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## Performance Analysis on 4-stroke single Cylinder Diesel Engine using B-20 Jathropa Bio- diesel blend & Ethanol as an Air Additive

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**ABSTRACT:** Environmental air pollution and global warming due to ozone depletion are alarming concerns in worldwide. Increasing air pollution, rapid growth of industrialization and the global trend of urbanization have totally disturbed the eco balance of resources on earth. Due to vast usage of fossil fuels it influences on energy economics. This thing made engineers to think use alternative fuels in the place of conventional fuels is become a big challenge to reduce ozone depletion, air pollution and as well as to show impact in energy savings. In this present work, an experimental investigation has been done on 4- stroke, single cylinder diesel engine using B-20 jathropa Bio- diesel blend & ethanol as an air-additive element to reduce NOX content. Initially, engine performance and emission analysis has been done with pure diesel, Later the same analysis has been done with B20 Jatropa bio diesel in the presence of ethanol (air additive element).

**KEYWORDS:** Environmental air Pollution, Global Warming, Fossil fuel, Jathropa, Bio diesel and Ethanol

### I. INTRODUCTION

Compression ignition engines are employed particularly in the field of heavy transportation and agriculture on account of their higher thermal efficiency and durability. However, diesel engines are the major contributors of oxides of nitrogen and particulate emissions. Usage of fossil fuels in Engines, are the major source of atmospheric pollution in today's world. So efforts are in progress to find alternative sources for this depleting energy source. Hence more stringent norms are imposed on exhaust emissions. Following the global energy crisis in the 1970s and the increasingly stringent emission norms, the search for alternative renewable fuels has intensified for easiness, availability and cost effectiveness. But the limited reserves of fossil fuels are a great concern owing to fast depletion of the reserves due to increase in worldwide demand. More no. of experiments and studies are carried and are still in progress to reduce the environment impact, caused by Exhaust smoke from Engine.

Kazi Mostafijur Rahman et al. (2007) [1] used JB-20, JB-50 and JB-100 blends for trial and found that the performance of biodiesel (JB-100), mixture of 50% biodiesel & 50% diesel (JB-50) when compared; the brake power, brake thermal efficiency was greater than diesel fuel. Also from the analysis of exhaust gas it was observed that % of CO<sub>2</sub> gas in biodiesel and from the mixture of 50% biodiesel & 50% diesel was found to be lower than the diesel. The % of O<sub>2</sub> and NO<sub>x</sub> are found to be higher in bio diesel and diesel. V. Hanumantha Rao et al. (2009) [2] Evaluated the performance of single cylinder water-cooled diesel engine using Jatropa oil blend with diesel, as the fuel. JB-20 and JB-100 blends were considered as the Jatropa biodiesel blends for the experimentation. JB-20 blend showed closer performance to diesel and JB-100 had lower brake thermal efficiency mainly due to its high viscosity compared to diesel. For Jatropa biodiesel and its blended fuels, the exhaust gas temperature was found to be increased with increase in power and amount of biodiesel. However, its diesel blends showed reasonable efficiencies, lower smoke, CO<sub>2</sub> and CO emissions. But percentage of NO<sub>x</sub> emission is in higher end.

Pavanendra Kumar et al. (2013) [3] Investigated performance and emissions of a DI diesel engine using Jatropa biodiesel (50%) blended-diesel fuel, known as JB - 20 & JB-50. Tests were carried out using three different CRs (14,

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16 and 18:1) at 1500 rpm with varying load from 0 to 100%. The results showed that increasing compression ratio improves the burning characteristics of biodiesel. At higher compression ratio, brake specific fuel consumption (BSFC) increased while brake thermal efficiency decreased. However, slight increase in brake power was found especially at higher load. Steep decrease was recorded in smoke opacity (OP), carbon monoxide (CO), oxygen (O<sub>2</sub>) and hydrocarbon (HC) emissions, while increase in CO<sub>2</sub> was also observed.

