energies

Review

State-of-the-Art of Strategies to Reduce Exhaust Emissions from Diesel Engine Vehicles

S. M. Ashrafur Rahman [1,*], I. M. Rizwanul Fattah [2], Hwai Chyuan Ong [2] and M. F. M. A. Zamri [3]

1 Biofuel Engine Research Facility, Queensland University of Technology, Brisbane, QLD 4000, Australia
2 School of Information, Systems and Modelling, Faculty of Engineering and Information Technology, University of Technology Sydney, Ultimo, NSW 2007, Australia; IslamMdRizwanul.fattah@uts.edu.au (I.M.R.F.); HwaiChyuan.Ong@uts.edu.au (H.C.O.)
3 Institute of Sustainable Energy, Universiti Tenaga Nasional, Jalan IKRAM-UNITEN, Kajang 43000, Selangor, Malaysia; Faiz.Muaz@uniten.edu.my
* Correspondence: s2.rahman@qut.edu.au

Abstract: Compression ignition engines play a significant role in the development of a country. They are widely used due to their innate properties such as high efficiency, high power output, and durability. However, they are considered one of the key contributors to transport-related emission and have recently been identified as carcinogenic. Thus, it is important to modify the designs and processes before, during, and after combustion to reduce the emissions to meet the strict emission regulations. The paper discusses the pros and cons of different strategies to reduce emissions of a diesel engine. An overview of various techniques to modify the pre-combustion engine design aspects has been discussed first. After that, fuel modifications techniques during combustion to improve the fuel properties to reduce the engine-out emission is discussed. Finally, post-combustion after-treatment devices are briefly discussed, which help improve the air quality of our environment.

Keywords: diesel emission; air quality improvement; renewable energy; biodiesel

Citation: Rahman, S.M.A.; Rizwanul Fattah , I.M.; Ong, H.C.; Zamri, M.F.M.A. State-of-the-Art of Strategies to Reduce Exhaust Emissions from Diesel Engine Vehicles. *Energies* **2021**, *14*, 1766. https://doi.org/10.3390/en14061766

Academic Editor: Diego Luna

Received: 14 February 2021
Accepted: 17 March 2021
Published: 22 March 2021

1. Introduction

The development of a country greatly depends upon its transportation, mining, and power generation sectors. Diesel engines, also known as compression ignition (CI) engines, have become a source of power for these sectors due to their having high innate efficiency, durability, and better power output. Hence, it shares a large portion of the passenger car and heavy machinery market [1]. However, with rapid growth in demand, the diesel engine has also become one of the key sources of pollutants. Both the environment and human health are adversely affected by the pollutants resulting from petroleum-derived fuel combustion. United Nation Intergovernmental Panel on Climate Change has reported a rapid surge of global warming due to increased greenhouse gas emission, including methane, nitrogen oxides, and carbon dioxide. It is predicted that more than a hundred million lives will be in danger if the average global temperature increases by more than 2 °C [2].

The main constituents of emission resulted from the combustion of diesel fuel are carbon monoxide (CO), nitrogen oxides (NOX), hydrocarbons (HC), and particulate matter (PM)—these are considered as regulated emission and Polycyclic aromatic hydrocarbon, benzene, toluene, xylene, soot—these are considered as unregulated emission. Diesel engines emit hydrocarbon as the by-product of incomplete or partial combustion [3]. Sneezing, coughing, drowsiness, eye irritation, symptoms akin to drunkenness, several lung diseases- these are the problems that can be caused by HC emission [4]. The incomplete oxidation product of hydrocarbon fuel results in CO emission [5]. Excessive inhaling of CO disrupts the proper functionality of several vital organs such as the brain, nervous tissue and heart by reducing the oxygen-carrying capacity of blood [6,7]. CO emission also can cause morbidity in people who have respiratory or circulatory complications [4]. NO_X formation is a complex mechanism, which can be divided into three parts, thermal, prompt and fuel. At first, the high combustion temperature breaks the triple bonds of "Nitrogen molecules." Then, these nitrogen molecules dissociate into their atomic states and produce NO_X while reacting with oxygen. The development of free radical in the flame front of hydrocarbon flames leads to rapid production of NOx [8]. During combustion of fuel, oxygen reacts with nitrogen bound in the fuel and forms NOX. Irritation of the lungs, lowering respiratory infection resistance, oedema, bronchitis, and pneumonia—these are the problems caused by NO_X emission [4]. Exposure to heavy metals causes adverse health effects, including toxicity, severe respiratory, and cardiovascular problems and shorten life expectancy [9,10].

The acute effect of polycyclic aromatic hydrocarbon (PAH) on human health depends upon several factors, such as concentration, extent, the process of exposure, etc. [11]. Exposure to PAH may result in nausea, diarrhoea, vomiting, skin irritation, etc. [12]. Long time exposure increases the chances of lung, skin, bladder, and gastrointestinal cancers [13,14]. The most prominent aldehydes have carcinogenic effects, which are harmful to human health. Aldehyde over-exposure results in sore throat, nausea, headache, irritation of eyes, nose, skin, and throat, and difficulty in breathing and can cause chronic diseases at higher concentrations. Studies have shown that haematological, immune, neurological, and reproductive systems are each affected by N2O emissions [15]. Furthermore, human exposure to benzene may cause adverse health effects and diseases, including cancer and aplastic anaemia [16]. Toluene is a respiratory irritant that can affect the central nervous system. Inhalation of high levels of toluene vapours for a short period may cause headache, drowsiness, visual changes, nausea, dizziness, muscle spasm, and loss of coordination. Long time exposure to high-level toluene may result in attention and concentration and motor performance deficits [17]. To reduce the health effects of the combustion of diesel in internal combustion engines, regulators have imposed more and more stringent regulations on manufacturers.

The increased effect of global warming, limited efficiency of diesel engines and stringent anti-pollution laws (especially NO_X and PM emissions) enforced by the governments have generated a spur to develop efficient engines with the acceptable emission level [18,19]. This development can be divided into three categories:

- Pre-combustion engine configuration modifications
- In-combustion fuel modification
- Post-combustion treatment techniques

The article's main focus is the in-combustion fuel modification section, where a thorough analysis was provided—pre-and post-combustion modifications discussed with less emphasis. The literature was selected through specific search parameters such as "biodiesel", "performance", and "emission" in "sciencedirect.com". Relevant studies from the past ten years were chosen for this review with very few necessary exceptions. This article intends to present the current scenario of research activities on strategies to reduce exhaust emissions from diesel engine vehicles.

2. Diesel Engine Emission Standards

In recent years, due to the increased impact of global warming and the adverse effect on human health, governments have imposed stringent anti-pollution laws. These have fostered the development of efficient engines with minimum emissions [19]. In Table 1, Euro emission standards for both passenger cars and heavy-duty vehicles [20] are shown and Table 2 exhibits emission standards followed in Australia from 2002 onwards [21].

Table 1. Euro emission standards for passenger and heavy-duty vehicles.

Euro Standards	Passenger Car			
	Nitrogen oxides (NO_X)	Total hydrocarbon $+NO_x$) $THC+NO_X$	Particulate Matter (PM)	Particle Number (PN)
	mg/km	mg/km	mg/km	#/km
Euro 1	-	970	140	-
Euro 2	-	700	80–100	-
Euro 3	500	560	50	-
Euro 4	250	300	25	-
Euro 5a	180	230	5	-
Euro 5b	180	230	5	6×10^{11}
Euro 6	80	170	5	6×10^{11}
Euro Standards	Heavy-Duty Vehicles			
	NO_X	THC	PM	PN
	g/kWh	g/kWh	mg/kWh	#/kWh
Euro 1	8	1.23	360	-
Euro 2a	7	1.1	250	-
Euro 2b	7	1.1	150	-
Euro 3	5	0.66	100	-
Euro 4	3.5	0.46	20	-
Euro 5	2	0.46	20	-
Euro 6	0.4	0.13	10	6×10^{11}

Table 2. Emission standards followed in Australia.

Category	**Gross Vehicle Mass**	**2002/03**	**2006/07**	**2007/08**	**2010/11**	**2013/16**	**2017/18**
Passenger Vehicles							
	≤3.5 t	Euro 2		Euro 4		Euro 5	Euro 6
	>3.5 t	Euro 3		Euro 4			
Buses							
Light	≤3.5 t	Euro 2		Euro 4		Euro 5	Euro 6
	3.5–5 t	Euro 3		Euro 4		Euro 5	
Heavy	>5 t	Euro 3		Euro 4		Euro 5	
Goods Vehicles (trucks)							
Light	≤3.5 t	Euro 2		Euro 4		Euro 5	Euro 6
Medium	3.5–12 t	Euro 3		Euro 4		Euro 5	
Heavy	>12 t	Euro 3		Euro 4		Euro 5	

3. Pre-Combustion Engine Design Considerations

The engine performance and pollutant emissions depend upon diesel engine configuration. By modifying the chamber geometry, compression ratios, inlet swirl location, injection parameters (pressure, timing, and duration), etc., improved engine performance and better fuel efficiency can be achieved [22–24]. Reduction of friction between elements, use of sophisticated bearings, and new lubricants will reduce mechanical losses, thus increasing engine efficiency [25,26].

For diesel engine, injection timing is one of the key parameters, which heavily influence engine performance, emissions, and combustion characteristics. Many studies reported the effect of retarding or advancing the injection timing from the standard value. Park et al. [27] reported that NOx emission was reduced when the injection timing is retarded. As more fuel is burnt after top dead centre (TDC), it reduces peak cylinder pressure and temperatures, which as a result reduces NOX emission, which is also supported by Sayin et al. [28]. However, Sayin et al. [28] also reported that retarded injection timings results in increased unburned HC and CO emissions. Muralidharan and Govindarajan [29] reported that when the injection timing is retarded, fuel injection starts later; thus, complete combustion is not possible to attain at this mode. Consequently, brake thermal efficiency (BTE) decreases and brake specific fuel consumption (BSFC) increases.

When the injection timing is advanced from the standard, it reduces the HC and CO emissions due to increased combustion temperature, increased oxidation of carbon and oxygen and decreased flame quenching thickness. However, this also increases CO_2 emission [28]. Moreover, advanced injection timing reduces PM emission, which is reported by [29–31]. However, with the advanced injection timing, the volumetric efficiency decreased, and the overall equivalence ratio increased [32]. On the contrary to the claim of increased CO_2 emission due to advanced injection timing, Nwafor [33] reported that advanced injection timing produced the lowest CO_2 emissions due to early combustion resulting in ash formation, a result of high cylinder pressure and temperature, which was supported other researchers [34–40]. Raheman and Ghadge [41] reported the reduction of mean BSFC and improvement of BTE when injection timing was advanced due to having enough time for proper combustion. The exhaust gas temperature (EGT) dropped continuously as injection timing was advanced. This can be attributed to a favourable pressure-temperature profile. Hariram and Kumar [42] similarly reported that advanced injection timing exhibited a significant reduction in BSFC, unburned HC, CO, and smoke, and increase of combustion pressure, rate of heat release, brake mean effective pressure (BMEP) and NO_X emissions. However, some researchers have reported that any change of injection timing from the standard value results in decreased BTE and increased BSFC [30,35].

Varying the injection pressure is another viable option to control engine performance and emission. When injection pressure is increased, it reduces the ignition delay [43]. Several researchers have reported that increased injection pressure results in an increase of peak in-cylinder pressure [44–46], and more fuel being burnt in the premixed combustion phase. Canakci et al. [44] reported better combustion when injection pressure is increased as it increases atomisation of fuel at the nozzle outlet and results in a more-distributed vapour phase. Sayin et al. [47] reported better BTE and reduced BSFC at higher injection due to improved atomisation and better mixing, which other researchers support, too [48–50]. Purushothaman and Nagarajan [51] stated that NO_X emission decreased when the fuel injection pressure increases due to corresponding changes in the in-cylinder gas temperature and the lower intensity heat release rate in the premixed combustion phase and longer combustion duration, which is also supported by other researchers [52,53]. The increasing injection pressure causes a good fuel-air mixing, easy and complete combustion of the smaller droplets, which resulted in CO and HC emission reduction [44,45,54–57]. Canakci et al. [44] attributed the reduction to easier combustion of the smaller fuel droplets because of increased injection pressure. In the case of particulate emissions, increased injection pressure reduces number concentration of particulates [45].

Mohan et al. [53] reported retardation of injection timing when injection pressure was increased, which can be attributed to an increase of required time to build up the nozzle opening pressure. Some researchers reported that if injection pressure is increased beyond a certain level, ineffective combustion occurs due to a decreased depth of penetration of fuel particles, and as a result, BTE decreases [50,58]. Furthermore, some researchers have reported engine performance deterioration when injection pressure is increased or decreased [44,45,59]. Canakci et al. [44] reported an increase of BSFC with any alternation of injection pressure. In the case of decreasing injection pressure, fuel particle diameters enlarge, and the ignition delay period increases, which in turn increases the BSFC. On the other hand, increased injection pressure causes a shorter ignition delay period, and as a result, opportunities for homogeneous mixing decrease and BSFC increases. An increase in injection pressure increases NO_X emission, which is reported by several researchers [44,46,54,56,60]. Higher injection pressure helps to decrease the fuel droplet diameter, and hence fuel spray vapourises quickly. Therefore, the fuel spray cannot penetrate deeply into the combustion chamber. Consequently, it generates faster combustion rates and higher combustion temperature initially. This phenomenon increases the NOx emission. Jindal et al. [49] reported that CO emissions increased due to poor diffusion flame combustion with the increase in injection pressure. Similar results were reported by others [51,60,61].

The compression ratio is another factor that can affect the performance of a diesel engine. It is the ratio between the combustion chamber volume when the piston is at the bottom and at the top. A higher compression ratio means more power can be extracted from the small amount of fuel, which increases the engine's efficiency. For diesel engine compression ratio is typically 14:1 to 16:1 (Direct injection) and 18:1 to 23:1 (Indirect injection). Jindal et al. [49] reported that increasing the compression ratio reduces the BSFC and increases BTE. Raheman and Ghadge [41] likewise reported comparable findings. The authors reported that an increase in compression ratio increases BTE and reduces BSFC and EGT. Several other studies have found similar results regarding the relation between BTE and increased compression ratio [62,63]. Furthermore, Jindal et al. [49] reported that a higher compression ratio reduces CO emission and smoke opacity. In contrast, several studies reported that increase in compression ratio increases HC and NO_X emission [49,62].

