

# Laminar flame speed of methane-air mixture as a function of temperature, pressure and equivalence ratio

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## 1 Introduction

Laminar flame speed is the speed at which an un-stretched laminar flame will propagate through a quiescent mixture of unburned reactants. Laminar speed is dependent on only three properties of a chemical mixture: thermal diffusivity, reaction rate (related to pressure) and temperature through the flame zone. The following report contains computer calculations based on Python (Cantera) which count the changes of laminar flame speed as a function of temperature and pressure. It also contains comparison of those results with the experimental data.

### 1.1 Mathematical model

$$S_L = S_{L,\text{ref}} \left( \frac{T_u}{T_{u,\text{ref}}} \right)^\gamma \left( \frac{P}{P_{\text{ref}}} \right)^\beta (1 - 2.1Y_{\text{dil}}) \quad (6.33)$$

for  $T_u \geq 350$  K.  $T_{u,\text{ref}} = 298$  K, and  $P_{\text{ref}} = 1$  atm.

$$S_{L,\text{ref}} = B_M + B_2(\Phi - \Phi_M)^2$$

$$\gamma = 2.18 - 0.8(\Phi - 1)$$

$$\beta = -0.16 + 0.22(\Phi - 1)$$

Figure 1: Mathematical model according to research [1].

There is a big variety of different experimental formulas. The one shown above is valid for various substance after using a proper coefficients.

## 2 Results

The following are results of Python program calculation:

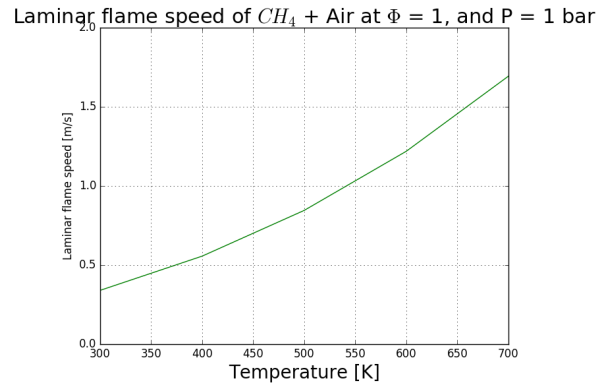


Figure 2: Flame speed and temperature dependence

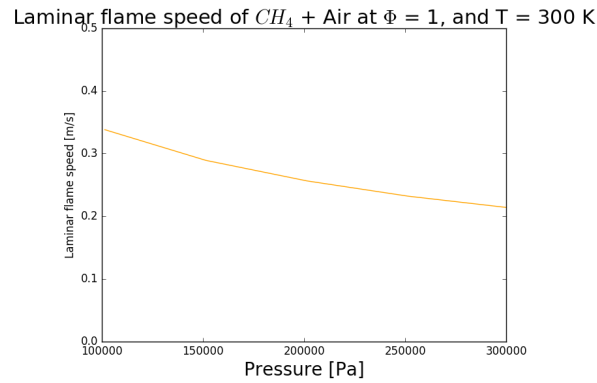


Figure 3: Flame speed and pressure dependence

On Figure 4 and Figure 5 is shown the comparison of Cantera results and the experimental data according to mathematical model.

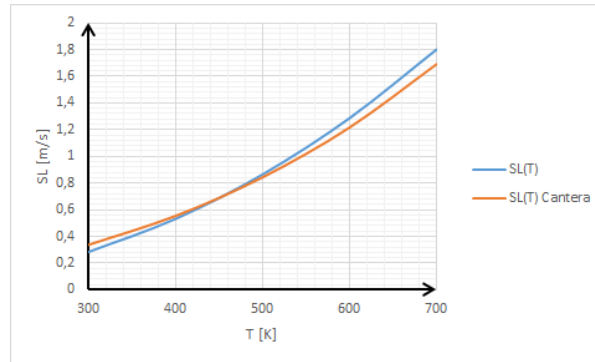


Figure 4: Flame speed and temperature dependence (comparison)

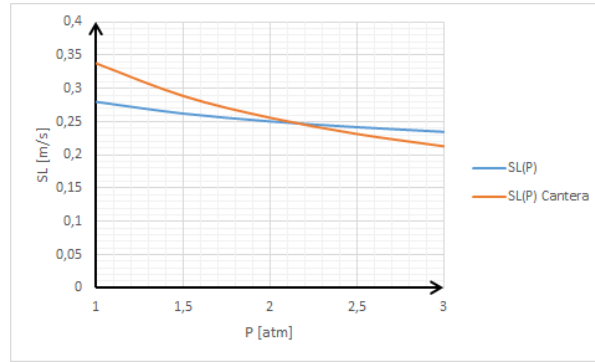


Figure 5: Flame speed and pressure dependence (comparison)

## 2.1 Remark and Summary

According to Figures 4 and 5 there is a difference between results counted by application program and experimental data. It may be caused by imperfections of the mathematical formulas implemented in Cantera and scarce number of iterations performed. In case of Figure 4 the tendency is growing. It means that the flame speed is bigger if the flame temperature is higher. Quite the contrary in case of Figure 5 where the flame speed is being decreased while the pressure is increasing.

## 3 References

<http://arrow.utias.utoronto.ca/~ogulder/ClassNotes6.pdf> [1]  
[http://en.wikipedia.org/wiki/laminar\\_flame\\_speed](http://en.wikipedia.org/wiki/laminar_flame_speed) [2]