Energy Conservation on Diesel Engine: A Review

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Abstract— Diesel engine is a popular prime mover for transportation, agricultural machinery and industries. Transportation Vehicle has the Heavy Diesel Engine. The transportation sector is the second largest source of greenhouse gas generation and Global Warming. India imports 70% of the required fuel and spending 30% of total foreign exchange earnings on oil imports. Fuel saving and Emission Control in the transportation is a global critical issue so that Research require to Concentrated on the Energy conservation of Diesel Engines. Generally in Internal Combustion Engine there is around 66 % of total heat is loss and around 33% of total heat is used for Brake Power. It is very important to improve the Energy Balance Sheet of Diesel Engine. To fulfill above requirement it is one of the requirement to experimental investigation on diesel engine for energy conservation using additives of fuel and lubricant oil. In this work Energy Conservation is one of the major Research Objective of Diesel Engine and effort apply on advance four stroke twin cylinder Diesel Engine is available for Experimental work. Many research shows that using fuel and lubricant oil additives the thermal performance improvement and Exhaust emission control can be achieved. The prime objective of this research to improve thermal performance & emission Control by applying the concept of Energy Management and Energy Conservation using Lubricant additives and fuel additives in the diesel engine.

Keywords: Energy Conservation, Diesel Engine, Performance Improvement, additives

I. INTRODUCTION

Energy conservation is mainly focus for reduction in the consumption of energy by using less of an energy service. It can be achieved by using energy more efficiently or by less amount of service used. Energy conservation is a part of the concept of Eco-sufficiency. Energy conservation is very important for all developing countries, including rest of the world. The rapid reduction in world petroleum reserves and uncertainty in petroleum supply due to some political and economic reasons, global warming, and climate change, rising population as well as the increase in the petroleum prices have stimulated many researcher for Energy Conservation and Energy Management in the world. Transport sector mainly the road transport is a major contributor for global warming and greenhouse effect by direct emissions of gases such as carbon dioxide (CO_2) (greenhouse gas), and nitrogen oxides (NO_x), un-burnt hydrocarbon and volatile organic compounds (VOCs), carbon monoxide (CO) and furthermore aerosols and particulate matter (PM) (indirect greenhouse gases), which is directly affect the oxidation–reduction capacity of the atmosphere. The situation is very serious in developing countries like India because India imports 70% of the total required fuel and spending almost 30% of total foreign exchange earnings on fuel imports. India has totally near 23 Million Registered Vehicles in which Mostly the Commercial Transport Vehicles, Taxis, Goods Transport Vehicles, Marines, Construction Machinery Have the Diesel Engine. The fast increase of fuel costs and more and stricter regulations for exhaust emission from automobiles strongly push the researcher to find cleaner fuel and more efficient combustion methods. Diesel engine exhaust emissions can be control by many possible ways but here we can classified by technologies used for that and there is mainly three possible ways that are: (1) Engine modification- It mainly improves the quality of combustion by developments and modification in engine design along with modification in fuel injection systems example of such development are the use of HCCI [1], PCCI [2], and RCCI engines [3]. (2) Exhaust gas treatment technique: This method mainly uses filters and catalysts on the engine exhaust gas line [4], [5] These devices are vary between two-way and three-way catalytic converters and also the diesel particulate filter, due to attachment of these device on exhaust gas line it gives negative impact on engine performance [6], [7]. (3) Fuel and lubricant additives: In this method by the use of additives such as biodiesel [8]–[10], Emulsions [11], fuel-water, and nanomaterial's [12], [13] that can be used or mixed with diesel fuel and by the help of this we can get engine performance improvement and reduction in exhaust emissions.

II. LITERATURE REVIEW

Some reviews on the Engine modification, Exhaust gas treatment techniques and fuel and lubricant additives have been studied various efforts made to improve the performance of engine and reducing the level of pollutants in the exhaust gases of diesel fuel engines (C.I.Engines). The engine performance and the level of pollutants in the exhaust gases are affected by many other technical parameters.

