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Performance & Emission Charecterstics of Diesel Engine Blended with Used Transformer Oil: A Review

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ABSTRACT
Our present fuel resources are not going to be around forever and with the ever increasing consumption their extinction is nearly unavoidable. Also our fuel resources which are mostly made up of fossil fuels are not renewable in nature. In the present study hydrogen at a constant flow rate of 4lpm was inducted in the suction, at some distance away from the intake manifold, along with air. Two different fuels on volume basis were tested as main fuels in a single cylinder, 4-stroke, air cooled, direct injection diesel engine developing a power of 4.4 kW, at a rated speed of 1500 rpm. One fuel was the sole used transformer oil (UTO/UTO100) and the other one was the UTO at 40% blended with 60% diesel fuel (UTO40). The results indicated increase in brake thermal efficiency for both the main fuels when hydrogen is inducted and also high reduction in smoke levels.

Key words: *Hydrogen, Used transformer oil, Performance, Emission, Combustion*

INTRODUCTION

The present energy situation has stimulated active research interest in non-petroleum, renewable and non polluting fuels. Much of the present world's energy demand may still be supplied by exhaustible fossil fuels (natural gas, oil and coal), which are also the material basis for the chemical industry. It is well known that combustion of fossil fuel causes air pollution in cities and acid rains that damages forests, and also leads to produce more carbon dioxide resulting environmental degradation. In recent year, the concern for cleaner air, due to strict air pollution regulation and the desire to reduce the dependency on fossil fuels. Many attempts are made to find various new and renewable energy sources to replace the existing petroleum fuels. Alternative fuels are available in the form of solid, liquid, and gas. Biomass, biodiesel from different vegetable oils and LPG are some of the examples for solid, liquid and gaseous alternative fuels respectively which are commonly used to run the internal combustion engines. Although these fuels are used, they generate considerable pollutants from the internal combustion engines. Hydrogen is found to be cleaner fuel among all other alternative fuels. Hydrogen is largely available and renewable in nature.

Transformer oils are an important class of insulating oils. It acts as heat transfer medium so that the operating temperature of a transformer does not exceed the specific acceptable limits. Transformer oils are produced from wax-free naphthenic oils. Although these types of crudes permit production of exceptionally low pour point insulating oils without the need for dew axing or special attention to the degree of fractionation or distillate cut width, they also contain high percentages of sulphur and nitrogen which must be removed in order to satisfy the stringent stability requirements of insulating oils . It has been found that a highly aromatic, low paraffinic content naphthenic crude oil is a suitable raw material to prepare good transformer oil.

Mineral oil is the base material for transformer oil that is used as coolant in transformers in electrical substations and welding transformers. After prolonged use, the transformer oil becomes deteoriated and becomes waste. However, the waste or used transformer oil (UTO) posses a considerable heating value and some of the properties similar to that of diesel fuel. Therefore, it can be used as an alternative fuel in compression ignition engines. But the use of UTO in compression ignition engine gives high vibration. Therefore attempts have been made to utilize the heating value of hydrogen to reduce the viscosity of UTO.

LITERATURE REVIEW:

There are some papers which have been studied and referred on my work.

L. M. Das studied that the mixture formation method plays a important role for the practical application of a hydrogen fuelled specific engine. The use of cryogenic hydrogen supplied from the liquid hydrogen tank, method of late fuel injection are studied and evaluated. It was suggested that the integrated fuel induction and storage method must be designed for an hydrogen specific engine

N. Saravanan et al. did experiments on DI diesel engine supplemented with hydrogen fuel. Two techniques were adopted to inject hydrogen inside the engine cylinder ;(1) Carburetion technique and (2) TPI –Timed Manifol d Injection technique and compared their performance, emission and combustion parameter with sole diesel by adopting both the techniques. It was concluded that TPI technique gives better performance compared to carburetion technique. The knock can occur at high flow rate of hydrogen. They concluded the optimum hydrogen enrichment with diesel was 30% by volume.

N. Saravanan et al. inducted hydrogen in a DI diesel engine adopted EGR technique to reduce NO_x emission. The arrangement was provided in such a way that, some part of exhaust gases is sent back to the engine intake manifold. This arrangement is called as Exhaust Gas Recirculation (EGR). Minimum Concentration of NO_x is 464 ppm with 25 % EGR.

