UGC Approved Journal

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified

Vol. 4, Issue 9, September 2017

Effect of CNG Induction in the Engine at Various Blends and Injections Pressures: An Experimental investigation

P. Vijayarao[1], Dr. K. Vijaya Kumar Reddy[2], Dr. B. Sudheer Prem Kumar[3]

PhD External Scholar, Dept of Mechanical Engineering, JNTUH, Hyderabad, India[1]

Senior Professor, Dept of Mechanical Engineering, JNTUH, Hyderabad, India[2,3]

Abstract: Bio-fuels are the renewable sources of power generation and propulsion. Karanja oil is one such a bio-fuel which can be extracted from seeds. Compressed natural gas is induced into the combustion chamber through inlet manifold. The performance is calculated and analyzed broke down at different extents of CNG at all injection pressures and at B15 and B20 Karanja Blends in this paper.

Keywords: Diesel, Karanja Oil, CNG, Experimental Diesel Engine and emissions.

I. INTRODUCTION

Research reports say that the oil that is being drilled out of the earth would exhaust within few decades. The fossil fuels using in the internal combustion engines are non-renewable and are high impact on a country's economy. This shows, the world need fuels that are renewable and can be indigenously produced in a country to save the economy. The bio fuels are considered to be best of the renewable fuels and are can be produced indigenously. Bio-fuels are both gaseous fuels that which are called Bio gas and liquid fuels that which are termed as bio-diesels.

II. COMPRESSED NATURAL GAS

Compressed Natural Gas (C.N.G.) has improved as an alternative as a perfect consuming fuel of an IC motor. To follow the ever-stringent emanation standards all through the world and smash in oil holds, the cutting edge car industry is constrained to chase for new and elective methods for fuel sources to keep the wheels turning universally. Paradoxical goals of accomplishing synchronous lessening in discharge alongside superior has given a couple of option. Petroleum gas creates essentially no particulates since it contains few broke down pollutions (e.g. sulphur compounds). Additionally, flammable gas can be utilized as a part of pressure start motors (double fuel diesel–petroleum gas motors) since the auto-start temperature of the vaporous fuel is higher contrasted with the one of traditional fluid diesel fuel.

Double fuel diesel– petroleum gas motors highlight basically a homogeneous characteristic gas– air blend compacted quickly underneath its auto-start conditions and touched off by the infusion of a measure of fluid diesel fuel around top right on target position. Flammable gas is treated into the admission air and premixed with it amid the enlistment stroke. At steady motor speed, the treated vaporous fuel replaces an equivalent measure of the drafted ignition air (on a volume premise) since the aggregate sum of the enlisted blend must be kept consistent. Besides, under treated double fuel working mode, the coveted motor power yield (i.e. brake mean viable weight) is controlled by changing the measures of the powers utilized. Therefore, at a given blend of motor speed and load, the difference in the fluid fuel "supplementary proportion" prompts a difference in the breathed in ignition air, along these lines coming about to the change of the aggregate relative air– fuel proportion.

III. KARANJA OIL

Karanja Oil or Pongamia oil is derived from the seeds of the Millettia. Pinnata tree, which is native to tropical and temperate Asia. Millettia pinnata is native to South and Southeast Asia. Referred to in different dialects as Indian beech, Pongam, Karanja, Honge, Kanuga, and Naktamala, it is currently developed everywhere throughout the world. . Commonly the plant begins yielding units from the fifth year on with the yields expanding every year until the point that it balances out around the tenth year. Milletti pinnata is originally born from South and Southeast Asia. Referred to in different dialects as Indian beech, Pongam, Karanja, Honge, Kanuga, and Naktamala, it is currently developed everywhere throughout the world. Ordinarily the plant begins yielding units from the fifth year on with the yields expanding every year until the point when it settles around the tenth year.

