International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 07, July 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354

LOAD TESTING OF IC-ENGINE BASED ON BIO DIESEL GENERATED THROUGH GASIFICATION PROCESS

Abhishek Pratap Shahi[1], K K Thakur[2], Santosh Khumbhare[3], B.B Saxena[4]

[1] Research Scholar, [2,3] Professor, [4]Professor& HOD, Patel College of Science and Technology, PCST, RGPV Bhopal, MP, (India)

ABSTRACT

At present every country is facing two major challenges namely the energy crisis and environmental degradation. Crying need of the day is to mean fuel, more fuel and cheaper fuel. Moreover the growing use of petroleum fuels in the ever-increasing number of automobiles is causing rapid degradation of environment in every country due to vehicular exhaust pollution. To meet this twin problem of fuel oil scarcity and air pollution caused by the growing use of petroleum fuel, alternate renewable clean burning fuel should be exploded for using motor vehicles. Most prominent eco-friendly fuels are the bio-solar fuels namely alcohol, natural gas and hydrogen.

Producer gas is also one such viable alternative fuel and its use can go a long way in meeting the energy needs of certain vital sectors of the economy and in certain important regions of the century. Producer gas fueled small sizes C.I.Engines have a vast potential, especially in the agricultural sector of developing countries like India. As per data available in 1989, 2.5 million diesel powered irrigation pump-sets of 3-5 hp ratings are currently in use in the country and these can be converted to run on producer gas a substantial saving in the consumption of diesel can be effected. Using the producer gas along with diesel in the engine can save nearly about 25% of the diesel.

Keyword: Energy Crisis, Bio-fuels, Internal Combustion Engine, Gasification, Load Testing.

I. INTRODUCTION

Biomass is all biologically-produced matter based in carbon, hydrogen and oxygen. The estimated biomass production in the world is 146 billion tons a year, consisting of mostly wild plant growth. The term biomass generally refers to renewable organic matter generated by plants through photosynthesis in which solar energy combines with carbon dioxide and moisture to form carbohydrates and oxygen [1].

During the last century, the consumption of energy has increased a lot due to the change in the life style and the significant growth of population. This increase of energy demand has been supplied by the use of fossil resources, which caused the crises of the fossil fuel depletion, the increase in its price and the serious environmental impacts as global warming, acidification, deforestation, ozone depletion. As fossil fuels are limited sources of energy, this increasing demand for energy has led to a search for alternative sources of energy

International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 07, July 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354

that would be economically efficient, socially equitable, and environmentally sound. Two of the main contributors of this increase of energy demand have been the transportation and the basic industry sectors, being the largest energy consumers.

