Journal of Current Research in Engineering and Science
Bi-Annual Online Journal (ISSN : 2581 - 611X)

Volume 7-Issue 1, January 2024
Paper: 5

FUEL EFFICIENCY IMPROVEMENT IN FOUR STROKE PETROL ENGINE BY USING ANTI-DETONANT INJECTION

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Abstract
Water injection, also known as anti-detonant injection, is a method of cooling internal combustion engines by spraying water into the incoming fuel-air combination. This allows for higher compression ratios and virtually eliminates engine knocking (detonation). This effectively lowers the combustion chamber's air intake temperature. Because the air intake temperature is lower, the ignition timing can be set more aggressively, increasing the engine's power output. Improvements in power and fuel efficiency can be achieved just by injecting water, depending on the engine. NOx and carbon monoxide emissions can also be reduced by water injection.

PROBLEMS IDENTIFIED

- The compression ratio must be increased to lessen the effect of explosion and to enhance the power output. As the compression ratio is increased, the temperature rises as well, resulting in auto-ignition. High pressure waves are generated as a result of this auto-ignition. These waves generate vibrations in the engine's walls. In these situations, a higher octane fuel is required. However, higher octane fuels are prohibitively expensive.
- Although water injection has the potential to lessen the effect of detonation, there is a risk of hydraulic lock if the water injector fails.

SOLUTION TO THE PROBLEM

- To avoid the hydraulic lock and to reduce the effect of detonation, the water injector is coupled with the micro-controller.
- This micro-controller controls the amount of water to be injected and the injection timing.

METHODOLOGY

The anti-detonant (Water) injection is used to lessen the specific fuel consumption and limit the risk of detonation. The water injector, which is drilled into the intake manifold, is used to feed a 4:1 combination of water and methanol, along with a trace amount of anti-corrosive oil, into the intake manifold. The PIC-16F877A microcontroller unit controls the injection time of water-methanol. The temperature rise during compression of the air-fuel mixture is reduced by this water-methanol mixture, lowering the risk of premature ignite. Premature ignition creates unwelcome combustion, which destroys engine components and causes

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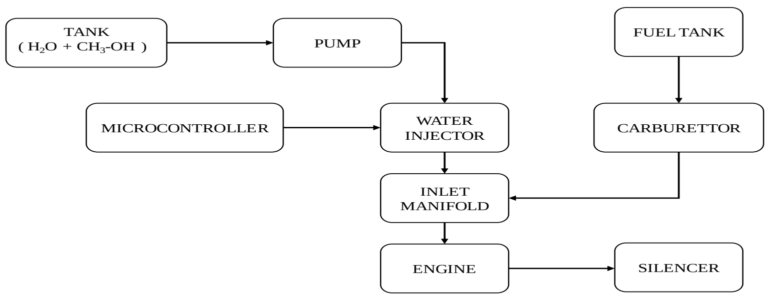
explosion. As a result, the amount of specific fuel consumed increases. As a result, the water injection system is employed.

