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Experimental Investigation on the performance of Single Cylinder Four Stroke Diesel Engine with Fuel blending (Diesel + Methanol + Ethanol)

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Abstract: The research on alternative fuels for compression ignition engine has become essential due to depletion of diesel products and its major contribution for pollutants, where blends of methanol, ethanol &diesel fuel is one of the most promising fuel alternatives for the future. In the present scenario, the very low combustion efficiency of compression ignition engine leads to poor performance of the engine and emission of incomplete combustion by-products. Physical properties relevant to the fuel were determined for the four blends of diesel. In this study, methanol and Ethanol are used to increase performance. In this experiment a four-stroke single cylinder engine is used and tested in constant and varying load condition with blends as mentioned bellow. This method is used for increasing the fuel efficiency of a vehicle by adding different percentage of methanol and ethanol to the conventional fuel. compression ignition engine will be tested on blends containing 5%, 10%, 15%, and 20% ethanol + methanol + diesel and performance characteristics is used for experiment process to find out the exact comparative study of fuels for different blending grades. Experiments results that D90EM10 is produced more power, have great solubility and more stable in nature as compare to the other blends. Sound and vibration caused by the combustion process in the engine have direct effects on users. Most important characteristics of diesel fuels is high noise and vibration. In the present study we also analyzed to examine the vibration acceleration of different diesel-Ethanol-Methanol fuel blends in single cylinder CI engine. The main goal was to present fuels with the minimum vibration for full load. The experiments indicated that the magnitude of vibration in the single cylinder CI engine depends on the axis of measurement, engine load and the fuel blends. The results of the experiments showed that vibration acceleration is significantly affected by the axis of measurement. The magnitude of vibration acceleration in linear axis was more than that in the lateral axis. •Fuel blends significantly influenced the vibration. It demonstrated that D90EM10 and D85EM15 have the lowest vibration, and D100EM0 and D80EM20 have the highest vibrations. Vibration acceleration amplitudes also depends upon load on engine. As load on engine increases vibration acceleration amplitude also increases in linear direction. Emissions percentages of CO_X and NO_X is continuous decreasing while we increase the percentages of alternative fuels.
Keywords: CI Engine, Diesel, Emission, Ethanol, Methanol, Brake Power, Experimental analysis, Alternate fuels etc.

