Investigation to set type of Pre-chamber fuel system in heavy gas engine HIMSEN 35/40

Mohammad Hassan Shojaeefard [a*], Arash Sadri Qahfarrokhi[b]

[a] Professor, Iran University of Science & Technology/ school of Automotive Engineering
[b] Master, Iran University of Science & Technology/ school of Automotive Engineering

ABSTRACT

Following concerns about air pollution and global warming in recent years, the use of heavy duty gas engines in major industries such as the marine industry, power plants, etc. has become more and more of a focus on heavy duty diesel engines designed for Similar applications were used and made by modifying their structure or adding new parts or a combination of the two approaches, because of the fact that heavy duty gas engines are more similar to diesel engines with similar emissions. They have less but on the other hand the productive power They are also lower, with various technologies being added to address this disadvantage and increase the power of the gas engine. One of these new technologies is the pre-combustion chamber, which results in increased power output. The pre-chambers are categorized into two types of refueling in terms of how the refueling is shared with the main chamber and refueling independent of the main chamber. The pre-combustion chamber should be used to increase the efficiency of the pre-chamber and overall engine efficiency, which is suggested after considering the use of the pre-combustion chamber with a stand-alone fuel system.

KEYWORDS

Heavy gas engine, Pre combustion chamber, Main combustion chamber. Nozzle. Fuel system

* Corresponding Author: Email: mhshf @ iust.ac.ir

1. Introduction

Heavy gas engines are often developed by diesel engines, which include changing different parts of diesel engines or adding new parts to them or a combination of the two, resulting in a new engine that fits the gas. One of the most effective technologies used in this field is pre-chamber technology, which leads to a significant improvement in the combustion process. There have been many studies on preoperative performance, which will be discussed below.

Toulson et al. [1] studied SI ignition and ignition systems with PCI pre-ignition on natural gas and propane fuels. Shah et al. In 2015 [2] Using simulation of prefabricated jet mixing features in a heavy-duty gas engine using CFD computational fluid dynamics method to investigate the effects of pre-chamber and nozzle dimensions on ignition caused by turbulent jet in the two-ratio format. In 2015, Gentz et al. [3] used combustion imaging and modeling of CFD computational fluid dynamics to examine the performance of a pre-chamber ignition system by the TJI turbulent jet in a high-density motor for different nozzle diameters. In 2015, Khan et al. [4], using a three-dimensional computational modeling, examined the ignition jet in a methane-hydrogen-air-mixed mixture in a fixed volume combustion chamber In 2016, Thelen et al. [5] conducted a computational analysis of the effect of nozzle size on the performance of the TJI turbulent jet ignition system. The turbulent jet ignition system is provided on a high-density machine. In 2018, Alvarez et al. [6] conducted a comprehensive study by reviewing pre-chamber ignition systems as poor combustion technologies in ignition spark motors. In 2018, Qin et al. [7] examined the pre-mixed combustion of methane-air mixture in the prefabricated system and main chamber using precise numerical simulation, which is suitable for use in internal combustion engines.

2. Methodology

In this article, by selecting the HIMSEN 35/40 gas engine made by Hyundai Korea with a cylinder diameter of 350 mm and a course length of 400 mm, this issue is examined. What should the pre-chamber fuel system look like, shared with the main or separate chamber refueling system? Dimensions and dimensions of the HIMSEN 35/40 engine are available from Hyundai's website [8]. This study is performed by numerical solution of CFD computational fluid dynamics with the help of simulation in CONVERGE business software. The computational network shown in "Figure 1"

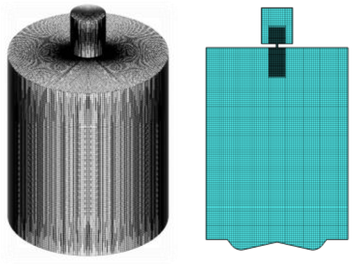
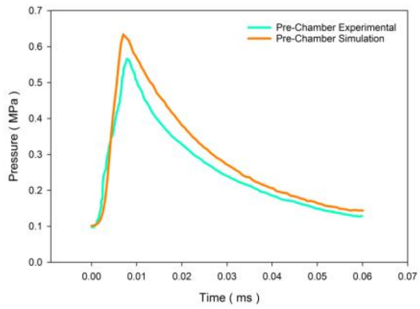


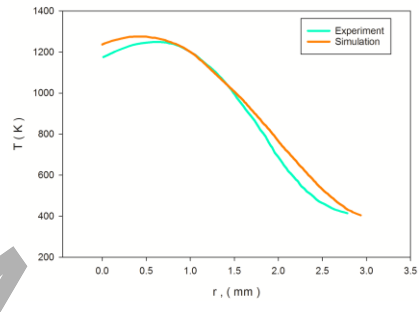
Figure 1, 3D and 2D view of the solution domain and its networking

3. Result and discussion

The pressure trace from the experiment and the results obtained from the simulation for pre-chamber based on time for pre-chamber mode with a cylindrical nozzle ("straight") are shown in "Figure 2".