Use of advanced materials in the engine chamber's construction, by using advanced coating materials and lubricating oils, engine losses can be reduced, which in turn help improve the combustion within the engine chamber [1]. Based on several studies, the part of fuel energy devoted to mechanical power to overcome friction can be divided as follows, 30–35% to overcome engine friction [64–66]. Advanced lubricating oils can be used to reduce this power loss due to friction. Several studies have been conducted, which focused on the modification of combustion chamber design, which reported that it was possible to attain improved performance [46,67–69].

Exhaust gas recirculation (EGR) is a technique in which some of the exhaust gas is recirculated to the engine intake. EGR is one of the essential ways to reduce NO_X emission [70–73]. EGR recirculates some portion of the exhaust gas into the combustion chamber, thus reducing the availability of oxygen and reducing the peak combustion temperature [74], which helps to reduce NO_X emission [75]. Moreover, low temperature combustion (LTC) techniques can help to achieve simultaneous NO_X and PM reduction [73,76]. Chadwell and Dingle reported that a reduction of 60% NO_X emission was possible to achieve by using 12% EGR [77]. Another study reported that, by using 10% EGR rate, NO_X, and smoke were reduced by 36% and 31%, respectively [78]. On the contrary, it is reported that as EGR reduces available oxygen in the chamber, it increases soot formation [79–82]. Furthermore, Chadwell and Dingle reported an increase of 8.6% BSFC when 12% of EGR is used [77]. Agarwal et al. [74] reported that at low load, the use of EGR slightly increases thermal efficiency and reduces BSFC. This can be attributed to exhaust gas containing higher oxygen and lower CO_2 at low loads. On the other hand, the authors reported higher HC and CO emission when EGR is used. Fathi et al. [83] reported that when EGR is used at homogenous charge compression ignition (HCCI) combustion mode, it results in further reduction of PM and NO_X emission, however, increased HC and CO emission is reported too. Multiple split injection strategies can be used to reduce PM emission without compensating for NO_X emission [84,85]. Several researchers have reported that multiple/port injections reduce both PM and NO_X emission [86–91]. However, some of them reported that using these strategies resulted in an increase in BSFC [87,88,90].

The introduction of new combustion techniques can help reduce both NO_X and PM emission. One of the techniques that offer a simultaneous reduction of NO_X and PM is LTC [92]. There have been several studies that evaluated the performance of different LTC techniques, HCCI, premixed charge compression ignition (PCCI) and reactivity controlled compression ignition (RCCI) combustion [93–96]. In HCCI mode, a drastic reduction of in-cylinder local temperature slows down chemical reactions that are accountable for NO_X formation and reduces soot formation by reducing the presence of the high local equivalence ratio during combustion. Controlling the combustion in HCCI engine is difficult. Thus, PCCI technique evolved, which offers better control of the start of combustion. Simultaneous reduction of NO_X and PM emission has been reported in several studies [97–99]. However, the major drawbacks of these LTC techniques are an increase in both HC and CO emission. These can be attributed to the reduction of in-cylinder combustion temperatures, and higher oxygen content results in incomplete combustion [92].

4. In-Combustion Fuel Modification

Modification of fuel properties to achieve improved combustion efficiency and emission reduction can be achieved by several processes blending biofuel with diesel, using fuel additives, etc. Biofuels are considered environmentally friendly, non-toxic, renewable, sustainable, etc. There have been several studies that focused on the performance improvement of the diesel engine while using biofuel. Fuel additives are used for the following reasons: improve handling properties and stability of fuel, improve combustion properties, reduce emissions from combustion, improve fuel economy, etc. [100]. Different techniques to improve fuel properties will be discussed henceforth.

4.1. Biodiesel as a Diesel Substitute

The use of biodiesel to operate the diesel engine dates back to 1900, when Dr Rudolph, the inventor of the engine, operated it using pure vegetable oil [101]. Afterwards, the use of petroleum diesel fuel popularised as it was readily available, and thus focus shifted from vegetable oils. The petroleum fuel industry is currently facing some problems, such as rapidly decreasing fuel reserves and strict laws enforced by governments to cut down engine emissions. Consequently, researchers have shifted their attention towards the search for an eco-friendly, technically feasible alternative-fuel [102,103]. Biodiesel having similar functional properties can be considered as one of the viable options to replace diesel fuel [104]. Biodiesel is produced from vegetable oil using the "transesterification" process, as is also known as fatty acid methyl ester (FAME) [105,106]. In this process, in order to chemically break the molecule of the raw renewable oil (triglyceride) into methyl or ethyl esters of the renewable oil, alcohol such as methanol or ethanol is used. The process contains three consecutive reversible reactions: conversion of triglycerides to diglycerides, conversion of diglycerides to mono-glycerides, and conversion of glycerides to glycerol. The process yields one ester molecule in each step. Properties of these esters are comparable to that of diesel. Biodiesels are considered renewable, biodegradable, non-flammable, non-explosive, non-toxic, and environment-friendly [107–109].

The foremost advantage of using biodiesel is that biodiesel can be used in a diesel engine (up to 20%) without making any engine modification [110,111]. Several researchers reported higher combustion efficiency, which can be attributed to having 10–11% more oxygen [112–114]. This extra oxygen of biodiesel allows more carbon molecules to burn, which results in complete fuel combustion. Further, as a result, less CO and HC emissions are emitted when biodiesel is used compared to diesel [115,116]. Biodiesel has a higher cetane than diesel fuel [113,117], which helps to reduce the HC and CO emission. Additionally, biodiesel has better lubrication properties, improving lubrication in fuel pumps and injector units, thus decreasing wear and tear of engine and improving engine efficiency [118,119]. Biodiesel contains a higher flash point than diesel, making it safe for handling, transportation, and storage [120,121]. However, there are several drawbacks of using biodiesel in the internal combustion engine. Biodiesel exhibits 12% lower energy contents, which results in an increase in fuel consumption by almost 2–10% [112,114,121–123]. Due to the use of biodiesel, engine durability problems such as injector cocking, piston ring sticking, filter plugging, etc., can occur [121]. As biodiesel has lower oxygen stability, corrosion of fuel tank, injector, and pipe can occur if biodiesel gets oxidised into fatty acids [124,125]. Due to higher oxygen content, advanced fuel injection timing, and early start of combustion, biodiesel usually emits higher NO_X than diesel fuel [112,126,127]. Other factors that can cause NO_X emission increase are soot radiation effects, bulk modulus effects, engine control module (ECM)-decision-making effects, prompt NO_X formation, changes in fuel composition that affect fuel spray or ignition patterns within the combustion chamber and adiabatic flame temperature, etc. [128]. Some relevant studies on highly researched feedstocks have been presented in Table 3. From the results, we can see that biodiesels' addition generally results in increased BSFC, NO_X emission, and reduced BTE, HC CO, and smoke emission. Poor atomisation and lower heating value compared to diesel fuel are the reason behind increased BSFC and decreased BTE [129]. Due to having a lower heating value, biodiesel and its blends release less heat during combustion, and thus to provide the same amount of power needs more fuel to be injected, thus increasing BSFC [130]. On the contrary, a study reported that biodiesel decreased BSFC and increases BTE [131] and CO, HC, and PM emissions and decreases NO_X emission [104,132–136]. Biodiesel is more oxygenative and it causes enhanced corrosion and material degradation [137–139].

Another problem with implementing the use of biodiesel is its production cost. The production price mainly depends on feedstock costs [140–142]. Currently, the biodiesels that are mostly used are edible in nature, such as soybeans, palm oil, sunflower, safflower, rapeseed, coconut, etc. These are known as first-generation biodiesels. The non-edible biodiesels are known as second-generation biodiesel. The advantages of using second generation biodiesels are that they are not affecting the requirements for human food, which means no food vs. fuel debate. Another promising biodiesel feedstock is algae, which is considered third-generation biodiesel. The advantages of algal biodiesel are that it is possible to get 5–20 k gallons of oil per year per acre, it is biodegradable, and a huge amount of CO_2 is consumed during cultivation. However, the production cost of algal biodiesel is high, and researchers are looking for improved technologies that can cut down the price so that it can be seen as a viable alternative to diesel fuel.

Table 3. Recent studies on engine performance, emission and combustion characteristics of highly researched feedstocks.

Biodiesel Feedstock	Ref.	Fuel Blends Used	Test Conditions	Combustion Characteristics		Performance Characteristics		Emission Characteristics			
				Pressure	Heat Release Rate	BSFC	BTE	NO_X	HC	CO	Smoke/PM
Palm	[143]	B10	15 operating points in engine map from NEDC and ARTEMIS cycle	−1% to +3% (p_{max})	−5% to +7%	-	-	−6% to +4%	-	-	−50% to +70% (smoke)
	[144]	B10, B20	1000 rpm to 2400 rpm at full-load condition	-	-	+3.81% to +7.13%	−3.04% to −5.9%	+4.81% to +8.03%	−10.23% to −13.27%	−2.45% to −4.79%	−26.34% to −27.45% (smoke opacity)

Table 3. *Cont.*

Biodiesel Feedstock	Ref.	Fuel Blends Used	Test Conditions	Combustion Characteristics		Performance Characteristics		Emission Characteristics			
				Pressure	Heat Release Rate	BSFC	BTE	NO_X	HC	CO	Smoke/PM
Jatropha	[145]	B20, B40, B60, B80 and B100	At 75% of engine load and different speeds	−10% to −27% (BMEP)	−4% to −11%	-	−10% to −33%	+10% to +47%	-	+2% to +16%	−4% to −22% (smoke)
	[146]	B10, B20	1200 rpm to 2400 rpm at 100% load	-	-	+1.81% to +3.1%	-	+3% to +6%	−3.84% and −10.25%	−16% to −25%	-
Soybean	[147]	B20	varying load (0 to 12 kg) at 1500 rpm	-	-	↑	↓	-	-	-	-
	[148]	B20, B40, B100	varying loads in brake power (0, 1.1, 2.2, 3.3, and 4.4 kW) at 1500 rpm	-	-	+4.2% to +14.65%	−2.61% to −8.07%	+7.5% to +23.81%	−15% to −38.4%	−11.36% to −41.7%	−20.5% to −48.23% (smoke opacity)
Canola	[149]	B5, B10, B15 and B20	Varying load (4.8, 3.6, 2.4, and 1.2 bar BMEP) at 2200 rpm	-	↓ (with increase in biodiesel percentage)	Max +6.56% (for B20)	Min −4.2% (for B20)	Max +8.9% (for B20)	Max +30.3% (for B20)	Max −32% (for B20)	Max −53% (for B20)
	[150]	B20, B50, B100	At seven different speeds, 800 (idle speed) –1000–1200–1400–1600–1800–2000 rpm	↓ (p_{max})	-	↑	↓	-	-	-	-
Waste cooking oil	[151]	B10, B20, B30	Varying load at 1500 rpm	-	-	↑	↓	↑	↓	↓	↓ (smoke opacity)
	[152]	B100	Varying loads (0–100%) at 1500 rpm	↑(p_{max})	↑ (CHR)	↑	↓	↓	↓	↑	-

↑ = increased; ↓ = reduced; NEDC: New European Driving Cycle; ARTEMIS: Assessment and Reliability of Transport Emission Models and Inventory Systems cycle; p_{max}: maximum pressure; BMEP: Brake mean effective pressure; CHR: Cumulative heat release rate.

4.2. Addition of Additives to the Fuel

In recent times, chemical additives are used to improve the performance of automotive fuel. There are several types of fuel additives for diesel engine, such as cetane improvers, combustion improvers, oxygenates, ignition improver, antioxidants, etc.

4.2.1. Effect of Additives on Fuel Properties

The introduction of additives has a significant effect on fuel properties [153–155]. The effect of various additives on fuel properties is shown in Table 4. Çaynak et al. [156]

studied the effect of the addition of manganese additives on the properties of pomace oil methyl ester. The authors reported that 12 µmol/Ll reduces viscosity by approximately 20%, reduces the freezing point by 15 °C and flash point by 7 °C. The authors also reported that the addition of additive results in an increase in vapour pressure—which means the additive dosage increases fuel volatility. In another study effect of the addition of Mn and Ni-based additives were studied [157], where the authors reported that both the additives reduced flash point, pour point and viscosity. Guru et al. reported that an increase in Mg-based additive concentrations from 0 to 16 mmol/l reduced freezing point, viscosity, and flash point [158]. Kannan et al. [159] reported that the addition of $FeCl_3$ slightly reduced flash point and improved heating value and cetane number. Yasin et al. [160] reported that the addition of methanol reduces viscosity and density and increases cetane number. From Table 4, it can be seen that kinematic viscosity is reduced up to 49% by oxygenated additives [161], up to 25% by antioxidants [162], 18% by metal-based additives [157] and up to 10% by cetane improvers [163]. Significant reduction of density was achieved by using oxygenated additives, such as methanol (reduction up to 30%) [160]. From Table 4, it can be seen that antioxidants and metal-based additives slightly increased the heating value [8,164,165]. Oxidation stability is significantly increased by the use of antioxidants [162,166,167]. Flash point was reduced when oxygenated, and metal-based additives were used [157,158,160,168–172] and increased when antioxidants were used [8,166,167]. From Table 4, it can be seen that the cetane number of fuel is significantly increased when antioxidants, oxygenated, metal-based additives, and cetane improvers are used [158,160,162,163,165,173–175].

Table 4. Effect of additives on fuel properties.

