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Impact of Cashew Nut Shell Liquid Biofuel on Performance and Emission Characteristics in Diesel Engine

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Abstract

Background: Inadequate reserve of fuel energy along with environmental concerns encompass benefits in the augment of alternative energy for internal combustion (IC) engines. Biomass as type of cashew nut shell characterizes fresh power basis plus copious resource for power.

Objectives: The bio-fuel be resultant as of cashew nut shell liquid (CNSL) and intermingle through diesel be capable substitute energy on behalf of standard engine. As per current research CNSO and diesel mingles are worn to lope the vertical, four strokes, water cooled diesel engine.

Methods: The tests were performed for a range of CNSL and diesel mingles specifically B20, B40, B60, B80 and B100. Engine loads be varied as of 0 to 100% and engine rapidity is sustained at 1500 rpm. Thus blends consequences are contrast with precise diesel process.

Conclusions: The outcomes confirmed about brake thermal efficiency (BTE) dropped off with raise in CNSL concentration. The brake specific fuel consumption (BSFC) augmented with raise in CNSL Concentration. The exhaust emissions of HC, CO and exhaust gas temperature amplified with raising the CNSL deliberation. The NOx release decreased with higher blends of CNSL.

Keywords: Cashew nut shell liquid, biodiesel, brake specific fuel consumption, Brake thermal efficiency, IC engine.

1. Introduction

Biodiesel is well-thought-out as an impending substitute fuel, which is renewable and produce less atmospheric carbon emission associated with regular diesel fuels [1].

Augmented environmental perception and fatigue of remnant fuel assets are rousing the scholars and the fuel manufacturers to figure up substitute energy being added adequate and renewable in nature [2]. The allegd of consuming vegetable lubricates as energy for diesel engine be in fact pursued usually Vegetable oil adept of actuality worn in diesel engines more over straight, or be capable of existence used as biodiesel[3,4].

The various asset factors of biodiesel remain to be perceived. It stood very notable that utmost with possessions being nearer through predictable diesel fuel. The viscosity, still being greater part at normal temperature, diminishes extremely through greater temperature. The measured stickiness at 30°C meant for cardanol be 31.97 cSt, and on 60°C it be 15.96 cSt. Spark and fire peak of the cardanol remained recorded at 208°C and 220°C correspondingly. Calorific assessment of CNSL is that 9845 Kcal/Kg [5]. Cardanol being entirely soluble in alcohol and diesel also inexplicable in water. CNSL be end result of the cashew production that incorporates as desidual liquid through cashew nut [6]. India is a primary manufacturer of CNSL which is a stretchy honey scrub folds a spotted blushed brown viscose liquid. Unprocessed cashew nut shell encompasses about 25% cashew nut shell oil [7,8]. The dominance serviceable system prohibiting of lubricate

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in India enfolds cashew nut with steaming rinse of CNSL through 185-190°C. With reverence to the higher temperature the anacardic acid tolerates de-carboxylation and it is transformed to cardanol and it is termed scientific CNSL [9]. Cashew nut shell liquid (CNSL) an offshoot with industrialized procedure through cashew has progressively stand like treasured uncooked factual with petroleum zone. With actuality high manufactured offshoots, the cardanol be presently skilled, like inhibitor with petrochemical production [10]. Here, cashew farming shields whole extent around 0 .8 million hectares of land, with yearly 0.49 million metric tons of unprocessed cashew nuts. The mediocre yield per 100000 m2 is nearby 760 kg [11]. In India treated cashew rules further partly the earth cashew arcade. Countless approaches include accounted in analysis with exclusion of CNSL as of Cashew Nut Shell (CNS), that encompass, boiling oil scorching, ice-cold extrusion and solvent elimination etc. The elimination altogether in the sequence of blankness pyrolysis being reported lately [12]. Obviously arrangement of scientific CNSL is coarsely 55% cardanol, 12% cardol and 33% polymeric material, through rest accomplished by supplementary substantial[13,14].

The cardanol is well-to-do in CNSL achieved over vacuity pyrolysis. The scientific CNSL is afterward treated with refinement through compact force to eradicate the compound substance. The arrangement of the cleansed scientific CNSL is about 80% cardanol, 10% cardol and 5% polymer material together with missing over additional matters. This oil is formerly ignition at 500˚C underneath vacuum (730mm Hg). The burning oil is said to be devising an awfully elevated calorific value (45MJ/kg) plus consequently might fine thought-out as skilled bio oil through conceivable like energy[15].

