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Performance Evaluation of Four Stroke Single Cylinder C.I Engine Using Diesel and Methonal - Diesel Blended Fuel as Alternate Fuels

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Abstract:

The attachment of supercharger to an engine increases the mass flow rate of ai r to t he cylinder which automatically increases the volumetric efficiency and performance of the engine. A comprehensive study on the methanol as an alternative fuel has been carried out. A four stroke single cylinder diesel engine was adopted to study engine power, torque, brake specific fuel consumption, brake thermal efficiency and exhaust temperature with the methanol- diesel blended fuel. In this study, the diesel engine was tested with and without supercharging using methanol blended with diesel at a mixing ratio 10:90, 20:80 of methanol to diesel respectively.

Keywords:

Exhaust Gas Recirculation, Air-Fuel Ratio, Cycle to Cycle Variation, Sound Pressure Level Spark Ignition, Alcohol Dehydrogenate, Aldehyde Dehydrogenate, M10 – Blend of 10% Methanol – 90% Diesel by volume, M20– Blend for 20% Methanol – 80% Diesel by volume.

INTRODUCTION:

Internal combustion engines are most commonly used for mobile propulsion in vehicles and portable machinery. In mobile equipment, internal combustion is advantageous since it can provide high power-to-weight ratios together with excellent fuel energy density. Generally using fossil fuel (mainly petroleum), these engines have appeared in transport in almost all vehicles (automobiles, trucks, motorcycles, boats, and in a wide variety of aircraft and locomotives).Diesel engines are found in virtually all heavy duty applications such as trucks, ships, locomotives, power generation, and stationary power. Where very high engines appear in the form of gas turbines. These applications include jet aircraft, helicopters, large ships and electric generators. Gasoline ignition systems generally rely on a combination of a lead-acid battery and an induction coil to provide a high-voltage electric spark to ignite the air-fuel mix in the engine's cylinder. This battery is recharged during operation using electricity – generating device such as a generator driven by the engine. Gasoline engines take in a mixture of air and gasoline and compress it to not more than 12.8 bar (1.28 MPa), then use a spark plug to ignite the mixture when it is compressed by the piston head in each cylinder.

These gasoline internal combustion engines are much easier to start in cold weather than diesel engines; they can still have cold weather starting problems under extreme conditions. Diesel and Homogeneous Charge Compression Ignition engines (HCCI), rely solely on the heat and pressure created by the engine in its compression process for ignition. Diesel engines take in air only, and shortly before peak compression, spray a small quantity of diesel fuel into the cylinder via a fuel injector that allows the fuel to instantly ignite. HCCI type engines take in both air and fuel, but continue to rely on an un-aided auto-combustion process, due to higher pressures and heat. Light duty diesel engines with indirect injection in automobiles and light trucks employ glow plugs that preheat the combustion chamber just before

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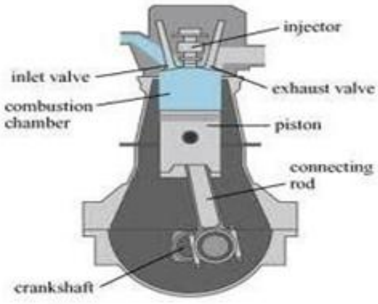
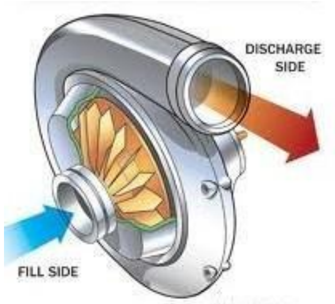
starting to reduce no- start conditions in cold weather. All internal combustion engines depend on combustion of a chemical fuel, typically with oxygen from the air. The combustion process typically results in the production of a great quantity of heat, as well as the production of steam and carbon dioxide and other chemicals at very high temperature; the temperature reached is determined by the chemical makeup of the fuel and oxidizers, as well as by the compression and other factors.