 DOI10.17148/IARJSET.2017.4907

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 4, Issue 9, September 2017

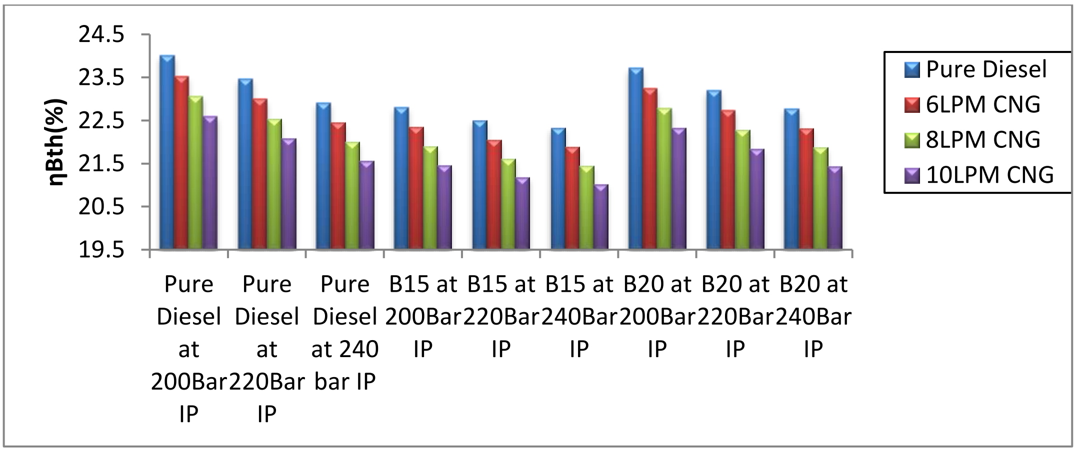
Pongamia oil is removed from the seeds by expeller squeezing, cold squeezing, or dissolved extraction. The oil is yellowish-orange to brown in colored in shading. It is dangerous and will actuate sickness and heaving if eaten, yet it is utilized as a part of numerous conventional cures. It has a high substance of triglycerides, and and its upsetting taste and scent are because of intense flavonoid constituents including karanjin, pongamol, tannin and karanjachromene.
The physical properties of the Karanja oil are as given below.

Table 1: Properties of Karanja Oil

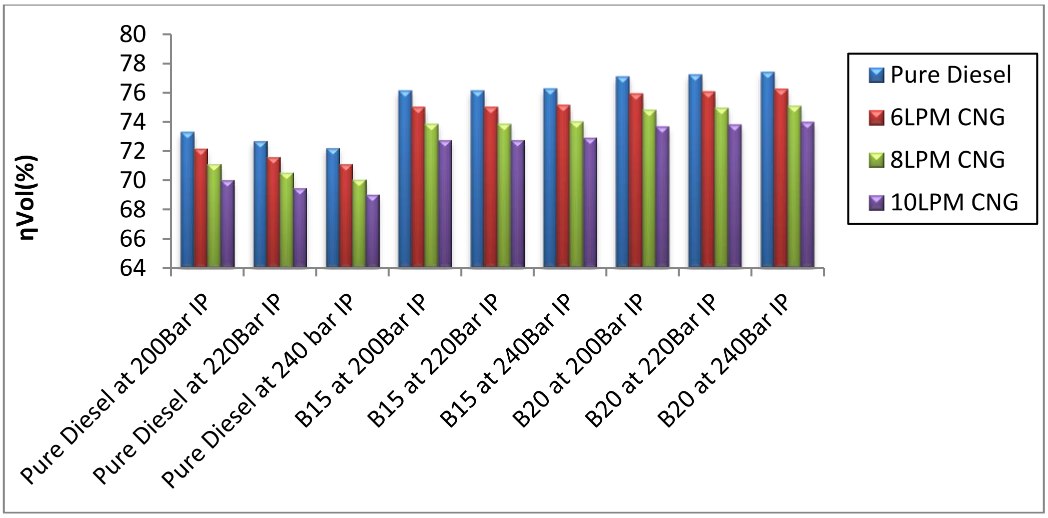
Property	Methyl esters	ASTM D6751	EN 14214
Acid value(mg KOH/g)	0.46 - 0.5	<0.8	<0.5
Calorific value(kcal/kg)	3700		
Cetane Number	41.7 - 56	>45	>51
Density at 15°C (g/cm3)	0.86 - 0.88	0.87 - 0.89	0.86 - 0.90
Viscosity at 40°C(mm2/s)	4.77	1.9 - 0	3.5 - 5.0
Boiling point (°C)	316		
Cloud point(°C)	19		0/-15
Fire Point(°C)	230		
Flash point(°C)	174	>130	>101

IV. RESULTS AND DISCUSSIONS

Compressed natural gas (C.N.G.) is induced into the combustion chamber through inlet manifold. The presentation is measured and analyzed at various proportions of CNG at all injection pressures and at B15 and B20 Karanja Blends in this Case.