Engine modification:

Celikten et al. [14] used four cylinder direct injection diesel engine and the test was carried out with diesel fuel, rapeseed oil methyl esters and soybean oil methyl ester, the engine runs with three different fuel injection pressures such as 250, 300 and 350 bar with each of these above fuel at full load condition. By the observations it is found that the performance and emission values of rapeseed oil methyl esters and soybean oil methyl esters were found nearly the same as those of diesel fuel when injection pressure was increased at 300 bar. More than that for rapeseed oil methyl esters biodiesel emissions, it reported reduction in smoke to 122% by increasing the injection pressure from 250 to 350 bar and reduction in CO emission to 21%, and NOx emission increased about 21% with the use of higher injection pressure. Researcher further reported results of emissions for soybean soybean oil methyl ester biodiesel which shows reduction in smoke by 16.7 %, reduction in CO by 28% and NOx emission was increased by 20% by increasing the injection pressures from 250 to 350 bar. Comparison of three different fuels test results showed that, rapeseed biodiesels and soybean biodiesels have less CO and smoke level than pure diesel fuel but have high NOx emission for all other injection pressures.

Yogish et al. [15] used single cylinder water cooled direct injection computerized 3.75 kW 1500 rpm CI engine and the test was carried out with Jatropha biodiesel and Pongamia biodiesel for performance and emissions by varying the fuel injection pressures from 160 bar to 180 bar using methyl esters of mixed Jatropha and Pongamia with different proportion is used for testing. Researcher found that the BSFC was decreased with the increasing load for all the tested fuels and BSFC was increased with increase in amount of biodiesel in the blends. They also found that that the fuel consumption was 20% lower and Brake Thermal Efficiency (BTE) was 34% higher for composite different biodiesel blend than the values of pure diesel. In addition they found that the improvement in the engine performance and the level of pollutants like HC, CO and NOx in the exhaust gasses was decreased significantly for composite biodiesel.

Sayin et al. [16] used a single cylinder, four stroke, direct injection, naturally aspirated diesel engine it was fueled with ethanol blended diesel fuel with various different injection timing of 21°, 24°, 27°, 30° and 33° Crank Angle Before Top Dead Center (CA BTDC) with speed of 1000, 1200, 1400, 1600 and 1800 rpm and engine loads at 15 and 30 Nm. Experiment reported that NOx emission was increased and HC and CO emissions were decreased with the increase in the proportion of ethanol in the fuel mixture because of high peak temperature in the cylinder for the injection timing of 27° CA BTDC. Whereas NOx emission was decreased and HC and CO emissions were increased for all test conditions at the retarded injection timings of 21° and 24° CA BTDC. inversely HC and CO emissions were decreased and NOx emissions were increased for all test conditions with the advanced injection timings of 30° and 33° CA BTDC.

Sayin and Gumus [17] used four stroke naturally aspired single cylinder diesel engine. Experiment carried out at different compression ratios, injection timings and injection pressures for the performance and emissions of a DI diesel engine by using biodiesel of 5%, 20%, 50% and 100 % that are blended with diesel fuel for three different compression ratio of 17- 18 and 19, injection timings at 15°, 20° and 25° CA BTDC, and injection pressure of 180, 200 and 220 bar at 20 Nm engine load and 2200 rpm. Test reported that BSFC was increased with the increase of biodiesel percentage in the fuel blend due to low heating value of biodiesel. There after by increasing the injection pressure BSFC could be decreased due to improved atomization and better mixing process in combustion chamber. In addition, they also reported that increased in the compression ratio cause a higher BTE due to better combustion and higher lubricity of biodiesel. The exhaust emissions gases such as HC, CO and smoke were decreased while NOx emission was increased with the increase in compression ratio. While increasing injection pressure for all fuel blends it is observed that HC, CO, and smoke emissions were decreased and NOx was increased and by retardation of the injection timing caused the decreased NOx emission due to lower combustion temperature in the engine cylinder. They also reported that better results for BSFC and BTE were obtained at the highest compression ratio and injection pressure for the original injection timing of 30° CA BTDC. The HC, CO and smoke emissions from engine exhaust were decreased while NOx emission was increased with an increase in injection pressure, injection timing and compression ratio.