INTRODUCTION TO COMPRESION IGNITION ENGINES:

The compression ignition engine (diesel engine) is an internal combustion engine that uses the heat of compression to initiate ignition and burn the fuel that has been injected into the combustion chamber. This contrasts with spark-ignition engines (petrol engines) or gasoline engines, which use a spark plug to ignite an air-fuel mixture. The diesel engine has the high thermal efficiency of any standard internal or external combustion engines due to its high compression ratio. Diesel engines are manufactured in two-stroke and four stroke versions. This engine mainly works under the thermodynamic diesel engine. The first compression ignition engine was invented by German named Rudolf Diesel in 1892. In the practical diesel engines, only air is initially introduced into the combustion chamber. The air is then compressed with a compression ratio typically between 15:1 and 22:1 resulting in 40 bar pressure compared to 8 to 14 bars in petrol engine. This high compression heats the air to 550^0 C. At about the top of the compression stroke, fuel is injected directly into the compressed air in the chamber. The fuel injector ensures that the fuel is broken down into small droplets, and that the fuel is distributed evenly. The heat of compressed air vaporizes fuel from the surface of the droplets. The vapor is then ignited by the heat from the compressed air in the combustion chamber, droplets continue to vaporize from their surfaces and burn, getting smaller, until all the fuel in the droplets has been burnt.



Compression ignition engine



SUPERCHARGING:

A supercharger is an air compressor which is used to increase the pressure, temperature and density of air supplied to an internal combustion engine. This compressed air supplies a greater mass of oxygen per cycle to the engine to support combustion than available to a naturally aspirated engine. This phenomenon makes it possible for more fuel to be burnt and more work to be done per cycle, which increases the power produced by an internal combustion engine. The power for the supercharger can be provided mechanically by a belt, gears, shaft or chain, connected to the engine's crankshaft. There are two main types of superchargers defined according to the method of compression: positive displacement, which delivers a fairly constant level of pressure increasing at all engine speeds and dynamic compressors, which deliver increasing pressures with increasing speeds. An increase in pressure and temperature of engine intake reduces the ignition delay and results in quiet and smooth operation with a low rate of pressure rise. Thus, supercharging encourages the use of low grade fuels in compression ignition engines.

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The rise in intake air temperature reduces the unit charge and also reduces the thermal efficiency but, the increase in the density due to supercharging pressure compensates for the loss, and inter-cooling is not necessary except for highly supercharged engines. Superchargers are natural addition to aircraft piston engines that are intended for operation at high altitudes. As an aircraft climbs to higher altitudes, the air pressure and air density decreases. The output of the engine drops because of the reduction of mass of air drawn in to the engine.

For example, the air density at 9100 m is 1/3 of that at sea level and only 1/3 of air can be drawn into the engine cylinder, with enough oxygen to provide efficient combustion for only 1/3 of fuel. A supercharger compresses back to sea level equivalent pressures, or even much higher, in order to make the engine produce just as much power at cruise altitude as it does at sea level. With the reduced aerodynamic drag at high altitude and the engine still producing rated power, a supercharged airplane can fly faster at high altitude than a naturally aspirated one.

METHANOL:

Methanol, also known as methyl alcohol, wood alcohol, wood naphtha or wood spirits, is a chemical with the formula CH 3 OH. Methanol acquired the name “wood alcohol” because it was once produces chiefly as a byproduct of the destructive distillation of wood. Modern methanol is produced in a catalytic industrial process directly from carbon monoxid e, carbon dioxide, and hydrogen Methanol is the simplest alcohol.

And is a light, volatile, colorless, flammable liquid with a distinct ive odor very similar to, but slightly sweeter than ethanol (drinking alcohol). At room temp erature, it is a polar liquid, and is used as an anti freeze, solvent, fuel, and as a denaturant for ethanol. It is also used for producing biodiesel via transesterificatin reaction.

EXPERIMENTAL PROCEDURE FOR SUPERCHARGING TEST ON THE ENGINE USING THE BLENDS OF METHANOL AND DIESEL:

1. Check the levels of the fuel and the lubricating oil in the engine.
2. Open the three-way cock so that the fuel flows into the engine.
3. Supply the cooling water to the engine and also to the dynamometer.
4. Supply the compressed air to the inlet by checking the
induced pressure at the inlet of the compression ignition engine.
5. Crank the engine with the help of the handle by
keeping the decompression lever in its position. After attaining certain momentum, push the decompression lever away from its initial position and remove the crank handle from the shaft. Repeat the above procedure till the engine starts.
Check the speed of the engine by using a hand tachometer, at the flywheel of the engine crankshaft.
7. After attaining steady state, note the readings in the observation table.
8. Note the time for fuel consumption from the burette
by closing the three-way cock.
9. Load the engine slowly in steps till the maximum load corresponding to the rated power is reached.
10. Note the time for the retardation test (test for the time taken to decrease the speed of the engine by particular value in rpm, say 200 rpm), using the governor of the engine.
11. Repeat the steps from 5 to 10 for each load.
12. Again increase the pressure by passing the compressed air and repeat the procedure again.

