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Performance of Carbon Nano Particles- A Review

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Abstract: Bio-diesel having environmental advantage is most favored fuel to replace diesel with minimal changes and can be implemented in the engine. A lot of experimental work and numerical investigations have been carried out using various bio-diesel diesel mixtures such as karanga bio-diesel, polanga bio-diesel, palm bio-diesel, etc. and are used with a variety of volumetric ratios ranging from 1:10 to1:100. For further enhancement in performance carbon nanoparticles such as copper oxide, aluminium oxide, zinc oxide and silver nanoparticles were added to neat fuel or mixture of diesel bio-diesel. In addition carbon nano-particles were investigated as they contribute to amplify the performance parameters of diesel engine. The experimental results show that the carbon nanoparticles not only enhanced the characteristic performance such as brake power, torque, specific fuel consumption rate etc. but also reduce the emission rate by limiting the exhaust of harmful gases such as UHC (unburnt hydrocarbon), CO(carbon monoxide)and oxides of nitrogen.

Keywords: UHC-Unburnt hydrocarbon CO-Carbon monoxide CO_2-Carbondioxide NO_X-Oxides of nitrogen TOR-Torque BMEP-Brake mean effective pressure BTH-Brake thermal efficiency

1.1 Introduction

In today's world with lots of advancement in automobile sector there is an exponential increase in usage of private vehicles for traveling, resulting into consumption of huge amount of fuel and also releasing many poisonous gases into the environment.

Most of the vehicles run on petrol and diesel, and both being renewable source of energy there is threat of depletion of these resources way before the predicted period. Hence there is an urgency to replace these fuels with an alternate fuel which produces lesser emission and gives good performance characteristics.

Biodiesel being a clean burning fuel has proved to be most promising alternate fuel with minimum changes to be done in the engine and provides good power output.

Biodiesel is an organic diesel fuel derived from organic sources such as vegetable oils, animal fats, waste cooking oil and fish oil. It is non-toxic, biodegradable, produces 60% less carbon dioxide than petroleum based diesel fuel and is free of Sulphur and aromatics. It burns better with higher cetane rating. [1]

Use of biodiesel leads to reduction in global warming. However 100% biodiesel is inept. In cold climates the biodiesel becomes viscous, can get blocked and prevent engine from running. Therefore most applications use blended form of biodiesel, i.e biodiesel mixed with petroleum diesel.

Hence considering the need of the hour, there is an urgency to introduce a new technology for elevating the engine efficiency and along with reducing fuel consumption as well as restricting the discharge of poisonous gases.

Many experiments have been performed adding various nano particle additives to increase the engine efficiency and reduction in greenhouse effect.

1.2 Introduction To Carbon Nanoparticles Additives

Due to development in the field of nanotechnology using various equipment's that are being made accessible to the scientists intend to enhance ignition purity of the engine. [2]

The carbon nanoparticles have very high tensile strength, elastic properties and also can be easily manipulated to different sizes and shapes. [3]

Their geometry is very complex but these particles exhibit excellent thermal conductivity, electrical conduction and are very lightweight with density one quarter than steel hence embedded in fuel to improve thermo-physical properties. [4]

Nanoparticles are those fuel additives which refine distinct characteristics of the propellant when added to the base propellant depending upon the proportion of it such as, flash point, fire point, kinematic viscosity, heating value and cetane number[1] [3]

With the augment in the vaporization rates, carbon nanoparticles cause reduction in combustion delay and a boost in the total heat of combustion.

Combining nanoparticles with biodiesel diminishes all kinds of environment deterioration and propellant utilization thereby increasing the output of the diesel engine.

2.1 Advantages of carbon nano particles

1 Carbon nanoparticles have such structure that can trap free radicals and hence carbon fibrils can function as antiknock additive.
2 The cetane value of the diesel engine increases with addition of carbon nanoparticles.
3 Carbon nanoparticles can work as a burning rate catalyst because when added to liquid fuel they amplify its consumption rate, stimulate complete burning and curb harmful gases.
4 The resources needed to produce carbon nanotubes are abundant and can be made with limited amount of material.
5 There is no effect of temperature change on its properties and can work well in any type of climate.

