Ignition Delay Time Calculations

Cloud Computing

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1 Task explanation

Goal of this task was to calculate any project written in programming language using cloud machine. For purposes of the project the code was written in **Python** language. Virtual machine was set up in **Microsoft Azure**. Code was sent to Azure using **Putty** and **PowerShell**.

1.1 Microsoft Azure

Azure is a website supported by Microsoft, which enables to set up virtual machines. Virtual machines are used to perform calculations on *computer farms*, which contain powerful calculating units. While setting up the machine, user may define how big and how many processors or what amount of RAM memory is needed. Of course, the better calculating unit, the higher costs. However, performed project is basic and it does not require powerful resources to be calculated. That is why most of the parameters of machine were set to cheapest options.

1.2 PowerShell

PowerShell is an open-source program, which is used in this subject to transfer files from local disc to server of virtual machine.

1.3 Putty

Putty is another free open-source, which enable to manage virtual machine. In this task it is used to initiate calculations. Putty enables user to use **Ubuntu**, which is **Linux** software, without need to install Linux on user's computer. Ubuntu is used, because it is well known and universal software and because of it's simplicity it is also one of the cheapest options to manage virtual machine.

2 Explanation of calculations

Codes used in this exercise calculate **Ignition Delay Time**. It gives information about the time which is needed to self-ignition occurrence after inserting fuel into the engine. It is dependent on:

- Cetane number - indicator of the combustion speed of diesel fuel and compression needed for ignition,
- Pressure and temperature in the engine at time of fuel insert,
- Setup of fuel,
- Rotation of air in the engine,
- Equivalence ratio - air to fuel ratio to the stoichiometric combustion.

Project contains of four codes, which calculate Ignition Delay Time for ethane-air mixture in function of pressure (temperature is constant) or in function of temperature (pressure is constant). Both cases were calculated for two types of initial conditions - constant pressure was set to 1 bar or 2,5 bar and temperature was set to 1900 K or 2500 K. All cases were calculated for different equivalence ratios.

3 Working with virtual machine

In order to perform calculations, following steps were made:

1) Virtual machine was set up in Azure, according to instructions from classes and manual provided.

2) PuTTYgen was used to generate SSH private key. Then, the key was used to connect with virtual machine via Ubuntu implemented in PuTTY.

3) In putty all packages, necessary to use codes, were installed (Cantera and Matplotlib),

4) Powershell was used to determine working folder on computer (fig. 1).

```
PS C:\Users\Kacper> set-location C:/
PS C:\> cd studia
PS C:\studia> cd '.\9 semestr\'
PS C:\studia\9 semestr> cd '.\Obliczenia Inżynierskie w Chmurze\'
PS C:\studia\9 semestr\Obliczenia Inżynierskie w Chmurze> cd .\projekt\
PS C:\studia\9 semestr\Obliczenia Inżynierskie w Chmurze\projekt>
```

Figure 1: Working folder in computer

5) Uploading codes to virtual machine (fig. 2),

```
PS C:\studia\9 semestr\Obliczenia Inżynierskie w Chmurze\projekt> scp mamaakin@13.73.179.196:/home/mama
akin/*.png .
mamaakin@13.73.179.196's password:
etan-temp.png                                 100%  717KB   2.2MB/s   00:00
etan-tempP.png                                100%  681KB   4.4MB/s   00:00
etan_pressure.png                             100%  570KB   4.4MB/s   00:00
etan_pressureT.png                            100%  549KB   5.7MB/s   00:00
```

Figure 2: Files uploaded to virtual machine

6) Checking files in putty using *ls* command (fig. 3).

```
mamaakin@Web:~$ ls
'constant pressure, ethane P.py'  'constant pressure, ethane.py'  'constant temp, ethane T.py'  'constant temp, ethane.py'
```

Figure 3: Files in virtual machine

7) Running all projects using 'python3 *filename.py*',

8) Downloading all png files from cloud in PowerShell (fig. 4)

```
PS C:\studia\9 semestr\Obliczenia Inżynierskie w Chmurze\projekt> scp mamaakin@13.73.179.196:/home/mama
akin/*.png .
mamaakin@13.73.179.196's password:
etan-temp.png                                 100%  717KB   2.2MB/s   00:00
etan-tempP.png                                100%  681KB   4.4MB/s   00:00
etan_pressure.png                             100%  570KB   4.4MB/s   00:00
etan_pressureT.png                            100%  549KB   5.7MB/s   00:00
```

