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Find the Performance of Dual Fuel Engine Followed by Waste Cooking Oil Blends with Acetylene

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Abstract: In the present scenario owing to the depletion of fossil fuel and at the same time increase in demand averts the researchers towards the alternative fuel. Various investigation is being carried out to find the most suitable alternate for the fossil fuel in IC engine, which satisfies the demand, improves the performance and decreases the emission. This paper deals with the dual fuel mode. Tests were performed at single cylinder fore stroke dual fuel diesel engine with blends of acetylene in different proportions (0.199 kg/hr,0.394 kg/hr and 0.588 kg/hr) with 20% waste cooking oil at a rated injection pressure of 200bar.The result shows the increased in BTE and decreased BSFC and exhaust gas temperature, furtherance the decrease in NOx and CO are observed as the amount of acetylene increases. BTE increases because of lower auto ignition temperature and high calorific value of acetylene. Graphs were obtained based on the performance of the engine and B20 with 0.394 kg/hr of acetylene is concluded to be optimum, B20 with 0.199 kg/hr shows the result similar to diesel operation, at B20 with 0.588 kg/hr the increase in the knocking effect was observed.

Keywords: Acetylene Blends, Dual Fuel Diesel Engine, Emission, Waste Cooking Oil Blends.

I. INTRODUCTION

Rudolf diesel who was the first inventor of the diesel engine which runs with the vegetable oil, operated the diesel engine using groundnut oil as fuel in 1900.[1] Many researchers are in hunt to render most suitable vegetable oil as an alternate to the diesel fuel .In order to conquer the increasing demand and day by day decreasing quantity of fossil fuel, lowering the hazardous effect of exhaust emission on the environment. A vegetable oil with supreme properties should be used to improve the performance and provide effective utilization of BTE in diesel engine emitting lower emission [2-6]. Transesterification is the process in which organic acid ester is converted in to another ester and glycerin when rated with alcohol .to improve the reaction rate NaOH can be used as a catalyst **A. S Ramadhas et.al.**[8] in his review concluded that the thermal efficiency of vegetable oil was same as diesel oil, but little amount of power loss was observed.

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While comparing to the diesel the particulate emissions of vegetable oil are higher at the same time NOx value lesser. **S.Bonaetal et.al** [9] in his steady said that vegetable oil and their derivatives in diesel engines provides lower emissions of sulfur oxides, Carbone monoxides (CO), polyaromatic hydrocarbon s(PAH), smoke .particulate matter (PM) and noise. **Forson et.al**.[10]. stated that the lower concentration of jatropha oil in the blend in the IC engine renders closer performance and emission characteristics to diesel engine**.** **Karim et.al** [11,12] worked on utilization of gaseous fuel and effect of knock on dual fuel engine. he reveals that the concentration of the gases fuel such as, propane, hydrogen acetylene, ethylene and methane effects the ignition delay period of the pilot fuel. And the maximum amount of gases consumption is decreases due to onset of knock. Furthermore, he stated that the quantity, quality, injection timing intake temperatures are the vital variable factor that effected the performance of dual fuel engine. **Wilff et.al**.[13]

investigated an internal combustion engine using acetylene. operated an engine on dual fuel made using a mixture of acetylene and alcohol in a spark ignition engine in a controllable way. He observed higher efficiency than

Properties	C_2H_2	H_2	Diesel	Waste cocking oil
Density at 1.0132 bar and 293K(kg/m^3)	1.092	0.08	815	878
Calorific Value (Kj/kg)	48,225	1,20,000	43,350	38,650
Viscosity at 300 K (mm^2/s)	-	-	4.3	10.3
Cetane Number	-	-	47	45
Auto Ignition Temperature (K)	578	572	527	-
Flame Speed(m/s)	1.5	3.5	0.3	3.9
Flammability Limits (volume %)		2.5-81	4-74.5	0.6-5.5 -
Ignition Energy(mj)		0.019	0.02	- -

Table 1: Chemical properties of fuels

the internal combustion engine with clear burning fossil fuel. He added that the life of the engine can be expected to increase as the combustion temperature was lower throughout the test performed.

