

The efficiency analysis of diesel engine by normal and coated piston

M.Srinivasnaik¹, Srinivas Banothu², D Srinivas³, B. Kavitha⁴, S.Raju

¹Associate Professor in the Department of Mechanical Engineering Chaitanya Deemed to be University Warangal

²Lecturer in Mechanical Engineering, Govt.Polytechnic, Kataram, Jayashanker Bhupalapally District

³Senior Lecturer in Mechanical, S.G.Govt.Polytechnic Adilabad

⁴Lecturer in mechanical engineering, Government polytechnic Warangal,

⁵Assistant Professor in the Department of Mechanical Engineering Chaitanya Deemed to be University Warangal

ABSTRACT: The diminished fuel utilization and the decrease of toxic emissions are the primary objectives of innovative work in the range of C.I engines. The utilization of Coatings and non coatings to come encourage toward that path is today a set up strategy for C.I engines. Coatings and non coatings lessen the outflows of nitrogen oxides with a low punishment in fuel utilization. The undeniably hard directions on emanations put high weight on the makers to enhance these frameworks. The present work goes for expanding the learning in the zone of Coatings and non coatings. Two of the fundamental difficulties while applying Coatings and non coatings are tended to, effectiveness. The effectiveness of the Coatings and non coatings - framework is investigated, concentrating on keeping the fuel punishment low for a given Coatings and non coatings, Distinctive designs of the Coatings and non coatings are contemplated and thought about in regards to their stationary and transient properties. Vitality examination is utilized to demonstrate the potential for development in various framework segments. The convenience of vitality examination of the gas trade is appeared by the case of an overwhelming obligation diesel Engine. The issue of Coatings and non coatings and air blending is drawn nearer by a definite investigation of the blending procedure in a substantial obligation diesel motor. Distinctive techniques for the estimation of Coatings and non coatings dissemination are introduced and thought about. Furthermore, the likelihood to anticipate the

blending impacts by 1-D and 3-D reproduction is surveyed. It is demonstrated that the fuel among air and Coatings and non coatings is very subject to the throbbing idea of the flow. This prompts the conclusion that quantity, as well as flow direction of fuel should be upgraded, as the circulation of Coatings and non coatings between the chambers are subject to the planning between the Coatings and non coatings and the valve opening time.

Key words: Thermal efficiency, coated pistons, surface ignition engine.

1.0 Introduction:

Overall strain to diminish car fuel utilization and CO₂ discharges is prompting the presentation of different new advances for the C.I Engine as it battles for piece of the pie with the oil. Up until this point, variable pressure proportion (VCR) motors have not achieved the market, notwithstanding licenses and analyses going back finished decades. VCR innovation could give the way to empower extraordinary proficiency at light loads without loss of full load execution. This paper will audit the numerous exemplifications of VCR, the suggestions for volume fabricate and the system for VCR execution so as to deliver the most extreme advantage.

LITERATURE REVIEW:

The regularly expanding interest for the oil based fills and their unnerve accessibility has prompt broad research on Diesel fuelled motors. A superior plan of the motor can altogether enhance the burning quality and thusly will prompt better brake arm efficiencies and henceforth reserve funds in fuel. [1] The capability of Diethyl ether (DEE) as a supplementary oxygenated fuel in a pressure start motor has been recognized through a trial examination. In this investigation the tests were led on a solitary chamber DI diesel motor energized with slick diesel fuel also, expansion of 2, 5, and 10% DEE in diesel fuel to discover the ideal mix on the premise of execution also, emanation attributes India however rich in coal liberally and enriched with sustainable power source in the type of sun powered, wind, hydro and bio-vitality has an exceptionally little hydro carbon saves (0.4%of the world's save) [2]. India is a net merchant of vitality. Almost 25% of its vitality needs are met through imports for the most part as raw petroleum and flammable gas. [3] The rising oil charge has been the center of genuine worries because of the weight it has set on rare remote trade assets and is likewise to a great extent in

