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Experimental Study On The Performance, Emission Characteristics Of C.I Engine Using Waste Cooking Oil

Dr. S. Arunprasad Department of Production Engineering Sri Sairam Engineering College Chennai,India

Dr.U.Tamilarasan Department of Production Engineering Sri Sairam Engineering College Chennai,India

Velmurugan V Department of Production Engineering Sri Sairam Engineering College Chennai,India

Prabhu V Department of Production EngineeringSri Sairam Engineering College Chennai,India

Manojkumar M Department of Production Engineering Sri Sairam Engineering College Chennai,India

Dr. L.Saravana Kumar Department of Mechanical Engineering Sri Sairam Engineering College Chennai,India

Abstract— Exhaust Gas Recirculation (EGR) without intercooler is being used widely to reduce and control the oxides of nitrogen (NOx) emission from diesel engines. EGR controls the NOx because it lowers oxygen concentration and flame temperature of the working fluid in the combustion chamber. However, the use of EGR without intercooler leads to a trade- off in terms of soot emissions moreover it exhausted more unburned hydrocarbons (25–35%) compared to conventional engines. Present experimental study has been carried out to investigate the effect of EGR on performance and emissions in twin cylinders, air cooled and constant speed direct injection diesel engine, which is typically used in genset. Such engines are normally not operated with EGR. The experiments were carried out to experimentally evaluate the performance and emissions for different EGR rates of the engine. Emissions of hydrocarbon (HC), NOx, carbon monoxide (CO) were measured. Performance parameters such as thermal efficiency, brake specific fuel consumption(BSFC) were calculated.

Keywords—Waste cooking oil, Diesel Engine, EGR

I. INTRODUCTION

Oil crisis and global warming led to the research has been oriented to find suitable alternative fuels to petroleum oil. Now biodiesel was produced from non edible vegetable oils because the high price of edible vegetable oils [1], it was becoming environmentally an alternative fuel to diesel oils. Biodiesel and its blends with diesel fuel are investigated to solve the problem of depletion of fossil fuels and environmental impact.

Biodiesel; as an alternative fuel for diesel fuel, is methyl or ethyl esters extracted from vegetable oils or animal fat by transesterification process [2]. A diesel engine test using waste cooking-oil biodiesel fuel was run to investigate engine performance. A diesel engine test using waste cooking-oil biodiesel fuel was run to investigate engine performance. By adding 20% of waste cooking-oil [3] biodiesel by volume, there were increase in specific fuel consumption and decrease in thermal efficiency for biodiesel blends compared to diesel fuel. Vegetable oils caused operational and durability problems when used in diesel engines. These problems are attributed to higher viscosity and lower volatility of vegetable oils. Transesterification was an effective method of reducing vegetable oil viscosity and eliminating operational and durability problems. The research on wild mustard oil is evaluated as a feedstock for biodiesel production[4,5]. Biodiesel was obtained in 94 wt.% yield by a standard transesterification procedure with methanol and sodium methoxide catalyst. The researcher[6,7] was investigated the production of biodiesel from three mixtures of vegetable oil and used cooking oil by alkalicatalyzed transesterification.

II. BIODIESEL FROM WCO

Waste cooking-oil was used to produce biodiesel by using transesterification method. Transesterification method was conducted using a conical equipped with a reflux condenser and thermometer with magnetic stirrer. The flask was charged with waste cookingoil and preheated to 65
°Sodium hydroxide. (NaOH) 1% by weight of waste cooking oil; as a catalyst was dissolved in methanol solution of 6:1 M ratio methanol to waste cooking oil. Meth-oxide solution was set in a flask for 1.5 h to react. Then mixture was poured into a separating funnel to separate glycerol from biodiesel. Biodiesel is then washed three times, using warm water with 5% acid then with water. The residual methanol, catalyst andwater were separated from biodiesel using a rotary evaporator at 80 °C. Waste cooking-oil biodiesel methyl was dried at 100 °C . Biodiesel is mixed with diesel oil at different proportions of 10, 20 and 30% by volume. Density, flash point, Cetane index and calorific value of biodiesel blends were measured.

III. METERIALS AND METHOD

A single cylinder 4-stroke water-cooled directinjection diesel engine with a displacement volume of 1670cc, compression ratio 18.5:1, developing 21 kW at 2000 rpm with a dynamometer was used for the present research work. The injector opening pressure recommended by the manufacturer was 250 bar. A provision was made to mount a piezoelectric pressure transducer flush with the cylinder head surface in order to measure cylinder pressure. The injection system of the engine was periodically cleaned and calibrated as recommended by the manufacturer A scratch is a score or mark created on the surface with a pointed object. However, a dent with scratches is a rare occasion. All the tests were conducted at the rated speed of 2000 rpm. All readings were taken only after the engine attained stable operation. The gas analyzers were switched on before starting the experiments to stabilize them before starting the measurements. All the instruments were periodically calibrated. The injector opening pressure and injection timing were kept constant at the rated value throughout the experiments.

IV. RESULTS AND DISCUSSIONS

The variations of BSFC for diesel with 5%,10% and 15% EGR is given in Figure 1. The brake specific fuel consumptions for diesel are almost similar at lower loads when engine is operated with EGR compared to without EGR. However, at higher engine loads, the brake specific fuel consumptions with EGR are higher to that of without EGR for diesel fuel. The brake specific fuel consumptions are decreased with increasing concentration of EGR rate due to unburned hydrocarbon present in the EGR.

