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Experimental Performance Of Gasoline Engines With EGR Fueled By Blends Of Gasoline and Butanol

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Abstract. The use of motorized vehicles increases along with the high mobility of the people in meeting their needs so that the use of fuel increases. This led to a fuel shortage crisis. One solution is the use of alternative fuels that are renewable and environmentally friendly, such as butanol. Butanol is an alcohol that has characteristics similar to gasoline so it is suitable for use as a fuel. Butanol also has a high octane rating so that the fuel can receive high pressure during the compression stroke. This increases the torque and power of the gasoline engine. In addition, the use of the EGR system also increases engine power because the unburned fuel from the combustion is recirculated back into the combustion chamber, thus helping the combustion process in the next cycle. Therefore, this study observed the addition of 5%, 10% and 15% butanol to gasoline on the performance of gasoline engines with and without the EGR system. The results showed that the addition of 15% butanol to gasoline using Cold EGR increased Brake Torque and Brake Power the highest by 13.42% respectively compared to without EGR. The use of Hot EGR in the engine reduces BSFC by 18.01% compared to no EGR. While Brake Thermal Efficiency increased by 21.96% by using Hot EGR.

1. Introduction

The use of motorized vehicles is increasing due to the high activity of the community in meeting their daily needs. This causes the uncontrolled use of fossil fuels resulting in an energy crisis and high air pollution [1]. Therefore, the government has launched the use of renewable alternative fuels as a substitute for fossil fuels that are renewable and environmentally friendly. Alcohol is an alternative fuel that can replace fossil fuels because it has almost the same characteristics as gasoline. The alcohol that is often used as a fuel is butanol [2][3].

Butanol has a higher octane number than gasoline so it can withstand high pressure in the compression stroke. This increases the explosion of the cylinder so that the engine power is better [4][5]. In addition, butanol has a high latent heat of vaporization so that the fogging process in the combustion chamber is better and increases the flame speed [6][7]. The high oxygen content in butanol helps the fuel oxidation process so that the combustion process in the cylinder becomes complete. This results in increased engine power and reduced engine exhaust emissions [4][8]. However, the use of butanol in the fuel increases the exhaust gas temperature so that NOx increases. This problem can be fixed using the Exhaust Gas Recirculation (EGR) system. The EGR system recirculates some of the remaining combustion gases to the combustion chamber in the next cycle so that the specific heat of the air mixture increases. This causes the flame temperature to decrease and the reaction rate of Nox formation to decrease [9].

Yusoff (2017) [10] explained that butanol can improve engine performance because the high octane number in butanol causes high pressure in the cylinder during the compression stroke so that the explosion in the combustion chamber is better and engine power increases. Yuanxu Li., et al., (2019) [11] that butanol can improve engine thermal efficiency because butanol has a high oxygen content so that the oxidation process in the combustion chamber is better. This causes the high propagation of fire in the combustion chamber. Hazim Sharudin, et al., (2017) [12]explained that adding butanol to fuel can reduce CO and HC emissions. This is because butanol is an oxygenated fuel compared to gasoline so that combustion in the combustion chamber is better. The complete combustion process can reduce CO and HC emissions. However, Syarifudin (2019) [8] in his research explained that butanol has a low calorific value so that butanol lowers the temperature in the combustion chamber and requires more fuel to produce the appropriate temperature in the combustion process.

Lifeng Zhaou., et al., (2020) [13] explained that the use of EGR in gasoline engines increases engine torque and power because EGR produces a longer combustion duration in the combustion chamber so that EGR increases IMEP. IMEP is an indication of the pressure received by the piston during the stroke. The pressure received by the piston in the stroke affects the power generated by the engine. However, according to Saket verma., et al., (2019) [14] the use of EGR reduces fuel consumption because unburned fuel is recirculated and enters the combustion chamber. This helps the supply of fuel in the next cycle.

2. Methods

This study observes the use of gasoline and butanol fuel mixtures on the performance of EFI gasoline engines using the EGR system. Gasoline and Butanol are the fuels used in this study. The percentage of butanol in the gasoline fuel mixture is 5% (B5), 10% (B10), and 15% (B15) of the total volume of the fuel mixture used. The characteristics of the fuel are described in table 1. This study uses a gasoline engine with an EFI fuel system and has 4 cylinders. Gasoline engine specifications are presented in Table 2.