Utluz, and kocak MS. [14] conducted experiment on direct injection diesel engine. they used waste frying oil as bio diesel in their investigation and found that the respective average deceases of torque .and power values of WFOME (waste frying oil methyl ester) was 4.3%and 4.5% because of the higher viscosity and density and lower heating value (8.8%) **M.k Senthil et.al**[15] stated that the reduction in power and increases in emission can overcome buy dual fuel operation even at all full load for high viscous fuel. He added that dual fuel made offer lower efficiency at part loads due to incomplete combustion of inducted fuel and air their effect can be reduced by the use of wide flammability limits and high flame velocities. **Swaminathan S et.al**.[16] Tested HCCI engine operates on acetylene. he conducted that the acetylene has high flame speed, lower ignition energy and wide flammability limits compared to the diesel and hydrogen, fuel leading to premature ignition and knock in the acetylene operated engine. experiment was conducted using LPG in dual fuel mode in a jatropha fueled diesel engine. The result shows reduced NOx and smoke during the test entire load range [17]

II. EXPERIMENTAL SETUP AND METHODOLOGY

The experiment was carried by single cylinder multi fuel water cooled engine with fully computerized interface system, the engine having special eddy current loading system as described in table-2, while the schematic diagram of the test ring setup is shows in fig-1. The test was carried out at different loads of 3kg, 6kg, 9kg, 12kg with a rated speed of 1500 rpm.

Make	Kirloskar
Model	TV1
Type	VCR engine
Bore × Stroke(mm)	87.5×110
Rated Power (KW)	3.5
Rated Speed (rpm)	1500
Injector Operating Pressure (bar)	200

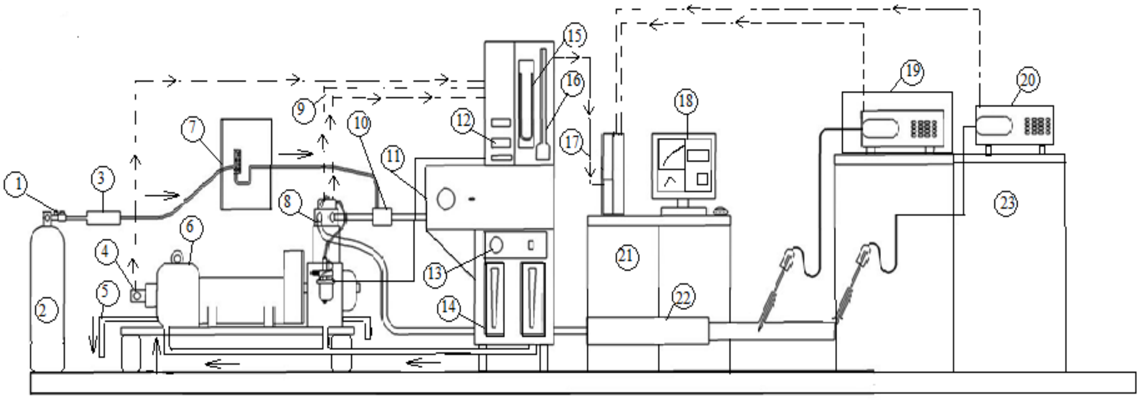
Table 2: Engine Specifications

III. ENERGY SHARING

The main concept of this system is to understand the dual fuel operation and incomplete combustion of fuels, the energy contribution of system measures the **to** be estimated from an energy balance, the energy table gives the detailed explanation of varies fuels energy values, to know the performance of the varies fuels the experiment is to measure the energy contributions to the diesel engine

