

## Abstract

The generation of energy is a crucial factor in the economic progress of a country. The global surge in modernity and industrialization has significantly amplified the need for petroleum products. The economic growth in developing countries has led to a substantial increase in energy demand.

The utilization of petroleum oil leads to the primary challenges of the twenty-first century, encompassing the accelerated exhaustion of fossil fuels, increasing environmental pollution, global warming, and climate change. These factors collectively contribute to catastrophic flooding, intense rainfall, and severe storms. Nitrogen oxides penetrate through the alveolar cells (epithelium) and the nearby capillary vessels of the lungs, causing damage to the alveolar structures and impairing their function in the lungs. The energy (fossil fuel) crisis in the world is a big challenge for all the research fraternity. A very promising alternative source of energy to this is renewable sources. As an agriculture-oriented country, India cannot deny the capability of biodiesel. Biodiesel is a highly reliable option for substituting diesel as the primary fuel. It possesses exceptional biodegradability and contains small amounts of sulphates, aromatics, and hazardous substances. Biodiesel is considered to be safer than diesel fuel due to its elevated cetane number and flash point. It generally contains oxygen that makes up around 10-11% of its weight. This oxygen content enhances the efficiency of combustion and decreases the emissions of carbon monoxide (CO) and unburned hydrocarbons (UBHC). When considering the complete life cycle of a tree, it does not generate any net carbon dioxide and releases less smoke and particulate matter. Consequently, internal combustion engines can operate on a blend of biodiesel and diesel fuel without requiring any alterations to the engine.

Again, it is a challenge to run an engine powered by biodiesel while keeping the NO<sub>x</sub> emissions within the allowable limits of emission norms. This issue has sparked research interest among researchers worldwide, with the aim of finding a solution. This study aims to mitigate the NO<sub>x</sub> emission without getting the penalty in case of engine performance, combustion and emission parameters. The NO<sub>x</sub> emission has been quantified for the various compression ratios, injection pressure, and diesel-biodiesel fuel blends at different engine load conditions in the first phase of experimentation. In the second phase of experimentation, the water was injected into

the exhaust pipe of the engine. The effect of water on NO<sub>x</sub> emissions as well as other emission elements has been analysed. The water is injected into the downstream of the engine which is a post combustion zone so the water injection is not going to affect the performance and combustion parameters of the engine.

Ultimately, we have effectively attained an average decrease of 17.72% in NO<sub>x</sub> emissions. In addition to the reduction in NO<sub>x</sub> emissions, we also obtained a significant decrease in CO emissions by 42.04% and smoke emissions by 69.36%.