Additives Type	Ref.	Additives Used		Characteristics Properties					
				Kinematic Viscosity	Density	Heating Value	Flash Point	Oxidation Stability	Cetane Number
Oxygenated	[161]	DEE	5, 8, 10, 15, 20, and 25%	↓49%	↓3.7%	↓8%			↑35%
	[160]	Methanol	5%	↓ slight	↓30%		↓61%		↑18%
	[168]	Ethanol	5%	↓9 to 10% avg	↓slight	↓up to 1.4%	↓13.5%		
		n-butanol							
		DEE							
	[169]	n-butanol	5%	↓12.5%	↓ up to 1.6%	↓1.4%	↓26%		
		DEE							
	[170]	DEE	10% and 15%		↓2.7%	↓~1%	↓12.8%		
	[176]	DEE	2, 4, 6, and 8%	↓26%	↓1%	↓2%	↓28%		↑4%
		Pentanol	10 and 20%						
		butanol							
Antioxidant	[167]	BHA	2000 ppm	↑ slight	↑ slight	↓ slight	↑ 1%	↑31% (BHA), ↑ up to 85% (BHT)	
		BHT							
	[162]	BHA	500, 750, and 1000 ppm	↓ up to 25%	↓0.7% avg			6.9 h (Base fuel), increased to 24.8, 11, 38.7, and 9.8 h, respectively	↑up to 24%
		BHT							
		TBHQ							
	[8]	DPPD	0.15%	↑2%	↑ slight	↑ slight	↑16%		
	[166]	BHA	2000 ppm	↑1%	↑1%	↓0.5%	↑1.3%	↑ 64 to 110%	
		BHT							
		TBHQ							
	[177]	TBHQ	300, 600, and 1000 mg/kg					IP increased up to 10.2 h (initial IP was 4.9 h)	
	[178]	BHA	500, 1000, and 2000 ppm	↑2%		↓1.8%	↑11%		
		BHT		↑3.8%					

Table 4. *Cont.*

Additives Type	Ref.	Additives Used		Characteristics Properties					
				Kinematic Viscosity	Density	Heating Value	Flash Point	Oxidation Stability	Cetane Number
Cetane Improver	[163]	EHN CHN MEE	0.3% (EHN, CHN) 3% (MEE)	↓3 to 10%					↑8 to 40%
Metal-based	[157]	Mn Ni	8 & 12 µmol/L	↓up to 18%			↓up to 10%		
	[158]	Mn	13.5, 27.1, 54.2, and 94.9 µmol/L	↓5%			↓5%		↑5%
	[179]	CeO_2	50, 100, 200, 500 ppm					↑ up to 38% (IP)	
	[171]	Mn Mg	8 and 16 µmol/L	↓ up to15%			↓ up to 15%		
	[164]	TiO_2	80 mg/L	↑ 6%	↑ slight	↑ slight	↑41.7%		
	[165]	CeO_2	20 ppm	↓2.8%	↓3%	↑5.8%			↑~1%
	[173]	Iron (ii, iii) Oxide nanoparticles	25 and 50 ppm		↑1%	↑1.5%	↑15%		↑5.5%
Mixed	[174]	Alumina, Ethanol and Iso-propanol	5%	↓9%	↓ slight	↓1%			↑24%

↑ = increased; ↓ = reduced; DI: Direct injection; IDI: Indirect injection; DTBP: Di-tert-butyl peroxide; DEE: Diethyl ether; BHA: Butylated hydroxyanisole; BHT: Butylated hydroxytoluene; TBHQ: tert-Butylhydroquinone; DPPD: N,N′-diphenyl-p-phenylenediamine; EHN: 2-ethylhexyl nitrate; CHN: Cyclohexyl nitrate; MEE: 2-methoxyethyl ether; ODA: Octylated/butylated diphenylamine; IP: Induction period.

4.2.2. Effect of Additives on Engine Performance and Emission

Oxygenates can be used to improve the combustion process by increasing the fuel's oxygen content [169,180]. Alcohols, ethers, and esters are common oxygenates. Many researchers have reported that the addition of ethanol significantly reduces emission [181–183]. n-butanol and diethyl ether also exhibit similar performance as oxygenated additive [184–186]. Biodiesel as well can be used as an oxygenated additive, and many studies have shown that the use of biodiesel reduces PM emission [128,187,188]. Oxygenated additives can also decrease ignition temperature [189,190]. However, there are some disadvantages of using oxygenated additives, such as high heat of vapourisation, low cetane number, high auto-ignition temperature, an increase of NO_X emission, and inadequate lubricating behaviours, etc. [191–194]. An et al. studied the effect of ethanol edition with waste cooking oil biodiesel and reported that, at light load, the addition of ethanol reduces peak cylinder pressure [195]. Chen et al. observed that the use of ethanol as fuel additives increases both the maximum heat release rate and peak cylinder pressure [196]. The authors implied that the increases were attributed to prolonged ignition delay and a faster rate of evaporation of ethanol in the premixed combustion phase.

One of the major problems of biodiesel is its oxidation stability. When biodiesel is stored for a long time, the oxidation stability reduces rapidly. Degradation by oxidation yields products that may compromise fuel properties, impair fuel quality and engine performance. In Europe, standardisation and fuel quality assurance are crucial factors for biodiesel market acceptance, and storage stability is one of the main quality criteria. Antioxidants can be added to avoid oxidation and prolong the shelf life of biodiesel [154,197,198]. Ryu reported that tert-butylhydroquinone (TBHQ) exhibited improved oxidation stability of biodiesel and a significant reduction in PM emission [199]. Tang et al. [200] reported that antioxidants enhanced oxidation stability. However, researchers have demonstrated that the use of antioxidants results in an increase in CO and HC emission [162,166,201,202].

Metal-based combustion catalysts are another type of fuel additives that can be used to modify the combustion process and achieve fuel savings. Kannan et al. studied the effect of metal-based additives ($FeCl_3$) on combustion characteristics [159]. The authors reported that the addition of additives increases maximum cylinder gas pressure, which was due to advanced injection timing and increased ignition pressure. Moreover, the addition of additives increased the maximum heat release rate, which is attributed to the higher accumulation of fuel and early injection. Valentine et al. [203] reported that by using a bimetallic catalyst, 5–7% fuel economy, and 10–25% PM emission reduction were achieved. May and Hirs [204] reported a 50% reduction in PM emission due to the use of bimetallic catalysts.

Cetane improvers can be used to improve the cetane number of diesel fuel. Cetane improvers ensure uniform and early injection and prevent premature combustion and excessive pressure increase in the combustion cycle. It also ensures smoother combustion and efficient burning of fuel. There are several types of cetane improvers that can be used, such as peroxides, nitrites, nitrates, nitroso-carbamates, thio-aldhydes, tetra-azoles, etc. Alkyl nitrates are the most commonly used, and 2-Ethylhexyl nitrate is being considered the most prominent cetane improving additive [205]. Altiparmak [206] reported that increasing cetane number results in a reduction of NO_X, SO_2 and CO emission. Tat [207] reported that the use of EHN improved cetane number by 24% and reduced ignition delay by 10%. Li et al. [163] reported a 3.87–12.9% reduction of NO_x and 11.76–38.24% reduction of smoke when cetane improvers were used due to reduction in temperature and hypoxia [208]. Vallinayagam et al. [209] reported that ignition promoting additives reduced the burning rate as well as the ignition delay.

The effect of various additives on engine performance and a diesel engine's emissions is shown in Table 5. From the table, it can be seen that most of the additives help reduce NOx emission significantly.

Table 5. Effect of various additives on engine performance and emission.

Additive Type	Additive Used		Engine Description	Fuel Consumption	Regulated Emission				Unregulated Emission (Smoke)	Ref.
					CO	HC	NO_X	PM		
Metal-based additives	Pt-Ce	4–8 ppm	5.9L, EGR equipped	↓5 to 7%				↓10 to 25%		[203]
	Mg-based	<500 ppm	Not Given		-	↓20%	-	↓70%	-	[210]
	CeO_2		Single cylinder, naturally aspirated, water-cooled, rated speed 1500 RPM			↓ 50%	↓ 23.5%		↓14.5%	[211]
		20 ppm	Single cylinder, 5.2 kW, naturally aspirated, 4 stroke, water-cooled, DI, constant speed	↓16.3%			↓25%			[165]
	Mn-based	8–16 µmol/L	Single cylinder, Swept Volume 395 cm^3, CR 18:1, Max Speed 3600 RPM	↓2 to 3%	↓6 to 11%	-	↑10%	-	↓29%	[171]
	Mg-based			↓1 to 2%	↓3 to 8%	-	-	-	↓17%	
	Ferrous Picrate	1:3200	Single cylinder, DI, CR 19.9:1, max power 3.5 kW	↓2%	-	-	-	-	↓6 to 26%	[212]
	TiO_2	80 mg/L	Single cylinder, naturally aspirated, DI and water-cooled, Rated power 3.8 kW	↓21%	↓25%	↓18%	↑32%			[164]
	Iron (ii, iii) Oxide nanoparticles	25, 50 ppm	Single cylinder, water-cooled, CR 17.5:1, Max power 5.2 kW	↓9%	↓48 to 52%	↓	↑		↓	[173]
Oxygenated Additives	ETBE	5–15%	Four cylinder, Euro 4, DI	↓ 1 to 2%	-	-	↑		-	[213]
	Diglyme									
	Ethanol	5%	Single cylinder, DI, CR 17.7:1, Max power 7.7 kW	-	↓14 to 42%	-	↓7.5 to 13%	-	-	[168]
	n-butanol									
	DEE									
	n-butanol	5–10%	Four cylinder, CR 21.1, Turbocharged, Rated power 65 kW	↓2 to 6%	↓11 to 30%	↑ 28.4 to 52%	↓8 to 12%	-	↓17 to 38%	[169]
	DEE									
	Ethanol	2.5, 5%	Single cylinder, air-cooled, Rated power 4.4 kW, CR 16.5:1	↓4 to 7%	↓13 to 17%		↓1 to 5%		↓6 to 15%	[214]
	DEE	5–25%	Single cylinder, DI, naturally aspirated, CR 18, rated power 3.7 kW	-	↓	↑	↓	-	↓	[161]
		8, 16, 24%	Ricardo/Cussons 'Hydra' single cylinder, DI, naturally aspirated, CR 19.8		↓	↑	↓	-	↓	[215]
		10, 15%	Single cylinder, DI		↓	↓	↓			[216]
		1–3%	Single cylinder, DI, CR 16.5:1		↓33%	↓38%	↓80%			[217]
		10, 15%	Single cylinder, 553 cc, CR 16:1, Rated Speed 1500 RPM						↓	[170]

Table 5. *Cont.*

Additive Type	Additive Used		Engine Description	Fuel Consumption	Regulated Emission				Unregulated Emission (Smoke)	Ref.
					CO	HC	NO_X	PM		
	Ethanol	5, 10%	Six cylinder, DI, Turbocharged, CR 18:1		↓	↑	↓ (slight)		↓	[218]
	n-butanol	8, 16%								
	butanol	10 and 20%	single cylinder, naturally aspirated, four-stroke, direct injection, 296cc	↑2 to 4%				↓		[219]
	pentanol			↑2 to 7%						
	methanol	10%	four cylinder 1.9 TDI CR 19.5	↑2 to 13%	↓7 to 22%	↑4 to 18%	↑2 to 8%	↓13 to 44.5% (soot)		[220]
Antioxidant	BHA	500–1000 ppm	DI, turbocharged, CR 19.8, Euro III standard	↓4 to 10%	↑20% (up to)	-	↓1 to 5%	-	-	[162]
	BHT									
	TBHQ									
	BHA	2000 ppm	Four cylinder, IDI, turbocharged, CR 21.1	↓marginal	-	-	↓2 to 5%	-	-	[201]
	BHT									
	TBHQ									
	DPPD	0.15% (m)	Four cylinder, 2.5 L, CR 21.1, max power 55 kW, radiator cooling	↓1 to 3%	↑	↑	↓16% (maximum)	-	-	[8]
	BHA	2000 ppm	Four cylinder, IDI, turbocharged, CR 21.1	↓marginal	-	↑10 to 22%	↓1 to 3%	-	-	[166]
	BHT									
	TBHQ									
	ODA	1%	Four cylinder, IDI, CR 21, max power 39 kW	-	↓	↓	↓22%	-	-	[221]
	p-phenylenediamin	0.025% (m)	Single cylinder, DI, CR 17.5	-	↑	↑	↓43%	-	-	[202]
	L-ascorbic acid	0.010, 0.020, 0.030 and 0.040% (m)	Single cylinder, CR 17.5:1	↑4%	↓48%	↓29.75	↓23%		↓28.6%	[222]
	BHA	500, 1000 and 2000 ppm	Single cylinder, 4-stroke, direct injection, air-cooled, rated power 4.4 kW, rated speed 1500 RPM	↓1.6%	↑15%	↑10%	↓11%		↑11.8%	[178]
	BHT			↓1%	116%	↑11%	↓9%		↑17.5%	
Cetane Improver	DTBP	0.5, 1, 1.5, 2, 2.5 & 3%	Single cylinder, rated speed 1500 RPM, rated power 7.5kW, CR 17.5:1	-	↓25%	-	↓3 to 5%	-	-	[223]
	EHN	0.3~3%	DI, Naturally aspirated, CR 19	-	-	-	↓4 to 13%	-	↓11 to 38% (Smoke)	[163]
	CHN									
	MEE									
	EHN	10%	Single cylinder, rated speed 1500 RPM, rated power 4.4kW, CR 17.5:1	↓	↓	↓	↓			[224]

↑ = increased; ↓ = reduced; DI: Direct injection; IDI: Indirect injection; TDI: Turbocharged direct injection; DTBP: Di-tert-butyl peroxide; DEE: Diethyl ether; BHA: Butylated hydroxyanisole; BHT: Butylated hydroxytoluene; TBHQ: tert-Butylhydroquinone; DPPD: N,N′-diphenyl-p-phenylenediamine; EHN: 2-ethylhexyl nitrate; CHN: Cyclohexyl nitrate; MEE: 2-methoxyethyl ether; ODA: Octylated/butylated diphenylamine; DTBP: Di-tert-butyl peroxide; CR: Compression ratio; ETBE: Di-tert-butyl peroxide.