Rachayya. Arakerimath et al. (2012) [4] Author used biodiesel from Jatropha oil in a M&M Turbo Charged, four stroke, four cylinders, water cooled, diesel engine in pure and blended form without any modification in engine design. The power, torque, and brake thermal efficiency using biodiesel were found higher at various load conditions compared to petro-diesel; however specific fuel consumption was found slightly more. The biodiesel blend JB-20 showed better performance than the diesel and other blends. According to the test, it was observed that at low load, mechanical efficiencies of diesel and all consider blends of biodiesel were same but the load increased, the mechanical efficiency was varied. At full load, JB-40 showed same efficiency as diesel.

## II. EXPERIMENTAL WORK

Experimental setup consists of single cylinder, four stroke, Diesel engine connected to eddy current type dynamometer for loading. It is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for P $\dot{O}$ -PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The setup has stand-alone panel box consisting of air box, fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator. Rotameters are provided for cooling water and calorimeter water flow measurement. The setup enables study of engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance. Lab view based Engine Performance Analysis software package "Engine soft LV" is provided for on line performance evaluation. A computerized Diesel injection pressure measurement is optionally provided.



Figure: Kirloskar TV1 Engine Experimental setup

Engine specifications: Make: Kirloskar; Model: TV1; Type: Single Cylinder, 4 Stroke Diesel engine; RPM: 1500  
Cooling Arrangement: Water cooled Engine; Power: 5.2 Kw; Stroke Length: 110 mm; Cylinder Diameter (Bore): 87.5 mm. 661 cc; Compression ratio: 17.5:1.

Jatropha Bio diesel is prepared from Jatropha curcas seeds. It is a non-edible vegetable oil which has been considered as a potential alternative fuel for C.I. Engines It has been chosen to find out its suitability for use as fuel oil. Jatropha curcas is a large shrub or tree native to the American tropics but commonly found and utilized throughout most of the tropical and subtropical regions of the world. Several properties of the plant, including its hardness, rapid growth, easy

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propagation and wide ranging usefulness have resulted in its spread far beyond its original distribution. Jatropha oil is slow- drying oil which is odorless and colorless when fresh but becomes yellow on standing.

Ethanol (CH<sub>3</sub>CH<sub>2</sub>OH) is a clear, colorless liquid. It is also known as ethyl alcohol, grain alcohol, and EtOH. Ethanol has the same chemical formula regardless of whether it is produced from starch- and sugar-based feed stocks, such as corn grain sugar cane, or from cellulosic feed stocks. Ethanol fumigation into the engine intake port is an alternative way to use ethanol in the diesel engine. As this method requires no modifications to the engine, except air intake manifold. Aftermarket ethanol fuel kits have been developed that allow port fuel injection of ethanol. Some kits also incorporate a heat exchanger to preheat the ethanol to a temperature of 50-80°C to improve fuel vaporization in the intake port. Ethanol has a higher octane number than gasoline, providing premium blending properties. Minimum octane number requirements prevent engine knocking and ensure drivability. Low-octane gasoline is blended with 10% ethanol to attain the standard 87 octane. Complete combustion of ethanol forms carbon dioxide ; Incomplete combustion of Ethanol forms Carbon monoxide

$$C_2H_5OH(g) + 3 O_2(g) \rightarrow 2 CO_2(g) + 3 H_2O(g); C_2H_5OH + 2 O_2 = 2 CO + 3 H_2O$$

Ethanol was sprayed in the air intake manifold of the engine. Ethanol fuel circuit works as follow: When piston is reaching to TDC or near to TDC, proximity sensor provided near crank shaft, will sense the crank shaft position. A Bolt arrangement is provided on crank shaft, by maintaining the appropriate sensing distance. After sensing the crank shaft position, proximity sensor send the output signal to fuel controller. Fuel controller is the main controlling element of components present in the fuel circuit. It coordinate with all auxiliaries present in Ethanol fuel circuit and receives output signal and give command to all auxiliaries for their functioning in time. After receiving the output signal from proximity sensor, Controller give start command to Ethanol fuel pump and solenoid valve. Once the Ethanol fuel pump receives start command from controller. Ethanol pump is started. Fuel transportation to injector can be ensured, by noticing raise in pressure gauge, which is provided in the discharge line of the pump. Thus Ethanol pump suck the Ethanol fuel from storage tank and pump the fuel to fuel injector. Solenoid present in the injector get charged, after receiving the start command from controller. Solenoid valve get open and allow the fuel to flow the Ethanol injector. Fuel received Ethanol pump, is sprayed in the air intake manifold through solenoid valve. Air with ethanol is entered into engine through air intake manifold.

