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DETERMINING PERFORMANCE BY VARYING COMPRESSION RATIO OF DIESEL ENGINE FUELED WITH METHYL ESTER OF RUBBER SEED OIL

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ABSTRACT

Now a day's usage of vehicles are going on increasing as fast as environmental impact and Scarcity of fossil fuel, Dependency of imported fossil fuel which increases GDP of country, we know that India stays 12years behind emission standard compare to Euro Emission norms, to overcome the drawback my focus has gone toward an alternative fuel research and development for biodiesel were going on for past (10-15) years much faster, concept arisen by Rudolph Diesel. He used to practice with Edible Vegetable oil (peanut) ,to reduce the scarcity of food products and to produce biodiesel at cheaper price inedible vegetable oil are chosen to improve performance and better emission compare to diesel, Inedible vegetable oil poses some problem when subjected to prolonged usage in compression ignition engine because of their high viscosity and low volatility. The problem are rectified by converting high viscosity oil into its blend (or) ester, Rubber seed oil contains high acid content to reduce acid content two Esterification process are carried out (Acid and Alkaline Esterification) ,It has been Experimentally proved that biodiesel at lower blends B5,B10,B15 increase the Brake Thermal efficiency, By Varying compression ratio(VCR) fuel consumption are reduced ,By Exhaust Gas Recirculation (EGR) NOx emissions are reduced which is most common problem occurs by using biodiesel and other Exhaust gas Emissions are also reduced, The experimental results proved that the use of biodiesel (produced from unrefined rubber seed oil) in compression ignition engines is a viable alternative to diesel without engine modification

Keywords: Rubber seed oil; Biodiesel; Esterification; Variable compression ratio (VCR); Exhaust Gas Recirculation (EGR)

1. INTRODUCTION

Diesel engine have become quite popular prime mover in transportation and agriculture sector, because of high brake thermal efficiency at which they are capable of operating as compare to petrol engines, however increasing price, scarcity of supply and emission leads to search of alternative fuel [1-4] .India is a agricultural country usage of inedible vegetable oil would be economical because of large production and reduced dependability on import of petroleum products. In inedible vegetable oil sulphur, aromatic hydrocarbon and metals which leads to emission of harmful gas are neglected due to absence of such composition [5].

Use of vegetable oil in IC engines is not an new concept and has been focus of research for decades [6],prolonged usage of vegetable oil in IC engine pose some problem such as carbon deposit, which requires frequent cleaning, spray penetration, atomization and mixture formation due to high viscosity and low volatility which results in lower brake thermal efficiency and high emission, this problems can be resolved by trans-esterification process due to high acid content about (21%) rubber seed oil (RSO) are not suitable for trans-esterification to make it suitable for Alkaline esterification process acid content should be less than (2%) so Acid-catalyzed pretreatment is carried

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away to reduce acid content and make it suitable for Alkaline Trans-esterification process to produce blend (or) ester.

Methyl ester of rubber seed oil are successfully used in CI engine [7], generally we know that biodiesel produce high nitrogen oxide NOx is reduce by exhaust gas recirculation (EGR) where break thermal efficiency are improved along with it, EGR works by diluting the N2 and providing gases inert to combustion (carbon dioxide primarily) to act as an absorbent of combustion heat to reduce peak in cylinder temperature .NOx is produced in narrow band high cylinder temperature and pressure.

In diesel engine exhaust gas replaces some of the excess oxygen in the pre-combustion mixture, because of NOx forms primarily when a mixture of nitrogen and oxygen is subjected to high temperature; the low combustion chamber temperature caused by EGR reduces the amount of NOx.

Greater the percentage of carbon and hydrogen better is the fuel in quality and calorific value since these two constituent are responsible for heat value, besides ash and moisture content is very low leaving no deposit and heat loss on account of this during combustion, another advantage of rubber seed oil is the oxygen content which reduces emission of CO and unburned hydro carbon from exhaust.

The research and development activities in several countries on this subject have been mostly on sunflower, safflor, soybean, rapeseed and peanut among others most of these being edible in Indian context. Thus, the emphasis of the present work is to experimentally evaluate the possibilities of using biodiesel developed from one of the non edible oil seeds available in India like jatropha, Karajan, neem, cotton, rubber and polanga. These have an estimated annual production potential of more than 20Mt of which rubber seed contributes 30,000 metric tonnes, with a high potential to produce biodiesel.

2.CHARACTERIZATION OF RUBBER SEED OIL

In the present investigation, the rubber seed oil, a non-edible type vegetable oil is chosen as a potential alternative for producing biodiesel and use as fuel in compression ignition engines. The annual rubber seed production potential in India is about 150kg per hectare. The estimated availability of rubber seed is about 30,000MT per annum [8].Rubber seed kernels (50-60% of seed) contain 40-50% of brownish yellow colored oil. Presently rubber seed oil does not find any major application and even natural production of seeds itself remains underutilized. The calorific value of rubber seed oil is comparable to that of diesel. Flash point of rubber seed oil is higher than that of diesel but its viscosity is about 10times greater than that of diesel.

The free fatty acid (FFA) content of unrefined rubber seed oil is about 21%.it has been established that the ester yield decrease with increase in FFA. Alkaline-esterification takes place only with refined oil having FFA value less than 2%.therefore alkaline catalyzed transesterification process is not suitable to produce ester from unrefined rubber seed oil. Oil is to be refined first in order to reduce acid value. Hence, the present efforts are aimed at the production of esters from unrefined high FFA rubber seed oil and to analyze its suitability as fuel in diesel engine. The important chemical and physical properties of rubber seed oil in comparison with diesel is depicted in Table 1.