5. Post-Combustion Treatment Considerations

There are numerous post-treatment processes available, such as exhaust after-treatment, Selective Catalytic Reduction (SCR), Diesel Particulate Filter, etc. Exhaust after-treatment involves a different process that treats the exhaust before it is released into the environment. A catalytic converter converts products of incomplete combustion (HC and CO) and NO_X into CO_2, H_2O, and N_2. Diesel Particulate Filter (DPF) removes PM from exhaust gas; Lu. Ku and Liao [225] reported that the introduction of DPF resulted in a reduction of PM weight by 92.5%.

Catalytic converters are used to convert harmful toxic pollutants present in the engine exhaust using redox reaction (oxidation or reduction) into less harmful pollutants. The most common catalytic converter used in the diesel engine is the diesel oxidation catalyst (DOC), which is used to promote of oxidation of pollutants such as HC, CO, and organic fraction of diesel particulates (SOF). Zhang et al. [226] reported a 21–38% and 8–16% reduction of HC and CO emissions, respectively, due to the introduction of DOC. The use of DOC can reduce the odour of diesel exhaust. PM consists of mainly three major fractions (solid particles, SOF, and sulphates). DOC oxidises the SOF of the PM, and thus some literature reported PM reduction due to the use of DOC [226–228]. Zhu et al. [227] reported that particulate mass concentration was reduced by 16–34%, and the particle number concentration was reduced by 15–38% when DOC was used. Similar results were reported by other researchers. Shah et al. [228] reported 20–65% PM reduction, whereas Zhang et al. [226] reported 10–28% particulate number reduction and 5–27% particulate mass reduction. Conversely, the use of DOC can increase sulphates by oxidising SO_2. This can result in increased total PM emission. Furthermore, diesel oxidation catalysts have negligible/no effect on the reduction of NO_X emission [226,229].

SCR is one of the proven technologies that can reduce NO_X emission by converting it to nitrogen by using an outside agent like ammonia. However, as ammonia is corrosive and toxic, urea is usually used. Loganathan and Chandrasekaran [230] reported that the use of SCR reduces NO_X, HC, CO, and CO_2 emission by 69–81%, 43–58%, 90–100%, and 80–84%, respectively. However, there are some disadvantages of using SCR, such as higher capital and operating costs, a large volume of catalyst requirement, strict monitoring of exhaust temperatures to avoid the formation of excessive NO_X emission.

DPF is an effective option to reduce PM. DPF uses a regeneration process to convert the entrapped elemental carbon portion of PM to CO_2 by letting it through elevated exhaust temperatures. DPF can be used alongside SCR to reduce both NO_X and PM emissions. Additionally, it can be used with a DOC to reduce SOF portions, which can ensure 90% total PM reduction. The disadvantages of DPF are its high cost and maintaining a threshold exhaust temperature to ensure regeneration.

6. Conclusions

The article's primary focus is the in-combustion fuel modification section, where a thorough analysis was provided—pre-and post-combustion modifications discussed with less emphasis. From the foregoing review of the literature, the following can be reported:

- Retardation of injection timing can reduce NO_X emissions, whereas advancement reduces EGT, BSFC, HC, and CO emissions, and smoke opacity. However, the advancement of injection timing results in an increase in NO_X emission. Contrary, some researchers reported an increase in PM emission and BSFC and reduced BTE when injection timing is advanced and an increase of NO_X emission when injection timing is retarded. Furthermore, some study reported that any change of injection timing, advanced or retarded, results in an increase of BSFC and reduction of BTE.
- Increasing the injection pressure improves BTE and reduces BSFC. However, some researchers had reported an increase of BSFC when the injection pressure was reduced or increased. An increase in injection pressure reduces CO, HC emission and particulate number concentration. Contrary, some researchers reported an increase in NO_X and CO emission with an increase in injection pressure.

- An increase in compression ratio reduces BSFC, EGT, CO emission, and smoke opacity and improves BTE; however, it increases NO_X and HC emission.
- LTC techniques and EGR can reduce NO_X and PM emission simultaneously; however, they generally increase HC and CO emission.
- Multiple or split injection strategies also reduce PM and NO_X emission but increases BSFC.
- Biodiesel can be used with diesel fuel, as it has better lubricity, higher flash point, emits less CO, HC, and PM emission. However, they reduce efficiency and increases fuel consumption and also emit higher NO_X compared to diesel fuel. Biodiesel lacks oxidation stability. If stored for a prolonged time, stability deteriorates rapidly. Furthermore, biodiesel production cost is still higher.
- The oxidation stability of biodiesel can be improved by using antioxidant but will result in an increase in CO and HC emission.
- Algal biodiesel can solve some of the problems of first-generation biodiesels, such as the food vs. fuel debate. There are a lot of researches going on which aims to find an economical production process.
- Metal-based additives improve fuel economy; reduce HC, CO, and smoke emission, on the other hand, increase NO_X emission.
- Oxygenated additives improve combustion by increasing oxygen contents. The use of additives increases the maximum heat release rate and in-cylinder pressure. In contrast, these additives have some disadvantages: the high heat of vapourisation, low cetane number, high auto-ignition temperature, an increase of NO_X emission, and inadequate lubricating behaviours.
- Cetane improvers reduce NO_X emission significantly; however, from the literature reviewed, there is a lack of studies, which focused on the effect of these additives on PM emission.
- DOC can reduce HC, CO emissions, and SOF. However, it has little/no effect on NO_X emission and sometimes can increase PM emission by producing more sulphates.

There are a robust debate and widespread demand for shifting away from combustion engines due to the harmful emissions. The use of hybrid and electric vehicles is getting popular day by day. Thus, it is imperative to continue research on combustion engines to improve their performance and limit their emission levels to a minimum. Shifting from petroleum fuels to bio-sustainable fuels is one of the options. Biodiesel is considered one of the popular alternatives. Biodiesel has some disadvantages, which can be eliminated by using additives. Thus, research on suitable additives should also be carried out. Algal biodiesel and biodiesel from waste products (such as waste cooking oil) can solve sustainability-related problems. However, extensive research should be carried out to find a way to reduce the production cost to make it economically feasible, minimise by-product generation and improve biodiesel yield. Further research on engine modification can pave the way for the construction of engine suitable for pure biodiesel utilisation.

Author Contributions: Conceptualisation, S.M.A.R.; methodology, S.M.A.R.; formal analysis, S.M.A.R. and M.F.M.A.Z.; investigation S.M.A.R. and I.M.R.F.; resources, M.F.M.A.Z., I.M.R.F., and H.C.O.; data curation, S.M.A.R.; writing—original draft preparation, S.M.A.R.; writing—review and editing, S.M.A.R. and I.M.R.F.; supervision, H.C.O. All authors have read and agreed to the published version of the manuscript.

Funding: No funding received.

Acknowledgments: The authors would also like to acknowledge the Research Development Fund of the School of Information, Systems and Modelling, Faculty of Engineering and Information Technology, University of Technology, Sydney, Australia.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

ARTEMIS	Assessment and Reliability of Transport Emission Models and Inventory Systems cycle
BHA	Butylated hydroxyanisole
BHT	Butylated hydroxytoluene
BMEP	Brake Mean Effective Pressure
BSFC	Brake Specific Fuel Consumption
BTE	Brake Thermal Efficiency
EHN	Cyclohexyl nitrate
CHR	Cumulative heat release rate
CI	Compression ignition
DEE	Diethyl Ether
DI	Direct Ignition
DOC	Diesel oxidation catalyst
DPF	Diesel Particulate Filter
DPPD	N,N′-diphenyl-p-phenylenediamine
DTBP	Di-tert-butyl peroxide
EGR	Exhaust gas recirculation
EGT	Exhaust Gas Temperature
EHN	2-ethylhexyl nitrate
FAME	Fatty acid methyl ester
HC	Hydrocarbon
HCCI	Homogenous charge compression ignition
IDI	Indirect injection
IP	Induction period
IPCC	Intergovernmental Panel on Climate Change
LTC	Low temperature combustion
MEE	2-methoxyethyl ether
NEDC	New European Driving Cycle
NO_X	Oxides of Nitrogen
ODA	Octylated/butylated diphenylamine
PAH	Polycyclic aromatic hydrocarbons
PCCI	Premixed charge compression ignition
PCI	Premixed compression ignition
PM	Particulate matter
RCCI	Reactivity controlled compression ignition
SCR	Selective Catalytic Reduction
SOF	Soluble Organic Fraction
TBHQ	tert-Butylhydroquinone
TDC	top dead centre
TDI	Turbocharged direct injection

References

1. Knecht, W. Diesel engine development in view of reduced emission standards. *Energy* **2008**, *33*, 264–271. [CrossRef]
2. IPCC. *The IPCC Special Report on Emissions Scenarios*; IPCC: Geneva, Switzerland, 2000.
3. Rahman, S.M.A.; Masjuki, H.H.; Kalam, M.A.; Abedin, M.J.; Sanjid, A.; Sajjad, H. Impact of idling on fuel consumption and exhaust emissions and available idle-reduction technologies for diesel vehicles—A review. *Energy Convers. Manag.* **2013**, *74*, 171–182. [CrossRef]
4. Faiz, A.; Sinha, K.; Walsh, M.; Varma, A. *Automotive Air Pollution: Issues and Options for Developing Countries*; The World Bank: Washington, DC, USA, 1990; Volume 492.
5. Rashedul, H.K.; Masjuki, H.H.; Kalam, M.A.; Ashraful, A.M.; Rahman, S.M.; Shahir, S.A. The effect of additives on properties, performance and emission of biodiesel fuelled compression ignition engine. *Energy Convers. Manag.* **2014**, *88*, 348–364. [CrossRef]
6. Department of the Environment and Heritage, A.G. Air Quality Factsheets. Available online: http://www.environment.gov.au/protection/publications/factsheet-carbon-monoxide-co (accessed on 15 March 2021).
7. Chou, C.H.; Lai, C.H.; Liou, S.H.; Loh, C.H. Carbon monoxide: An old poison with a new way of poisoning. *J. Formos. Med. Assoc.* **2012**, *111*, 452–455. [CrossRef] [PubMed]

8. Palash, S.M.; Kalam, M.A.; Masjuki, H.H.; Arbab, M.I.; Masum, B.M.; Sanjid, A. Impacts of NOx reducing antioxidant additive on performance and emissions of a multi-cylinder diesel engine fueled with Jatropha biodiesel blends. *Energy Convers. Manag.* **2014**, *77*, 577–585. [CrossRef]
9. Chow, J.C.; Watson, J.G. *Guideline on Speciated Particulate Monitoring*; Report Prepared for US Environmental Protection Agency, Research Triangle Park, NC; Desert Research Institute: Reno, NV, USA, 1998.
10. Zhang, Q.; Gangupomu, R.H.; Ramirez, D.; Zhu, Y. Measurement of ultrafine particles and other air pollutants emitted by cooking activities. *Int. J. Environ. Res. Public Health* **2010**, *7*, 1744–1759. [CrossRef]
11. Kim, K.H.; Jahan, S.A.; Kabir, E.; Brown, R.J.C. A review of airborne polycyclic aromatic hydrocarbons (PAHs) and their human health effects. *Environ. Int.* **2013**, *60*, 71–80. [CrossRef]
12. Unwin, J.; Cocker, J.; Scobbie, E.; Chambers, H. An assessment of occupational exposure to polycyclic aromatic hydrocarbons in the UK. *Ann. Occup. Hyg.* **2006**, *50*, 395–403.
13. Bach, P.B.; Kelley, M.J.; Tate, R.C.; McCrory, D.C. Screening for lung cancer: A review of the current literature. *Chest J.* **2003**, *123*, 72S–82S. [CrossRef]
14. Diggs, D.L.; Huderson, A.C.; Harris, K.L.; Myers, J.N.; Banks, L.D.; Rekhadevi, P.V.; Niaz, M.S.; Ramesh, A. Polycyclic aromatic hydrocarbons and digestive tract cancers: A perspective. *J. Environ. Sci. Health C* **2011**, *29*, 324–357. [CrossRef]
15. Brodsky, A.P.J.B.; Cohen, E.N. Adverse effects of nitrous oxide. *Med. Toxicol.* **1986**, *1*, 362–374. [CrossRef]
16. The World Health Organization (WHO). *Exposure to Benzene: A Major Public Health Concern*; WHO Document Production Services: Geneva, Switzerland, 2010.
17. Kang, S.K.; Rohlman, D.S.; Lee, M.Y.; Lee, H.S.; Chung, S.Y.; Anger, W.K. Neurobehavioral performance in workers exposed to toluene. *Environ. Toxicol. Pharmacol.* **2005**, *19*, 645–650. [CrossRef] [PubMed]
18. Agarwal, A.K.; Das, L. Biodiesel development and characterization for use as a fuel in compression ignition engines. *J. Eng. Gas. Turbines Power* **2001**, *123*, 440–447. [CrossRef]
19. Murugesan, A.; Umarani, C.; Subramanian, R.; Nedunchezhian, N. Bio-diesel as an alternative fuel for diesel engines—A review. *Renew. Sustain. Energy Rev.* **2009**, *13*, 653–662. [CrossRef]
20. Lindqvist, K. Airclim Factshee. Available online: https://www.airclim.org/sites/default/files/documents/Factsheet-emission-standards.pdf (accessed on 15 March 2021).
21. DieselNet. Emission Standards Australia: On-Road Vehicles and Engines. Available online: https://www.dieselnet.com/standards/au/ (accessed on 15 March 2021).
22. Kim, M.-H.; Chung, W.-I.; Chyun, I.-B. *Three-Dimensional Flow Characteristics and Engine Performance for the Geometry Modification of Intake Manifold in Multi-Cylinder Diesel Engine*; SAE Technical Paper 2000-05-0020; Seoul 2000 FISITA World Automotive Congress, Seoul, Korea; SAE International: Warrendale, PA, USA, 2000.
23. Barroso, P.M.; Dominguez, J.; Pita, M., Sr.; Ribas, X. *Performance and Emissions of a HD Diesel Engine Converted for Alternative Fuel Use*; SAE Technical Paper 2014-01-2685; SAE International: Warrendale, PA, USA, 2014. [CrossRef]
24. Montajir, R.M.; Tsunemoto, H.; Ishitani, H.; Minami, T. *Fuel Spray Behavior in a Small DI Diesel Engine: Effect of Combustion Chamber Geometry*; SAE Technical Paper 2000-01-0946; SAE International: Warrendale, PA, USA, 2000. [CrossRef]
25. Payri, F.; Desantes, J.M.; Benajes, J. Compression Ignition Engines: State-of-the-Art and Current Technologies. Future Trends and Developments. In *Handbook of Clean Energy Systems*; John Wiley & Sons: Hoboken, NJ, USA, 2015; pp. 1–35. [CrossRef]
26. Gulzar, M.; Masjuki, H.H.; Kalam, M.A.; Varman, M.; Fattah, I.M. Oil filter modification for biodiesel–fueled engine: A pathway to lubricant sustainability and exhaust emissions reduction. *Energy Convers. Manag.* **2015**, *91*, 168–175. [CrossRef]
27. Park, S.H.; Youn, I.M.; Lee, C.S. Influence of ethanol blends on the combustion performance and exhaust emission characteristics of a four-cylinder diesel engine at various engine loads and injection timings. *Fuel* **2011**, *90*, 748–755. [CrossRef]
28. Sayin, C.; Uslu, K.; Canakci, M. Influence of injection timing on the exhaust emissions of a dual-fuel CI engine. *Renew. Energy* **2008**, *33*, 1314–1323. [CrossRef]
29. Muralidharan, K.; Govindarajan, P. Influence of Injection Timing on the Performance and Emission Characteristics of DI Diesel Engine using Pongamia Pinnata Methyl Ester. *Eur. J. Sci. Res.* **2011**, *59*, 417–431.
30. Ganapathy, T.; Gakkhar, R.P.; Murugesan, K. Influence of injection timing on performance, combustion and emission characteristics of Jatropha biodiesel engine. *Appl. Energy* **2011**, *88*, 4376–4386. [CrossRef]
31. Kumar, S.; Srinivas, P.; Shrinivasa, R. Influence of injection timings on performance and emissions of a biodiesel engine operated on blends of Honge methyl ester and prediction using artificial neural network. *J. Mech. Eng. Res.* **2013**, *5*, 5–20. [CrossRef]
32. Zeng, K.; Huang, Z.; Liu, B.; Liu, L.; Jiang, D.; Ren, Y.; Wang, J. Combustion characteristics of a direct-injection natural gas engine under various fuel injection timings. *Appl.Therm. Eng.* **2006**, *26*, 806–813. [CrossRef]
33. Nwafor, O.M.I. Effect of advanced injection timing on emission characteristics of a diesel engine running on biofuel. *Int. J. Ambient Energy* **2004**, *25*, 115–122. [CrossRef]
34. Zhu, R.; Miao, H.; Wang, X.; Huang, Z. Effects of fuel constituents and injection timing on combustion and emission characteristics of a compression-ignition engine fueled with diesel-DMM blends. *Proc. Combust. Inst.* **2013**, *34*, 3013–3020. [CrossRef]
35. Sayin, C.; Ilhan, M.; Canakci, M.; Gumus, M. Effect of injection timing on the exhaust emissions of a diesel engine using diesel–methanol blends. *Renew. Energy* **2009**, *34*, 1261–1269. [CrossRef]
36. Sayin, C.; Ertunc, H.M.; Hosoz, M.; Kilicaslan, I.; Canakci, M. Performance and exhaust emissions of a gasoline engine using artificial neural network. *Appl. Therm. Eng.* **2007**, *27*, 46–54. [CrossRef]