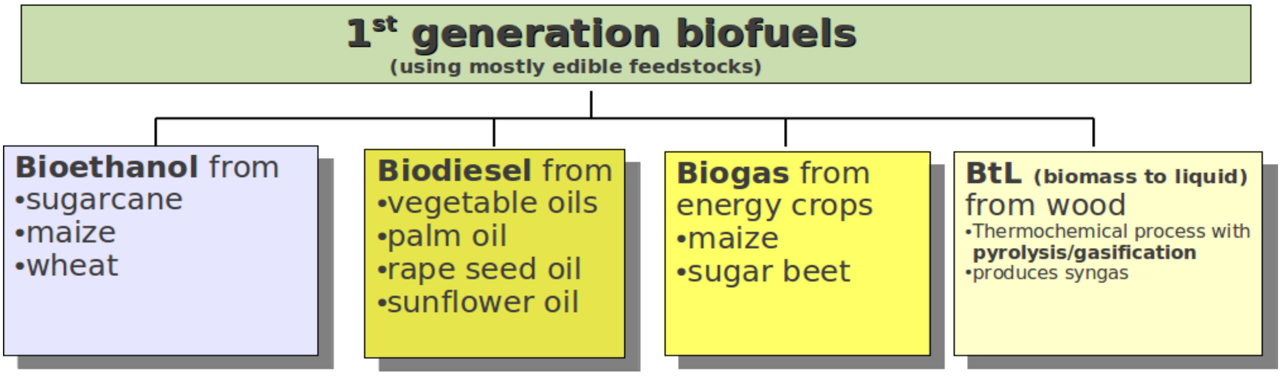

Figure 1: Classification of First Generation Biofuels

1.1 Limitations of the 1st-Generation Bio-Fuels are That They

- ✓ contribute to higher food prices due to competition with food crops;
- ✓ are an expensive option for energy security taking into account total production costs excluding government grants and subsidies;
- ✓ provide only limited GHG reduction benefits (with the exception of sugarcane ethanol and at
- ✓ relatively high costs in terms of $ /tonne of carbon dioxide ($ /t CO2) avoided;
- ✓ do not meet their claimed environmental benefits because the biomass feedstock may not always be produced sustainably;
- ✓ are accelerating deforestation (with other potentially indirect land use effects also to be accounted for);
- ✓ Potentially have a negative impact on biodiversity; and compete for scarce water resources in some regions.

1.2 Second Generation Biofuels

These are also known as advanced biofuels, are fuels that can be manufactured from various types of biomass. Biomass is a wide-ranging term meaning any source of organic carbon that is renewed rapidly as part of the carbon cycle. Biomass is derived from plant materials but can also include animal materials. ***Lignocelluloses*** refer to plant dry matter (***biomass***), so called ***lignocelluloses biomass***. It is the most abundantly available raw material on the Earth for the production of bio-fuels, mainly bio-ethanol. It is composed of carbohydrate polymers (cellulose, hemicelluloses), and an aromatic polymer (lignin)[2].

First generation biofuels are made from the sugars and vegetable oils found in arable crops, which can be easily extracted using conventional technology. In comparison, second generation biofuels are made from lignocelluloses biomass or woody crops, agricultural residues or waste, which makes it harder to extract the required fuel.

1.3 Biodiesel as an Engine Fuel

Fast depletion of fossil fuels is demanding an urgent need to carry out research work to find out the viable alternative fuels. Diesel fuel is largely consumed by the transportation sector. Thermodynamic tests based on the engine performance evaluations have established the feasibility of using vegetable oils. It has been found that vegetable oils hold special promise in this regard, because they can be produced from the plants grown in rural areas. Vegetable oils from crops such as soybean, peanut, sunflower, rape, coconut, Karana, neem, cotton, mustard, jatropha, linseed and coster have been evaluated in many parts of the world in comparison with other non-edible oils. Karanja (pungamia) is an oil seed-bearing tree, which is non-edible and does not find any suitable application with only 6% being utilized of 200 million tons per annum.

Biodiesel refers to a vegetable oil - or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat) with an alcohol producing fatty acid ester [3].

1.4 Engine Performance Characteristics of Biodiesel

Biodiesel has low heating value, (10% lower than diesel) on weight basis because of presence of substantial amount of oxygen in the fuel but at the same time biodiesel has a higher specific gravity (0.88) as compared to mineral diesel (0.85) so overall impact is approximately 5% lower energy content per unit volume. Thermal efficiency of an engine operating on biodiesel is generally better than that operating on diesel. Brake-specific energy consumption (bsec) is a more reliable criterion compared to brake-specific fuel consumption (bsfc) for comparing fuels having different calorific values and densities.

