www.sphinxsai.com

International Journal of ChemTech Research
CODEN(USA): IJCRGG ISSN : 0974-4290
Vol.5, No.4, pp 1797-1801, April-June 2013

Formulation Of Novel Bio Based Tri Fuel For I.C. Engines

D.Kumaran[1]*, M.Rajendran[2], P.A.Jeeva[3], S.Karthikeyan[4]

[1*]Anna University, Coimbatore Region, Coimbatore - 641047, Tamilnadu, India.

[2]Department of Mechanical Engineering,Govt. College of Technology, Coimbatore, Tamilnadu, India.

[3] School of Mechanical&Building Sciences,VIT University,Vellore,India.

[4]Centre for Nanobiotechnology, VIT University,Vellore,India.

***Corres.author: kumaran_gym@yahoo.in**

Abstract: The present study focused on non-petroleum renewable and non-polluting fuels to be used for I.C engines. The tri-fuel is assortment of diesel, turpentine blend and acetylene gas. The acetylene gas is produced from the lime stone ($caco_3$) and the turpentine oil obtained from the pine tree. The performance of a tri-fuel has been analysed experimentally in a single cylinder direct injection and compression ignition engine with diesel and turpentine blend as primary fuel and acetylene inducted as secondary gaseous fuel i.e., diesel and the turpentine blend (40% turpentine(40T) and 60% diesel) . The results showed that the blend and the acetylene gas flow rate of 3 litres per minute (through a gas flow meter) offered higher brake thermal efficiency between 1% and 3% than that of diesel baseline operation .

Keywords: Tri-fuel, turpentine, acetylene, brake thermal efficiency, combustion engine.

Introduction

The use of fossil fuel is increasing drastically due to its consumption in all consumer activities. The high utility of fossil fuel depleted its existence, degraded the environment and led to reduction in underground carbon resources. Hence the search for alternative fuels is paying attention for making, sustainable development, energy conservation, efficiency and environmental preservation, has become highly pronounced now a days [1-3] **.** The world wide reduction of underground carbin resources can be substituted by the bio-fuels. The SI and CI engines are the major contributors of the GHG. The main researchers around the world are finding the alternate fuel that should have the least impact on the environmental degradation. Rudolf Diesel patented an engine design for used dual fuel system [4-6]. The present fuel system involves the adaptation of Rudolf with diesel as a single fuel. The emission of CO_X is unavoidable in fuel combustion systems. An attempt has been made to develop a tri fuel system without additives in conventional C.I engines to achive biofuel and to reduce emission of pollutants. The results are presented and discussed.

Literature Review

Jorge [7] have analysed a dual fuel engine adapting propane and diesel fuel. It is reported that, the replacement of ninety percentage diesel input by propane gas without modifying thermal efficiency of engines. The emission of more CO was realized at all load conditions than that of standard diesel operation. Jatropha oil and orange oil was used by Senthilkumar and his coworkers[8] orange oil retarded smoke and NO emission with improved thermal efficiency. The work of Karim [9,10] investigated the utility of gases like methane, propane, acetylene, ethylene and hydrogen in diesel engine and the knocking was found less. Rao et al[11] and Tomita reported that incorporation minimum quantity of hydrogen improved the performance of diesel engine in dual fuel mode in lower loads and reciprocated in higher loads .

Recently Nagarajan et al.[12], Ashok Kumar et al.[13], Swami Nathan et al.[14] conducted investigated the performance of acetylene in a CI engine and found reduction CO_x emissions with increased level of hydrocarbons. The present work used an one such type of oil called turpentine in a regular DI diesel engine along with the form of blends (60%diesel+40% turpentine) and the acetylene gas of fixed quantity inducted in the inlet manifold at a point closer to the intake valve. The reason choosing turpentine is to fix the characteristics of fuel in between the properties of petrol and diesel in DI diesel engine.

Experimental details

A 4.4 kW single cylinder four stroke engine at 1500 rpm, fuelled with diesel and turpentine fuel blend was utilized with acetylene for tri-fuel operation. The experimental setup is given in **Figure 1.** Acetylene was supplied in a controlled way by means of a flame trap. A Manometer was used for measuring internal pressure drop and the flow time of injection was noted. The cathodic ray oscilloscope along with piezoelectric pressure transducer was installed on the cylinder nozzle to monitor the pressure changes. A thermocouple was used for exhaust gas temperature measurement. The exhaust gas constituents CO, CO_2, and smoke were measured as described earlier.

Initially the engine is started from the diesel and turpentine fuel blend and allowed to warm up. The flow rate during acetylene supply can be monitored by the present experimental setup.

