Ignition Delay Time

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1 Introduction

The aim of a simulation is measurement the ignition delay time for a mixture of air and methane as well as how this time depends on quantity of fuel.

2 Description of phenomenon

Ignition delay is the time between fuel injection and fuel ignition. During this time the fuel get mixed with hot compressed air and vaporizes. After the ignition delay, spontaneous ignition of the fuel occurs.

3 Simulation

The simulation was conducted using Cantera, which is a software tool for Python language.

3.1 Initial conditions

Temperature was set to $1000K$
Pressure : $1atm$
Mole composition: CH_4: 0,5, O_2: 1, N_2: 3,76

3.2 Calculations

Time range was set to 1,4 s and measurements of temperature and mole fractions $(0_2, CH_4, H)$ were written every 0,005 s. Results are shown after execution of the program. They are too long to put them in the report. Ignition is defined as the moment, when occurs rapid increase of temperature. Plot below points it exactly:

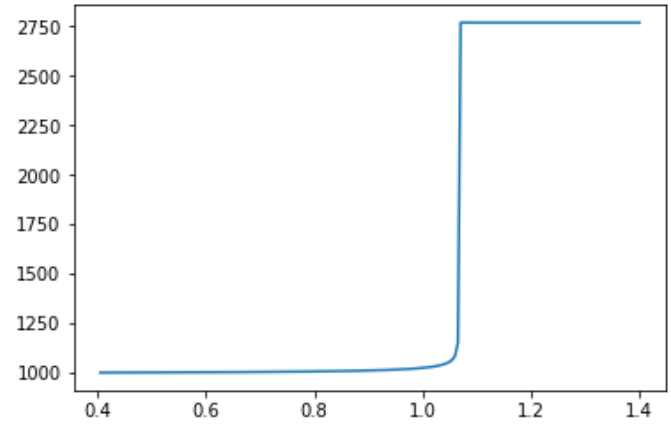
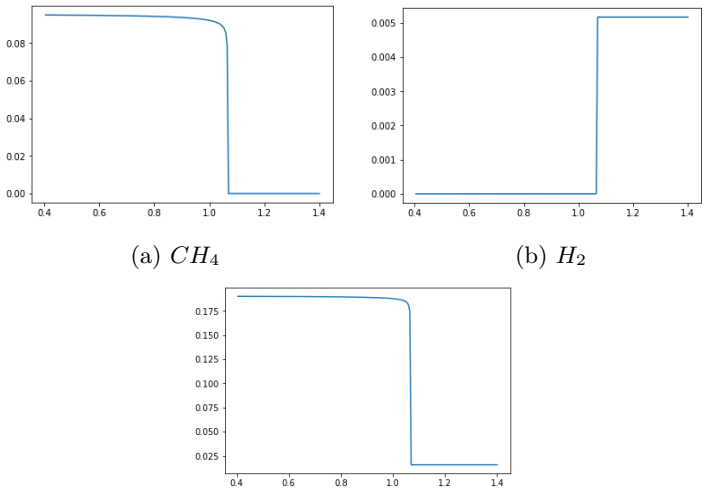


Figure 1: Plot of temperature [K] versus time [s]

Now let's take a look at plots of mole fractions.



(a) CH_4 (b) H_2

(c) O_2

Figure 2: Plots mole fraction [%] versus time [s]

On figure 2c it is seen that not all of O_2 disappeared. It exists in products too. On the other hand all of H_2 discharged after combustion.

3.3 Additional calculations

Next calculations were conducted to show how quantity of fuel depends on ignition delay. The range for moles of methane was set from 0,1 to 0,8. Initial temperature and pressure remained the same as in above calculations. Below there's a comparison:

CH4 [mole]	Ignition time [s]
0.1	0.550
0.2	0.680
0.3	0.825
0.4	0.950
0.5	1.065
0.6	1.170
0.7	1.270
0.8	1.365

Figure 3: Comparative table

And plot:

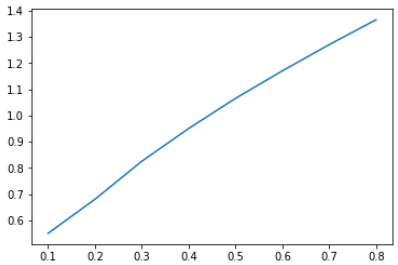


Figure 4: Plot of ignition time [s] versus mole of methane

4 Conclusion

- Ignition delay time strictly depends on quantity of fuel
- For the same quantity of oxidant if there's more fuel then ignition delay is longer (Only in mentioned conditions - this function is not linear).
- Not all of oxygen is burned.
- All of hydrogen discharged after combustion.
- Ignition delay time is an important parameter in combustion issues.