

Internal Combustion Engine: Fundamental Concepts and Principles of Fuel Injection

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Abstract

Ultrasonic fuel injectors are becoming more popular due to a growing demand for flexibility in a diesel engine's fuel injection system to fulfil pollution, fuel economy, and noise standards. Furthermore, because to its high boiling point, diesel has a significant mixing issue, resulting in reforming efficiency fluctuations. For efficient diesel delivery, an ultrasonic injector has been developed. Using a piezoelectric transducer, the UI may atomize diesel into tiny droplets. Furthermore, as compared to a non-UI reformer under the same operating conditions, reforming efficiency rise. As a result, fuel may be atomized utilising ultrasonic energy to improve the engine's injection mechanism.

Keywords: *Internal Combustion Engine, Fuel Injection, Diesel, Combustion*

INTRODUCTION

Since the speed of the chemical reaction is considerably quicker than the speed of mixing the fuel and air in traditional diesel diffusion combustion, the combustion begins at the stoichiometric air-fuel ratio and progresses over a wide range of conditions from lean to rich. Nox and soot are produced as a result, and it is difficult

to minimise both at the same time. It's preferable to finish mixing before starting combustion and burn the fuel in a lean, homogenous state. The formulation of a proper fuel-air mixture is critical for combustion and exhaust generation. The use of ultrasonic energy allows for the atomization of fuel. Before being installed on the engine, the Usfi system was

designed in two phases, tested, and exhibited. It comprises of a piezo amplifier, a function generator, and a low-pressure fuel delivery system made of lead zirconia titanite (LZT) crystal (piezoelectric components material). A low-pressure electric pump (06 bar) and a low-pressure port fuel injector make up the fuel supply system (0-10 bar). The piezo amplifier amplifies the input voltage six times before impressing it on the bonded crystal plate. By delivering voltage via the amplifier, the bonded crystal plate was made to vibrate at the desired frequency. The scope cored and function generator were used to measure and tune the applied frequency. The applied frequency causes the surface waves to become unstable. Fuel was injected at a very low pressure of 2 bar on an atomizing surface when the plate vibrated at an ultrasonic frequency. The unstable surface waves created at the free surface of a film that develops as the fuel spreads across the atomizing surface cause ultrasonic breakdown of the fuel into droplets. When the frequency was increased, very tiny droplets were seen (droplet diameter decreased). A vibrating probe, probe holder, vibrocell, and fuel delivery system make up the second stage atomizer system. The probe holder was created using the probe setup as a guide.

The vibrocell's job is to control the amplitude and frequency. The frequency was adjusted between 20 and 40 kHz. Within this range, studies were done to see how frequency affected engine combustion, emissions, and performance.

Related Work

The literature review in this part will provide a brief overview of the fuel injector, which atomizes gasoline using ultrasonic energy, and how it impacts the engine's overall performance.

Much study has been done on injection systems to ensure that fuel is consumed effectively and that maximum output power is produced. However, more work has to be done to improve the approaches in order to make the environment greener and healthier.

Moldovanu¹,L. Kocsis¹ found that ultrasonic conditioning of biodiesel lowers its density, slowing down the process, and having a direct impact on injection process parameters. As a result, we have a longer spray liquid phase length penetration, resulting in higher CER values (1.4-2.0). Increased CER values lengthen the thermodynamic duration of combustion stages in compression ignition engines, which has a direct impact on nox emission.

Chris A. Satkoski demonstrated that for a piezoelectric diesel fuel injector, an estimator method is suggested that utilises the available feedback signals of piezo stack voltage and rail-to-body line pressure for improved flow rate estimate.

Tomojiro sugimo recommended Mikiyaraaki. Using a tiny nozzle array and an ultrasonic instrument, a fine constant spray may be created. It has been found that when the nozzle diameter is increased, the droplet size and velocity increase. The 2nd power of the nozzle exit diameter is generally proportional to the fuel flow rate.

Sangho yoon, Inyong kang, Joongmyeon bae, Inyong kang, Inyong kang, Inyong kang, Inyong kang, Inyong The manner of fuel supply has a significant impact on reforming efficiency. One alternative for supplying the fuels for the reforming system is an ultrasonic injector. When the

UI was utilised in the micro-reactor, the reforming efficiency rose by around 20%. Even if there are various techniques being followed in the reduction of CO₂ and other harmful emissions, shashank. M stated that Alternate fuels or changes in design characteristics inside the ic engine system are two of the most common ways used. Emission control is substantially aided by the design of piezoelectric diesel injectors. Fuel consumption can also be reduced by adjusting injector nozzle placement and orientation angles.

This study offers numerous results derived using the most recently developed injection and combustion models, according to Phillip Beard and Olivier Lagte. In a high pressure cell for non-evaporating and evaporating ambient circumstances, as well as in the case of a DISI engine, the numerical modelling of a piezo-electric injector was presented.

Proposed Solution



Fig. 1 Ultrasonic Injector

This study is based on a method for increasing fuel economy in injection systems by utilising ultrasonic waves. We presented a redesigned injection method in which gasoline is atomized utilising ultrasonic energy to solve the issue of lower fuel efficiency and greater polluting gases. Providing flexibility to the diesel engine's fuel injection system in order to fulfil requirements for fuel economy, noise, and emissions, among other things.

CONCLUSION AND FUTURE WORK

We suggested a novel method for atomizing fuel by utilising ultrasonic radiation at a very high frequency in this study. This technology will address the drawbacks of traditional injection systems, resulting in improved air-fuel ratios and overall efficiency.

Using ultrasonic energy in injection systems is a difficult undertaking, but considering the benefits, it appears to be a promising and growing technology.

Ultrasonic fuel conditioning reduces the density of the fuel, resulting in a faster procedure with a direct impact on the injection process parameters. As a result, we get a significant spray liquid phase length penetration, resulting in the presence of high CER values (1.4-2.0).

Increased CER values lengthen the thermodynamic duration of the engine's combustion phases, which has a direct impact on nox emission.

We hope to obtain data on fuel droplet diameter and spray length in the future. Compare it against the present approach in terms of reforming efficiency and so on.

REFERENCES

1. Cfd simulation of ultrasonic conditioning influences on biodiesel injection” in: researchgate/221958429 january 2011
2. Annalisa dalmoro, anna angela barba “analysis of size correlations for microdroplets produced by ultrasonic atomization” in: hindawi publishing corporation volume 2013, article id 482910,7 pages.
3. Inyong, joongmyeon bae, sangho yoon, youngsung yoo , “ performance improvement of diesel autothermal reformer by applying ultrasonic injector for effective fuel delivery” in: sciencedirect 2007 array” in: researchgate/264883537 Mikiya

araki “ultrasonic fuel injector using
a micro nozzle

4. Chris A. Satkoski, gregory M. Shaver “design of a dynamic fuel flow estimator for a piezoelectric fuel injector” in: IFAC symposium advances in automotive control july 2010.
5. Chien-pei Mao, John Short, Norwalks ,” Fuel injection and mixing systems having piezoelectric elements and methods of using the same” in Patent US 8,074,895 B2
6. Lee Kirby Jameson, Lamar Heath Gipson “ Ultrasonic Unitized fuel injector with ceramic valve body”
In: US 6,543,700 B2