Table 1. Fuel Properties

Properties	Gasoline	Butanol
Octan Number	88	98,3
Density 15oC (Kg/m3)	744	815
Calorific Value MJ/Kg	42,7	33,3
Water content (%V)	0,003	>5
Viscosity (mm2/s)	0,22	2,63
Oxygen content (%)	2,7	21,69

Table 2. Gasoline Engine Specifications

Specification	Description
Type Engine	Gasoline
Production	Toyota
Number of Cylinders	4
Capacity	1798 cc
Number of valves	(SOHC) 8 Valve
Maximum Power	94 Hp - 5000 rpm
Maximum Torque	155 Nm - 3200 rpm
Fuel system	EFI

The measurement of engine torque and power uses Dynotest (18) which is connected inline to the gasoline engine (8). The Dyno test is flowed with pressurized water and burdens the rotation of the dyno test rotor so that the engine speed gets a load. The load given to the dyno test is 25% of the total load that can be accepted by the gasoline engine. The load received by the machine is displayed on the dyno test display screen (17). The constant engine speed of 3000 rpm and measurements using a tachometer (17). Mixer (1) is used to mix gasoline and butanol so that the fuel mixture becomes homogeneous. The fuel mixture flows into the burret (2) and the fuel is pumped (3) to the injector (4) to be atomized. Burrets are used to measure the fuel consumption of gasoline engines. EGR (13) recirculates some of the remaining combustion gases into the cylinder in the next cycle. This study varies the use of Hot EGR and Cold EGR systems.

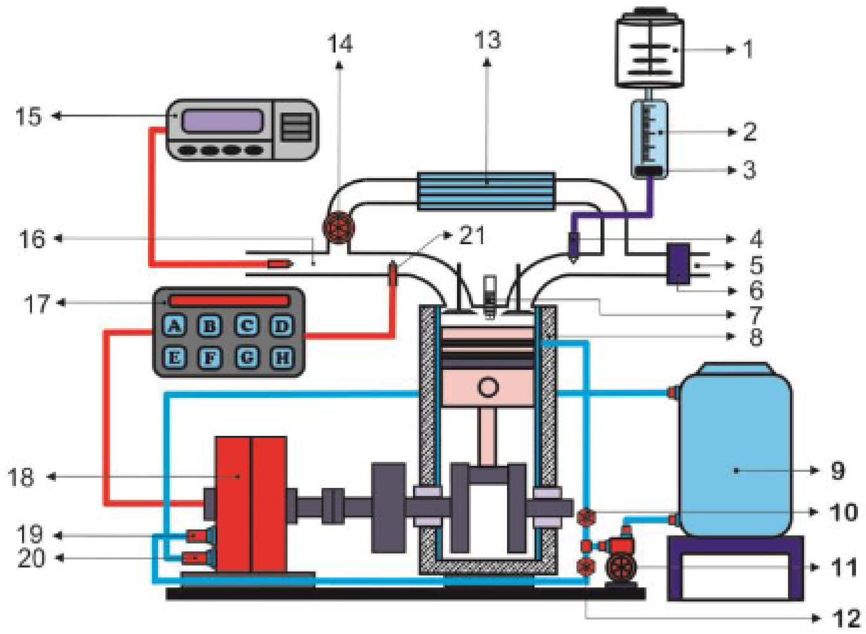

Figure 1. Eksperimental Set Up

3. Results and Discussion

3.1 Brake Torque and Power

This test was carried out using an EFI gasoline engine with or without a hot and cold EGR system on a gasoline and butanol fuel mixture. The test results are presented in Figures 2.

