Performance Investigation of Indicated Parameters of a Diesel Blended Engine

Nitin Kukreja, Sanjeev Kumar Gupta,
Department of Mechanical Engineering, Institute of Engineering & Technology, GLA University Mathura, UP, India -281406
corresponding author’s e-mail: nitinkukreja07@gmail.com

Abstract. The significance of the diesel motor for public activity is rising each day. Experience has indicated that the exhibition of interior ignition motor taking a shot at diesel is huge as a camper to some other fuel. The components that are answerable for the smooth working of a motor likewise assume a significant job. This paper investigates the attainability of utilizing four strokes four-chamber diesel motors. The aftereffects of the exhibition of CI Engine by differing the heap are introduced in this paper. The impact of shifting the heap affects execution, outflow, and ignition boundaries. The motor exhibition boundary examined was brake warm productivity, brake explicit fuel utilization, demonstrated force, brake power, volumetric proficiency, energy equilibrium, and wind stream estimation. Results have demonstrated that the brake power increments as the heap's increments on the four strokes four-chamber motor. The measure of fumes and coolant misfortunes are nearly little at high motor speed and high at low motor speed.

Keywords: Indicated Power, Specific Fuel Consumption (SFC), Brake Thermal Efficiency (BTE), Diesel Engine

1. Introduction

The inside burning motor came into visualization in the late nineteenth century and it is a significant innovation of that period. This innovation has acquired uncommon changes in numerous businesses, for the most part in the car area. Inner ignition motors can convey power in the reach from 0.01 kW to 20*103 kW, contingent upon their dislodging. By far most inward ignition motors are delivered for vehicular applications, requiring a force yield on the request for 102 kW, the primary distinction between a cutting edge motor and one assembled 100 years prior is the warm proficiency and the level of the discharge [1]. The examination was pointed toward improving warm productivity and lessening commotion and vibration. As a result, warm productivity has expanded from about 10% [1]. In the current world, the utilization of diesel motors is expanding step by step and individuals are utilizing diesel motors for a wide scope of uses. This prompts numerous progressions and exploration in this field to improve execution by different methods. A few boundaries, for example, change of infusion timing, pressure proportion, infusion pressures, and numerous others have been done by different analysts [2,3,4,5]. Execution, discharge, and burning attributes were assessed at different pressure proportions with a half burden for diesel and WCO Biodiesel where the outcomes demonstrated that fumes gas Temperature expanded with higher pressure proportions. The mechanical effectiveness bit by bit diminished with the expanding Compression proportion. The brake warm effectiveness expanded and brake explicit fuel utilization decreased on expanding CR. The Peak chamber pressure additionally expanded with the expansion of CR. Warmth discharge rate decreased with the expansion of
Compression proportion and the Heat discharge pace of standard diesel was discovered higher than the mixes [6,7]. Exploratory examinations were done on a variable speed motor at different pressure proportions worked with diesel and biodiesel mixes which uncovered the expansion of motor force with expanding pressure proportion at all rates. At full burden conditions, an expansion in force was about 15% and a decrease of brake-explicit fuel utilization was about 17.3% when the pressure proportion was expanded from 14 to 18 for standard diesel. The brake warm productivity expanded for diesel and different mixes on expanding the pressure proportion. The normal increment of chamber pressure was about 8.4% on expanding the pressure proportion and this was seen at all rates. The defer period diminished with expanding pressure proportion which was likewise seen at all paces. A huge decrease was seen in the postpone period which could be because of early burning on expanding pressure proportions [8].

Fig. 1: Year wise growth of Diesel Propulsion [8]

In this examination, we had assessed the presentation normal for the four-stroke four-chamber diesel motors at different burdens. The motor presentation boundary examined was brake warm proficiency, brake explicit fuel utilization, demonstrated force, brake power, volumetric productivity, energy equilibrium, and wind current estimation.

A. Brake Power: Brake power is the force conveyed by the motor at the drive shaft. The brake power is typically estimated by connecting a force retention gadget to the drive shaft of the motor. Such a gadget sets up quantifiable powers neutralizing the powers conveyed by the motor and the decided estimation of these deliberate powers is demonstrative of the powers being conveyed.

B. Specific Fuel Consumption: Specific fuel consumption (s.f.c.) is defined as the rate of fuel consumed per unit power produced.

\[
S.F.C. = \frac{\text{Fuel consumed per unit time}}{\text{Power output}}
\]
C. Thermal Efficiency: It is defined as the ratio of power output to the energy supplied to the engine.

\[ \eta_{\text{beh}} = \frac{\text{Power output}}{\text{Mass of fuel} \times \text{Calorific value of fuel}} \]

On the off chance that force yield in the above articulation is shown power, we have demonstrated warm effectiveness.