37. Alla, G.; Soliman, H.; Badr, O.; Rabbo, M. Effect of injection timing on the performance of a dual fuel engine. *Energy Convers. Manag.* **2002**, *43*, 269–277. [CrossRef]
38. Pulkrabek, W.W. *Engineering Fundamentals of the Internal Combustion Engine*, 2nd ed.; Pearson Prentice Hall: Upper Saddle River, NJ, USA, 2004; Volume 2.
39. Robert Bosch GmbH. *Bosch Automotive Handbook*, 10th ed.; Wiley: Chichester, UK, 2018.
40. Bari, S.; Yu, C.W.; Lim, T.H. Effect of fuel injection timing with waste cooking oil as a fuel in a direct injection diesel engine. *Proc. Inst. Mech. Eng. Part. D J. Automob. Eng.* **2004**, *218*, 93–104. [CrossRef]
41. Raheman, H.; Ghadge, S.V. Performance of diesel engine with biodiesel at varying compression ratio and ignition timing. *Fuel* **2008**, *87*, 2659–2666. [CrossRef]
42. Hariram, V.; Mohan Kumar., G. The Effect of Injection Timing on Combustion, Performance and Emission Parameters with AOME Blends as a Fuel for Compression Ignition Engine. *Eur. J. Sci. Res.* **2012**, *79*, 653–665.
43. Aldhaidhawi, M.; Chiriac, R.; Badescu, V. Ignition delay, combustion and emission characteristics of Diesel engine fueled with rapeseed biodiesel—A literature review. *Renew. Sustain. Energy Rev.* **2017**, *73*, 178–186. [CrossRef]
44. Canakci, M.; Sayin, C.; Ozsezen, A.N.; Turkcan, A. Effect of injection pressure on the combustion, performance, and emission characteristics of a diesel engine fueled with methanol-blended diesel fuel. *Energy Fuels* **2009**, *23*, 2908–2920. [CrossRef]
45. Agarwal, A.K.; Srivastava, D.K.; Dhar, A.; Maurya, R.K.; Shukla, P.C.; Singh, A.P. Effect of fuel injection timing and pressure on combustion, emissions and performance characteristics of a single cylinder diesel engine. *Fuel* **2013**, *111*, 374–383. [CrossRef]
46. Jaichandar, S.; Annamalai, K. Combined impact of injection pressure and combustion chamber geometry on the performance of a biodiesel fueled diesel engine. *Energy* **2013**, *55*, 330–339. [CrossRef]
47. Sayin, C.; Gumus, M.; Canakci, M. Effect of fuel injection pressure on the injection, combustion and performance characteristics of a DI diesel engine fueled with canola oil methyl esters-diesel fuel blends. *Biomass Bioenergy* **2012**, *46*, 435–446. [CrossRef]
48. Kumar, M.D.; Ramudu, M.V.; Reddy, K.V.K. Effect of Injection Pressure on the Performance and Emission Charactaristics of DI Diesel Engine Running on Nelli Oil and Diesel Fuel Blend. *Int. J. Mech. Eng. Robot. Res.* **2014**, *3*, 130–137.
49. Jindal, S.; Nandwana, B.P.; Rathore, N.S.; Vashistha, V. Experimental investigation of the effect of compression ratio and injection pressure in a direct injection diesel engine running on Jatropha methyl ester. *Appl. Eng.* **2010**, *30*, 442–448. [CrossRef]
50. Reddy, C.; Reddy, C.; Reddy, K. Effect of fuel injection pressures on the performance and emission characteristics of D.I. Diesel engine with biodiesel blends cotton seed oil methyl ester. *Int. J. Res. Rev. Appl. Sci.* **2012**, *13*, 139–149.
51. Purushothaman, K.; Nagarajan, G. Effect of injection pressure on heat release rate and emissions in CI engine using orange skin powder diesel solution. *Energy Convers. Manag.* **2009**, *50*, 962–969. [CrossRef]
52. Belagur, K.V.; Chitimini, R.V. Effect of injector opening pressures on the performance, emission and combustion characteristics of DI diesel engine running on honne oil and diesel fuel blend. *Therm. Sci.* **2010**, *14*, 1051–1061. [CrossRef]
53. Imtenan, S.; Ashrafur Rahman, S.M.; Masjuki, H.H.; Varman, M.; Kalam, M.A. Effect of dynamic injection pressure on performance, emission and combustion characteristics of a compression ignition engine. *Renew. Sustain. Energy Rev.* **2015**, *52*, 1205–1211. [CrossRef]
54. Gumus, M.; Sayin, C.; Canakci, M. The impact of fuel injection pressure on the exhaust emissions of a direct injection diesel engine fueled with biodiesel–diesel fuel blends. *Fuel* **2012**, *95*, 486–494. [CrossRef]
55. Ajav, E.; Singh, B.; Bhattacharya, T. Experimental study of some performance parameters of a constant speed stationary diesel engine using ethanol–diesel blends as fuel. *Biomass Bioenergy* **1999**, *17*, 357–365. [CrossRef]
56. Hwang, J.; Qi, D.; Jung, Y.; Bae, C. Effect of injection parameters on the combustion and emission characteristics in a common-rail direct injection diesel engine fueled with waste cooking oil biodiesel. *Renew. Energy* **2014**, *63*, 9–17. [CrossRef]
57. Ryu, K. Effects of pilot injection pressure on the combustion and emissions characteristics in a diesel engine using biodiesel–CNG dual fuel. *Energy Convers. Manag.* **2013**, *76*, 506–516. [CrossRef]
58. Mohan, B.; Yang, W.; Raman, V.; Sivasankaralingam, V.; Chou, S.K. Optimization of biodiesel fueled engine to meet emission standards through varying nozzle opening pressure and static injection timing. *Appl. Energy* **2014**, *130*, 450–457. [CrossRef]
59. Kannan, K.; Udayakumar, M. Experimental study of the effect of fuel injection pressure on diesel engine performance and emission. *Arpn. J. Eng. Appl. Sci.* **2010**, *5*, 42–45.
60. Can, Ö.; Çelikten, I.; Usta, N. Effects of ethanol addition on performance and emissions of a turbocharged indirect injection Diesel engine running at different injection pressures. *Energy Convers. Manag.* **2004**, *45*, 2429–2440. [CrossRef]
61. Pandian, M.; Sivapirakasam, S.P.; Udayakumar, M. Investigation on the effect of injection system parameters on performance and emission characteristics of a twin cylinder compression ignition direct injection engine fuelled with pongamia biodiesel–diesel blend using response surface methodology. *Appl. Energy* **2011**, *88*, 2663–2676. [CrossRef]
62. Muralidharan, K.; Vasudevan, D. Performance, emission and combustion characteristics of a variable compression ratio engine using methyl esters of waste cooking oil and diesel blends. *Appl. Energy* **2011**, *88*, 3959–3968. [CrossRef]
63. Sayin, C.; Gumus, M. Impact of compression ratio and injection parameters on the performance and emissions of a DI diesel engine fueled with biodiesel-blended diesel fuel. *Appl. Therm. Eng.* **2011**, *31*, 3182–3188. [CrossRef]
64. Tung, S.C.; McMillan, M.L. Automotive tribology overview of current advances and challenges for the future. *Tribol. Int.* **2004**, *37*, 517–536. [CrossRef]
65. Pearce, J.M.; Hanlon, J.T. Energy conservation from systematic tire pressure regulation. *Energy Policy* **2007**, *35*, 2673–2677. [CrossRef]

