Project MKWS 2022
Laminar flame propagation speed

Ilya Shymialevich
Lotnictwo i Kosmonautyka

June 14, 2022

1 Introduction

The main purpose of this project is to calculate laminar flame propagation speed and to check how different initial conditions of a gas influences the results. As fuel there will be used a mixture of a hydrogen and air in proportions shown below. When burnt with clear oxygen, hydrogen is a 'zero-emission' fuel, which means that there will be no waste products after the combustion. This kind of fuel is used in many cases such as passenger cars etc.

2 Flame propagation speed

Laminar flame speed is the propagation velocity of a laminar flame front into the unburned premixed gas, which depends on the fuel type, air-fuel ratio, temperature and pressure. The laminar flame speed is maximal near stoichiometric conditions for hydrocarbon fuels.

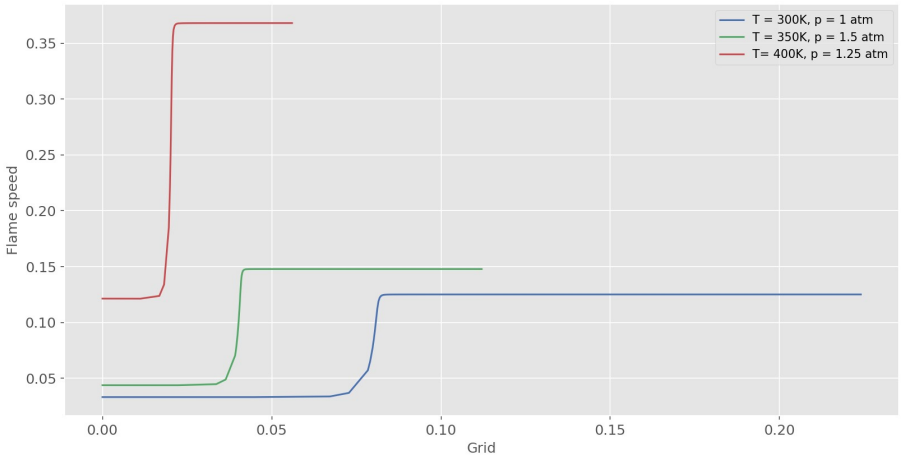
3 Description

In introduction we are already said that we are use a mixture of hydrogen and air. The fractions of each component was decided to be constant for every gas in this project.
$H_2 = 0.7$
$Air = 1$ ($O_2 = 1$, $N_2 = 3.76$)
To check the differences between different initial conditions there are three gases with different temperatures and pressures.
The first gas has parameters: $T_1 = 300$ [K], $p_1 = 101325$ [Pa] $= 1$ [atm]
The second gas has parameters: $T_2 = 350$ [K], $p_2 = 151987$ [Pa] $= 1.5$ [atm]
The third gas has parameters: $T_3 = 400$ [K], $p_3 = 126656$ [Pa] $= 1.25$ [atm]

4 Solution

When the flames are defined, program can solve them using Cantera and show results afterwards. Below there is an array showing exact results from calculations for the third flame. We can see, that the flame propagation speed is not

z	velocity
0	0.1213
0.0112	0.1213
0.0168	0.1237
0.0182	0.1339
0.0196	0.1849
0.01995	0.2225
0.02012	0.2502
0.0203	0.2844
0.02048	0.3196
0.02065	0.3436
0.02083	0.3561
0.021	0.3623
0.02135	0.366
0.0217	0.3672
0.02205	0.3677
0.0224	0.3679
0.0238	0.3681
0.0252	0.3681
0.0266	0.3681
0.028	0.3682
0.0308	0.3682
0.0336	0.3682
0.0448	0.3682
0.056	0.3682



so high at first, but after some time it speeds up and we can see how depends temperature and pressure on LFS(Laminar flame speed). For higher temperatures flame propagation is faster than for lower temperatures, higher pressure makes flame move slower.