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COMBUSTION CHARACTERISTIC OF GASOLINE-BIODIESEL ON RAPID COMPRESSION EXPANSION MACHINE USING VARIOUS FUEL INJECTION PRESSURE

Ardhika Setiawan [1)], Bambang Wahono[1)], Muhammad Khristamto Aditya Wardana[1)], Ocktaeck Lim[*2)]

[1)] Graduate School of Mechanical Engineering, University of Ulsan, Ulsan, 44610, South Korea
[2)]School of Mechanical Engineering, University of Ulsan, 44610, South Korea

ABSTRACT

An experimental study was conducted on Rapid Compression and Expansion Machine (RCEM) that have similar characteristic with Compression Ignition (CI) engine for gasoline-biodiesel (GB) blend 10% and 20% by volume with varying fuel injection pressure 800-1400bar. Particularly, the aim was to study the combustion phenomena of Gasoline Compression Ignition (GCI) engine. For the various fuel injection pressure and chosen GB blends fuel. The engine compression ratio was set at 16, 1000 µs of injection duration and 12.5^{o}BTDC Before top dead center. The results show that GB 20 have shorter ignition delay than GB 10, and by increasing the injection pressure make the auto ignition occur faster. Injection pressure also effect on thermal efficiency. Increase injection pressure from 800-1000bar increase the thermal efficiency drastically. But increase injection pressure above 1000bar make thermal efficiency decrease due the constant air capacity.

Keywords: rapid compression expansion machine, gasoline compression ignition

NONMENCLATURE

RCEM	Rapid Compression Expansion Machine
GB10	10% biodiesel
GB20	20% biodiesel
TDC	Top dead center
BTDC	Before top dead center
GCI	Gasoline Compression Ignition

1. INTRODUCTION

Gasoline fuel are well known as clean fuel that produce small pollution after combustion process than diesel fuel [1]. That's the reason many researchers study about Gasoline Compression Ignition engine (GCI) to applied gasoline fuel on diesel engine to produce more power than on spark engine. That's the base reason this study was conducted.

Biodiesel fuels have much lower volatility than conventional diesel fuel. Biodiesel typically has T10 distillation temperatures of 350^{o} C and T90 temperatures that can exceed 400^{o} C. In contrast, conventional diesel fuels have T10 and T90 temperatures of roughly 210 and 300^{o} C, respectively. The impact of volatility related changes in fuel behavior is exacerbated under low temperature combustion regimes, due to decreased temperatures and densities during the injection event which lead to both faster penetration and slower vaporization [2].

Spray mixing and combustion processes are regarded as the major factors that determine the energy conversion efficiency and emission level of internal combustion engines [3]. Improving spray atomization and optimizing the combustion process are becoming more and more important for enhancing engine performance, reducing fuel consumption and pollutant emissions [4].

This study discusses a GCI engine fueled with biodiesel blended into gasoline in some percentage by volume with single injection mode and variable pressure of fuel injection. The objectives of blending a small amount of biodiesel into gasoline were to increase cetane number, against auto ignition resistance. By vary the injection pressure for two different fuel

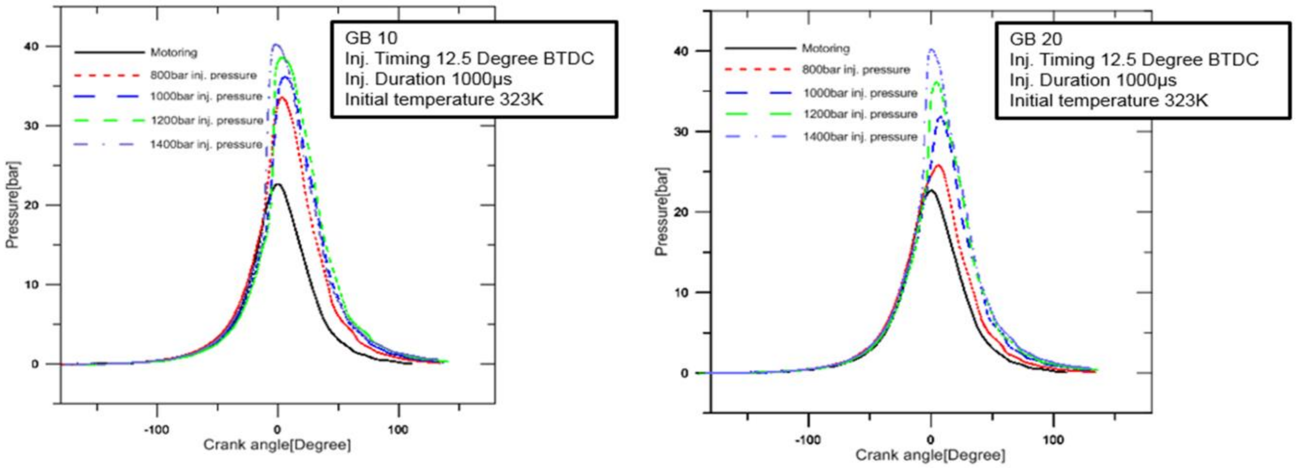

Fig. 1. In-cylinder pressure of GB10 and GB20

characteristics, combustion characteristic will be analyzed.