By using Jathropa Biodiesel (B20 blend) and Ethanol as an air additive, Engine parameters are varied in a satisfied range comparing with Diesel alone as a fuel. Mechanical Efficiency and Brake thermal Efficiency was increased at 25%, 50%, 75% & full load on the engine, when B20 blend was used as a fuel and Ethanol as an air additive. Volumetric efficiency and Specific fuel consumption and Indicated Thermal efficiency remains same. CO<sub>2</sub> Percentage in exhaust gas was witnessed in lower range comparing with diesel. NOx percentage was reduced CO Emission in exhaust gas was reduced

Tab 2.1 - Fuel properties of Jathropa Biodiesel, Diesel & Ethanol

S.NO.	PROPERTY	B20 BLEND	DIESEL	ETHANOL
1	Density (kg/m <sup>3</sup> )	880	850	788
2	Kinematic Viscosity (mm <sup>2</sup> s <sup>-1</sup> )	3.20	2.6	1.2
3	Flash point (°C)	78	68	40
4	Pour point (°C)	2	-20	36
5	Calorific value (MJ/kg)	39.23	42	39
6	CETANE NUMBER	51.2	41- 48	8
7	Auto Ignition temp (°C)	300	210	326

Tests carried on the Kirloskar TV1 Engine, at No- load, 25%, 50%, 75% & Full loads on the Engine considering the following fuel. 100% Diesel, 20% Jatropha bio diesel + 80% Diesel (B20 blend), B20 blend (Ethanol as an air additive by 20%), B20 blend (Ethanol as an air additive by 30%)

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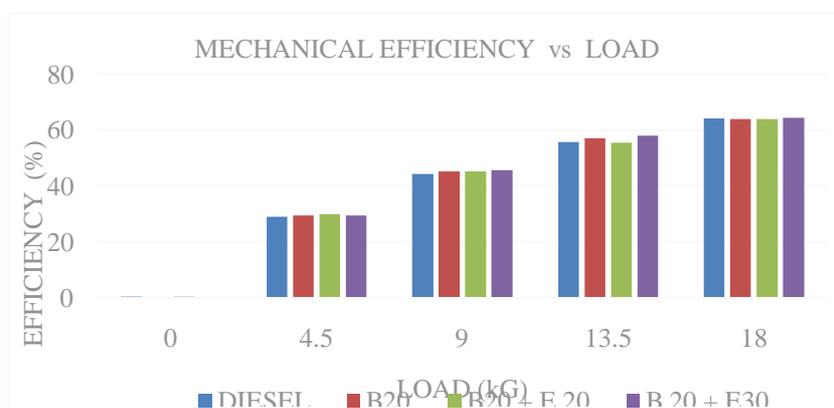
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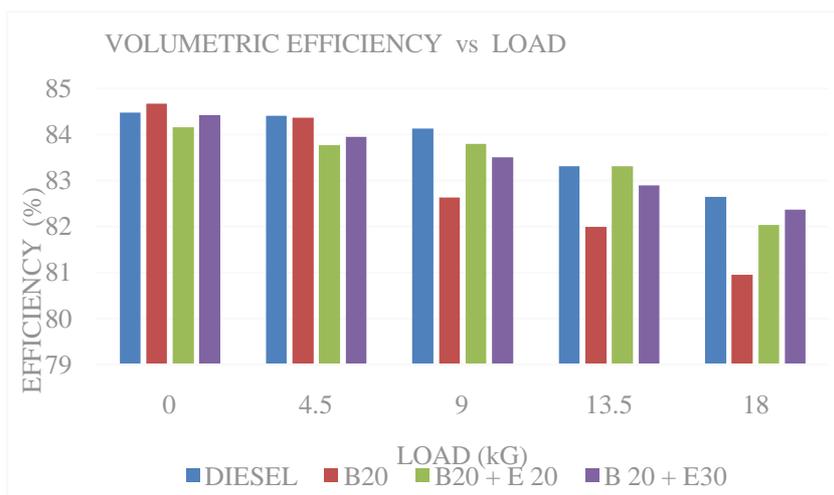
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Complete the checklist before starting the engine and carried the experiment Start the engine using the handle. Allow the engine to run at no load and 1500 rpm for some minutes. Open he exhaust valve and arrange the smoke detector inside the exhaust pipe. Record the smoke parameters.Record the remaining parameter at same condition of the engine.Raise the load to 25 %, using the Dynamometer loading unit knob.Run the system for some time at same load.Record the parameters at 25% of the load and 1500 rpm.Raise the load to 50% and record the parameters.Raise the load on the engine to 75% and record the parameters Raise the load on the engine to full load and record the parameters