D. Volumetric efficiency: It means that the breathing limit of the motor and is characterized as the proportion of the volume of air really drafted at encompassing conditions to the cleared volume of the motor.

\[ \eta_v = \frac{\text{(Mass of charge actually inducted)}}{\text{(mass of charge that will fill swept volume at ambient temp. and pressure)}} \]

\[ \text{eta} = \frac{\text{(Volume of charge aspirated per stroke at ambient conditions)}}{\text{(Swept Volume)}} \]

| TABLE I \nENGINE SPECIFICATIONS |
|---------------------------|
| **S. No** | **Engine** | **Mahindra & Mahindra** |
| 1 | Make & Type | Four cylinders, four strokes, water cooled diesel engine |
| 2 | Displacement volume (cc) | 1895 |
| 3 | Density of fuel, \( \rho_f \) (kg/m\(^3\)) | 720-800 |
| 4 | LHV of Diesel MJ/kg | 42 |
| 5 | Density of air, \( \rho_{\text{air}} \), kg/m\(^3\) | Density of air, \( \rho_{\text{air}} \), kg/m\(^3\) |

2. Methodology Adopted:

The idea of miniaturization The setup in this experiment comprises four-stroke four-cylinder water cooled diesel engine of Mahindra & Mahindra. Further details are mentioned in Table 1. The engine displacement capacity is 1895. Temperature measurement is done by the means of K type thermocouples. The temperatures that are measured were.

1. The inlet coolant temperature.
2. The outlet coolant temperature.
3. The exhaust gas temperature.
4. The inlet air temperature.
5. The exhaust air temperature.

The fuel tank is of 15L capacity. The engine was firstly run at the no-load condition for about 5 minutes and the water flow as a coolant and the lubrication is properly checked at that time. Engine load was set up to 3 kW then and the performance parameters such as brake power are measured by forces delivered by the engine and the determined value of these measured forces is indicative of the forces being delivered. The time required for the fuel consumption of 50 ml is being recorded; B.S.F.C is calculated after thermal efficiency. The mass flow rate of air is measured by measuring the pressure drop across the sharp-edged orifice.
Experimentally following details of energy balance sheet has been calculated.

**TABLE II**

| S.No | Loads (KW) | $E_F$ (KW) | $E_{BP}$ (KW) | $E_C$ (KW) | $E_E$ (KW) | $E_{RAD}$ (KW) |
|------|------------|------------|---------------|------------|------------|----------------|
| 1    | 3          | 29.1333    | $1.244 \times 10^{-3}$ | 33.101     | 1.2602     | 6.0605         |
| 2    | 6          | 29.0766    | $2.322 \times 10^{-3}$ | 52.165     | 1.6545     | 27.614         |
| 3    | 9          | 32.1006    | $3.733 \times 10^{-3}$ | 33.939     | 1.9081     | 7.3303         |
E_F - Rate of energy input.
E_B.P - Rate of energy supplied at the shaft.
E_C - Rate of energy flow to coolant.
E_E - Rate of energy flow to exhaust gases.
E_RAD - Rate of energy flow to radiation

3. Result

3.1. Variation in Break Specific Consumption

In the chart, the variation of brake explicit fuel utilization was indicated when the heap was changed from 3 kW to 10 kW. The brake explicit fuel utilization gets decreased to about 60% when the heap was expanded from 3 kW to 10 kW.

![Fig. 4: Variation of B.S.F.C with load.](image)

3.2. Variation in Break Thermal Efficiency

Brake thermal efficiency expanded consistently when the heaps are expanded and it is appeared in the diagram. This outcomes in an expansion in the fumes gases temperature as more fuel is burned-through to higher burdens.

![Fig. 5: Variation of B.T.E with load.](image)
Brake power likewise increments as the heaps are expanded from 3 kW to 10 kW the varieties appear in the diagram.

### 3.3. Variation in Air Flow Measurement

At higher burdens and higher r.p.m. the wind current has a slight change at each progression here and there it stays steady for a time of progress.

![Graph of Air Flow Measurement](image)

**Fig. 6:** Variation of Air Flow Measurement with load.

### 3.4. Variation in Volumetric Efficiency

The volumetric efficiency first increases up to a certain point and then starts decreasing.

![Graph of Volumetric Efficiency](image)

**Fig. 7:** Variation of Volumetric Efficiency with load.
4. Conclusion

The effect of shifting burdens on the exhibition boundaries was obviously researched in this exploratory examination. These are the accompanying perceptions:

1. The BSFC decreased to about 60% when the heap was expanded from 3 to 10%.
2. Brake warm productivity expanded consistently.
3. Brake force likewise increments as the heap was expanded.
4. It is likewise seen that the coolant loses and depletes gas misfortunes are similarly higher when the heaps are lower and the motor speed is lower and radiative energy misfortunes are high at low motor rates.

