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Effect of combustion saturated and unsaturated fatty acids pure vegetable oil for noise

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Abstract:

The steady increase in fossil fuel prices and the dependence on oil from producing countries to searched fuel alternatives to combustion engines. Vegetable oil is one of the renewable sources of energy that can be used. Vegetable oils also have the advantage of containing little to nitrogen. Radiated noise from diesel engines can be broken down into mechanical noise and combustion noise. The sound of combustion is distinguished into direct combustion noise and indirect combustion noise. The purpose of this researched is to know the effect of the chemical composition of variated pure vegetable oils to the noise generated in the combustion process. The study was conducted in an open tray which is heated by a heating element, which is filled with vegetable oil and then burned and given airflow variatiated velocity 39, 49 and 55 cm/s, the combustion is recorded using a softwere steinberg wavelab 6 (spectrum analyzer). Combustion of pure vegetable oil (jatropha curcas lin, ceiba petandra, catton seed, coconut) produced the highest noise level is on jatropha oil (-81 dB) followed ceiba petandra oil (-90 dB), catton oil seed oil (-99 dB) and Coconut oil (-108 dB). The study concluded that the content of unsaturated fatty acids one double bond (monounsaturated fatty acids) in the hydrocarbon chain thus facilitate reacted with oxygen and flammable.

Keywords: vegetable oil, saturated, noise, combustion, open tray

1. Introduction

The consumption of energy has ever increasing trend due to two reasons, mainly: (1) a change in the lifestyle and (2) the significant growth of population. Two of the main contributors are the transportation and the basic industry sectors. This increase of energy demand has been supplied using fossil resources (crude oil, natural gas and coal, principally), which have caused serious environmental impacts as global warming, acidification, deforestation, ozone depletion, eutrophication and photochemical smog, among others as demonstrated (Korbitz W, 1999). The world is facing two major problems, namely energy and environment. Another issue which is closely linked with the above is economy. So, energy, economy and environment are bonded by three dimensional relation-ships with bidirectional causal relationship among them as demonstrated (Omri,A.,2013). Ong,H.C et al. (2011) have recently shown the world energy consumption is likely to grow faster than the increase in the population. The Kyoto Protocol was a significant step for reduction of carbon dioxide and five other greenhouse gases as it set a legal binding on quantitative emanation for industrialized nations. It indirectly introduced the concept of ‘‘carbon neutral fuel’’. There are many emission standards, which focus on regulating pollutants released by automobiles and other powered vehicles, which generally specify certain limiting value of the emissions of nitrogen oxides (NOx), particulate matter (PM) or soot, carbon monoxide (CO), or volatile hydrocarbons. Traffic noise is the second environmental burden on health after air pollution according to the World Health Organization. These finite reserves are highly concentrated in certain regions of the world. Therefore, those countries not having these resources are facing energy/foreign exchange crisis, mainly due to the import of crude petroleum. Hence, it is necessary to look for alternative fuels which can be produced from resources available locally within the country such as alcohol, biodiesel, vegetable oils etc. as demonstrated (Agarwal AK., 2007).

Noise emissions are a major concern for both aircraft and engine manufacturers. This is mainly caused by increasing restrictions and regulations regarding the global noise generated by aircraft during take-off and landing. At the same time, aircraft operators are concerned with passenger comfort and therefore demand a quieter cabin. Noise has become another pollutant source due to engines and airframe, which must be controlled both outside and inside aircraft and helicopters. For these reasons, the reduction of acoustic emissions is now a major field of research both for industry and research groups. There are various studies to clarify the mechanism of noise and vibration in diesel engines and classified various sources and their contribution to the total engine noise. Pruvost L et.al. (2009), Tousignant T et.al. (2009), Redel-Macı ´as MD et.al. (2012) have recently shown internal combustion engine radiated noise can be divided into mechanical noise, combustion noise and noise resulting from the accessories. Furthermore, combustion-related noise is divided into direct and indirect combustion noise as well as flow noise. The combustion noise is purely a load dependent phenomenon. Russell MF et.al. (1985), Rust A and Pflueger M (2000), Albarbar A et.al. (2010) have recently shown the conventional combustion process in diesel engines is considered as the most important source of noise. Payri F et.al. (2002) have recently shown efforts are mainly concentrated on the overall level reduction of the combustion noise and improvement of sound quality, mainly oriented to customer satisfaction. Generally, the radiated noise from diesel engines can be broken down into mechanical noise and combustion noise, as shown in Fig. 1. Pruvost L et.al. (2009), Tousignant T et.al. (2009) have recently shown combustion noise is separated into direct combustion noise (directly proportional to the combustion gas pressure) and indirect combustion noise. When combustion takes place, a sudden pressure rise is produced causing the vibration of the engine block, which in turn radiates air-borne noise. The block vibration is caused by pressure forces exerted directly by the gas and the mechanical forces associated with piston slap, bearing clearances and friction. Redel-Macı ´as MD et.al. (2012) have recently shown a combined analysis of exhaust and noise emissions of an three-cylinder direct injection diesel engine running on palm oil methyl esters (PME) and olive pomace oil methyl esters (OPME), both blended with diesel fuel in different proportions, is proposed to evaluate their suitability as partial substitute to fossil fuels. A strong correlation the saturation degree of the raw materials used to produce biodiesel seems to have a positive influence over air and noise emissions was found.