Table 1

Properties of rubber seed oil in comparison with diesel

Properties	Rubber seed oil	Diesel
Specific gravity	0.91	0.835
Viscosity (mm2/s) at 40°	66.3	4.5
Flash point (°C)	198	48

Fire point (°C)	210	55
Calorific value (kJ/kg)	37,250	42,500
Acid value	34	0.062

3.ESTERIFICATION OF RUBBER SEED OIL

3.1. Methodology

The unrefined rubber seed oil cannot be used directly as fuel in CI engine due to unfavorable physical and chemical properties, particularly their high viscosity which causes poor fuel atomization, incomplete combustion, carbon deposition on the injector; this necessitates the reduction in viscosity of neat vegetable oil for use as substitution in diesel engine,The esterification process consist of two stage

Acid-Esterification: It's carried out to reduce acid value

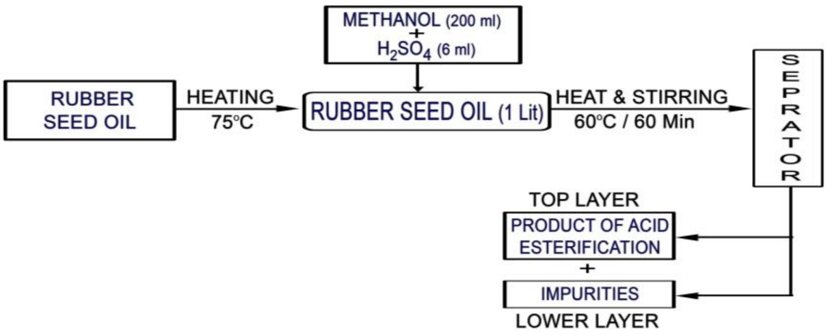

Fig.1. Block diagram of acid esterification

Rubber seed oil is pre-heated for 75°C and required quantity is taken 1 liter of rubber seed oil is mixed with methanol of 200ml and sulphuric acid of 6ml is heated at 60°C and 60minutes and passed to separator top layer contains product of acid esterification whose value is less than 2% suitable for alkaline esterification and impurities at lower layer.

Alkaline-Esterification: Acid esterification is followed by alkaline esterification

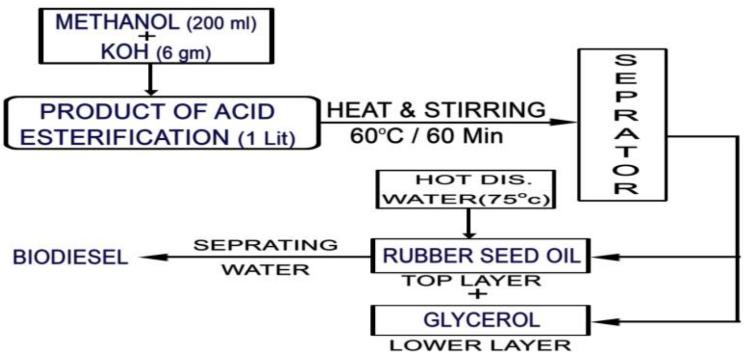

Fig.2. Block diagram of alkaline esterification

The Product of acid esterification {1 liter} sample is taken and mixed along with methanol of 200ml and potassium hydroxide (KOH) 6ml is heated and stirred at 60°C for 60 minutes and send to separator where two layers are formed lower layer consist of glycerol and top layer consist of rubber seed oil its separated by spraying hot distilled water at 75°c biodiesel is obtained.

4.ENGINE TESTS

4.1. Experimental methodology

A single cylinder four stroke diesel engine, direct injection is employed for the present study. The detailed specifications of the engine used are given in Table.2.

AVL smoke meter and gas analyzer was used to measure the concentration of gaseous emission such as carbon dioxide, carbon monoxide and smoke intensity.

Performance and emission test are carried out on the variable compression ignition engine with ERG and without EGR for various blends of biodiesel and pure diesel fuel and comparisons made between them shown in Fig 3 and 4, The test are conducted at rated speed of 1500rpm at various loads, The experimental data's are documented and presented here by appropriate graph, Performance and engine emission for various blends Bxx determines percentage of ester (xx) B5, B10, B15 are taken and Brake thermal efficiency, specific fuel consumption and engine emission such as carbon dioxide, carbon monoxide, nitrogen oxide are measured.

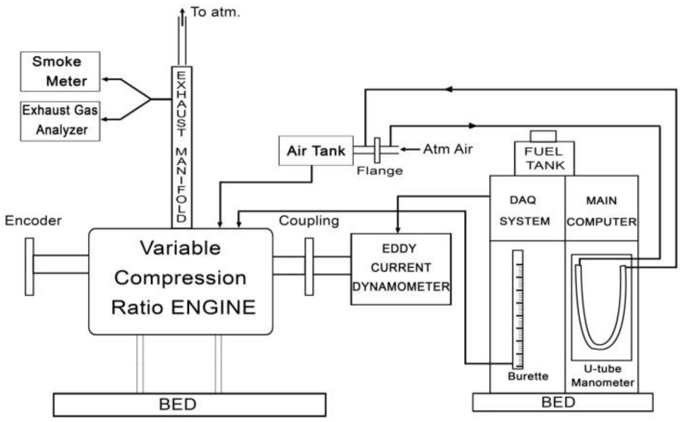

Fig.3. Schematic diagram of experimental setup without EGR unit

Table 2

Specifications of the engine used

Make	Kirloskar TAF-1
No of cylinder	One
Type of cooling	water cooling
Ignition	compression ignition
Bore	87.5 mm
Stroke	110mm
Compression ratio	12:1-22:1 variable compression ratio

Speed	1500rpm
Brake power	3.7 kW
Fuel oil	HS diesel
Lubrication oil	SAE 30 / SAE 40
SFC	245 g/kW-h

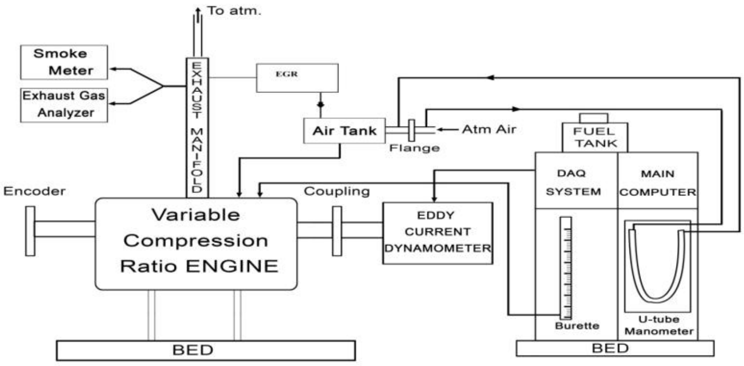

Fig.4. Schematic diagram of experimental setup with EGR unit

4.2 Brake thermal efficiency

The variation of brake thermal efficiency with respect to load, compression ratio and EGR percentage of exhaust gas flow for different fuel considered for the present analysis is presented in Fig.5,Fig.6,Fig.7,Fig.8.In all cases, brake thermal efficiency has tendency to increases with increase in applied load. This is due to reduction in heat loss and increase in power developed with increase in load.

