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Parameter optimization for performance and emissions of diesel using nanoparticle by Taguchi method

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ABSTRACT

In this research paper, the use of nanoparticles as fuel additives in plane diesel for use in the I.C engine for improving performance and reducing the harmful emission is explored. The nanoparticle is mixed properly using ultrasonicator and physiochemical property are characterized. The fuel prepared and then use to run the test rig and the result shows a significant increase in performance and reduction in emissions as compared to plane diesel. Particulate Carbon monoxide(co), Carbon dioxide(co2) and Unburned hydrocarbons(HC), Engine torque, Brake power, Brake thermal efficiency, Specific fuel consumption, kinematic viscosity at 40˚C, Flash point, Fire point, Cloud point, Pour point, Gross calorific value and more.

Keywords: *Cerium oxide, Ultrasonicator, Additive, Diesel engine.*

1. INTRODUCTION

The use of C.I engines is prefer because it is reliable and provide more economy. As it well known that our reserve of crude oil is depleting at a fast rate due to growing number of people using the machines and increase in demand for energy. Therefore there is an urgent need for the research in renewable energy and also to increase the efficiency of the existing fuel. Also there is an increase in global warming. These facts lead to use of nanoparticle in diesel for a reduction in emissions and increase in efficiency. Using an optimized blend of nanoparticle and diesel can help reduce a significant percentage of crude oil without modifying the existing engine and it also improve the environmental benefits. For an example, it reduces the particular matter (pm), carbon monoxide (co), sulphur oxides (sox) and unburned hydrocarbon (HC). Also, additives are now an essential part of fuels. With using the careful optimized formulated blend also contribute in the long life of the engine. They provide very surprisingly effect even when put in very less part per million (ppm) range.

The reason why we can make use of nanoparticles is that of the several advantages they have over the Organic molecules which are currently being used. Due to their nanometer size, they can easily enter into the molecular level of diesel. They immediately show their efficiency at ambient temperatures also. The manufacturing of Nano lubricant uses polymer, organic-inorganic, metals, metal oxides is done using nanoparticles.

2. EXPERIMENTAL STUDY

The experimental investigation in research is carried out in two phases.in the first face, the various physiochemical properties of diesel and nanoparticles blend will be determined. The study property is cloud and pour point, flash point, kinematic viscosity, firer point gross calorific value using standard ASTM guidelines. In the second phase of research the emission characteristics and performance on a VCR Engine test setup of 1 cylinder, 4 strokes, Diesel by using the plane diesel and modified diesel. The method of preparing the Nano additive fuel along with the experimental procedure is given below. The nanoparticle use for modifying the fuel is bought for the company name Nano wing, Telangana, India. The fuel is mixed properly using the ultrasonicator machine of 45 KH. The nanoparticle used in mixing is measure using a high precision electronic weighing machine .the blend made is used immediately to avoid any settlements of nanoparticles.

3. LITERATURE SURVEY

[1] Nitin samuel, muhammed saffek k: ‘performance and emission characteristics of a c.i engine with cerium oxide nanoparticle as additive to diesel ‘. International journal of science and research (ijsr) (online):2319-7064.:-

The analysts have contemplated the utilization of nanoparticles mixed with the energizes as an elective fuel in the diesel motor. In this specific survey we investigate the analysis performed wherein an unadulterated diesel was first tried independently for every one of its esteems and afterward it was mixed with cerum oxide nanoparticles and see the change in the execution of the motor Cerum oxide is an oxygen giving impetus or ingests oxygen for the diminishment of no2. The oxygen required for oxidation of co is given by cerum oxide. At the point when cerum oxide is included as nanoparticles the outflows of NO2 and hc were lessened by 30% and 45% and the effectiveness of the motor was expanded by 5%.

[2] J. Sadhik basha, rb. anand b: “performance, emission and combustion characteristics of a diesel engine using carbon nanotubes blended jatropha methyl ester emulsions”. alexandria engineering journal (2014):-

In this specific paper, tests are done on the properties of a fuel when mixed with carbon nanotubes (cnt) and jatropha methyl esters (jme). At the point when jatropha oil experienced transesterification process jme was created. Also, the jme emulsion was in extents 2% surfactants, 5% water, and 93% jme. These emulsions were made with a lipophilic-hydrophilic adjust of 10. The test comes about demonstrated to us an extraordinary increment in the brake warm effectiveness of the jme regarding the unadulterated diesel. also, because of the joined impacts of auxiliary atomization and miniaturized scale blast related with the jme mixed cnt, the measure of unsafe toxins in fumes gases was lessened altogether when contrasted with that of perfect diesel.