I. INTRODUCTION

At low concentrations of methanol in ethanol-methanol binary system, the molecular interactions are seen to be uniquely complex. It is observed that the ethanol aggregates are not strictly hydrogen-bonded complexes; dispersion forces also play a dominant role in the self-association of ethanol molecules. On the addition of small amount of methanol to ethanol, the dipolar association of ethanol is destroyed. The repulsive forces between the two moieties dominate the behavior of the binary system at lower concentration of methanol. At higher concentration of methanol (> 30%), the strength and extent (number) of formation of hydrogen bonds between ethanol and methanol increases. The geometry of molecular structure at high concentration favors the fitting of component molecules with each other. Intermolecular interactions in the ethanol-methanol binary system over the entire concentration range were investigated in detail using broadband dielectric spectroscopy, FTIR, surface tension and refractive index studies. Molecular Dynamics simulations show that the hydrogen bond density is a direct function of the number of methanol molecules present, as the ethanol aggregates are not strictly hydrogen-bond constructed which is agreement with the experimental results. While The current situation of fossil fuel is very critical, and it is become urgent to look for a suitable alternative due to the continuous increasing demand for these fuels and depleting of their sources. The transportation sector is the primary consumer of these fuels because of the huge number of vehicles that uses in different walks of life [1]. Diesel fuel occupies the larger share of fuel trade in 2010 resulting from the extensive usage of a diesel engine in the different a applications [2]. Furthermore, the usage of fossil fuel can be considered as the main contributor to air pollution and global warming. Diesel engine designed and developed to operate using mineral diesel fuel, therefore, it is important to look for a suitable alternative with similar characteristics to suit the existing diesel engines. Though many alternative fuels have been suggested to replace mineral diesel in a diesel engine, it is still facing the challenge of high engine modification cost. Therefore, the implemented alternative fuel should be suit the current engine design. Biodiesel fuel has been considered as the unique alternative fuel that can be used directly for a diesel engine with no or little modification. The different sources of biodiesel are available in mostly all the regions of the world and can be considered as a domestic product. Furthermore, these fuels can be adopted to mitigate the environmental pollution from diesel engine due to the high CO2 saving and fewer engine emissions [3]. In general, the properties of biodiesel from different sources are slightly different depending on the biodiesel feedstock according to the ASTM biodiesel fuel standard. The blending of biodiesel with mineral diesel is one of the common methods to introduce biodiesel as a fuel for direct usage in diesel engine under the ASTM blended fuel standard [4,5]. Accordingly, selection of the maximum percentage of biodiesel for blending with diesel according to the blended fuel standard depends on the biodiesel feedstock property. Therefore, evaluating the blended fuel properties is the most important criteria to choose the suitable blend ratio. Engine cyclic variation has been investigated recently by many researchers as it is related to the output power and fuel consumption [6,7]. The earlier studies mainly focused on spark ignition engine. However, recent studies were conducted to analyze diesel engine cyclic variations with different alternative fuels [8]. These fuels have different chemical combustion and therefore, different combustion behavior is expected. Accordingly, the engine stability for long-term operation should be considered and evaluated using diesel fuel as the threshold. The aim of this paper is to characterize the blended fuel, B20 properties compared to the palm biodiesel and mineral diesel as well as according to the biodiesel blended fuel standard ASTM D7467. Moreover, this study also evaluates the engine cyclic variations at 2500 rpm with engine load of 60%, operating with the test fuels at 1000 cycles each using the coefficient of variation of the indicated mean effective pressure (COV imep) and wavelet spectrum analysis approach. Ethanol and methanol strongly self-associate due to hydrogen bonding [1, 2, 3, 4]. These primary polar liquids with C-OH group form very similar 1 arXiv:1611.05987v1 [physical-chem] 18 Nov 2016 hydrogen bond acceptors and hydrogen bond donors and they exhibit extended network [5]. On mixing, these two liquids do not form zoetrope's. Also, methanol does not form zoetrope with water, whereas ethanol forms an zoetrope with it. Although the binary system of ethanol and methanol is assumed to be ideal, their behavior at low concentrations is far from ideal [6]. Vast experimental information is available concerning the dielectric properties, excess volume parameters, FTIR spectra and refractive index of binary system of ethanol-water [7], methanol-water [7, 8], ethanol-higher alcohols [9], methanol-higher alcohols [10], ethanol-pyridine [11], methanol-pyridine [11], etc. All these systems show a deviation from ideal behavior for most physical and chemical properties at 50%. On the other hand, comparatively very few reports are available for the ethanol-methanol binary system. Amer et. al., found the non-ideal behavior of ethanol-methanol at low concentrations while investigating the activity measurements of ethanol-methanol-acetone system [6]. The current study is undertaken to understand the anomalous behavior of intermolecular interactions of ethanol-methanol system. Dielectric, FTIR, surface tension, density, refractive index and molecular dynamics studies for this system is undertaken over the complete concentration range, with emphasis on concentration regions where anomalous behavior in properties is seen. The excess values of molar volume and refractive index, molar refraction and total partial pressure were determined using the experimental values. Complex impedance Cole-Cole plots were used to study the relaxation mechanism in the ethanol-methanol system. Molecular dynamics simulations were done to verify the behavior of ethanol methanol binary system. The structure of molecules and the number of hydrogen-bonded molecules determined from the simulations are used to interpret the experimental results of surface tension, density, refractive index and dielectric values relating hydrogen bond structure. It is understood from the present study that the methanol molecules are responsible for increase in hydrogen bond density and they play the role of a mediator in connecting ethanol molecules.

II. LITERATURE

1) *B. Prabakaran *, Anurag Udhoji*- This study is to investigate the effect of zinc oxide nano particle addition to diesel biodiesel-ethanol blends. Solubility tests were done for the fuels at three different temperatures. Out of eighteen blends, six blends were stable at 5 _C, 15 _C and above 25 _C. Out of the six blends, two blends were checked for properties as per ASTM standards. One of them was chosen for testing the performance, combustion and emission characteristics in a diesel engine. In the same blend, zinc oxide was added in the amount of 250 ppm. Property testing of the blended fuel indicated that there was an increase in calorific value due to addition of nano particle. The performance tests were conducted on a single cylinder four stroke direct injection diesel engine at a constant speed of 1500 rpm. For the blend containing zinc oxide, there was an increase in BSFC, HRR and cylinder pressure. Also, there was a decrease in BTE, NOx and smoke, as compared to diesel. The addition of zinc

oxide nano particles increased the BTE and decreased the BSFC as compared with the biodiesel diesel ethanol blend at full load. This study gives a direction to utilize the renewable fuel to reduce the consumption of fossil fuel.