2.2 Drawbacks of carbon nano particles

1 It is partially miscible in most solvents that are befitted with water based fuels. [5]
2 It is not feasible to use it on a large scale as it requires high quality maintenance and special filtration technique

3. Results and discussion

Table 1: Emission Characteristics

ENGINE	FUEL	CO	CO_2	UHC	NOx	SMOKE EMISSION	EGE	REFERENCE
SINGLE CYLINDER 4 STROKE WATER COOLED DIESEL ENGINE	BLENDED MIXTURE OF POLANGANA DIESEL USING ARTIFICIAL NEURAL NETWORKS (ANN)			↓ 12.5%	↑ 5.4%	↓ 2%		[7]
SINGLE CYINDER 4 STROKE WATER COOLED CI ENGINE	METHANOL + BLEND OF DIESEL AND PALM STREAIN BIODIESEL	↓2.2%			↓16.92%	↓48.98%	INCREASES WITH INCREASE IN BRAKE POWER	[9]
A DIRECT INJECTION SINGLE CYLINDER FOUR STROKE CYCLE DIESEL ENGINE	BIODIESEL WITH DIESEL FUEL	↓37%		↓4%	↑ 10% ↓12%			[10]
CI ENGINE SIX CYLINYDER 4 STROKE NATURALLY ASPIRATED DIRECT INJECTION	MULTIWALL CNT AND NANO SILVER PARTICLES ADDED TO BIODIESEL FUEL.	↓ 25.2%	↑17%	↑14.21%	↑25.3%			[11]

SINGLE CYLINDER, CONSTANT-SPEED (1500 RPM), FOUR-STROKE VARIABLE COMPRESSION RATIO (VCR) DIESEL ENGINE	THUMBA BIODIESEL BLENDED WITH DIESEL			↑ 23%	↑ 11%	↑ 17%		[13]
STROKE SINGLE CYLINDER WATER COOLED DI DIESEL ENGINE	WASTE COOKING OIL BIODIESEL + TIO2	↓ 10.8%	↑ 10%	↓ 34.39%	↑ 12%	↓ 9.90%	↓ 0.43%	[16]
	WASTE COOLING OIL + TIO2 + BUTANOL	↓ 38%	↑ 7%	↓ 34.12%	↓ 2.48%	↓ 3.71%	↑ 1.46%	[16]
FOUR STROKE SINGLE CYLINDER CI ENGINE	COPPER OXIDE NANO PARTICLES WITH PONGAMIA BIODIESEL	↓ 29%		↓ 7.9%	↓ 9.8%	↓ 12.8%		[17]
MARINE MEDIUM SPEED DIESEL ENGINE	BLENDS OF DIESEL AND BIODIESEL @1000RPM	↓ 15%	↓ 0.4%	↓ 10.26%	↓ 7.5%			[18]
MARINE MEDIUM SPEED DIESEL ENGINE	BLENDS OF DIESEL AND BIODIESEL WITH WATER ADDED AT 2% BY WT AND CERIUM OXIDE AS NANOPARTICLE(90PPM)	↓ 36%	↓ 0.45%	↓ 43.59%	↓ 16.25%			[18]
MARINE MEDIUM SPEED DIESEL ENGINE	BLENDS OF DIESEL AND BIODIESEL WITH WATER ADDED AT 4% BY WT AND CERIUM OXIDE AS NANOPARTICLE(90PPM)	↓ 43%	↓ 0.6%	↓ 48.72%	↓ 21.25%			[18]
MARINE MEDIUM SPEED DIESEL ENGINE	BLENDS OF DIESEL AND BIODIESEL WITH WATER ADDED AT 6% BY WT AND CERIUM OXIDE AS NANOPARTICL	↓ 31%	↓ 0.2%	↓ 17.95%	↓ 18.75%			[18]

	E(90PPM)							
4STROKE SINGLE CYLINDER AITCOOLED 6LD 400 LAMBORGHINI MODEL DIESEL ENGINE	CORN OIL METHYL ESTER DIESEL	↓26%			↑6.2%	↓11.2%		[19]
SINGLE CYLINDER FOUR STROKE NATURALLY ASPIRATED DI DIESL ENGINE	DIESEL BIODIESEL DI-TERTIARY BUTYL PEROXIDE (DTBP)	↓18%		↓24%	↓34%	+9%		[20]
KIRLOSKAR STATIONARY DIESEL ENGINE	PINE-OIL BIOFUEL	↓67.5%		↓58.6%	↓15.2%	↓70.1%		[21]
SINGLE STROKE TURBOCHARGED DIESEL ENGINE	SOYBEAN BIODIESEL FUEL	↓27%		↓12%	↓13%			[22]
OM355 EU2 ENGINE	WASTE COOKING OIL	↓39%		↓71.4%	↓18.9%	↓26.3%		[23]
SINGLE CYLINDER WATER COOLED DI DIESEL ENGINE	WASTE COOKING PALM OIL	↓53%		↓26.6%		↓6.9%		[24]
SINGLE CYLINDERAIR COOLED DI DIESEL ENGINE	PETROLEUM DIESEL				↓6.2%	↑11.5%		[25]
SINGLE CYLINDER DIESEL ENGINE	JOTROPHA BIODIESEL	↓60%		↓33%	↓13%	↓32%		[26]
SINGLE STROKE DI DIESEL ENGINE	PINE OIL BIOFUEL	↓68%		↓58.6%	↓15.2%	↓70.1%		[21]
FOUR STROKE DI HEAVY DUT DIESEL ENGINE	BIODIESEL-ETHANOL-DIESEL				↓73%	↓70%		[27]
FOUR STROKE FOUR CYLINDER DIESEL ENGINE	PETROLEUM DIESEL	↓96%		↓83%	↑0.1%	↓92%		[28]