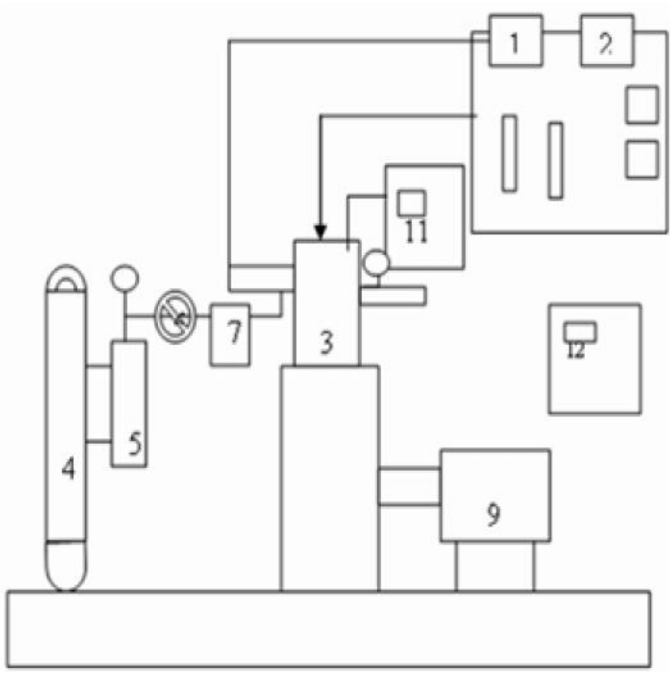

Figure 1 Schematic of the experimental setup

1. Air flow meter 2. Diesel and turpentine blend fuel tank 3.Diesel engine 4.Acetylene generator 5. Flame trap6.Flow control valve7.Gas flow meter 8.Intake manifold 9. Dynamometer 10.Control panel 11.Oscilloscope 12.Gas analyser

Table 1 Physical and chemical properties of turpentine & acetylene

Properties	1.Gasoline	2.Diesel	3.Turpentin	4.Hydrogen	5.Acetylene
Formula	C_4 to C_{12}	C_8 to C_{25}	$C_{10}H_{16}$	H_2	C_2H_2
Molecular weight	105	200	136	1	26.04
Density kg/m^3	780	830	860-900	0.08	1.092
Specific gravity	0.78	0.83	0.86-0.9	0.0696	0.920
Boiling point ^{0}c	32-220	180-340	150-180	- 252.8	-84.44
Latent heat of vaporization kj/kg	350	230	305	0.904	801.9
Lower heating value kj/kg	43,890	42,700	44,000	1,20,000	48,225
Flash point ^{0}c	-43	74	38	-	32
Auto ignition temperature ^{0}c	300-450	250	300-330	572	305
Flammability limit %volume	1.4	1	0.8	4	2.3

Results and Discussion

The following are the results were obtained in a single cylinder four stroke air cooled naturally aspirated direct injection diesel engine. The performance study has been made for break thermal efficiency, CO emission, HC emission, Ignition delay and heat release rate of tri-fuel and compared with standard fuel (Diesel). Figure 2 shows the variation of brake thermal efficiency of tri-fuel concept in a fully loading condition. It shows comparatively higher brake thermal efficiency than that of standard fuel (Diesel) at all loads. This is due to the presence of high volatile turpentine in the blend. Basically, turpentine is a cyclic compound of terpene (Basic element of turpentine). It decomposes easily at low temperature and releases more intermediate compounds (lighter HC fractions) immediately after injection. The presence of turpentine in the blend causes longer ignition delay and rapid combustion. During longer ignition delay engine accumulates more fuel before the commencement of combustion and releases more fraction of heat during the premixed phase of combustion. This leads to higher cylinder pressure. The improved volatility, increased heat content and improved air entrainment could be the other reasons for higher thermal efficiency these may be the reasons for higher brake thermal efficiency. In general it is noted that in the Dual fuel engines, the thermal efficiency decreases at low load sand increases above the base line at fuel load operation with addition of inducted fuels like LPG and CNG etc [15].. However in the above Tri fuel concept because of wide flammability limit and high combustion rate of acetylene and release of lighter HC fractions by turpentine blend the thermal efficiency of Tri fuel concept is not lower than pure diesel fuel operation

The maximum brake thermal efficiency obtained in a tri-fuel concept is 32 % and it is 3% higher than that of standard fuel operation. From table 2 and Figure 3, that the CO emission of tri-fuel concept with standard fuel operation. It shows that the CO emission of tri-fuel is lower than that of standard fuel at all loads. This is due to complete burning of the fuel and reduction in overall C/H ratio of the total inducted fuel.Correct fuel admission and effective fuel utilization are the other reasons for low CO emission at all loads. The CO emission of tri-fuel at all load is 5% lower than standard fuel[16].

The combustion and turpentine has low cetane number and offers longer ignition delay. This is the main reason for higher brake thermal efficiency, shorter burn duration and higher peak pressure of Tri Fuel.