charge of vitality supply deficiencies. The imperfect utilization of business vitality unfavorably influences the beneficial areas, which thus hampers monetary development. [4]. The exhibit work bargains with finding the better pressure proportion for the Diesel fuelled C.I motor at variable load and consistent speed operation. The pressure proportion of an internal combustion motor or outside ignition motor is a esteem that speaks to the proportion of the volume of its ignition chamber from its biggest ability to its littlest limit. It is a key determination for numerous normal burning motors. Trial comes about demonstrated that there is a slight increment in brake particular fuel utilization, break power and brake warm productivity when contrasted with diesel fuel. In expansion, it was discovered that there is a decline in smoke, oxides of nitrogen, unburned hydrocarbon, and carbon monoxide and start delay alongside increment in carbon dioxide. [5] The execution of the diesel motor is expanded with the expansion of oxygenates to the fuel preceding the burning. This paper exhibits the impact of mixing of Diethyl ether (DEE) with diesel at different extents (5%, 7.5% and 10%) on the execution of diesel motor. The exploratory outcomes showed that with the expansion in the centralization of DEE to diesel builds the brake warm productivity, mechanical proficiency and abatements the particular fuel utilization. The execution of diesel motor at various pressure proportions for diesel with 5% DEE mix was likewise assessed in this work. [6] The information acquired from experimentation is displayed dissected in this paper. To discover the Optimum Compression Ratio of the Automated Variable Compression Ratio (VCR) Single Cylinder Four Stroke Diesel Engine utilizing Experimentation analysis. Various parameters characterizing the execution of V.C.R diesel motor are ascertained what's more, they are used as means for getting ideal pressure proportion. By plotting execution charts of distinctive burdens and diverse pressure proportions from that ideal pressure proportion acquired. [7] Transient reproductions in GT-Power have some additional troubles when contrasted with consistent state reenactments. For the transient response of the turbocharger, some additional alignment and learning of the turbocharger's dormancy is required. To get this data, dormancy estimations were executed as proposed by [8]. Moreover, the evolving EGR-rate amid a transient has high effect on the ignition. As the ignition in the performed recreations was not mimicked, but rather forced from estimations, a database was fabricated containing various warmth discharge rates in reliance of admission weight and EGR rate. Thusly, a right warmth discharge rate could be decided for each cycle amid the transient reproduction. More insights about the transient alignment can be found in Paper [9]

Objectives:

1. To enhance the efficiency of the C.I Engine with the coated and non-coated materials
2. To calculate the validation of the efficiency to analytical results
3. To study the mechanical, thermal, standard properties of the C.I Engine subjected efficiency finding process.

Calculations for finding the efficiency of the engine with ethanol as fluid**IC ENGINE SPECIFICATIONS:**

- Number of cylinders (k): single
- Mean effective pressure (p_m): 180bar
- Stroke length (L): 0.130 mm
- Rotational speed (N): 750
- Torque (T) :150 Nm
- Colorific value ethanol (C_v) =27900 kJ/kg
- Mass flow rate (m_f) = 0.75 kg/ sec

Materials and Methods:-**Air Fuel Ratio (A/F)**

$$\begin{aligned} \text{Air Fuel Ratio (A/F)} &= \text{Mass of Air/Mass of Fuel} \\ &= m_a/m_f \\ &= 1:14 \end{aligned}$$

Indicated power (IP):

$$\text{IP} = \frac{100 * P_m * L * A * n * k}{60000}$$

K= number of cylinders

P = mean effective pressure

$$= 180 \text{ Bar}$$

L = Stroke length=0.130

A= Area of the cylinder

$$= 2\pi r h + 2\pi r^2$$

$$= 0.1696$$

n= rotation of speed= $N/2=750/2=375\text{Rpm}$

K= number of cylinders=1

$$\frac{100 * 180 * 0.130 * 0.1696 * 375 * 1.}{60000}$$

$$= 2.4804 \text{kw}$$

Brake Power (BP)

Brake Power is measured by the Eddy current Dynamometer:

$$\text{Brake Power (BP)} = \frac{2\pi INT}{60 * 1000}$$

Where T= torque, (F force *r radius) N /m²

N=Speed in rpm,

C = constant

$$= \frac{2 * 3.14 * 750 * 21.5}{60 * 1000}$$

$$= 1.687 \text{ kW}$$

Fuel Consumption (FC):**The fuel consumption per unit IP or BP**

- Indicated specific fuel consumption $I_{sfc} = m_f / I_p$ in kg/ kilo watt hour

$$I_{sfc} = m_f / I_p$$

$$= 0.75 / 2.4804$$

$$= 0.3024 \text{ kg/ kilo watt hour}$$

- Break specific fuel consumption $B_{sfc} = m_f / B_p$ in kg/ kilo watt hour

$$B_{sfc} = m_f / B_p$$

$$= 0.75 / 1.68$$

$$= 0.595 \text{ kg/ kilo watt hour}$$

Friction Power (IP)

