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ENGINE PERFORMANCE ON ATOMIZATION OF FUEL INJECTOR: A REVIEW

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Abstract

The impact of the fuel injection of fuel atom on engine performance has been investigated to improve fuel efficiency and waste disposal features. The fuel swirl method for injection atomization was evaluated both by the analysis of the fuel flow and the sample test.The goal of the paper is to establish a good fuel atomization over the range of engine performance. As a result of our studies, it has been concluded that the desired atomization can be achieved when gasoline is thrown into a circular motion. Fuel spray and atomization features play an important role in the performance of internal combustion engines. An atomization study to evaluate the numerical fuel injection used in the IGC (Inner Guide-vane Combustor) under various combination and performance conditions has been performed to determine the suspension of the proposed fuel injection to be used in the IGC. Additional results have shown that a single-hole fuel injection, forward injection direction and a splash of ‘<’ type back can achieve better atomization performance compared to other tested cases.

Keywords: Fuel injector, Atomization, Small Droplet, Swirl, Nozzle

Introduction

Internal fire engine, fuel injection systems are those that deliver fuel or a mixture of fuel to the cylinders by means of pressure from the pump. Fuel injection means adding fuel per meter to an internal combustion engine. The fuel injection is also now used in gasoline engines instead of carburetor. In a diesel engine, the fuel is injected directly into the combustion chamber (direct injection) or into a small auxiliary connected chamber (indirect injection). In automotive ignition engines, the cable has been replaced by a fuel injection system that controls mechanical or electronic fuel gauge[1].
Therefore, the improved atomization of fuel injection should lead to improved engine performance. Similarly, in this study, a fuel injection with excellent spray characteristics and atomization features was made to more accurately determine the effects of fuel quality on engine performance[2].

With the exception of the nozzle component, the structure is similar to the standard type (Pintle type). A fuel injection of this type is a type of swirl that goes up and down a stream that includes a ball valve and a rotating fuel component (Swirler) that provides a circulating flow of fuel upstream and a metering orifice stream. For our purposes, the following has been considered in the nozzle configuration:
1) The correct size was determined by observation and calculation of the valve behavior.
2) The flow passage correction was developed using analytical flow analysis inside the hole.
The factors that affect the atomic composition of the jet fuel circulating in the outlet area are determined by testing and converting the compression force of the fuel into circulating power.

ITB technology (inter-stage burner) is expected to provide a new way to design green continuation and more efficient future applications. Sirignanoet al. [3][12] find that deliberate continuous burning inside the turbine can increase the efficiency and gravity / power of the engine. Sirignano et al. [4] publish a system combustor placed between a high-pressure turbine platform and a low-pressure turbine will be easier to achieve, known as ITB.

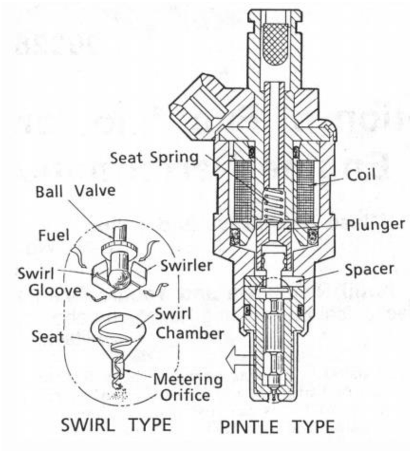

Fig.l Structure of Injector

The atomization function of the fuel injection is one of the most important factors to consider in the construction of a new fuel-generating engine. With the blast atomizer, N. K. Rizk and A. H. Lefebvre [6] examined eight different atomizers and found that the atomic quality improved by increasing atmospheric pressure, decrease in atomizer size, and by reducing the impact angle between the fuel. jet and high-speed air flow.Ch Fig.2 shows complete Inner Guide-vane Combustor (IGC) systems and fuel injection used in the IGC. The first step in the fuel atomize is made by an explosive air atomizer at the fuel injection. Drops of fuel will be burned and evaporated as they hit the steering van just before the atomizer. At the same time, the van will be cooled and protected from the heat caused by the forthcoming flow. The fuel-air mixture will flow out of the van through a hole and form a vortex for future flow, the hole can be used as a fire extinguisher[2].

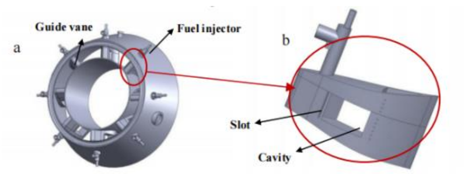

Fig.2. (a)overall schematics of IGC; (b)fuel injector in IGC

A modern aero engine is capable of emitting a small amount of exhaust gas over a wide range of applications. This is due to techniques that include turbo charging, EGR, air-cooled charging and sophisticated fuel injection process [7].