Graph 1: Brake thermal efficiency Vs Injection pressures at various blends



Graph 2: Volumetric efficiency Vs Injection pressures at various blends

UGC Approved Journal

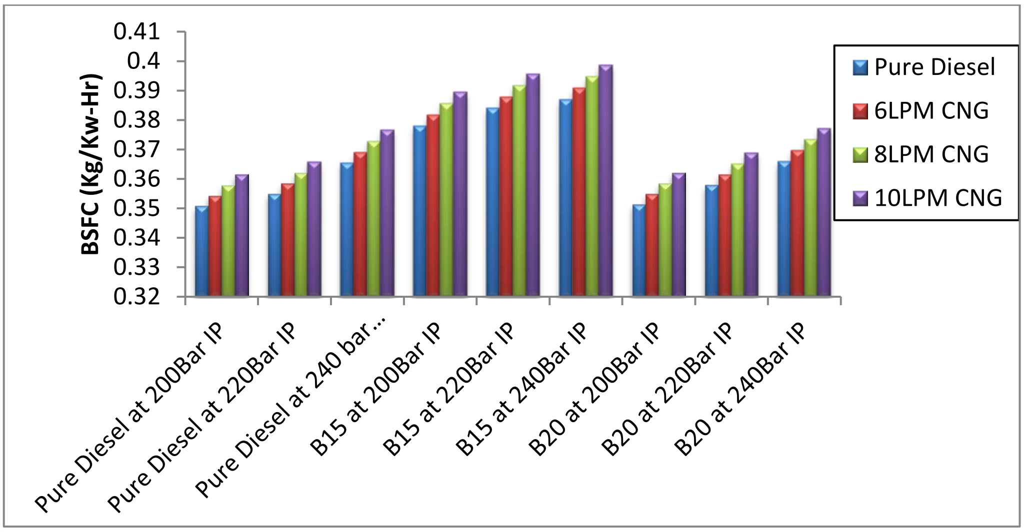
IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified

Vol. 4, Issue 9, September 2017



Graph 3: BSFC Vs Injection pressures at various blends

Brake thermal efficiency:

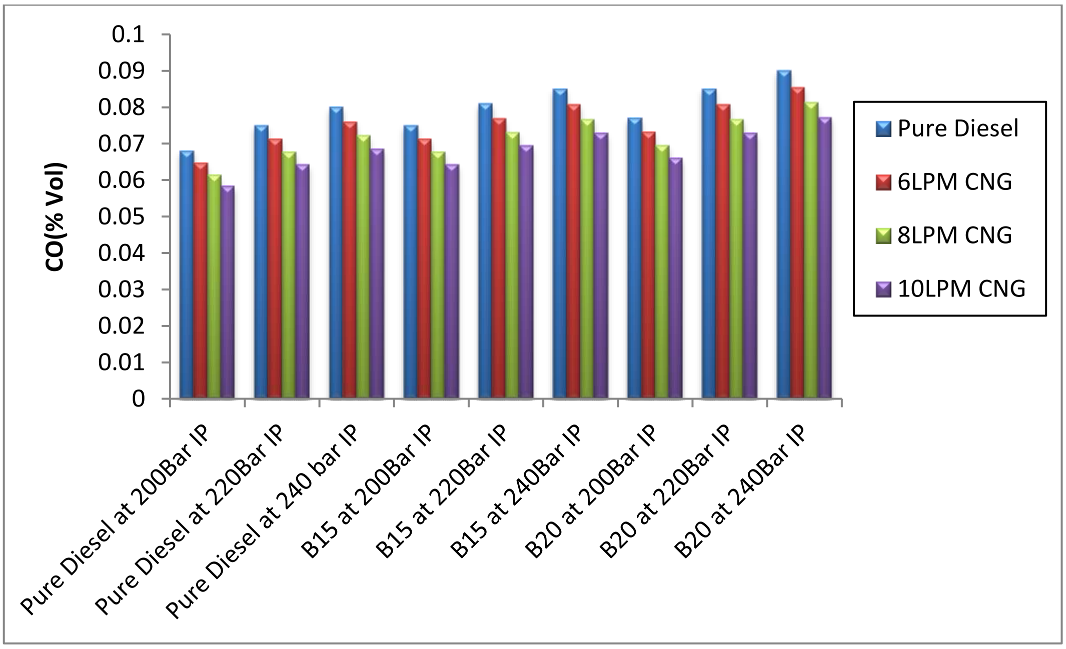
Brake thermal efficiency is an important performance parameter of an IC engine; it determines or evaluates the suitability of a particular running condition; it determines or evaluates the suitability of a particular running condition. Graph 1 shows effect of injection pressure all the CNG proportions. There is decrease in the brake thermal efficiency at all the blends at all the injection pressures with the increase in the CNG substitutions.