Selvan et al. [18] used computerized single cylinder four stroke direct injection variable compression ratio (VCR) engine. Comparing the combustion characteristics of engine at the compression ratios of 15, l7 and 19 by using neat diesel and Jatropha methyl ester biodiesel, and ethanol blends as a fuel. They observed that the cylinder gas pressure, maximum rate of pressure rise and heat release rate were increased with higher ethanol concentration due to longer ignition delay. They also observed that ignition delay was decreased with the compression ratio.

Park et al. [19] used four stroke single cylinder direct injection diesel engine and here they studied the effect of multiple injection on combustion and exhaust emissions characteristics of a C.I. engine using biodiesel. After experimental work they analyzed and found that the multiple-injection manners have higher Indicated Mean Effective Pressure (IMEP) than the corresponding value of single-injection manner and the pilot injection method showed higher IMEP than the split injection mode. The multiple-injection manner showed that the short injection interval induced a decrease of soot, HC and CO emissions, while NOx emission was increased. After experimental work it was concluded that the reduced size of the injected fuel particles in the case of the multiple-injection manners causes the improvement in the engine performance and emission characteristics of engine. Similar study was carried out by researcher Suh [20] they used single cylinder compression ignition (CI) engine by employing the multiple injections and he observed that the engine exhaust emissions such as HC, NOx and soot emissions were decreased and CO formation was increased at lower compression ratio. Single injection and pilot injection method showed the higher Indicated Mean Effective Pressure (IMEP) compared to the split injection mode. The multiple-injection method showed that the short injection interval induced a decrease of soot, HC and CO emissions, while NOx emission was increased. They also concluded that the engine performance and emission characteristics improved by reduced size of the injected fuel particles in multiple-injection method. Similar study was carried out by same researcher Suh [20] by using the multiple injections, he observed that the exhaust emissions such as HC, NOx and soot were decreased and CO formation was increased at lower compression ratio.

Aydin [21] used four stroke single cylinder direct injection test diesel engine and his studies to establish the effects of zirconium oxide (ZrO2) as thermal barrier coating (TBC) on the engine performance and emission characteristics of a diesel engine. They used cottonseed oil and sunflower oil as fuel and observed that thermal efficiency, power and torque values were improved for the vegetable oil blends due to thermal barrier coating (TBC). They also observed that sunflower oil blends have better torque and power values thus the heating value is much higher compared with cotton seed oil blends. But the level of exhaust gas pollutants HC and CO was decreased for the vegetable oil blends because of excess oxygen available and NOx emission was increased due to the increased combustion temperature in the coated engine. Smoke emission was decreased for the vegetable oil blends in coated engine compared to the diesel fuel in both coated and uncoated engine. They also observed that engine exhaust emission gases like HC, CO and smoke emissions were decreased while NOx emission was increased for the all tested fuels with the increase in engine speed.

Buyukkaya et al. [22] used six cylinder direct injection, turbocharged Diesel engine and experiments conducted to evaluate the engine performance and exhaust emissions. Using thermal barrier coatings at different speeds of 1000 to 2400 rpm, in steps of 200 rpm and injection timings of 18° and 16° CA BTDC. The engine cylinder head and valves were coated with CaZrO3 material and piston was coated by MgZrO3 with a thickness of 350 µm and over a 150 µm thickness of NiCrAl bond coating. Due to the higher exhaust gas temperatures in the coated engine BSFC was decreased by 6% and the NOx emission was increased by 9% against that of the uncoated engine. They have also reported that the fuel injection timing of the standard engine was assumed to be 20° CA BTDC, NOx emission was achieved below those of the standard engine by 11% and 26% at 18° and 16° CA BTDC respectively.

Uzun et al. [23] used six cylinder direct injection, turbocharged intercooled Diesel engine and experiment conducted to evaluate the effects of thermal barrier ceramic coatings on the engine performance and exhaust emissions of a diesel engine. The cylinder valves and head were coated with 0.35 mm thickness of CaZrO3 material over a 0.15 mm thick NiCrAl material bond coating and the piston was coated with MgZrO3 material. They reported that with coated engines the BTE was increased by 10% and the BSFC was decreased by 2% compare with uncoated engine. The pollutants gases in coated engine such as CO, HC and particulate emissions were decreased by 40%, 40% and 48 % respectively and NOx emission was increased with the increase of temperature.