It is also reported that there is a significant decrease in droplet diameter near the spray axis in Fig.3. Generally, the separation of droplets into smaller droplets due to the aerodynamic force acting on them due to the interaction with surrounding gas is known as secondary atomization. Trbulence and cavitation caused by nozzle geometry initiate the separation of a liquid column into an iconic spray the first place of atomization is closest to the exit of the mouth. [9].

The difference in power received by the droplet leads to different separation paths during the second atomization. It shows the physiological process involved in the various divisions. Vibration variations include drip vibration with its natural frequency and breakdown into fragments of size comparable to the parent drop. In bag split mode, the parent droplet turns into an empty bag attached to a thick toroidal edge. The sheet disperses into a large number of small droplets and the line breaks up into a small number of large droplets. The diversity of species is similar to the state of bag divergence and the addition of stamen oriented anti-parallel to the direction of drag movement. The bag begins to disintegrate followed by a stamen that produces droplets of many sizes. In stripping mode, the film erodes progressively on the ground surface resulting in a very large number of tiny droplets. During catastrophic fragmentation, the droplet surface is bounded by large amplitude waves producing a small number of large droplets as shown in fig.3 [10].

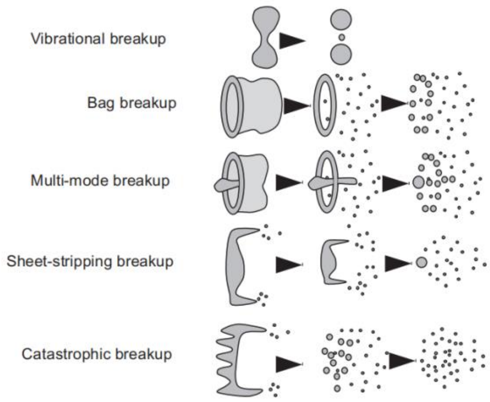

Fig.3 Secondary breakup modes

Objectives of Fuel Injection

The functional objectives of fuel injection systems may vary. They all share the important task of providing fuel to the fuel system, but it is a matter of designing how a particular system will be developed. There are several competing objectives such as: Power outage, Fuel efficiency, Emissions efficiency, Fuel acceptance, Stability, Reliability, Driving and efficiency, Starting costs, Maintenance costs and diagnostic ability [8].

Benefits of Injecting Fuel

The two main improvements are:

1. Reduced response time for fast-changing inputs, e.g., fast throttle movements.

2. Bring an accurate and equivalent fuel weight to each engine cylinder, significantly improving the distribution of cylinder-cylinder-cylinder engine.

Port Fuel Injection System

In a perforated syringe system, the injection is placed on the side of the pull-out pile. The injection sprays gas into the air inside the application area. Gasoline mixes with air completely. This mixture of gasoline and air then passes through the inlet valve and enters the cylinders. Injectable oil injection (PFI), systems use one injection per cylinder. They are fitted with a large intake near the cylinder head where they can inject crude, atomic, fog as close as possible to the suction valve. Since each cylinder has its own injector, the fuel supply is exactly the same.

To determine the flow rate of the fuel chamber, a three-dimensional analysis of the flow of fuel was performed. The fuel flow velocity was low at the inlet and rapidly accelerated near the outlet, and the loss in the orifice section was approximately 95% of the total value so that with this microphone meter measurement was made in the orifice component.

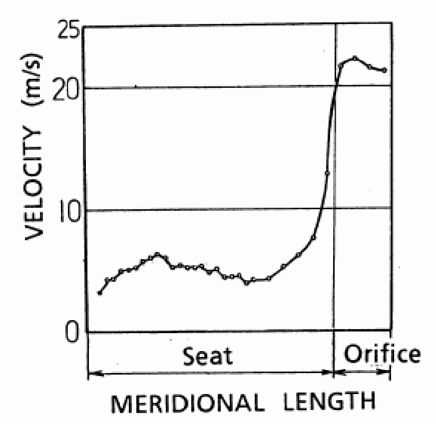

Fig.4 Velocity in Swirl Chamber

Test Equipment and Method

Fuel injector test equipment for the detection of sprayed fuel and the size of the droplet size. The view ship has a view window and a quick image mode using strobe light. Photos of the fuel spray were taken and reviewed. Spray angles obtained from spray images.

Rotating fluid, which is produced in liquids and gutters inside atomis, has been found to be very effective in reducing the fall size and increasing the spray angle. it will drop to room temperature thus increasing gas emissions. In any given liquid, the key factors that control the quality of the atomization are the variable pressure of the atomic air and the relative velocity between the fuel and the surrounding air. Particle size research was performed using a state-of-the-art laser system called the Phase Doppler Particle Method[10].

