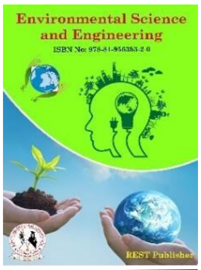
Environmental Science and Engineering
Vol: 2(2), 2023
REST Publisher; ISBN: 978-81-956353-2-0
Website: http://restpublisher.com/book- series/environmental-science-and-engineering/
DOI:https://doi.org/10.46632/ese/2/2/2



Investigating Emission Control Techniques in Glow Plug Direct Injection CI Engines using Preheated Coconut Oil Blends

[*1]B.Omprakash,[2]R.Ganapathi
[1]*JNTUA College of Engineering, Ananthapuramu, A.P, India*
[2]*ANURAG Engineering College, Kodada, Telangana, India*
*Corresponding Author Email:omprakash1715@gmail.com

Abstract:*This work provides an abstract of an experimental study into methods for lowering energy consumption and, in turn, enforcing an indirect control over emission techniques in a CI engine. Emissions were regulated in three distinct ways, and the outcomes were compared. The initial approach was to increase the efficiency of the vaporization process by placing a copper perforated medium under the atomized fuel spray. The alternative approach was mixing coconut oil with diesel. The final step was to preheating the diesel that had been mixed with coconut oil. From a range of 10% to 50% coconut, the 20% blended ratio performed best in terms of both fuel efficiency and lowered emissions. Even with increased quantities of coconut oil, the preheated blends exhibited significantly reduced emissions.*
Keywords: *engine, emission control, blended fuel, coconut oil.*

1. INTRODUCTION

Both the depletion of fossil resources and the deterioration of the environment are major problems that the world is currently facing. The amount of subsurface hydrocarbons has decreased as a result of careless drilling and excessive use. The need for a fuel alternative that can work in tandem with other goals like sustainable development, energy efficiency, and environmental protection has never been greater. Biofuels offer a workable alternative for countries still developing their energy infrastructure. Alcohol, vegetable oils, biomass, and biogas are all examples of bio-origin fuels. Some of these fuels are ready to use as is, while others must be made to more closely match the characteristics of conventional fuels. In light of the increasing popularity of diesel fuel's application in a variety of industries, this investigation focuses on determining if, with some tweaks to the current design, warmed diesel fuels combined with coconut oil may be used in diesel engines.Coconut oil stands out among vegetable oils because of its unique ability to blend seamlessly with diesel. At temperatures below 20 degrees Celsius, it retains its white crystalline solid form, but becomes a transparent liquid when mixed with regular diesel fuel (ODF). The fraction of coconut oil in blends also did not separate or form layers on the interior wall of the fuel tank, unlike other vegetable oils. Masjuki et al. [1] looked into this in Malaysia, where the average annual temperature is between 23 and 33 degrees Celsius. As a result, concerns about the fuel filter

Test Engine Specifications

Make	:	Field Marshal
Class	:	single cylinder, 4-stroke, direct injection type
Power output, kW	:	3.7 (5 Bhp)
SFC, g/kWh	:	240
Speed, rpm	:	1500
Fuel	:	high speed diesel
Bore, mm f	:	80
Swept volume, cc	:	553
Valve timing	:	IVO–5° BTDC IVC–27.8° ATDC EVO–38° BBDC

freezing up in the cold and the possibility of clogged injection lines have been disregarded. The use of preheated coconut oil combined diesel eliminates the issues that researchers encountered due to slight variations in viscosities.Three emission-control strategies were tested, with positive results for engine efficiency. First, a perforated copper medium was placed directly under the atomized fuel spray to increase combustion efficiency. This enhances combustion by vaporizing the fuel and shortening the first phase of combustion's physical delay time. Because of its high oxygen concentration, coconut oil was added to diesel in the second procedure. Finally, the performance was enhanced by preheating the coconut oil-blended diesel to lessen the extremely small viscosity changes.