Rahiman et al. [24] used kirlosker make single cylinder direct injection water cooled engine and analyzed the effects on the engine performance and emission parameters using fuels 1) Diesel and Pongamia Biodiesel blend (DB) with ratio 50:50, 2) Diesel, Pongamia Biodiesel and ethanol blend (DBE) with ratio 50:40:10 respectively, 3) Diesel, Pongamia Biodiesel and Diethyl ether blend (DBD) with ratio 50:40:10 respectively with uncoated diesel engine and 1) Diesel, Pongamia Biodiesel and ethanol blend (TDBE) with ratio 50:40:10 respectively, 2) Diesel, Pongamia Biodiesel and Diethyl ether blend (TDBD) with ratio 50:40:10 respectively with thermal barrier coated diesel engines. The diesel engine parts such as cylinder head, Piston crown, and valve faces were coated with thermal barrier coating (TBC) with the layers of 0.3 mm and material aluminum oxide (Al2O3) of and 0.2mm layer of yttria-stabilized zirconia. They have observed that brake thermal efficiency (BTE) was increased with the thermal barrier coating (TBC) engine as the coating reduces the heat loss to the surroundings and the brake thermal efficiency (BTE) was increased in order from DBE, DB, TDBE, DBD, to TDBD fuels. They have also observed that as the load increases the NOx emission was increased for DBD and TDBE fuels due to increase in the combustion temperature.

A. Exhaust Gas Treatment Technique:

Pradeep and Sharma [25] used kirlosker make Single cylinder, DI, Four stroke, Water cooled diesel engine for experiment with Jatropha biodiesel in a compression ignition engine. They studied the effect of EGR on a NOx emission and they reported that the NOx emission was decreased by 15% using EGR with nominal adverse effects on the performance and emission of diesel engine.

Prasad Rao and Kaleemuddin [26] used Water-cooled 4-S, four-cylinder, Diesel engine for experiment and evaluate the performance and emissions of CI engine using variable timing fuel injection cam (VIC) and EGR. They have observed that NOx and smoke emission level reduce significantly. Both combined effect of VIC with 7% and EGR reduce the CO by 88% and reduction in HC and NOx by 37%, PM emissions by 90%.

Hebbar and Bhat [27] used kirlosker make 4-stroke, single cylinder diesel engine facilitated with data acquisition systems (DAS) for experiment and evaluate the performance and emissions of engine and found out the effect of hot EGR and ethanol on a NOx emission and reported that NOx emission was decreased along with marginal loss of efficiency. HC and smoke emissions were increased with the cooled and hot EGR. By addition of Ethanol along with EGR recovered the efficiency and lower the emissions of engine.

B. Fuel and lubricant additives:

Sadhik Basha and Anand [28] used kirlosker make Single-cylinder, four-stroke, naturally aspirated, mechanical-injection type, air-cooled, direct injection Diesel Engine for experiments and to evaluate the effects of carbon nanotubes (CNT) blended with diesel fuel and they observed a considerable improvement in the BTE and reduced harmful pollutants compared with neat diesel due to the enhancing combustion property of nano particles. The same researcher team [29] have reviewed the applications of nanoparticle-nano fluids in diesel engines and stated that adding a suitable quantity of nanoparticles-carbon nanotubes to conventional diesel fuels to reduce the evaporation time and shorten ignition delay.

Selvan et al. [30] used single cylinder, computerized VCR engine with the use of cerium oxide size 25 ppm nanoparticles as additive in neat diesel and a fuel blend with neat diesel + castor oil biodiesel + ethanol (D70C10E20) with ratio 70:10:20 for testing the performance and emission characteristics of engine. They have reported that BSFC was good for the diesel ethanol blends than neat diesel at all the brake mean effective pressure (BMEP) due to lower calorific value of the diesel ethanol blend and lowest BSFC was found as 0.3586 kg/kW-hr for the diesel with cerium oxide (25 ppm) particles blend and 0.3931 kg/ kW-hr for neat diesel at the BMEP of 0.44 MPa due to addition of cerium oxide which promotes combustion in engine cylinder. The level of pollutants in the exhaust gases such as HC, CO and smoke were decreased with the addition of cerium oxide against that of neat diesel and NOx emission was lower for neat diesel compared to all other fuel blends.