2) *.C. A. Harch, M. G. Rasul*, N. M. S. Hassan, M. M. K. Bhuiya*- Increasing interest in diesel engine technology and the continuous demand of finding alternative sustainable fuels as well as reducing emissions has motivated over the years for the development of numerical models, to provide qualitatively predictive tools for the designers. Among the alternative fuels, biodiesel especially second generation biodiesel is considered as a sustainable and the most promising option for diesel engine. In this study an engine combustion model has been developed using computational fluid dynamics (CFD) software, AVL Fire, which can predict the engine performance, and emission characteristics for second generation biodiesel produced from Australian native beauty leaf seed (BLS). This model involves simulation of fuel atomization, burning velocity, combustion duration, and temperature and pressure development in a combustion chamber. The model has been developed for petroleum diesel (normal diesel used in automobiles), 5% BLS biodiesel (B5) and 10% BLS biodiesel (B10) for different injection timings and compression ratios. The simulation results revealed that overall B10 biodiesel provides better performance and efficiency, and significantly reduced engine emissions. On the other hand, the B5 blend provides slightly improved performance and efficiency, and moderately reduced emissions compared to petroleum diesel.
3) *Dean Bishopa, Rong Situa*, Richard brownb, Nicholas Surawskic*- Biodiesel is a biofuel which has similar properties to diesel and can readily be used in a diesel engine with minimal modifications. Promising results have been determined using mixtures of biodiesel and diesel with the reduction of soot and emissions of a diesel engine. Experimental analysis of diesel engines can be expensive and therefore Computation Fluid Dynamics programs are used to analyses the combustion process. The AVL Fire ESED program is currently being employed to investigate the effects of biodiesel on the diesel engines soot, emissions and power generation from a Cummins ISBE220 engine. Investigation is performed on pre and post injection-rate shapes on the combustion process establishing the results correlate accurately with researched data. A pre injection was determined to increase maximum power, reduce combustion generated noise, increase early in cylinder temperature and reduce fuel consumption due to the increase in power. A post injection was verified to reduce soot emissions while increasing NOx emissions marginally. The investigation of the injection-rate shape established the soot- NOx trade-off which was also found in the research. The models developed were agreeable with biodiesel data with percentage error in indicated power ranging from 1.62-8.85%. The models suggested that biodiesel assists in reducing NOx and soot emissions. The soot- NOx trade-off was further investigated determining the theory that then by reducing the combustion temperature in the combustion chamber the NOx emissions can be reduced while increasing soot emissions. By increasing the temperature in the combustion chamber the opposite effect was found to occur.
4) *Szuhánszki J.a, Black S.a, Pranzitelli A.*a, Ma L.a, Stanger P.J.a,b, Ingham D.B.a, Pourkashanian M.a*- The utilisation of biomass in coal-fired power plants can mitigate CO2 emissions, especially when combined with carbon capture and storage (CCS) technologies, such as oxy-fuel combustion. In this paper, a commercial computational fluid dynamics software was used, with small or no modifications to the physical submodels, to predict the performance of a 500 MWe sub-critical coal fired boiler under air and oxy-fuel conditions when firing coal, biomass, and a 20% biomass blend, for the same thermal input. The results suggest that for a wet recycle retrofit, the optimum oxygen concentration lies between the simulated range of 25 and 30%, where heat transfer characteristics of the air-fired design could be matched when firing either coal or a 20% biomass blend. However, for 100% biomass firing modifications of the firing arrangement may be necessary to achieve an output closer to the original design.
5) *Y. Datta Bharadwaz *, B. Govinda Rao, V. Dharma Rao, C. Anusha*- The main objective of this work was to improve the performance of biodiesel–methanol blends in a VCR engine by using optimized engine parameters. For optimization of the engine,operational parameters such as compression ratio, fuel blend, and load are taken as factors, whereas performance parameters such as brake thermal efficiency (Bth) and brake specific fuel consumption (Bsfc) and emission parameters such as carbon monoxide (CO), unburnt hydrocarbons (HC), Nitric oxides (NOx) and smoke are taken as responses. Experimentation is carried out as per the design of experiments of the response surface methodology. Optimization of engine operational parameters is carried out using Derringers Desirability approach. From the results obtained it is inferred that the VCR engine has maximum performance and minimum emissions at 18 compression ratio, 5% fuel blend and at 9.03 kg of load. At this optimized operating conditions of the engine the responses such as brake thermal efficiency, brake specific fuel consumption, carbon monoxide, unburnt hydrocarbons, nitric oxide, and smoke are found to be 31.95%, 0.37 kg/ Kw.

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III. METHODOLOGY

Engine specifications: -
Engine Type: Single cylinder Four stroke Diesel engine (Kirloskar),
Bore: 0.0875m,
Stroke: 0.11m,
Capacity: 661.5 cc,
Power: 5bhp at 1500 rpm,
Torque: 3.7 kw at 1500 rpm and
Compression Ratio: 17.5:1

Fig-1 Experimental setup

A. Working of engine with fuel

1) Studying a single cylinder four stroke diesel engine.
2) Measuring the performance of the engine at constant speed.
3) Obtaining the bmep Vs bsfc, bmep Vs efficiency and bmep vs exhaust gas temperature curves for the engine.
4) Drawing Willan's line and obtaining friction power and mechanical efficiency.

