Simulation of Hydrogen Combustion Chamber

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1. Introduction

The aim of this project was to perform numerical simulation of a process of combustion taking place in theoretical 2D rectangular combustion chamber using Hydrogen as fuel. OpenFOAM software was used for calculations and ParaView for visualisation of the results.

2. Simulation

The simulation was performed in the finite volume rectangular combustion chamber modelled as a plane. Whole process' duration was set at 0.005 s with 0.0001 s step.
The process initialises from the bottom left corner of the chamber.
Boundary and initial conditions, solver methods and thermophysical properties are attached in the repository.

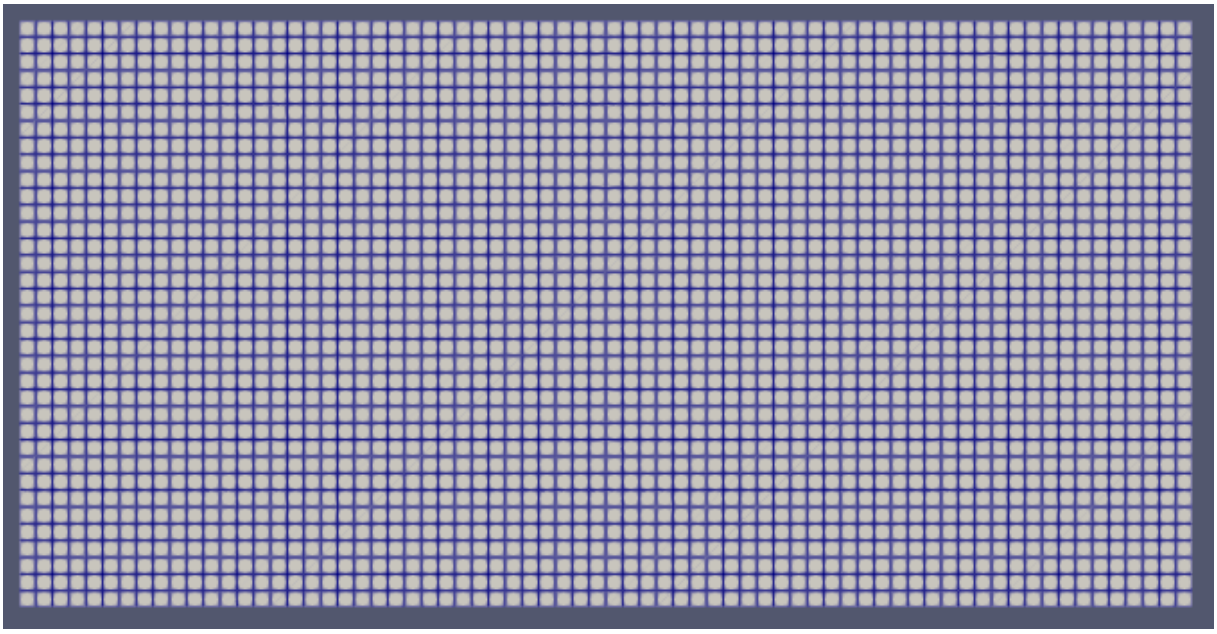

Figure 1. Mesh used in simulation.

In this paragraph results of such variables will be presented:

- Temperature
- Pressure
- Velocity Magnitude
- Density.

2.1. Temperature

Figure 2.1.1. Temperature, t = 0.0001 s.

Figure 2.1.2. Temperature, t = 0.001 s.

Figure 2.1.3. Temperature, t = 0.0015 s.

Figure 2.1.4. Temperature, t = 0.002 s.

2.2. Pressure

Figure 2.2.1. Pressure, t = 0.0001 s.

Figure 2.2.2. Pressure, t = 0.001 s.

Figure 2.2.3. Pressure, t = 0.0015 s.

Figure 2.2.4. Pressure, t = 0.002 s.

2.3. Velocity Magnitude

Figure 2.3.1. Velocity magnitude, t = 0.0001 s.

Figure 2.3.2. Velocity magnitude, t = 0.0005 s.