Guru et al. [31] used Four-stroke, DI, air cooled Diesel engine and investigated the effect of magnesium size 12 µmol Mg additive to evaluate the performance and emissions of engine using chicken fat biodiesel. The engine was tested at the engine speed of 1800 to 3000 rpm with steps of 200 rpm using blend of 10% chicken fat biodiesel and diesel fuel. They also found that the BSFC of biodiesel fuel was increased by 5.2% due to the lower heating value of biodiesel and BTE of biodiesel fuel was decreased by 4.8% at all the engine speeds as compare with neat diesel fuel. Exhaust emission gases like CO and smoke emissions were decreased by 13% and 9% respectively, but NOx emission was increased by 5% against those of neat diesel fuel.

Miqdam et al.[32] used four cylinder four stroke diesel engine for experimental work and observed changes in the performance and emissions characteristics of a conventional diesel engine using the combustion of a mixture of nano-fluid water and Al_2O_3 and conventional Iraqi diesel fuel. Nano-fluids are suspensions of nanoparticles mixed in liquids and show significant enhancement in some thermo physical and combustion properties of the resulting suspension. The nano-Al_2O_3 of 51 nm diameter was used for study and multiple weight ratios of this nanoparticle were mixed with water to form a nanoparticle suspension. The weight fractions used were 1%, 3%, 5%, 7%, and 10%. After that a fixed volume ratio of the resulting suspension of 10% was added to the diesel and mixed completely. The results indicate that the addition of the nano-alumina-water suspension has increased the brake thermal efficiency (BTE) up to 5.5%, and reduced the relative fuel consumption up to 3.94%, compared with diesel fuel. The exhaust emissions gases like CO, HC, NOx, PM and noise emissions was decreased and CO_2 emission increased compare with diesel fuel.

Ang. F. Chen et al. [33] used single-cylinder direct-injection diesel engine and studied the effect of nanoparticle and diesel fuel blends on combustion characteristics, performances and exhaust emissions. In this experiment three types of nanoparticles used that were aluminum oxide, carbon nanotubes and silicon oxide. The nanoparticles were dispersed with dosage of 25 ppm, 50 ppm and 100 ppm with pure diesel that blends were (1) aluminum oxide blends that were labelled as DA25, DA50 and DA100 respectively, (2) carbon nanotubes blends that were labelled as DC25, DC50, and DC100 respectively, and (3) silicon oxide blends that were labelled as that were labelled as DS25, DS50 and DS100. To quantify the stability of nanoparticle-diesel blends the ultraviolet visible spectrophotometer analysis was done for 200 hour. The blended fuels were experimentally tested with engine at engine loads of 0, 25, 50, 75 and 100% at a constant 1800 rpm engine speed. They reported that the brake specific fuel consumption (BSFC) was reduced up to 19.8% and brake thermal efficiency (BTE) enhanced by 18.8%. Silicon oxide blends show better results with higher combustion pressure, lower brake specific fuel consumption (BSFC) and lower carbon monoxide emissions compare to aluminum oxide blends. Aluminum oxide blends and silicon oxide blends were in stable conditions with 28.1% and 22.0% absorption ratio at 200 hour sedimentation time, while carbon nanotube blends were less stable with absorption ratio reducing to less than 30% after 10 hour. Carbon nanotubes blends have the potential for research as an additives for neat diesel fuel due to significant combustion improvement and NOx emissions but the issue on the stability of carbon nanotube blends.

