Theoretical Investigation on Combustion Chamber Geometry of DI Diesel Engine to Improve the Performance by using Diesel-RK

S. K. Abdul Siddique, K. Vijaya Kumar Reddy

Abstract: Diesel engines are prime sources to generate power in transportation industrial sectors. Limited petroleum reserves and stringent environmental norms are the two parameters to influence the diesel engine usage in this field. In diesel engines, fuel is injected into the combustion chamber and mixed with the compressed air. Proper mixing of fuel and air is important to produce controlled burn rate. Combustion chamber geometry is the key element in air fuel mixing process. In the present research paper, an attempt is made to simulate the critical combustion and put efforts to optimize the combustion chamber geometry. Diesel –RK is one of the computational fluid dynamics software specifically developed for internal combustion engine simulations. In the present study, single cylinder, four stroke direct ignition diesel engine and Diesel-RK software are considered for investigation.

Keywords: DI Diesel engine, combustion chamber, Diesel-RK, Simulation

I. INTRODUCTION

Diesel engine is one of the important selection as prime mover in transportation industrial usage. Four stroke Direct Ignition diesel engine is having higher compression ratios compared to other engines. Fuel is injected into the combustion chamber and mixed with compressed air at the end of compression stroke. The proper mixing of air and fuel plays a major role in performance of the engine. The heterogeneous mixing is resulted in the chamber. The geometry of combustion chamber is the key element in the total engine system to produce standardised burn rate and it leads to increase in the efficiency of the engine. Diesel engine system is having complex features compared to any other power producing systems. Developing of full scale engine for small change every time is costly and time taking. Based on the previous experiences and from literature, the researchers understood to simulate the entire systems before the engine manufacture. Powerful modeling tools made the research in combustion is more costly, diverse and interdisciplinary. The rapid advancement in computer technology has given confidence to use complex simulation techniques to quantify the engine systems. In the present study 5.2kW single cylinder, four stroke direct ignition diesel engine is selected to investigate. This system is having a hemi spherical shaped combustion chamber with single injector having three 0.3mm nozzles. In this research paper, four combustion chamber geometries (1) Toroidal, (2) Shallow Depth, (3) Re-entrant and (4) Double wedge shallow are considered for investigation.

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Computational Fluid Dynamics software Diesel-RK is used to model the combustion phenomenon in compression ignition diesel engine.

II. MODELLING AND SIMULATION

Diesel-RK is a modeling and simulation software specifically developed for Internal Combustion engine simulation. DIESEL-RK software is developed in 1981-82 in the department of Internal Combustion Engines (Piston Engines), Bauman Moscow State Technical University. It is mainly designed for simulating and optimizing the working processes of internal combustion engines with all types of boosting. This software is used for torque curves, engine performance predictions, fuel consumption predictions, emission analysis and optimization of fuel injection profile including multiple injection, sprayer design and location as well as piston bowl shape optimization in models of DI Diesel engines. In the present simulation study, Diesel-RK software is used for calculation of performance and emission values for four piston bowls in which Diesel is used as fuel. The following figures shows piston bowls modelled with Diesel- RK. In the simulation analysis, the input parameters mentioned in the Table No (1) are considered.