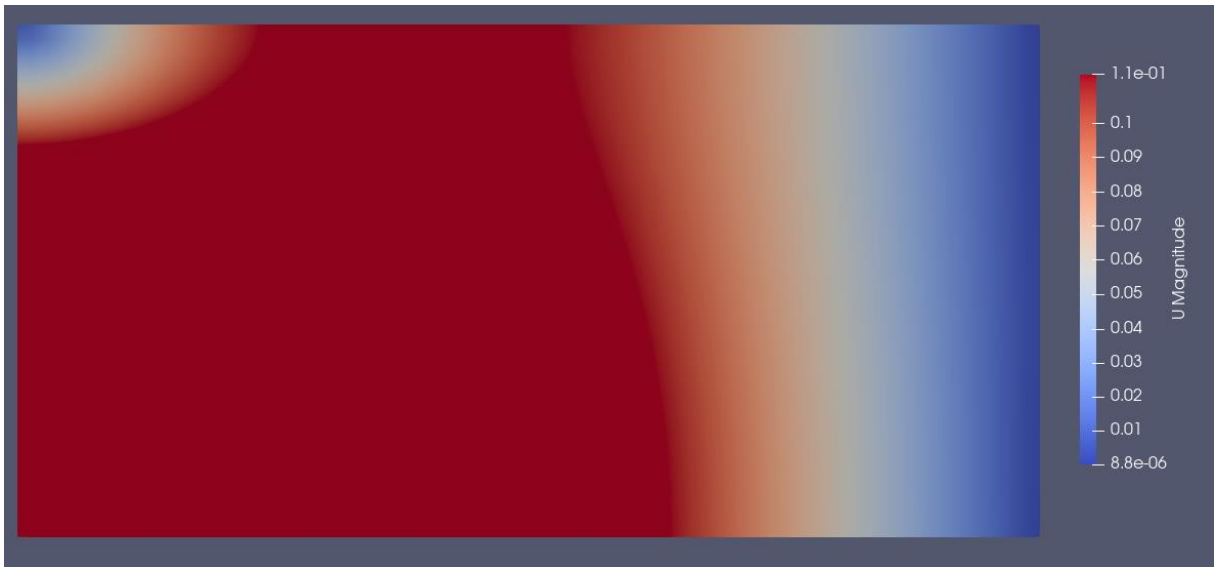

Figure 2.3.3. Velocity magnitude, t = 0.001 s.

Figure 2.3.4. Velocity magnitude, t = 0.0015 s.

Figure 2.3.5. Velocity magnitude, t = 0.002 s.

Figure 2.3.6. Velocity magnitude, t = 0.0025 s.

2.4. Density

Figure 2.4.1. Density, t = 0.0001 s.

Figure 2.4.2. Density, t = 0.001 s.

Figure 2.4.3. Density, t = 0.002 s.

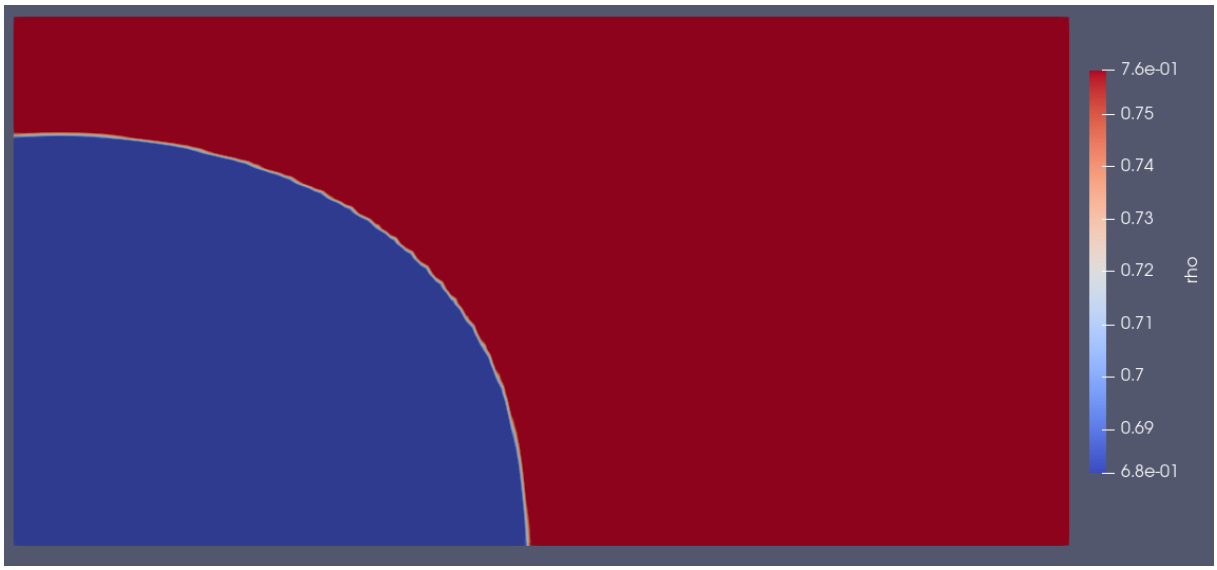

Figure 2.4.4. Density, t = 0.003 s.