4.2.1. Without EGR (EGR-0%)

At low compression ratio 12:1 for high load maximum brake thermal efficiency obtained about 34% for B15, which is quite higher than diesel (17%), The brake thermal efficiency obtained B10, Diesel,B5 are respectively 25,17 and 10%,the brake thermal efficiency increase with increase in blend concentration increases for low compression ratio.

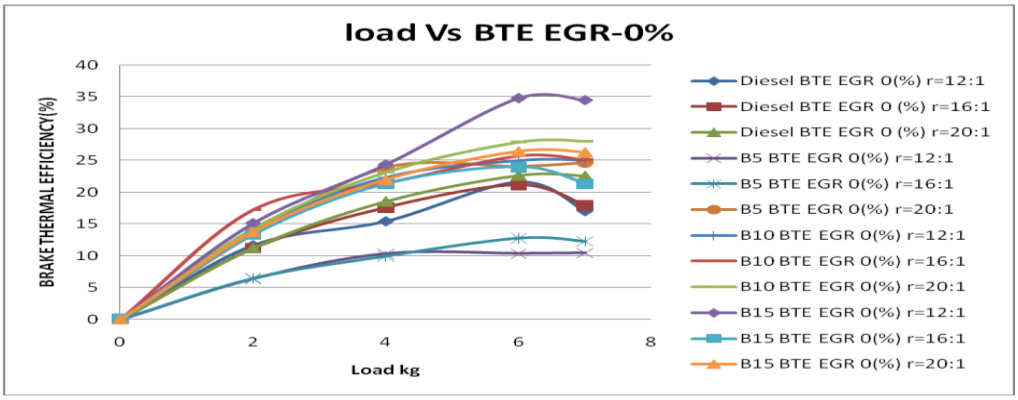

Fig.5. Load Vs Brake Thermal Efficiency for EGR-0%

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At moderate compression ratio 16:1 for medium load maximum brake thermal efficiency obtained about 25% for B10, which is quite higher than diesel (17.9%), the brake thermal efficiency obtained B15,Diesel,B5 are respectively 21, 17.9 and 12.24%

At high compression ratio 20:1 for low load condition maximum brake thermal efficiency obtained about 28% for B10,which is quite higher than Diesel (22.59%), the brake thermal efficiency obtained B15,B5,Diesel are respectively 26, 24 and 22.59%

From the above documented readings its came to know that maximum thermal efficiency for higher compression ratio obtained is B15 and for medium and low compression ratio maximum thermal efficiency is obtained for B10, brake thermal efficiency increases with increase in concentration of blend for low compression ratio, brake thermal efficiency increases for moderate blend for both medium and high compression ratio. The mixing of biodiesel in diesel oil yield, in general, good thermal efficiency curves. The possible reason for this is the additional lubricity provided by the biodiesel. The molecule of biodiesel (i.e., methyl ester of the oil) contains some amount of oxygen, which takes part in combustion process.

4.2.2. With EGR-5%

At low compression ratio 12:1 for high load maximum brake thermal efficiency obtained about 25.25% for B15, which is quite higher than diesel (17.84%), The brake thermal efficiency obtained B10, Diesel,B5 are respectively 24,17.84 and 10.47%,the brake thermal efficiency increase with increase in blend concentration increases for low compression ratio.

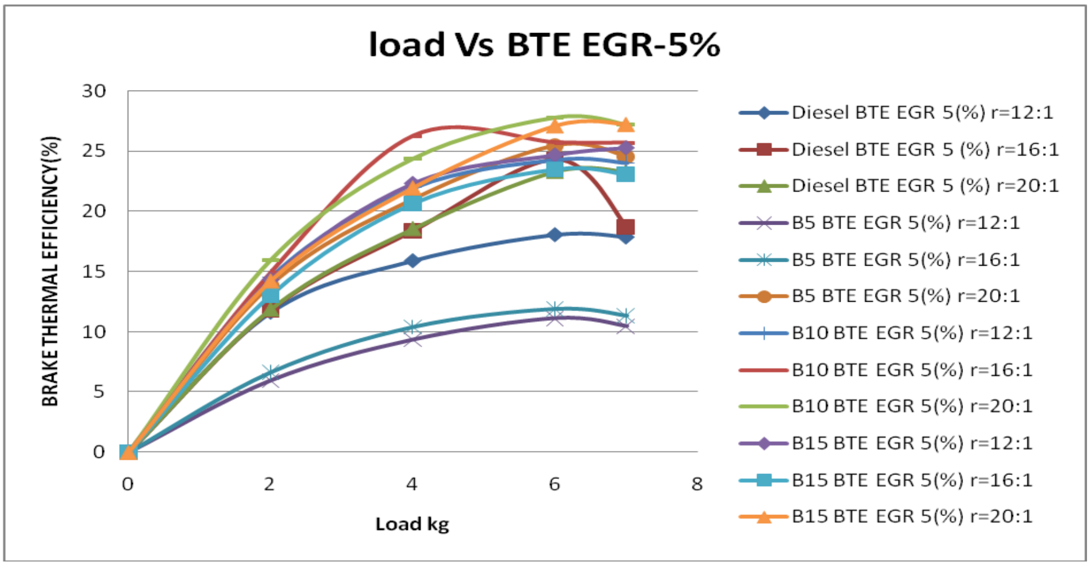

Fig.6. Load Vs Brake Thermal Efficiency for EGR-5%

At moderate compression ratio 16:1 for medium load maximum brake thermal efficiency obtained about 25.7% for B10, which is quite higher than diesel (18.74%), the brake thermal efficiency obtained B15,Diesel,B5 are respectively 23, 18.74 and 11.34%

At high compression ratio 20:1 for low load condition maximum brake thermal efficiency obtained about 27.25% for B15,which is quite higher than Diesel (23.26%), the brake thermal efficiency obtained B10,B5,Diesel are respectively 27.17, 24 and 23.26%

From the above documented readings its came to know that maximum thermal efficiency for higher compression ratio and low compression ratio obtained is B15 and for medium compression ratio maximum thermal efficiency is obtained at B10, brake thermal efficiency increases with increase in concentration of blend for low and high compression ratio, brake thermal efficiency increases for moderate blend for medium. The

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mixing of biodiesel in diesel oil yield, in general, good thermal efficiency curves.