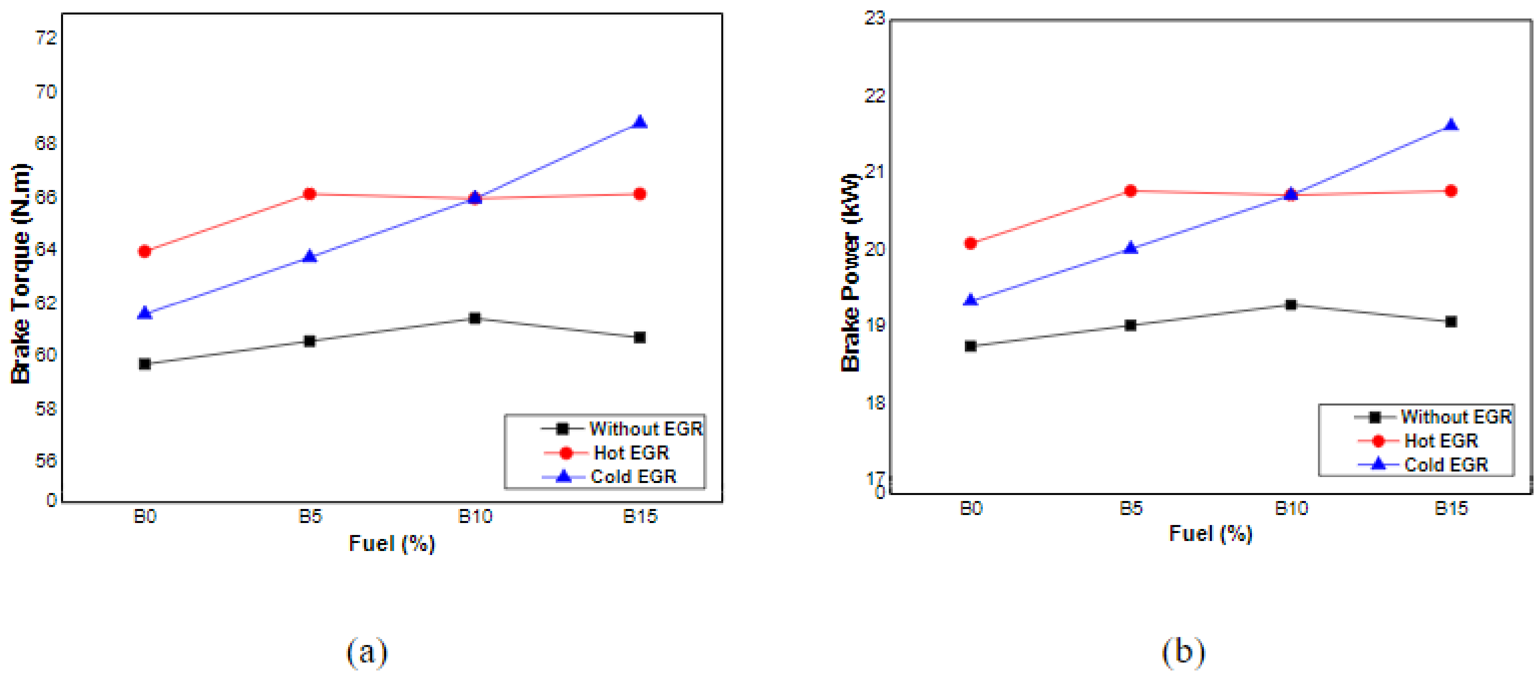

Figure 2. Brake torque (a) and Power (b) EFI gasoline engines with or without EGR use a variation of adding butanol to gasoline.

Figures 2 explain the effect of using butanol in gasoline on Brake Torque and Power on EFI gasoline engines with or without the EGR system. The addition of butanol to gasoline has been shown to increase the brake torque and power of gasoline engines. The high octane number in butanol increases the resistance of the fuel to receive high pressure during the compression stroke so that the explosion in the cylinder is higher [2] [15]. In addition, butanol has a high oxygen content so that the oxidation process of fuel in the combustion chamber increases. This increases the acceleration of the flame in the combustion chamber so that the combustion process is more complete [4] [16]. The highest brake torque and power were 61.43 N.m and 19.28 k.W with the addition of 10% butanol (B10). The use of Cold EGR increases Brake Torque and Power by 13.2% and 13.42%, respectively, compared to without EGR. This increase is because EGR recirculates the remaining combustion gases in the cylinder so that the unburned fuel is carried away and helps the combustion process in the next cycle [14] [17].

3.2 Brake Thermal Efficiency (BTE)

This test is to measure Brake Efficiency Thermal on EFI gasoline engines with or without EGR fueled by gasoline and butanol. The test results are presented in Figure 3.