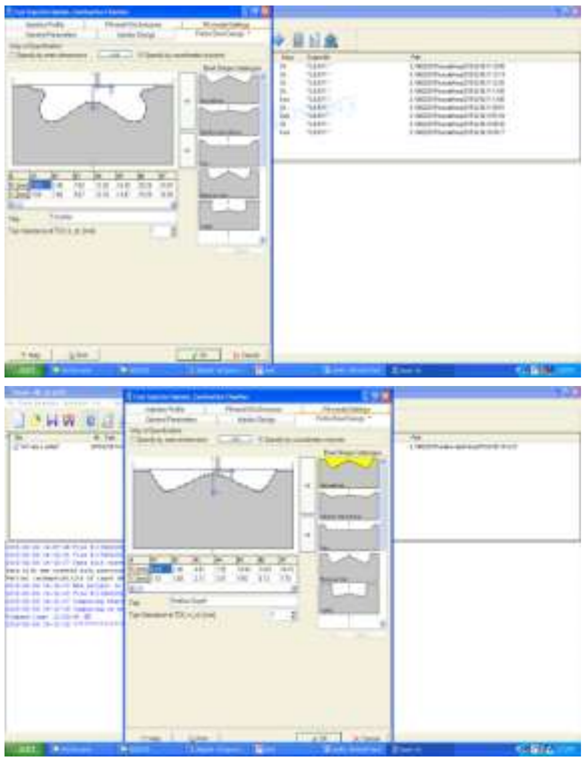


Fig. (1) Modeling of combustion chamber geometries

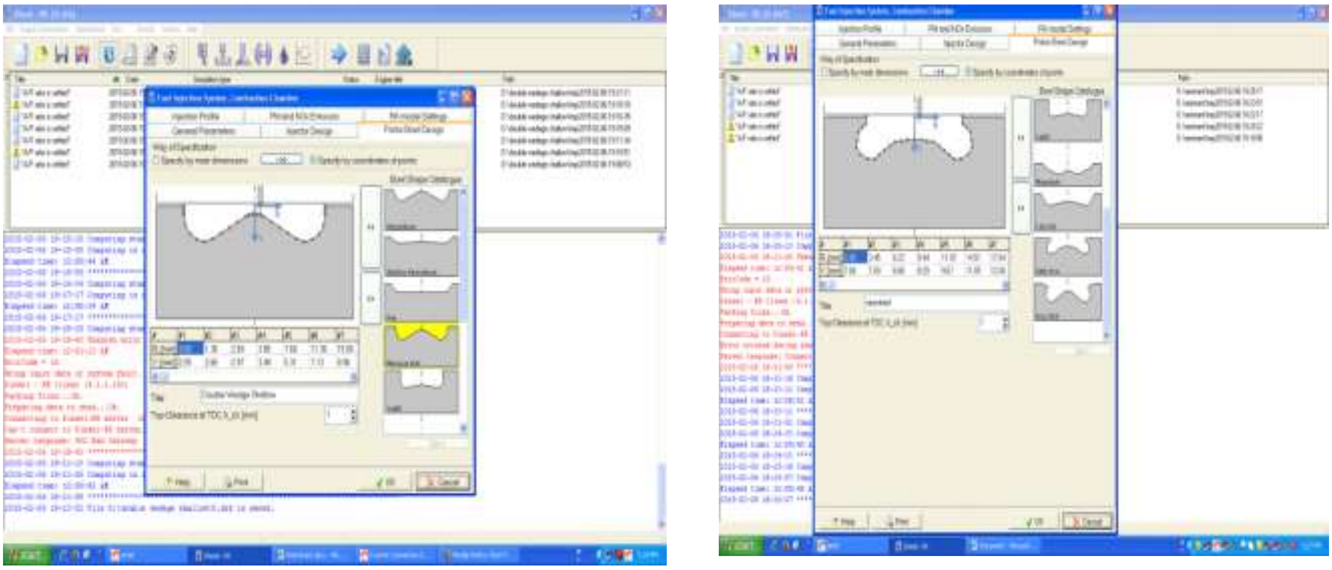


Fig. (3) Simulation results

Table (I): Input Parameters considered for simulation

Engine Specifications	Single cylinder, 4 stroke Diesel, water cooled, power 5.2 kW at 1500 rpm, stroke 110 mm, bore 87.5 mm. 661 cc, CR 17.5
Connecting rod length	234mm
No. of fuel injectors	01
No. of nozzles	03
Injector nozzle bore	0.3 mm
Inlet valves opening	4.50 before TDC
Inlet valve closing	35.50 after BDC
Start of fuel injection	230 before TDC
Exhaust valve opening	35.50 before BDC
Exhaust valve closing	4.50 after TDC
Connecting rod length	234mm

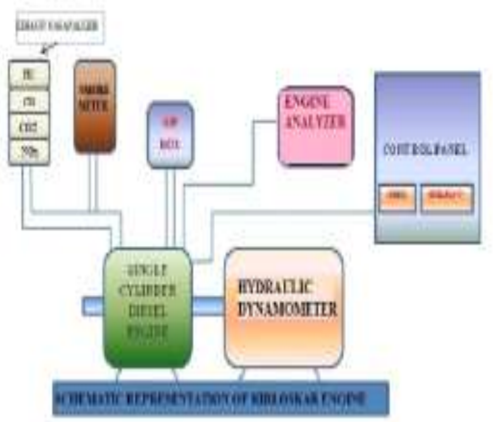


Fig-1.Schematic representation of experimental set up.

