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Experimental Study on Performance of Disc Type Cam Operated Fuel Injector Nozzle to Improve the Ignition Characteristics and Combustion of Fuel

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Abstract - To design a disc type cam operated injector nozzle to improve the ignition characteristic of fuel. This project include the injector nozzle disc with holes for spray and cam mechanism for needle operation. Nozzle needle will be operated by camshaft instead of fuel pressure as operated in conventional fuel injection system. Disc will be placed at the tip instead of multi hole. Disc consist number of holes in specific pattern. Disc will be rotated to obtain the swirl flow & fuel will be injected in such a way that it will be completely mixed with the air to form a uniform mixture. By this swirl flow and wide spray injection the fuel will be properly mixes with air and desired output can be obtained. By this project it is assumed that ignition characteristics will be improved increase in efficiency increase in power and reduction in pollution.

Key Words **Diesel-Engine, Injector, Nozzle, Spray**

1. INTRODUCTION

As we All know that world is suffering from air pollution. The air pollution is created major by industries & automobiles vehicles especially by Diesel engine. Several research are done to control air pollution and going on till today various system have been developed, designed & employed to control the automobile air pollution in this project one of the new & innovative design of injector is developed to improve in this project new design of injector is developed in this type the injector nozzle is of disc type operated by direct cam mechanism holes are made on disc to spray & inject in wide area disc will rotate at the time of injection to produce the swirl mixture fuel will be injected in such a way that it spreds in whole combustion chamber it is assumed that it spray far better than single hole & multi hole nozzle.

2. Objective & Methodology

- Reduce automobile pollution
- Improve the ignition characteristic by injecting the diesel in atomized form by swirl & wide spray
- By this new design of injector it is assumed that knocking tendency can be reduced in diesel engine
- Flame propogation effect can be improved
- Ignition delay can be reduced in diesel engine
- Overheating can be reduced in diesel engine

2.1 Injector Design

It has been known that spray atomization and targeting have a great impact on engine performance and exhaust hydrocarbon emissions. For port fuel injection engines, mixture formation process starts with the injection of liquid fuel into the intake ports". The spray introduced can be defined by its mean droplet sizes, initial velocity, spray pattern, and targeting. The fuel droplets interact with the air inside the intake manifolds, as well as intake port walls and intake valves, creating fuel vapor and wall films. "Many spray parameters including fuel metering, atomization characteristics, targeting, and pulse-to-pulse variability have a direct impact on engine performance". A better understanding of spray characteristics of port injector is very important in matching spray parameters with different engine operations. As a result, there is an explosive increase of research publications in port injector sprays

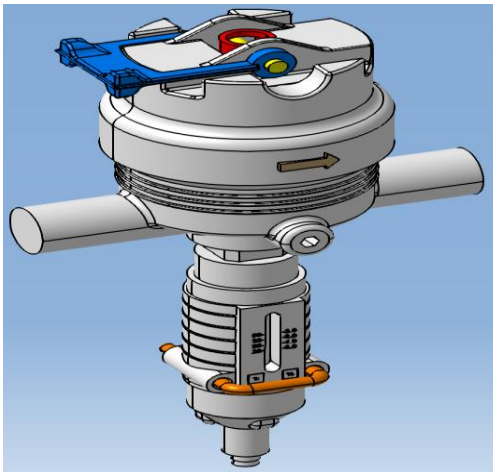

Figure 1 Injector Design

2.2 Description.

The injector injects the pressurized fuel in the rail into the engine combustion chamber at the optimal injection timing, Injection quantity, injection rate, and injection pattern, in accordance with signals from the ECU.
 Injection is controlled using a TWV (Two-Way Valve) and orifice. The TWV controls the pressure in the control

chamber to control the start and end of injection. The orifice controls the injection rate by restraining the speed at which the nozzle
Opens.

- The command piston opens and closes the valve by transmitting the control chamber pressure to the nozzle needle.
- When the nozzle needle valve is open, the nozzle atomizes the fuel and injects it.
- There are three types of injectors: the X1, X2, and G2.