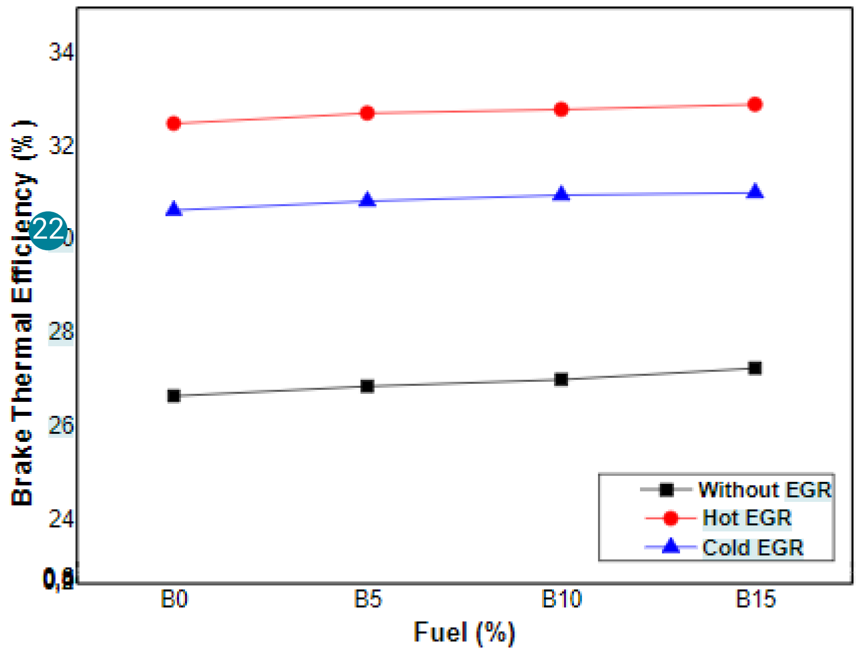

Figure 3. Brake Efficiency Thermal (BTE) EFI gasoline engines with or without EGR use variations in the addition of butanol to gasoline fuel.

BTE is one indicator of gasoline engine performance assessment. Figure 3 is the result of BTE testing on the effect of using butanol on fuel using an EFI gasoline engine with an EGR system. The test results show that BTE increases with the addition of butanol to gasoline. The addition of butanol increases the oxygen content in the fuel mixture so that the combustion process is better and thermal efficiency increases [18] . In addition, the high latent heat of vaporization in butanol helps the fuel mixture to evaporate more easily when sprayed by the injector. Good evaporation accelerates the process of flame propagation in the combustion chamber so that thermal efficiency increases [15] [19]. The highest BTE occurred in the addition of 15% butanol to gasoline fuel by 27.36%. In addition, the use of the Hot EGR system increases the highest BTE by 21.96% compared to machines without an EGR system. This is because the hot EGR system recirculates the remaining gas from the combustion into the combustion chamber without a cooling process so that the temperature increases in the cylinder. This process increases the BTE of the machine [13] [16].

3.3 Brake Specific Fuel Consumption (BSFC)

This test explains the effect of adding butanol to gasoline on the BSFC of EFI gasoline engines using the EGR system. The test results are shown in Figure 4.

