Performance Analysis of 4-Stroke Single Cylinder SI Engine by Pre-heating Gasoline and Injecting 50% volume/volume Water-Methanol Mixture in Carburettor (Category-Engineering)

KEYWORDS: Pre-heating of gasoline, 50%volume/volume Water-Methanol, Carburettor, Indicated power, Fuel consumption

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ABSTRACT *In this study, the effects of pre-heating of gasoline and injecting 50% volume/volume water-methanol in the carburettor on various performance parameters of a 4-stroke single cylinder Spark Ignition (S.I) engine is investigated. In the current research, the study has been done by pre-heating gasoline at different temperature and varying the quantity of 50% volume/volume water-methanol mixture going into the carburettor. The performance is evaluated on the basis of work done, Indicated power, fuel consumption and exhaust emissions.*

1.0INTRODUCTION

An engine is always known by its performance; hence it is very important to know the impact of varying the input conditions on performance of the engine. It's a known fact that methanol has high octane number, so mixing of methanol with fuel will enhance the overall octane number of fuel which in return will provide better combustion which implies less fuel consumption, increased power and less emission in terms of carbon monoxide (CO) and hydrocarbon (HC) [1,2]. Also, for efficient combustion, pre-heating [2] is done at certain temperature as suggested by Leonard [2]; the gasoline if pre-heated is more effectively vaporized resulting in more efficient combustion inside the combustion chamber [2]. The pre-heating temperature of fuel should not increase its limit because this will create vapor pressure [2] inside the fuel line or fuel tank. So temperature has to be maintained properly. After preheating of gasoline the requirement of efficient combustion was fulfilled but it results in the knocking characteristics of the engine [3]. Using fuel having high octane number like 100% methanol will nevertheless have a significant disadvantage as they have low energy content. So increasing the octane number of the low grade fuel was more cost effective way to deal with the current condition. So 50% volume/volume water methanol mixture is introduced into the carburettor where in methanol will increase the octane number and act as a anti freezing agent and water will absorb the additional heat generated in the combustion chamber, thus reducing the knocking and detonation tendency of the engine [4] and leads to less emission of the carbon monoxide (CO) and hydrocarbon (HC) content into the atmosphere

The effect of above condition was further analyzed experimentally on S.I engine by following test.

1. Normal running condition of the engine.
2. Pre-heated gasoline at 40°C and 0.5 ml of water methanol mixture for 10ml of gasoline.
3. Pre-heated gasoline at 41°C and 0.8 ml of water methanol mixture for 10ml of gasoline.
4. Pre-heated gasoline at 41°C and 0.9 ml of water methanol mixture for 10ml of gasoline.
5. Pre-heated gasoline at 41°C and 1.5 ml of water methanol mixture for 10ml of gasoline.

The performance parameter like work done, indicated power and fuel consumption (ml/sec) where evaluated for all the above conditions.

2.0 METHODOLOGY AND EXPERIMENTATION

The engine was procured from scrap for the experimentation and was assembled to run at normal condition.

Table 1: Specification of engine.

Specification of engine	
Model	Kawasaki bajaj 4s champion
Engine type	4-stroke single cylinder
Cylinder volume	99.35 cm^3
Compression ratio	9.2
Maximum power	7.02b hp@8500rpm
Note: company has stopped manufacturing this model	

The gasoline line of the above engine was connected with an heating tank in which the gasoline was preheated before it enters the carburettor.

The carburettor of the engine was modified for introduction of 50% volume/volume water-methanol mixture. This was done by drilling a hole of 1mm at the venturie of the carburettor and the nozzle was inserted of O.D 0.6mm I.D 0.4mm at an angle of (35-40) °. Then a separate water-methanol line was connected to the carburettor and a ball valve and a needle valve were connected intermediately for the controlling the flow rate of the water-methanol mixture going in the carburettor.

Temperature and speed sensors were placed to measure the engine inlet and exhaust temperatures as well as the engine speed. The consumption of the gasoline and water-methnol mixture was measured by connecting burette to the gasoline line and water-methanol line respectively.

The fig 1 shows the arrangement of the experimental setup for testing the engine for various conditions.

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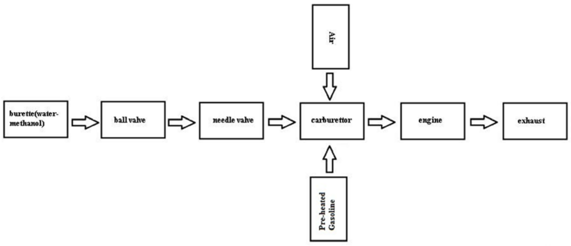

Fig: 1 Block diagram of experimental setup

After the experimental setup was complete the ball valve, needle valve was initially kept at off position to ensure no water methanol mixture enters the system. Then temperatures for various inlet and exhaust condition were measured and time taken for the consumption of 10 ml of fuel was noted. Moreover CO and HC levels were also measured at this condition using gas analyzer.