N. Saravanan and G. Nagarajan conducted experiment were on a DI Diesel engine with hydrogen in the dual fuel mode The optimized injection timing was found to be 5CA before gas exchange top dead centre (BGTDC) with injection duration of 30 CA for hydrogen diesel dual fuel operation in hydrogen port injection. The optimum hydrogen flow rate is found to be 7.5 lpm based on the performance, combustion and emissions behaviour of the engine. The brake thermal efficiency for hydrogen diesel dual fuel operation increases by 17% compared to diesel at optimized timings. The NO_X emission is found to be similar at 75% load and full load for both hydrogen and diesel operation. However the concentration is lower at lower loads in hydrogen dual fuel operation due to lean mixture operation. The smoke emission reduces by 44% in hydrogen diesel dual operation compared to diesel operation. The CO and HC for hydrogen operation at optimized conditions are same as that of diesel emissions. It was concluded that the engine operated smoothly with hydrogen except at full load that resulted in knocking especially at high hydrogen flow rates.

N. Saravanan et al. investigated the combustion analysis on a direct injection DI diesel engine using hydrogen with diesel and hydrogen with diethyl ether as ignition source. Hydrogen was inducted hydrogen through intake port and diethyl ether through intake manifold and diesel was injected directly inside the combustion chamber. The optimized timing for the injection of hydrogen was 5^0 CA before gas exchange top dead centre and 40^0CA after gas exchange top dead centre for diethyl ether. They concluded that the hydrogen with diesel results in increased brake thermal efficiency by 20% and oxides of nitrogen showed an increase of 13% compared to diesel whereas hydrogen – diethyl ether showed a higher brake thermal efficiency of 30% with a significant reduction in oxides of nitrogen compared to diesel.

Li Jing Ding et al. experiment by using hydrogen as a sole fuel and then hydrogen mixed with petrol and hydrogen diesel oil mixed fuel. The main aim was to improve the combustion properties of hydrogen fuelled engine. It was concluded that increase in compression ratio is the best technique to make petrol engine or diesel engine free from back fire. An increase in compression ratio brings about a wider back fire free range of engine output and an increase in thermal efficiency and a reduction in exhaust gas temperature. Smoke can be reduced by using diesel oil – hydrogen mixed fuels (rather than oil alone).Under low speed and in high load conditions the result will be better.

J. M. Gomes Antunes et al. described the development of an experimental set up for the testing of a diesel engine in the direct injection hydrogen fuelled mode. The use of hydrogen direct injection in a diesel engine gave a higher power output to weight ratio when compared to conventional diesel fuelled operation with approximate 14% high peak power. The direct injection of hydrogen allows much better control of engine operation compared to port injection in HCCI mode. Comparison of direct injection of hydrogen with HCCI mode of operation was done and concluded that the direct injection of hydrogen offers the possibility to control and limit excessive mechanical loads while this is virtually uncontrolled in the HCCI mode of operation. They also observed the reduction of NO_x emission level.

L. M. Das studied the phenomenon such as backfire, pre ignition, knocking and rapid rate of pressure rise and presented in his review paper on the development of hydrogen fuelled internal combustion engines. According to him," Hydrogen is the only one such fuel which can meets the twin challenges of the energy crisis and the environmental pollution".

METHOD USED

The engine used for the present investigation is a single cylinder four stroke air cooled diesel engine. Initially the engine was operated with neat diesel and the performance, emission and combustion parameters were evaluated. Then the engine was allowed to run with UTO40 and UTO100/UTO respectively without hydrogen. Again the performance, emission and combustion parameters were evaluated. Now for the third test, hydrogen gas is introduced by considering first UTO40 as a main fuel and then UTO100 as a main fuel respectively.