PROCESS LAYOUT



EXPERIMENTAL PROCEDURE

WITHOUT WATER INJECTION

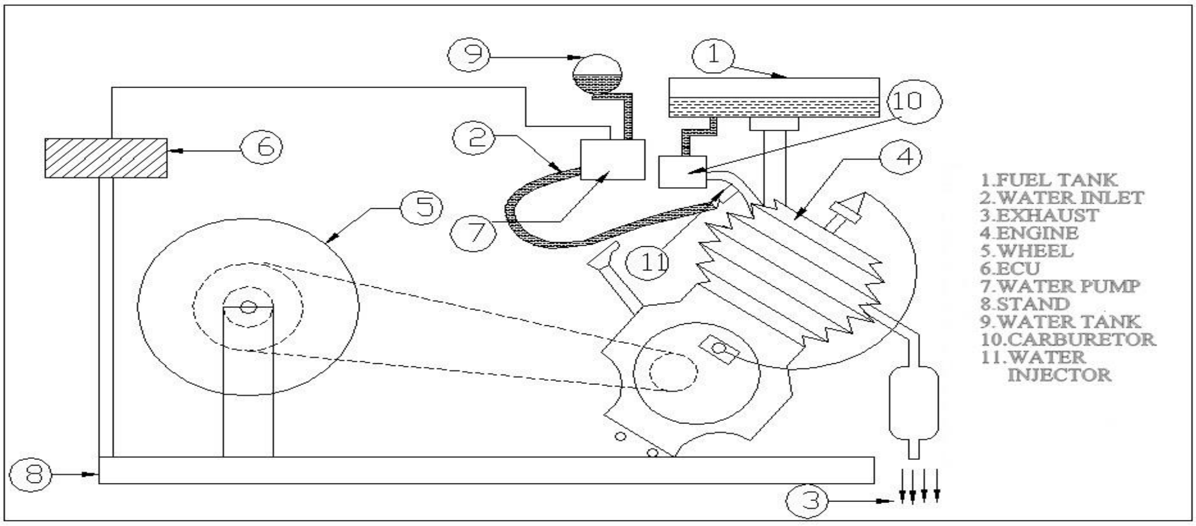
1. Start the engine by the kicker pedal.
2. When the engine pick up speed, allow the engine to run at no load for about 5-10 minutes to warm up and attain steady state condition and rated speed.
3. Take down the following readings at no load conditions,
   a) Speed by means of tachometer
   b) Time taken for 10cc fuel consumption in seconds using stop clock.

Load Setup

. Apply these loads one by one on the engine and in each load allow the engine to run for about 5 minutes to attain steady state operating condition.
5. Note down the speed (which should always be rated speed) for every load and note down the time taken for 10cc of fuel consumption.
6. Release the load on the engine, stop the engine .

WITH WATER INJECTION

1. Start the engine by the kicker pedal.
2. When the engine pick up speed, allow the engine to run at no load for about 5-10 minutes to warm up and attain steady state condition and rated speed.
3. Switch on the water pump and regulator by battery.
4. Water flow is controlled by regulator.
5. Water injector is used to inject the water into inlet manifold.
6. Take down the following readings at no load conditions,
    a) Speed by means of tachometer.
    b) Time taken for 10cc fuel consumption in seconds using stop clock.
7. Apply these loads one by one on the engine and in each load allow the engine to run for about 5 minutes to attain steady state operating condition.
8. Note down the speed (which should always be rated speed) for every load and note down the time taken for 10cc of fuel consumption.
9. Release the load on the engine, stop the engine



DIAGRAMMATIC REPRESENTATION

NO LOAD TEST

WITHOUT WATER INJECTION

S.NO	Speed (rpm)	Time for 10cc of fuel consumption (sec)
1	304	80
2	652	85
3	843	95

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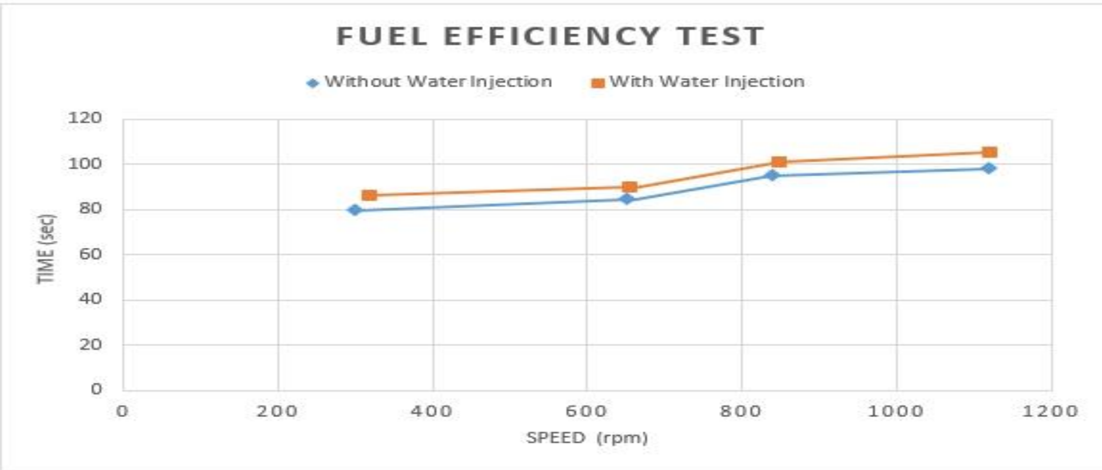
4	1120	98