Friction power (Fp) = IP-BP

$$FP = 2.4804 - 1.687$$

$$= 0.7937 \text{ watts}$$

Brake Thermal Efficiency (BTE)

$$\text{BTE} = \frac{BP}{m_f \times CV} \times 100$$

$$= \frac{1.687}{0.75 \times 29700} * 100$$

$$= 0.0004087 * 100$$

$$= 27.26\%$$

Where, m_f = Mass Flow rate of fuel in Kg/s,

C V = Calorific value of fuel

Indicated Thermal Efficiency (ITE)

$$\text{ITE} = \frac{IP * 3600}{m_f \times CV} \times 100$$

$$= \frac{2.4804 * 3600}{0.75 * 29700} * 100$$

$$= 40.08\%$$

$$\begin{aligned} \text{Mechanical efficiency} &= \eta_0 = \frac{P}{m_f * C_v} \\ &= \frac{180}{0.75 * 27900} \\ &= 84780 / 20925 \\ &= 40.5\% \end{aligned}$$

Volumetric Efficiency

$$\begin{aligned} \text{Volumetric Efficiency} &= \frac{\text{Actual Volume of air Consumed}}{\text{Theoretical Volume of air in handle}} \\ &= \frac{622.8}{8.65} \\ &= 72\% \end{aligned}$$

Where, d = diameter of the cylinder = 0.0875 m

L = Stroke length = 0.130 m

N = No. of working cycles per minute = RPM of the Engine

Brake Mean Effective Pressure (bmep)

Brake Mean Effective Pressure is portion which produces the useful power delivered by the Engine

$$\begin{aligned} \text{bmep} &= \text{imep} - \text{fmep} \\ &= \frac{IP}{BP} \times \text{imep} \end{aligned}$$

$$= 2.4804/1.687*1.566$$

$$= 2.293\text{N/m}^2$$

Where imep = Indicated mean effective pressure in bar

fmep= Friction Mean Effective Pressure in bar which is that portion of power of imep that required to overcome friction losses.

Calculations for finding the efficiency of the engine with diesel as fluid

SPECIFICATIONS:

- Bore : 80mm
- Stroke : 110 mm
- Rated Speed : 1500 rpm
- Max. B.P : 3.7KW (5 H.P)
- Compression Ratio : 16.5:1
- Orifice Diameter : 30mm
- Fuel : Diesel
- Density of Diesel : 0.827 gm / ml
- Calorific Value of Diesel : 43400 KJ / kg
- Brake drum diameter : 0.3m
- Rope diameter : 0.015m
- Equivalent diameter : 0.315 m

Brake Power (BP)

Brake Power is measured by the Eddy current Dynamometer:

$$\text{Brake Power (BP)} = \frac{2\pi NT}{60*1000}$$

Where T= torque =16.65N -m

N=Speed in rpm=1500rpm

C = constant

$$= \frac{2*3.14*1500*16.65}{60*1000}$$

$$= 2.61 \text{ kW}$$

Mass of fuel consumption per sec, $m_f = \frac{10*\text{specific gravity of fuel}}{60*1000}$

$$= 10*850/6000$$

$$= 0.136 \text{ kg/sec}$$

Total Fuel consumption, TFC = $m_f \times 60$

$$= 0.136 \times 60$$

$$= 8.16 \text{ kg/sec}$$

Heat input HI = $TFC \times C_v / 60 \times 60$

$$= 80.14$$

Specific fuel consumption, SFC = TFC/B.P

$$= 3.121 \text{ Kg/ Kw-hr}$$

Indicated power (IP):

$$IP = \frac{100 * P_m * L * A * n * k}{60000}$$

K= number of cylinders

P = mean effective pressure

$$= 180 \text{ Bar}$$

L = Stroke length= 0.130

A= Area of the cylinder

$$= 2\pi r h + 2\pi r^2$$

$$= 0.1696$$

n= rotation of speed = $N/2 = 750/2 = 375 \text{ Rpm}$

K= number of cylinders=1

$$\frac{100 * 180 * 0.130 * 0.1696 * 375 * 1.}{60000}$$

$$= 2.4804 \text{ kw}$$

Brake thermal efficiency $\eta_{\text{Bth}} = \text{B.P./H.I} * 1000$
 $= 32.6 \%$