Table: 1 Test Sample

Injector Type	Mean Droplet Size (um)	Spray Angle(Degree)
Swirl	85	18
	110	15
	126	15
Pintle	176	15
Without Swirl	260	10
	357	8

Experimental Method.

In order to evaluate the effect of different integration systems on the performance of the fuel injection at IGC, test parameters under different parameters, such as air fluid volume (ALR), injection direction, backsplash and slot type, are required [2].

Table 2: Experimental cases of fuel injector

No	Slot Type	Injection Direction	Backsplash
1	single	Forward	/
2	single	Backward	/
3	intersect	Forward	flat
4	intersect	Forward	‘>’ shaped
5	intersect	Forward	‘<’ shaped

Numerical model procedure

For more information on the entire fuel injection industry, a Computational Fluid Dynamic (CFD) study was conducted and based on the Discrete Particle Model (DPM) [6] with the CFD trading software FLUENT 14.0. The flow phase of the continuous phase was first resolved with a standard k-H turbulence model [7], and then the continuous phase solution results were combined with clear particles in the DPM model, FLUENT calculates the trajectories of these specific phase phases, too. such as heat and mass transfer to / from them.

The impact on injection direct atomization, slot and backsplash type was discussed in this study. The droplet distribution of Sauter Mean Diameter (SMD) is used to evaluate the atomization performance of the fuel injection into the IGC under different operating conditions in different given locations, the Rosin-Rammler

(R-R) distribution [8] is used to obtain a similar indication n. and check the droplet size similarity.
To assess the effect of backsplash type on local SMD distribution, atomization comparison tests are ongoing with fuel injection. % which means that the last fuel injection can get the best atomization performance between them. We think this is because the air can get much faster compared to the pit area with a ‘<’ backsplash, which results in We becoming larger and the droplet separation process in the hole is intensified[11].

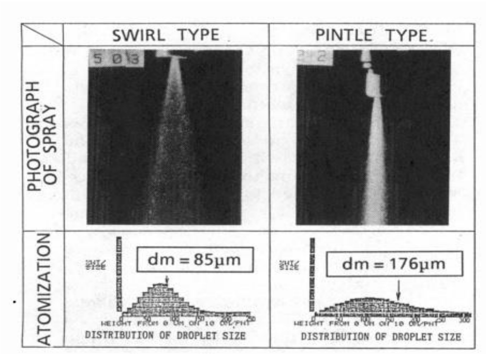

Fig.5 Spray Pattern to compareSwirl Type with Pintle Type

Results

Experimental Results

Function of the fuel injection itself The relationship between the switching power and the size of the drop indicator and the spray angle. As the flow rate of the fuel flow increased, the size of the center drop gradually decreased and the spray angle gradually increased.

Engine test results

The relationship between the medium-sized droplets of sprayed petrol and gas exhaust material is shown in Fig.6. Examination of the exhaust gas field was represented by HC (hydro carbon). Engine testing is performed at an engine speed of 2,000 rpm, with a maximum pressure of 40 kPa. HC exhaust concentration tends to decrease as the droplet diameter decreases especially in the region where the droplet size is more than 200 pm.

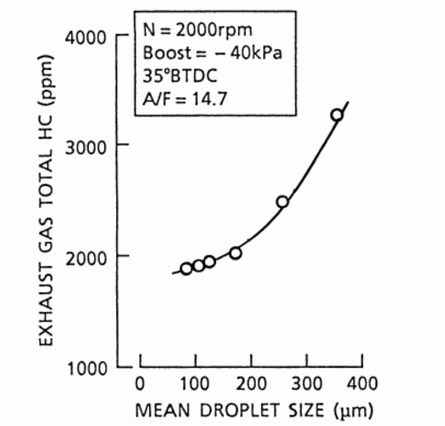

Fig.6 Emission

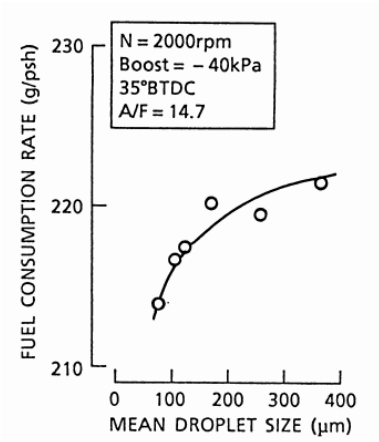

Fig.7 Consumption

The relationship between the average droplet size of sprayed petrol and fuel consumption is shown in Fig.7. The experimental condition was similar to that of the gas exhaust study above. Fuel consumption rate decreases as droplet size decreases. Depending on the level of fuel consumption in the medium drop size was relatively high.Therefore, when the HC exhaust capacity is limited, the fuel consumption rate is improved.