Figure 4: Files uploaded to virtual machine

4 Results presentation

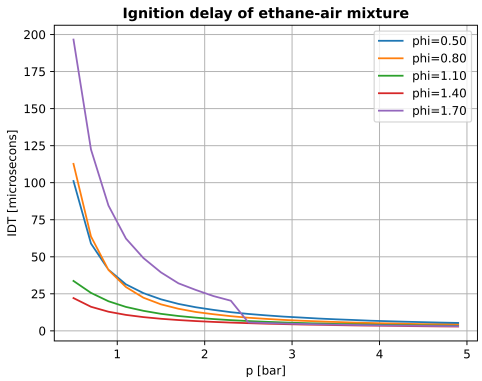

Figure 5: T = 1900K

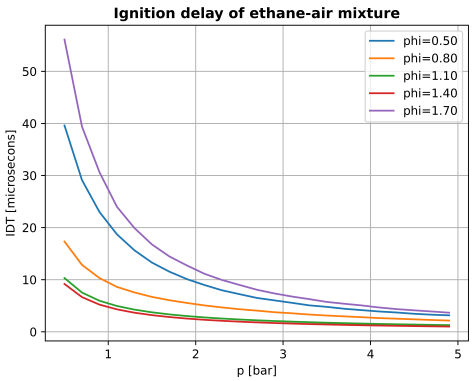

Figure 6: T = 2500K

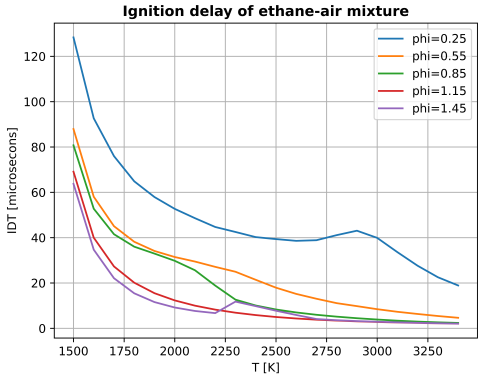

Figure 7: p = 1bar

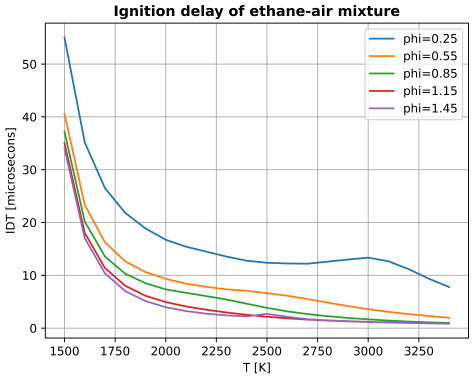

Figure 8: p = 2.5 bar

Figures 6 - 8 present results obtained due to performed calculations. As expected, increase in pressure and temperature decreases Ignition Delay. Increasing those parameters result in higher rate of diffusion, which lead to better combusting properties. Also, one may notice, that increase in equivalence ratio results in even further decrease of ignition delay. Exception are figures 6 and 5, where for the highest ϕ ignition delay is higher than for lower ϕ. Possibly, critical value of equivalence ratio is exceeded and further increasing ot would give even worse results. On figures 7 and 8 for higher temperatures one may also notice local increase in ignition delay. All those considerations lead to conclusion, that ignition delay time is highly dependent on the initial conditions and equivalence ratio. Optimizing delay time is very complex task and demands great experience. However, results of optimalization may be very beneficial, as it increases efficiency of an engine and reduce noise or thermal stress.

5 Conclusions

Creating this project allowed to familiarize with cloud calculations, which is a very efficient way to process great amount of data. Although calculation made within this project are very simple, for more complicated programs, procedures are very similar. However, more complicated programs demands using more efficient computing units, which is more expensive. Although there are ways to perform enormous calculations for relatively low price everything leads to compromise between speed of calculations and their costs.

6 Bibliography

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