Now, fuel was pre-heated around 40-41°C and metered quantity of 50% volume/volume water-methanol was introduced in the system, inlet and exhaust temperatures of engine, engine speed were measured and time taken for fuel consumption of 10ml fuel was noted and hence performance parameter like work done, indicated power, fuel consumption (ml/sec) and emissions level of CO and HCwere calculated and compared with the normal running condition of the engine. Now, the same process was repeated 3 times but the quantity of 50% volume/volume water-methanol mixture entering the carburettor was changed during each time.

Calculation

R_c = Compression ratio = 9.2 (for given engine)

γ = 1.4(assumed to be constant)

$R_c = \frac{V_c+V_s}{V_c}$ = 9.2; where V_c= clearance volume and V_s= swept volume

Bore diameter of cylinder = 50 mm

Stroke length = 50.6 mm

$$V_s = \frac{\pi}{4} d^2 L$$

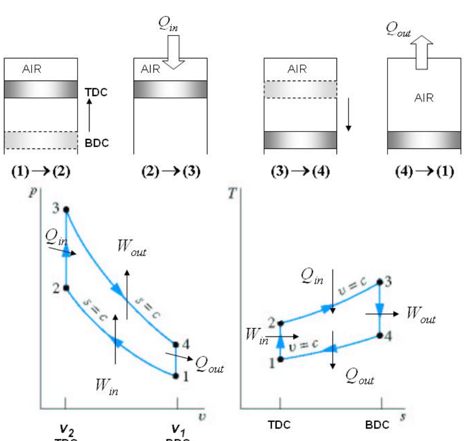

Fig 2 Thermodynamic process of the engine

$V_2 = V_3 =$

For Finding T_2&T_3:

$$\frac{T2}{T1} = \left(\frac{V1}{V2}\right)^{\gamma-1}$$

For Finding P_2, P_3& P_4:

$$\frac{P2}{P1} = \left(\frac{V1}{V2}\right)^{\gamma}$$

$$V_1 = V_4 = V_c + V_s$$

Work done during cycle:

Work done during cycle = work done during expansion – work done during compression

$$W = \frac{P3V3 - P4V4}{\gamma - 1} - \frac{P2V2 - P1V1}{\gamma - 1}$$

Indicated Mean effective pressure of the cycle:

$$P_m = \frac{W}{V_S}$$

Air standard efficiency:

Air standard efficiency = (net work done)/ (heat supplied)

Net work done = (heat supplied –heat rejected)

$$W = mc_v (T_3 - T_2) - mc_v (T_4 - T_1)$$

$$\text{Heat supplied} = mc_v (T_3 - T_2)$$

$$\eta = 1 - 1/R_c\text{^}(\gamma-1)$$

3.0RESULTS AND DISCUSSIONS:
Engine performance

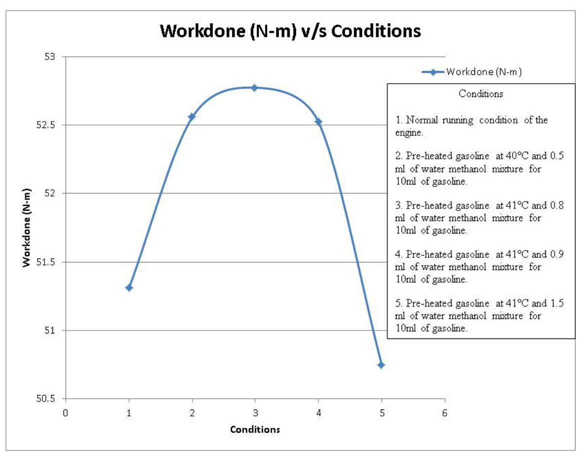

Fig 3: Workdone(N-m) v/s Conditions

Figure 3 indicates the work done by the engine on various conditions that are listed in the figure. When pre-heated fuel is introduced in the carburettor along with 50% volume/volume water-methanol injection into the system the work done increases as the quantity of the 50% volume/volume water-methanol is increased till certain point after which increasing the quantity of 50% volume/volume water-methanol reduced the work done by the engine and hence shows the negative impact on the engine performance.