Zhang et al. [34] used Cummins make heavy-duty four-stroke diesel engine and studied the effect of nanoparticle and diesel fuel blends on combustion characteristics, performances and exhaust emissions using Cerium oxide nano-additives (CeO_2) of 25 nm and 50 nm sizes and blended with standard diesel fuel that labelled as DF-Ce25 and DF-Ce50 at various engine speed and load conditions. Other than that, carbon nanotube (CNT) is employed as a single additive with standard diesel fuel labelled as DF-CNT. They reported that in-cylinder pressure of DF-CNT is slightly less than that of DF under the most conditions due to more heat absorption during the evaporation process and the in-cylinder pressure of DF-Ce25 and DF-Ce50 is higher than that of DF at relatively low speed due to the improved fuel spray and faster combustion. Exhaust emissions for all fuels with nano-additives are overall lower compare with DF. Exhaust gases like CO, HC, NOx and PM reduced by 20%, 22.6%, 21% and 5.5% using DF-CNT blend compared with DF due to its improved spray and lower combustion temperature. Other than that all exhaust pollutants are in higher level except PM for DF-Ce25 blend and DF-Ce50 blend. Low speed engine limit and a maximum engine limit were found for CO emissions. Furthermore, DF-Ce25 blend emits higher NOx and lower HC than DF-Ce50 blend, because CeO_2 nanoparticles of size 25 nm has a higher reaction rate due to its larger surface area and in return hinders the reaction of Ce_2O_3.

Ahmed et al. [35] used four stroke water cooled compression ignition (CI) diesel engine with eddy current dynamometer. In this study for improving human health without using metallic combustion catalyst and use of nonmetallic fuel additives like less toxic and non-metallic graphite (G) nano diesel-fuel additive and evaluate the effects on the performance and regulated gaseous emissions from engine. They reported and experimented with Iron oxide (Fe_2O_3) nanoparticles and statistical analyses were implemented to have a comparison with graphite nano particles. The graphite (G) and iron oxide (Fe_2O_3) nanoparticles with concentrations of 50 mg/l, 100 mg/l and 150 mg /l mixed with neat diesel by magnetic stirring to prepare homogeneous fuel blends. The physicochemical properties of the fuel blends were examined and for graphite blends it was observed maximum decrease in viscosity by 4.9% and cetane index was increase by 3.26%. The parameters which include torque (T), brake power (BP), brake specific fuel consumption (BSFC), brake thermal efficiency (BTE), carbon monoxide (CO) and nitrogen oxides (NOx) emissions at engine speed varying from 1500 to 3000 rpm with an interval of 300 rpm at full engine load. They observed that at a confidence level of 95% and significance level ($\alpha = 0.05$), graphite (G) blends indicated increase in torque (T), power (BP), brake thermal efficiency (BTE) and a greater decrease in brake specific fuel consumption (BSFC) compare with Fe_2O_3 blends. Graphite (G) blends generate lower NOx emissions compare with Fe_2O_3 treated blends.

Fe2O3 (150 mg/l) reported increase in T, BP and BTE by 2.4%, 8.9% and 3.9% respectively and with G-blends (150 mg/l) by 2.9%, 9.6% and 4.1% respectively, and with Graphite blends resulted in reduction in BSFC by 2.6%. NOx emissions was increased by 34.7% with Fe2O3 and 29.2% with G at concentrations of 150 mg/l. and CO increased by 14.2% with G blends. Researcher conclude that G nanoparticles are more environment friendly additives than Fe2O3 but their application was recommended for large turbocharged CI engines by that it improved oxygen density in inlet compressed air.

Zhang et al. [36] used commercial diesel engine oil (15w/40) with Cu nanoparticles (NPs) and study The effect of Cu nanoparticles (NPs) on the tribological behaviors of serpentine powders (SPs) suspended in diesel engine oil was investigated. The researcher observed that the optimum mass ratio of Cu nanoparticles (NPs) to serpentine powders (SPs) was 7.5: 92.5. With addition of the NPs and SPs mixture to engine oil, the tribological properties can be significantly enhanced compared with those of the engine oil containing SPs alone. By that smooth and compact tribo-film was formed on worn surface, which was reduced friction and wear with iron oxides, silicon oxides, species enriched in SiO structures, graphite, organic compounds.