[3] Rolvind’silva, binu k.g, thirumaleshwarabhat: “performance and emission characteristics of a c.i. engine fuelled with diesel and tio2 nanoparticles as fuel additive”. Materials today: proceedings 2 (2015) 3728 –3735:-

In this paper the titanium dioxide nanoparticles are made utilization of as fuel added substances in CI motor this specific examination is performed to break down the parameters like calorific esteem, thickness, fire point, consistency, and so on. There was likewise an expansion in brake warm productivity by the expansion of titanium dioxide. Likewise there was a lessening in the brake particular fuel utilization on option of these nanoparticles and it is watched that with including cerum oxide 5% expansion in motor effectiveness. Nox and hc emanations diminish 30% and 45% separately and with titanium dioxide (tio2) emissions of co lessens by 25% and outflows of unburnt hc decreases by 18%. bsfc diminishes by 22%.

[4] T. Venkateshwara Rao, G. Prabhakar Rao and K. Hema Chandra Reddy, Experimental investigation of pongamia, jatropha and neem methyl esters as biodiesel on ci engine volume 2, number 2, Jun, 2008. ISSN 1995-6665 pages 117-122t:-

Directed trial examination on execution and emanation qualities of diesel motor fuelled with methyl esters of pongamia (pme), Jatropha (JME) and Neem (NME) oil and its mixes with diesel. Amid examination, they watched that motor execution and emanations with B20 (20% pme and 80% diesel) were nearer to diesel.

[5] Silvio c. a almeida, carlos rodrigues belchior, marcos v.g. nascimento, leonardo dos s.r. vieira, guilherme fluery, “performance of a diesel generator fuelled with palm oil’’. Fuel 81 (2001) 2097-2102:-

Examined execution of a normally suctioned MWM 229 direct infusion four-stroke 70 kW diesel-generator fuelled with 100% palm oil. Amid examination the palm oil is warmed to 100°C for enhancing the fuel properties like thickness for better ignition and lower motor stores. They watched second rate motor execution because of its higher thickness and they additionally watched stopping up of fuel lines and beginning troubles in low temperatures.

[6] Stein rune nordtvedt, institute for energy technology, instituttveien 18, n-2027 kjellerbjarne r. horntvedt, hybrid energy as, ole deviksvei 4, n-0666 oslo jan eikefjord, john johansen, nortura as, rudshøgda, norway stein.nordtvedt@ife.no-hybrid heat pump for waste heat recovery in norwegian food industry this paper was published in the proceedings of the 10th international heat pump conference 2011:-

Conventional nourishment organizations generally have offices for the generation of refrigeration and steam. Regularly, these offices run autonomously of each other regardless of whether they are a piece of the vitality framework in the organizations. There are just a modest bunch of organizations that need steam and as a rule, high temp water up to 80-100°C is adequate. Establishment of Energy Technology has done research on vitality recuperation in a mechanical setting, and particularly inside the sustenance business since 1995. This has brought about a half and half warmth pump (pressure/assimilation warm pump) utilizing a blend of smelling salts and water as working liquid. The mixture warm pump has the ability to convey high temp water up to 100°C, recouping waste warmth at approx. 50°C. This paper presents operational encounters with a particular cross breed warm pumps establishment at a Norwegian slaughterhouse. The half and half warmth pump recuperates warm from the refrigeration framework and deliver boiling water at 90°C.

4. TEST RIG DETAILS

- Product:- VCR Engine test setup 1 chamber, 4 strokes, Diesel (Computerized)
- Product code:- 234
- Engine Make: - Kirloskar, Type 1 chamber, 4 stroke Diesel, water cooled, control 3.5 kW at 1500 rpm, stroke 110 mm, bore 87.5 mm. comp ration ratio 12-18 .with 661 cc engine.661 cc.
- Type of dynamometer: - water cool, eddy current.