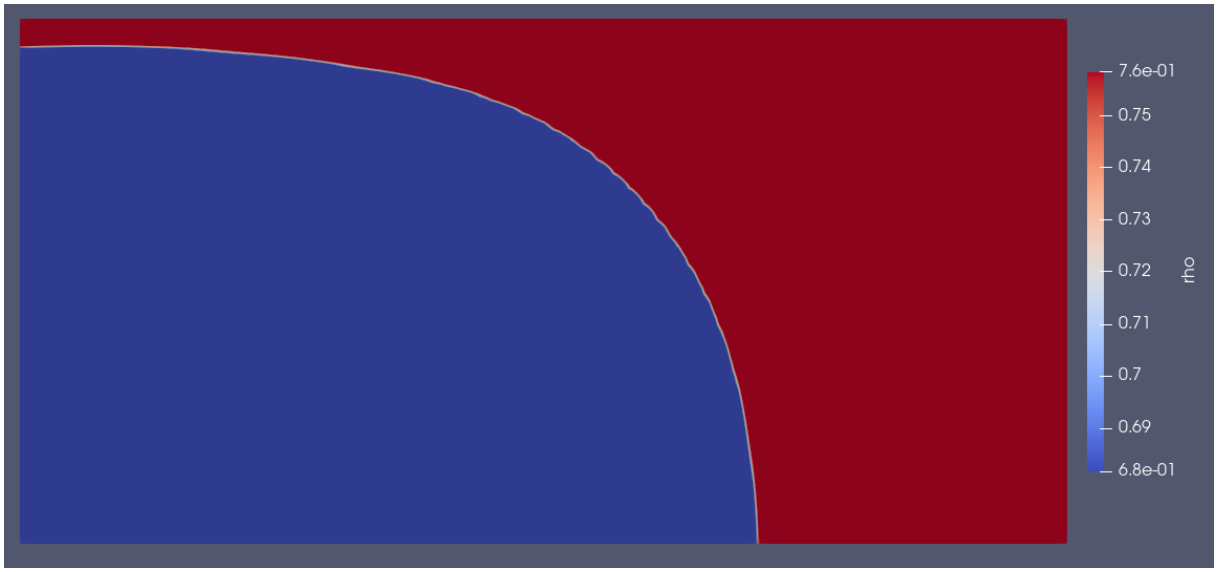

Figure 2.4.5. Density, t = 0.004 s.

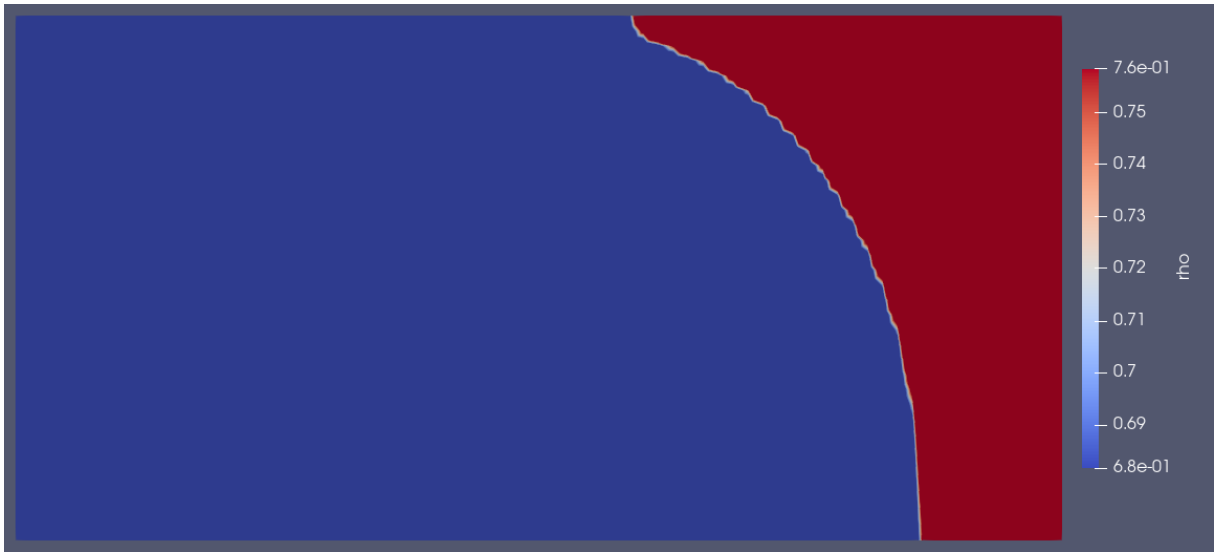

Figure 2.4.6. Density, t = 0.005 s.

1. Conclusions

Taking into consideration changes of variables shown in previous paragraph, such conclusions can be made:

- Temperature and pressure reach their extremum values at the shortest time (0.002 s)
- Temperature and velocity in chamber increase from the ignition point through the entire volume, while pressure increases uniformly in entire chamber
- Density change rate is the lowest of all discussed variables, as in 0.005 s temperature, pressure and velocity have stabalized, the density has not
- There is a visible border between the lowest and the highest value of density as the process proceeds so discontinuity appears