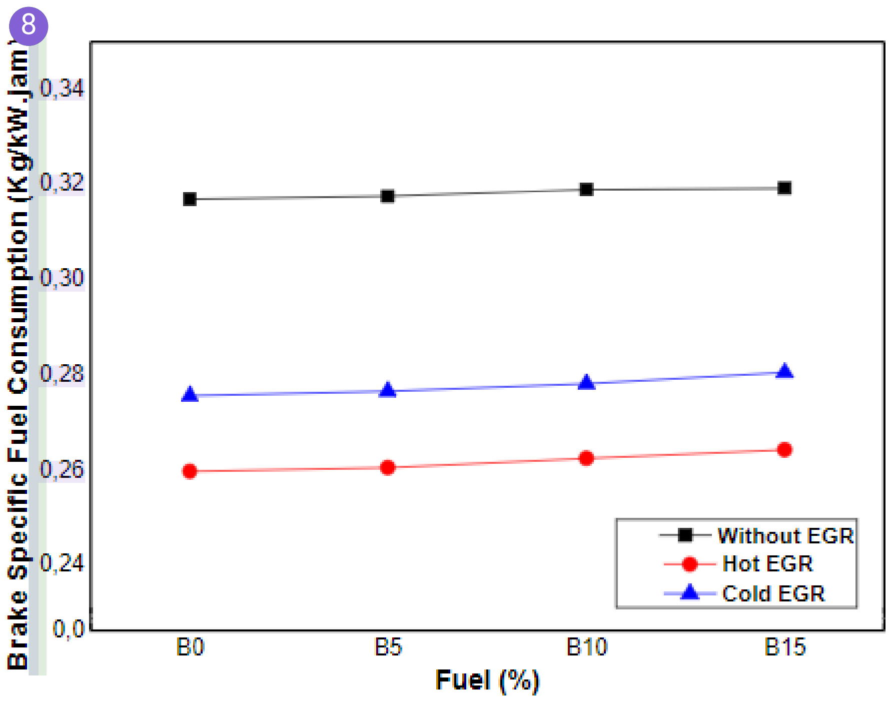

Figure 4. Brake Specific Fuel Consumption (BSFC) EFI gasoline engines with or without EGR use variations in the addition of butanol to gasoline fuel.

BSFC increases with increasing butanol percentage in gasoline. The increase in BSFC because the calorific value of butanol is lower than gasoline fuel so that the combustion chamber temperature decreases during the combustion process. This causes a high need for fuel in the combustion process so that the energy produced is sufficient to produce motion energy in the engine [10] [20]. The highest BSFC was 19.28 Kg/kW.hour when 10% butanol was added to gasoline. The use of the EGR system also increases the BSFC. This is because the unburned fuel is recirculated in the combustion chamber and helps the next discuss combustion process so that the fuel demand decreases [9] [21]. The highest decrease in BSFC occurred in the use of Hot EGR by 18.01% compared to without EGR.

4. Conclusion

This study observes the addition of 5%, 10%, and 15% butanol in gasoline to the performance of EFI gasoline engines with or without the EGR system. The results showed that the highest Brake Torque and Power were 61.43 N.m and 19.28 k.W at the addition of 10% butanol (B10). The use of Cold EGR increases Brake Torque and Power by 13.2% and 13.42%, respectively, compared to without EGR. The highest BTE occurred in the addition of 15% butanol to gasoline fuel by 27.36%. In addition, the use of the Hot EGR system increases the highest BTE by 21.96% compared to machines without an EGR system. The highest BSFC was 19.28 Kg/kW.hour when 10% butanol was added to gasoline. The use of Hot EGR reduces the highest BSFC by 18.01% compared to no EGR.

References

[1] S. Syarifudin and S. Syaiful, 2019, "Pengaruh Penggunaan Energi Terbarukan Butanol Terhadap Penurunan Emisi Jelaga Mesin Diesel Injeksi Langsung Berbahan Bakar Biodiesel Campuran Solar Dan Jatropa," *Infotekmesin*, vol. 10, no. 1, pp. 18–22.

[2] F. L. Sanjaya and S. Syarifudin, 2020, "Pengaruh Penambahan Butanol Sebagai Campuran Bahan Bakar Premium Terhadap Torsi dan Daya Mesin Bensin Dengan Sistem EGR," *Accurate J. Mech. Eng. Sci.*, vol. 1, no. 1, pp. 7–10.

[3] F. Fatkhurrozak, F. L. Sanjaya, S. Syarifudin, and S. Syaiful, 2020, "Pengaruh Diethyl Ether Terhadap Torsi dan Daya Mesin Diesel Injeksi Langsung Berbahan Bakar Solar Campuran Jatropa," *Infotekmesin*, vol. 11, no. 2, pp. 137–140.

[4] Syarifudin, Syaiful, and E. Yohana, 2018, "Effect of butanol on fuel consumption and smoke

emission of direct injection diesel engine fueled by jatropha oil and diesel fuel blends with cold EGR system," *SHS Web Conf.*, vol. 49, p. 02010.

[5] Z. Tian, X. Zhen, Y. Wang, D. Liu, and X. Li, 2020, "Combustion and emission characteristics of n-butanol-gasoline blends in SI direct injection gasoline engine," *Renew. Energy*, vol. 146, pp. 267–279.

[6] Q. Tang, P. Jiang, C. Peng, H. Chang, and Z. Zhao, 2021, "Comparison and analysis of the effects of spark timing and lambda on a high-speed spark ignition engine fuelled with n-butanol/gasoline blends," *Fuel*, vol. 287, no. August, p. 119505.

