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COMPUTATIONAL METHODS IN COMBUSTION

Piston Movement Simulation

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1 Introduction

The project simulates work of moving piston. A closed cylinder is divided into two equal parts:

- massless piston,
- two walls.

Lower side is filled with argon and the higher side is filled with methane/air mixture.
The piston begins to move due to the pressure difference.
Under the influence of compression, mixture of methane and air explodes.
While the compression process for mixture is taking place, argon is being decompressed.
Following process is being analyzed for 11 different temperatures in function of pressure.
We are expecting to see significant increase in pressure and in temperature of methane/air mixture and drop of the temperature for argon.
Wall surface between cylinder and piston is set to 2 m^2.
Wall surface between engine and environment is set to 3 m^2.

Temperature of Argon [K]	Pressure of Argon [Bar]	Temperature of mixture [K]	Pressure of mixture [Bar]
1000	20	300	0.20
1100	20	300	0.20
1200	20	300	0.20
1300	20	300	0.20
1400	20	300	0.20
1500	20	300	0.20
1600	20	300	0.20
1700	20	300	0.20
1800	20	300	0.20
1900	20	300	0.20
2000	20	300	0.20

Table 1: Initial values

2 Results

Below results in the form of diagrams for the simulation of the pistons were added.

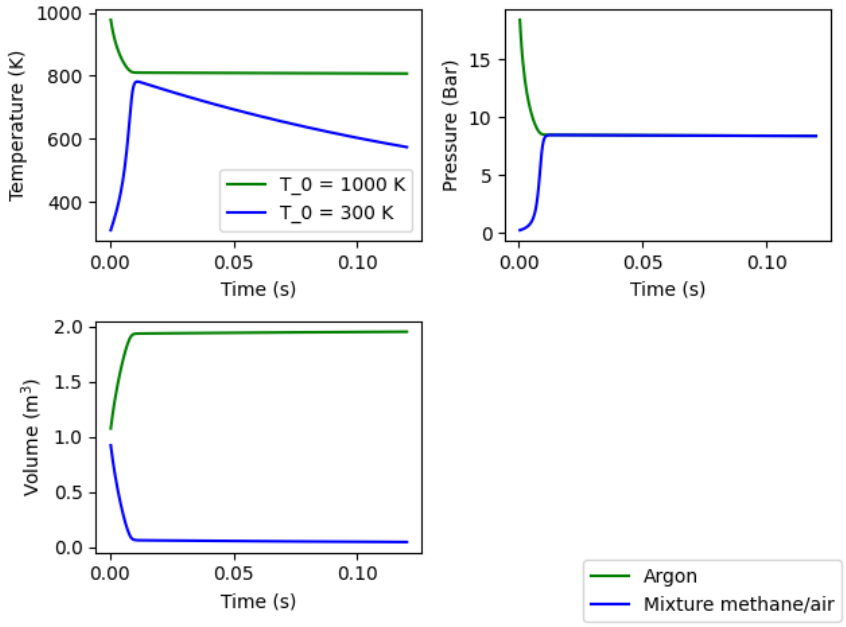

Figure 1: Temperature, pressure, volume

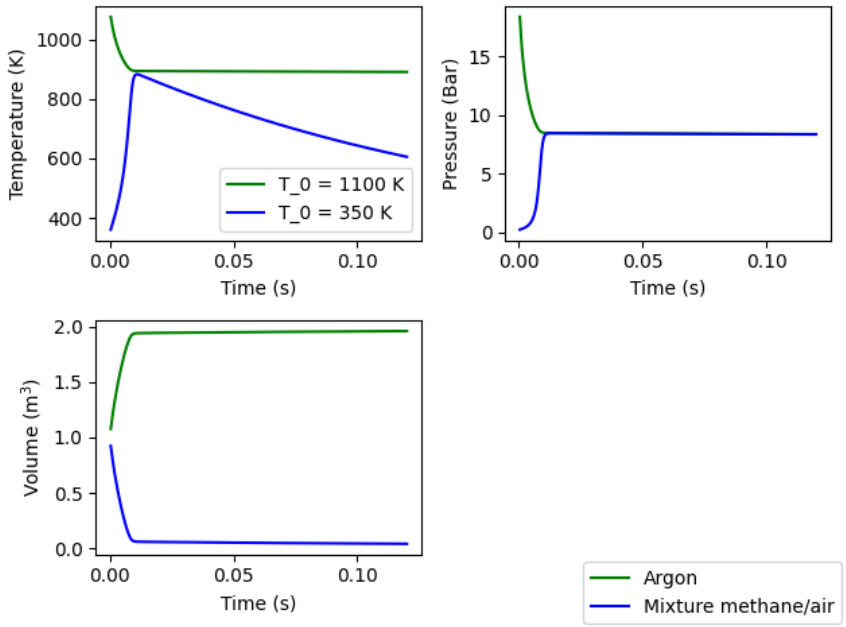

Figure 2: Temperature, pressure, volume

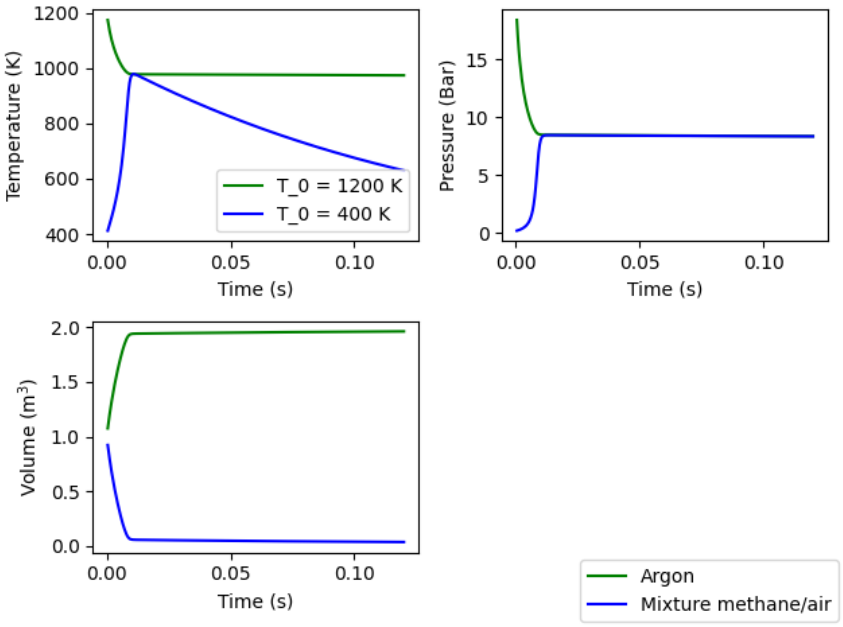

Figure 3: Temperature, pressure, volume

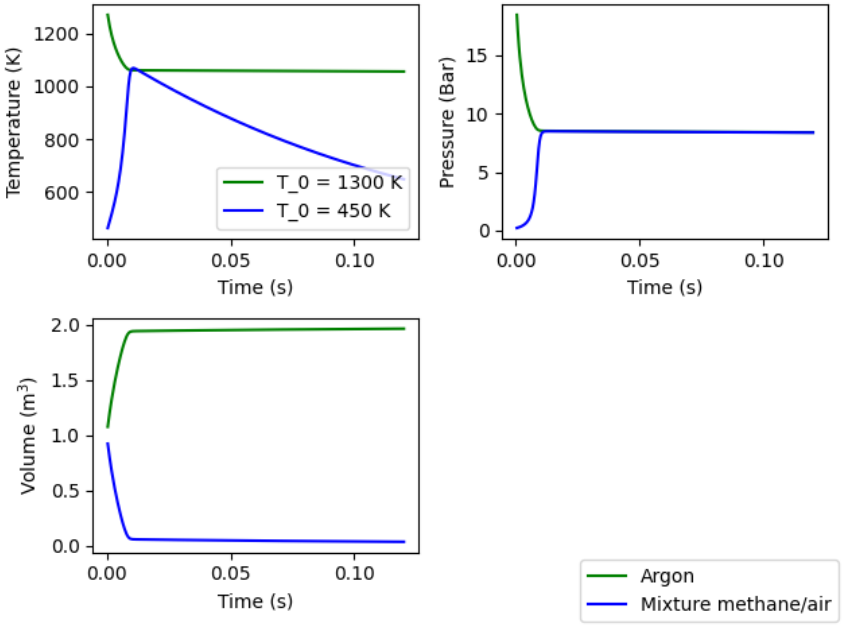

Figure 4: Temperature, pressure, volume