CALCULATIONS

Brake Power:

An IC engine is used to produce mechanical power by combustion of fuel. Power is referred to as the rate at which work is done. Power is expressed as the product of force and linear velocity or product of torque and angular velocity. In order to measure power one needs to measure torque or force and speed. The force or torque is measured by Dynamometer and speed by Tachometer. The power developed by an engine and measured at the output shaft is called the Brake Power (BP) and is given by,

$$BP = \frac{2\pi NT}{60000}$$

Total Fuel Consumption (TFC):

It is defined as the amount of fuel consumed (10cc of fuel) with respect to time. It indicates the total fuel consumed by the engine and use for calculating the power.

$$TFC = \frac{10x0.8x3600}{tx1000}$$

t is the time taken for 10cc of fuel consumption. TFC is total fuel consumption in Kg/hr.

Specific Fuel Consumption (sfc):

It is defined as the amount of fuel consumed for each unit of brake power per hour it indicates the efficiency with which the engine develops the power from fuel. It is used to compare performance of different engines. The amount of fuel which an engine consumes is rated by its SPECIFIC FUEL CONSUMPTION (SFC). For most internal combustion engines the BSFC will be in therange of 0.5 to 0.6. The fuel efficiency will tend to peak at higher engine speeds. At near wide open throttle the SFC will be closer to a value of 0.5. The SFC tends to be the same for similar engines. Really huge diesel engines have reported SFC values in the 0.35 range. The estimate of specific fuel consumption for two-stroke engines ranges from 0.55 to as high as 0.8 pounds of fuel per horsepower per hour.

$$SFC = \frac{TFC}{BP}$$

Brake Thermal Efficiency (B.Th.η):

It is the ratio of the heat equivalent to one KW hour to the heat in the fuel per brake power hour. It evaluates how engine converts the heat energy into mechanical energy.

$$B.Th.\eta = \frac{BPx3600x100}{TFCxCV}$$

Indicated Thermal Efficiency (I.Th.η):

It is the ratio of output to that of energy input in the form of fuel. It gives the efficiency with which the chemical energy of fuel is converted into mechanical work. It shows that all chemical energy of fuel is not converted into heat energy. Thermal efficiency and total energy input- The methodology for calculating thermal efficiency of a unit is described in this section to help to determine whether the unit qualifies to exemption or not. It also includes total energy input which also helps in determining thermal efficiency.

$$I.Th.\eta = \frac{IPx3600x100}{TFCxCV}$$

Indicated Power:

It is defined as the power developed by combustion of fuel in the combustion chamber. While calculating the mechanical efficiency we need indicated power. It is always more than break power. It is given by

$$IP = BP + FP$$

Mechanical Efficiency:

Mechanical Efficiency is defined as ratio of brake power to the indicated power.

$$\eta = \frac{BP}{IP}x100$$

For calculation purpose, the required details i.e. specific gravity and calorific values for M10 and M20 are downloaded from available data in the literature

The calorific value for 10% methanol – 90% diesel blend =

42880 KJ / kg

The specific gravity for 10% methanol – 90% diesel blend

= 0.799

The calorific value for 20% methanol – 80% diesel blend =

40760 KJ / kg

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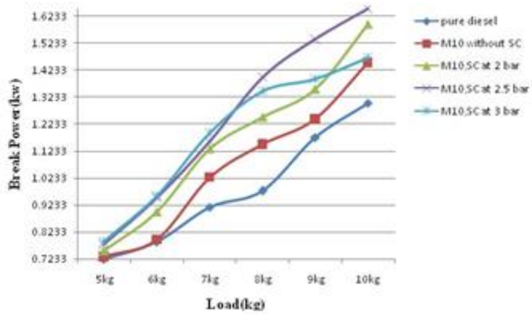
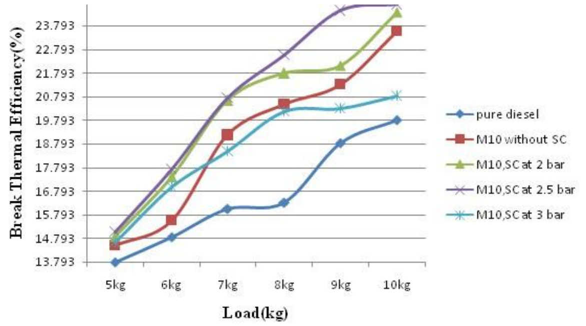
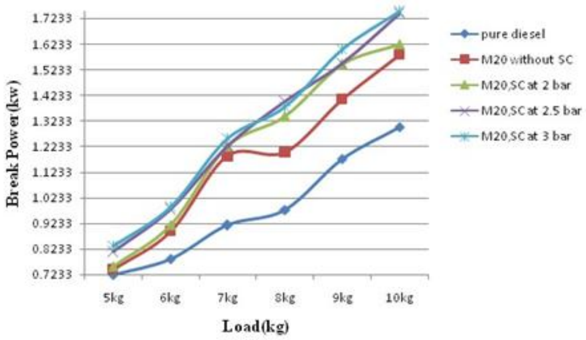
RESULTANT GRAPHS:



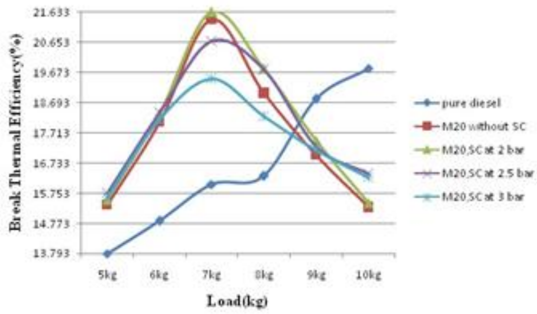
Variation of break power with loads for M10 blend



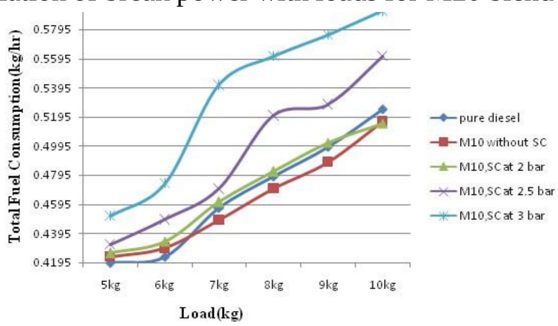
Variation of Break Thermal Efficiency with loads for M10 blend



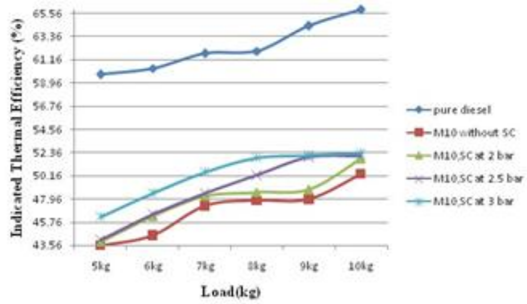
Variation of break power with loads for M20 blend



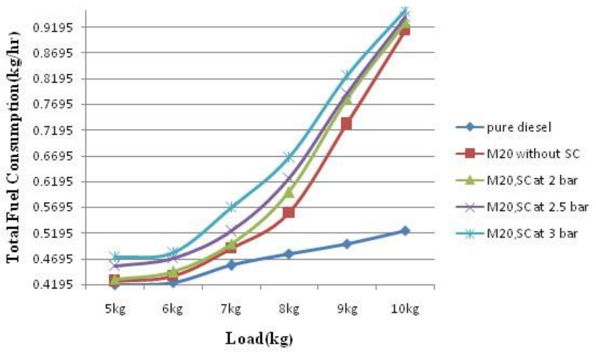
Variation of Break Thermal Efficiency with loads for M20 blend



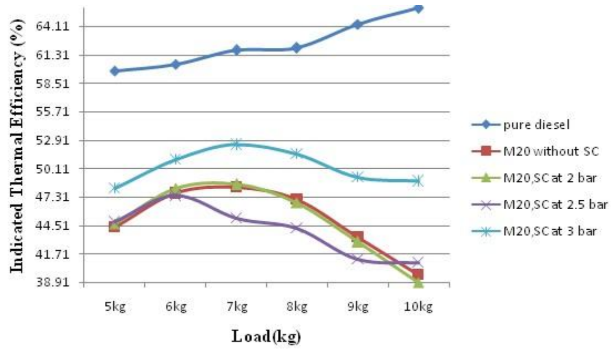
Variation of Total Fuel Consumption with loads for M10 blend