The possible reason for this is the additional lubricity provided by the biodiesel. The molecule of biodiesel (i.e., methyl ester of the oil) contains some amount of oxygen, which takes part in combustion process.

4.2.3. With EGR-10%

At low compression ratio 12:1 for high load maximum brake thermal efficiency obtained about 24.9% for B10, which is quite higher than diesel (17.78%), The brake thermal efficiency obtained B15, Diesel,B5 are respectively 24.37,17.78 and 10.47%,the brake thermal efficiency increase with increase in blend concentration increases for low compression ratio.

At moderate compression ratio 16:1 for medium load maximum brake thermal efficiency obtained about 26.63% for B10, which is quite higher than diesel (20.25%), the brake thermal efficiency obtained B15,Diesel,B5 are respectively 22.22, 20.25 and 12.16%

At high compression ratio 20:1 for low load condition maximum brake thermal efficiency obtained about 26.35% for B10,which is quite higher than Diesel (24.70%), the brake thermal efficiency obtained B15,B5,Diesel are respectively 26.31, 26.19 and 24.70%

From the above documented readings its came to know that maximum thermal efficiency for higher compression ratio, low compression ratio and medium compression ratio obtained at B10. The mixing of biodiesel in diesel oil yield, in general, good thermal efficiency curves

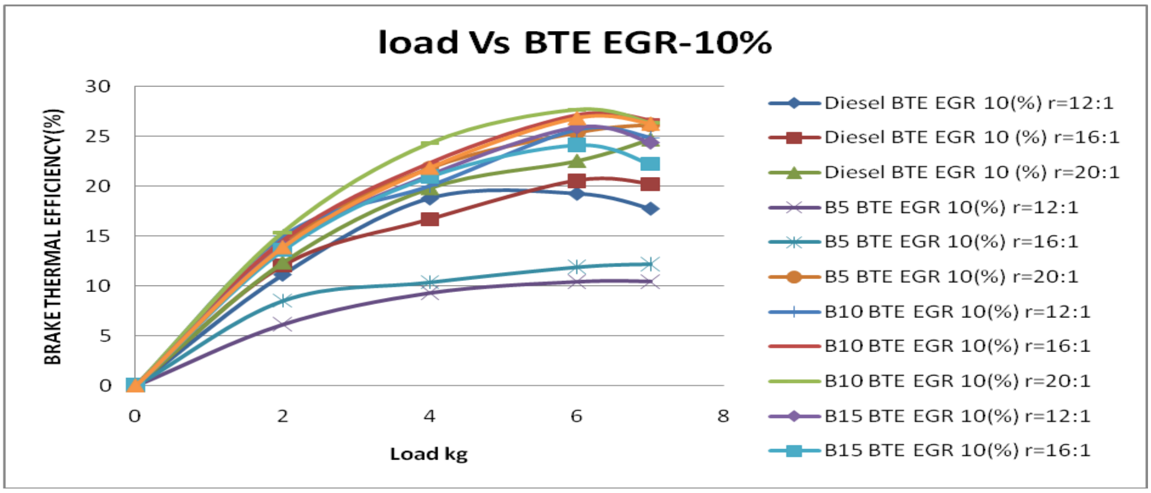

Fig.7. Load Vs Brake Thermal Efficiency for EGR-10%

The possible reason for this is the additional lubricity provided by the biodiesel. The molecule of biodiesel (i.e., methyl ester of the oil) contains some amount of oxygen, which takes part in combustion process.

4.2.4. With EGR-15%

At low compression ratio 12:1 for high load maximum brake thermal efficiency obtained about 25.29% for B15, which is quite higher than diesel (16.41%), The brake thermal efficiency obtained B10, Diesel,B5 are respectively 24.90,16.41and10.46%,the brake thermal efficiency increase with increase in blend concentration increases for low compression ratio.

At moderate compression ratio 16:1 for medium load maximum brake thermal efficiency obtained about 25.89% for B10, which is quite higher than diesel (18.65%), the brake thermal efficiency obtained B15,Diesel,B5 are respectively 20.45, 18.65 and 12.12%

At high compression ratio 20:1 for low load condition maximum brake thermal efficiency obtained about 30.47% for B10,which is quite higher than Diesel (22.61%), the brake thermal efficiency obtained B15,B5,Diesel are respectively 28, 26.14 and 22.61%

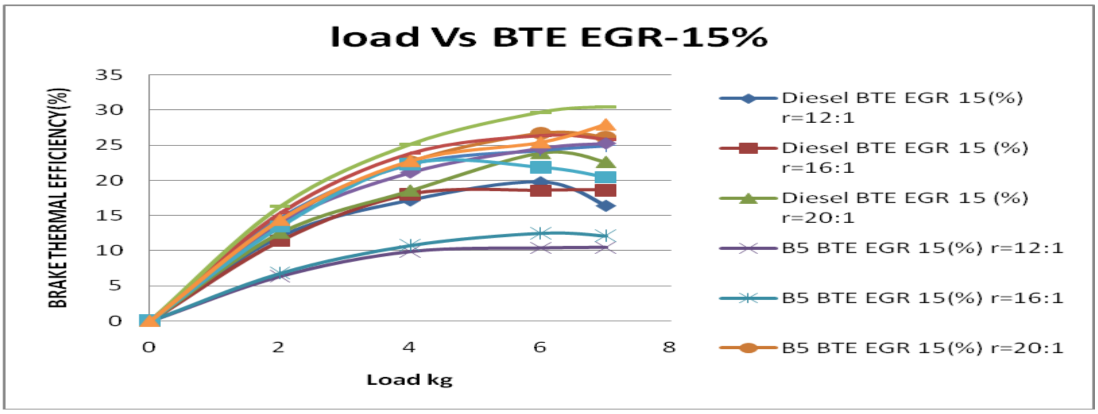

Fig.8. Load Vs Brake Thermal Efficiency for EGR-15%

From the above documented readings its came to know that maximum thermal efficiency for high compression ratio and medium compression ratio obtained at B10. For low compression ratio maximum thermal efficiency obtained at B15, The mixing of biodiesel in diesel oil yield, in general, good thermal efficiency curves.

The possible reason for this is the additional lubricity provided by the biodiesel. The molecule of biodiesel (i.e., methyl ester of the oil) contains some amount of oxygen, which takes part in combustion process.