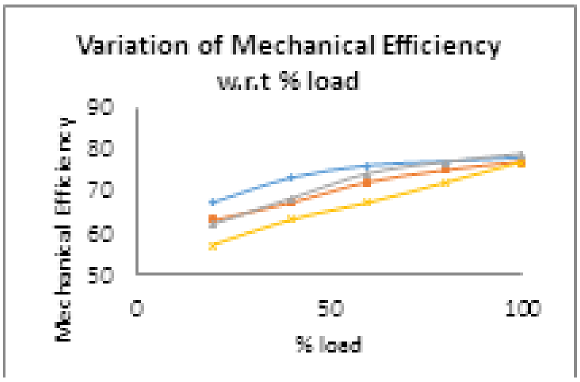
Fig (2) Schematic representation of Diesel engine system

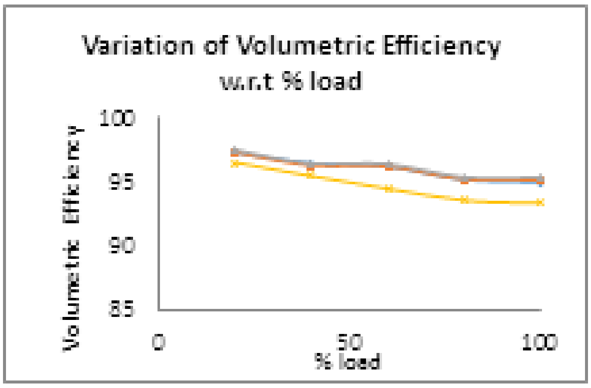
III. CONCLUSIONS

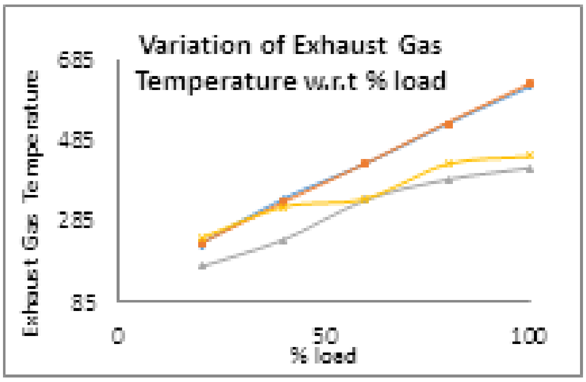
The 5.2kW, Kirlosker make single cylinder, four stroke engine is selected for investigation because it can withstand higher pressures and also is used extensively in agriculture and industrial sectors.The DIESEL-RK has been used to simulate the combustion characterstics of direct injection diesel engine. Four combustion chamber geometries, toroidal, shallow depth, re-entrant and double wedge shallow shapes are selected for simulation. Simulated results including specific fuel consumption, rate of pressure rise, heat release rate, mechanical efficiency, volumetric efficiency and. Performance, emission and combustion characteristics using diesel fuel alone at different loads by using DIESEL -RK. The following graphs shows the results of different efficiencies, exhaust emissions, specific fuel consumptions and cylinder pressures for all combustion chamber geometries.

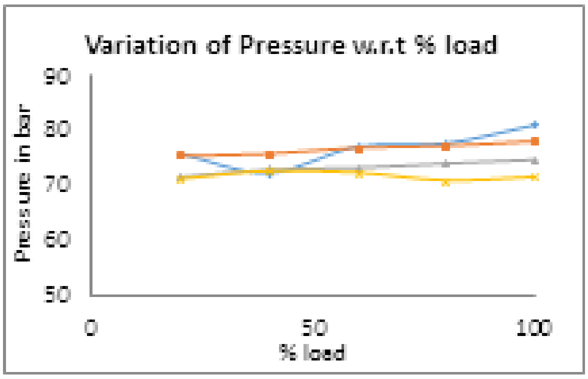
IV. RESULTS

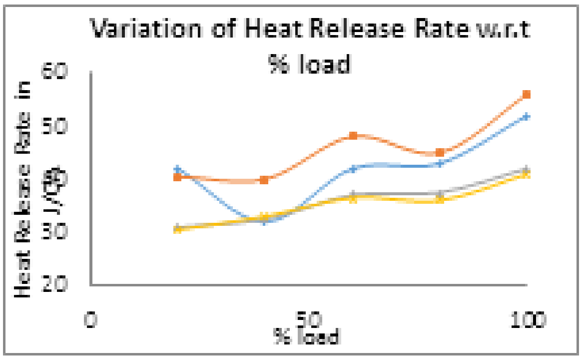
In this investigation, four pistons of different configurations suitable to 5.2kw single cylinder four stroke DI diesel engine are considered. The hemispherical shaped geometry is taken as a base engine combustion chamber geometry. In the present work, simulations are conducted to investigate the exhaust emission have been analysed. The comparison revels that re-entrant combustion chamber geometry is the best among the selected geometry configurations.