Exploitation of CNSL like an imminent energy in IC engines being recommended by. Existing detection be verification through Biofuel. This includes exposing refined scientific cashew nut shell liquid (CNSL) like key factor used for biofuel as well as procedure through manufacture along with devising. Here, the cardanol with incinerated CNSL oil be there worn to track the DI diesel engine through mixtures of diesel as well as engine routine with release distinctiveness be evaluated. CNSL is a derivative from the cashew fruit which is the carp liquefied of the cashew nut [16]. Cashew nut shell liquid is a lithe honey rub composition enfolds a flushed brown liquid. The cashew nut shell surrounds about 20-40% CNSO [17]. The predominance scheme segregation of CNSO is allure of the cashew nuts in a boiling wash of shell liquid at 180-200°C [18]. This course of action get betters about 40-60% of shell liquid and the roasting removal makes a different shell liquid from traditional, acquired by frosty removal [19,20].

2. Objectives

The biofuel, monoalkyl esters of elongated series fattyacids extracted through transesterification of vegetal oils necessitates high response time and requires methanol or ethanol. In addition only biodiesel utilized in diesel engine. Besides, biofuel has to blend with fossil diesel fuel [10]. Nowadays biodiesel fuel is not cost-effectively attractive as it requires blending with diesel and it furthermore does not combust cleanly as it affects the life of the engines [11]. Pyrolysis process, which is an undeviating thermal decay scheme, drives at a precise max temperature (500-1200°C) then the outcomes predominantly gassy fuel yields contain conventional hydrocarbons [12]. Among different methods, biofuels attained through catalytic cracking from vegetable oils surpass other biofuels due to their (i) no difficulty to use in diesel engines in isolation, (ii) eco-friendly and non-polluting nature and (iii) low production cost [13]. Catalytic cracking of vegetable oils has a border over other processes as it necessitates lower operating temperature range (<600°C) and small catalyst amount to oil ratio [14].The biofuel acquired through cracking shows very high selectivity in the direction of fuel fraction and burn ups cleanly [15]. Along with the non-edible plants, cashew nut tree, a drought defiant plant has the prospective to satisfy necessitates of an alternative fuel from its oil [16]. This cashew nut tree is widely cultivated in alkaline soils, semiarid and tropical region like India and it is a dearth resistant perennial that grows over thirty years. It needs minimum rainfall of 150mm [17]. The catalytic conversion of others to biofuel does not grasp much promise because it will depend on the harvest production and the sell price of vegetable oil [18]. The catalytic change of CNSL oil into fuelstate supposing the outcomes showed the prospective of acquiring liquid hydrocarbons [19]. In this study, CNSL - based fatty acid mixture filtrate is used as the raw material in catalytic cracking process to biofuel [20].

The fatty acid assortment is a residue to portrayal and recovery of aspiration fatty acids. The mixture of fatty acids cannot be further distilled as a consequence of higher operating cost and minimal recovery [21].Through renovating fatty acid mixture into biofuel, portable equipment could be launched to make available economic opportunities and promote the environment lacking challenging with the oil market [22].At one fell swoop, the mixture of fatty acids probably converted to an alternative energy source into biofuel. CNSL is derived from the cashew, which is a carp liquefied by the cashew [23]. Cashew nut shell liquid is a lithe honey rub composition enfolds a flushed brown liquid. The cashew nut shell

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surrounds about 20-40% CNSO. The predominance scheme segregation of CNSO is allure of the cashew nuts in a boiling wash of shell liquid at 180-200°C.