Working model of experimental engine diagram

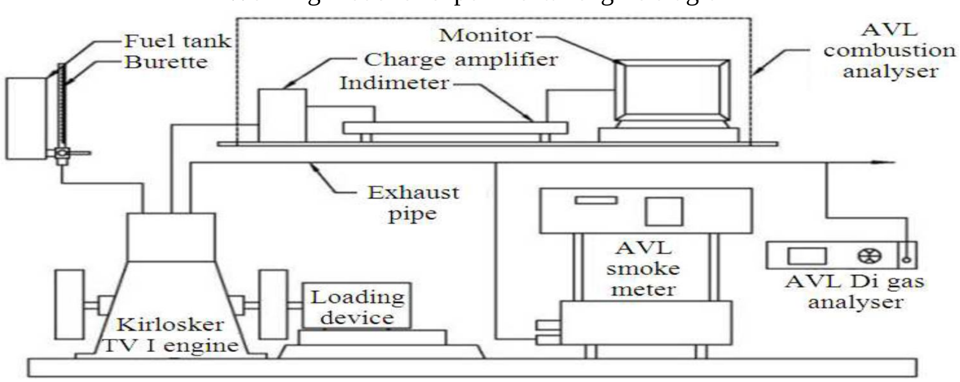

Fig -2 Experimental model setup with description

B. Working Process Of Engine When Fuel Is Blending

1) Study Of The Single Cylinder Diesel Engine: Study the following components: Crank shaft, flywheel, piston and connecting rod; camshaft, push rods and valve system; diesel pump and injector; governing system; lubrication: oil sump and pump, oil paths; cooling system: water paths.
2) Measure bore and stroke, and observe valve opening and closing when you rotate the crankshaft.
3) How does the engine start? How does it stop?

4) If you want to change engine speed, what would you do?
5) Do you find any parts missing in the engine you studied? Are they there in the engine you did experiments on? What are the differences between these engines?

C. Measuring The Performance At Constant Speed

1) Study the instrumentation: Loading the engine: how is this done? How is the load measured? Speed: how is it measured? Exhaust temperature: how is it measured? Note: the question "how is it measured" should be answered in terms of what the measuring device is, what it measures, how it measures it, if there is any calibration constant, what it is, how you calibrate the device, etc.
2) Start the engine. Run the engine at different loads from zero to maximum. At each load, measure the engine speed (this should be constant: how is this controlled?), fuel consumption rate, air consumption rate, exhaust gas temperature.
3) From the data, compute the BMEP (Brake mean effective pressure), BSFC(brake specific fuel consumption), thermal efficiency and plot curves mentioned in objective 3 above.
4) Plot fuel flow rate Vs brake power and obtain the frictional power: Willan's line method (what is this?). Using this calculate the indicated power and mechanical efficiency at the loads you measured engine data.

Manufacturer	Kirloskar oil engine ltd.
Model	TV1
Type	4 strokes, direct injection
No. of cylinders	1
Rated power	3.7 kW @ 1500 rpm
Bore Diameter	87.5 mm
Stroke Length	110 mm
Connecting rod length	234 mm
Method of cooling	Water cooled
Ignition timing	23°bTDC
Injection pressure	20 kgf/cm²
Compression ratio	17.5:1

D. The Working Cycle Of Four-Stroke Single Cylinder Diesel Engine Are Shown In Figure

The cycle of operation in a four-stroke diesel engine is completed in two revolutions of crankshaft or four strokes of piston using diesel oil as fuel. This engine works on diesel cycle.