The variations of brake thermal efficiency of diesel and WCO with 5%,10% and 15% EGR is given in Figure 2. It is observed that from the figure the brake thermal efficiencies are increased with increase in load with EGR at lower load due to re-burning of hydrocarbons that enter in to the combustion chamber with the recirculated exhaust. gases and at full load operation the brake thermal efficiency not affected by exhaust gases.

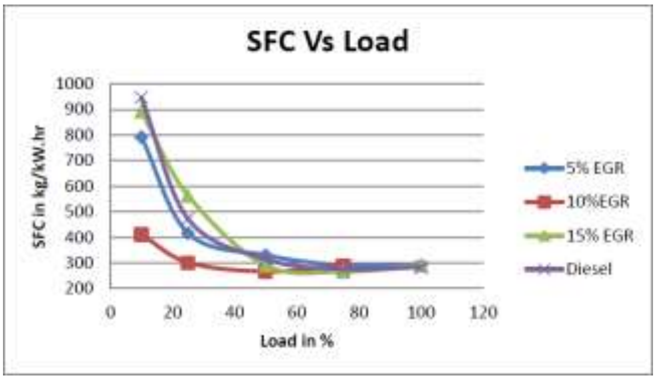

Fig.1. The variation of SFC with Load

Fig.2. The variation of BTE with Load

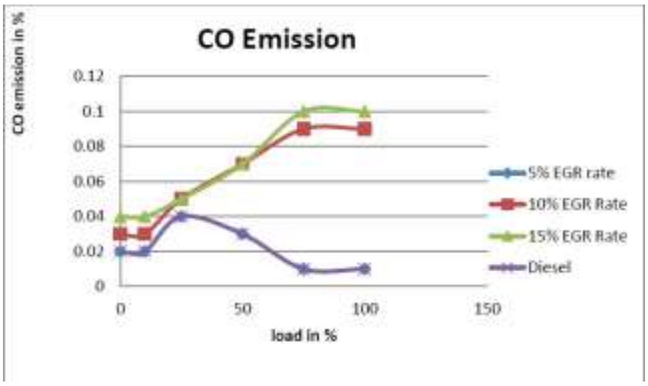

Fig.3. The variation of CO with Load

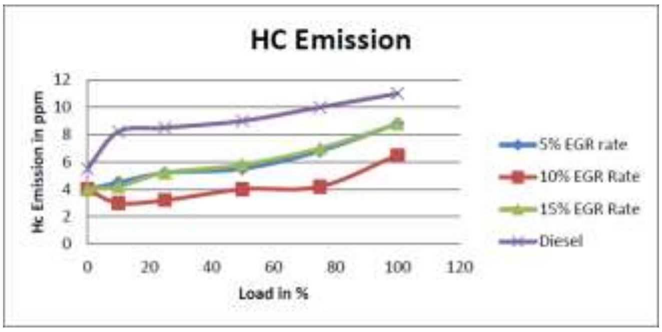

Fig.4. The variation of HC with Load

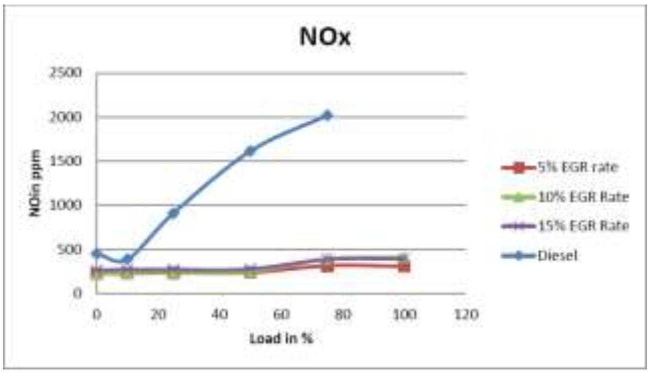

Fig.5. The variation of NOx with Load

Effect of EGR on unburned hydrocarbon (HC) and carbon monoxide (CO) are shown in Figure 3 and 4, respectively. These graphs show that HC and CO emissions increase with increasing EGR. Lower excess oxygen concentration results in rich air–fuel mixtures at different locations inside the combustion chamber. This heterogeneous mixture does not combusticom completely and results in higher hydrocarbons, and carbon monoxide emissions. At part loads, lean mixtures are harder to ignite because of heterogeneous mixture and produce higher amount of HC and CO. Fig. 5 shows the main benefit of EGR in reducing NOx emissions from diesel engine. The degree of reduction in NOx at higher loads is higher. The reasons for reduction in NOx emissions using EGR in diesel engines are reduced oxygen concentration and decreased flame temperatures in the combustible mixture.

V.CONCLUSION

Engine performance and emission results of blends of transesterified waste cooking oil and diesel were compared with the results obtained with mineral diesel. The following are the major conclusions that are drawn. The brake specific fuel consumptions are decreased with increasing concentration of EGR rate due to unburned hydrocarbon present in the EGR. It is observed that from the figure the brake thermal efficiencies are increased with increase in load with EGR at lower load due to re-burning of hydrocarbons that enter in to the combustion chamber with the recirculated exhaust. gases and at full load operation the brake thermal efficiency not affected by exhaust gases.The Coemission is higher for 15 % EGr and HA emission is lower for 10 % EGR. The NOx emission is lesser than diesel for all percentage of EGR

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