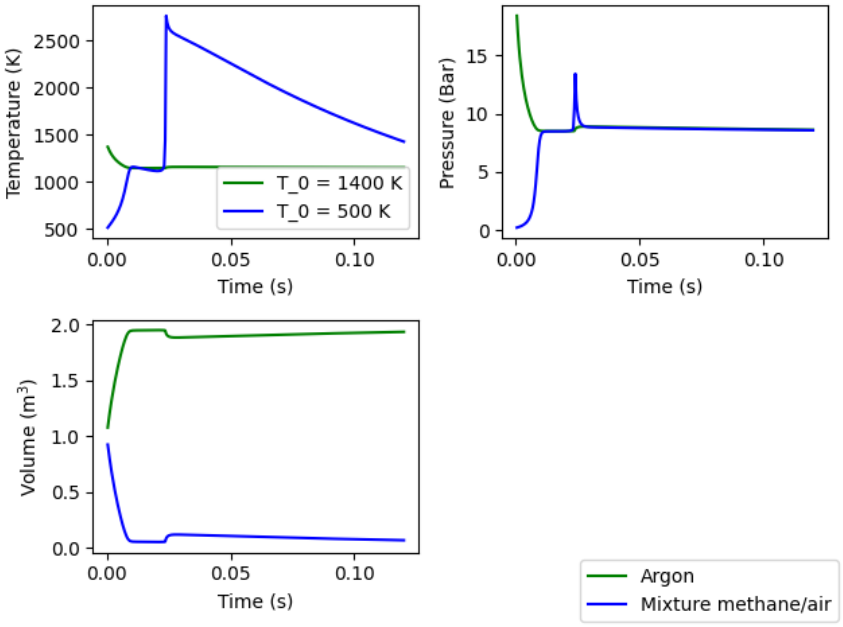

Figure 5: Temperature, pressure, volume

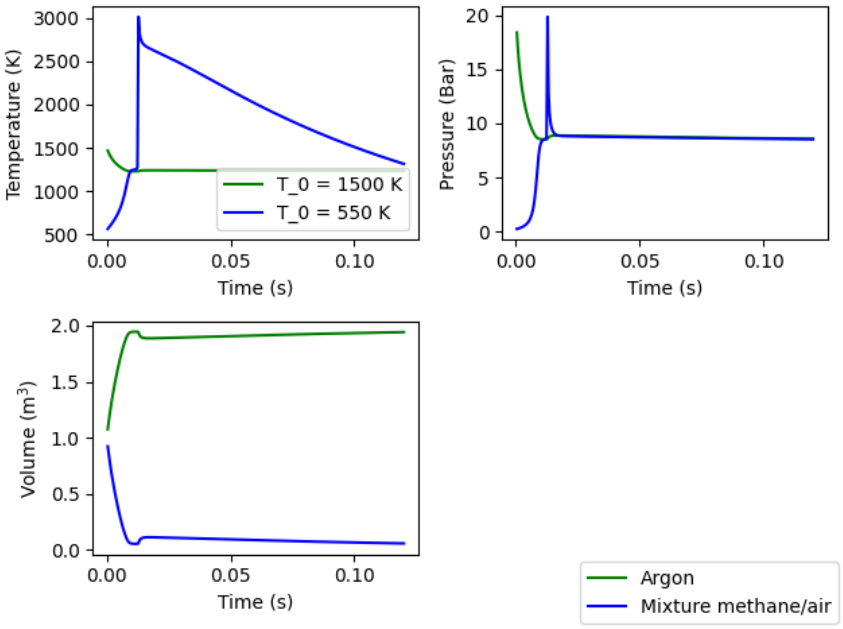

Figure 6: Temperature, pressure, volume

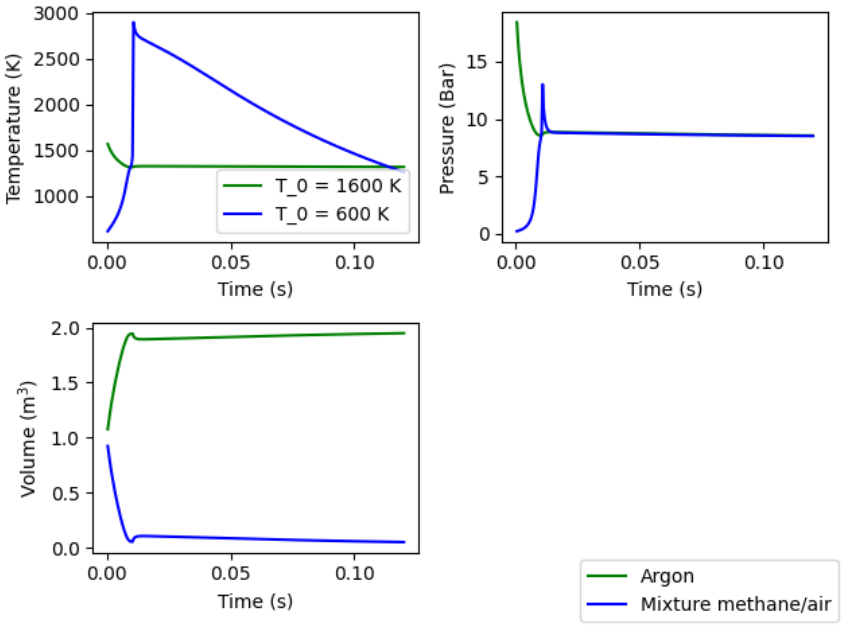

Figure 7: Temperature, pressure, volume

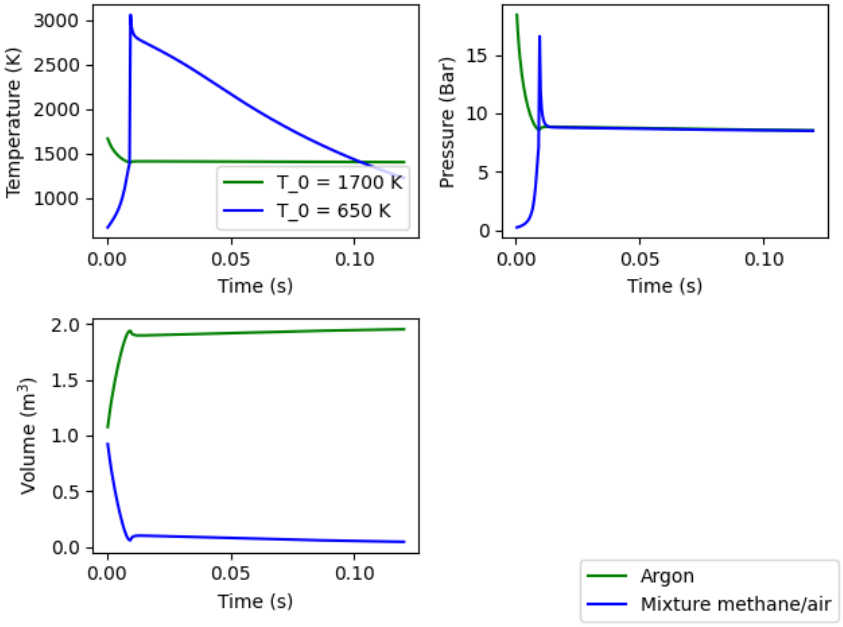

Figure 8: Temperature, pressure, volume

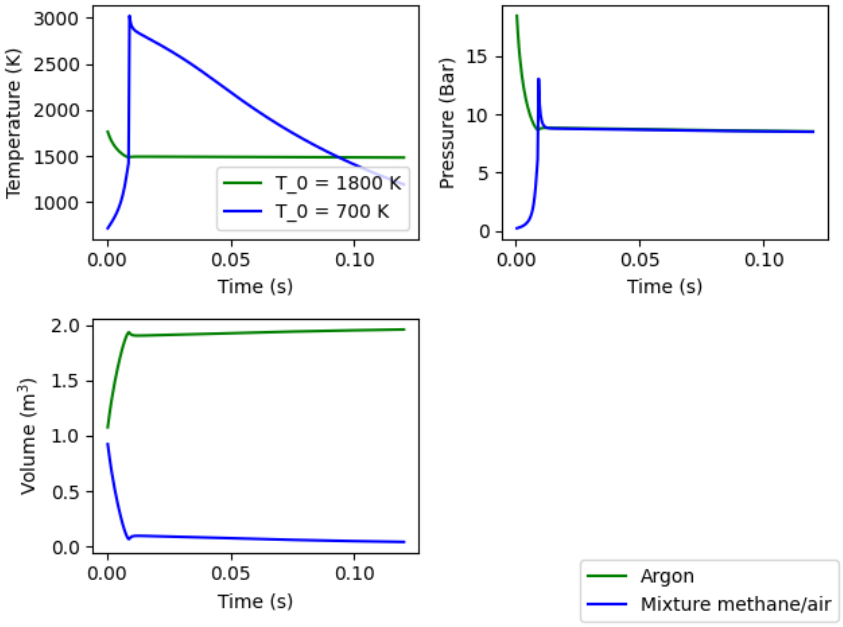

Figure 9: Temperature, pressure, volume

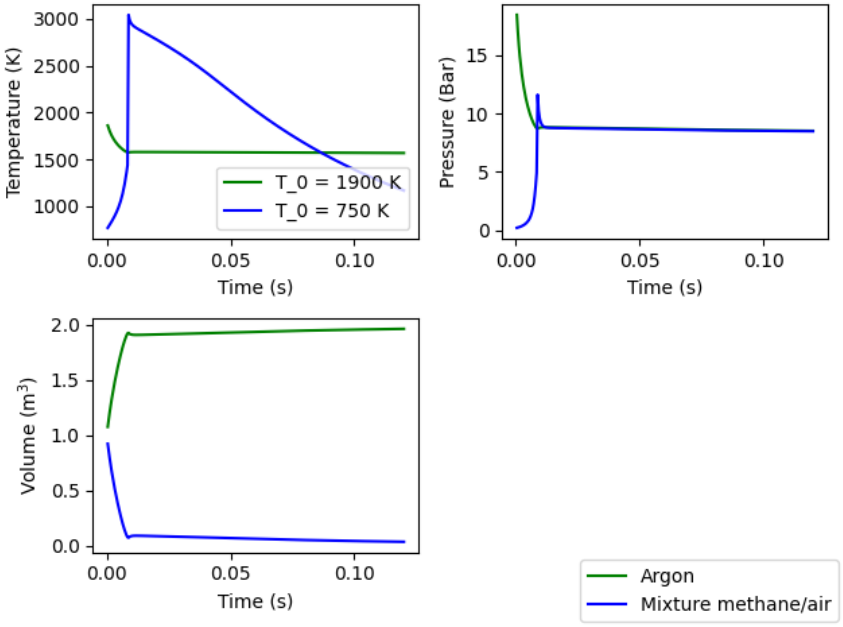

Figure 10: Temperature, pressure, volume

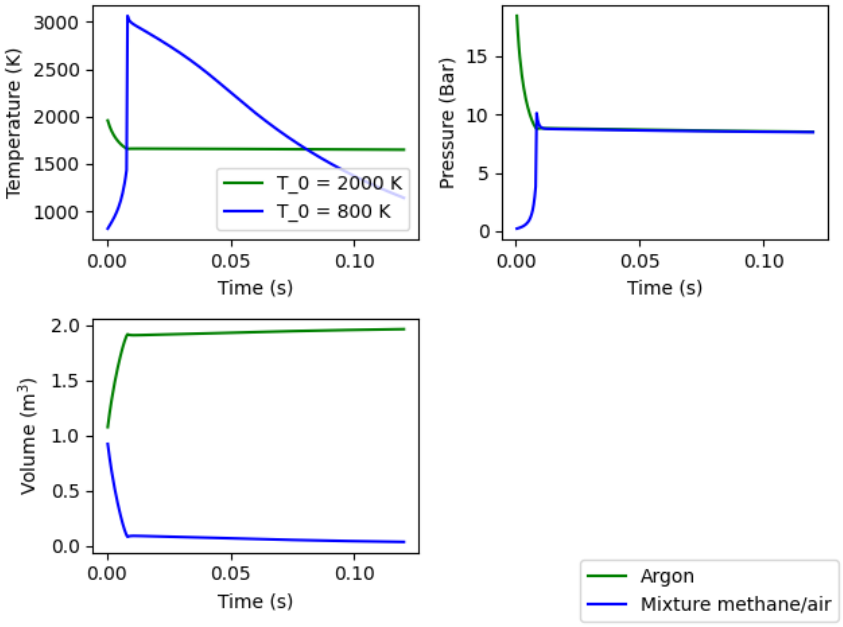

Figure 11: Temperature, pressure, volume

3 Conclusions

As expected, the simulation of the piston movement causes a sudden increase in pressure and temperature for methane/air mixture. The compression process is visible by the drop in the volume of the methane/air mixture.
At the same time we can see that argon is expanding and cooling.
From 500 K of initial temperatures of methane/air mixture, there is visible large rise of the temperature. This leads to conclusion that minimal temperature for detonation process is about 500K.

4 Bibliography

https://cantera.org/documentation/