2. METHOLOGY

An experimental study was conducted on Rapid Compression and Expansion Machine (RCEM) that have similar characteristic with Compression Ignition (CI) engine for gasoline-biodiesel (GB) blend 10% and 20% by volume with varying fuel injection pressure 800-1400bar. Particularly, the aim was to study the combustion phenomena of Gasoline Compression Ignition (GCI) engine. For the various fuel injection pressure and

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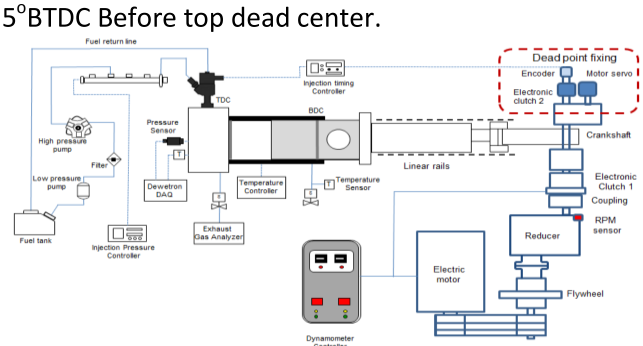

Fig. 2. Schematic diagram of rapid compression expansion machine

The injection flow rate was measured to analyze the capacity of injection in every cycle. By varied injection pressure with constant injection duration will result different amount of fuel injected to the chamber. The injection pressures were 800, 1000, 1200 and 1400 bar produced from common rail and a high-pressure pump controlled by a common rail

Table 1.
Injection flow rate of GB10 and GB20 with various injection pressure

Bore	100	mm
Stroke	420	mm
Rod length	900	mm
Maximum speed	250	rpm
Compression ratio	16	

Table 2.
Engine specification

Fuel	rate/injection (gram)			
	800bar	1000bar	1200bar	1400bar
GB 10	0.0094	0.0124	0.0162	0.0191
GB 20	0.0151	0.0205	0.0261	0.0329

3. RESULTS

Pressure trace of GB10 and Gb20 with variation fuel injection pressure was obtained from experiment and displayed on figure 2. Base of those data, combustion characteristic was analyzed and displayed as burn duration, ignition delay and thermal efficiency.

Both of GB10 and GB20 shown similar characteristics in In-cylinder pressure by vary fuel injection pressure. The maximum pressure produced from combustion will increase by increasing fuel injection pressure.

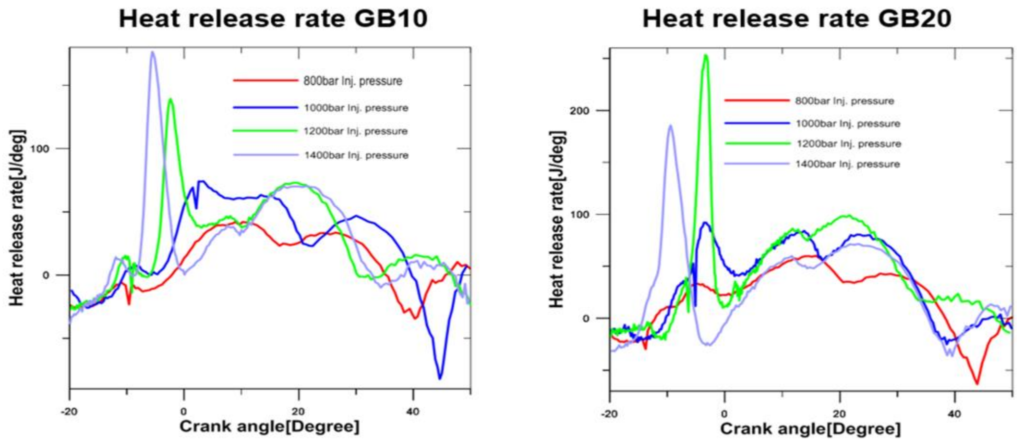

Fig.3. In-cylinder pressure of GB10 and GB20

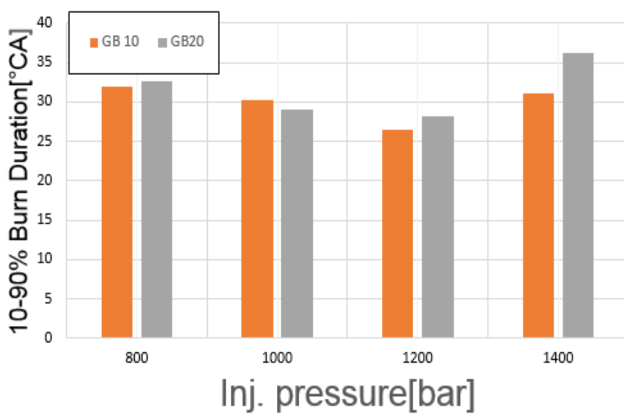

Fig. 4. Burn duration of GB10 and GB20

Fig. 3 shows the combustion duration from 10% to 90%. Fig. 4 shows Heat release rate, Fig. 5 shows ignition delay of GB10 and GB20 with different fuel injection pressure, while Fig. 6 shows thermal efficiency with same condition.