### III. RESULTS



Graph 3.1: Mechanical Efficiency (vs) Load



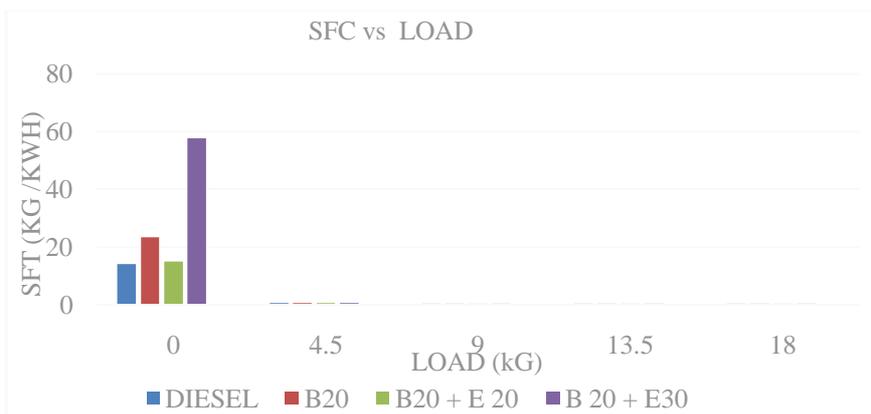
Graph 3.2: Volumetric Efficiency vs Load

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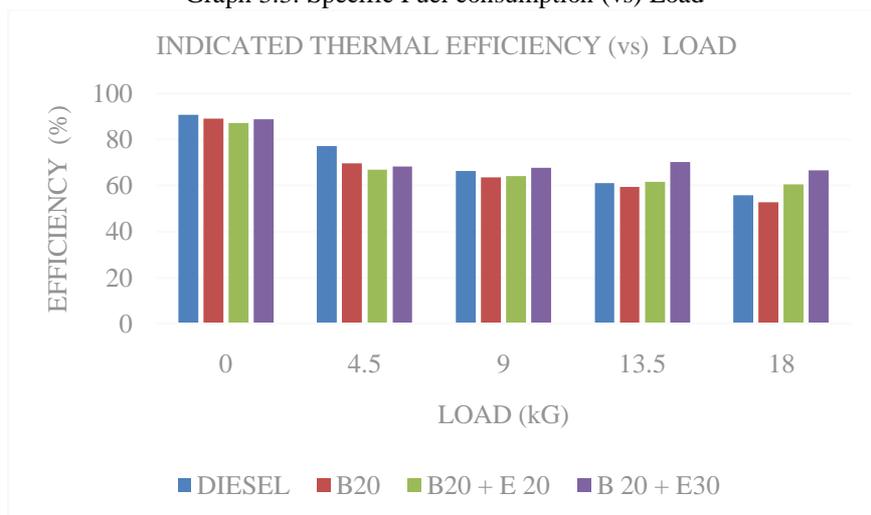
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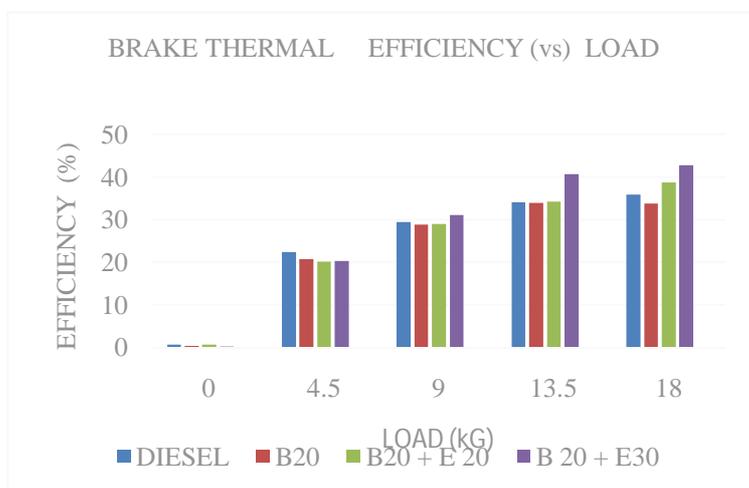
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Graph 3.3: Specific Fuel consumption (vs) Load