WITH WATER INJECTION

S.NO	Speed (rpm)	Time for 10cc of fuel consumption (sec)
1	315	86
2	656	90
3	850	101
4	1122	105



LOAD TEST

WITHOUT WATER INJECTION

S.NO	Brake drum load kg	Speed Rpm	Time for 10cc of fuel consumption sec	Total fuel consumption kg/hr	Brake power output kw	Specific fuel consumption Kg/KWh	Heat input kw	Brake thermal efficiency %
1	0	1160	98	0.264	0	0	3.525	0
2	1.5	1050	82	0.316	0.076	4.155	4.213	1.8
3	3.5	1015	75	0.346	0.172	2.0125	4.608	3.72
4	5.5	980	68	0.381	0.26	1.4663	5.081	5.12

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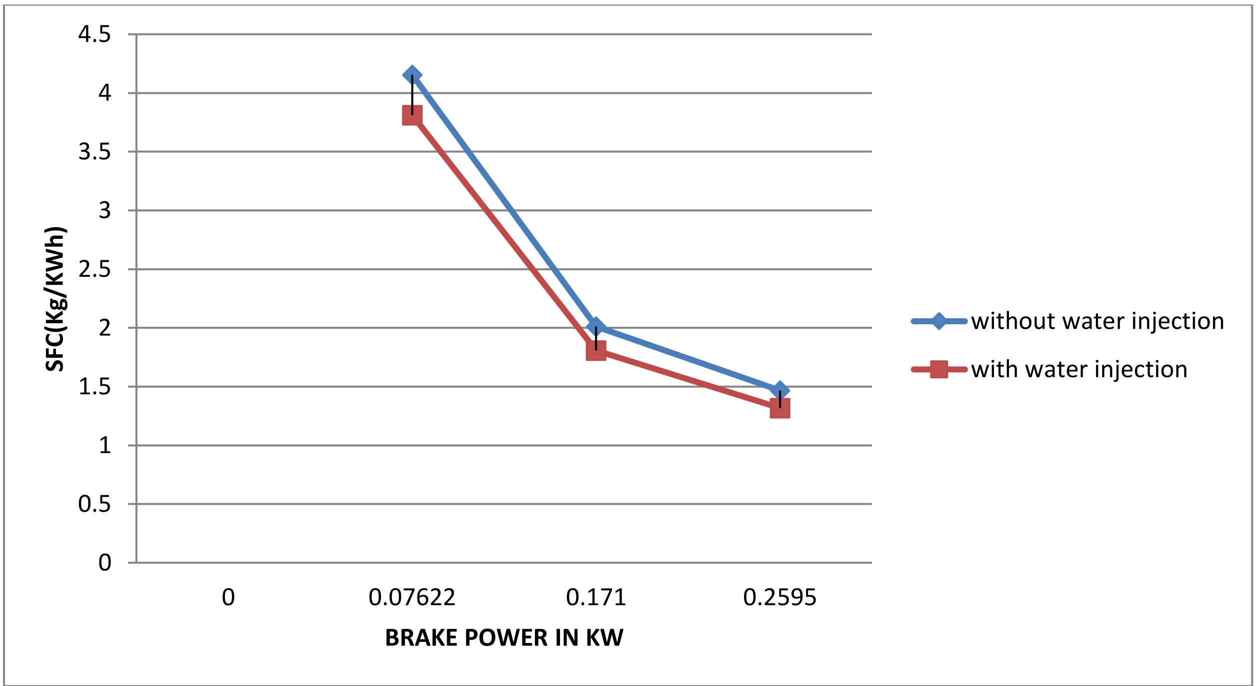
WITH WATER INJECTION

S.NO	Brake drum load kg	Speed Rpm	Time for 10cc of fuel consumption sec	Total fuel consumption kg/hr	Brake power output kw	Specific fuel consumption Kg/KWh	Heat input kw	Brake thermal efficiency %
1	0	1160	104	0.25	0	0	3.322	0
2	1.5	1056	89	0.29	0.076	3.812	3.882	1.967
3	3.5	1010	84	0.31	0.171	1.808	4.113	4.147
4	5.5	975	76	0.34	0.259	1.317	4.545	5.695

SPECIFIC FUEL CONSUMPTION VS BRAKE POWER



Without water injection:

1. Total fuel consumption (TFC) $= \frac{x}{t} \times \frac{\text{specific gravity of petrol}}{1000} \times 3600$

Where x = number of cc fuel (generally 10cc)

t = time for 'x' cc of fuel consumption (s)

Specific gravity of petrol = 0.72

$$= \frac{10 \times 0.72 \times 3600}{82 \times 1000}$$

TFC = 0.3160 kg/h

2. Brake power output $= \frac{2\pi NWR_e \times 9.81}{60 \times 1000}$

Where N = speed (rpm)

W = load (kgf)

R_e = Effective brake drum radius (m)

=Brake drum radius + radius of rope

=0.045+0.002=**0.047**

$= \frac{2\times\pi\times1050\times1.5\times82\times0.047\times9.81}{60\times1000}$

BP =0.07604 KW

3. Specific fuel consumption (SFC) $= \frac{TFC}{BP}$

$= \frac{0.3160}{0.07604}$

SFC = 4.1550 kg/KWh

4. Heat input rate $= \frac{TFC}{3600} \times$ calorific value of petrol

Calorific value of petrol = 48000 KJ/kg

$= \frac{0.3160}{3600} \times 48000$

HP = 4.2133 KW

5. Brake thermal efficiency $= \frac{\text{brake power output}}{\text{Heat input}} \times 100$

$= \frac{0.07604 \times 100}{4.2133}$

Brake thermal efficiency = 1.80 %

With water injection (Readings 2)

1. Total fuel consumption (TFC) $= \frac{x}{t} \times \frac{\text{specific gravity of petrol}}{1000} \times 3600$

$$= \frac{10 \times 0.72 \times 3600}{85 \times 1000}$$

TFC = 0.2912 kg/h

2. Brake power output $= \frac{2\pi N W R_e \times 9.81}{60 \times 1000}$

R_e = Effective brake drum radius (m)

= Brake drum radius +radius of rope

= 0.045+0.002=**0.047 m**

$$= \frac{2\times\pi\times1056\times1.5\times82\times0.047\times9.81}{60\times1000}$$

BP = 0.07640 KW

3. Specific fuel consumption (SFC) $= \frac{TFC}{BP}$

$$= \frac{0.2912}{0.07640}$$

SFC = 3.8115 kg/KWh

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4. Heat input rate $= \dfrac{\text{TFC}}{3600} \times \text{calorific value of petrol}$