Variation of Indicated Thermal Efficiency with loads for M10 blend



Variation of Total Fuel Consumption with loads for M20 blend



Variation of Indicated Thermal Efficiency with loads for M20 blend

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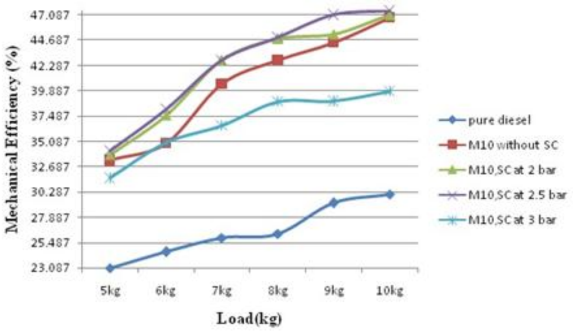
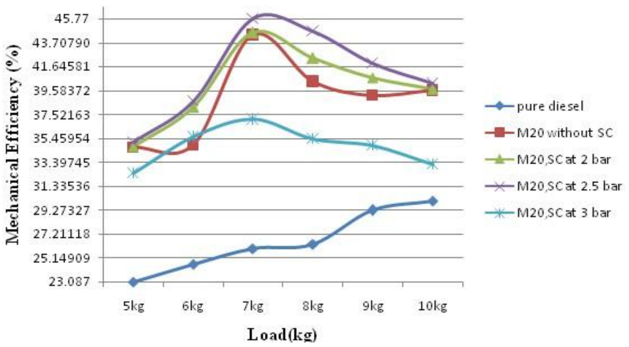


Variation of Mechanical Efficiency with loads for M10 blend



Variation of Mechanical Efficiency with loads for M20 blend

CONCLUS IONS A ND FU T URE SCOPE

A comprehensive study on the methanol as an alternative fuel has been carried out. A four stroke single cylinder diesel engine was adopted to study engine power, torque, Total fuel consumption, specific fuel consumption, break thermal efficiency, Indicated thermal efficiency and Mechanical efficiency with the fuel, fraction of methanol in diesel. In this study, the diesel engine was tested using methanol blended with diesel at certain mixing ratio of 10:90 and 20:80 of methanol to diesel respectively. Also an experimental study was conducted to find the performance of the engine with supercharging at different inlet pressures, viz 2 bar, 2.5 bar and 3 bar by using the blended fuel at the above mentioned mixing ratios. The following are the conclusions made from the results after conducting the experiments using diesel, blends of methanol M10 and M20 as a fuel at without supercharging and with supercharging by varying the inlet pressure as 2 bar, 2.5 bar and 3 bar.

The results were plotted as graphs for the performance parameters of the engine like Break Power, Total Fuel Consumption, Break Thermal Efficiency, Indicated Thermal Efficiency and Mechanical Efficiency against the load. the following are the conclusions we can make from these graphs that are, According to the analysis of the experimental results , it was confirmed that Methanol and diesel may be used as a resource to obtain the bio fuel as a replacement to the usage of pure diesel.

- Experimental results showed that the output power and torque for diesel fuel is lower compared to methanol-diesel blended fuel at any ratio and the exhaust temperature for diesel fuel was observed to be lower compared to any mixing of the blended fuel.
- It can be concluded easily that M10 , even without supercharging produces a higher brake power than the pure diesel at all loads.
- Also it can be noticed that the break power obtained in any supercharging case, for any mixing ratio up to a load of 7 kg is much more effective than the loading beyond 7 kg.
- Also it can be seen that both the blended fuels i.e M10 and M20 are providing more break power than pure diesel. The increment in break power was observed as 0.350 to 0.47 KW. However, the rise in brake power beyond a supercharging of 2.5 bar is less.
- Blending of methanol in higher amounts is giving rise to consumption of more fuel due to more frictional losses.
- Also the specific fuel consumption means the ratio of break power to TFC for M10 is more significant, by which we can easily understand that the M10 will be the better mixing ratio.
- It was found that, the break thermal efficiency was considerable for both the blends M10 and M20 compared to diesel and it was increasing with loads at all working conditions i.e with out and with supercharging.

 It is very interesting to note that the brake thermal efficiency of the M20 is higher than pure diesel and M10 at initial loading conditions irrespective of supercharging conditions. However the performance of the engine is observed to be better with M10 even at higher loads for all cases of supercharging.