1) Suction Stroke: Starting of engine is done by an electric motor or manually. In both cases the energy is supplied to the engine. In this stroke the inlet valve opens and the outlet valve remains closed. Piston moves from T.D.C. to B.D.C. and in this way a vacuum is created in the cylinder. This vacuum is filled by air alone and piston reaches to B.D.C.
2) Compression Stroke: Both valves are closed. This time piston moves from B.D.C. to T.D.C. Air is compressed in this stroke up to a compression ratio of 15:1 to 22:1 and a very high temperature is produced due to high pressure. The high temperature is the only cause of combustion of the fuel. The piston takes the power in this stroke from the flywheel. During this stroke the pressure and temperature attain a high value of 40 to 60 bar and 600º C to 700º C.
3) Working Stroke: At the end of compression stroke or when the piston reaches the T.D.C. position, a fine spray of diesel is injected in the cylinder through injector. The fuel burns by the heat of compressed air and due to its burning the power is produced. This power pushes the piston downward i.e. from T.D.C. to B.D.C. The excess energy of the piston is stored in the flywheel of the engine, which is further used for the remaining three strokes of the engine. The reciprocating motion of the piston is converted into the rotary motion of the crankshaft by connecting rod and crank. During expansion the pressure drops due to increase in volume of gases and absorption of heat by cylinder walls.
4) Exhaust Stroke: The exhaust valve begins to open when about 85% of the working stroke is completed. The force of piston coming from B.D.C. to T.D.C. forces the burnt gases into the exhaust manifold. Some of the gases are forced out due to higher pressure in the cylinder and the remaining gases are forced out by the piston. Some of the burnt gases are however left inside the clearance space. The exhaust valve closes shortly after T.D.C. The inlet valve opens slightly before the end of exhaust and in this way the cycle repeats.

The working cycle of four stroke single cylinder engine are shown in figure: -

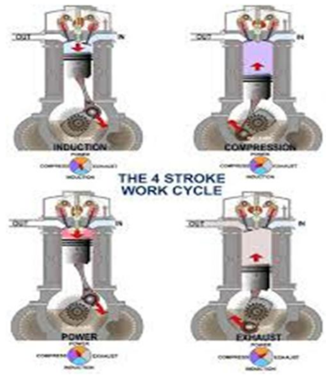

Fig –3 working cycle of engine

E. 5- Tachometer And Its Properties

Tachometer is an instrument used for measuring the rotation or revolution speed of objects, such as an engine or a shaft. The tachometer measures revolutions per minute (RPMs) of engines and is widely used in automobiles, airplanes, marine engineering field and many others.

Characteristics

1) Beautiful and elegant appearance design, convenient and comfortable to use;
2) Wide measurement range, and high resolution;
3) Single-chip microcomputer technology, photoelectric technology and anti-interference technology used, to accurately measure the rotation speed;
4) Super large-size LCD, with clear reading;
5) Automatically memorizing the measured maximum, minimum and the last displayed values;
6) Low power indication when the battery voltage is lower than the specified value;
7) Automatic off: Automatic off in about 15min when no key is operated.

Display: 5-digit 18mm LCD
Accuracy: ± (0. 05%+1)
Range selection: Automatic range
Effective distance: 50mm-500mm
Dimension: 150mm*65mm*31mm
Power supply: 4*1.5V AAA batteries
Power consumption: Less than 40mA
Weight: About 156g (including batteries)
Measurement range: 2.5-99999 rpm for photoelectric rotation speed
1.0-19999 rpm for contact rotation speed
1.00-1999.9 m/min for contact line speed Resolution:
Photoelectric rotation speed: 0.1rpm (2.5-999.99rpm)
1rpm (above 1000rpm)
Contact rotation speed: 0.1rpm (0.5-999.99rpm)
1rpm (above 1000rpm)
Contact line speed: 0.01m/min (0.05-99.999m/min)
0.1m/min (above 100m/min)

Digital tachometer descriptions are shown in figure:-

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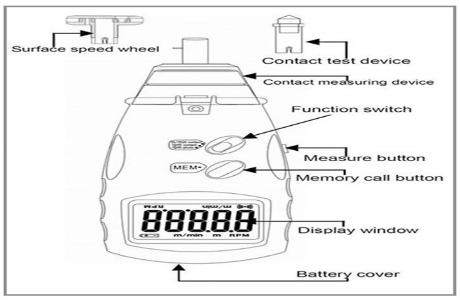

Fig-4 Digital tachometer with label diagram and shown reading in display

F. Methodology

In the present work, the effect of using diesel, ethanol and methanol blend (5%, 10%, 15% and 20%) on the performance and emission characteristics of a compression ignition engine were simulated using Diesel-RK software. In order to carry out the simulations, a numerical model of a four stroke, single cylinder, TV1 engine was fed into the software along with the thermo-physical properties of the different fuels. In order to check the compatibility of the various blends of fuels with the CI engine and study their effect on the engine, different engine parameters were successfully predicted by the software and a thorough study has been made for the same. The parameters, which were calculated in order to find the performance and emission characteristics of the engine were: brake specific fuel consumption, brake thermal efficiency, exhaust gas temperature, NOx, CO2, PM and smoke emissions. These parameters were calculated for all the fuels at constant engine speed of 1500 rpm. The engine used in this work has the specification shown in Table 5

The mixture can be created 0%, 5%, 10%, 15% and 20% are shown in table-5:

G. For Vibration Measurements

Vibrometer Model- VB-8201HA is used to measure the vibration acceleration in head of

the engine cylinder. The engine vibrations are measured using accelerometers with the help of vibrometer which is used to measure the engine vibration acceleration amplitudes in the form of its root mean square (rms) value of vibration acceleration. We measured the vibration in both direction that is linear (x direction) and lateral (y direction) putting accelerometer at positions as shown in figure.