2. CONTROLMETHODS

Combustion in a Porous Medium Durst and Weclas2 of Germany conducted an experimental investigation employing porous medium, and found that the performance of an indirect injection Hartz diesel engine increased while emissions decreased. Using a perforated copper medium in a directional injection engine, similar work had been experimented.The plan was to place a sheet of perforated copper or brass, which is a heat capacitance material, directly under the fuel atomizer. In order to vaporize the incoming fuel spray, the medium must first absorb heat during combustion in the preceding cycle. Improved combustion characteristics result from a shorter physical delay phase. It is important to place the perforated medium carefully so as not to disturb the finely atomized fuel spray. However, the perforated medium, which hindered the test engine's performance by altering the spray characteristics, was unable to contribute to the desired reduction in emissions. Test with coconut oil blends: It has already been discussed how coconut oil's unique property of being easily mixed with diesel. In tropical nations like India, Sri Lanka, and Malaysia, coconut oil is abundant and could serve as a viable substitute for traditional ODF. Coconut oil is slightly more expensive than regular petroleum fuels, which is a major disadvantage. Coconut oil based fuels create lower exhaust emissions; hence they may be the most cost-effective option for global emissions management. Ratios between 10% andSamples of diesel combined with 80 percent coconut oil were prepared and used to power the test engine for an extended amount of time. Specific energy consumes ptiontests: Specific energy measurements provide the most accurate conclusion when comparing the performance of fuels of varying origins [5]. The ODF test findings were used as a benchmark against which the results of the coconut oil blends were evaluated (10% to 80%). The test engine was kept running for extended periods of time on this mixture of fuels while maintaining all other variables.The blending-induced shift in specific gravity was accounted for, and the results are shown in Table-1. The TFC numbers were derived from these estimates. To get the SEC value, multiply the SFC value by the equivalent calorific value, which was derived from the system's total output. Figure-1 shows a graph of the computed values without applying any heat. Emission tests: Emissions testing now follows a protocol that's very similar to fuel efficiency testing. As with the performance tests, a Kane-May flue gas analyzer was used to check the emissions. The time spent warming up the engine was considerable. All other engine settings were held fixed while fuel mixtures were experimented with. First, we had to calibrate the gas analyzer. Care was taken to insert the analyzer's probe into the exhaust pipe without touching the pipe's inner wall.placed in the middle of the exhaust pipe where it would be subjected to the hottest exhaust gas temperatures. Throughout the whole experiment, these parameters wereera during which the trials were conducted. Experiment data, including levels of CO and NOx, were recorded and examined graphically.Testwithpreheatedcoconutoilblends: Most vegetable oils have issues with flow because their viscosities vary widely, unlike ODF, which keeps everything moving smoothly. Transesterification, micro- emulsion, pyrolysis, and dilution all work to lower the viscosities of vegetable oils, which could help solve these issues. Preheating is another option for getting around this problem. The project team decided to use this strategy, so they could compare the results of performance and emission tests with those of ODF. Preheating reduces SEC values, as shown in Figures 4 through 6.Engineman deification:An adapter was used to secure a 12V, 15W glow plug in the high pressure tubing between the injector and the fuel injection pump. To speed up the combustion process and decrease the fuel's viscosity and physical delay, a glow plug was installed. The adapter's glow plug was meticulously placed such that it would not come into contact with the tubes' inner surfaces, hence reducing energy waste. Then, the same process was used to test coconut oil blends without a heater, and the performance test was conducted under the same operating conditions. First, we ran the performance and emission tests on pure ODF, and then we switched to a blend. Graphical comparisons of the outcomes were generated (Figures 4–6).

