

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

From [2]: 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,[1] John von Neumann,[2] and Werner Dring,[3] hence the name.

ZND python code was acquired from [3]

3 Results

From figure 1 can be seen that induction time for hydrogen calculated using SDToolbox is around 0.4 micro seconds. Comparing it to figure 2 can be seen a very similar graph shape.

Taking above into consideration, we can write:

$$t_{ind} = a\lambda$$
$$a = \frac{t_{ind}}{\lambda} = 3.42538 * 10^{-5}$$

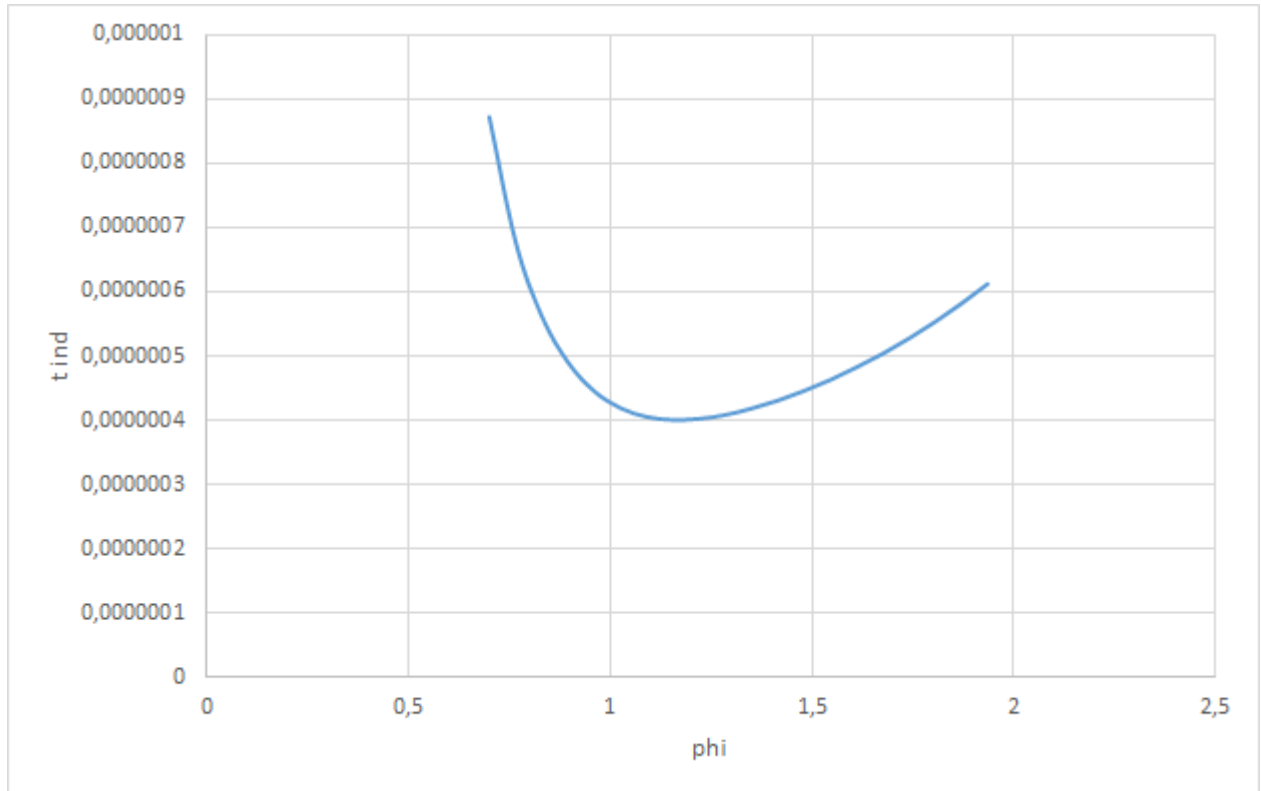


Figure 1: Calculated induction time using SDToolbox

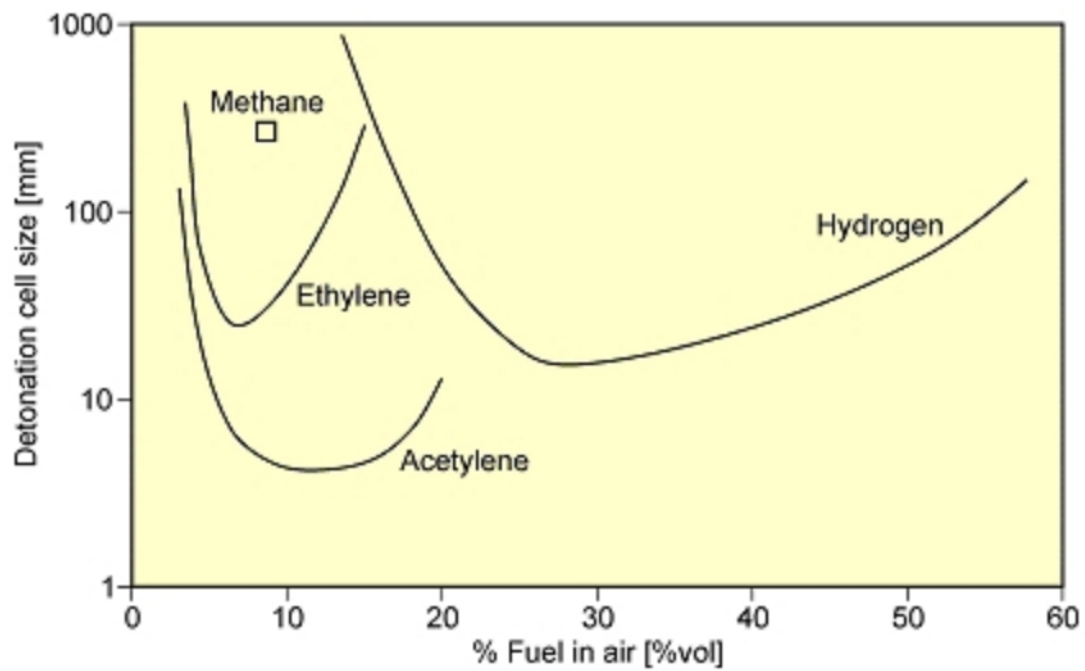


Figure 2: Experimental values of detonation cell size (from [1])

4 Summary

Induction time proved to indeed be a very small value, counted in microseconds. Calculations using ZND.exe in SDToolbox happened to produce very similar graph shape as experiments which made calculating proportional constant straightforward.

References

- [1] Chemical Properties of Hydrogen
<http://www.hysafe.net/wiki/BRHS/ChemicalPropertiesOfHydrogen>
- [2] ZND detonation model, Wikipedia
https://en.wikipedia.org/wiki/ZND_detonation_model
- [3] SDToolbox
http://shepherd.caltech.edu/EDL/public/cantera/html/SD_Toolbox/#ZND