Made of operation full load	mass of diesel (kg/hr)	Mass of WCO (kg/hr)	Mass of acetylene (kg/hr)	Energy equivalent to diesel (KW)	Energy equivalent to WCO (KW)	Energy equivalent to C2H2 (KW)	Energy Shearing To Diesel (%)	Energy Shearing To WCO(%)	Energy Shearing To C2H2 (%)
Pure diesel	0.95	-	-	11.084	-	-	100	-	-
80%de+20%wc	0.92	0.2479	-	10.7341	2.661	-	80.1	19.86	-
80%de+20%wc +0.199 kg/hr .	0.809	0.2023	0.0288	9.439	2.172	0.3811	78.7	18.11	3.178
80%de+20%wc +0.394 kg/hr	0.586	0.1467	0.0576	6.8372	1.5751	0.784	74.34	17.127	8.52
80%de+20%wc +0.588 kg/hr	0.422	0.1057	0.0864	4.9342	1.1348	1.176	68.103		

Table 3: Energy Share Ratio of Diesel Acetylene and waste Cooking Oil



1.Regulater 2.Cylinder 3.Fire Resistor 4.CA Encoder 5.Water Outlet 6.Eddy Current Dynamometer7. Flow meter 8.Engine 9.Fuel Line Pressure sensor line 10.Gases mixed chamber 11.Orifice Meter 12.RPM Indicator 13.Loading unit 14.Rota meter 15.U-Tube Manometer 16.burette 17.NI-6210 USB Multi function line 18.Computer 19.Exhaust gas analyzer 20.Smoke meter 21.Computer Table 22.Exhaust Gas Calorimeter 23.Analyser Table

Figure 1 Schematic Diagram of Experimental Set Up

which is treated as a thermodynamics system, the performance values and consumption of fuel for different fuels depends up on their calorific values and specific fuel consumption, the table indicates that c2h2 value is increases and diesel blends is decreases as I increasing the acetylene proportion value

IV. RESULT AND DISCUSSION

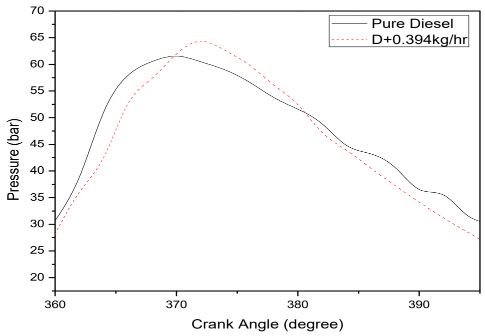


Figure 3.1 Variation of Cylinder Pressure with Crank Angle

The Figure 3.1 shows the variation of pressure with the crank angle for (B20+0.394 Kg/hr) of acetylene and pure diesel at a rated speed of 1800 rpm. The values of peak pressure for pure diesel and (B20+0.394 Kg/hr) were obtained as 60.47 bar and 64.12 bar. This is due to the high calorific value of acetylene and wide flammability limits.

The analysis of the heat release rate depends upon the concept of first law of thermodynamics which involves the ratio of specific heat of fuel and air, average pressure of the combustion chamber taken for 100 cycles and volume of the combustion chamber. Figure 3.2 shows the relation between the heat release rate and crank angle. The net heat release rate at 3600 CA was 66 J/0 CA for pure diesel and for B20+0.394 Kg/hr at 3640 CA the net heat release was 80 J/0 CA which is the maximum heat release rate and assumed to be optimum. This is because in dual fuel mode slight time is taken for burning the charge due to the phase change and high viscosity of the pilot fuel.