3. RESULTS AND DISCUSSIONS

The perforated medium combustion technique, one of the three options proposed to boost performance and cut emissions, was deemed unfeasible due to fabrication challenges in determining where to place the perforated medium. The atomized diesel spray was heated and turned into a vapor, according to the proposed operating principle. The combustion chamber's depth should have been greater than the spray's length to accomplish this. However, there was a limit to how much deeper the chamber could go without interfering with the engine's cooling system.The second strategy was to use pure coconut oil mixtures. Using a variety of vegetable oils, scientists were able to demonstrate that the performance and environmental impact of an engine running on vegetable oil were both improved. Vegetable oils were also non-toxic and biodegradable in addition to being a renewable energy source. Oxygen was found to be present in significant amounts in the molecular structure of most vegetable oils, while Sulphur was found to be present in a small proportion. Figures 1 through 6 depict several characteristic curves and emissions curves for coconut oil. While the SEC values for a blend of 10% coconut oil and 100% diesel are fairly low, those for a blend of 20% coconut oil and 30% diesel are quite

Table 1 Comparison of properties of coconut oil and diesel

Properties	Fuel blend									
	100% diesel	100% coconut oil	Diesel + percentage coconut oil							
			10	20	30	40	50	60	0	0
Cal value kJ/kg	42500.00	37260.000	41976.000	41452.000	40928.000	40404.000	39880.000	39356.000	8832.000	8308.00
Specific gravity	0.83	0.918	0.838	0.847	0.856	0.865	0.874	0.882	0.891	0.90
Sulphur, wt, %	0.10	0.009	0.090	0.081	0.071	0.060	0.040	—	—	—
Cetane number	52.00	37.000	49.000	47.000	46.000	44.000	44.000	—	—	—
Cost (approx), Rs/kg	18.00	40.000	20.200	22.400	24.600	26.800	29.000	31.200	3.400	5.60
Kinematic viscosity, Cst 40°C	3.60	26.220	3.700	3.930	4.700	4.800	5.300	—	—	—

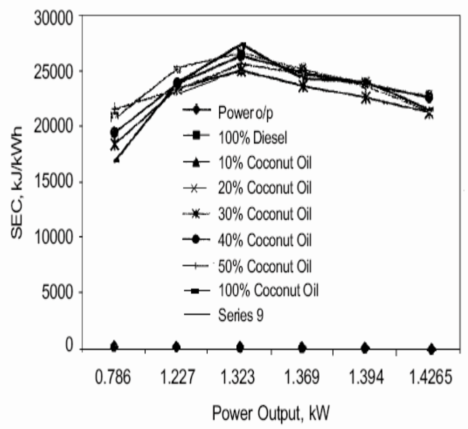


Figure 1 Power output against SEC (without heater)

The results (Figure-1) showed that a combination containing 20% coconut oil was the most effective. More thorough combustion and the extra lubricity of coconut oil are two potential causes of the decreased SEC values or the increased thermal efficiency. The frictional horsepower losses in the engine exhibited a decreasing trend in tests conducted with blends of coconut oil. SEC values mirrored the decline in frictional losses and the subsequent decrease in unexplained losses. As a result, the usable energy, cooling losses, and exhaust losses all received an increase thanks to the reduced frictional horse power. In most cases, the surplus air operation of CI engines results in a lower percentage of CO. Emission curves (Figure-2) reveal that CO concentration is lowered across the board for different blending percentages. The 20% coconut oil line represents the lowest possible concentration of carbon monoxide in this case as well. The improved and more thorough combustion contributes to the greater thermal efficiency. The molecules of coconut oil include some quantity of oxygen that participates in combustion, which is why the oil burns completely. The temperature-dependent pollutant nitrogen oxide (NOx) is the most significant problem for diesel engines. NOx curves (Figure-3) showed that as the percentage of coconut oil in the formula grew, NOx values dropped. Because of the reduced heat release rate produced by coconut oil blends, at the premix combustion stage, reducing NOx emissions by decreasing the peak combustion temperature. Vegetable oil and coconut oil, thanks to their chemical bond and features, provide a lower combustion temperature. Exhaust temperatures dropped as coconut oil fractions increased. Since hydrocarbons are being oxidized during the expansion stroke instead of the exhaust, the exhaust temperature is reduced. Therefore, this approach gives off a bright positive light. As a third option, preheating the fuel before injecting it into the cylinder has been proposed. Its primary goal was to eliminate flow-related issues by lowering viscosity. The experiments were run with mixed coconut oil and warmed diesel. Figures 4 through 6 depict the various characteristic curves and emission curves for various blends of coconut oil. For warmed fuel, the SEC curve trend improved from being 100 percent diesel to 50 percent coconut oil. Figure 4 shows the results obtained with 50% coconut oil, while Figure 1 shows the results obtained with blended coconut oil without a heater. As a result, the SEC after preheating is lower than the SEC before preheating for diesel. When the mixing ratio is raised above 50%, growth begins.