Volumetric efficiency:

The volumetric efficiency is the breathing capacity of the engine, good volumetric efficiency indicates healthy engine. The volumetric efficiency is the breathing capacity of the engine, good volumetric efficiency indicates healthy engine. The gaseous fuel like CNG decreases the space for inlet air into the combustion chamber and reduces the volumetric efficiency of the engine. The graph 2 is following the theoretical trend decreasing volumetric efficiency with increasing CNG substitution at diesel, B15 and B20 at all the injection pressures.

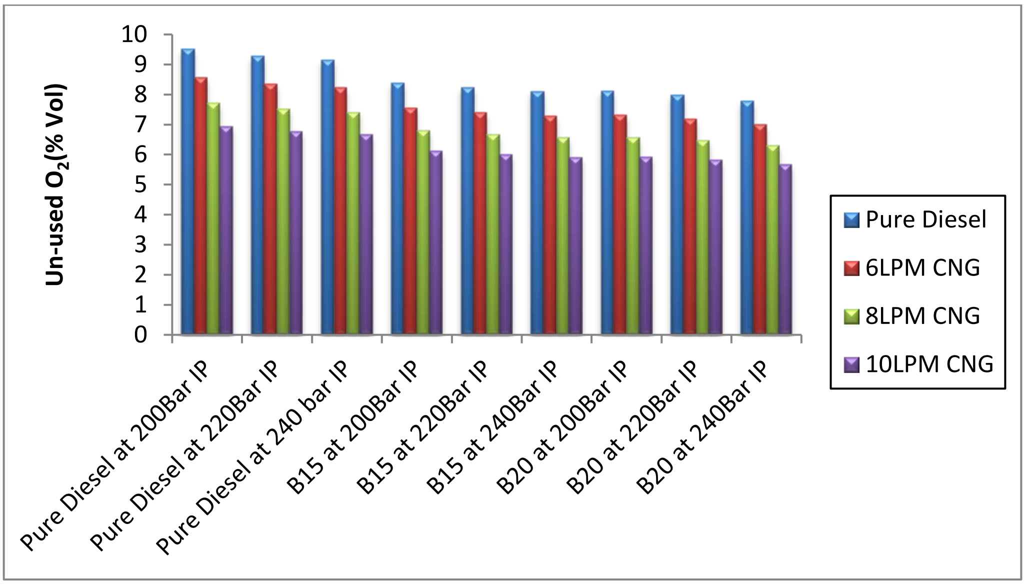
Brake Specific Fuel Consumption:

Brake Specific fuel consumption is another important parameter that determines the performance of any engine. It is the specific quantity of fuel used to generate a unit of power. The graph 4 shows the increasing BSFC with increasing CNG substitution at diesel, B15 and B20 at all the injection pressures.



Graph 4: CO Vs Injection pressures at various blends

UGC Approved Journal
IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 4, Issue 9, September 2017



Graph 5: Un-used O2 Vs Injection pressures at various blends

Emissions:

After validation of performance parameters emissions stand to determine the suitability of a running condition of an Engine. Below given are the emissions that are measured and compared at the focussed running conditions.

Oxides of Carbon (CO and CO2):

Carbon Monoxide (CO):
Carbon monoxide is an oxide of carbon that is partially oxidized during the combustion process and has adverse effect on the environment and human health. Carbon monoxide is an oxide of carbon that is partially oxidized during the combustion process and has adverse effect on the environment and human health. The Graph 4 presenting the increasing CO with decreasing CNG substitution at diesel, B15 and B20 at all the injection pressures.

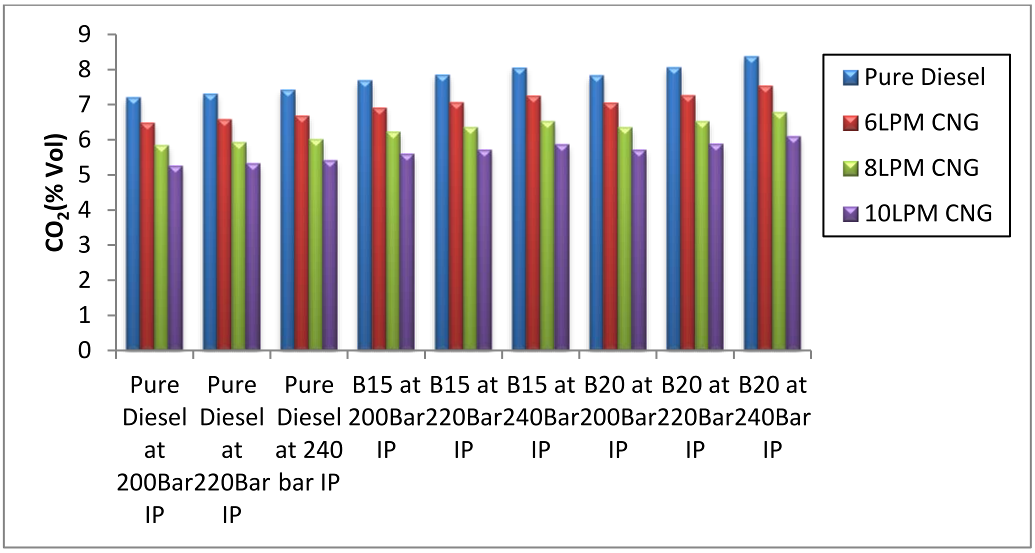
Carbon-Dioxide (CO2):
Carbon Dioxide is another oxide of carbon that is the complete oxidized form of carbon in the combustion chamber. Emissions of CO2 also need to be considered serious as it is one of green house gas. The Graph 5 presenting the decreasing CO2 with decreasing CNG substitution at diesel, B15 and B20 at all the injection pressures. As the CNG substitution increases the space for oxygen inside the combustion chamber, thereby the decrease in the oxidation of the carbon compounds and resulting in the decrease in the CO2 Emissions with the increase in the CNG substitution.