4.3. Specific fuel consumption

The variation of specific fuel consumption with respect to load , different compression ratio and EGR percentage of exhaust gas flow for different fuel considered for the present analysis is presented in Fig.9,Fig.10,Fig.11,Fig.12.In all cases, fuel consumption has tendency to decreases with increase in applied load. This is due to higher percentage increase in brake power with load as compare to increase in fuel consumption

4.3.1. Without EGR (EGR-0%)

At low compression ratio 12:1 for high load minimum brake specific fuel consumption obtained about 0.282kg/kWh for B15, which is quite lower than diesel (0.496 kg/kWh), the brake specific fuel consumption obtained B10, Diesel, B5 are respectively 0.385 kg/kwh, 0.496 kg/kwh and 0.917 kg/kwh.

At moderate compression ratio 16:1 for medium load minimum brake specific fuel consumption obtained about 0.385 kWh for B10, which is quite lower than diesel (0.47 kWh), the brake specific fuel consumption obtained B15, Diesel and B5 are respectively 0.455 kWh, 0.473kwh and 0.783 kWh.

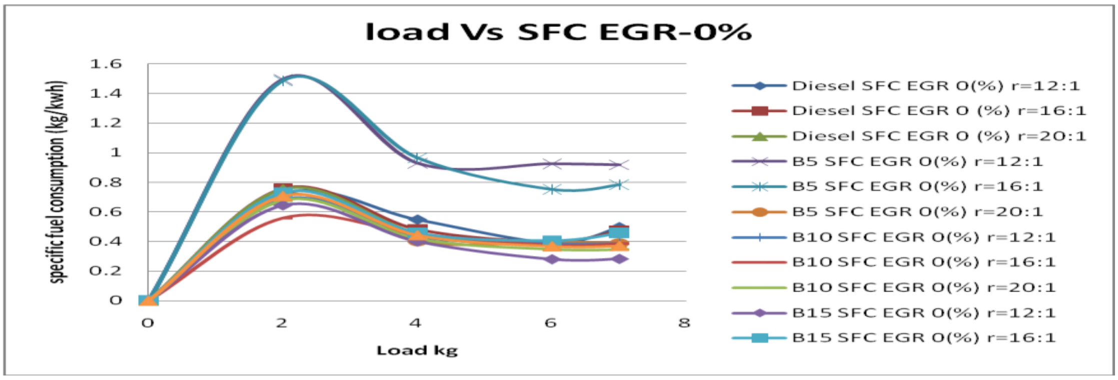

Fig.9. Load Vs Specific fuel consumption for EGR-0%

At high compression ratio 20:1 for low load condition minimum brake specific fuel obtained about 0.344kwh for B10,which is quite lower than Diesel (0.375kwh), the brake specific fuel consumption obtained B15,Diesel, B5 are respectively 0.344 kwh,0.370kwh and 0.388 kwh.

From the above documented readings its came to know that minimum brake specific fuel consumption for high and medium compression ratio obtained is B10 and for low compression ratio minimum specific fuel consumption is obtained for B15, Hence the specific fuel consumption of the higher percentage of biodiesel in blends increases as compare to that of diesel. This caused due to the combined effect of higher viscosity and low calorific value of the rubber seed oil.

4.3.2. With EGR (EGR-5%)

At low compression ratio 12:1 for high load minimum brake specific fuel consumption obtained about 0.385kg/kWh for B15, which is quite lower than diesel (0.474kg/kWh), the brake specific fuel consumption obtained B10, Diesel, and B5 are respectively 0.402kg/kWh, 0.474kg/kWh and 0.916kg/kWh.

At moderate compression ratio 16:1 for medium load minimum brake specific fuel consumption obtained about 0.375kWh for B10, which is quite lower than diesel (0.451 kWh), the brake specific fuel consumption obtained B15, Diesel and B5 are respectively 0.422 kWh, 0.451kwh and 0.846 kWh.

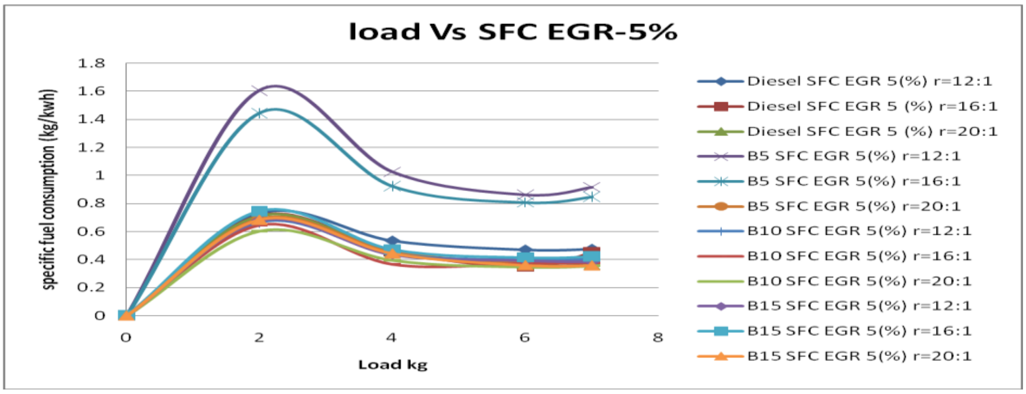

Fig.10. Load Vs Specific fuel consumption for EGR-5%

At high compression ratio 20:1 for low load condition minimum brake specific fuel obtained about 0.355kwh for B10,which is quite lower than Diesel (0.364kwh), the brake specific fuel consumption obtained B15,Diesel, B5 are respectively 0.357kwh,0.3640kwh and 0.390kwh.

From the above documented readings its came to know that minimum brake specific fuel consumption for high and medium compression ratio obtained is B10 and for low compression ratio minimum specific fuel consumption is obtained for B15, Hence the specific fuel consumption of the higher percentage of biodiesel in blends increases as compare to that of diesel. This caused due to the combined effect of higher viscosity and low calorific value of the rubber seed oil.

4.3.3. With EGR (EGR-10%)

At low compression ratio 12:1 for high load minimum brake specific fuel consumption obtained about 0.388kg/kWh for B10, which is quite lower than diesel (0.476kg/kWh), the brake specific fuel consumption obtained B15, Diesel, and B5 are respectively 0.399kg/kWh, 0.476kg/kWh and 0.916kg/kWh.