[7] F. Sanjaya, S. Syaiful, and N. SINAGA, 2019, "Effect of butanol on performances and exhaust gas emissions of gasoline engine with egr system," *Int. J. Innov. Eng. Technol.*, vol. 13, no. 4, pp. 117–125.

[8] S. Syarifudin, 2019, "Daya Dan Emisi Jelaga Dari Mesin Diesel Berbahan Bakar Solar-Jatropa-Butanol," *J. Rekayasa Mesin*, vol. 14, no. 3, p. 142.

[9] D. Agarwal, S. K. Singh, and A. K. Agarwal, 2011, "Effect of Exhaust Gas Recirculation (EGR) on performance, emissions, deposits and durability of a constant speed compression ignition engine," *Appl. Energy*, vol. 88, no. 8, pp. 2900–2907.

[10] M. N. A. M. Yusoff *et al.*, 2017, "Performance and emission characteristics of a spark ignition engine fuelled with butanol isomer-gasoline blends," *Transp. Res. Part D Transp. Environ.*, vol. 57, no. September, pp. 23–38.

[11] Y. Li, Z. Ning, C. fon F. Lee, J. Yan, and T. H. Lee, 2019, "Effect of acetone-butanol-ethanol (ABE)–gasoline blends on regulated and unregulated emissions in spark-ignition engine," *Energy*, vol. 168, pp. 1157–1167.

[12] M. S. M. Zaharin, N. R. Abdullah, H. H. Masjuki, O. M. Ali, G. Najafi, and T. Yusaf, 2018, "Evaluation on physicochemical properties of iso-butanol additives in ethanol-gasoline blend on performance and emission characteristics of a spark-ignition engine," *Appl. Therm. Eng.*, vol. 144, no. August, pp. 960–971.

[13] L. Zhao, W. Qi, X. Wang, and X. Su, 2020, "Potentials of EGR and lean mixture for improving fuel consumption and reducing the emissions of high-proportion butanol-gasoline engines at light load," *Fuel*, vol. 266, no. November 2019, p. 116959.

[14] S. Verma, L. M. Das, S. C. Kaushik, and S. S. Bhatti, *The effects of compression ratio and EGR on the performance and emission characteristics of diesel-biogas dual fuel engine*, vol. 150. Elsevier Ltd, 2019.

[15] G. Dhamodaran, G. S. Esakkimuthu, Y. K. Pochareddy, and H. Sivasubramanian, 2017, "Investigation of n-butanol as fuel in a four-cylinder MPFI SI engine," *Energy*, vol. 125, pp. 726–735.

[16] C. Hergueta, M. Bogarra, A. Tsolakis, K. Essa, and J. M. Herreros, 2017, "Butanol-gasoline blend and exhaust gas recirculation, impact on GDI engine emissions," *Fuel*, vol. 208, pp. 662–672.

[17] A. S. Ayodhya, V. T. Lamani, P. Bedar, and G. N. Kumar, "Effect of exhaust gas recirculation on a CRDI engine fueled with waste plastic oil blend," *Fuel*, vol. 227, no. X, pp. 394–400, 2018, doi: 10.1016/j.fuel.2018.04.128.

[18] F. L. Sanjaya, Syaiful, and D. N. Sinaga, "Effect of Premium-Butanol Blends on Fuel Consumption and Emissions on Gasoline Engine with Cold EGR System," *J. Phys. Conf. Ser.*, vol. 1373, no. 1, pp. 11–17, 2019, doi: 10.1088/1742-6596/1373/1/012019.

[19] Y. Li, Y. Chen, G. Wu, C. fon F. Lee, and J. Liu, 2018, "Experimental comparison of acetone-n-butanol-ethanol (ABE) and isopropanol-n-butanol-ethanol (IBE) as fuel candidate in spark-ignition engine," *Appl. Therm. Eng.*, vol. 133, pp. 179–187.

[20] Z. Chen, Y. Zhang, X. Wei, Q. Zhang, Z. Wu, and J. Liu, 2017, "Thermodynamic process and performance of high n-butanol/gasoline blends fired in a GDI production engine running wide-open throttle (WOT)," *Energy Convers. Manag.*, vol. 152, no. September, pp. 57–64.

[21] H. Wei, T. Zhu, G. Shu, L. Tan, and Y. Wang, 2012, "Gasoline engine exhaust gas

recirculation - A review," *Appl. Energy*, vol. 99, no. X, pp. 534–544.