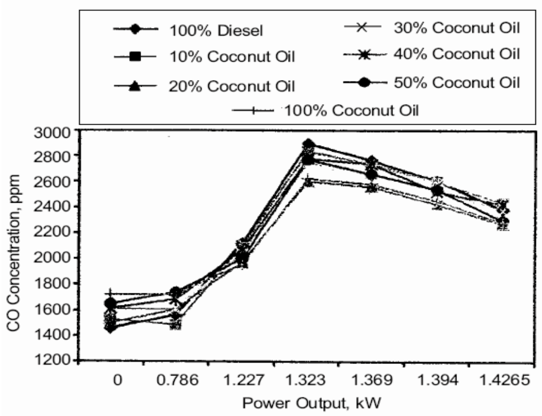


Figure 2 Power output against CO concentration (without heater)

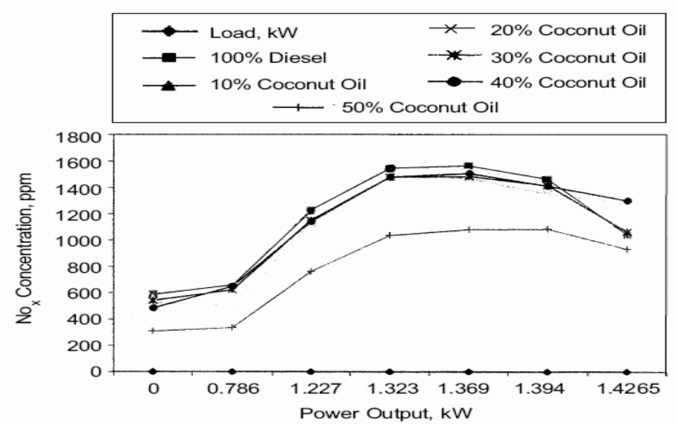


Figure 3 Power output against NO_X concentration (without heater)

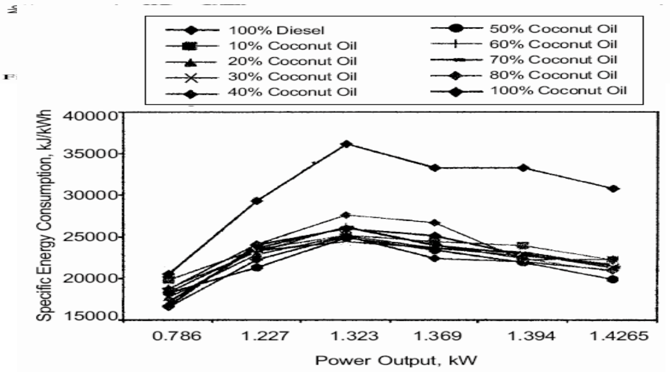


Figure 4 Power output against specific energy concentration (without heater)

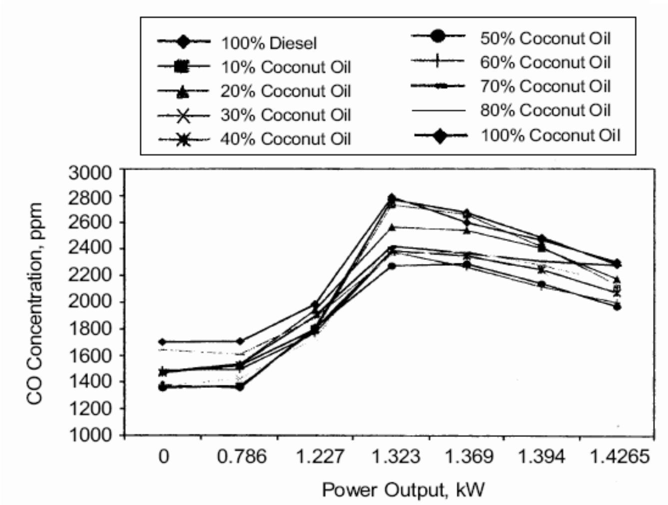


Figure 5 Power output against CO concentration (without heater)