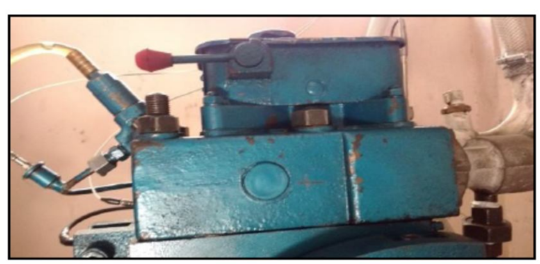

Figure : Location of vibration measurements in linear(x) and Lateral (y) directions

Above figures show that the actual location of vibration measured in linear and lateral directions.

1) *Gas Analyser And Smoke Meter Specifications:* AVL Digas 444 gas analyzer was used to measure the constituents of CO, CO2, HC, NOx and O2 in the exhaust gas which is interfaced with RS 232 C, pick up, oil temperature probe. AVL 437 Smoke meter of IP 52 type is used to measure the exhaust gas opacity, absorptivity and smoke temperature.

Mixture of fuel can be created in table – 5 are as follows:

a) First step 100% of diesel will use for blending process and engine speed will observed with the of digital tachometer which shown in mixture percentage table.

b) Second step 95% diesel, 2.5% ethanol and 2.5% methanol are used to make 5% mixture for blending process and engine speed will observed with the of digital tachometer which shown in mixture percentage table.

c) Third step 90% diesel, 5% ethanol and 5% methanol are used to make 10% mixture for blending process and engine speed will observed with the of digital tachometer which shown in mixture percentage table.

d) Fourth step 85% diesel, 7.5% ethanol and 7.5% methanol are used to make 15% mixture for blending process and engine speed will observed with the of digital tachometer which shown in mixture percentage table.

e) Fifth step 80% diesel, 10% ethanol and 10% methanol are used to make 20% mixture for blending process and engine speed will observed with the of digital tachometer which shown in mixture percentage table.

Table1 :Mixture percentage of fuel

Sr. no	Mixture %	Diesel %	Ethanol %	Methanol %	Engine speed N (rev/min)	Engine speed N (rev/sec)	Engine Torque T (N.m)	Brake Power b.p (KW)
1	0	100	0	0	20179	336.32	19.210	6.46
2	5	95	2.5	2.5	19084	318.07	18.169	5.78
3	10	90	5	5	19598	326.63	18.656	6.09
4	15	85	7.5	7.5	19227	320.45	18.304	5.86
5	20	80	10	10	19415	323.58	18.483	5.98

Table 2 – Mixture of fuel for blending

IV. RESULTS AND DISCUSSION

A. *Calculation Discription*

1) *Torque*

Where in table-5 calculation use constant or engine horse power(hp) which is 5bhp and calculate torque with different speed when different percentage of fuel (ethanol + methanol +diesel) mixture is used blending process. (hp=5bhp)

1) Puer diesel or zero percent mixture engine speed will be 20179 rpm then calculate torque

$T(N.m) = hp \times speed/5252 = 19.210$ N.m

2) Five percent mixture engine speed will be 19084 rpm then calculate torque

$T(N.m) = hp \times speed/5252 = 18.169$ N.m

3) Ten percent mixture engine speed will be 19598 rpm then calculate torque

$T(N.m) = hp \times speed/5252 = 18.656$ N.m

4) Fifteen percent mixture engine speed will be 19227 rpm then calculate torque

$T(N.m) = hp \times speed/5252 = 18.304$ N.m

5) Twenty percent mixture engine speed will be 19415 rpm then calculate torque

$T(N.m) = hp \times speed/5252 = 18.483$ N.m

B. *Brake power*

Calculating braking power with the help of torque and speed which calculate in different fuel blending (ethanol + methanol + diesel) mixture percent ratio. On experiment table- 5 engine speed will observed in RPM(Revolution per minute) and it covert into RPS(Revolution per second).A minute has 60 seconds, 1 rpm equals 1/60 revolution per second. Where Brake power will be calculated in watt then it converts into kilowatt (1 watt = 0.008 Kilowatt).

