Ethylene - oxygen mixture CJ speed in the function of temperature, pressure and equivalence ratio

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1 Introduction

This report consists of calculations based on Cantera. Program counts CJ speed and state of the ethylene - oxygen mixture and its state after the detonation.

2 Mathematical model

Calculations are performed using the three following mechanic rules:

a. $\rho_1 w_1 = \rho_2 w_2$

b. $P_1 + \rho_1 (w_1)^2 = P_2 + \rho_2 (w_2)^2$

c. $h_1 + w_1^2/2 = h_2 + w_2^2/2$

3 Results

3.1 Constant parameters: P = 101325 Pa, phi = 1 and different initial temperature:

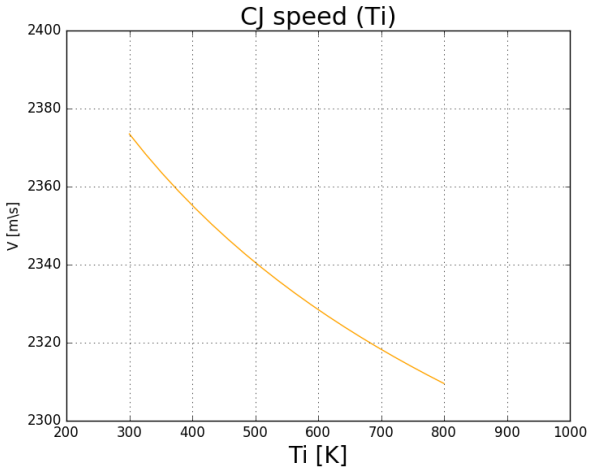

Figure 1: CJ speed in the function of initial temperature

Decent drop of the CJ speed with increasing initial temperature Noticeable

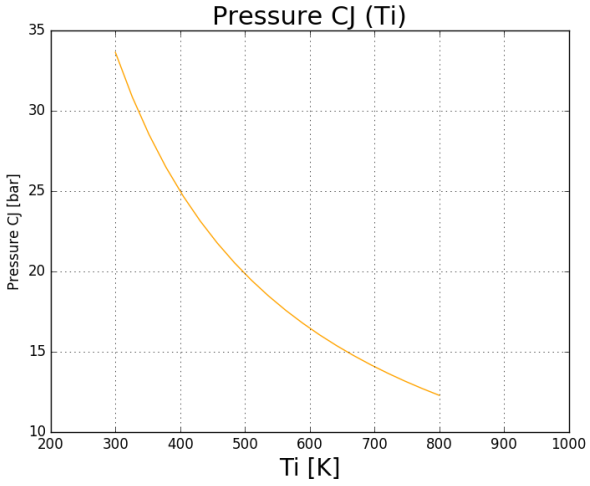

Figure 2: CJ pressure in the function of initial temperature

decrease of CJ pressure with increasing initial temperature

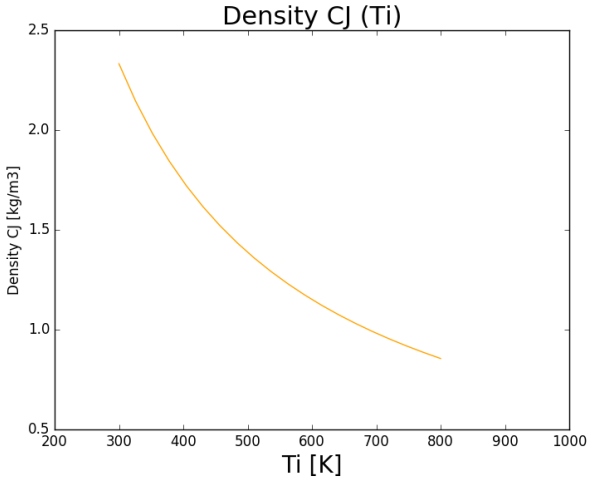

Figure 3: CJ density in the function of initial temperature