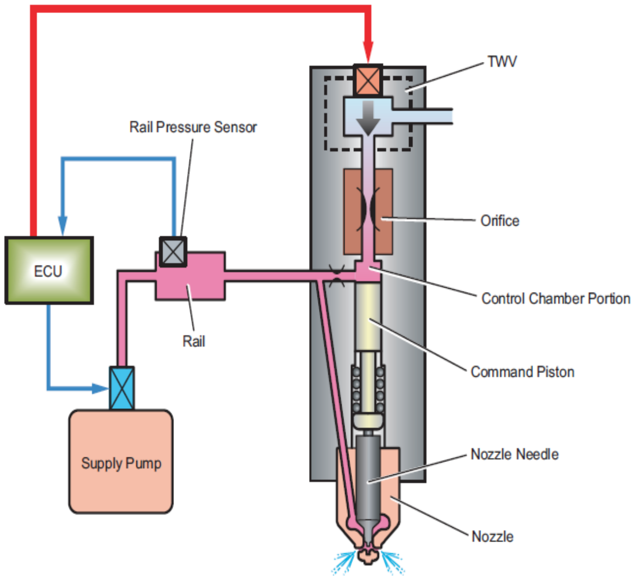

Figure 2 Details Diagram

2.3 TYPES OF SPRAY INJECTOR NOZZLE

There are four basic types of nozzle in common use. These include

- Single hole nozzle
- Multi hole nozzle
- Pintle hole nozzle
- Pintaux nozzle

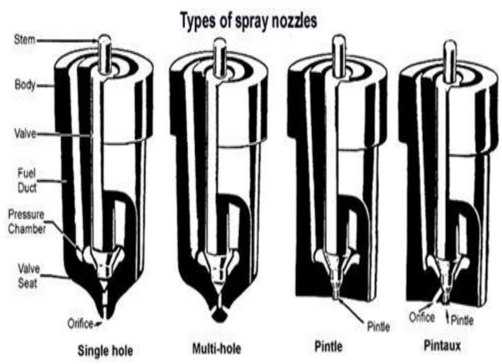

Figure 3 Injector Nozzle Types

2.4 Injector Spray Test

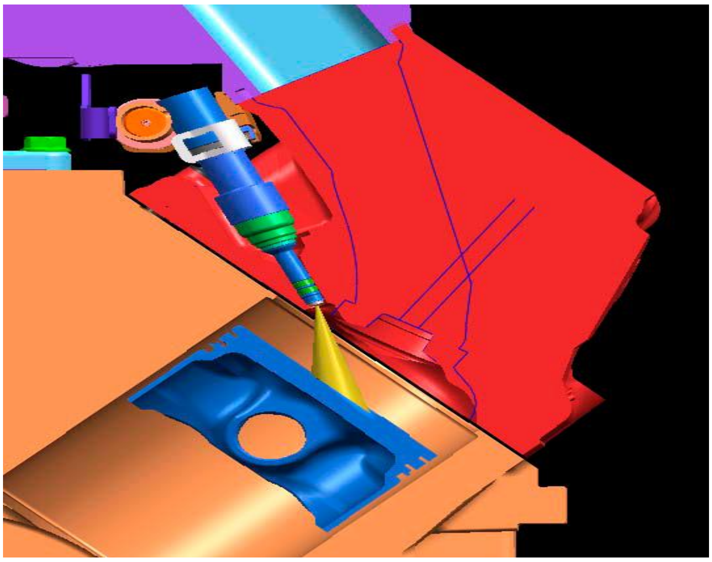

Figure 4 Injector Spray Test

2.5 Injector Data

Table 1 Technical Specification

Multi hole injector	
Operating Pressure	380 Kpa
Weight	200gm
Overall Length	80mm
Fuel input	Top-feed injector
Operating Temp.	-40 to 110°C
Permissible Fuel temp.	≤ 70°C
Flow rate at 3 bar	146 to 1,462 cm^3/min 116 to 1,000 g/min
Spray angle	15 to 85°
Bent angle	0 to 15°
Spray type	Conical

3. Injector Performance.

3.1 CNC MACHINE

"Computer Numerical Control (CNC) is one in which the functions and motions of a machine tool are controlled by means of a prepared program containing coded alphanumeric data.CNC can control the motions of the workpiece or tool, the input parameters such as feed,depth of cut, speed, and the functions such as turning spindle on/off, turning coolant on/off".