This course of action get betters about 40-60% of shell liquid and the roasting removal makes a different shell liquid from traditional, acquired by frosty removal. As regards the raised the temperature, anacardic acid undergoes de-carboxylation reaction and it is transferred to cardanol substitute of built-up process from cashew nut has progressively appropriate raw material for the petroleum industries. While an effect of being high manufactured imitative, the cardanol is at being experienced, as an antioxidant material in the petrochemical trade [24]. The CNSL is reported to be 26-32% by mass in India. Taking into consideration cashew nut shell mass is around >50% of the mass of the nut [25]. Particularly, India processed cashew leads above half the world cashew production. Various methods include reconsidering the removal of CNSL from the shell, including open pan frying, boiling frying, drum frying, and solvent removal methods. The confiscation all the technique throughout vacuum pyrolysis process has been used in recent times. Obviously the concerto of CNSL is almost 50-60% cardanol, 10-15% cardol and around 25-30% of polymeric material, among deposit material. Cardanol is affluent in CNSL conquered during vacuum pyrolysis. The CNSL is then progression via distillation at diminished pressure to get rid of the polymeric component. Generally, progression at 120-190˚C, the shell liquid was form brown coloured oil. This brown oil is then burning at 450˚C under vacuum pressure.

3. Methods

The engine worn in this investigate effort is one cylinder, water chilled, 4 stroke DI compression ignition diesel engine and perceptibly enunciated. The firmness ratio of the engine is 17.5:1 and darts at 1500 rpm speed and fabricates 3.7kW of power. The fuel injection opening angle is fixed as 23 bTDC. The analysis engine is encumbered with eddy current dynamometer as straightly attached with the engine. The engine equipment is entirely digital system. The fuel flow rate was measured with help of weighing machine. Here processed CNSL is blended through diesel by 20%, 40%, 60%, 80% plus 100% with CNSL capacity additionally acknowledged as B20, B40, B60, B80 and B100 energy. Possessions by energy are listed in Table 2. The test engine was connected with eddy current dynamometer for accurate loading. The investigational arrangement being exposed in fig.1. The fuel consumption has been measured with weighing machine in mass basis.

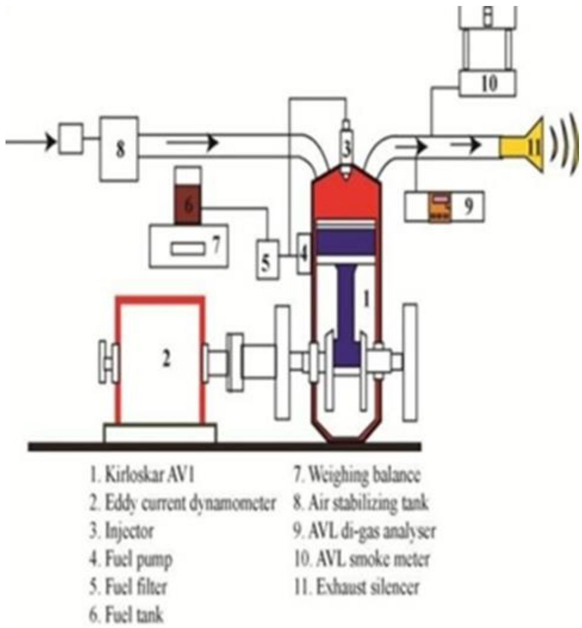

Fig. 1 Schematic view of Experimental Setup

The exhaust temperature of the engine was deliberated by k type thermocouple. The engine exhaustion gas emission namely HC, CO and NOx were measured by HORIBA (Japan make) NDIR gas analyser. The in cylinder pressure of the engine were measured by Kistler make pressure transducer. The testing was carried out for different mingles of CNSL and diesel for different loads varies from 0 to 100%. The recital with discharge uniqueness was estimated through standard diesel parameters.

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4. Results

Performance Characteristics

Brake Thermal Efficiency: The discrepancy of brake thermal efficiency with reverence to weight for diverse mingles of CNSL oil be measured for the current study and offered in Fig.2. Within all cases, brake thermal efficiency has the affinity to amplify with raise in functional load. This is owing to the diminution in heat defeat and raise in power developed with raise in load.