(a)



(b)

Figure 2, Comparison (a) of pre-chamber pressure trace and (b) cylinder temperature along radial distance from the cylinder axis, for experimental results and simulation results in CONVERGE software

In this paper, the results are validated in the Converse software on a fixed volume combustion chamber, while the engine is intended for the analysis of a larger gas engine with larger dimensions. The first stage is the independence of the network in the simulation of the fixed volume combustion chamber "Figure 3 a", and the second stage is the independence of the network in the simulation of a heavy gas engine "Figure 3 b" ("40/35HIMSEN gas engine").

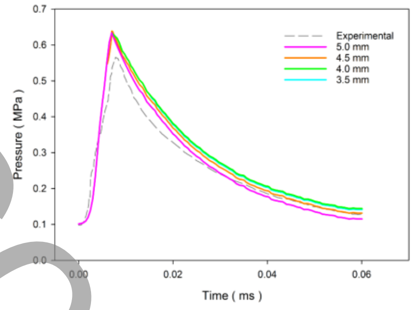


Figure 3, Pre-chamber pressure trace for mesh sizes 5.0, 4.5, 4.0 and 3.5 mm in constant volume combustion chamber

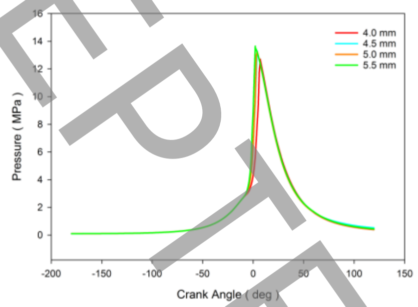


Figure 4, Main chamber pressure trace for mesh sizes 5.5, 5.0, 4.5 and 4.5 mm in HIMSEN 35/40 engine chamber

As shown in "Figure 5", the pressure inside the main chamber increases during the time, while the increase in pressure inside the pre-chamber is very small so that it can be ignored. This means that the pressure inside the pre-chamber is not affected by the increase in pressure inside the main chamber, because unlike light gas-fired engines [9], the nozzle dimensions are very small compared to the main chamber and pre-chamber, so it can be ignored when the pre-chamber pressure is still low during ignition. There is no mixture of fuel and air into the pre-chamber, so the pre-chamber pressure at the time of ignition will be lower than the desired value, and even after ignition and combustion.

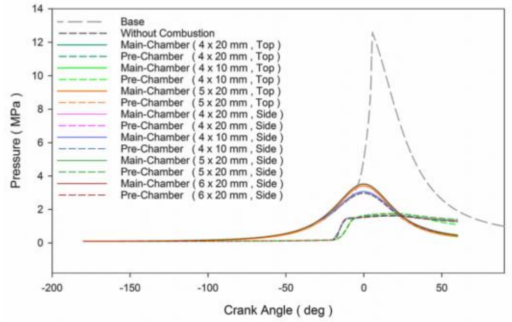


Figure 5, Main chamber pressure trace for common main and pre-chamber fuel system

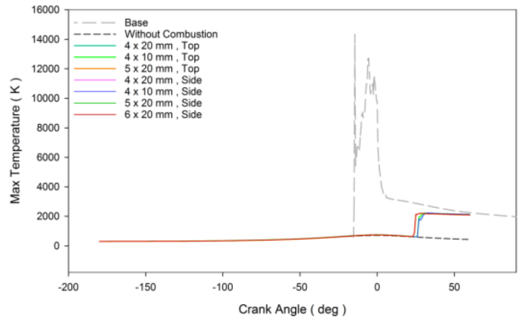


Figure 6, Maximum temperature trace for the common main and pre-chamber fuel system

4. Conclusion

In general, it can be stated that in the HIMSEN 35/40 gas engine, the pre-chamber refueling system must be independent of the main chamber's refueling system, which is true for all large-scale heavy-duty gas engines, based on the reasons stated in result section the flame jet does not flow efficiently from the pre-chamber to the main chamber, so there is no effective combustion inside the main chamber.

5. References

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