Fuel Efficiency Improvement with Water Methanol Injection for Internal Combustion Engine

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Abstract. Fossil fuel used by many car. Reduce fuel usage make a big change to our environment. Water Methanol Injection system injected water and methanol mixture into combustion chamber of an engine. In fact methanol has high octane number and water has characteristic that delay the combustion also cooling effect for combustion chamber. Then injecting premixed water and methanol beside the fuel will produce higher power and more fuel efficiency. The aim of this study was to increase fuel efficiency for a greener engine with the same engine model because the system can be mounted into any engine and just tune it properly. Injection method required system that able to control pressure, and flow rate to keep it efficient while working. Previous research found optimum range ratio is 10-25% premixed water methanol to fuel. To make the system meets the injection ratio target it must be connected with the Engine Control Unit that tells amount of fuel required. The research used an electronic fuel injection K24Z Honda engine.

1. Introduction

Many fuel saver devices and performance upgrade now available with various model now available on the market. Basically there are many ways of working method from fuel saver device. Mechanical or electronic is method that used to increase fuel mileage. Or from both sections, combine electronic and mechanical. Most popular device that used mechanical method is fuel catalyst to improve the quality of fuel or engine shape modification to gain efficiency that modify intake, combustion, and exhaust. Then the most popular electrical device that used to gain fuel mileage is piggyback that manipulated data that will be send to Electrical Control Unit so it can change some parameter like fuel pressure, injector duty cycle, throttle opening, and ignition timing.

Now Water Methanol Injection becomes popular, WMI works with mechanic and electrical component. It can applied without electrical component directly to intake because Naturally Aspirated engine create vacuum while works but its not efficient and tune able. It is hard to reach the maximum power gain. Therefore, precision and efficient Water Methanol Injection is needed, added some algorithm allow user to set injection target and create they own map and read input data from ECU.

With DC water pump controlled by Arduino help gain mileage and power output. When working WMI read data from ECU then some sensor used to tell feedback. Injector Duty Cycle feed WMI system to tell the amount of fuel that being injected. Then Throttle Position Sensor trigger the system to works. WMI system suitable to works simultaneously with ECU because they calculate all parameter from the engine sensor to works efficiently.
2. Methodologies
Honda K24Z2 engine is type of modern naturally aspirated engine with electronic fuel injection system. Dynamometer will be used to tell horsepower and torque changes. But the dyno is not yet tested. Only WAI system will be analyzed. This experiment used fix diameter nozzle with 0.2 and 0.3 diameter orifice. To aim the ratio target injector nozzle will be tested on measuring glass with different pressure. Then the electrical component tested to obtain system response. To tell the amount of 50:50 premixed methanol and water that being injected [1, 2]. A programmable controller will be control the pump to target pressure. The controller will use Arduino and VNH2SP30 as interface to control the pump. From this experiment result from different nozzle and pressure will be compared Some of original equipment manufactur sensor will be used, read the injector duty cycle and throttle position sensor signal.

3. Setup

| Part         | Description                                     |
|--------------|-------------------------------------------------|
| Nozzle       | Inject premixed methanol and water              |
| Pump         | Pump the water methanol                         |
| Ball Valve   | Create pressure                                 |
| Solenoid Valve | Turn on water supply                           |
| Controller   | Control injection pressure                      |

Table 1. List of part used.

Part needed and the main function.

![Flow chart of system](image)

Figure 1. Flow chart of system.

Throttle Position Sensor as trigger to switch the system on. Then, Injector Duty Cycle feed the system to calculate pressure.

4. Results
Based on the test conducted. There are 3 major part that need to be analyzed. Nozzle flow rate, system response, and injector duty cycle reading. First, we want to analyze the nozzle flow rate result. K24Z2 engine used 270cc/min fuel injector flow rate. 10-25% premixed water methanol to fuel is the optimal ratio target [3-5].
4.1. Nozzle flow rate

![Nozzle Flow Rate Graph](image)

**Figure 2.** Nozzle flow rate.

From the graph above, max flow rate 27.9 obtained when 0.3mm nozzle tested with 80psi pressure. Stock fuel injector spray 270cc/min of fuel at 100% duty cycle. From injector duty reading we obtain highest duty cycle around 40-50%. In case the higher requirement of premixed methanol and water need. Multiple injector, bigger orifice, and higher pumping pressure may solve the problem.

4.2. System response and signal waveform

![System Response Graph](image)

**Figure 3.** System response.

0.4Sec of Dead Time. To slow to follow Injector Duty reference tracking. Add some PID controller may solve it.
Figure 4. Injector duty cycle waveform.

Injector waveform reading, 3ms pulse used to trigger the injector.

5. Conclusions

All the objective of water methanol injection development been achieved. Further analysis depends of application needed. Dynotest machine will be conducted to prove horsepower and power gain.

References

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