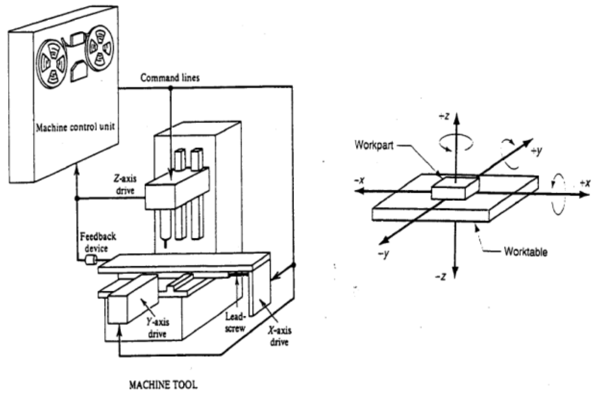

Figure 5 CNCMachine Diagram

Figure 6 CNCMachine Setup

3.2 Disc Injector

Figure 7 Disc Injector

3.3 Comparison of multi hole injector with Disc type injector

Table 2 Comparison

Data	Multi hole	Disc Type
Operating Pressure	380 Kpa	400Kpa
Weight	200gm	280gm
Overall Length	80mm	105mm
Fuel input	Top-feed injector	Top-feed injector
Operating Temp.	-40 to 110°C	-40 to 110°C
Permissible Fuel temp.	≤ 70°C	≤ 60°C
Flow rate at 3 bar	146 to 1,462 cm^3/min 116 to 1,000 g/min	-
Spray angle	15 to 35°	15 to 85°
Bent angle	0 to 15°	-
Spray type	Conical	Cylindrical As well as conical

3.4 INJECTOR SPRAY TESTER

Figure 8 INJECTOR SPRAY TESTER

3.5 INJECTOR DISC SPECIFICATIONS

Table 3 SPECIFICATIONS

DISC THICKNESS	20 MM
DISC DIAMETER	40 MM
NO OF HOLES	11
SHAPE	CYLINDRICAL & CONICAL AT EDGE
MATERIAL	STAINLESS STEEL
CAVITY	10 MM

3.6 INJECTOR TESTED AT DIFFRENT PRESSURE

As shown in fig at 200 MPa injection pressure spray is analysed. It is observed that at high injection pressure spray is more wide as compared to multi hole injector.

Disc type injector have more spray width and wide spray. Spray angle is more inclined than compared to multi hole nozzle. No of observations are carried out at different pressure 200,210,230,250,275,280 MPa.

4. CONCLUSION

From the above research its is studied and observed that to increase spray width the disc type nozzle is more suitable as the spray width is twice in multihole nozzle than in single hole.

The cylindrical nozzle with 8.6% larger diameter, in spite of higher mass flow rate and momentum flux, shows slower spray tip penetration when compared to the conical nozzle. The spreading angle is found to be inversely proportional to the spray tip penetration. The spreading angle is largely influenced by the nozzle geometry and the ambient density. By proper spreading angle & swirl flow there will be improve in spray tip penetration.

As studied and observed in other research paper that the results show that the Sauter Mean Diameter (SMD) reduces with the increase of the distance from injector tip and the SMD of the central axis is bigger than that of the periphery. With the increase of the injection pressure (40–120 MPa), the spray SMD decreases significantly. In addition, as the orifice diameter goes smaller, the SMD decreases and the effect of the orifice diameter on the spray SMD becomes weak.