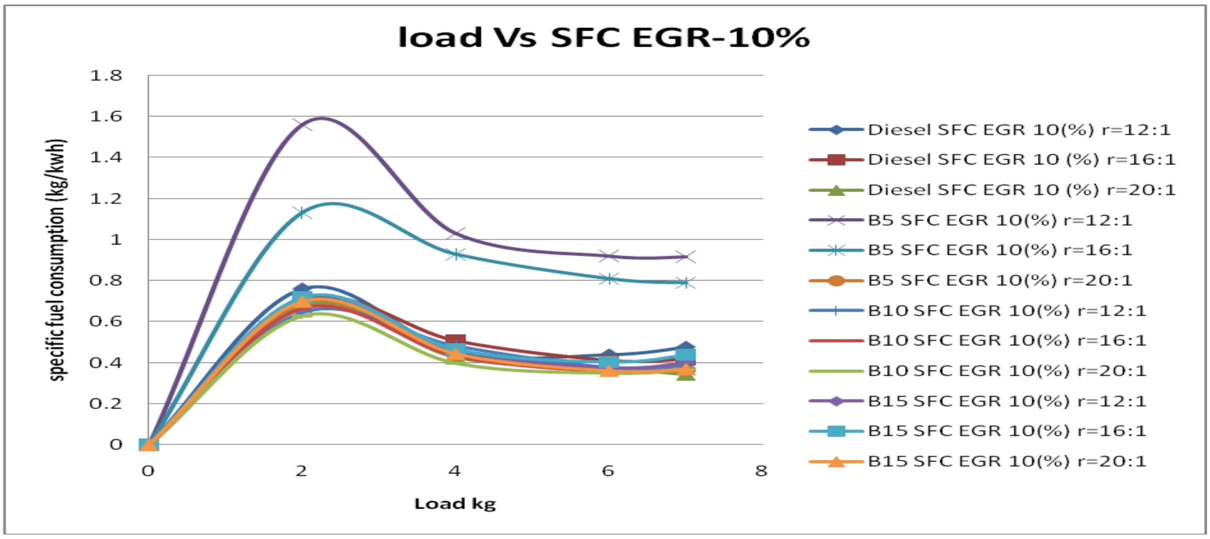

Fig.11. Load Vs Specific fuel consumption for EGR-10%

At moderate compression ratio 16:1 for medium load minimum brake specific fuel consumption obtained about 0.362kWh for B10, which is quite lower than diesel (0.418 kWh), the brake specific fuel consumption obtained Diesel, B15 and B5 are respectively 0.418kWh, 0.437kwh and 0.789kWh.

At high compression ratio 20:1 for low load condition minimum brake specific fuel obtained about 0.342kwh for Diesel, The brake specific fuel consumption obtained B5,B10, B15 are respectively 0.366kwh,0.3667kwh and 0.3696kwh.

From the above documented readings its came to know that minimum brake specific fuel consumption for low and medium compression ratio obtained is B10 and for high compression ratio minimum specific fuel consumption is obtained for Diesel, Hence the specific fuel consumption of the higher percentage of biodiesel in blends increases as compare to that of diesel. This caused due to the combined effect of higher viscosity and low calorific value of the rubber seed oil.

4.3.4. With EGR (EGR-15%)

At low compression ratio 12:1 for high load minimum brake specific fuel consumption obtained about 0.384kg/kWh for B15, which is quite lower than diesel (0.516kg/kWh), the brake specific fuel consumption obtained B10, Diesel, and B5 are respectively 0.388kg/kWh, 0.516kg/kWh and 0.917kg/kWh.

At moderate compression ratio 16:1 for medium load minimum brake specific fuel consumption obtained about 0.373kWh for B10, which is quite lower than diesel (0.454 kWh), the brake specific fuel consumption obtained Diesel, B15 and B5 are respectively 0.454 kWh, 0.475kwh and 0.791kWh.

At high compression ratio 20:1 for low load condition minimum brake specific fuel obtained about 0.317kwh for B10,which is quite lower than Diesel (0.374kwh), the brake specific fuel consumption obtained B15,B5, Diesel are respectively 0.347kwh,0.367kwh and 0.374kwh.

From the above documented readings its came to know that minimum brake specific fuel consumption for high and medium compression ratio obtained is B10 and for low compression ratio minimum specific fuel consumption is obtained for B15, Hence the specific fuel consumption of the higher percentage of biodiesel in blends increases as compare to that of diesel. This caused due to the combined effect of higher viscosity and low calorific value of the rubber seed oil.

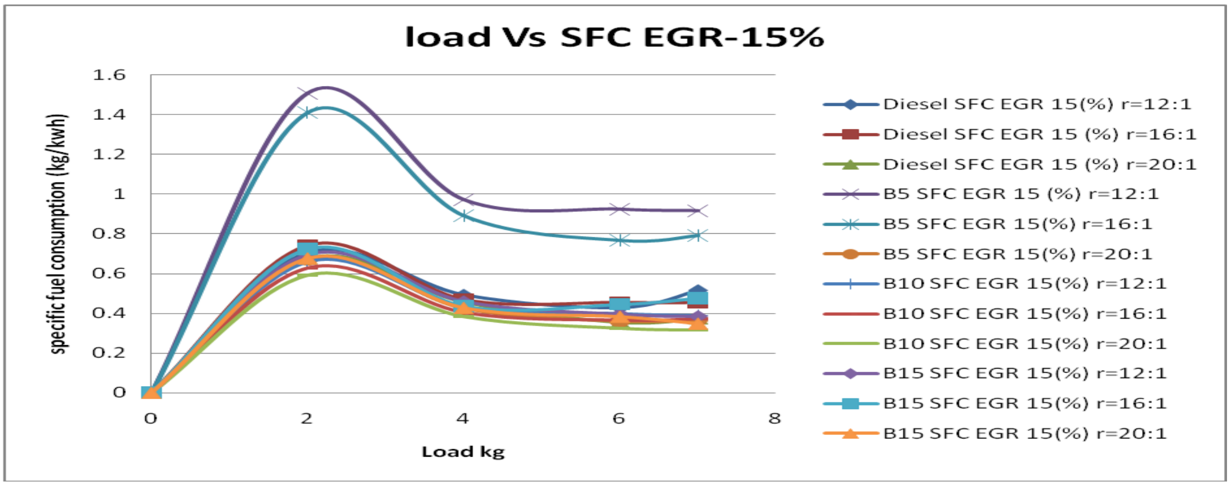

Fig.12. Load Vs Specific fuel consumption for EGR-15%

4.4. Nitrogen oxide (NOx)

The variation of Nitrogen oxide with respect to load , different compression ratio and EGR percentage of exhaust gas flow for different fuel considered for the present analysis is presented in Fig.13,Fig.14,Fig.15,Fig.16.In all cases, Nitrogen oxide has tendency to increase with increase in applied load.AS the percentage of EGR increases emission of nitrogen oxide level decreases. This is due to oxygen content in blend improves performance and reduces NOx