$$= \frac{0.2912 \times 48000}{3600}$$

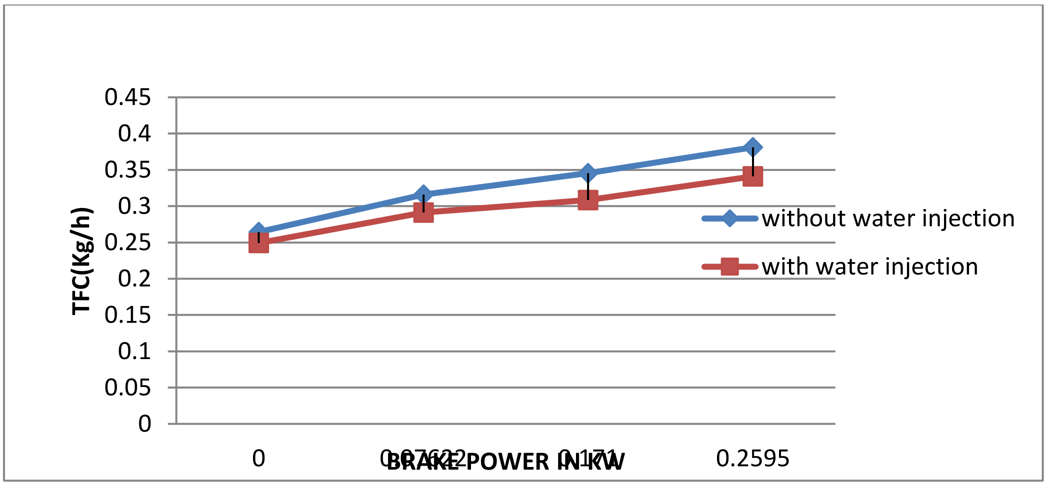
HP = 3.8825 KW

5. Brake thermal efficiency $= \dfrac{\text{brake power output}}{\text{Heat input}} \times 100$

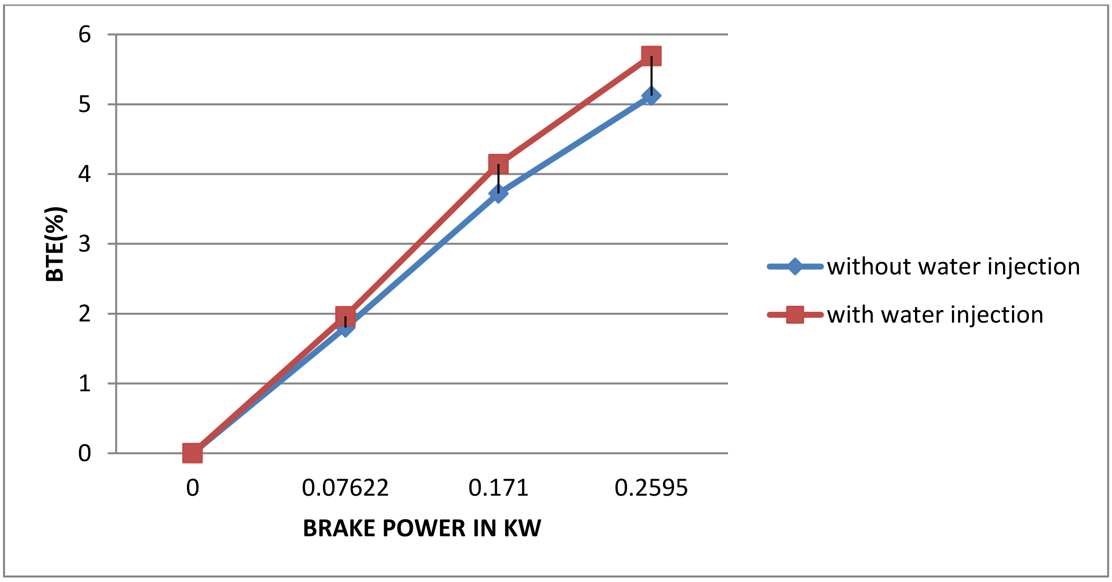
$$= \frac{0.07640 \times 100}{3.8825}$$

Brake thermal efficiency = 1.967 %

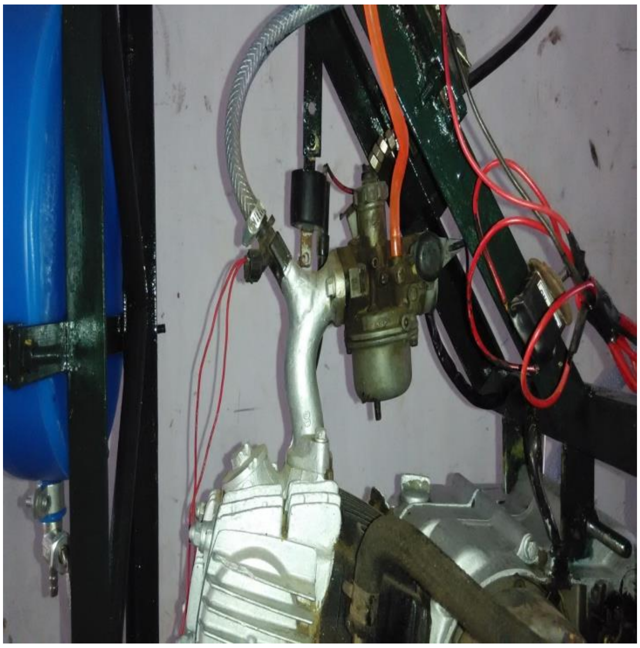
TOTAL FUEL CONSUMPTION VS BRAKE POWER



BRAKE THERMAL EFFICIENCY VS BRAKE POWER



4 Stroke Petrol Engine Kit



Location of Water Injector

CONCLUSION

No load, performance tests with and without water injection were done on the 4-stroke SI engine with experimental kit. Based on the readings collected, the fuel efficiency with and without water injection was evaluated, and graphs were generated. According to the graph, water was injected into the IC 4Stroke petrol engine, and specific fuel consumption was compared to the IC engine without water injection. We've noticed a 7 to 10% increase in fuel efficiency, which is higher than the current system.

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