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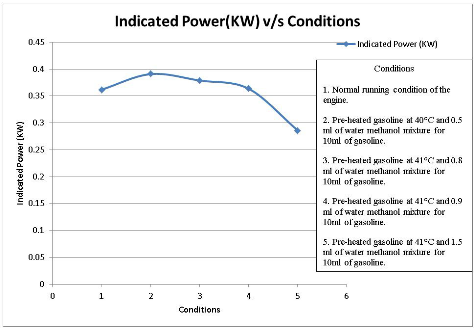

Fig 4: Indicated Power (KW) v/s Conditions

In figure 4 the curve explains the impact of the changing the quantity of the 50% volume/volume water-methanol in the system and pre-heating of gasoline on the Indicated power of the engine. With the increase in the quantity of the 50% volume/volume water-methanol injection in the system the indicated power initially increased showing the positive impact on the engine performance but when more of 50% volume/volume water-methanol is being injected in the system the indicated power tends to show reduction and hence the negative impact.

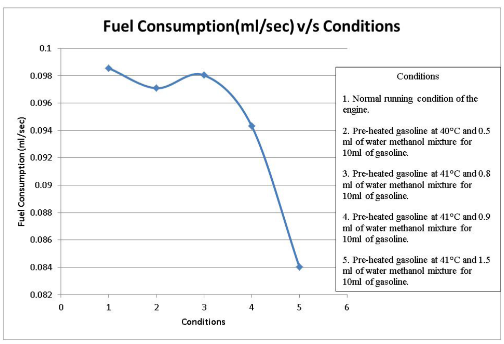

Fig 5: Fuel Consumption(ml/sec) vs Condition

Figure 5 clearly shows how the fuel consumption of the engine is reduced when the pre-heating of fuel and 50% volume/volume water-methanol is injected in the system. The fuel consumption is reduced for all the conditions as compared with the normal running condition of the engine but it can be seen clearly that there is a point where the if optimized quantity of 50% volume/volume water-methanol is injected in the system then the fuel consumption is minimum.

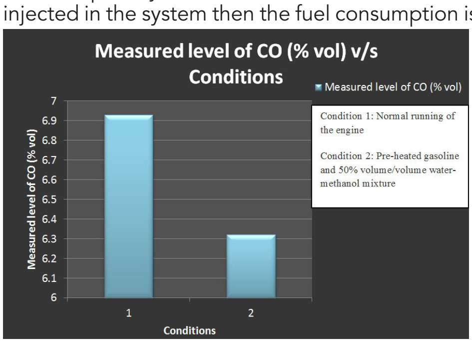

Fig 6: Measured level of CO(% vol) vs Condition

From above fig 6 it is observed that when fuel was pre-heated at 39°C and 50% volume/volume water-methanol was injected into the system, the emissions of carbon monoxide(CO) were reduced by 8.80% as compare to the normal running condition of the engine. This is because of the methonal which has oxygen rich chemical compoud help to convert CO into CO_2 . hence CO emissions were reduced.

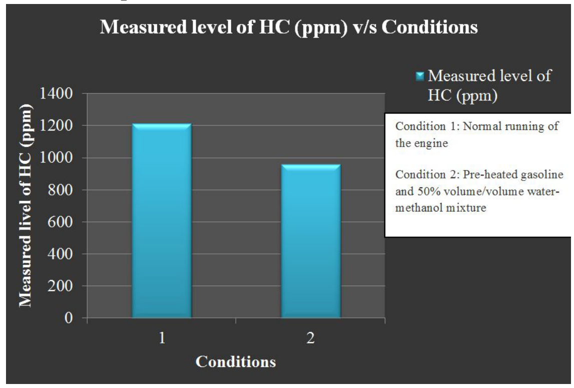

Fig 7: Measured level of HC(ppm) vs Condition

fig 7 indicated that the measured level of hydrocarbon (HC) content in the emissions is reduced by 22.80% when fuel was pre-heated and 50% volume/volume water-methanol mixture was injected in the system. The reduction in the hydrocarbon (HC) emissions was observed since methanol having high octane number, ensure that the combustion was improved hence less unburnt hydrocarbon were left after the combustion.

If effect of all the above performance parameters i.e. work done, indicated power, fuel consumption and CO and HC emissions is studied simultaneously then it is clearly visible that at certain pre-heating temperature of fuel and quantity of 50% volume/volume water-methanol, the performance parameters like work done and indicated power is maximum with least consumption of fuel moreover the emission level of CO and HC showed a significant reduction.

4.0 CONCLUSIONS:

The current research demonstrates:

The pre-heating of fuel and injecting 50% volume/volume water-methanol in carburettor can enhance the engine performance with less consumption of the fuel and simultaneously have reduced the emissions of carbon monoxide (CO) and hydrocarbon (HC) by 8.8% and 22.8% respectively

Hence it can be concluded that pre-heating of fuel ensured proper vaporization of the gasoline and injection of 50% volume/volume water-methanol mixture into the carburettor increased the octane number and so improved combustion boosted the engine performance.

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