1) Puer diesel or zero percent mixture engine speed will be 20179 rpm then calculate Brake Power

BP(Kw) = T× speed/60 = 6460.64 watt = 6.46 kw

2) Five percent mixture engine speed will be 19084 rpm then calculate Brake Power
   BP(Kw) = T× speed/60 = 5778.95 watt = 5.78 kw
3) Ten percent mixture engine speed will be 19598 rpm then calculate Brake Power
   BP(Kw) = T× speed/60 = 6093.67 watt = 6.09 kw
4) Fifteen percent mixture engine speed will be 19227 rpm then calculate Brake Power
   BP(Kw) = T× speed/60 = 5865.51 watt = 5.86 kw
5) Twenty percent mixture engine speed will be 19415 rpm then calculate Brake Power
   BP(Kw) = T× speed/60 = 5980.79 watt = 5.98kw

C. Varying load

In this process varying load measured at05, 10 kg, 15kg, and 20 kg load are observed by Digital tachometer is shown in table – 6. When varying load on engine then speed of rotation will be decreased and fuel consumption will be increased in working cycle.

S. No	Mixture (%)	05 Kg Varying Load Speed (rpm)	10 Kg Varying Load Speed (rpm)	15 Kg Varying Load Speed (rpm)	20 Kg Varying Load Speed (rpm)
1	0	20179	18749	17849	16949
2	05	19084	17654	16754	15854
3	10	19598	18168	17268	16368
4	15	19227	17797	16897	15997
5	20	19415	17985	17085	16185

Table 3 – Varying load at different mixture of fuel blending

S.NO	10 Kg Varying Load Speed (rpm)	Engine Torque T (N.m)	Brake Power b.p (KW)	15 Kg Varying Load Speed (rpm)	Engine Torque T (N.m)	Brake Power b.p (KW)	20 Kg Varying Load Speed (rpm)	Engine Torque T (N.m)	Brake Power b.p (KW)
1	18749	17.85	5.58	17849	16.99	5.05	16 949	16.13	4.55
2	17654	16.80	4.94	16754	15.95	4.45	15854	15.09	3.99
3	18168	17.29	5.23	17268	16.43	4.72	16368	15.59	4.25
4	17797	16.94	5.02	16897	16.09	4.53	15997	15.22	4.05
5	17985	17.12	5.13	17085	16.27	4.63	16185	15.40	4.15

Table 4 – Torque and Brake power on varying load at different mass

Results obtained from the experiment at full load (20 kg load) are

Sr. no	Mixture %	Diesel %	Ethanol %	Methanol %	VIBRATION OF ENGINE (m/s^2) X Max	X Min	Y Max	Y Min
1	0	100	0	0	57.3	56.4	21.8	21.2
2	5	95	2.5	2.5	52.3	51.9	20.1	19.7
3	10	90	5	5	50.2	49.8	18.4	17.9
4	15	85	7.5	7.5	47.3	47.1	16.2	15.8
5	20	80	10	10	53.2	52.7	21.5	21.1

Table 5- Measurements of acceleration of engine at full load condition for different blends

D. Evaluation Of Emission Characteristics

FUEL	MASS FRACTION OF CO_2	MASS FRACTION OF CO	MASS FRACTION OF NO	MASS FRACTION OF NO_2
DIESEL	9.45e-01	6.24e-02	9.54e-05	5.05e-06
D95EM5	8.43e-01	6.14e-02	8.51e-05	5.31e-06
D90EM10	8.12e-01	5.45e-02	6.25e-05	5.96e-06
D85EM15	7.71e-01	5.14e-02	3.24e-05	6.25e-06
D20EM20	6.85e-01	4.25e-02	2.17e-05	7.15e-06

Table no. 6 Mass fraction of different emission characteristics for various blends

V. CONCLUSION

1) Efficieny based- The experimental study was conducted concerning phase stability of various blends at room temperature and analysis of their Performance. The effects of these alternate fuel blends on the engine performance were compared with diesel. The tests blends were from 5% -20% Ethanol and Methanol with Diesel and by volume. Experimets were conducted for both constant load & varying load conditions for evaluating the Brake power of the engine. Experiment result shows that as we increase the percentages of ethanol and methanol engine speed is varying at constant load conditions. Brake power is decreasing in D95EM5 as compare to the pure Diesel. At constant load conditions it is clearly shown among the all four blends(D95EM5, D90EM10, D85EM15 & D80EM20) that D90EM10 more stable blends and produce maximum power as compare to other blends. Insecond part of the study we have taken varying load conditions so that we can also anlyzed various blends for flactuating loading. In the second part of the study results shows that as we increase the load , Brake power of the engine is decreased for particular blends and among the all four blends D90EM10 is better as compare to others. Emissions percentages of CO_X and NO_X is continuous decreasing while we increase the percentages of alternative fuels.