66. National Research Council. *Assessment of Fuel Economy Technologies for Light-Duty Vehicles*; The National Academies Press: Washington, DC, USA, 2011. [CrossRef]
67. Vedharaj, S.; Vallinayagam, R.; Yang, W.M.; Saravanan, C.G.; Lee, P.S. Optimization of combustion bowl geometry for the operation of kapok biodiesel–Diesel blends in a stationary diesel engine. *Fuel* **2015**, *139*, 561–567. [CrossRef]
68. Jaichandar, S.; Kumar, P.; Annamalai, K. Combined effect of injection timing and combustion chamber geometry on the performance of a biodiesel fueled diesel engine. *Energy* **2012**, *47*, 388–394. [CrossRef]
69. Jaichandar, S.; Annamalai, K. Influences of re-entrant combustion chamber geometry on the performance of Pongamia biodiesel in a DI diesel engine. *Energy* **2012**, *44*, 633–640. [CrossRef]
70. Zheng, M.; Reader, G.T.; Hawley, J.G. Diesel engine exhaust gas recirculation—-a review on advanced and novel concepts. *Energy Convers. Manag.* **2004**, *45*, 883–900. [CrossRef]
71. Maiboom, A.; Tauzia, X.; Hétet, J.-F. Experimental study of various effects of exhaust gas recirculation (EGR) on combustion and emissions of an automotive direct injection diesel engine. *Energy* **2008**, *33*, 22–34. [CrossRef]
72. Millo, F.; Giacominetto, P.F.; Bernardi, M.G. Analysis of different exhaust gas recirculation architectures for passenger car Diesel engines. *Appl. Energy* **2012**, *98*, 79–91. [CrossRef]
73. Asad, U.; Zheng, M. Exhaust gas recirculation for advanced diesel combustion cycles. *Appl. Energy* **2014**, *123*, 242–252. [CrossRef]
74. Agarwal, D.; Singh, S.K.; Agarwal, A.K. Effect of Exhaust Gas Recirculation (EGR) on performance, emissions, deposits and durability of a constant speed compression ignition engine. *Appl. Energy* **2011**, *88*, 2900–2907. [CrossRef]
75. Abd-Alla, G. Using exhaust gas recirculation in internal combustion engines: A review. *Energy Convers. Manag.* **2002**, *43*, 1027–1042. [CrossRef]
76. Ogawa, H.; Li, T.; Miyamoto, N. Characteristics of low temperature and low oxygen diesel combustion with ultra-high exhaust gas recirculation. *Int. J. Engine Res.* **2007**, *8*, 365–378. [CrossRef]
77. Chadwell, C.J.; Dingle, P.J. *Effect of Diesel and Water Co-Injection with Real-Time Control on Diesel Engine Performance and Emissions*; SAE Technical Paper 2008-01-1190; SAE International: Warrendale, PA, USA, 2008. [CrossRef]
78. Gomaa, M.; Alimin, A.; Kamarudin, K. The effect of EGR rates on NOx and smoke emissions of an IDI diesel engine fuelled with Jatropha biodiesel blends. *Int. J. Energy Environ.* **2011**, *2*, 477–490.
79. Pidol, L.; Lecointe, B.; Starck, L.; Jeuland, N. Ethanol–biodiesel–diesel fuel blends: Performances and emissions in conventional diesel and advanced low temperature combustions. *Fuel* **2012**, *93*, 329–338. [CrossRef]
80. Shahir, V.K.; Jawahar, C.P.; Suresh, P.R. Comparative study of diesel and biodiesel on CI engine with emphasis to emissions—A review. *Renew. Sustain. Energy Rev.* **2015**, *45*, 686–697. [CrossRef]
81. Hoekman, S.K.; Robbins, C. Review of the effects of biodiesel on NOx emissions. *Fuel Process. Technol.* **2012**, *96*, 237–249. [CrossRef]
82. Bose, P.K.; Maji, D. An experimental investigation on engine performance and emissions of a single cylinder diesel engine using hydrogen as inducted fuel and diesel as injected fuel with exhaust gas recirculation. *Int. J. Hydrog. Energy* **2009**, *34*, 4847–4854. [CrossRef]
83. Fathi, M.; Saray, R.K.; Checkel, M.D. The influence of Exhaust Gas Recirculation (EGR) on combustion and emissions of n-heptane/natural gas fueled Homogeneous Charge Compression Ignition (HCCI) engines. *Appl. Energy* **2011**, *88*, 4719–4724. [CrossRef]
84. Montgomery, D.; Reitz, R.D. *Six-Mode Cycle Evaluation of the Effect of EGR and Multiple Injections on Particulate and NOx Emissions from a D.I. Diesel Engine*; SAE Technical Paper 960316; SAE International: Warrendale, PA, USA, 1996. [CrossRef]
85. Herfatmanesh, M.R.; Lu, P.; Attar, M.A.; Zhao, H. Experimental investigation into the effects of two-stage injection on fuel injection quantity, combustion and emissions in a high-speed optical common rail diesel engine. *Fuel* **2013**, *109*, 137–147. [CrossRef]
86. Dürnholz, M.; Endres, H.; Frisse, P. *Preinjection A Measure to Optimize the Emission Behavior of DI-Diesel Engine*; SAE Technical Paper 940674; SAE International: Warrendale, PA, USA, 1994. [CrossRef]
87. Pierpont, D.; Montgomery, D.; Reitz, R.D. *Reducing Particulate and NOx Using Multiple Injections and EGR in a DI Diesel*; SAE Technical Paper 950217; SAE International: Warrendale, PA, USA, 1995. [CrossRef]
88. Chen, S.K. *Simultaneous Reduction of NOx and Particulate Emissions by Using Multiple Injections in a Small Diesel Engine*; SAE Technical Paper 2000-01-3084; SAE International: Warrendale, PA, USA, 2000. [CrossRef]
89. Choi, C.Y.; Reitz, R.D. An experimental study on the effects of oxygenated fuel blends and multiple injection strategies on DI diesel engine emissions. *Fuel* **1999**, *78*, 1303–1317. [CrossRef]
90. Fang, T.; Chia-fon, F.L. Bio-diesel effects on combustion processes in an HSDI diesel engine using advanced injection strategies. *Proc. Combust. Inst.* **2009**, *32*, 2785–2792. [CrossRef]
91. Shundoh, S.; Komori, M.; Tsujimura, K.; Kobayashi, S. *NOx Reduction from Diesel Combustion Using Pilot Injection with High Pressure Fuel Injection*; SAE Technical Paper 920461; SAE International: Warrendale, PA, USA, 1992. [CrossRef]
92. Imtenan, S.; Varman, M.; Masjuki, H.H.; Kalam, M.A.; Sajjad, H.; Arbab, M.I.; Fattah, I.M. Impact of low temperature combustion attaining strategies on diesel engine emissions for diesel and biodiesels: A review. *Energy Convers. Manag.* **2014**, *80*, 329–356. [CrossRef]
93. Shimazaki, N.; Tsurushima, T.; Nishimura, T. *Dual Mode Combustion Concept With Premixed Diesel Combustion by Direct Injection Near Top Dead Center*; SAE Technical Paper 2003-01-0742; SAE International: Warrendale, PA, USA, 2003. [CrossRef]

94. Okude, K.; Mori, K.; Shiino, S.; Moriya, T. *Premixed Compression Ignition (PCI) Combustion for Simultaneous Reduction of NOx and Soot in Diesel Engine*; SAE Technical Paper 2004-01-1907; SAE International: Warrendale, PA, USA, 2004. [CrossRef]
95. Musculus, M.P.; Singh, S.; Reitz, R.D. Gradient effects on two-color soot optical pyrometry in a heavy-duty DI diesel engine. *Combust. Flame* **2008**, *153*, 216–227. [CrossRef]
96. Srinivasan, K.; Krishnan, S.; Qi, Y.; MIDKIFF∗, K.; Yang, H. Analysis of diesel pilot-ignited natural gas low-temperature combustion with hot exhaust gas recirculation. *Combust. Sci. Technol.* **2007**, *179*, 1737–1776. [CrossRef]
97. Kook, S.; Bae, C.; Miles, P.C.; Choi, D.; Pickett, L.M. *The Influence of Charge Dilution and Injection Timing on Low-Temperature Diesel Combustion and Emissions*; SAE Technical Paper 2005-01-3837; SAE International: Warrendale, PA, USA, 2005. [CrossRef]
98. Alriksson, M.; Denbratt, I. *Low Temperature Combustion in a Heavy Duty Diesel Engine Using High Levels of EGR*; SAE Technical Paper 2006-01-0075; SAE International: Warrendale, PA, USA, 2006. [CrossRef]
99. Noehre, C.; Andersson, M.; Johansson, B.; Hultqvist, A. Characterization of Partially Premixed Combustion. In Proceedings of the Powertrain & Fluid SAystems Conference and Exhibitechioni, Toronto, ON, Calnada, 16–19 October 2006.
100. Keene, P.; Browne, B. Effective Preservation Strategies for Ultra Low Sulfur Diesel, Biodiesel and Unleaded Gasoline. In Proceedings of the Eighth International Fuels Colloquium, Technische Akademie Esslingen, Ostfildern, Germany, 19–20 January 2011.
101. Mahlia, T.M.I.; Syazmi, Z.; Mofijur, M.; Abas, A.E.P.; Bilad, M.R.; Ong, H.C.; Silitonga, A.S. Patent landscape review on biodiesel production: Technology updates. *Renew. Sustain. Energy Rev.* **2020**, *118*. [CrossRef]
102. Huang, G.; Chen, F.; Wei, D.; Zhang, X.; Chen, G. Biodiesel production by microalgal biotechnology. *Appl. Energy* **2010**, *87*, 38–46. [CrossRef]
103. Habibullah, M.; Rizwanul Fattah, I.M.; Masjuki, H.H.; Kalam, M.A. Effects of Palm–Coconut Biodiesel Blends on the Performance and Emission of a Single-Cylinder Diesel Engine. *Energy Fuels* **2015**, *29*, 734–743. [CrossRef]
104. Lin, L.; Cunshan, Z.; Vittayapadung, S.; Xiangqian, S.; Mingdong, D. Opportunities and challenges for biodiesel fuel. *Appl. Energy* **2011**, *88*, 1020–1031. [CrossRef]
105. Fattah, I.M.R.; Ong, H.C.; Mahlia, T.M.I.; Mofijur, M.; Silitonga, A.S.; Rahman, S.M.A.; Ahmad, A. State of the Art of Catalysts for Biodiesel Production. *Front. Energy Res.* **2020**, *8*. [CrossRef]
106. Ong, H.C.; Tiong, Y.W.; Goh, B.H.H.; Gan, Y.Y.; Mofijur, M.; Fattah, I.M.R.; Chong, C.T.; Alam, M.A.; Lee, H.V.; Silitonga, A.S.; et al. Recent advances in biodiesel production from agricultural products and microalgae using ionic liquids: Opportunities and challenges. *Energy Convers. Manag.* **2021**, *228*. [CrossRef]
107. Lee, H.V.; Taufiq-Yap, Y.H.; Hussein, M.Z.; Yunus, R. Transesterification of jatropha oil with methanol over Mg–Zn mixed metal oxide catalysts. *Energy* **2013**, *49*, 12–18. [CrossRef]
108. Kafuku, G.; Mbarawa, M. Biodiesel production from Croton megalocarpus oil and its process optimization. *Fuel* **2010**, *89*, 2556–2560. [CrossRef]
109. Demirbas, A. Importance of biodiesel as transportation fuel. *Energy Policy* **2007**, *35*, 4661–4670. [CrossRef]
110. Fattah, I.M.R.; Masjuki, H.H.; Liaquat, A.M.; Ramli, R.; Kalam, M.A.; Riazuddin, V.N. Impact of various biodiesel fuels obtained from edible and non-edible oils on engine exhaust gas and noise emissions. *Renew. Sustain. Energy Rev.* **2013**, *18*, 552–567. [CrossRef]
111. Jain, S.; Sharma, M.P. Oxidation stability of blends of Jatropha biodiesel with diesel. *Fuel* **2011**, *90*, 3014–3020. [CrossRef]
112. Balat, M.; Balat, H. Progress in biodiesel processing. *Appl. Energy* **2010**, *87*, 1815–1835. [CrossRef]
113. Atadashi, I.; Aroua, M.; Aziz, A.A. High quality biodiesel and its diesel engine application: A review. *Renew. Sustain. Energy Rev.* **2010**, *14*, 1999–2008. [CrossRef]
114. Jena, P.C.; Raheman, H.; Kumar, G.; Machavaram, R. Biodiesel production from mixture of mahua and simarouba oils with high free fatty acids. *Biomass Bioenergy* **2010**, *34*, 1108–1116. [CrossRef]
115. Devan, P.; Mahalakshmi, N. Study of the performance, emission and combustion characteristics of a diesel engine using poon oil-based fuels. *Fuel Process. Technol.* **2009**, *90*, 513–519. [CrossRef]
116. Ulusoy, Y.; Tekìn, Y.; Çetinkaya, M.; Karaosmanoglu, F. The engine tests of biodiesel from used frying oil. *Energy Sources* **2004**, *26*, 927–932. [CrossRef]
117. Porte, A.F.; Schneider, R.d.C.d.S.; Kaercher, J.A.; Klamt, R.A.; Schmatz, W.L.; Da Silva, W.L.T.; Filho, W.A.S. Sunflower biodiesel production and application in family farms in Brazil. *Fuel* **2010**, *89*, 3718–3724. [CrossRef]
118. Bozbas, K. Biodiesel as an alternative motor fuel: Production and policies in the European Union. *Renew. Sustain. Energy Rev.* **2008**, *12*, 542–552. [CrossRef]
119. Moser, B.R.; Vaughn, S.F. Evaluation of alkyl esters from Camelina sativa oil as biodiesel and as blend components in ultra low-sulfur diesel fuel. *Bioresour. Technol.* **2010**, *101*, 646–653. [CrossRef]
120. Demirbas, A. Progress and recent trends in biodiesel fuels. *Energy Convers. Manag.* **2009**, *50*, 14–34. [CrossRef]
121. Shahid, E.M.; Jamal, Y. Production of biodiesel: A technical review. *Renew. Sustain. Energy Rev.* **2011**, *15*, 4732–4745. [CrossRef]
122. Gerpen, J.V. Biodiesel processing and production. *Fuel Process. Technol.* **2005**, *86*, 1097–1107. [CrossRef]
123. Ong, H.C.; Milano, J.; Silitonga, A.S.; Hassan, M.H.; Shamsuddin, A.H.; Wang, C.T.; Mahlia, T.M.I.; Siswantoro, J.; Kusumo, F.; Sutrisno, J. Biodiesel production from *Calophyllum inophyllum*-Ceiba pentandra oil mixture: Optimization and characterization. *J. Clean. Prod.* **2019**, *219*, 183–198. [CrossRef]
124. Li, S.; Wang, Y.; Dong, S.; Chen, Y.; Cao, F.; Chai, F.; Wang, X. Biodiesel production from Eruca Sativa Gars vegetable oil and motor, emissions properties. *Renew. Energy* **2009**, *34*, 1871–1876. [CrossRef]