Table 2 CO emission of Standard fuel and Tri-fuel

S.No.	Load in %	CO emission in %	
		Tri-fuel	Standard fuel
1	0	0.25	0.35
2	25	0.2	0.3
3	50	0.25	0.35
4	75	0.3	0.4
5	100	0.65	0.7

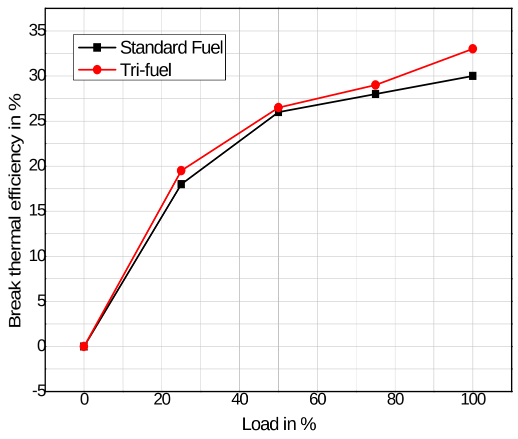

Figure 2 Load Vs Break thermal efficiency

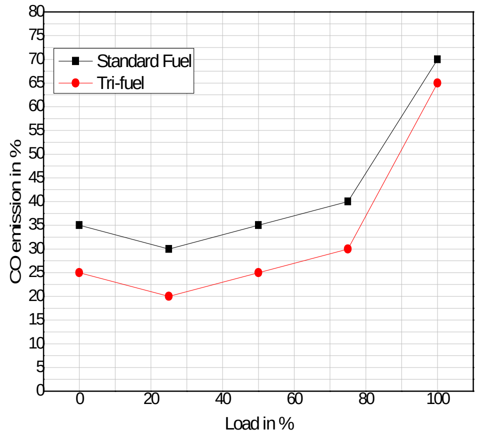

Figure 3 Load VsCO emission of Standardfuel and Tri-fuel

Conclusion

Tri-fuel concept(acetylene aspiration in let manifold up to 3 lpm and mixing of turpentine with diesel fuel up to 40%) for brake thermal efficiency increased by 1-3 % from the standard fuel. It exhibited lower exhaust gas temperature compared with diesel operation.

An appreciable reduction in HC,CO and CO_2 emissions was observed in Tri fuel concept with increased engine performance without much worsening its emission. There is an increase in the peak cylinder pressure and rate of pressure raise, when gas is inducted.

References

1. Kesse DG. Global warming—facts, assessment, countermeasures. J Pet SciEng , 2000, 26:157–68.
2. Goldemberg J, Johnsson TB, Reddy AKN, Williams RH. Energy for the new millennium.R SwedishSci2001;30(6):330–7.
3. Gilbert R, Perl A. Energy and transport futures. A report prepared for national round table on the environment and the economy, University of Calgary, June 2005. p. 1–96.
4. Karim GA, Moore NPW. Knock in dual-fuel engines. Proceedings of the Institution of Mechanical Engineers
5. Devan.P.K, and Mahalakshmi.N.V. (2010). Combustion, Emission and Performance Characteristics of Diesel engine Fuelled with Eucalyptus oil with an Ignition Enhancer, International Journal of Green Energy, Energy and Environment, Vol.1, No.1, April 2010,pp. 40-49.
6. Karthikeyan R. and Mahalakshmi N.V. (2005). Performance and emission characteristics of four stroke DI diesel engine fuelled with turpentine diesel blends, Proceedings of the ICEF2005 ASME Internal Combustion Engine Division 2005 Fall Technical Conference, Sep 11-14, 2005, Ottawa, Canada
7. P.M. George a, NishaPillai b, Nisha Shah b. (2004). Optimization of shot peening parameters using Taguchi technique, Journal of Materials Processing Technology, 153–154 (2004) 925–930..
8. Senthilkumar.M,Ramesh.A,Nagalingam.B(2001), Experimental Instigation on a jatropa Oil Methanol Duel fuel engine',SAE Trans,2001-01-0513.
9. Karim GA, Moore NPW. Knock in dual-fuel engines. Proceedings of the Institution of Mechanical Engineers
10. Karim GA. The ignition of a premixed fuel and air charge by pilot fuel spray injection with reference to dual-fuel combustion. SAE Paper No. 680768.
11. Rao H, Shrivastava KN, Bhakta NH. Hydrogen for dual-fuel engine operation. International Journal of Hydrogen Energy 1983;8:381e4.
12. Nagarajan G, Saravanan S, Dhanasekaran C, Kalaiselvan KM. Experimental investigation of

hydrogen port fuel injection in DI dual fuel diesel engine. International Journal of Hydrogen Energy 2007;18:421e31.1
13. Ashok V, Mohammed Sikander, Mohammed Najmul Islam Khan. Experimental investigation on use of welding gas (acetylene) on SI engine. In: Proceedings of AER Conference, IIT Mumbai, India; 2006. p. 422e7.
14. SwamiNathan S, Mallikarjuna JM, Ramesh A. HCCI engine operation with acetylene the fuel. SAE Paper No. 2008-28-0032.
15. Holman JB. Experimental techniques for engineersMcGraw Hill Publications; 1992.
16. Karthikeyan.R, Nallusamy.N, Alagumoorthi.N, Ilangovan.V (2010) A Detailed Experimental Investigation on Hot Air Assisted Turpentine Direct Injected compression Ignition Engine, International journal of Engineering science and Technology. Vol.2(10),2010,5034-5049.

*****