Auto (total) ignition timing is determined as the time after the HRR exceeding more than 20 J/deg due to a high-temperature reaction [5]. GB20 has shorter ignition delay than GB10, meaning that the GB20 containing biodiesel has a lower calorimetry value. The fatty acid composition of biodiesel has been identified as the main element for shorter ignition delay [6]. Gasoline biodiesel blend fuel has fuel stratification, so when the higher biodiesel content of the gasoline mixture ignites faster than the other part of the fuel mixture, it will also influence the ignition delay [7]. The lower compressibility and viscosity of GB20 lead to the advanced start of injection (shorter ignition delay). This relation shows that by adding some biodiesel into a gasoline reduced ignition delay, due to the increase in the cetane number also the combustion duration will increase.

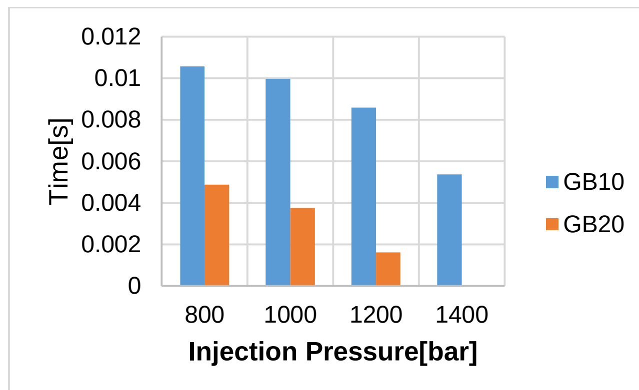

Fig. 5. Ignition delay of GB10 and GB20

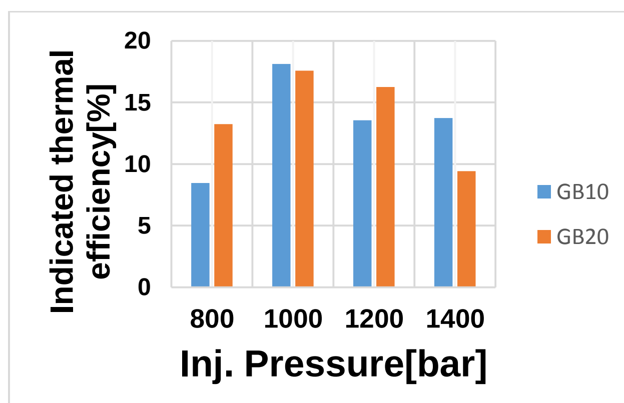

Fig. 6. Thermal efficiency of GB10 and GB20

The low CN of gasoline causes longer ignition delays or more resistance to autoignition. To a certain extent, this behavior is profitable because it provides more time for fuel mixing after injection and before combustion starts, therefore allowing combustion to take place near TDC. However, too long ignition delay could result in delayed combustion phasing, leading to an inefficient engine work or low thermal efficiency. Therefore, to overcome the too long ignition delays, more reactive fuel (more reactive stratification fuel) is necessary in the gasoline. In the gasoline biodiesel blend fuel, there are more fuel stratifications, so that when the higher biodiesel content of the gasoline mixture ignites faster than the other part of the fuel mixture, it will also influence the ignition delay, combustion phasing and combustion duration. The shorter ignition delay of GB20 compared to GB10 in this experiment is associated with the higher reactivity of biodiesel in the blend.

Increasing injection pressure will increase the capability of fuel penetration and lead fuel to change into vapor more easily. Higher injection pressure, will produce air-fuel mixture perfectly in the chamber and increase auto ignition characteristics both on GB10 and GB20. However, higher injection pressure will increase fuel capacity that would be injected in to the chamber. Since air mass flow was constant, the fuel-air ratio will be insufficient along with increasing fuel injection pressure.

4. CONCLUSION

The results show that GB 20 have shorter ignition delay than GB 10, and by increasing the injection pressure make the auto ignition occur faster. This is due to the gasoline biodiesel stratification characteristics. Gasoline biodiesel blend fuel has fuel stratification, so when the higher biodiesel content of the gasoline mixture ignites faster than the other part of the fuel mixture, it will also influence the ignition delay, combustion phasing and combustion duration. Injection pressure also effect on thermal efficiency. Increase injection pressure from 800-1000bar increase the thermal efficiency drastically. But increase injection pressure above 1000bar make thermal efficiency decrease due the constant air capacity.

5. REFERENCE

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