The fall of CJ pressure with increasing initial temperature

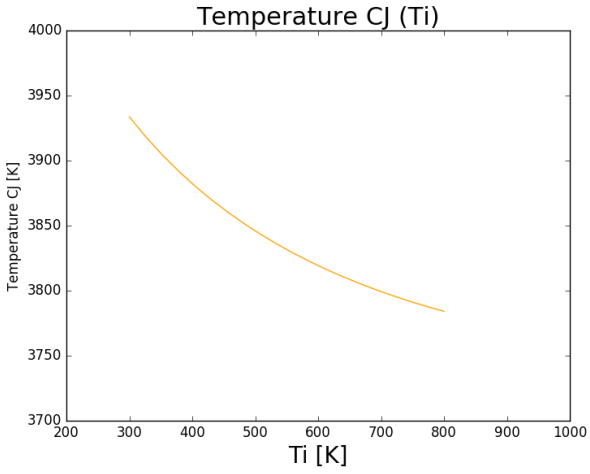

Figure 4: CJ temperature in the function of initial temperature

The fall of CJ temperature with increasing initial temperature

3.2 Constant parameters: T = 300 K, phi = 1 and different initial pressure:

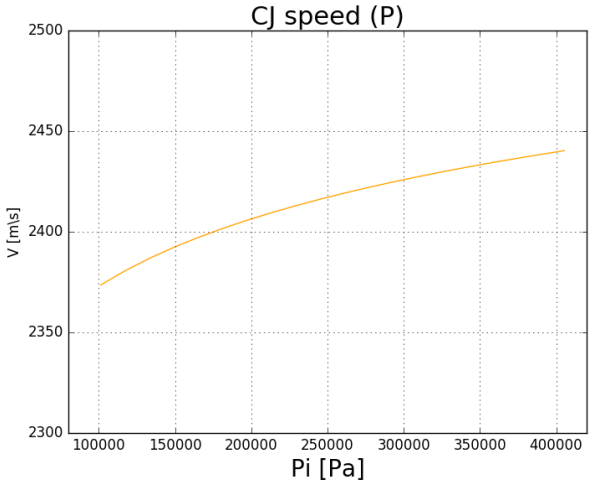

Figure 5: CJ speed in the function of initial pressure

Mild increase of CJ speed for next values of initial pressure

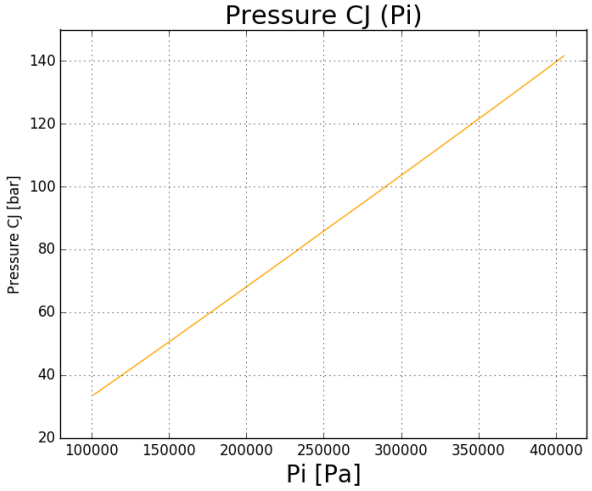

Figure 6: CJ pressure in the function of initial pressure

Severe growth of CJ pressure for higher initial pressure

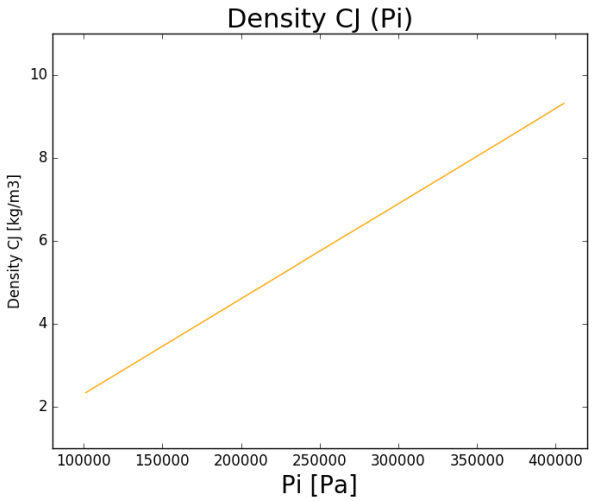

Figure 7: CJ density in the function of initial pressure

The density is increasing when the initial pressure is higher

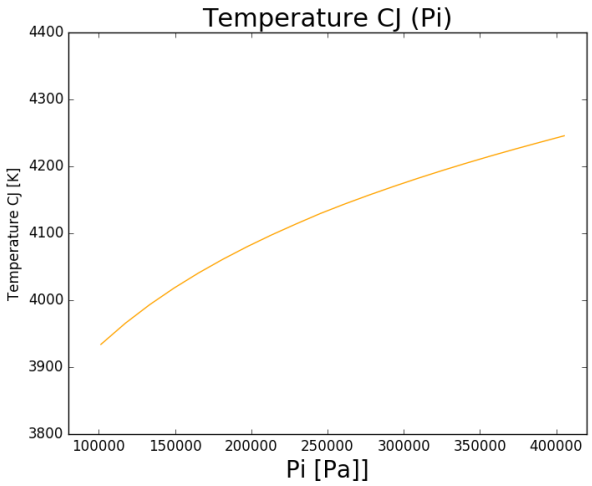

Figure 8: CJ temperature in the function of initial pressure

The CJ temperature is slightly increased by the higher initial pressure

3.3 Constant parameters: T = 300 K, P = 101325 Pa and different equivalence ratio:

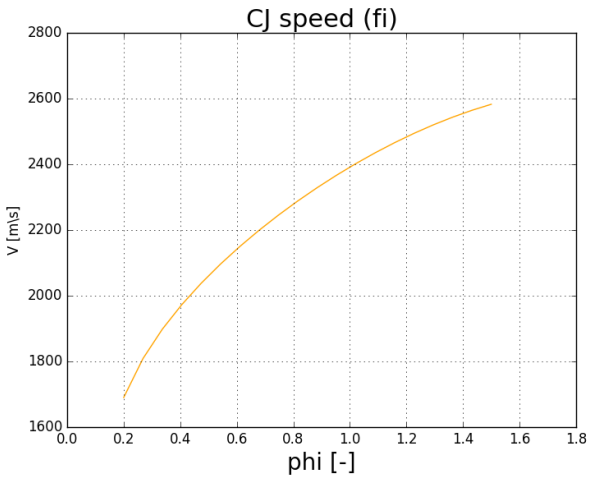