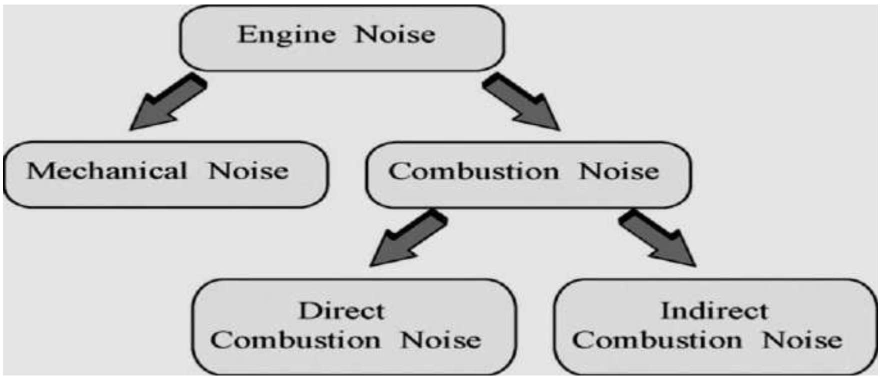

Fig. 1: Engine noise contributions

In this paper, to evaluate the effect of saturated fatty acids and unsaturated fatty acids degree of pure vegetable oils, an analysis of noise emissions of a combustion open tray fueled with jatropha curcas oil, ceiba petandra oil, catton seed oil and coconut oil is proposed.

2. Experimental procedure

2.1 Experimental set up

The experiments were conducted using the experimental Equipment shown schematically in Figure 2. A blower to exhale the air velocity is placed parallel with a stainless steel tray 184 x 25 x 15 mm (LxWxH) pure vegetable oil filled above the heated tray of combustion with heating element, with the highness of oil above the tray is 14 mm. Softwere steinberg wavelab 6 associated with microphone placed on the tray is burning drained by blowing air from the blower

2.2 Measuring technique

Pure vegetable oil was heated using a tray above the heating element until it evaporated and then switched thus formed the flame. At the time of the flame formed heating element is switched off then followed with a switch on the blower with the velocity of air flow being varied in varied amount 39, 49, and 55 cm/s. The sound waves from burning flames recorded microphone connected to softwere steinberg wavelab 6 over 100 seconds, these steps are performed until the until the flame is extinguished. The recordings of sound waves of flame be cut by using a photo software free video to jpg converter. Photos of the results of free video to jpg converter in the form of an image spectrum analyzer.

2.3 Fuel in test

The types of pure vegetable oils to be tested include jatropha curcas lin oil, ceiba petandra, cotton seed oil and coconut oil. All vegetable oils that are obtained as a result of oil presses from the seeds that are available commercially. Physical properties of pure vegetable oils are presented in Table 1.

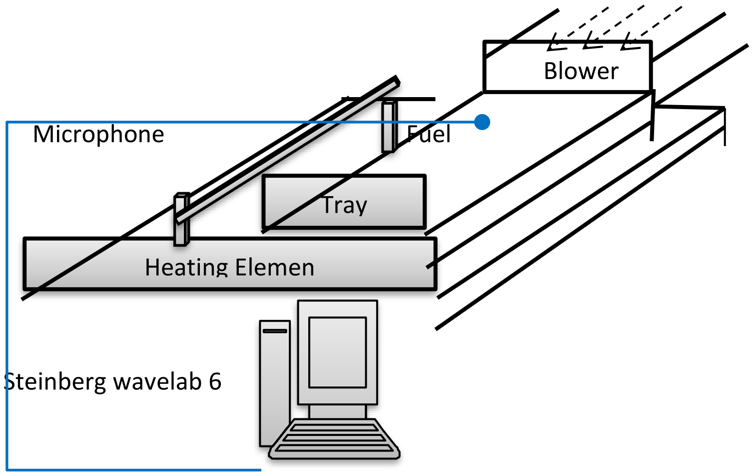

Fig. 2: Equipment used for the experiments.