Hydrogen fuel from a high pressure cylinder was inducted through an intake pipe. A double stage diffusion pressure regulator was employed over the high pressure cylinder. The regulator is used to control the outlet pressure. Hydrogen fuel, at a pressure of 2 bars and a constant flow rate of 4 lpm is then supplied to the flame arrester and flame trap and finally to the intake pipe (a distance of 40 cms away from the intake manifold) where it mixes with air and finally, this hydrogen- air mixture get inducted into the engine cylinder. Used transformer oil of 40% blended with 60% diesel fuel (UTO40) on volume basis is introduced from the fuel tank into the engine cylinder by direct injection. Then engine is allowed to run for different loads. The same procedure is adopted by considering sole used transformer oil (UTO/UTO100) as a main fuel with hydrogen flow rate of 4 lpm. The performance and combustion parameter is obtained by computer provided into data acquisition system. AVL exhaust gas analyser is used to calculate the emission parameter whereas smoke meter is used to get smoke values. Combustion diagnosis was carried out by means of a Kistler make quartz piezoelectric pressure transducer (Model Type 5395A) mounted on the cylinder head in the standard position. The air flow rate is calculated according to the difference in the level of water in the U- tube manometer mounted into the air suction line. The engine specification is given in the Table 4. The test is also carried out by considering diesel as a main fuel without using hydrogen. All the test results of engine using UTO40 and UTO as a main fuel with hydrogen induction were compared with neat diesel fuel and other two main fuels without hydrogen.

CONCLUSIONS

A single cylinder, four stoke, air cooled direct injection compression ignition engine was operated successfully using hydrogen gas, supplying at a flow rate of 4 LPM and inducting at a distance of 40 cm from the intake manifold. The performance, emission and combustion parameters of the engine using UTO40 and UTO100 as a main fuel, with and without hydrogen induction were obtained in the investigation are compared with the diesel fuel. The following conclusions are drawn Experimental results shows UTO40 as the optimum blending compared to all other blending proportion with diesel. The performance, emission and combustion characteristics of UTO40 can be improved further by hydrogen induction along with air. Also with UTO100, the engine was able to run but engine gives high vibration. So by inducting hydrogen on UTO100, the engine was able to run smoother. The brake thermal efficiency for both the main fuel inducted with hydrogen was found to be high, UTO40 with hydrogen is 42.14% and UTO100 with hydrogen addition was 38.91 %, because of proper combustion and high burning velocity.

REFERENCES

1. V.M. Domkundwar,"A course in internal combustion engines" Dhanpat Rai publication, ISBN 81-7700-003-0, pp 22.22-22.32.
2. G. D. Rai,"Non conventional energy sources" Khann a publishers, ISBN 81-7409-073-8, pp 315-615.
3. R.B. Gupta,"Hydrogen fuel-Production, storage and t ransportation" CRC Press publication Taylor and Francis group, ISBN 978-1-4200-4575-8, pp 1-12.
4. V.Ganeshan,"A textbook on Internal Combustion En gines" 2^{nd} edition, ISBN 0-07-049457-6, pp 220-223.

5. L.E. Reid, D.A. Gudelis, Low Pour Point Transformer Oils from Paraffinic Crudes, US Patent 4, 018, 666, and 1977
6. Tulstar products, inc. material safety data sheet Transformer Oil, Type II, and TS-3487.
7. P. Behera, S. Murugan,"combustion, performance, a nd emission parameters of used transformer oil and its diesel blends in a DI diesel engine" Fuel manuscript no: JFUE-D-11-00382,2011.
8. L. M. Das,"Fuel induction techniques for a hydrog en operated engine" Int. J. Hydrogen Energy, Vol. 15, pp 833-842, 1990.
9. N. Saravanan, G. Nagarajan, S. Narayanswamy,"An exp erimental investigation of DI diesel engine with hydrogen fuel", Renewable Energy 33, pp 415-421, 2008.
10. N. Saravanan, G. Nagarajan, K. M. Kalaiselvan, C. Dhanasekaran,"An experimental investigation on hydrogen as a dual fuel for engine system with exhaust gas recirculation technique" Renewable Energy 33, pp 422-427, 2008.
11. N. Saravanan, G. Nagarajan, "Performance and em ission studies on port injection of hydrogen with varied flow rates with diesel as an ignition source" Applied Energy, Vol.87, pp 2218-2229, 2010.
12. N. Saravanan, G. Nagarajan, G. Sanjay, C. Dhanasekaran, K. M. Kalaiselvan, "Combustio n analysis on a DI diesel engine with hydrogen in dual fuel mode", Fuel 87,pp 3591-3599, 2008.
13. Li Jing-Ding, Lu Ying-Qing and Du Tian-Shen, "I mprovement on the combustion of a hydrogen fuelled engine" Int. J. Hydrogen Energy, Vol 11.No.10,pp 661-668, 1986.