125. Murugesan, A.; Umarani, C.; Chinnusamy, T.; Krishnan, M.; Subramanian, R.; Neduzchezhain, N. Production and analysis of bio-diesel from non-edible oils—A review. *Renew. Sustain. Energy Rev.* **2009**, *13*, 825–834. [CrossRef]
126. Jain, S.; Sharma, M. Biodiesel production from Jatropha curcas oil. *Renew. Sustain. Energy Rev.* **2010**, *14*, 3140–3147. [CrossRef]
127. Palash, S.M.; Kalam, M.A.; Masjuki, H.H.; Masum, B.M.; Fattah, I.M.; Mofijur, M. Impacts of biodiesel combustion on NOx emissions and their reduction approaches. *Renew. Sustain. Energy Rev.* **2013**, *23*, 473–490. [CrossRef]
128. Baiju, B.; Naik, M.; Das, L. A comparative evaluation of compression ignition engine characteristics using methyl and ethyl esters of Karanja oil. *Renew. Energy* **2009**, *34*, 1616–1621. [CrossRef]
129. Hasib, Z.M.; Hossain, J.; Biswas, S.; Islam, A. Bio-diesel from mustard oil: A renewable alternative fuel for small diesel engines. *Mod. Mech. Eng.* **2011**, *1*, 77–83. [CrossRef]
130. Arbab, M.I.; Masjuki, H.H.; Varman, M.; Kalam, M.A.; Imtenan, S.; Sajjad, H. Fuel properties, engine performance and emission characteristic of common biodiesels as a renewable and sustainable source of fuel. *Renew. Sustain. Energy Rev.* **2013**, *22*, 133–147. [CrossRef]
131. Anbumani, K.; Singh, A.P. Performance of mustard and neem oil blends with diesel fuel in CI engine. *ARPN J. Eng. Appl. Sci.* **2006**, *5*, 14–20.
132. Bannikov, M. Combustion and emission characteristics of Mustard biodiesel. In Proceedings of the 6th International Advanced Technologies Symposium (IATS'11), Elzag, Turkey, 16–18 May 2011; pp. 1–5.
133. Bannikov, M.; Vasilev, I. Combustion characteristics of the mustard methyl esters. *Key Eng. Mater.* **2012**, *510–511*, 406–412. [CrossRef]
134. Mohanty, C.; Jaiswal, A.; Meda, V.S.; Behera, P.; Murugan, S. *An Experimental Investigation on the Combustion, Performance and Emissions of a Diesel Engine Using Vegetable Oil-Diesel Fuel Blends*; SAE Technical Paper 2011-01-1187; SAE International: Warrendale, PA, USA, 2011. [CrossRef]
135. Ndayishimiye, P.; Tazerout, M. Use of palm oil-based biofuel in the internal combustion engines: Performance and emissions characteristics. *Energy* **2011**, *36*, 1790–1796. [CrossRef]
136. Yusaf, T.; Yousif, B.; Elawad, M. Crude palm oil fuel for diesel-engines: Experimental and ANN simulation approaches. *Energy* **2011**, *36*, 4871–4878. [CrossRef]
137. Sgroi, M.; Bollito, G.; Saracco, G.; Specchia, S. BIOFEAT: Biodiesel fuel processor for a vehicle fuel cell auxiliary power unit: Study of the feed system. *J. Power Sources* **2005**, *149*, 8–14. [CrossRef]
138. Tsuchiya, T.; Shiotani, H.; Goto, S.; Sugiyama, G.; Maeda, A. *Japanese Standards for Diesel Fuel Containing 5% FAME: Investigation of Acid Generation in FAME Blended Diesel Fuels and Its Impact on Corrosion*; SAE Technical Paper 2006-01-3303; SAE International: Warrendale, PA, USA, 2006. [CrossRef]
139. Jain, S.; Sharma, M. Stability of biodiesel and its blends: A review. *Renew. Sustain. Energy Rev.* **2010**, *14*, 667–678. [CrossRef]
140. Leung, D.Y.; Wu, X.; Leung, M. A review on biodiesel production using catalyzed transesterification. *Appl. Energy* **2010**, *87*, 1083–1095. [CrossRef]
141. Gui, M.M.; Lee, K.; Bhatia, S. Feasibility of edible oil vs. non-edible oil vs. waste edible oil as biodiesel feedstock. *Energy* **2008**, *33*, 1646–1653. [CrossRef]
142. Silitonga, A.; Shamsuddin, A.; Mahlia, T.; Milano, J.; Kusumo, F.; Siswantoro, J.; Dharma, S.; Sebayang, A.; Masjuki, H.; Ong, H.C. Biodiesel synthesis from Ceiba pentandra oil by microwave irradiation-assisted transesterification: ELM modeling and optimization. *Renew. Energy* **2020**, *146*, 1278–1291. [CrossRef]
143. Kousoulidou, M.; Fontaras, G.; Ntziachristos, L.; Samaras, Z. *Evaluation of Biodiesel Blends on the Performance and Emissions of a Common-Rail Light-Duty Engine and Vehicle*; SAE Technical Paper 2009-01-0692; SAE International: Warrendale, PA, USA, 2009. [CrossRef]
144. Monirul, I.M.; Masjuki, H.H.; Kalam, M.A.; Mosarof, M.H.; Zulkifli, N.W.M.; Teoh, Y.H.; How, H.G. Assessment of performance, emission and combustion characteristics of palm, jatropha and *Calophyllum inophyllum* biodiesel blends. *Fuel* **2016**, *181*, 985–995. [CrossRef]
145. Gad, M.S.; El-Shafay, A.S.; Abu Hashish, H.M. Assessment of diesel engine performance, emissions and combustion characteristics burning biodiesel blends from jatropha seeds. *Process. Saf. Environ. Prot.* **2021**, *147*, 518–526. [CrossRef]
146. Mofijur, M.; Masjuki, H.H.; Kalam, M.A.; Atabani, A.E. Evaluation of biodiesel blending, engine performance and emissions characteristics of Jatropha curcas methyl ester: Malaysian perspective. *Energy* **2013**, *55*, 879–887. [CrossRef]
147. Madiwale, S.; Karthikeyan, A.; Bhojwani, V. Properties investigation and performance analysis of a diesel engine fuelled with Jatropha, Soybean, Palm and Cottonseed biodiesel using Ethanol as an additive. *Mater. Today: Proc.* **2018**, *5*, 657–664. [CrossRef]
148. Al_Dawody, M.F.; Bhatti, S.K. Experimental and Computational Investigations for Combustion, Performance and Emission Parameters of a Diesel Engine Fueled with Soybean Biodiesel-Diesel Blends. *Energy Procedia* **2014**, *52*, 421–430. [CrossRef]
149. Can, Ö.; Öztürk, E.; Yücesu, H.S. Combustion and exhaust emissions of canola biodiesel blends in a single cylinder DI diesel engine. *Renew. Energy* **2017**, *109*, 73–82. [CrossRef]
150. Efe, Ş.; Ceviz, M.A.; Temur, H. Comparative engine characteristics of biodiesels from hazelnut, corn, soybean, canola and sunflower oils on DI diesel engine. *Renew. Energy* **2018**, *119*, 142–151. [CrossRef]
151. Abed, K.A.; El Morsi, A.K.; Sayed, M.M.; Shaib, A.A.E.; Gad, M.S. Effect of waste cooking-oil biodiesel on performance and exhaust emissions of a diesel engine. *Egypt. J. Pet.* **2018**, *27*, 985–989. [CrossRef]

152. Patel, C.; Chandra, K.; Hwang, J.; Agarwal, R.A.; Gupta, N.; Bae, C.; Gupta, T.; Agarwal, A.K. Comparative compression ignition engine performance, combustion, and emission characteristics, and trace metals in particulates from Waste cooking oil, Jatropha and Karanja oil derived biodiesels. *Fuel* **2019**, *236*, 1366–1376. [CrossRef]
153. Shahir, S.A.; Masjuki, H.H.; Kalam, M.A.; Imran, A.; Fattah, I.M.; Sanjid, A. Feasibility of diesel–biodiesel–ethanol/bioethanol blend as existing CI engine fuel: An assessment of properties, material compatibility, safety and combustion. *Renew. Sustain. Energy Rev.* **2014**, *32*, 379–395. [CrossRef]
154. Fattah, I.M.R.; Masjuki, H.; Kalam, M.; Hazrat, M.; Masum, B.; Imtenan, S.; Ashraful, A. Effect of antioxidants on oxidation stability of biodiesel derived from vegetable and animal based feedstocks. *Renew. Sustain. Energy Rev.* **2014**, *30*, 356–370. [CrossRef]
155. Imtenan, S.; Masjuki, H.H.; Varman, M.; Arbab, M.I.; Sajjad, H.; Fattah, I.M.; Abedin, M.J.; Hasib, A.S.M. Emission and Performance Improvement Analysis of Biodiesel-diesel Blends with Additives. *Procedia Eng.* **2014**, *90*, 472–477. [CrossRef]
156. Çaynak, S.; Gürü, M.; Biçer, A.; Keskin, A.; İçingür, Y. Biodiesel production from pomace oil and improvement of its properties with synthetic manganese additive. *Fuel* **2009**, *88*, 534–538. [CrossRef]
157. Keskin, A.; Gürü, M.; Altıparmak, D. Biodiesel production from tall oil with synthesized Mn and Ni based additives: Effects of the additives on fuel consumption and emissions. *Fuel* **2007**, *86*, 1139–1143. [CrossRef]
158. Gürü, M.; Karakaya, U.; Altıparmak, D.; Alıcılar, A. Improvement of diesel fuel properties by using additives. *Energy Convers. Manag.* **2002**, *43*, 1021–1025. [CrossRef]
159. Kannan, G.; Karvembu, R.; Anand, R. Effect of metal based additive on performance emission and combustion characteristics of diesel engine fuelled with biodiesel. *Appl. Energy* **2011**, *88*, 3694–3703. [CrossRef]
160. Yasin, M.M.; Yusaf, T.; Mamat, R.; Yusop, A.F. Characterization of a diesel engine operating with a small proportion of methanol as a fuel additive in biodiesel blend. *Appl. Energy* **2014**, *114*, 865–873. [CrossRef]
161. Patil, K.R.; Thipse, S.; Warke, A. *Effect of Oxygenate and Cetane Improver on Performance and Emissions of Diesel Engine Fuelled with Diethyl Ether-Diesel Blends*; SAE Technical Paper 2015-26-0057; SAE International: Warrendale, PA, USA, 2015. [CrossRef]
162. İİleri, E.; Koçar, G. Effects of antioxidant additives on engine performance and exhaust emissions of a diesel engine fueled with canola oil methyl ester–diesel blend. *Energy Convers. Manag.* **2013**, *76*, 145–154. [CrossRef]
163. Li, R.; Wang, Z.; Ni, P.; Zhao, Y.; Li, M.; Li, L. Effects of cetane number improvers on the performance of diesel engine fuelled with methanol/biodiesel blend. *Fuel* **2014**, *128*, 180–187. [CrossRef]
164. D'Silva, R.; Binu, K.G.; Bhat, T. Performance and Emission Characteristics of a C.I. Engine Fuelled with Diesel and TiO2 Nanoparticles as Fuel Additive. *Mater. Today: Proc.* **2015**, *2*, 3728–3735. [CrossRef]
165. Vairamuthua, G.; Kailasanathana, S.S.C.; Thangagiric, B. Investigation on the Effects of Nanocerium Oxide on the Performance of CalophyllumInophyllum (punnai) Biodiesel in a DI Diesel Engine. *J. Chem. Pharm. Sci.* **2015**. Available online: https://www.academia.edu/download/37983463/Journal_of_Chemical_and_Pharmaceutical_Sciences.pdf (accessed on 15 March 2021).
166. Fattah, I.M.R.; Masjuki, H.H.; Kalam, M.A.; Wakil, M.A.; Ashraful, A.M.; Shahir, S.A. Experimental investigation of performance and regulated emissions of a diesel engine with *Calophyllum inophyllum* biodiesel blends accompanied by oxidation inhibitors. *Energy Convers. Manag.* **2014**, *83*, 232–240. [CrossRef]
167. Fattah, I.M.R.; Masjuki, H.H.; Kalam, M.A.; Wakil, M.A.; Rashedul, H.K.; Abedin, M.J. Performance and emission characteristics of a CI engine fueled with Cocos nucifera and Jatropha curcas B20 blends accompanying antioxidants. *Ind. Crop. Prod.* **2014**, *57*, 132–140. [CrossRef]
168. Imtenan, S.; Masjuki, H.H.; Varman, M.; Kalam, M.A.; Arbab, M.I.; Sajjad, H.; Rahman, S.M. Impact of oxygenated additives to palm and jatropha biodiesel blends in the context of performance and emissions characteristics of a light-duty diesel engine. *Energy Convers. Manag.* **2014**, *83*, 149–158. [CrossRef]
169. Imtenan, S.; Masjuki, H.H.; Varman, M.; Fattah, I.M.; Sajjad, H.; Arbab, M.I. Effect of n-butanol and diethyl ether as oxygenated additives on combustion–emission-performance characteristics of a multiple cylinder diesel engine fuelled with diesel–jatropha biodiesel blend. *Energy Convers. Manag.* **2015**, *94*, 84–94. [CrossRef]
170. Jawre, S.S.; Lawankar, S.M. Experimental Analysis of Performance of Diesel Engine Using Kusum Methyl Ester With Diethyl Ether as Additive. *Int. J. Eng. Res. Appl.* **2014**, *4*, 106–111.
171. Keskin, A.; Gürü, M.; Altıparmak, D. Influence of metallic based fuel additives on performance and exhaust emissions of diesel engine. *Energy Convers. Manag.* **2011**, *52*, 60–65. [CrossRef]
172. Razzaq, L.; Mujtaba, M.A.; Soudagar, M.E.M.; Ahmed, W.; Fayaz, H.; Bashir, S.; Fattah, I.M.R.; Ong, H.C.; Shahapurkar, K.; Afzal, A.; et al. Engine performance and emission characteristics of palm biodiesel blends with graphene oxide nanoplatelets and dimethyl carbonate additives. *J. Environ. Manag.* **2021**, *282*, 111917. [CrossRef]
173. Aalam, C.S.; Saravanan, C.; Premanand, B. Influence of Iron (II, III) Oxide NanoparticlesFuel Additive on Exhaust Emissions andCombustion Characteristics of CRDI SystemAssisted Diesel Engine. *Int. J. Adv. Eng. Res. Sci. (Ijaers)* **2015**, *2*, 23–28.
174. Shaafi, T.; Velraj, R. Influence of alumina nanoparticles, ethanol and isopropanol blend as additive with diesel–soybean biodiesel blend fuel: Combustion, engine performance and emissions. *Renew. Energy* **2015**, *80*, 655–663. [CrossRef]
175. Fattah, I.M.R.; Masjuki, H.H.; Kalam, M.A.; Mofijur, M.; Abedin, M.J. Effect of antioxidant on the performance and emission characteristics of a diesel engine fueled with palm biodiesel blends. *Energy Convers. Manag.* **2014**, *79*, 265–272. [CrossRef]
176. Ali, O.M.; Mamat, R.; Masjuki, H.H.; Abdullah, A.A. Analysis of blended fuel properties and cycle-to-cycle variation in a diesel engine with a diethyl ether additive. *Energy Convers. Manag.* **2016**, *108*, 511–519. [CrossRef]

