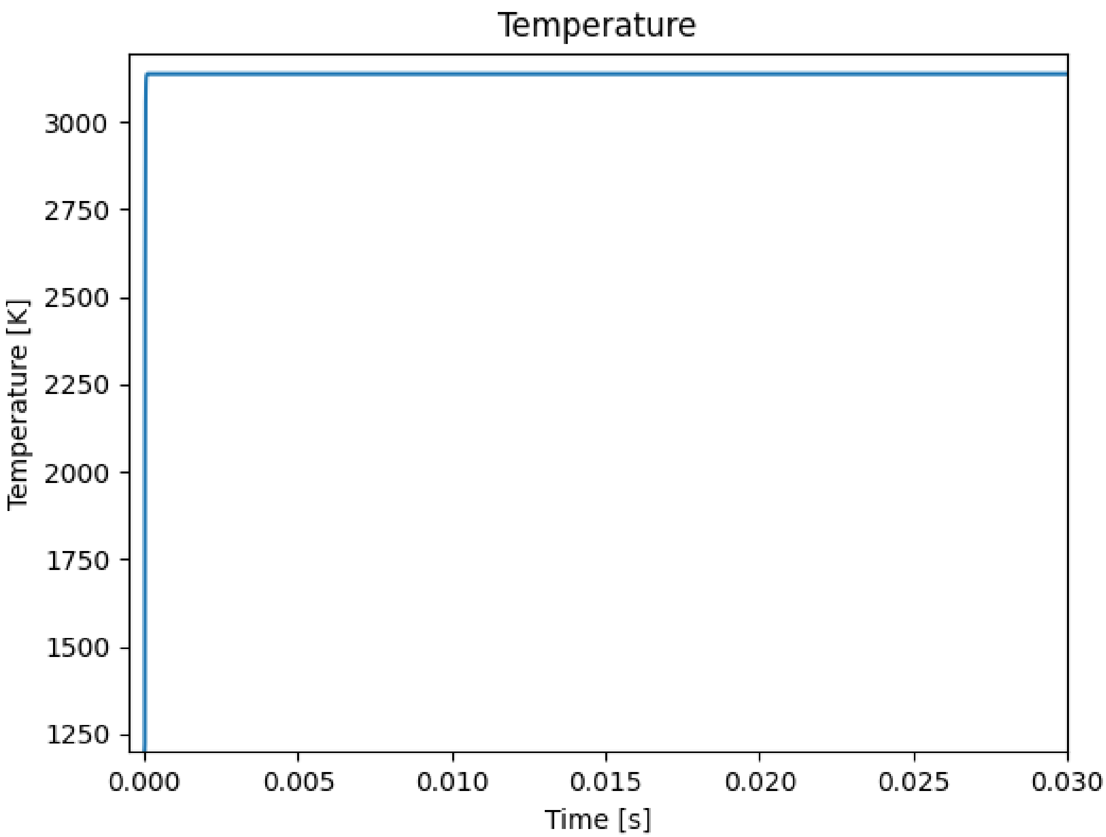
H2 2-1 T1 p1


Temperature
2960
2950
2940
2930
2920
2910
2900
Temperature [K]
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

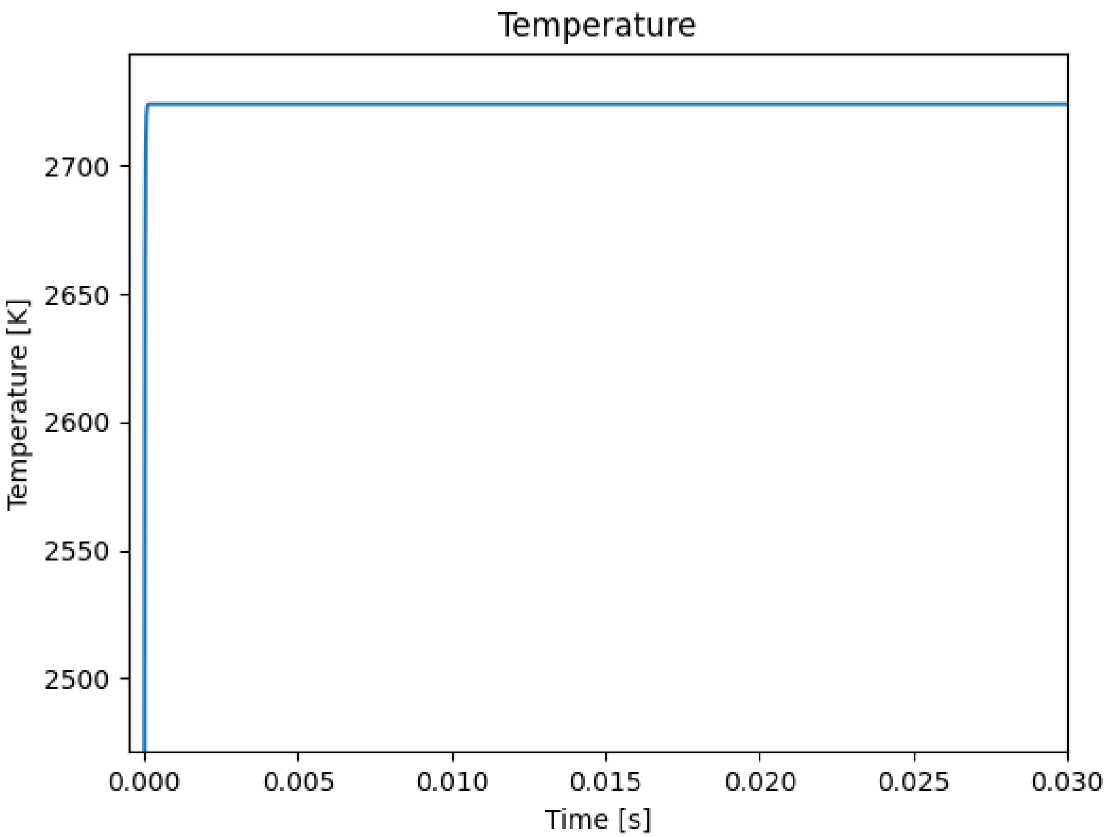
H2 2-1 T2 p2


Temperature
Temperature [K]
2380
2360
2340
2320
2300
2280
2260
2240
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