4.4.1. Without EGR (EGR-0%)

At low compression ratio 12:1 for high load NOx obtained about 31% of volume for Diesel, which is quite lower than B15 (42%), the NOx obtained B10,B5 and B15 are respectively 36, 38 and 42% of volume

At moderate compression ratio 16:1 for medium load NOx obtained about 23% of volume for B15, which is quite lower than Diesel (34%), the NOx obtained B10,Diesel, and B5 are respectively 34, 34 and 47% of volume

At high compression ratio 20:1 for low load condition NOx obtained about 32% of volume for B10, which is quite lower than Diesel (34%), the NOx obtained Diesel, B15 and B5 are respectively 34, 36 and 40% of volume

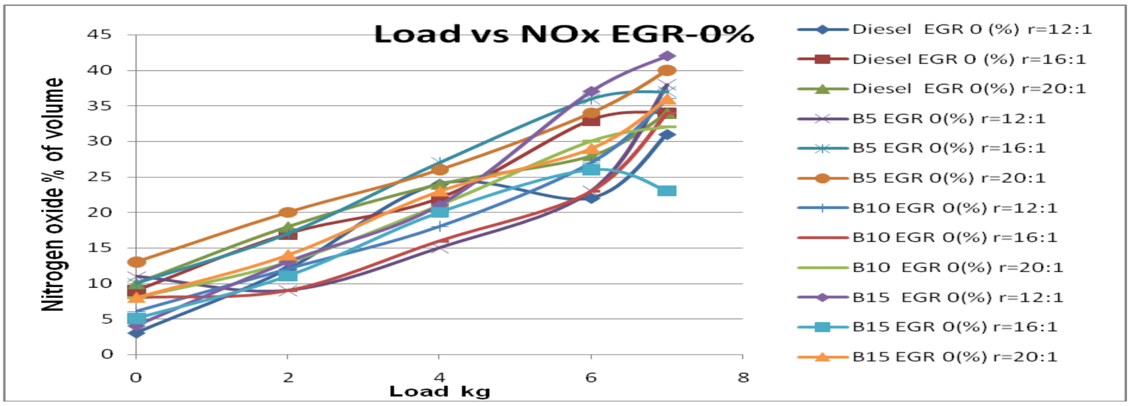

Fig.13. Load Vs NOx for EGR-0%

From the above documented readings its came to know that minimum NOx for high and medium compression ratio obtained is B10 and B15 and for low compression ratio is obtained for Diesel, Hence Exhaust gas replaces some of the excess oxygen in the pre-combustion mixture and this leads to low combustion chamber temperature caused by EGR reduces the amount of NOx.

4.4.2. With EGR (EGR-5%)

At low compression ratio 12:1 for high load NOx obtained about 29% of volume for Diesel, which is quite lower than B5 (35%), the NOx obtained B15,B10 and B5 are respectively 33, 33 and 35% of volume

At moderate compression ratio 16:1 for medium load NOx obtained about 20% of volume for B15, which is quite lower than Diesel (32%), the NOx obtained B10,Diesel, and B5 are respectively 30, 32 and 36% of volume

At high compression ratio 20:1 for low load condition NOx obtained about 30% of volume for B10, which is quite lower than Diesel (34%), the NOx obtained B15, Diesel and B5 are respectively 32, 34 and 42% of volume

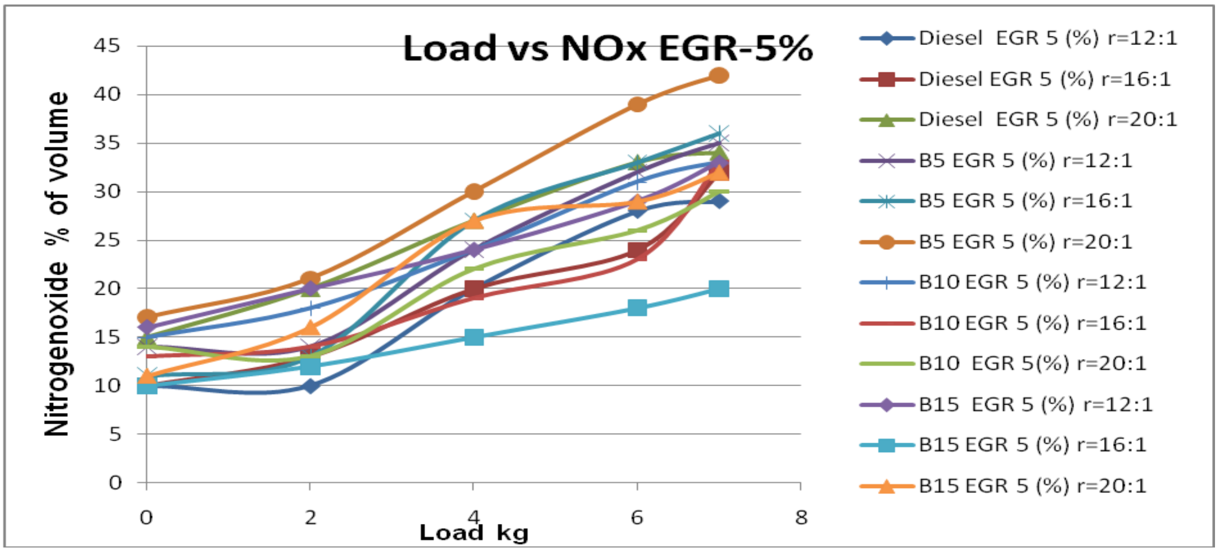

Fig.14. Load Vs NOx for EGR-5%

From the above documented readings its came to know that minimum NOx for high and medium compression ratio obtained is B10 and B15 and for low compression ratio is obtained for Diesel, Hence Exhaust gas replaces some of the excess oxygen in the pre-combustion mixture and this leads to low combustion chamber temperature caused by EGR reduces the amount of NOx.