Tabel 1: Physical properties of pure vegetable oils

Property	ASTM methode	Instrument	Model	Value: Ceiba petandra oil	Jatropha curcas lin oil	Catton seed oil	Coconut oil	Palm kernel oil
Density at 40^{0}C (kg/m^3)	D1298	Hydrometer	Nikky, Japan	974	921	955	936	940
Kinematic vizcosity at 40^{0}C (cSt)	D445	Kinematic viscometer	Leybold Didactic, Germany	45,55	35,48	41,65	55,55	52,65
Flash point (^{0}C)	D93	Pensky-Martens closed cup tester	Leybold Didactic, Germany	260	240	250	265	270
pH	D6423	pHep tester	UAS HANNA Instrument UAS	5,0	4,5	4,0	6,0	6,0

Tabel 2: The chemical composition of pure vegetable oil fatty acids

Pure Vegetable oil	Fatty acid: Saturated fatty acid						Unsaturated fatty acid			
	C6:0 - C10:0	C12:0	C14:0	C16:0	C18:0	C20:0	C18:2	C18:3	C16:1	C18:1
		Laurat	Miristat	Palmitat	Stearat	Arachidat	Linoleat	Linolenat	Palmitoleat	Oleat
Coconut oil	10,123	46,256	20,508	10,706	3,711	0,051	0,060	0,107	0,018	8,413
Catton seed oil	-	-	1,4	24,70	2,60	1,30	51,10	0,70	0,60	17,60
Ceiba petandra oil	-	-	0,25	16,10	3,55	0,10	56,22	1,00	0,40	21,88
Jatropha curcas lin oil	-	-	0,05	14,0	3,70	0,05	37,55	0,30	0,10	44,05

3. Result and discussion

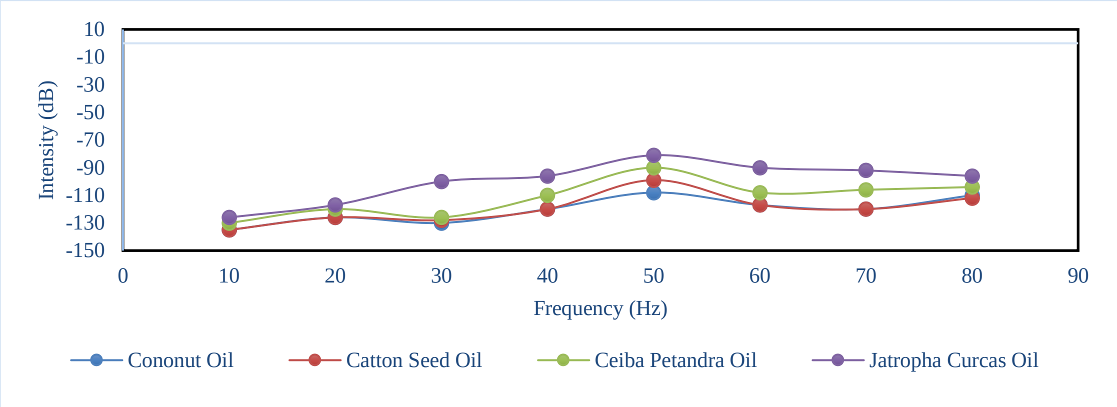

Fig. 3: Spectrum analyzer pure vegetable oil (v = 39 cm/s)

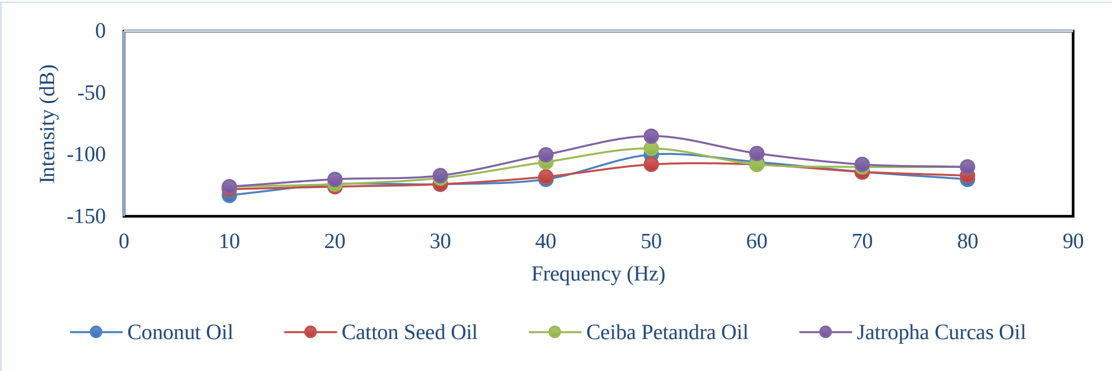

Fig. 4: Spectrum analyzer pure vegetable oil (v = 49 cm/s)