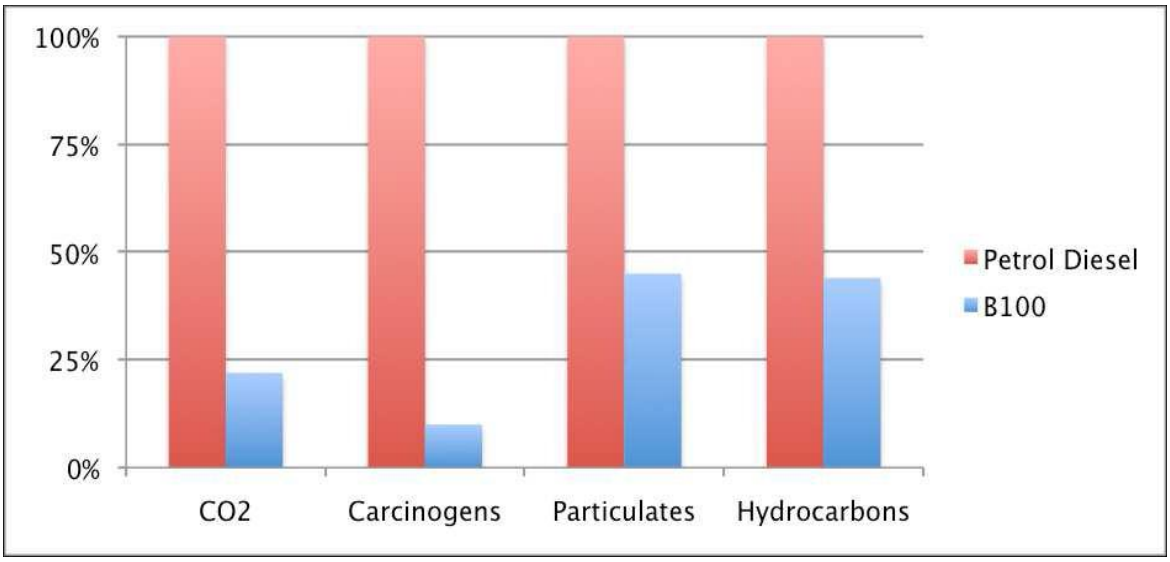

Figure 2: Emissions Compared to Petroleum Diesel Emissions by Percentage

1.5 Environmental Benefits of Biodiesel Fuel

The steadily rising price of petroleum products and the environmental impact of procuring, manufacturing, and using them create the need for alternate energy sources. Biodiesel, fuel that is chemically prepared from vegetable oil, provides an environmentally friendly substitute for diesel fuel. It is classified as a biofuels because it originates from a biological source. Its biological origin makes it biodegradable and nontoxic [4, 5].

II. EXPERIMENTAL DETAIL OF PRODUCING BIOMASS

Gasification is a process that converts organic or fossil fuel based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide. This is achieved by reacting the material at high temperatures (>700 °C), without combustion, with a controlled amount of oxygen and/or steam. The resulting gas mixture is called syngas (from synthesis gas or synthetic gas) or producer gas and is itself a fuel. The power derived from gasification and combustion of the resultant gas is considered to be a source of renewable energy if the gasified compounds were obtained from biomass. The advantage of gasification is that using the syngas is potentially more efficient than direct combustion of the original fuel because it can be combusted at higher temperatures or even in fuel cells, so that the thermodynamic upper limit to the efficiency defined by Carnot's rule is higher or not applicable. Syngas may be burned directly in gas engines, used to produce methanol and hydrogen.

2.1 Desirable Properties of Biomass for Gasifier

1. Average moisture content less than 15%
2. Average heating value(AHV) not less than 10 MJ/Kg
3. Size range 1.25cm and less than 7.62cm (>1/2" and 3").
4. Ash fusion temperature not less than 1150°C
5. Ash content (less than 6%).
6. Easy ignition characteristics.
7. Uniform chemical composition.
8. Cand form structurally strong char.
9. Relatively simple to collect, store and handle.

2.2 Details of Gasifier

Table 1: Details of Gasifier

S.no	Various biomass	Air-fuel ratio	Capacity of hopper (kg of fuel)	Volume of hopper (m^3)	Height of hopper (m^3)	Density of biomass (Kg/m^3)
1	Rice husk	1.2	95.22	0.6801	5.99	140
2	Wood chips	2.4	47.61	0.2061	1.817	231
3	Coconut shell	1.405	81.33	0.3253	2.868	250
4	Groundnut shell	1.3879	82.33	1.029	9.047	80
5	Bagasse	0.6961	164.15	0.2984	2.631	550
6	Cashew nut shell	1.3938	81.982	0.6831	6.0239	120
7	Saw dust	1.511	75.62	0.5215	4.598	145

International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 07, July 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354