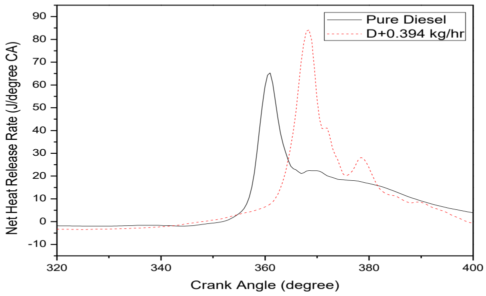


Figure 3.2 Variation of Net Heat Release Rate with Crank Angle

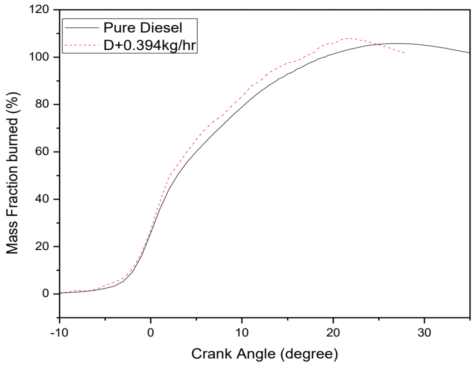


Figure 3.3 Variation of Mass Fraction Burned with Crank Angle

It was determined from the measured cylinder pressure. It is a Ratio Between energy released from the fuel combustion to the total energy produced at the end of combustion as shown in the Figure 3.3. At the beginning of combustion, acetylene has wide flammability and less auto ignition temperature it gives complete combustion of acetylene it helps to give a complete combustion of B20+0.394 Kg/hr. From Fig. (B20+0.394 Kg/hr) is 10%, 50% and 90% mass fraction burned was observed at crank angle 1.20, 4.50 and 14.30

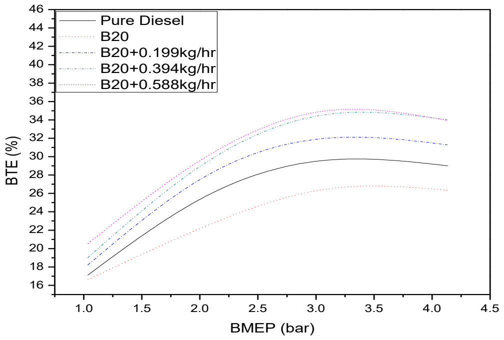


Figure 3.4 variation of Brake Thermal Efficiency with Break Mean Effective Pressure

The Figure 3.4 shows the variation of brake thermal efficiency with break mean effective pressure different flow rates were taken and plotted on graph and compared with the standard pure diesel values. The fuel B20 was compared with the standard pure diesel and it was found out that the Brake Thermal Efficiency of B20 is low the reason is that the viscosity of B20 is high compared to pure diesel and also when combustion takes place inside the cylinder the carbon gets deposited on the walls of the cylinder which changes the fuel Cetane value and this effect the calorific value of the fuel which relatively decreases the Break Thermal Efficiency. Then along with B20 acetylene was induced i.e B20+0.199 kg/hr and the Break Thermal Efficiency is 30.2 for B20+0.394kg/hr the Brake Thermal Efficiency is 35.4 and for B20+0.558 kg/hr Break Thermal Efficiency is 35.6 and on comparison of these three fuel values it was found out that the Brake Thermal Efficiency increases with increase in LPM of acetylene and the optimum value occurs at B20+0.394 kg/hr due to the reason that acetylene increases combustion points in combustion chamber

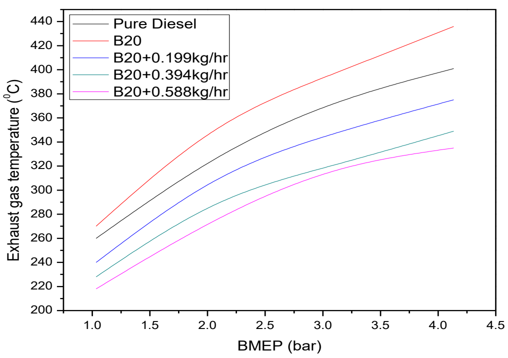


Figure 3.5 Variation of Exhaust Gas Temperature with Break Mean Effective Pressure