Un-used Oxygen:
The un-used or the un-reacted oxygen is percentage of oxygen inside the exhaust gas, more usage of oxygen implies better combustion and thereby better performance, less amount of un-used oxygen is desired ait indicates the better combustion. The Graph 6 presenting the increasing un-used O2 with decreasing CNG substitution at diesel, B15 and B20 at all the injection pressures. As the CNG substitution increases the space for oxygen inside the combustion chamber, thereby the decrease in the un-used O2.

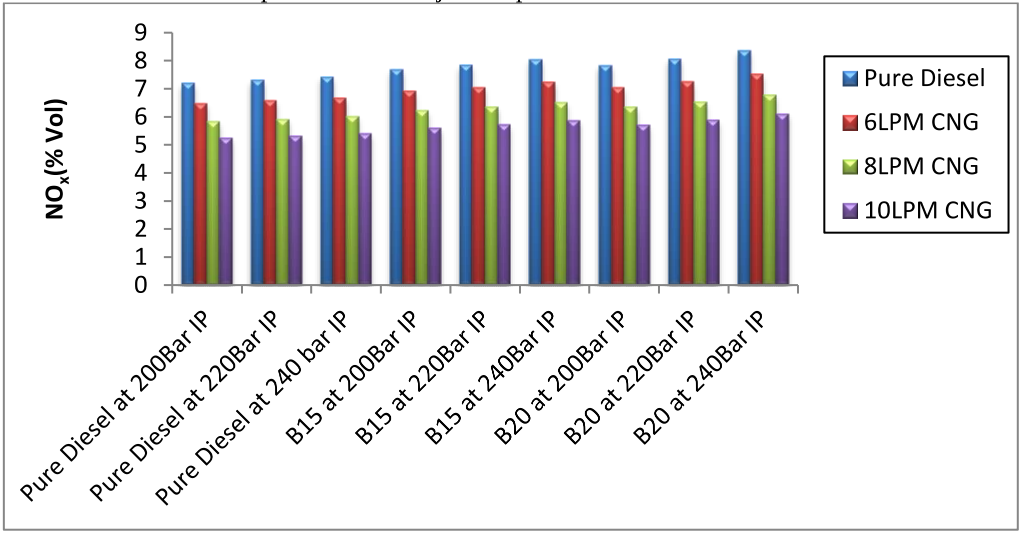
Oxides of Nitrogen (NOx):
Oxides of Nitrogen are the automotive emissions that need to be adversely considered in engine life and environmental stand point. The Graph 7 presenting the decreasing NOx with decreasing CNG substitution at diesel, B15 and B20 at all the injection pressures. As the CNG substitution increases the space for oxygen inside the combustion chamber, thereby the decrease in the oxidation of the Nitrogen compounds and resulting in the decrease in the NOX Emissions with the increase in the CNG substitution.

Un-burnt hydro Carbons (HC):
The fuels used in the engine are hydro carbon fuels, the fully burnt or reacted hydro carbons generate power where as the un-burnt hydro carbons come out of tail pipe as harmful emissions. The graph 8 projects the decrease in hydrocarbons with the increase in the CNG substitution.