2) Vibrational Analysis

a) The maximum vibration amplitude is related to the rate of pressure rise and the maximum pressure in the cylinder during ignition, as the rate of pressure rise increases the vibration amplitude also increases.

b) The vibration acceleration values in linear directions were more than that in lateral directions.

c) Vibration Amplitudes also depends upon load on engine head, as load on engine increases vibration acceleration amplitude also increases in linear direction.

d) Experiments results shows that Vibration of engine is continously decreasing with increse rate of fuel blends in linear and lateral directions but as per previous analysis D90EM10 is in a stable nature at all conditions so in present cases this blend is better as compere to others. .

Finally we conclude for this complex combustion process that different kind of blending grade can be used with alternate fuels for increasing the combustion efficiency and reducing the emissions for CI engines. Alternate fuels are very cheaper, easily available in nature and can be formed at very low cost as compare to the conventional fuels.

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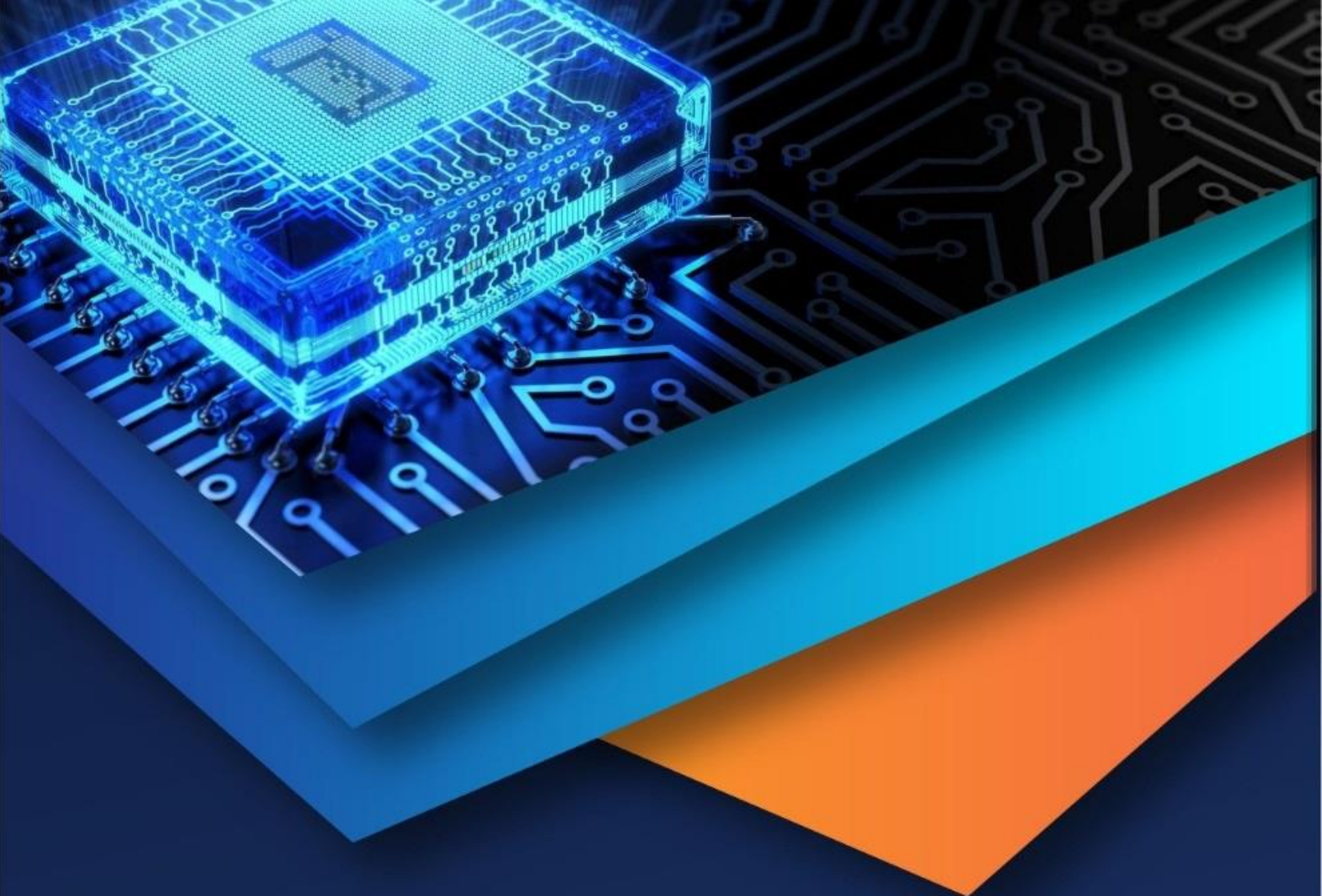

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