Energy consumption is necessary for human existence. The increasing demand for fossil fuels in all sectors of human life, like residential consumption transportation, industrial processes, and electricity made an attempt in search of alternative fuel which is economic, technically feasible and readily available. There are several alternatives such as wind, solar, hydro, nuclear, bio fuel, and biodiesel. Biodiesel which is also called as fatty acid methyl ester (FAME) is a clean burning, renewable fuel produced from vegetable oils, animal fats and recycled cooking oil etc. Once these fats or oils are filtered from their hydrocarbons and then combined with alcohol like methanol, biodiesel is brought to life from the chemical reaction. The increasing production of cooking oils from household and industrial sources is a growing global problem. This residue is regularly sent to the watercourses, which cause problems for wastewater treatment plants and energy loss, and also into the food chain through animal feeding, becoming a major cause of human health problems. Thus cooking oil will become the major material to make biodiesel. Catalysts can be generally classified into homogeneous, heterogeneous and biocatalyst. Homogeneous base catalysts like sodium and potassium hydroxides are the most studied and industrially used catalysts for biodiesel production but there are many obstacles to their utilizations it is hygroscopic in nature, hazardous for the environment and also it leads to saponification. Acidic catalysts like sulphuric acid are also being used for the transesterification reaction. The acid catalysed reaction requires higher temperatures and pressures and also the reaction is very slow.

In recent years the use of enzyme catalytic production of biodiesel has grabbed much attention because it helps in easy purification of biodiesel and glycerol. Due to long residence time and high cost, enzymatic transesterification could not be marketed.

Taking all this into consideration heterogeneous catalysis has played an important role as it is considered to be a green process. Heterogeneous catalysts are easier to be separated from the liquid products through physical means such as filtration and centrifugation. Very high yields of methyl esters are obtained, high purity glycerine is produced.

The objective of this work is to minimize the catalyst usage, lower the reaction temperature on energy input and using the lowest possible oil to methanol ratio on technical feasibility.
and safety considerations. Hence, it is found that sonication was able to satisfy all the above conditions.

Ultrasonication can produce a homogeneous mixture in a very short time to subsequently increase the biodiesel production yield and also helps to increase the liquid–liquid interfacial area through emulsification, which is important for the formation of vapour bubbles and cavitation bubbles in viscous liquids, such as plant oils and animal fats. Generally cavitation is the generation, consequent growth and crumble of bubbles releasing large amount of energy in the form of high temperatures and pressures over a small location resulting in very high densities.

Diesel engines are used in various fields such as power and industrial sectors, transportation. These diesel engines are responsible for the emissions such as particulate matter (PM), NOx, smoke. In order to control these emissions, researchers have been working in this field to develop these engines and to make it more efficient. Even though methods like the alternation of fuel injection, exhaust gas recirculation was developed to reduce the emissions; it could not satisfy the standards. Therefore, researchers made an attempt to develop other methods like biodiesel, fuel additives and mixing of potential nanoparticles which act as nano catalyst.

The use of vegetable oil in the diesel engine is nearly as old as the diesel engine. Rudolf Diesel, the inventor of the diesel engine, employed peanut oil as a fuel. During the late 1930s, many works have been performed to use vegetable oils as a potential fuel. It has been found that the diesel engine fueled with biodiesel emits the lesser quantity of carbon monoxide and hydrocarbon. On the other hand, the biodiesel-fueled engine also produces a significant increase in nitric oxide (NOx) compared to diesel. Studies have also reported a drop in engine power with biodiesel-fueled compression ignition engines. It has also been reported that by adding an additive in liquid form to biodiesel significantly reduces NOx emission. Additive also increases the contact between the fuel and oxidizer which in turn enhances the combustion rate owing to its higher area-to-volume ratio. Moreover, it has been reported that by adding an additive in nanoscale to fuel increases the ignition quality of the air and fuel mixture.

Effect of emulsion fuel on combustion efficiency of the engine: Induction of water in combustion chamber through any kind of emulsion has a significant effect on the efficiency of the engine. As water content increases, the yield of torque also increases over the entire operational range. When the charge is injected into the cylinder, the water turned into steam due to very high pressure and temperature. Another basis for the improvement in combustion efficiency is low interfacial tension present in the oil-water compound, promotes better atomization for burning of injected fuel. Higher contacts with air facilitated due to better dispersion of oil-water molecules and therefore boost the burning process, which is favourable for the combustion.

The presence of water in diesel brings about an appreciable reduction in the quantity of NOx and particulate matters (PM) emissions. It was experimentally found that by adding smaller size additive to fuel change its chemical composition and enhances its combustion and performance characteristics. Additives in nanoscale also enhance the oxidation of fuel with air which in turn reduces the emissions. Further, thermal conductivity and diffusivity of fuel are also improved with the addition of an additive.
Taking all these into consideration, the present work is carried out to reduce the emissions and improve the efficiency of the diesel engine by using waste cooking oil for the preparation of biodiesel, blended biodiesel and blended biodiesel with ferrofluid (ferric oxide nanoparticles in water in oil emulsion).

For the production of biodiesel homogenous reaction has some disadvantages such as low tolerance towards FFA, and water content and the purification process is complicated. Meanwhile, heterogeneous reaction with solid catalysts eliminates these factors. Transesterification of waste cooking oil with application of ultrasonic energy at 20 kHz has been attempted. The alkali catalyst required for the reaction has been replaced by MgO. The MgO catalyst was found to be highly efficient for the synthesis of biodiesel from methanol and waste cooking oil as raw material. Under the reaction conditions of catalyst dosage 1.0, 2.0, 3.0 wt%, Methanol/Waste cooking oil molar ratio 6:1,9:1,12:1, with reaction temperature 60ºC and reaction time 1 hr, the MgO catalyst was able to produce biodiesel with efficiencies in the range of 80% to 95%. MgO catalyst was characterized by XRD, FTIR, PSA, BET and the biodiesel was analysed by 1H-Nuclear Magnetic Resonance (1H-NMR). The performance and emission characteristics of a diesel engine which was improved using blended biodiesel with ferrofluid were conducted experimentally. Fe3O4 catalyst was characterized by XRD, Particle size analyser. The experiments were conducted in an experimental set-up consisting of a single cylinder CI engine. The whole experiment was divided and carried out into three parts. First is by using pure diesel, blended biodiesel (10%, 20%, and 30% by volume) in the second part, and ferrofluid (50 and 100 ppm) with blended biodiesel in the third part. Usage of ferrofluid (50ppm) with blended biodiesel showed a significant improvement in the CI engine compared to pure diesel and blended biodiesel.

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