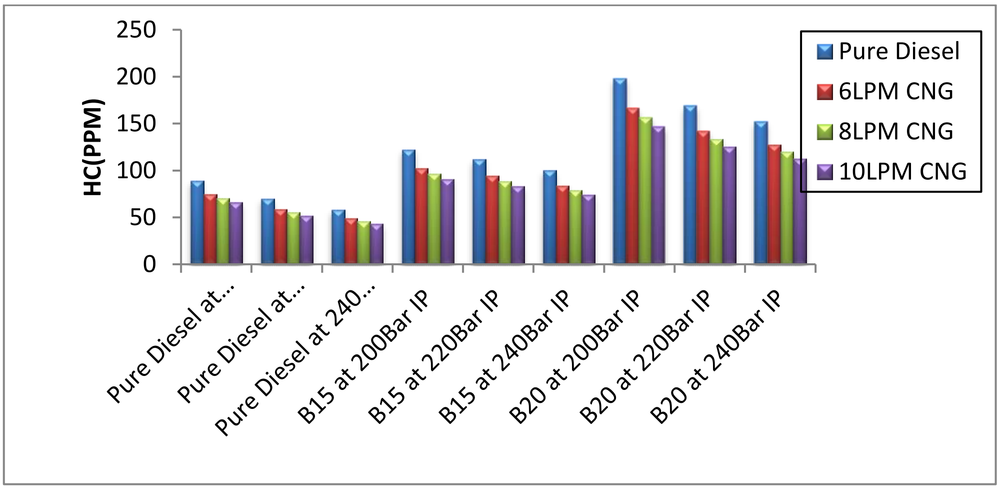
IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 4, Issue 9, September 2017



Graph 6: CO2 Vs Injection pressures at various blends



Graph 7: NOX Vs Injection pressures at various blends



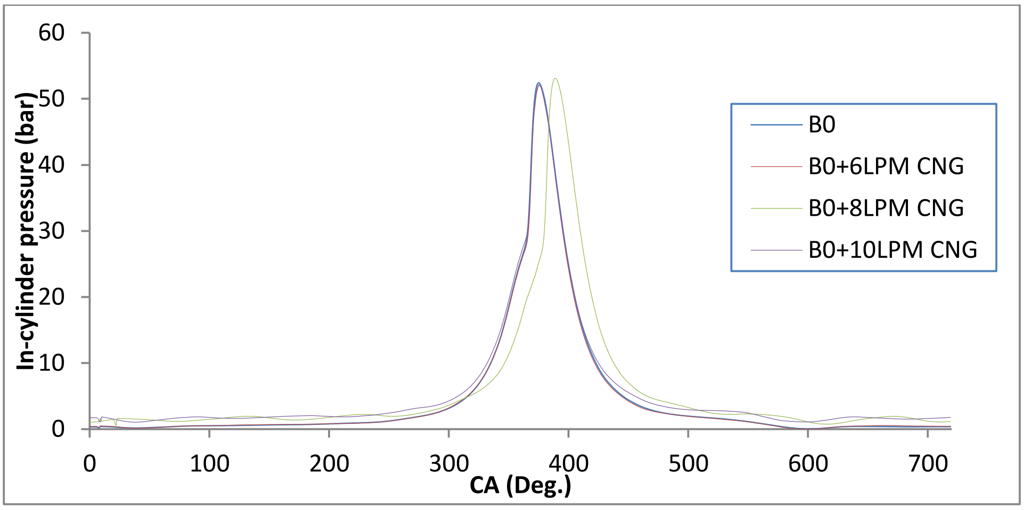
Graph 8: HC Vs Injection pressures at various blends

In-cylinder pressure Vs Crank Angle (P-θ diagrams)

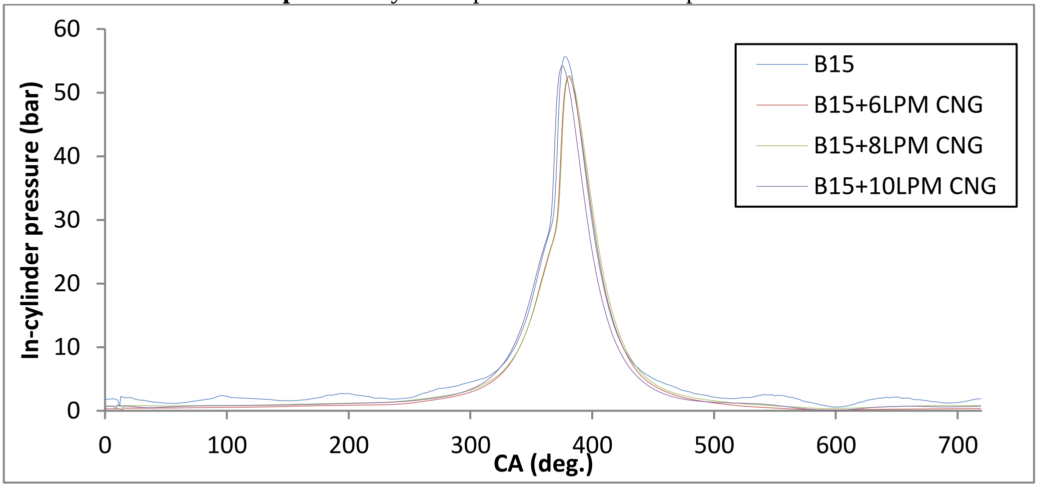
The in-cylinder pressure Vs Crank angle diagram is an important part of study of the combustion inside the combustion chamber. The profile of the diagram explains the timing of the injection and combustion and the magnitude of peak pressure. The abnormal combustion phenomena like Knocking, Detonation, pre-ignition etc., can be detected.