Numerical simulation results

The calculation is done with commercial CFD software FLUENT 14.0, both geometry with two sides and border conditions. Dissociation, evaporation and droplet collision processes were considered in this numerical simulation. The DPM model is used to determine the total atomization field of the fuel injection range from No.1 to No.5, the results of the particle diameter simulation are shown in Fig.7. more. distribution without future flow. Furthermore, it can be assumed in Figs.8 (c), (d) and (e) that the fuel injector No.5 can obtain the optimal atomization field, these results harmonize well with the test results [8].

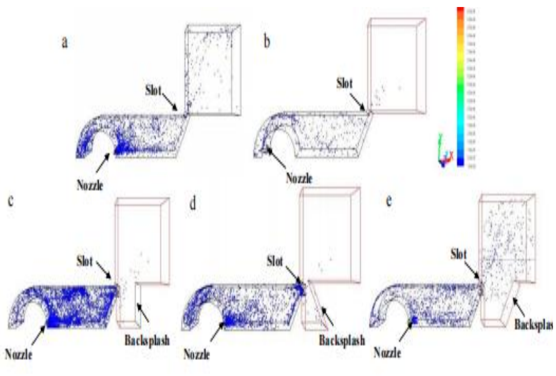

Fig.8 Atomization field simulation results (a)No.1; (b) No.2; (c)No.3; (d)No.4; (e)No.5

Conclusion

The fuel atomizer breaks down the fuel into smaller droplets and thus increases the surface area of the fuel. This improves fuel combustion. Too much atomization will reduce fuel inflow, which in turn will have a negative impact on fuel temperature. Therefore, proper fuel atomization is essential for achieving proper fuel burning. However, further research (both experimental and computational) on the main atomization, adjacent to the oral structure and the effect of fuel structures on these factors is important to clearly understand all the main components of the separation.

With the current method of swirl injection, the atomic form of droplets sprayed under a size of 85um drops was discovered. As for the result of the current test of the engine - the increase in engine performance depends largely on the size of the average drop of spray oil. In particular, low fuel droplets contribute to the reduction of fuel consumption and HC in the engine and to the development of low-temperature launches. flow, the result shows that test conditions can achieve good atomization performance, while test cases in one place, forward injection direction and '<' backsplash-shaped type of backsplash can achieve better atomization performance. Numerical solutions with DPM model show good agreement with test results.

References

[1] Performance of electronic fuel injection system using compressor and controller MalleboyenaMastanaiah

[2] The Effect of Atomization of Fuel Injectors on Engine Performance Author(s): MineoKashiwaya, TokuoKosuge, Kouji Nakagawa and Yoshio Okamoto Source: SAE Transactions, Vol. 99, Section 3: JOURNAL OF ENGINES, Part 1 (1990), pp. 699-705

[3] Sirignano W A, Liu F. Performance increases for gas-turbine engines through combustion inside the turbine[J]. Journal of Propulsion and Power, 1999, 15(1): 111-118.

[4] Delplanquef W A S J J R, Liu F. Selected challenges in jet and rocket engine combustion research[J]. 1997.

[5] Liu F, Sirignano W A. Turbojet and turbofan engine performance increases through turbine burners[J]. Journal of Propulsion and Power, 2001, 17(3): 695-705.

[6] Rizk N K, Lefebvre A H. Influence of atomizer design features on mean drop size[J]. AIAA Journal, 1983, 21(8): 1139-1142.

[7] Design and Analysis of Fuel Injection Nozzle for better performance aero engines using finite element method 1 DudduKiranteja, 2 P Narendhra Mohan,

[8] Atomization Performance Study of a Fuel Injector in IGC by Experimental and Numerical Investigation Can Ruana ,XiaoyuanFanga , GuanxingHuangb , Hongzhou Hob , Fei Xinga

[9] Baumgarten, C. Mixture Formation in Internal Combustion Engines, Springer, 2006.

[10] Guildenbecher, D. R., Lo´pez-Rivera, C. and Sojka, P. E., Secondary atomization, Experiments in Fluids, 2009, 46, 371-402.

[11] M. Gremer,et al. , BOSCH Fuel Injectors - New Development : SAE paper 870124 (1987).

[12] Conceptual design of Blended Wing Body for Future Air TransportationShruti Dipak Jadhav Er, Pawan Hiteshbhai Jethwa Er, Shiva Prasad U Asst. Prof, and Suresh Kumar M Prof.DOI: 10.47893/GRET.2022.1046