Figure 9: CJ speed in the function of equivalence ratio

The CJ speed is higher for increasing equivalence ratio

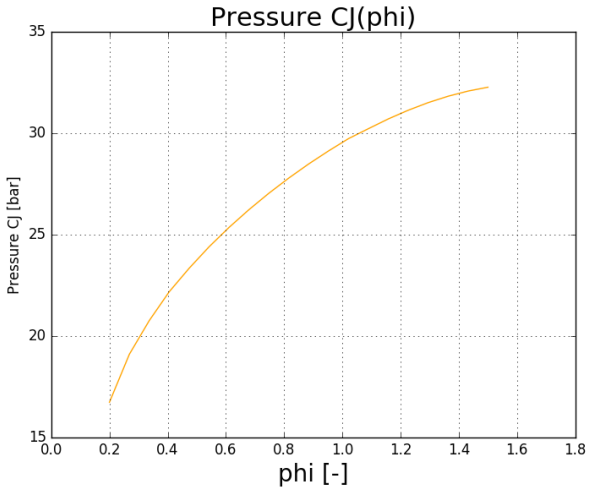

Figure 10: CJ pressure in the function of equivalence ratio

From the range of 0.2 to 1.5 of equivalence ratio, the CJ pressure grows almost twice

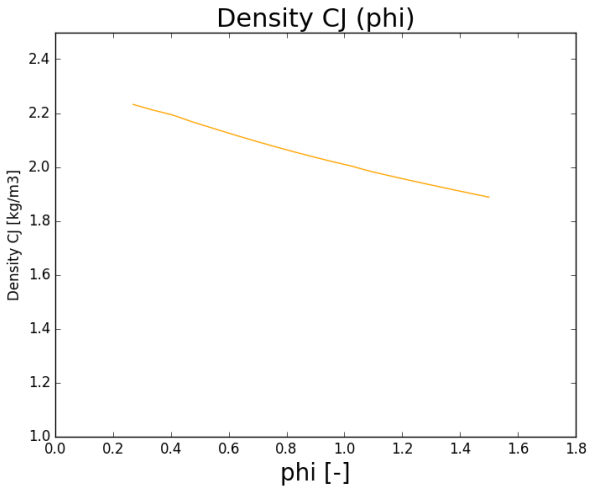

Figure 11: CJ density in the function of equivalence ratio

Quite the contrary in the case of density. It is being decreased while the equivalence ratio is growing

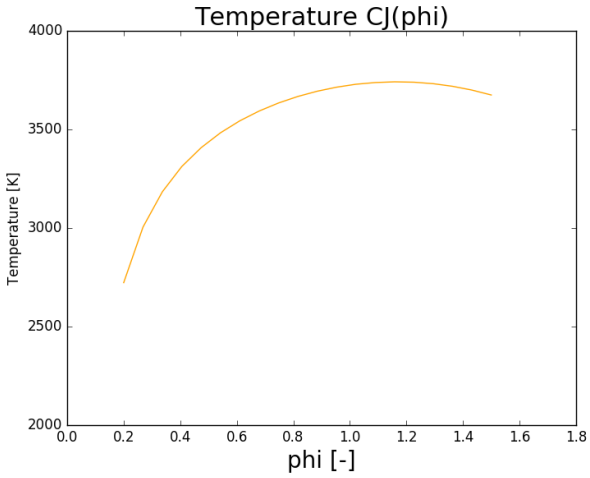

Figure 12: CJ temperature in the function of equivalence ratio

CJ temperature is growing as the equivalence ratio grows to the value of 1.1. Then it starts to decrease

4 Summary

Data shown on the plots is just the approximation of the real state. The mixture of ethylene and oxygen reacts in a predictable and physical way. Mistakes in calculation may be decent because of the high magnitudes of parameters.

5 References

"Wybrane zagadnienia w spalaniu", M.Gieras, Warszawa 2011 [1]
CANTERA_HandsOn.pdf [2]