COMPUTIONAL METHODS IN COMBUSTION

Zeldovich-von Neumann-Doring model of detonation for calculating induction time

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1 Introduction

The purpose of the project was to evaluate the proportional constant in relation between induction time and detonation cell size. Usually in approximated solutions induction time is considered to be zero. In fact it is rather very small. Experiments proved detonation cell size to be proportional to induction time.

2 Mathematical model

The ZND detonation model is a one-dimensional model for the process of detonation of an explosive. It was proposed during World War II independently by Y. B. Zel'dovich, John von Neumann and Werner Doring,[3] hence the name. ZND code has been downloaded from Caltech website. The program calculating simple detonation, has been published for the first time in 1944.
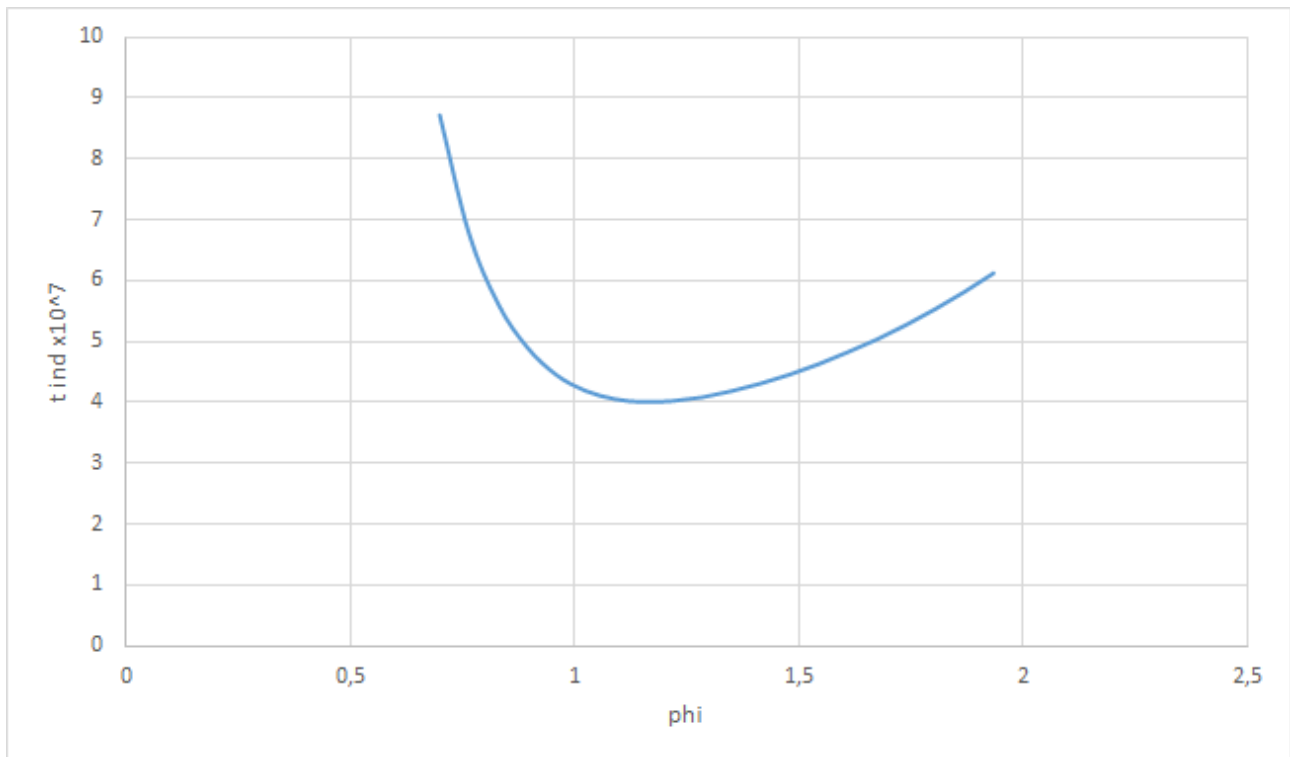
3 Results