Indicated thermal efficiency $\eta_{\text{Ith}} = \text{I.P./H.I} * 1000$
 $= 31.1\%$

Mechanical efficiency $\eta_{\text{m}} = \text{B.P./I.P} * 100$
 $= 106.95\%$

Calculations for finding the efficiency of the engine with Methanol as fluid

SPECIFICATIONS:

- Bore : 80mm
- Stroke : 110 mm
- Rated Speed : 1500 rpm
- Max. B.P : 3.7KW (5 H.P)
- Compression Ratio : 16.5:1
- Orifice Diameter : 30mm
- Fuel : methonal
- Density of Diesel : 0.67 gm / ml
- Calorific Value of Diesel : 38400 KJ / kg
- Brake drum diameter : 0.3m
- Rope diameter : 0.015m
- Equivalent diameter : 0.315 m

Brake Power (BP)

Brake Power is measured by the Eddy current Dynamometer:

$$\text{Brake Power (BP)} = \frac{2\pi NT}{60 \times 1000}$$

Where T= torque =15.5N -m

N=Speed in rpm=1500rpm

C = constant

$$= \frac{2 \times 3.14 \times 1500 \times 15.5}{60 \times 1000} = 2.03 \text{ kW}$$

$$\text{Mass of fuel consumption per sec, } m_f = \frac{10 \times \text{specific gravity of fuel}}{60 \times 1000}$$

$$= 10 \times 650 / 6000$$

$$= 0.108 \text{ kg/sec}$$

Total Fuel consumption, TFC = $m_f \times 60$

$$= 0.108 \times 60$$

$$= 6.49 \text{ kg/sec}$$

Heat input

$$\text{HI} = \text{TFC} \times C_v / 60 \times 60$$

$$= 69.22$$

Specific fuel consumption, SFC = TFC/B.P

$$= 3.197 \text{ Kg/ Kw-hr}$$

Indicated power (IP):

$$\text{IP} = \frac{100 \times P_m \times L \times A \times n \times k}{60000}$$

K= number of cylinders

P = mean effective pressure

$$= 180 \text{ Bar}$$

L = Stroke length= 0.130

A= Area of the cylinder

$$= 2\pi rh + 2\pi r^2$$

$$= 0.1696$$

$n = \text{rotation of speed} = N/2 = 750/2 = 375 \text{Rpm}$

$K = \text{number of cylinders} = 1$

$$\frac{100 * 180 * 0.130 * 0.1696 * 375 * 1.}{60000}$$

$$= 1.79 \text{ kw}$$

Brake thermal efficiency $\eta_{\text{Bth}} = \text{B.P}/\text{H.I} * 1000$

$$= 29.32 \%$$

Indicated thermal efficiency $\eta_{\text{Ith}} = \text{I.P}/\text{H.I} * 1000$

$$= 25.85\%$$

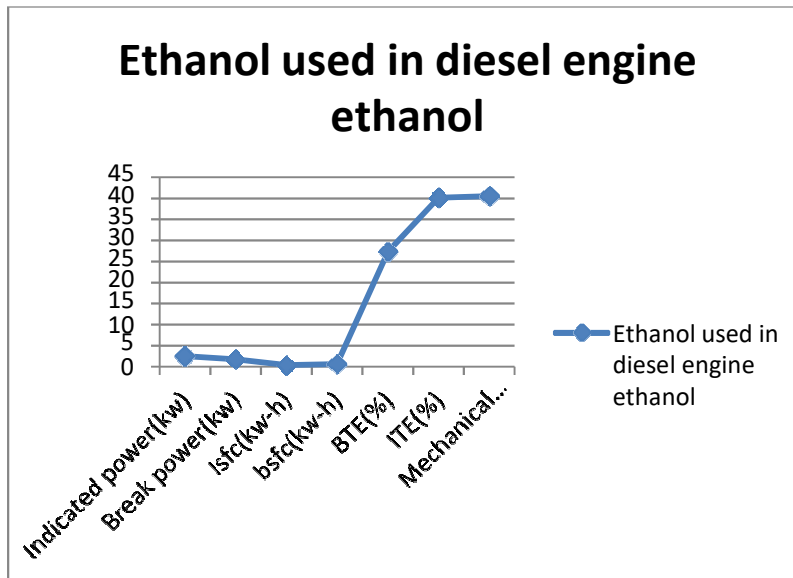
Mechanical efficiency $\eta_m = \text{B.P}/\text{I.P} * 100$

$$= 113.42\%$$

CONCLUSIONS:

TABLE ETHANOL PERFORMANCE IN DIESEL ENGINE

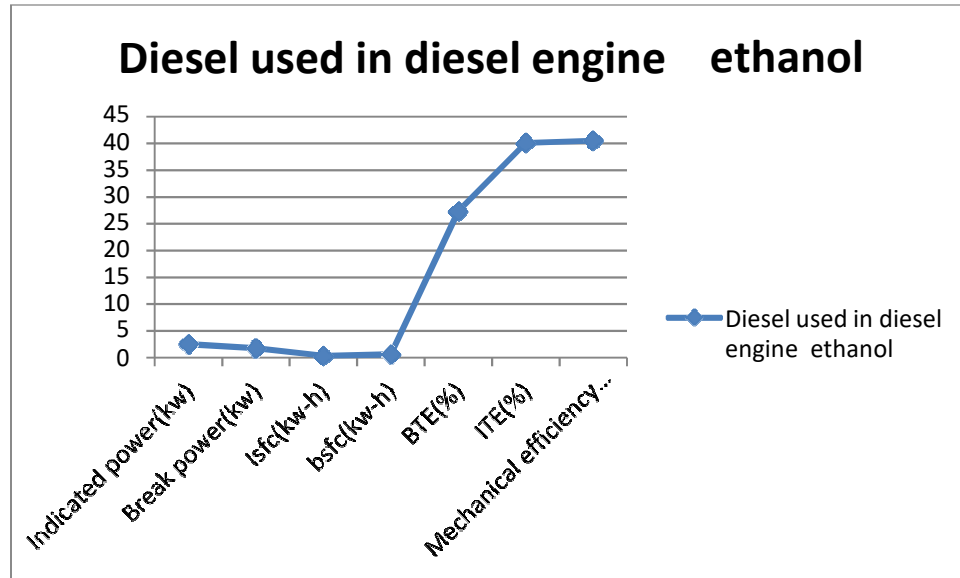
Parameters	Ethanol used in diesel engine
	ethanol
Indicated power(kw)	2.4804
Break power(kw)	1.687
Isfc(kw-h)	0.3024
bsfc(kw-h)	0.595
BTE(%)	27.26
ITE(%)	40.08
Mechanical efficiency (%)	40.5



GRAPH ETHANOL PERFORMANCE IN DIESEL ENGINE VARIATIONS

TABLE DIESEL PERFORMANCE IN DIESEL ENGINE

Parameters	Diesel used in diesel engine
	ethanol
Indicated power(kw)	2.4804
Break power(kw)	1.687
Isfc(kw-h)	0.3024
bsfc(kw-h)	0.595
BTE(%)	27.26
ITE(%)	40.08
Mechanical efficiency (%)	40.5