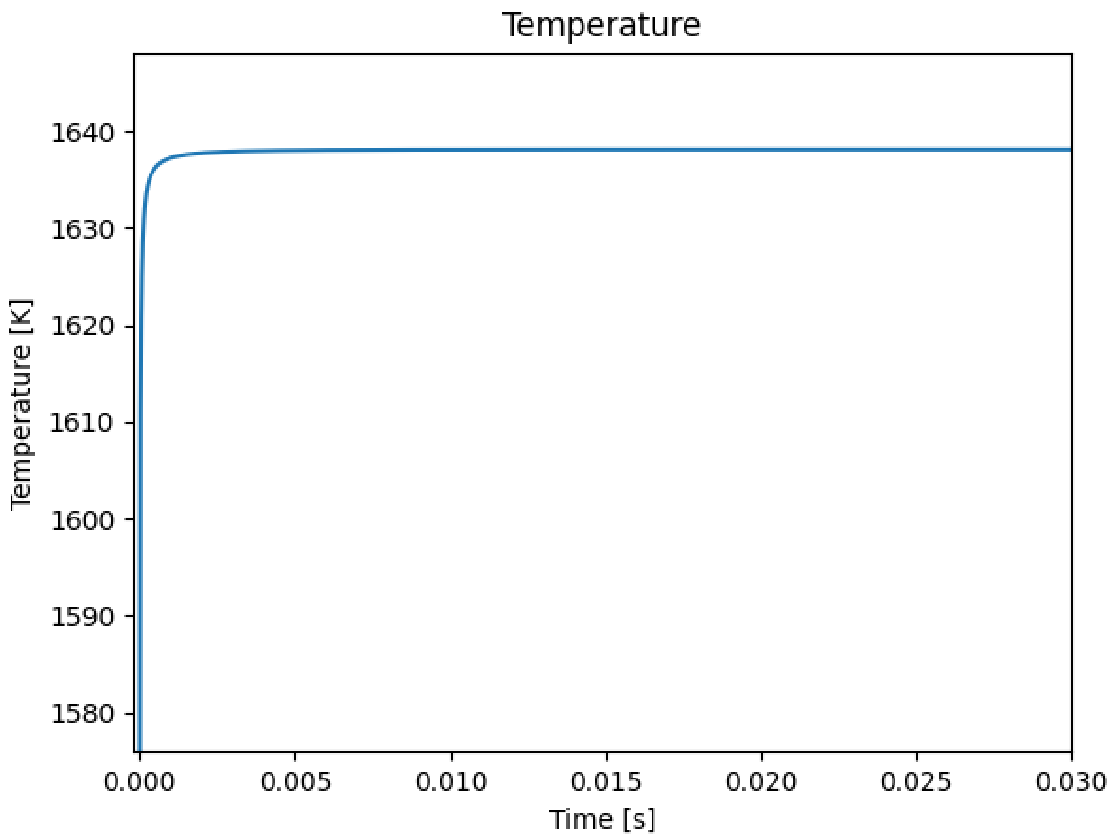
H2 2-1 T3 p3


Temperature
3000
2750
2500
2250
2000
1750
1500
1250
Temperature [K]
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

H2 3-1 T1 p1


Temperature
2700
2650
2600
2550
2500
Temperature [K]
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Time [s]

H2 3-1 T2 p2



H2 3-1 T3 p3

3.2 Heat combustion

1	CH4	ratio	1	p	1	LHV:	50.025	MJ/kg,	HHV:	55.511	MJ/kg
2				p	2	LHV:	49.938	MJ/kg,	HHV:	54.488	MJ/kg
3				p	3	LHV:	49.886	MJ/kg,	HHV:	52.520	MJ/kg
4		ratio	2	p	1	LHV:	28.167	MJ/kg,	HHV:	31.460	MJ/kg
5				p	2	LHV:	28.206	MJ/kg,	HHV:	30.938	MJ/kg
6				p	3	LHV:	28.296	MJ/kg,	HHV:	29.877	MJ/kg
7		ratio	3	p	1	LHV:	20.881	MJ/kg,	HHV:	23.443	MJ/kg
8				p	2	LHV:	20.963	MJ/kg,	HHV:	23.087	MJ/kg
9				p	3	LHV:	21.100	MJ/kg,	HHV:	22.330	MJ/kg
10	H2	ratio	1	p	1	LHV:	119.952	MJ/kg,	HHV:	141.780	MJ/kg
11				p	2	LHV:	120.709	MJ/kg,	HHV:	138.814	MJ/kg
12				p	3	LHV:	121.413	MJ/kg,	HHV:	131.896	MJ/kg
13		ratio	2	p	1	LHV:	66.687	MJ/kg,	HHV:	78.822	MJ/kg
14				p	2	LHV:	68.021	MJ/kg,	HHV:	78.087	MJ/kg
15				p	3	LHV:	69.315	MJ/kg,	HHV:	75.143	MJ/kg
16		ratio	3	p	1	LHV:	48.932	MJ/kg,	HHV:	57.836	MJ/kg
17				p	2	LHV:	50.459	MJ/kg,	HHV:	57.845	MJ/kg
18				p	3	LHV:	51.949	MJ/kg,	HHV:	56.225	MJ/kg

Particular Heat combustion values

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