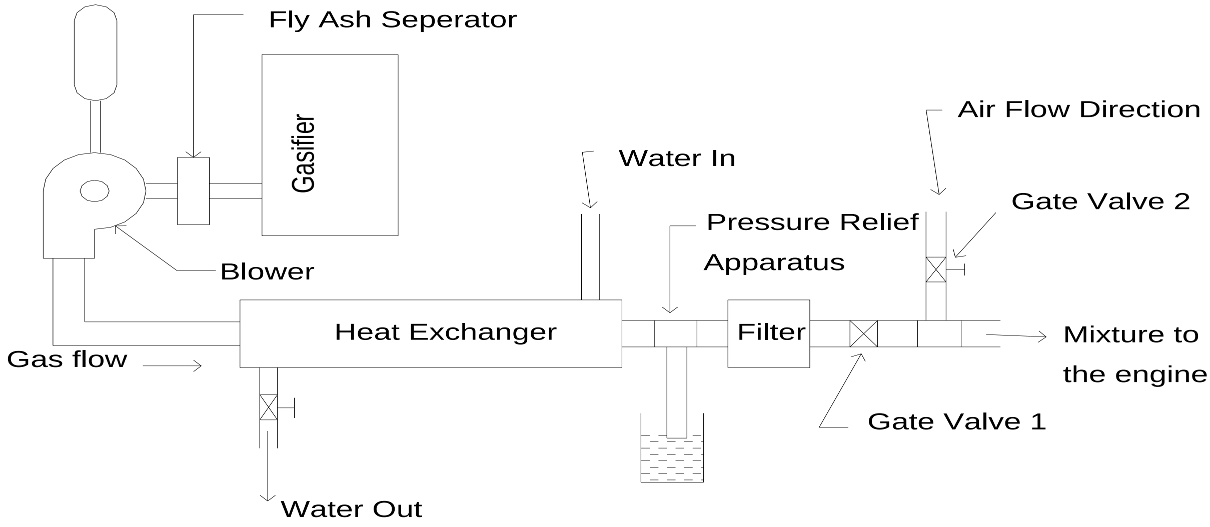

Figure 3: A Systematic Diagram of the Test Setup (Outline)

2.3 Load Testing Results on I.C. Engine

The apparatus consist of a single cylinder four stroke diesel engine to which a brake drum with rope arrangement is fitted. The brake drum and engine are cooled by circulating water. A burette is fixed in the fuel line to measure the fuel consumption.

2.3.1 Formula Used

- Net load = (W – S) x 9.81 (N)
- Brake power (BP) = $2\pi NR(W-S) \times 1/60000$ (kW)
- Total fuel consumption (TFC) = $V \rho / T$ (kg/sec) (V= 5 ml)
- Brake specific fuel consumption = TFC/ BP (kg / kW hr)

2.3.2 Tabulation

Table 2: For Diesel

S.no	Load (W) kg	Spring load (S) Kg	Net load (N)	Brake power (BP) KW	Total fuel consumption(TFC) Kg/sec	Brake specific fuel consumption Kg/kW hr	Time for 5ml of fuel consumption T sec
1	0	0	0	0	1.0487×10^{-4}	0	41
2	2	0	19.62	0.4992	1.5925×10^{-4}	1.148	27
3	4	0.25	36.79	0.9361	1.8695×10^{-4}	0.71898	23
4	6	0.5	53.96	1.3729	1.9545×10^{-4}	0.51250	22
5	8	0.75	71.123	1.8098	2.15×10^{-4}	0.42767	20
6	10	1	88.29	2.2467	2.3888×10^{-4}	0.38277	18
7	12	1.25	105.46	2.6835	2.5294×10^{-4}	0.33933	17