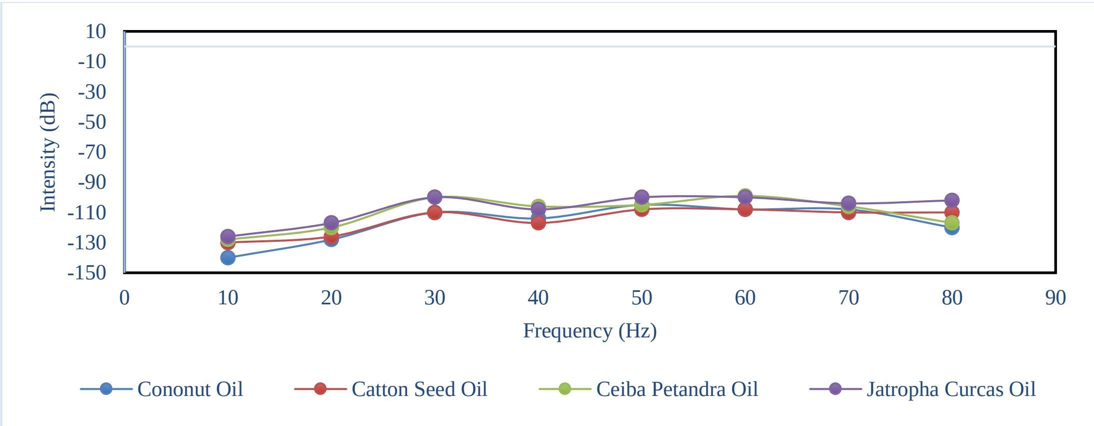

Fig. 5: Spectrum analyzer pure vegetable oil (v = 55 cm/s)

Figs 3-5 showed the spectrum analyzer of combustion of pure jatropha curcas lin oil, ceiba petandra oil, catton seed oil and coconut oil with the speed of air flow being varied in varied amount 39, 49, and 55 cm/s. Each combustion process of into four pure vegetable oil had different characteristic spectrum analyzer with air generated from the blower velocity varied. Figs 3 (39 cm/s) showed the noise that occurs on the jatropha curcas lin oil range -80 dB at frequency range of 50 Hz, as well as in figs 4 (49 cm / s) noise occurred at 50 Hz with range of -85 dB as well as on the figs 5 (55 cm/s) that is equal to -100 dB. This was due to the fact that pure jatropha curcas lin oil consisted of trglyceride molecules containing glycerol with three carbon chains and three fatty acid branches. Whereas, saturated fatty acid (table 2) contains single bond on its hydrocarbon chains enabling them to bind. As a result, the tensile strength of vander waals among its molecules became very strong. There fore more energy was needed to separates its molecules. When the oil was heated, three reactions were occur. The first reaction was the hydrolysis of trglyceride molecules to be fatty acid and glycerol by the water cointained in the oil. The second reaction was the combustion of unsaturated fatty acid (table 2) due to its lower flash point (table 1). At hight temperature, unsaturated fatty acid was highly flammable due to its volatile and highly reactive characteristic. In addition it has faster. It was also highly flammable when heated.

4. Conclusions

The experiment findings on the combustion of pure jatropha curcas lin oil, ceiba petandra oil, catton seed oil and coconut oil which were recorded by wavelab 6 (spectrum analyzer) can be conclude as follows:

The combustion of pure jatropha curcas lin oil, ceiba petandra oil, catton seed oil and coconut oil occurred noise pollution is highest in jatropha curcas lin oil followed by ceiba petandra oil, catton seed oil and coconut oil with each noise value of -81 dB, -90 dB, -99 dB and -108 dB. Due to the combustion of unsaturated fatty acid, its lower flash point, unsaturated fatty acid was highly flammable, its volatile and highly reactive.

5. Nomenclature

L	length	cm
W	width	cm
H	high	cm
V	velocity	cm/s
I	intencity	dB
F	frequency	Hz
T	temperature	^{0}C
Greek letters		
ρ	density	kg/m^3
Ʊ	Kinematic viscosity	cSt

6. Acknowledgements

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