The Figure 3.5 shows exhaust gas temperature and break mean effective pressure B20 fuel exhaust temperature is high the reason is high boiling point constituents i.e the diesel, the ignition delay and high viscosity, incomplete combustion **Forson et.al**.[10].In dual fuel case the exhaust gas temperature is lower than 0.199 Kg/hr value and is near to the standard diesel value. It happens in the combustion chamber acetylene reduces the ignition delay and high thermal efficiency. The various acetylene flow rates 0.199 Kg/hr, 0.394 Kg/hr and 0.584 Kg/hr the exhaust gas temperatures are 370,338- and 309-degree C respectively. This is due to higher flame speed and faster energy released in cycle **Hazar.H et.all**[6] the pressure diagram indicates high pressure that occurs when acetylene was introduced and heat loss will happen gases to the wall increased due to higher thermal conductivity **Hazar.Het.all**[6]

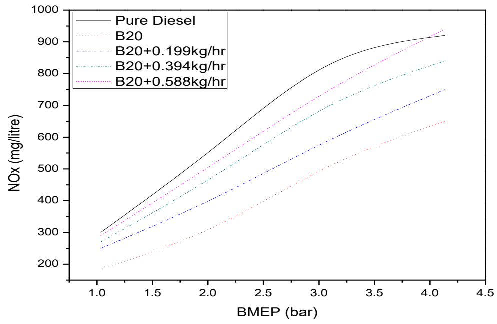


Figure 3.6 Variation of NOx With Break Mean Effective Pressure

The NOx formation depends on the oxygen availability in combustion chamber, high peak pressure and combustion temperature. Figure 3.6 shows the relation between BMEP and NOx, The NOx value decreases compared to pure diesel due to low cylinder gas temperature and higher cetane number than diesel this effect reduces the ignition delay. As on increasing the acetylene flow rates the NOx increases at 0.199 kg/hr,0.394 kg/hr and 0.588 kg/hr the NOx value is 662,778, and 887 respectively, the (B20+ 0.588 Kg/hr) value is closer to the pure diesel. This is due to the higher-pressure rate in combustion chamber which indicate faster combustion and higher NOx formation **Forson et.al**.[10].

The Figure 3.7 Indicates the variation of carbon monoxide and break mean effective pressure the value of B20 decreases, this fuel value is near to the diesel value. As the amount of acetylene increases the CO value decreases this is due to oxygen content that provide complete combustion **Forson et.al**.[10]. The emission of the CO depends on the air fuel ratio and stoichiometric quantities. Due to the lean mixture of fuels in CI engine the CO value will be minimum **Aydin H et.all**[5].

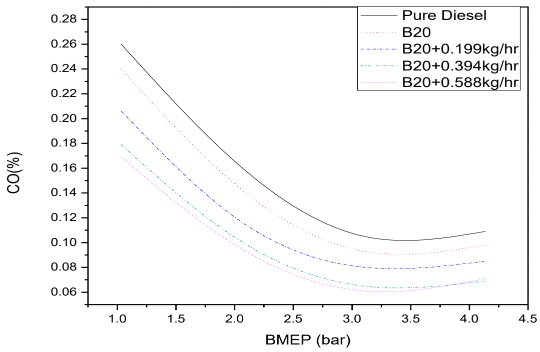


Figure 3.7 Variation of CO with Break Mean Effective Pressure

V. CONCLUSIONS

The duel fuel operation is conducted on single cylinder water cooled four stroke CI engine, the test was carried on varies flow rates (B20, B20+0.199kg/hr, B20+0.394 kg/hr, B20+0.588 kg/hr) in dual fuel mode.

I. Break thermal efficiency is increased as compared to standard values of diesel. It is increased by 32.91%, 37.5%, and 42.43% with 0.199 kg/hr, 0.394 kg/hr and 0.588 kg/hr of acetylene respectively, the value of B20+0.199 kg/hr is near to diesel values.
II. Break specific fuel consumption is decreased.
III. In duel fuel mode the NOx value also decreases as compare to the diesel value.
IV. Lower CO emissions due to the complete combustion of charge in dual mode as CO being converted to CO_2.
V. Exhaust temperature is also low in duel fuel mode as compared to the standard value of diesel.

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