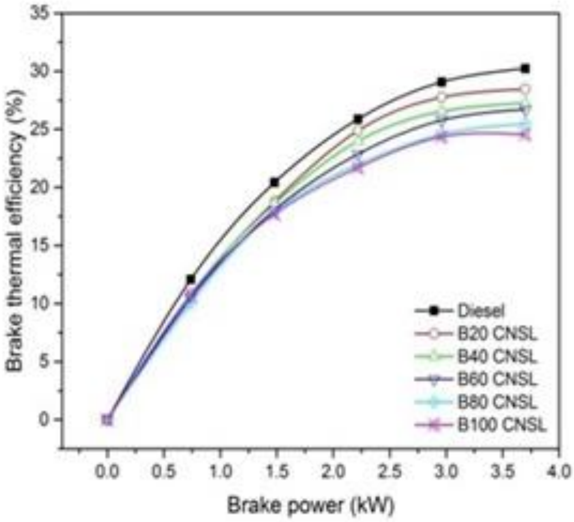

Fig. 2 Variation of BTE vs Brake power

The thermal competence of all blends of CNSL oil is inferior to that of standard diesel. This is owing to poor mixture formation as a result of low volatility, higher viscosity and elevated density of CNSL oil. The thermal competence of B20 mingles provides the advanced effectiveness contrasted to extra mingles namely B40, B60, and B80. This is since additional mingles given the elevated viscosity of fuel and deprived atomization and therefore deprived combustion. Inferior brake thermal competence attained for B100 could be owing to the deprived mixture arrangement as contrasted to B20. While operating the engine with precise CNSL oil, brake thermal efficiency is forever inferior to mingles of CNSL oil along with diesel. Variation on brake specific fuel consumption. The BSFC with CNSL mingles raise with mounting the deliberation of CNSL and it is shown in fig.3. Thus with increased stickiness and deprived spray characteristics of CNSL. The BSFC of B20 is very near with BSFC of neat diesel operation.

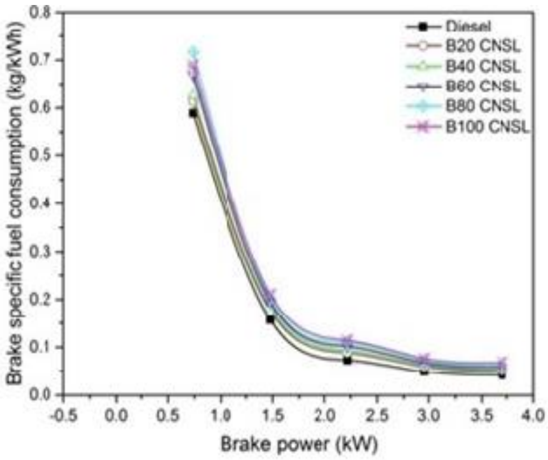

Fig. 3 Variation of BSFC vs Brake power

Variation on Exhaust gas temperature. The fig. 4 characterizes discrepancy of tire out gas temperature and brake power of engine.

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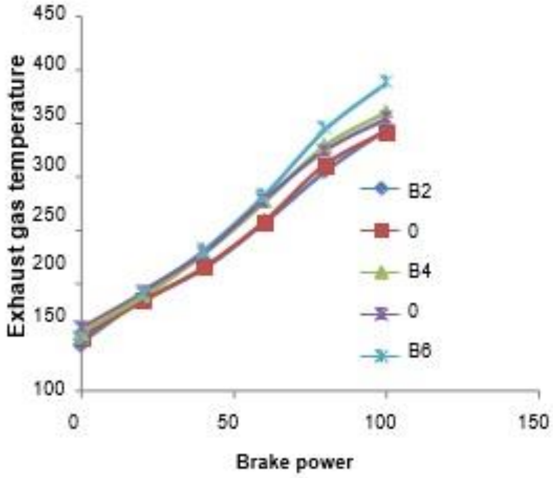

Fig. 4 Variation of Exhaust gas temperature vs Brake Power

Thus results showed the exhaust gas temperature augmented through increasing the blend ratio of the CNSL. This is owing to after burning of unburned fuel in the exhaust pipe.

Emission Characteristics

Variation on hydrocarbon emission. The discrepancy of hydrocarbon (HC) emission for diverse loads by means of CNSL mixtures with diesel is demonstrated in Fig.5. The HC release through all mingles of CNSL- diesel increased contrast to the standard diesel operation. This is owed to more viscosity and poor spray characteristics of CNSL. However the B20 gives more reduction of HC emission contrasted to other blends and neat diesel. Carbon monoxide emission. Fig. 6 shows illustrate of carbon monoxide release of mingles of CNSL oil and diesel procedure with paced engine velocity of 1500rpm as a variety of weight settings.