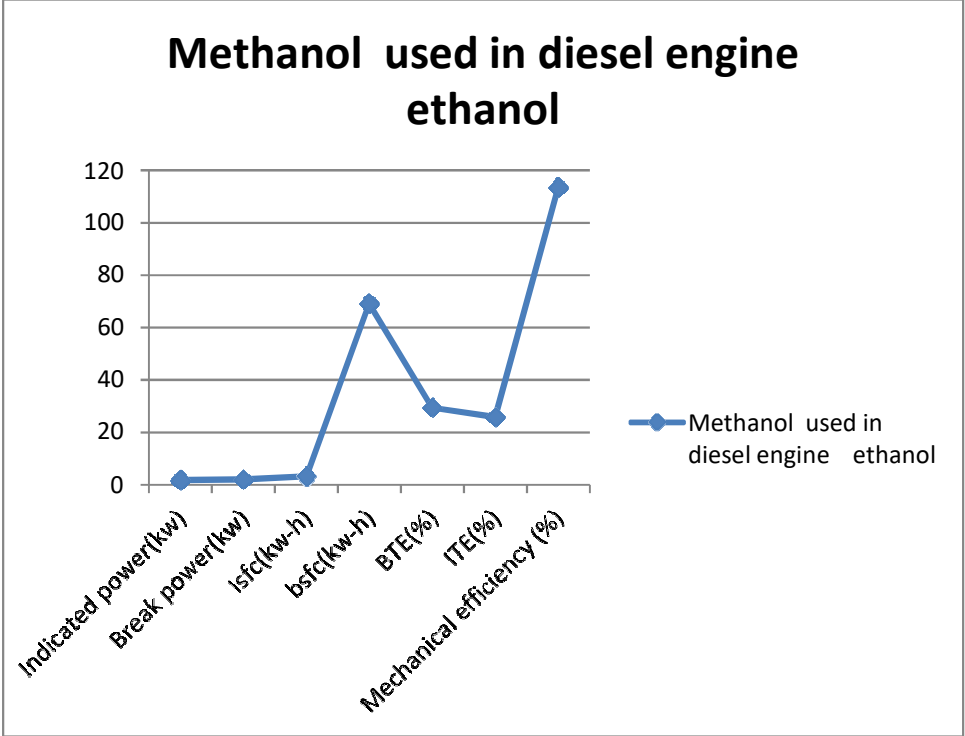


GRAPH DIESEL PERFORMANCE IN DIESEL ENGINE VARIATIONS

TABLE METHANOL PERFORMANCE IN DIESEL ENGINE

Parameters	Methanol used in diesel engine
	ethanol
Indicated power(kw)	1.79
Break power(kw)	2.03
Isfc(kw-h)	3.197
bsfc(kw-h)	69.22
BTE(%)	29.32
ITE(%)	25.85
Mechanical	113.42

efficiency (%)	
----------------	--



GRAPH METHANOL PERFORMANCE IN DIESEL ENGINE VARIATIONS

TABLE COMPARISON OF VARIOUS FLUIDS OF DIESEL ENGINE

Parameters	Various Fuels used in diesel engine		
	ethanol	diesel	Methanol
Indicated power(kw)	2.4804	2.4804	1.79
Break power(kw)	1.687	2.61	2.03
Isfc(kw-h)	0.3024	3.21	3.197
bsfc(kw-h)	0.595	80.14	69.22
BTE(%)	27.26	32.6	29.32
ITE(%)	40.08	31.1	25.85

Mechanical efficiency (%)	40.5	106.49	113.42
----------------------------------	-------------	---------------	---------------