Ankit Kotia et al. [37] used four stroke diesel engine to evaluate the performance of engine by adding Al2O3 or SiO2 nanoparticles to the engine oil (15W40). By varying volume fraction and the temperature the viscosity and density of the resulting nano-lubricants were determined. Field emission scanning electron microscopy (FE-SEM) showed that the nanoparticles had a spherical morphology and dynamic light scattering analysis determined some aggregation of the nanoparticles in the engine oil. A pin-on-disc test apparatus was used for friction and wear analysis in the presence of the nano-lubricants. Examination of wear scars by FE–SEM and energy dispersive spectroscopy found of ball bearing and surface polishing effects, which were responsible for improvements in the tribological properties of the engine oil. With adding 0.3% vol AL2O3 to engine oil and testing with 4-stroke diesel engine test rig the greatest improvements in the tribological behavior observed.

N.W.Awang et al. [38] used a novel Cellulose Nanocrystals (CNC) nanoparticles with SAE 40 Engine oil for experimental work. CNC were green additives for improving tribological properties of lubricants oil. With varying concentrations of nanoparticles in engine oil under variable load, speed and temperature the Enhanced tribological performance was measured using piston–skirt liner tribometer. Study on a worn surface on the plate was characterized by SEM and EDX. They also conclude that by the mixing of CNC nanoparticles in engine oil improves the friction and wear rate and hence improves the lubricating properties of engine oil. Base engine oil containing 0.1% CNC gives excellent tribological properties with the lowest COF and the strongest wear resistance under all lubrication conditions.

Ghaffarkhah et al. [39] used SAE 40 engine oil for experiment and the dynamic viscosity of four different hybrid nano-lubricants was investigated. The suspended nanoparticles consisted of 20 Vol% of COOH-Functionalized MWCNTs and 80 Vol% of oxide nanoparticles like SiO2, Al2O3, MgO, and ZnO. The experiment was carried out at temperatures between 25℃ and 50℃ and solid volume fractions of 0.05%, 0.25%, 0.50%, 0.75% and 1%. They also used different methods in which the decision tree and random forest methods have the highest accuracy in terms of predicting the dynamic viscosity of different prepared nano-lubricants.

Ramtake et al. [40] used 20W40 engine oil with concentration of boric acid for experiment. For that different concentration of boric acid based engine oil nanofluids have been prepared using the two-step technique. The mass concentration of boric acid nanoparticles such as 0.5, 0.75, 1 wt%, have been prepared by dispersing in the engine oil using magnetic stirrer and ultra-sonication bath technique. The prepared nanofluid was characterized using UV-spectroscopy and Thermal Gravimetric Analysis (TGA) for dispersion stability and thermal stability analysis. The boric acid nanoparticles are characterized by using X-ray diffractometer (XRD) for phase, unit cell, and size identification. The scanning electron microscopy (SEM) was done for its morphology and nanofluid dispersion analysis. The UV spectroscopy analysis gives that 0.75 wt% boric acid nanofluid shows more stable and homogeneous dispersion stability for engine oil. The TGA analysis shows that thermal stability of 0.75 wt% nanofluid was superior compare with base oil SAE 20W40 which enhance the heat transfer rate. The XRD and SEM analysis indicates that the nanoparticles are crystalline in nature and belongs to the boric acid phase only with a mean particle size of 49 nm and boric acid nanoparticles are spherical in nature and show agglomerated nature respectively.

III. Conclusion

Through all the research it is found that the various tools are used as discussed for energy conservation, there are so many research are going on this research area. From research it is conclude that lots of work still required to research and its beneficial to improve the Brake power, Thermal efficiency and it also reduce Exhaust emission from engine. It is very Crest problem for the country like India. To improve thermal efficiency and brake power it is required to use maximum heat in brake power as in diesel engine only 33% of heat used in B.P and remaining around 66% of heat lost in various component like…cooling water jacket, Exhaust gas and unaccounted heat loss. It is one of the research required to improve the heat balance sheet and it will utilize maximum heat in brake power, to fulfill above requirement here concentrated on the lubricant oil additives and diesel fuel additives. By using that it reduce the frictional power as well as to improve the Brake power, Thermal efficiency and emission pollutants, research required to improve quality of lubricant oil and diesel fuel by using different additives. It is required to found best or smart additives to improve performance.

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