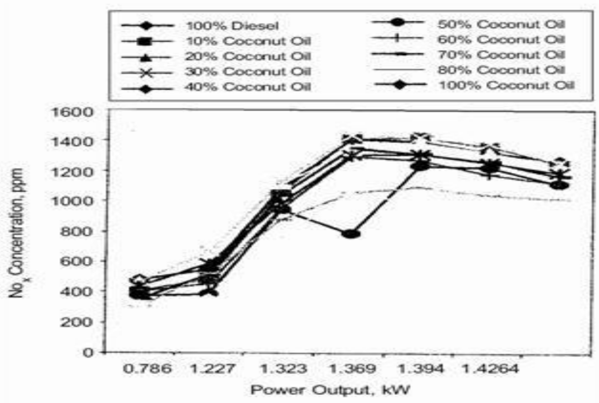


Figure 6 Power output against NO_x (with heater)

Lower fuel viscosity and shorter physical delay before combustion could be to credit for the improved thermal efficiency. Spray properties are enhanced when fuel is preheated because its viscosity and density decrease, respectively. Therefore, the physical delay is decreased as atomized droplets easily combine with air. Increases in the proportion of coconut oil used resulted in lower CO concentrations in the preheated emission curves (Figure 5). There was a decrease in NOx emissions as the percentage of coconut oil in the mixture increased (Figure 6). Possible causes include preheating blends, which decreases SEC levels.Particulate matter and unburned hydrocarbon readings, however, have been omitted. Because the engine used in the experiment is a lean-burn type, the NOx emissions will be much higher than the hydrocarbon ones. Furthermore, the finer particles can be minimized by using ultra-refined coconut oil. Particulate matter emissions are also affected by fuel sulphur concentration. Since coconut oil contains so little sulphur, it can be used to significantly cut PM emissions. The fatty acids in coconut oil work as a corrosion resistant material and also contribute to the oil's viscosity, which improves the engine's resistance to wear.

4. CONCLUSION

Extensive testing of engines has led to the conclusion that ordinary diesel engines can run on coconut oil with minimal modification. In terms of emissions and efficiency, preheated (50%) coconut oil blends fared best. The best results were achieved with a 20% blend of unheated coconut oil, although the SEC and emissions were greater than with a preheated blend. Even though coconut oil is more expensive than diesel, it may be the most cost-effective replacement to the current system if emissions are managed.

REFERENCES

[1]. H.H Masjuki, M.A. Kalam, M.A. Maleque, A. Kubo and T. Nonaka.Performance Emissions and Wear Characteristics of an Indirect Injection Diesel Engine using Coconut Oil Blended Diesel. Proceedings of the Institution of Mechanical Engineers. Vol.215, part D. pp.393-404.

[2]. F Durst and M Weclas. 2001. A New Type Internal Combustion Engine based on the Porus Medium Combusting Technique. Proceedings of Institution of Mechanical Engineers. PartD. pp.63-81.

[3]. B E Milton, Chapman and Hall. Thermodynamics Combustions andEngines. Combustion and Pollution Formation in Engines. pp. 302-331.

[4]. YHotta, KNakakuda and MInayoshi.1997. Combustion Improvement for Reducing Exhaust Emissions in IDI Diesel Engine. Proceeding of SAE- 98053. pp.17-34.

[5]. AKAgarvalandLMDas.2001.Biodiesel Development and Characterizations for use as a Fuel in Compression Ignition Engines. ASME Journal of Engineering for Gas Turbines and Power.Vol.123, April.pp.440-447.