177. Fernandes, D.M.; Serqueira, D.S.; Portela, F.M.; Assunção, R.M.; Munoz, R.A.; Terrones, M.G. Preparation and characterization of methylic and ethylic biodiesel from cottonseed oil and effect of tert-butylhydroquinone on its oxidative stability. *Fuel* **2012**, *97*, 658–661. [CrossRef]
178. Sathiyamoorthi, R.; Sankaranarayanan, G. Effect of antioxidant additives on the performance and emission characteristics of a DICI engine using neat lemongrass oil–diesel blend. *Fuel* **2016**, *174*, 89–96. [CrossRef]
179. Hajjari, M.; Ardjmand, M.; Tabatabaei, M. Experimental investigation of the effect of cerium oxide nanoparticles as a combustion-improving additive on biodiesel oxidative stability: Mechanism. *Rsc Adv.* **2014**, *4*, 14352–14356. [CrossRef]
180. Fattah, I.M.R.; Hassan, M.H.; Kalam, M.A.; Atabani, A.E.; Abedin, M.J. Synthetic phenolic antioxidants to biodiesel: Path toward NOx reduction of an unmodified indirect injection diesel engine. *J. Clean. Prod.* **2014**, *79*, 82–90. [CrossRef]
181. Kwanchareon, P.; Luengnaruemitchai, A.; Jai-In, S. Solubility of a diesel–biodiesel–ethanol blend, its fuel properties, and its emission characteristics from diesel engine. *Fuel* **2007**, *86*, 1053–1061. [CrossRef]
182. Shi, X.; Pang, X.; Mu, Y.; He, H.; Shuai, S.; Wang, J.; Chen, H.; Li, R. Emission reduction potential of using ethanol–biodiesel–diesel fuel blend on a heavy-duty diesel engine. *Atmospheric. Environ.* **2006**, *40*, 2567–2574. [CrossRef]
183. Vedaraman, N.; Puhan, S.; Nagarajan, G.; Velappan, K. Preparation of palm oil biodiesel and effect of various additives on NOx emission reduction in B20: An experimental study. *Int. J. Green Energy* **2011**, *8*, 383–397. [CrossRef]
184. Rakopoulos, D. Combustion and emissions of cottonseed oil and its bio-diesel in blends with either n-butanol or diethyl ether in HSDI diesel engine. *Fuel* **2013**, *105*, 603–613. [CrossRef]
185. Qi, D.; Chen, H.; Geng, L.; Bian, Y. Effect of diethyl ether and ethanol additives on the combustion and emission characteristics of biodiesel-diesel blended fuel engine. *Renew. Energy* **2011**, *36*, 1252–1258. [CrossRef]
186. Nagdeote, D.; Deshmukh, M. Experimental Study of Diethyl Ether and Ethanol Additives with Biodiesel-Diesel Blended Fuel Engine. *Int. J. Emerg. Technol. Adv. Eng.* **2012**, *2*, 195–199.
187. Dincer, K. Lower emissions from biodiesel combustion. *Energy Sourcespart A: Recover. Util. Environ. Eff.* **2008**, *30*, 963–968. [CrossRef]
188. Sahoo, P.; Das, L.; Babu, M.; Naik, S. Biodiesel development from high acid value polanga seed oil and performance evaluation in a CI engine. *Fuel* **2007**, *86*, 448–454. [CrossRef]
189. Ribeiro, N.M.; Pinto, A.C.; Quintella, C.M.; Da Rocha, G.O.; Teixeira, L.S.; Guarieiro, L.L.; Rangel, M.; Veloso, M.C.; Rezende, M.J.; Da Cruz, R. The role of additives for diesel and diesel blended (ethanol or biodiesel) fuels: A review. *Energy Fuels* **2007**, *21*, 2433–2445. [CrossRef]
190. Kitamura, T.; Ito, T.; Senda, J.; Fujimoto, H. Extraction of the suppression effects of oxygenated fuels on soot formation using a detailed chemical kinetic model. *Jsae Rev.* **2001**, *22*, 139–145. [CrossRef]
191. Lapuerta, M.; Armas, O.; Rodriguez-Fernandez, J. Effect of biodiesel fuels on diesel engine emissions. *Prog. Energy Combust. Sci.* **2008**, *34*, 198–223. [CrossRef]
192. Sharma, Y.; Singh, B.; Upadhyay, S. Advancements in development and characterization of biodiesel: A review. *Fuel* **2008**, *87*, 2355–2373. [CrossRef]
193. Basha, S.A.; Gopal, K.R.; Jebaraj, S. A review on biodiesel production, combustion, emissions and performance. *Renew. Sustain. Energy Rev.* **2009**, *13*, 1628–1634. [CrossRef]
194. Broukhiyan, E.; Lestz, S. *Ethanol Fumigation of a Light Duty Automotive Diesel Engine*; SAE Technical Paper 811209; SAE International: Warrendale, PA, USA, 1981. [CrossRef]
195. An, H.; Yang, W.; Li, J. Effects of ethanol addition on biodiesel combustion: A modeling study. *Appl. Energy* **2015**, *143*, 176–188. [CrossRef]
196. Chen, H.; Shi-Jin, S.; Jian-Xin, W. Study on combustion characteristics and PM emission of diesel engines using ester–ethanol–diesel blended fuels. *Proc. Combust. Inst.* **2007**, *31*, 2981–2989. [CrossRef]
197. Rashed, M.; Kalam, M.; Masjuki, H.; Rashedul, H.; Ashraful, A.; Shancita, I.; Ruhul, A. Stability of biodiesel, its improvement and the effect of antioxidant treated blends on engine performance and emission. *Rsc Adv.* **2015**, *5*, 36240–36261. [CrossRef]
198. Kivevele, T.; Mbarawa, M.; Bereczky, A.; Laza, T.; Madarasz, J. Impact of antioxidant additives on the oxidation stability of biodiesel produced from Croton Megalocarpus oil. *Fuel Process. Technol.* **2011**, *92*, 1244–1248. [CrossRef]
199. Ryu, K. The characteristics of performance and exhaust emissions of a diesel engine using a biodiesel with antioxidants. *Bioresour. Technol.* **2010**, *101*, S78–S82. [CrossRef]
200. Tang, H.; Wang, A.; Salley, S.O.; Ng, K.S. The effect of natural and synthetic antioxidants on the oxidative stability of biodiesel. *J. Am. Oil Chem. Soc.* **2008**, *85*, 373–382. [CrossRef]
201. Fattah, I.M.R.; Masjuki, H.H.; Kalam, M.A.; Masum, B.M. Effect of synthetic antioxidants on storage stability of *Calophyllum inophyllum* biodiesel. *Mater. Res. Innov.* **2014**, *18*, S6-90–S6-94. [CrossRef]
202. Varatharajan, K.; Cheralathan, M.; Velraj, R. Mitigation of NOx emissions from a jatropha biodiesel fuelled DI diesel engine using antioxidant additives. *Fuel* **2011**, *90*, 2721–2725. [CrossRef]
203. Valentine, J.M.; Peter-Hoblyn, J.D.; Acres, G. *Emissions Reduction and Improved Fuel Economy Performance from a Bimetallic Platinum/Cerium Diesel Fuel Additive at Ultra-Low Dose Rates*; SAE Technical Paper 2000-01-1934; SAE International: Warrendale, PA, USA, 2000. [CrossRef]
204. May, W.; Hirs, E. Catalyst for Improving the Combustion Efficiency of Petroleum Fuels in Diesel Engines. In Proceedings of the 11th Diesel Engine Emissions Reduction Conference, Chicago, IL, USA, 21–25 August 2005; pp. 21–25.

205. Stein, Y.; Yetter, R.; Dryer, F.; Aradi, A. *The Autoignition Behavior of Surrogate Diesel Fuel Mixtures and the Chemical Effects of 2-Ethylhexyl Nitrate (2-EHN) Cetane Improver*; SAE Technical Paper 1999-01-1504; SAE International: Warrendale, PA, USA, 1999. [CrossRef]
206. Altıparmak, D.; Keskin, A.; Koca, A.; Gürü, M. Alternative fuel properties of tall oil fatty acid methyl ester–diesel fuel blends. *Bioresour. Technol.* **2007**, *98*, 241–246. [CrossRef]
207. Tat, M.E. Cetane number effect on the energetic and exergetic efficiency of a diesel engine fuelled with biodiesel. *Fuel Process. Technol.* **2011**, *92*, 1311–1321. [CrossRef]
208. Kidoguchi, Y.; Yang, C.; Kato, R.; Miwa, K. Effects of fuel cetane number and aromatics on combustion process and emissions of a direct-injection diesel engine. *JSAE Rev.* **2000**, *21*, 469–475. [CrossRef]
209. Vallinayagam, R.; Vedharaj, S.; Yang, W.; Saravanan, C.; Lee, P.; Chua, K.; Chou, S. Impact of ignition promoting additives on the characteristics of a diesel engine powered by pine oil–diesel blend. *Fuel* **2014**, *117*, 278–285. [CrossRef]
210. Chłopek, Z.; Darkowski, A.; Piaseczny, L. The influence of metalloorganic fuel additives on CI engine emission. *Pol. J. Env. Stud.* **2005**, *14*, 559–567.
211. Sajith, V.; Sobhan, C.; Peterson, G. Experimental investigations on the effects of cerium oxide nanoparticle fuel additives on biodiesel. *Adv. Mech. Eng.* **2010**, *2*, 581407. [CrossRef]
212. Zhu, M.; Ma, Y.; Zhang, D. An experimental study of the effect of a homogeneous combustion catalyst on fuel consumption and smoke emission in a diesel engine. *Energy* **2011**, *36*, 6004–6009. [CrossRef]
213. Barrios, C.C.; Martín, C.; Domínguez-Sáez, A.; Álvarez, P.; Pujadas, M.; Casanova, J. Effects of the addition of oxygenated fuels as additives on combustion characteristics and particle number and size distribution emissions of a TDI diesel engine. *Fuel* **2014**, *132*, 93–100. [CrossRef]
214. Subbaiah, G.; Gopal, K. An experimental investigation on the performance and emission characteristics of a diesel engine fuelled with rice bran biodiesel and ethanol blends. *Int. J. Green Energy* **2011**, *8*, 197–208. [CrossRef]
215. Rakopoulos, D.C.; Rakopoulos, C.D.; Giakoumis, E.G.; Dimaratos, A.M. Characteristics of performance and emissions in high-speed direct injection diesel engine fueled with diethyl ether/diesel fuel blends. *Energy* **2012**, *43*, 214–224. [CrossRef]
216. Akshatha, M.; Kumarappa, S. Performance Evaluation Of Neem Biodiesel On Ci Engine With Diethyl Ether As Additive. *Int. J. Innov. Res. Sci. Eng. Technol.* **2013**, *2*. [CrossRef]
217. Swaminathan, C.; Sarangan, J. Performance and exhaust emission characteristics of a CI engine fueled with biodiesel (fish oil) with DEE as additive. *Biomass-Bioenergy* **2012**, *39*, 168–174. [CrossRef]
218. Rakopoulos, D.C.; Rakopoulos, C.D.; Giakoumis, E.G. Impact of properties of vegetable oil, bio-diesel, ethanol and n-butanol on the combustion and emissions of turbocharged HDDI diesel engine operating under steady and transient conditions. *Fuel* **2015**, *156*, 1–19. [CrossRef]
219. Zhang, Z.-H.; Chua, S.-M.; Balasubramanian, R. Comparative evaluation of the effect of butanol–diesel and pentanol–diesel blends on carbonaceous particulate composition and particle number emissions from a diesel engine. *Fuel* **2016**, *176*. [CrossRef]
220. Žaglinskis, J.; Lukács, K.; Bereczky, Á. Comparison of properties of a compression ignition engine operating on diesel–biodiesel blend with methanol additive. *Fuel* **2016**, *170*, 245–253. [CrossRef]
221. Masjuki, H.; Kalam, M.; Syazly, M.; Mahlia, T.; Rahman, A.; Redzuan, M.; Varman, M.; Saidur, R.; Yau, Y. Experimental Evaluation of an Unmodified Diesel Engine Using Biodiesel with Fuel Additive. In Proceedings of the Strategic Technology, The 1st International Forum on Strategic Technology "e-Vehicle Technology", IFOST, Ulsan, Korea, 18–20 October 2006; pp. 96–99.
222. Senthil, R.; Silambarasan, R. Environmental effect of antioxidant additives on exhaust emission reduction in compression ignition engine fuelled with Annona methyl ester. *Environ. Technol.* **2015**, *36*, 2079–2085. [CrossRef]
223. Patel, N.; Singh, R. Optimization of NOx Emission from Soya Biodiesel Fuelled Diesel Engine using Cetane Improver (DTBP). *Jordan J. Mech. Ind. Eng.* **2014**, *8*, 213–217.
224. Narasimha, C.; Rajesh, M. Performance and emissions characteristics of diesel engine fuelled with rice bran oil. *Int. J. Eng. Technol.* **2013**, *4*, 4574–4578.
225. Lu, J.H.; Ku, Y.Y.; Liao, C.F. *The Effects of Biodiesel on the Performance and the Durability of Diesel Engine Active-DPF*; SAE Technical Paper 2012-01-1089; SAE International: Warrendale, PA, USA, 2012.
226. Zhang, Z.H.; Cheung, C.S.; Chan, T.L.; Yao, C.D. Emission reduction from diesel engine using fumigation methanol and diesel oxidation catalyst. *Sci. Total Env.* **2009**, *407*, 4497–4505. [CrossRef]
227. Zhu, L.; Cheung, C.S.; Zhang, W.G.; Fang, J.H.; Huang, Z. Effects of ethanol–biodiesel blends and diesel oxidation catalyst (DOC) on particulate and unregulated emissions. *Fuel* **2013**, *113*, 690–696. [CrossRef]
228. Shah, S.D.; Cocker, D.R.; Johnson, K.C.; Lee, J.M.; Soriano, B.L.; Miller, J.W. Reduction of particulate matter emissions from diesel backup generators equipped with four different exhaust aftertreatment devices. *Environ. Sci. Technol.* **2007**, *41*, 5070–5076. [CrossRef] [PubMed]
229. Mogi, H.; Tajima, K.; Hosoya, M.; Shimoda, M. *The Reduction of Diesel Engine Emissions by Using the Oxidation Catalysts of Japan Diesel 13 Mode Cycle*; SAE Technical Paper 1999-01-0471; SAE International: Warrendale, PA, USA, 1999. [CrossRef]
230. Loganathan, K.; Chandrasekaran, M. Investigation on Emission Characteristics of CI Engine Using Vegetable Oil With SCR Technique. *Int. J. Renew. Energy Res. (IJRER)* **2013**, *3*, 969–975.