Cantera Project
Laminar flame propagation speed

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1 Introduction

The main purpose of this project is to calculate flame propagation speed and to check how different initial conditions of a gas influences the results.

2 Literature

The only literature, which was used here was Cantera Tutorial from offical Cantera website.

3 Flame propagation speed

Flame propagation speed is a parameter that measures rate of expansion of the flame front in a combustion reaction.

4 Description of the project

In this project it was said that the gas should be a mixture of hydrogen and air. The fractions of each component was decided to be constant for every gas in this project and they were:

H2 = 0.7

Air = 1 (=> O2 = 1, N2 = 3.76)

To check the differences between different initial conditions there are three gases with the same reactants but with different temperatures and pressures.

The first gas (gas1) has tempterature T = 300 K and pressure p = 1 atm.

The second gas (gas2) has tempteterature T = 300 K and pressure p = 1.5 atm.

The third gas (gas3) has tempterature T = 400 K and pressure p = 1 atm.

When gases are defined, the program initialises flames based on them. By doing so, we get three different flames with conditions coming from gases.

5 Solution

With the flames defined, program can solve them using Cantera and show results afterwards.

In this project it was decided, that the best way to examine differences between flames is making three plots of flame propagation speed for different flames on the same graph. It was possible thanks to the matplotlib library, which was imported and the beginnig.

Besides that, program will show exact numerical results on screen, so the values can be checked not only from a graph but from an array as well.

Below there is an array showing exact results from calculations for the first flame (T= 300K, p = 1 atm):

```
Pressure:   1.013e+05 Pa

-------------------------------
          z            u
-------------------------------
          0       0.0494
      0.006      0.05191
      0.009      0.06334
     0.0105      0.08594
    0.01125       0.1099
    0.01162       0.1272
      0.012       0.1487
    0.01219       0.1604
    0.01238       0.1711
    0.01256       0.1793
    0.01275       0.1847
    0.01294       0.1879
    0.01313       0.1899
    0.01331        0.191
     0.0135       0.1917
    0.01387       0.1923
    0.01425       0.1926
      0.015       0.1928
    0.01575       0.1929
     0.0165       0.1929
      0.018        0.193
      0.024        0.193
       0.03        0.193
```

Figure 1: Numerical results for the first flame

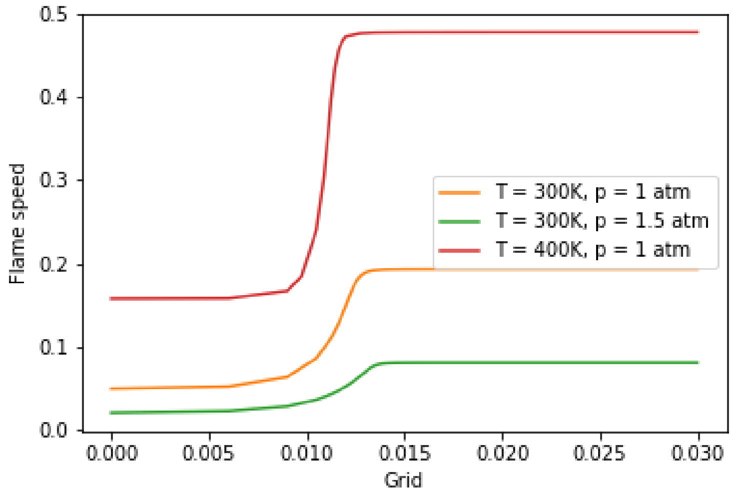

Figure 2: Flame propagation speed

6 Summary

As one can see, the flame propagation speed is not so high at first, but after some time it speeds up very quickly to its highest value. Moreover, for higher temperatures flame propagation is faster than for lower temperatures, however, higher pressure makes flame move slower.