As studied and observed in other research paper that the results show Detailed comparisons were made between the experiments and computations in terms of spray/mixture characteristics. The results show that numerical parameter dependencies are significantly reduced with the new models, and good levels of agreement are obtained in terms of spray structure, liquid/vapor penetration, overall SMD and cumulative vaporized fuel mass. Both experimental measurements and simulations reveal the importance of included-angle in group-hole nozzle sprays. In particular, some important features of group-hole nozzle spray are captured in the computations by the present models.

It is observed that in test of injectors, the increased injection pressure leads to the decrease of the droplet size distribution in the initial spray. But, there is little difference of the droplet size at low and high injection pressure in middle and latter period after the injection.

5. REFERANCES

[1] Fuying Xue , Fuqiang Luo, Huifeng Cui, Adams Moro, Liying Zhou, "Numerical analyses of transient flow characteristics within each nozzle hole of an asymmetric diesel injector", International Journal of Heat and Mass Transfer 104 (2017) 18–27

[2] F.J. Salvador, D. Jaramillo, J.-V. Romero, M.-D. Rosello, "Using a homogeneous equilibrium model for the study of the inner nozzle flow and cavitation pattern in convergent–divergent nozzles of diesel injectors s", Journal of Computational and Applied Mathematics

[3] F.J. Salvador, J. De la Morena . Martínez-López. Jaramillo, "Assessment of compressibility effects on internal nozzle flow in diesel injectors at very high injection pressures" , Energy Conversion and Management 132 (2017) 221–230

[4] V. Lazarev, G. Lomakin, E. Lazarev, "Modeling of Injection Parameters for Diesel Engine Injector Nozzles with the Additional Precision Guiding Interface",Procedia Engineering 150 (2016) 52 – 60

[5] Tao Qiu , Xin Song, Yan Lei, Hefei Dai , Chunlei Cao , Hui Xu , Xiang Feng, "Effect of back pressure on nozzle inner flow in fuel injector", Fuel 173 (2016) 79–89

[6] Hengzhou Wo , Karl D. Dearn , Ruhong Song , Enzhu Hu , Yufu Xu , Xianguo Hu, "Morphology, composition, and structure of carbon deposits from diesel and biomass oil/diesel blends on a pintle-type fuel injector nozzle", TribologyInternational91(2015)189–196

[7] Zhixia He, Wenjun Zhong, Qian Wang, Zhaochen Jiang, Zhuang Shao, "Effect of nozzle geometrical and dynamic factors on cavitating and turbulent flow in a diesel multi-hole injector nozzle", International Journal of Thermal Sciences 70 (2013) 132e143

[8] Tong Haoa, Li Yonga, Zhang Longa, Li Baoquanb , "Mechanism design and process control of micro EDM for drilling spray holes of diesel injector nozzles",

Precision Engineering 37 (2013) 213– 221

[9] Zhixia He , Zhengyang Zhang , Genmiao Guo , Qian Wang , Xianying Leng , Shenxin Sun, "Visual experiment of transient cavitating flow characteristics in the real-size diesel injector nozzle ", International Communications in Heat and Mass Transfer 78 (2016) 13–20

[10] Simin Anvari , Hadi Taghavifar, Shahram Khalilarya , Samad Jafarmadar , Mohammad Taghi Shervani-Tabar, "Numerical simulation of diesel injector nozzle flow and in-cylinder spray evolution", Applied Mathematical Modelling 0 0 0 (2016) 1–13

[11] Sanghoon Lee , Sungwook Park, "Spray atomization characteristics of a GDI injector equipped with a group-hole nozzle", Fuel 137 (2014) 50–59

[12] Bo Wang, Tawfik Badawy , Yizhou Jiang , Hongming Xu, Akbar Ghafourian , Xinyu Zhang, "Investigation of deposit effect on multi-hole injector spray characteristics and air/fuel mixing process", Fuel 191 (2017) 10–24

[13] Yangbo Deng, Hongwei Wu , Fengmin Su, "Combustion and exhaust emission characteristics of low swirl injector", Applied Thermal Engineering 110 (2017) 171–180