Table 2: Performance Characteristics

ENGINE	**FUEL**	**POWER**	**BMEP**	**BSFC**	**BTH**	**TOR**	**REFERENCE**
STROKE SINGLE CYLINDER WATER COOLED DI DIESEL ENGINE	WASTE COOKING OIL BIODIESEL + TIO2	↑ 10%		↓ 27.7%		↑ 10%	[14]
	WASTE COOLING OIL + TIO2 + BUTANOL	↑ 9.7%		↓ 28.4%		↑ 9.7%	[16]
CI ENGINE SIX CYLINYDER 4 STROKE NATURALLY ASPIRATED DIRECT INJECTION	MULTIWALL CNT AND NANO SILVER PARTICLES ADDED TO BIODIESEL AND DIESEL FUEL	↑ 2%		↓ 7.08%		↑ 2%	[11]

SINGLE CYLINDER 4 STROKE WATER COOLED DIESEL ENGINE	BLENDED MIXTURE OF POLANGANA DIESEL USING ARTIFICIAL NEURAL NETWORKS (ANN)				↑ 1.33% ↑ 1.6%(4 DEGREE ADVANCE) ↑ 3% (FULL LOAD)		[7]
SINGLE CYINDER 4 STROKE WATER COOLED CI ENGINE	METHANOL + BLEND OF DIESEL AND PALM STREAIN BIODIESEL	3.5 KW		↑ 9.14%	↑ 2.47%		[9]
FOUR STROKE SINGLE CYLINDER CI ENGINE	COPPER OXIDE NANO PARTICLES WITH PONGAMIA BIODIESEL	3.5KW		↓ 1%	↑ 4.01		[17]
FOUR STROKE DIESEL ENGINE	BIODIESEL WITH DIESEL FUEL	3.81KW		↑ 2.7%	↑ 33.65%		[10]
1 CYLINDER, CONSTANT-S, 4 STROKE VCR SI ENGINE	THUMBA BIODIESEL BLENDED WITH DIESEL		4 BAR	↓ 20%	↑ 0.3%		[13]
MARINE MEDIUM SPEED DIESEL ENGINE	BLENDS OF DIESEL AND BIODIESEL @1000RPM	↑ 4.76%	↑ 0.7%	↓ 3.7%	↑ 2.5%	↑ 4%	[18]
MARINE MEDIUM SPEED DIESEL ENGINE	BLENDS OF DIESEL AND BIODIESEL WITH WATER ADDED AT 2% BY WT AND CERIUM OXIDE AS NANOPARTICLE(90PPM)	↑ 2.38%	↓ 0.7%	↓ 5.96%	↑ 4.5%	↑ 2%	[18]
MARINE MEDIUM SPEED DIESEL ENGINE	BLENDS OF DIESEL AND BIODIESEL WITH WATER ADDED AT 4% BY WT AND CERIUM OXIDE AS NANOPARTICLE(90PPM)	↑ 0.95%	↓ 1.2%	↓ 6.89%	↑ 6%	↑ 1%	[18]
MARINE MEDIUM SPEED DIESEL ENGINE	BLENDS OF DIESEL AND BIODIESEL WITH WATER ADDED AT 6% BY WT AND CERIUM OXIDE AS NANOPARTICLE(90PPM)	↓ 2.38%	↓ 2.1%	↓ 1.38%	↓ 4.5%	↓ 2%	[18]

4. Conclusion

In this review study of carbon nano particles we have tabulated various performance and emission characteristics. They are as follows:

Carbon nanoparticles increases the brake power by 2-10% with increase in torque output by 2-10% and correspondingly reduces brake propellant utilization by 15-30%.

Carbon nanoparticles have great effect on reducing harmful emissions such as reduction in levels of carbon monoxide by 15-25%, unburnt hydrocarbon by 7-12% and oxides of nitrogen by 3-17%.

Carbon nano particles decrease the exhaust gas temperature by 2-3% and reduce smoke emissions by 3-15%.

Hence the usage of carbon nano particles is found to be quite useful in diesel engines and has a great scope of development in the coming future.

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