Graph 3.4: Indicated Thermal Efficiency vs Load



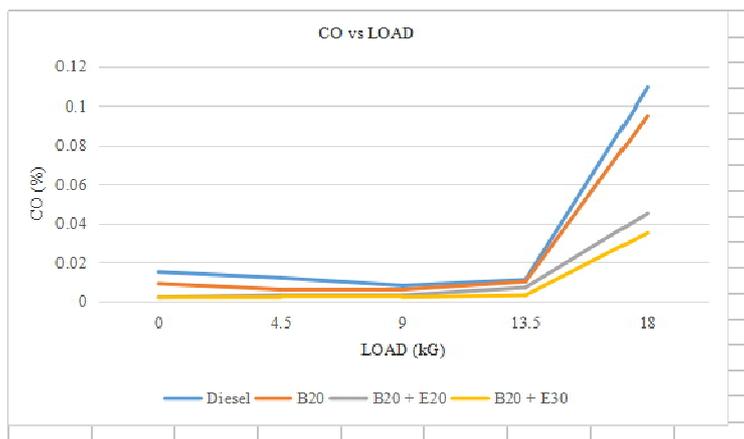
Graph 3.5: Brake Thermal Efficiency vs Load

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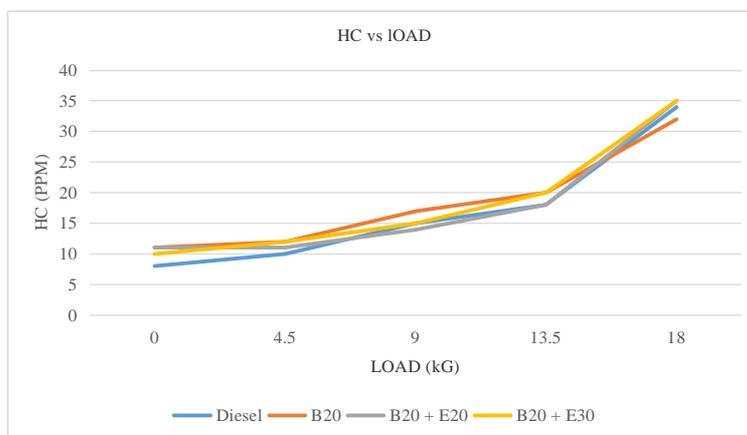
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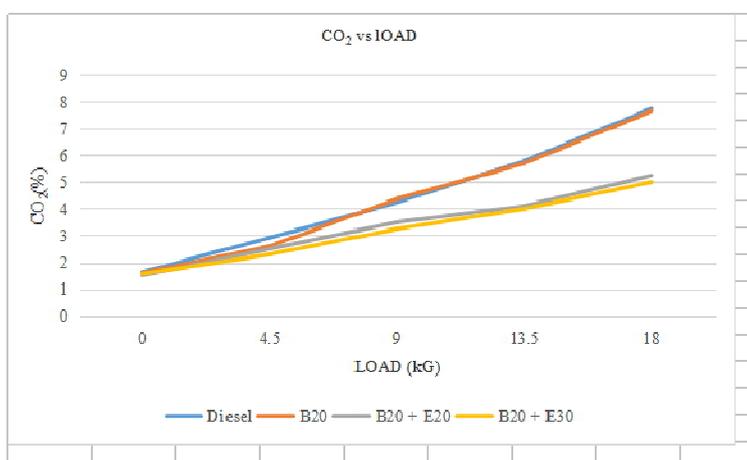
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Graph 3.6: CO vs Load