4.4.3. With EGR (EGR-10%)

At low compression ratio 12:1 for high load NOx obtained about 30% of volume for B10, which is quite lower than Diesel (30%), the NOx obtained Diesel,B15 and B5 are respectively 30, 31 and 33% of volume

At moderate compression ratio 16:1 for medium load NOx obtained about 18% of volume for B15, which is quite lower than Diesel (34%), the NOx obtained B10, B5 and Diesel are respectively 28, 34 and 34% of volume

At high compression ratio 20:1 for low load condition NOx obtained about 27% of volume for B10, which is quite lower than Diesel (34%), the NOx obtained B15, Diesel and B5 are respectively 29, 34 and 38% of volume

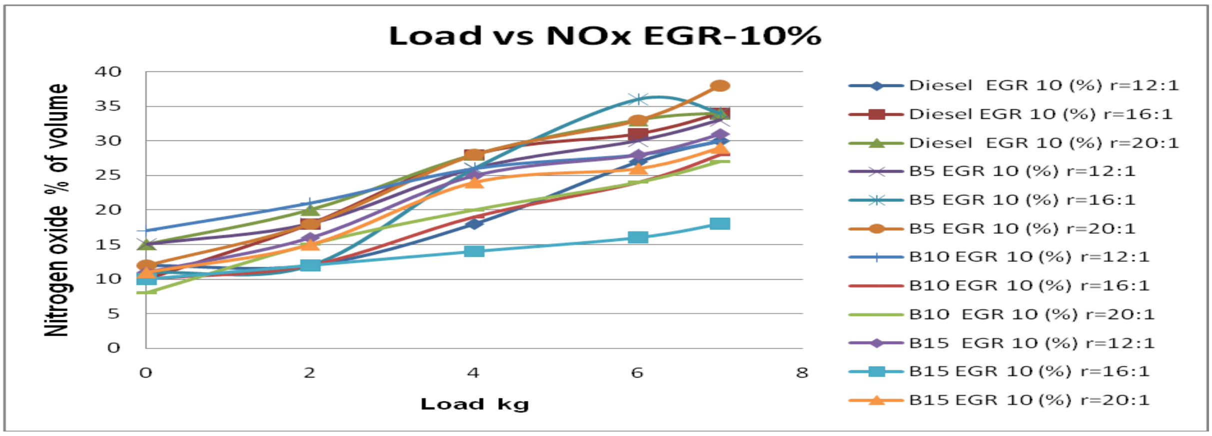

Fig.15. Load Vs NOx for EGR-10%

From the above documented readings its came to know that minimum NOx for low and high compression ratio obtained is B10 and for medium compression ratio is obtained for B15, Hence Exhaust gas replaces some of the excess oxygen in the pre-combustion mixture and this leads to low combustion chamber temperature caused by EGR reduces the amount of NOx.

4.4.4. With EGR (EGR-15%)

At low compression ratio 12:1 for high load NOx obtained about 28% of volume for B10, which is quite lower than Diesel (28%), the NOx obtained Diesel, B15 and B5 are respectively 28, 29 and 31% of volume

At moderate compression ratio 16:1 for medium load NOx obtained about 17% of volume for B15, which is quite lower than Diesel (30%), the NOx obtained B10, Diesel and B5 are respectively 25, 30 and 32% of volume

At high compression ratio 20:1 for low load condition NOx obtained about 24% of volume for B15, which is quite lower than Diesel (32%), the NOx obtained B10, Diesel and B5 are respectively 25, 32 and 35% of volume

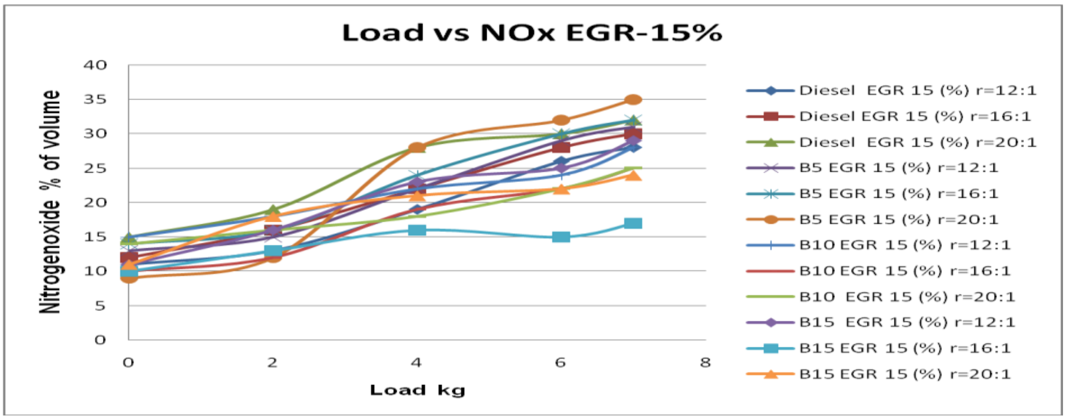

Fig.16. Load Vs NOx for EGR-15%

From the above documented readings its came to know that minimum NOx for medium and high compression ratio obtained is B15 and for low compression ratio is obtained for B10, Hence Exhaust gas replaces some of the excess oxygen in the pre-combustion mixture and this leads to low combustion chamber temperature caused by EGR reduces the amount of NOx.

5. CONCLUSIONS

Hence the methyl esters of rubber seed oil can be a prospective fuel or performance improving additive in compression ignition engines, The various blends of biodiesel-diesel are used as fuel in compression ignition engines and its performance emission characteristics are analyzed. The exhaust gas temperature increased as a function of concentration of biodiesel in the blend. Since, the NOx emission formation is a highly temperature dependent phenomenon, with increase in biodiesel blends, NOx, emission is also expected to increase by using exhaust gas recirculation NOx emission is reduced to an extent.

The present experimental results supports that methyl esters of rubber seed oil can be successfully used in existing diesel engines without any modifications. Use of the biodiesel as partial diesel substitute can boost the farm economy, reduce uncertainty of fuel availability and make farmers more self-reliant. Also, this help in controlling air pollution to extent.

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