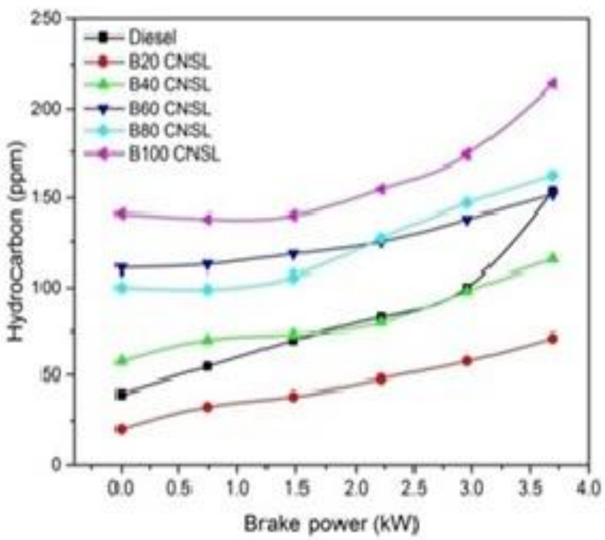

Fig. 5 Variation of Hydrocarbon emission vs Brake Power

The CO release decrease with atmosphere energy proportion turns into superior with stoichiometric value. With mounting CNSL oil proportion, CO release stage augments. With effect of, 100% CNSL lubricate, the carbon monoxide release be superior with diesel and other CNSL mingles. Thereby with more stickiness and deprived mixture formation inside the cylinder.

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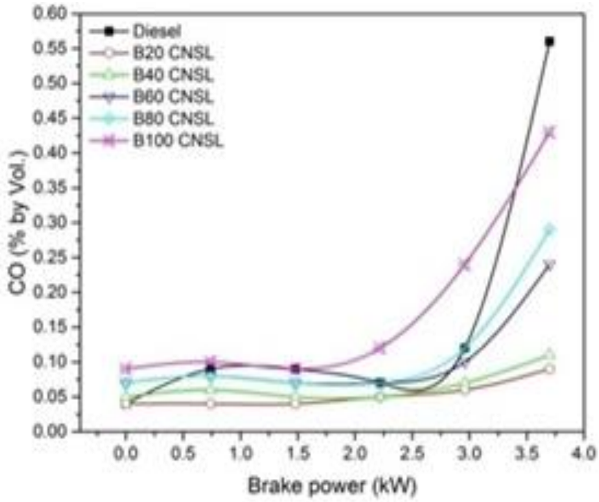

Fig. 6 Variation of Carbon monoxide emission vs Brake Power

NOx Emission. Fig.7 indicates disparity in NOx emission with different that mingles of CNSL oil and diesel fuel. The formation of NOx is mainly due to oxygen availability and mixture temperature. The NOx emission is lower for B100, compared to other CSNL blends and standard diesel fuel. This is due to incomplete burning of CNSL diesel blends, shows higher NOx emission compared to neat diesel fuel.

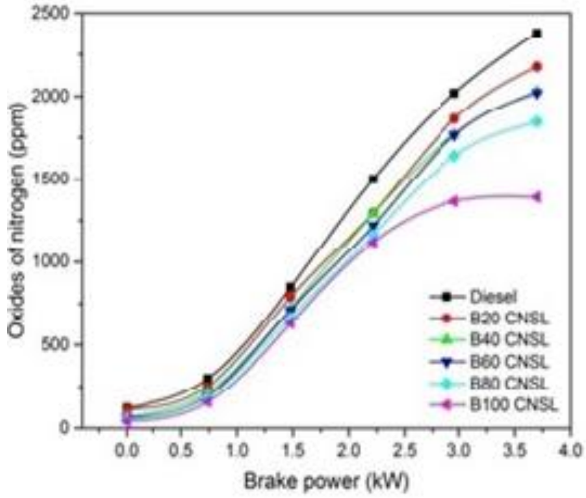

Fig. 7 Variation of NOx emission vs Brake Power

5. Discussion

In this research the recital along with release on a diesel engine operating on CNSL-diesel mingles are investigated plus contrasted through neat diesel oil. With respect to the investigational outcomes, the subsequent summary has been arrived. The BTE decrease with increasing the CSNL blends. The BSFC and tire out gas temperature increase through increasing mingles of CNSL. The HC and CO emission increase with increasing the blends of CNSL. NOx release decrease through mounting the mixtures of CNSL.

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