Nomenclature

\( \rho \): Density of fluid flowing
\( u \): Velocity of flow in \( x \)-direction
\( v \): Velocity of flow in \( y \)-direction
\( p \): Pressure in the flow direction
\( X \): \( x \)-direction Body force
\( Y \): \( y \)-direction Body force
\( T \): Fluid temperature
\( T_\infty \): Free-stream Temperature
\( T_s \): Surface Temperature
\( c_p \): Specific heat of fluid at constant pressure
\( Nu \): Nusselt Number
\( h \): Convective heat transfer coefficient
\( L \): Characteristic Length
\( k \): Thermal Conductivity of the fluid
\( Re \): Reynolds Number
\( D \): Diameter of the cylinder
\( Pr \): Prandtl Number
\( \mu \): Dynamic Viscosity
\( \nu \): Kinematic Viscosity

References

[1] Colin R. Ferguson, Allan T. Kirkpatrick, Internal Combustion Engine (Applied Thermosciences), Wiley Second edition.

[2] V. Hariram *, R. Vagesh Shangar, Influence of compression ratio on combustion and performance characteristics of direct injection compression ignition engine

[3] R. Anand, G.R. Kannan, Effect of injection pressure and injection timing on DI diesel engine fuelled with biodiesel from waste cooking oil, Biomass Bioenergy 46 (2012) 343–352.

[4] V. Hariram, G. Mohan Kumar, The effect of injection timing on combustion, performance and emission parameters with AOME blends as a fuel for compression ignition engine, Eur. J. Sci. Res. 79 (4) (2012) 653–665.

[5] Hifjur Raheman, Sweeti Kumari, Combustion characteristics and emissions of a compression ignition engine using emulsified jatropha biodiesel blend, Biosyst. Eng. 123 (2014) 29–39.
[6] K. Muralidharan, D. Vasudevan, Performance, emission and combustion characteristics of a variable compression ratio engine using methyl esters of waste cooking oil and blends, Appl. Energy 88 (2011) 3959–3968.

[7] A.S. Ramadhas, S. Jayaraj, C. Muraleedharan, Performance and emission evaluation of a diesel engine fueled with methyl esters of rubber seed oil, Renewable Energy 30 (2005) 1789–1800.

[8] Richard Stone, Introduction to Internal Combustion engines, MacMillan Press, 1999.

[9] Nitin Kukreja, Sanjeev Kumar Gupta, Manish Kumar Rawat, “Performance Analysis on Biplane Structure At Different Mach Numbers”, International Journal of Scientific & Technology Research, 9(1), pp: 1541-1546, ISSN 2277-8616, January 2020.

[10] R.W. Keyes, “Heat transfer in forced convection through fins”, IEEE Trans. Electron Dev. ED-31 (1984) 1218–1221.

[11] Omar Mokrani, Brahim Bourouga, Cathy Castelain, Hassan Peerhossaini, Fluidflow and convective heat transfer in flat microchannels, Int. J. Heat Mass Transfer 52 (2009) 1337-1352.

[12] R.J. Phillips, Micro-channel heat sinks, in: A. Bar-Cohen, A.D. Kraus(Eds.), Advances in Thermal Modeling of Electronic Components, vol.2, ASME Press, New York, 1990, pp. 109–184.

[13] Sanjeev Kumar Gupta, Manish Kumar Rawat, Nitin Kukreja, “Analysis Of Heat Transfer Enhancement of Electronic Chip Using CFD”, International Journal of Scientific & Technology Research, 8(12), pp: 1017-1020, ISSN 2277-8616, December 2019.

[14] Nitin Kukreja, Prakhar Vatsa, “Advanced Energy Storage Technique and its Conversion”, International Journal of Engineering and Advanced Technology (IJEAT)’ at Volume-8 Issue-3, February 2019.

[15] Nitin Kukreja, Sanjeev Kumar Gupta, Comparison of Performance Characteristic of A Diesel Engine Using Diesel and Kerosene – Diesel Blend, International Journal of Advanced Science and Technology, Vol. 29 No. 10s (2020), June 2020.

[16] Sanjeev Kumar Gupta, Nitin Kukreja, CFD Analysis of Flow Over Backward Facing Step at Different Inclination Angle, International Journal of Advanced Science and Technology, Vol. 29 No. 10s (2020), June 2020.

[17] Manish Kumar Rawat, Nitin Kukreja, Naveen Kumar Gupta, “Performance Analysis of High Temperature Heat Pipe Sodium: A Review”, Test Engineering & Management, ISSN:0194-4120, Page 17733-17739, May-June 2020.

[18] Nitin Kukreja, Sanjeev Kumar Gupta, Manish Kumar Rawat, “Performance Analysis of Phase Change Material using Energy Storage Device”, Materials Today Proceeding, January 2020.

[19] Manish Kumar Rawat, Nitin Kukreja, Sanjeev Kumar Gupta, “Effect of Reinforcing Micro Sized Aluminum Oxide Particles on Mechanical Properties of Polymer based Composite”, Materials Today Proceeding, January 2020.

[20] Sumit Nagar, Kamal Sharma, Nitin Kukreja, Manoj Kumar Shukla, PhD, “Micromechanical and Experimental Analysis of Mechanical Properties of Graphene/ CNT Epoxy Composites”, Materials
Today Proceeding, January 2020.