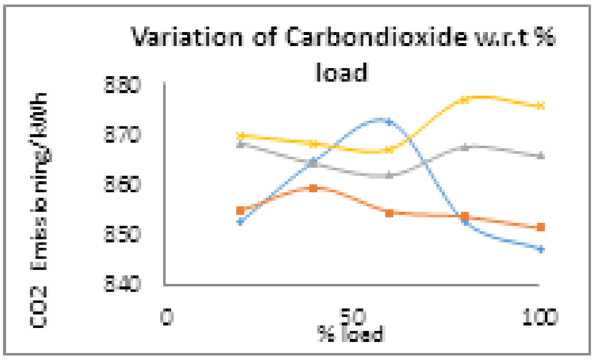












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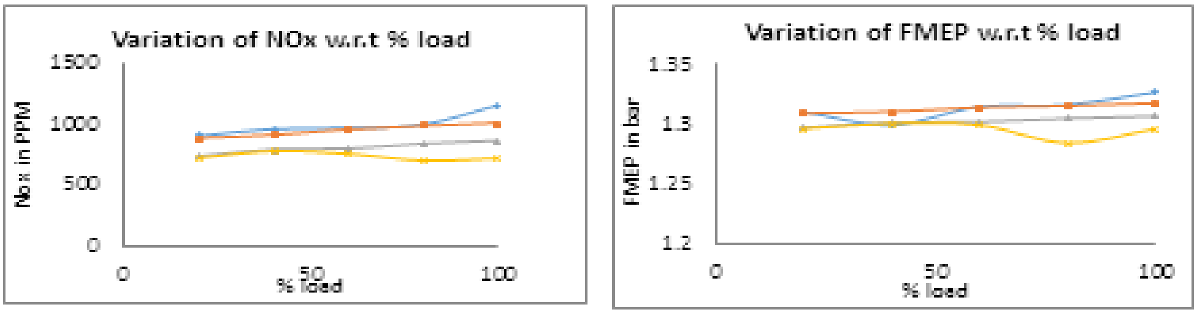

Fig (3) Simulation results

It exhibits lower emissions, lower specific fuel consumption rate, improved performance compared to other shapes. From the results, it is concluded that the numerical simulation is one of the powerful tool for optimisation and to improve performance of internal combustion engine instead of developing a new proto type systems and test and evaluate every time

REFERENCES

1. Umakant V.Kongre, Vivek K.Sunnapwar, 2010, "CFD modelling and Experimental Validation of Combustion in Direct Ignition Engine with Diesel" International journal of applied engineering, Dindigul, Volume 1, No 3, pp 508-517.
2. F.Payri, J.Benajes, X.Margot,A.Gil, "CFD modeling of the in-cylinder flow in direct-injection Diesel engines" computers & Fluids 33 (2004) 995-1021
3. Mohamed F. Al-Dawody, "effect of soybean oil biofuel Blending on the performance And emissions of diesel engine using diesel-rk software" International Journal of Engineering Science and Technology (IJEST), Vol. 3 No. 6 June 2011, pp 4539-4555
4. Alper, B., "Injection angle effect on performance and emission of biodiesel fuelled compression ignition engine", The Journal of Macro Trends in Energy and Sustainability, Vol. 1(1), 2013.
5. Mohd, N.N., "Simulation and environmental assessment of compression ignition engine powered by neat biodiesels of different origin", Indian journal of Science and Technology, Vol.5(7), 2012.
6. Hamdan, M.A., Khalil, R.H., "simulation of compression engine powered by biofuel", Energy conversion and management, Vol.51, pp.1714-18, 2010.
7. Mohd, N.N., Yarasu. R.B., Yamin, J., "simulation of CI Engine powered by vegetable oil under variable fuel inlet temperature", Indian journal of science and technology, Vol.3(4), pp.387-92, 2010.
8. Sheet, E.A Eh, Yamin, J., "Improvement of an SI engine performance using modified Al-Doura pool gasoline formulae: Simulation Study", Arab J Sci. Eng., Vol.38, pp-2855-64, 2013.

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