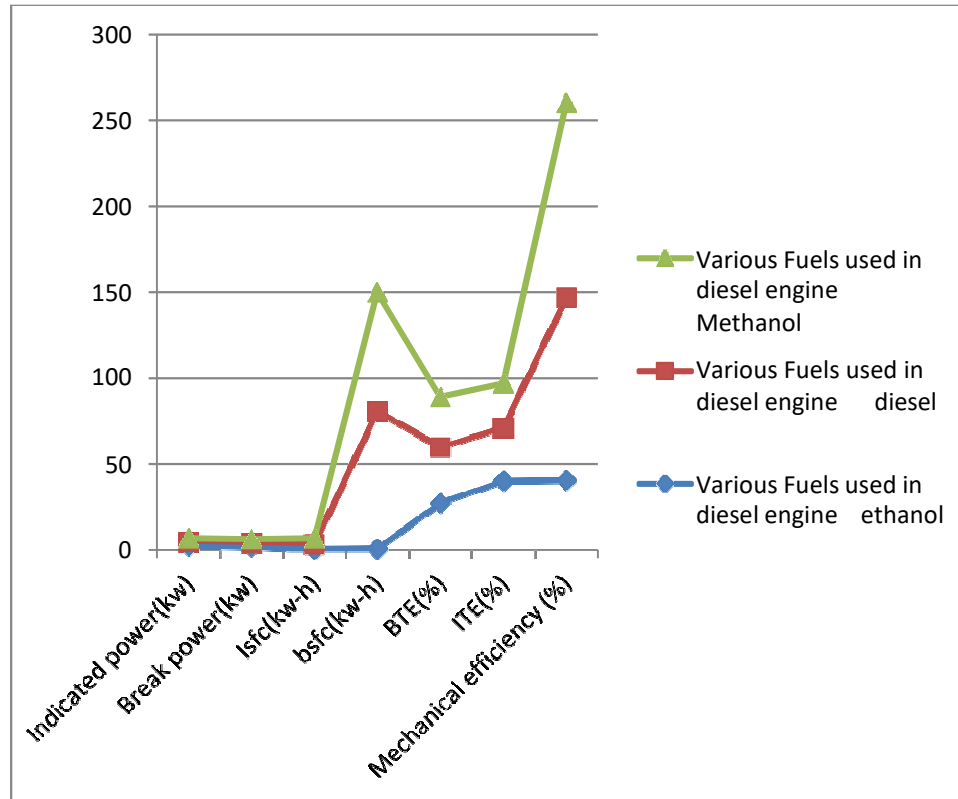


TABLE COMPARISON OF FLUIDS IN DIESEL ENGINE DIFFERENT VARIATIONS

Analysis results on piston crown with bronze uncoated surface subjected ignition process and coated piston crown surface subjected to maximum temperature. As the amount of coating increases temperature at the piston crown surfaces decreases. From the result it is concluded that the piston with bronze coating on piston crown has higher efficiency with coating when compared to uncoated piston resulting in saving in amount of fuel consumption through piston. This saved energy increase the overall efficiency of the engine.

References

- [1] Helmisyah Ahmad Jalaludina, ShahrirAbdullahb, MariyamJameelahGhazalib, BulanAbdullahc, NikRosliAbdullahc, "Trial Study of Ceramic Coated Piston Crown for Compressed Natural Gas Direct Injection Engines", "The Malaysian International Tribology Conference 2013", MITC2013, 505.
- [2] V. Gnanamoorthi and G. Devaradjane, "The impact of warm hindrance covering material in CI motor utilizing higher portion ethanol diesel mix", "Diary of Chemical and Pharmaceutical Research" , 2015, ISSN : 0975-7384, 7(2):416-422.
- [3] M. L. S. Dev Kumar Sir and P. Poornima, "warm investigation of diesel motor cylinder utilizing 3-d limited component strategy", "Worldwide Journal of Manufacturing Technology and Industrial Engineering", Vol. 2, No. 2, July-December 2011, pp. 97-102.

- [4] Ajay Raj Singh , Dr. Pushpendra Kumar Sharma, "Outline, examination and improvement of three aluminum cylinder compounds utilizing FEA", "Int. Diary of Engineering Research and Applications", Vol. 4, Issue 1, Version 3, January 2014, pp.94-102, ISSN : 2248-9622.
- [5] AnkitManral, Kapil and Pankaj Kumar, "Contrasting the aggregate disfigurement result in static auxiliary for ci motor cylinder covered with single TBC material Layer", "Universal Journal for Research in Emerging science and Technology ", volume-3, issue-7, jul-2016, E-ISSN: 2349-761.
- [6] S.sathyamoorthi, M.prabhakaran, S.A.muhammedabraar, "Numerical examination of artistic covering on cylinder crown utilizing limited component investigation", "Universal Journal of Scientific Engineering and Applied Science ", Volume-2, Issue-4, April 2016, ISSN: 2395-3470.
- [7] BaalaganapathyManohar, Miller Jothi, Udaykumar R, "The impacts of warm hindrance covering on warm anxiety and temperature dissemination in a diesel motor cylinder for magnesia/yittria mostly stablilized zirconia", "IJRMET" ,Vol. 6, Issue 1, Nov 2015-April 2016, ISSN : 2249-5762.
- [8] Sharukh K, Majo T Varghese, Steven Anto, Sijin E.B, Visakh K.K and Arun Raj A, "Trial Analysis of YSZ Coating on an IC Engine Piston", "Universal Journal of Engineering And Science", Vol.6, Issue 4, April 2016, PP - 106-111, ISSN: 2278-4721.
- [9] NarsaiyollaNaresh, P.SampathRao, "Basic Analysis of a Ceramic Coated Diesel Engine Piston Using Finite Element Method", "SSRG International Journal of Mechanical Engineering", volume1, issue 5, September2014.
- [10] K. Sridhar, R. Reji Kumar, M. Narasimha, "Warm hindrance Analysis in Diesel", "Universal Journal of Modern Engineering Research", Vol.3, Issue.3, May-June. 2013 pp-1435-1441, ISSN: 2249-6645.