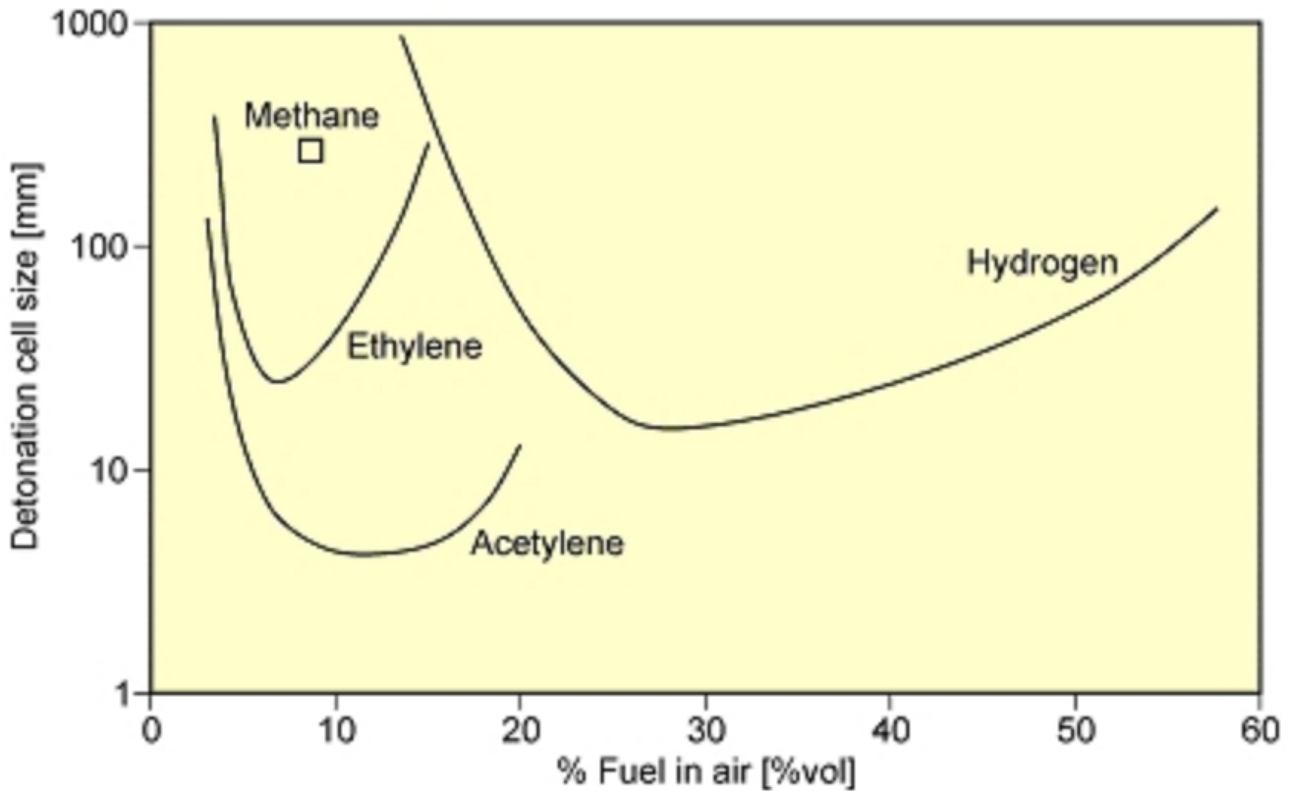Figure 1: Calculated ZND detonation

Figure 2: Experiments data

These two charts have similar properties. There is a relation which will be calculated below:

$$a = \frac{t_{ind}}{\lambda} = \frac{4,0077 * 10^{-7}}{0,0121} = 3,312 * 10^{-5}$$

4 Summary

Induction time proved to indeed be a very small value, counted in microseconds. Calculations in SDToolbox produced related to experiments results. Induction time happened to be measured in $10^{-7}sec$. Detonation of hydrogen with oxygen is extremely fast, this is why this mixture is called Knallgas (Scandinavian and German Knallgas: "bang-gas").

5 References

1. ZND program
   http://shepherd.caltech.edu/EDL/public/cantera/html/SD_Toolbox/ZND

2. Chemical Properties of Hydrogen
   http://www.hysafe.net/wiki/uploads/BRHS/Ch_1_3_Fig_1_3.jpg

3. SDToolbox
   http://shepherd.caltech.edu/EDL/public/cantera/html/SDToolbox/#ZND