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 4, Issue 9, September 2017

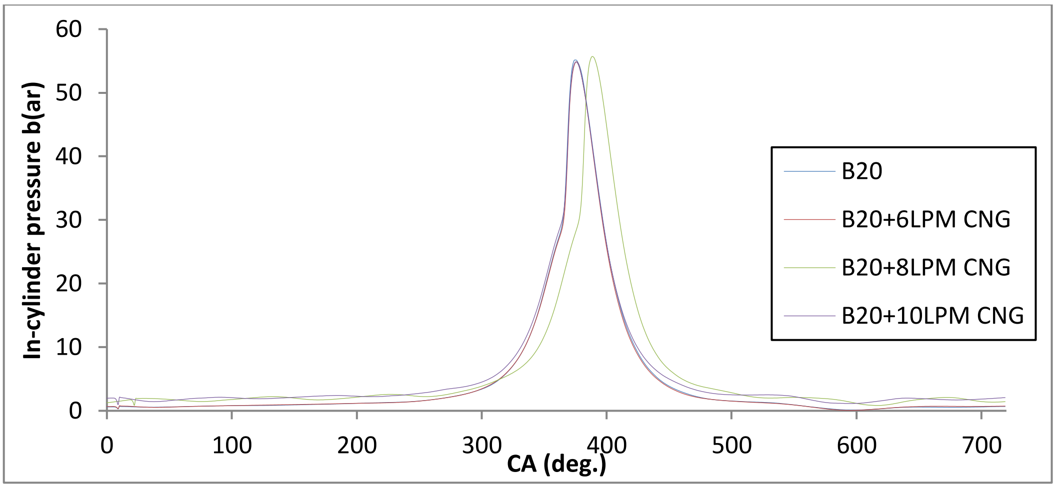
The graphs 9, 10 and 11 show the P-θ diagrams of the engine at B0, B15 and B20 at various CNG substitutions. These diagrams show the increase of peak pressure with the CNG substitutions.



Graph 9: In-cylinder pressure Vs CA for pure diesel



Graph 10: In-cylinder pressure Vs CA for B15



Graph 11: In-cylinder pressure Vs CA for B20

V. CONCLUSIONS

The data inferred from the results and discussions suggest; The variation of injection pressures has shown a significant effect on all the performance parameters. The fall in the performance is noted under the increasing injection pressures,

UGC Approved Journal
IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 4, Issue 9, September 2017

all the performance parameters are affected by the injection pressures. Injection pressure variation also has shown negative effect on the emissions at majority of Karanja blends, except on un-used oxygen. The CNG induction into combustion chamber has shown decreasing performance for all blends. Positive effect on the emissions is seen in the CNG induction on all the blends and majority of injection pressures.

Nomenclature:

Table 2: Nomenclature

Notation	Term	Units
η_{Bth}	Break thermal efficiency	%
η_{Vol}	Volumetric efficiency	%
BSFC	Break specific fuel consumption	Kg/KW-Hr
CNG	Compressed Natural Gas	LPM
CO	Carbon Mono Oxide	% volume
CO_2	Carbon Di-Oxide	% volume
NO_X	Oxides of Nitrogen	PPM
HC	un-burnt Hyrdro carbons	PPM
LPM	Litres Per Minute	-