 It can be concluded that, M10 and M20 are producing better mechanical efficiency than pure diesel at all conditions. Also it can be observed that at initial loads the mechanical efficiency of both M10 and M20 are closure, but M20 is giving a lesser mechanical efficiency than M10 at higher loads for all the conditions of supercharging.

• After a clear observations and the performance evaluation, it can be conclude that the better mixing ratio we can suggest is M10.

BIBLOGRAPHY

1.P. C. Jikar, M.D.Bawankure, A.G.Rokade , Performance Evaluation of Using Methanol- Diesel Blended Fuels in Cl Engine ,ICMPAE, Pattaya Dec. 2011.

2.Jagadish, D., et al, The Effect Of Supercharging On Performance And Emission Characteristics Of Compression Ignition Engine With Diesel-Ethanol-Ester Blends ,Thermal Science, Year 2011, Vol. 15, No.4, pp. 1165 - 1174.

3.S.Ganesan, Dr.A.Elango, Performance Analysis of CI Engine using blends o f Castor Oil and E t h a no l International Journal of Mining , M e t a l l u r g y &Mechanical Engineering (IJMMME) Volume 1, Issue 1 (2013) ISSN 2320-4060.

4.G.Najafi and T. F Yusaf, , Experimental investigation of using methanol-diesel blended fuels in diesel engine, Proceedings of the Fourth International Conference on Thermal Engineering: Theory and Applications January 12 -14, 2009.

5.Yousef S.H. Najjar, Alternative Fuels f o r S p a r k I g ni t i o n Engines, The Open Fuels & Energy Science Jouma1,2009,pages 1 -9.

6.Bhojraj N. Kale, Dr.S.V.Prayagi , Performance Analysis of Cottonseed Oil Methyl Ester for Compression Ignition Engines, IJETE, ISSN 2250-2459, Volume 2, Issue 8, August 7,2012.

7.A m b a r i s h D a t t a , A c h i n K u m a r C h o w d h u r i , B i j a n K u m a r Mandal , Experimental Study on the Performances of Spark Ignition Engine with Alcohol-Gasoline Blends as Fuel, India International Journal of Energy Engineering,2011.

8.Sudheer B.P.K, Murthy V.S.S, K.K Radha , Performance Evaluation of Low Heat Rejec tion CI Engine Using Vegetable oils, International Journal of Multi disciplinary Research & Advances in Engineering (IJMRAE), ISSN 0975- 7074, Vol. 1, No. I, November 2009, pp 53-70.

9.D.K. Ramesha, H.N. Vidhyasagar, Madhusudan M. Kishore , Diesel Engine Exhaust Emission Characteristics of CI Engine Using Non-Edible plant oil as Fuel, International Journal of Emerging trends in Engineering and Development, ISSN 2249-6149 Issue 2,Vol.3 ,April-2012.

10. Charalampos Arapatsakos, Dimitrios Christoforidis, Anastasios Karkanis, Konstantinos Mitroulas, Fuel of diesel-olive seed oil mixtures, International journal of energy, Issue 3, Vol. 2,2008.

11.M. Martin, D. Prithviraj, Performance of Pre - heated Cottonseed Oil and Diesel Fuel Blends in a Compression Ignition Engine, Jordan Journal of Mechanical and Industrial Engineering, Vol. 5, No. 3, ISSN 1995-6665,2011, Pages 235 — 240.

12. Peter Van Blarigan "Alternative Fuels for Spark Ignition Engines", DOE Hydrogen Program Review,2000.

13. M.A. Ceviz,F. Yuksel, Effects of ethanol — unleaded gasoline blends on cyclic variability and emissions in an SI engine, Applied Thermal Engineering vol 25,2005, 917-925.

14. Waadysaaw Mitianiec , Aukasz Rodak, Con trol Problems In a Turbocharged Spark -Igntio n Engine, Journal of KONES Power train and Transport, Vol. 18, No.3,2011.

15.Jianqin Fu, Jingping Liu "A new approach for exhaust energy recovery of internal combustion engine: Steam turbo charging",Applied Thermal Engineering Volume 52, Issue 1,2013 Pages 150 -159.

16.C. Ananda Srinivasan and C.G.Saravanan, Study o f Combustion Characteristics of an SI Engine Fuell ed wit h Ethanol and Oxygenated Fuel Additives Journal of Sustainable Energy & Environment,2010, 85 -91.

17.Maher A. R. Sadiq AI-Baghdadi, Ignition Engine Fueled with alternative Fuels, IJEE,2013.