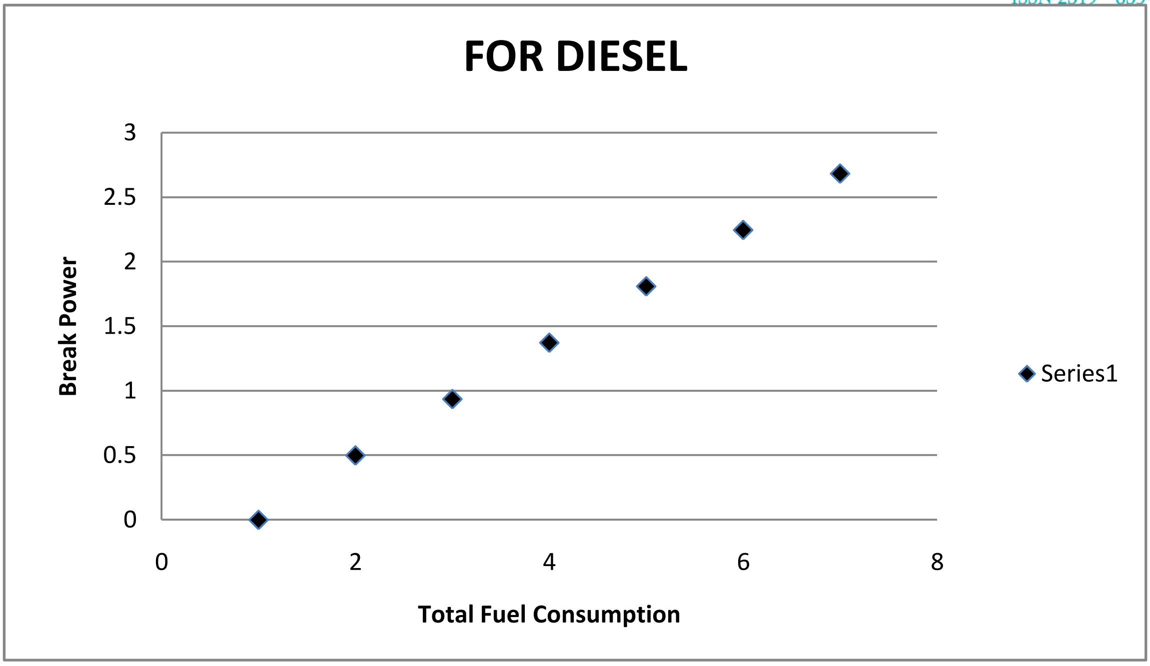

Figure 4: Break Power Vs Total Fuel Consumption

Table 3: For Bio-Fuel Engine

S.No	Load W, kg	Spring load S Kg	Net load N	Brake power (BP)kW	Total fuel consumption Kg/sec	Brake specific fuel consumption Kg/kW hr	Time for 5ml of fuel consumption T sec
1	0	0	0	0	7.8182×10^{-5}	0	55
2	2	0	19.62	0.4992	1.1621×10^{-4}	0.8381	37
3	4	0.25	36.79	0.9361	1.4333×10^{-4}	0.5512	30
4	6	0.5	53.96	1.3729	1.5926×10^{-4}	0.4176	27
5	8	0.75	71.123	1.8098	1.72×10^{-4}	0.3421	25
6	10	1	88.29	2.2467	1.7917×10^{-4}	0.2871	24
7	12	1.25	105.46	2.6835	1.9685×10^{-4}	0.2508	23

III. CONCLUSION

This work on testing an engine using producer gas and diesel is done by using some components like heat exchanger, filter, etc., which enables one to understand the real working principles and function of various components and engine.

It is seen that maximum of 27.02% of diesel fuel replacement is obtained for the load 19.62 Newton (2 kg). By improving the design of the gasifier for increase in the production and by using other biomass more replacements of diesel could be obtained.

REFERENCE

[1] Pulkrabek, Willard W. (1997). *Engineering Fundamentals of the Internal Combustion Engine*. Prentice Hall. p. 2. ISBN 9780135708545.

[2] Bridgewater A V 1995 The technical and economic feasibility of biomass gasification for power generation. Fuel 74: 631–53.

[3] Chen Hu, Wang Jianxin, Shuai Shijin and Chen Wenmiao 2008 Study of oxygenated biomass fuel blends on a diesel engine. Fuel 87: 3462–3468

[4] Ciolkosz Daniel 2010 Characteristics of Biomass as a Heating Fuel. Penn State College of Agricultural Sciences research, Pennsylvania State University.

[5] Dogru M, Howarth C R, Akay G, Keskinler B and Malik A A 2002 Gasification of hazelnut shells in a downdraft gasifier. Energy 27: 415–27