Table 3: Explanation of blends

Notation	constituents	
	Diesel%	Karanja%
B5	95	5
B10	90	10
B15	85	15
B20	80	20

REFERENCES

1. B. Jayashankara, V. Ganesan, “Effect of fuel injection timing and intake pressure on the performance of a DI diesel engine – A parametric study using CFD”, Energy Conversion and Management, Volume 51, Issue 10, October 2010, Pages 1835–1848.
2. İsmet Çelıkten, “An experimental investigation of the effect of the injection pressure on engine performance and exhaust emission in indirect injection diesel engines”, Applied Thermal Engineering, Volume 23, Issue 16, November 2003, Pages 2051–2060.
3. J. A. Bittle and T. J. Jacobs, “On the Relationship Between Fuel Injection Pressure and Two-Stage Ignition Behavior of Low Temperature Diesel Combustion”, Author and Article InformationJ. Energy Resour. Technol.134(4), 42201(Aug31,2012)(6pages) doi:10.1115/1.4007252 History: Received J
4. J. A. Bittle and T. J. Jacobs”On the Relationship Between Fuel Injection Pressure and Two-Stage Ignition Behavior of Low Temperature Diesel Combustion” J. Energy Resour. Technol. 134(4), 042201 (Aug 31, 2012) (6 pages)doi:10.1115/1.4007252History: Received January 18, 2012; Revised May
5. Junnian Zheng, erald A. Caton, “Second law analysis of a low temperature combustion diesel engine: Effect of injection timing and exhaust gas recirculation”, Energy, Volume 38, Issue 1, February 2012, Pages 78–84.
6. M.L.S Deva Kumar, S.Drakshayani, K.Vijaya Kumar Reddy, "Effect of Fuel Injection Pressure on Performance of Single Cylinder Diesel Engine at Different Intake Manifold Inclinations", International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 4, October 2012.
7. Muammer Özkan, Derya Burcu Özkan, Orkun Özener, Hasan Yılmaz, “Experimental study on energy and exergy analyses of a diesel engine performed with multiple injection strategies: Effect of pre-injection timing”, Applied Thermal Engineering, Volume 53, Issue 1, 29 April 2013, Pages 21–30.
8. R.B. Melton Jr., S.J. Lestz, R.D. Quillian Jr., "Direct water injection cooling for military engines and effects on the diesel cycle", Symposium (International) on Combustion, Volume 15, Issue 1, 1975, Pages 1389–1399, Fifteenth Symposium (International) on Combustion.
9. Keeler, B., and Shayler, P. J., 2008, “Constraints on Fuel Injection and EGR Strategies for Diesel PCCI-Type Combustion,” SAE Paper No. 2008-01-1327.
10. M. Nagarhalli, V Nandedkar, K. Mohite. Emission and performance characteristics of karanja biodiesel and its blends in a CI engine and it’s economics. ARPN J Eng Appl Sci, 5, (2010) 52–6.
11. M.A. Wail, S.A. Khaled,Performance of Diesel Engine Fuelled by a Biodiesel Extracted From A Waste Cocking Oil, Energy Procedia 18, (2012) 1317-1334
12. M.M. Roy, W. Wang, J. Bujold, Biodiesel production and comparison of emissions of a DI diesel engine fueled by biodiesel–diesel and canola oil–diesel blends at high idling operations, Applied Energy, 106, (2013) 198–208.
13. M.S. Shehata, Emissions, performance and cylinder pressure of diesel engine fuelled by biodiesel fuel, Fuel 112, (2013) 513–522.
14. Maiboom, A., Tauzia, X., and Hétet, J., 2008, “Experimental Study of Various Effects of Exhaust Gas Recirculation (EGR) on Combustion and Emissions of an Automotive Direct Injection Diesel Engine,” Energy, 33 (1), pp. 22–34.
15. Montgomery, D. and Reitz, R., “Effects of Multiple Injections and Flexible Control of Boost and EGR on Emissions and Fuel Consumption of a Heavy-Duty Diesel Engine,” SAE Technical Paper 2001-01-0195, 2001, doi: 10.4271/2001-01-0195.
16. O. Ozener, J. Yuksek, A.T. Ergenc, M. Ozkan, Effects of soybean biodiesel on a DI diesel engine performance, emission and combustion characteristics, Fuel, 115, (2014) 875–883.
17. Peng, H., Cui, Y., Shi, L., and Deng, K., 2008, “Effects of Exhaust Gas Recirculation (EGR) on Combustion and Emissions During Cold Start of Direct Injection (DI) Diesel Engine,” Energy, 33 (3), pp. 471–479.
18. Qi D.H., H. Chen, L.M. Geng, Y. ZH. Bian, Experimental studies on the combustion characteristics and performance of a direct injection engine fueled with biodiesel/diesel blends, Energy Conversion and Management, 51, (2010) 2985–2992.
19. Qi, Y., Srinivasan, K. K., Krishnan, S. R., Yang, H., and Midkiff, K. C., 2007, “Effect of Hot EGR on the Performance and Emissions of an Advanced Injection Low Pilot-Ignited Natural Gas Engine,” Int. J. Engine Res.8 (3), pp. 289–305.