Graph 3.7: HC vs Load



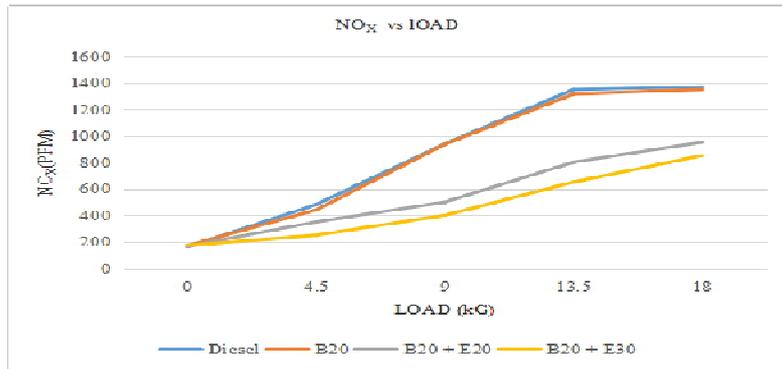
Graph 3.8: CO<sub>2</sub> vs Load

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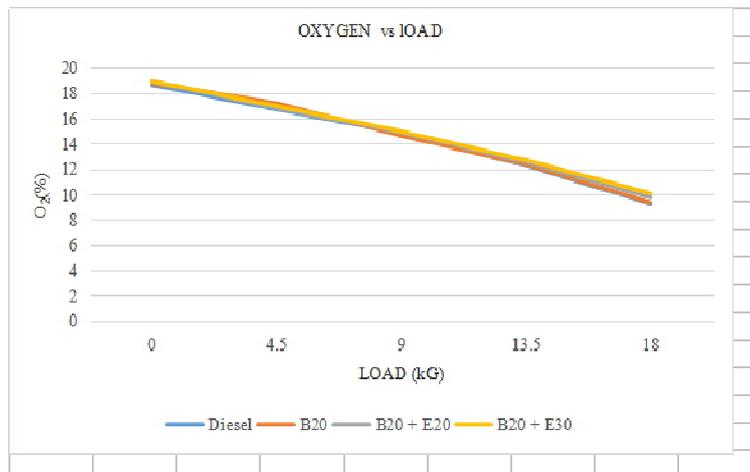
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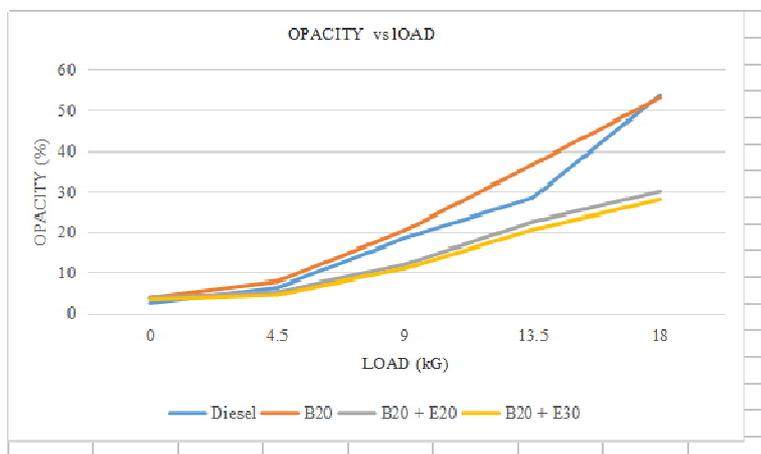
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Graph.3.9: NO<sub>x</sub> vs Load



Graph 3.10: O<sub>2</sub> vs Load



Graph 3.11: Opacity vs Load

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## IV. CONCLUSION

- Mechanical Efficiency is raised, by using Jathropa blend and Ethanol as an air additive comparing with Diesel. Volumetric efficiency remains same in all cases. Specific fuel consumption remains same. Indicated thermal efficiency is same. Brake thermal efficiency is raised, by using Jathropa blend and Ethanol as an air additive comparing with Diesel.
- CO<sub>2</sub> existence in exhaust gas is less in case of B20 + Ethanol air additive, comparing with diesel.
- NO<sub>x</sub> percentage was reduced in exhaust gases using B20 + Ethanol air additive.
- CO Emission in exhaust gas was reduced by using B20 + Ethanol air additive.
- Environmental impact and pollution is Controlled

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