ABSTRACT

In the era of global warming where the people are making their living more and more comfortable and they are deteriorating the environment also. The world is on brink of energy crisis. The limited fossil fuel sources are increasing demand of energy. This associated with increasing cost of fossil fuels and the consciousness of the impacts of environmental pollution has forced a search for an alternative source of energy, which is renewable, harmless and non-polluting. Compared to spark ignition (SI) engines, compression ignition (CI) engines are widely used. Bigger concentration is being committed to extend an alternative source of fuel for CI engine. The vegetable oils gratify the major necessities for a diesel engine fuel, their suitability as alternative to diesel fuel have been consider as a topic of research.

Most research on biodiesel has paying attention on using plant based oils as feed stocks. The aim of the research is utilize the used vegetable oil methyl ester (UVOME), as a substitute for diesel in compression ignition engine. Used vegetable oil was converted into their methyl ester using transesterification process. This process can be done by using bio diesel processor (BDP). The bio diesel processor model is developed by using CATIA V5 Software. The CATIA models such as assemble view of Bio-diesel processor, pipeline connections with reservoir tank to mixing tank and mixing tank to collecting tank are done by using CATIA V5 software. The BDP is constructed as per the model and design. Used vegetable oil methyl ester (UVOME) is derived through transesterification process by using used vegetable oil (UVO) and methanol in the presence of either sodium hydroxide (NaOH) or Potassium hydroxide (KOH) catalyst. The UVO, methanol and NaOH catalyst are mixed with various proportions in mixing tank and heated
up to 55-60°C at constant speed stirring for 4 hours and cool it for 12 hours to retrieve the UVOME. To get the better yield of Bio-diesel, the various proportions of UVO, methanol and NaOH are taken for producing the Bio-diesel. Then this yield is compared with the same proportions of UVO and methanol in presence of the catalyst KOH. The yield of produced Bio-diesels of BN (Bio-diesel in presence of NaOH), BK (Bio-diesel in presence of KOH) were analyzed. The maximum yield (87\%) of UVOME (BK) is derived through transesterification in the presence of KOH catalyst by using biodiesel processor is higher than the yield of UVOME (BN) which is derived by using NaOH catalyst. If the methanol and catalyst concentration are increased in transesterification process, the yield of BK and BN are also increased.

The experiments were carried out to investigate the performance, combustion and emission characteristics of used vegetable oil and their blends with diesel for varying proportions. A single cylinder, water cooled, four stroke diesel engine was used for this work. The experiment is covered a range of loads (0\%, 25\%, 50\%, 75\% and 100\%). An AVL smoke meter was used to measure the smoke density in HSU. The exhaust emissions were measured by using exhaust gas analyzer. High volume sampler was employed to measure the particulate matter in exhaust. Experiments were conducted when the engine was fueled with used vegetable oil methyl ester and their blends with diesel in proportions of 20:80, 40:60, 60:40, 80:20 and 100\% (by volume), which are generally called as B20, B40, B60, B80 and B100 respectively. The following fuels are tested such as diesel, BN, B20N, B40N, B60N, B80N, BK, B20K, B40K, B60K, and B80K (where K and N are mentioned as the catalyst KOH and NaOH respectively) by using the tested engine and observed the combustion and exhaust emission characteristics. The performance of the engine was evaluated in terms of brake specific fuel consumption and brake thermal efficiency. The combustion characteristics of the engine were studied in terms of cylinder pressure and heat release with
respect to crank angle. The emission characteristics of the engine were studied in terms of exhaust gas temperature, concentration of NO\textsubscript{x}, CO, HC, particulate matter and smoke density. The results are obtained for used vegetable oil methyl ester and their blends with diesel were compared with the results of diesel.

Brake Thermal Efficiency (BTE) of UVOME and its blends are lower when compared to diesel. The BTE of B100K is lower than that of B100N at rated load condition. At rated load, the BTE of BK, BK blends, BN and its blends are lower than diesel. Brake specific fuel consumption (BSFC) falls with increasing load and brake power. The lowest BSFC value of 0.2852 kg/kW-h was obtained for diesel than all other BN and its blends, BK and its blends. The higher BSFC value is obtained, in the case of B100N at rated load condition than all other BK blends and BN blends. The exhaust gas temperature (EGT) of BN and its blends, BK and its blends are higher than that of diesel. The maximum EGT of 394\textdegree{}C is obtained when the B100K fuel is tested at rated load condition. Compared to B100K, the exhaust gas temperature is reduced in all BN blends and BK blends even at higher loads. Compared to all biodiesel blends fuels, diesel has the highest heat release and cumulative heat release with respect to crank angle in the rated load conditions. The maximum rate of pressure rise of 79.2 bar found to be higher for diesel at rated engine loads than all other tested biodiesel blends fuels.

Compared to diesel, the emission of Carbon monoxide (CO) is reduced by 16% to 34% for BN blends and also the emission of CO is reduced by 15% to 35% for BK blends at full load condition. Hydro Carbon (HC) emission is reduced with increase in % of BK and BN in the blend. Every 20% is increased in the blend; the emission of HC is reduced by 2-11% at 100% load condition. Compared to BK fuel blends, the emission of HC is slightly increased in BN fuel blends in all blend levels such as B20, B40, B60, B80
and B100. The value of Oxides of Nitrogen (NOx) in ppm for B100K is 1748ppm which is higher than diesel, BN blends, and other BK blends. Compared to BN fuel blends, the emission of NOx is slightly increased for BK fuel blends in all blend levels such as B20, B40, B60, B80 and B100. The lowest particulate matter emission of 0.731g/min is obtained for B100N. Compared to bio diesel blends of B20K, B40K, B60K, B80K and B100K, the particulate emissions are higher than the respective bio diesel blends of B20N, B40N, B60N, B80N, and B100N. The lowest smoke density of 18.1HSU is obtained when the fuel B100N is tested. Compared to bio diesel blends of B20K, B40K, B60K, B80K and B100K, the value of smoke density are slightly higher than the respective bio diesel blends of B20N, B40N, B60N, B80N, and B100N. The emission of CO is reduced by 49-54 % and emission of HC is reduced by 50-55%, when the exhaust gases passes through the catalytic converter. The emission of NOx is also reduced by 50-56 % when the exhaust gases passes through the catalytic converter. BN blends are emits less pollution than BK blends. Hence the used vegetable oil methyl esters (bio-diesels BN and BK) and their blends can be directly used in diesel engine without any engine modifications. Compared to all fuels the B20 blends are obtained all the results almost closer to diesel. Among B20N and B20K, the B20K is better.