- Propeller shaft:- With universal joints
- Air box:- m s created with orifice meter and manometer
- Fuel tank:- Capacity 15 lit with glass fuel metering section
- Calorimeter:- Type Pipe in pipe
- Crank point sensor: - 1degree resolution with 5500 rpm.
- Data obtaining gadget: - NI USB-6210, 16-bit, 250kS/s.
- Digital voltmeter :- Range 0-200mV, board mounted
- Temperature sensor:- Type RTD, PT100, and Thermocouple, Type K
- Temperature transmitter:- Type two wire, Input RTD PT100, Range 0– 100 Deg C, Output 4– 20 mA and Type two wire, Input Thermocouple, Range 0– 1200 Deg C, Output 4– 20 mA
- Load pointer:- Digital, Range 0-50 Kg, Supply 230VAC
- Load sensor:- Load cell, type strain check, go 0-50 Kg
- Fuel stream transmitter:- DP transmitter, Range 0-500 mm WC
- Air stream transmitter:- Pressure Transmitter, Range (-) 250 mm WC
- Software:- Engine soft LV
- Rotameter:- 40-400 LPH and 25- 250 LPH for engine and calorimeter respectively
- Pump Type:- Monoblock
- Overall measurements :- W 2000 x D 2500 x H 1500 mm

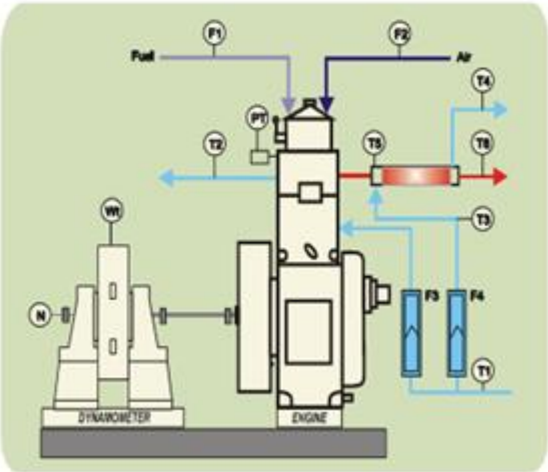


Fig no 1:- Systematic diagram of the test rig

5. METHODOLOGY

1) To gain more knowledge about the nanoparticle and its behavior.

2) To sort the type of nanoparticle which can be used.

3) The preparation process of nanoparticle and its blending techniques.

4. Searching Test ring for study and experimentation.

5) Performing test and collecting the required data

6) Data required

6.1.1. Engine description

6.1.2. flash and fire point

6.1.3. Volatility

6.1.4. Kinematic Viscosity

6.1.5. Bake thermal efficiency

6.1.6. engine torque and power

6.1.7. Hydrocarbon (HC)

6.1.8. Shoot

6.1.9. Carbon monoxide (CO)

6.1.10. Nitrogen oxide (NOx)

7) Evolution of data and finding the results

8) Conclusion

6. OBJECTIVES

The objectives considered to achieve above aims are as follows:

1) A critical review of literature pertaining to the nanoparticle as an additive.

2) To Study the performance of nanoparticle additive diesel with respect to plane diesel.

3) To prepare set of experimental apparatus to know the property of additive fuel by conducting series of experimentation on it.

4) To study the effect of different nanoparticles materials and to evaluate the overall performance of nanoparticle additive diesel made up of different materials.

5) To evaluate the effect of the different amount of nanoparticle on the performance of the CI engine.

6) To reduce the harmfull emission by burning of fuel.

7) To find the maximum amount of increase in efficiency and reduce in harmfull emission.

8) To study the effect of nano particles on engine emission and exhaust heat recovery.

9) Analysis of the data obtained by experimentation.

7. EXPERIMENTATION AND RESULTS

A. Preparation of Modified Fuels

The modified fuel is formed by adding required amount of the nanoparticle in the diesel and emulsifying it using the ultrasonicator machine in this case we use Alumina and cerium oxide.

To for 10ppm solution, we have to add 0.01g of nanoparticle in 1 liter of fuel

Therefore for 30ppm, we added 0.03g nanoparticle

B. Determination of Fuel Properties

The viscosity, flash, pour and cloud points were measured using standard test methods. Perthrotest viscometer is used to find viscosity. An important property is cloud point which is the point of temperature, at which the first wax network is created in the cooling liquid to cloud. It is the lowest temperature that the fuel can be used. Using fuel in temperature lower than cloud point can cause fuel filter clogging. The cloud point is determined according to ASTM D5773 standard by observing the fuel transparency that is cold under the controlled conditions.The pour point is the lowest temperature, which the fuel can flow. Then the fuel becomes solid after this temperature and it’s not useable. This point is very important to transfer the fuels in cold temperatures. ASTM D97 is the standard to determine the point. A Cleveland open cup flash and fire point apparatus was used for measuring the flash point.

Table-1: property of diesel and modified diesel

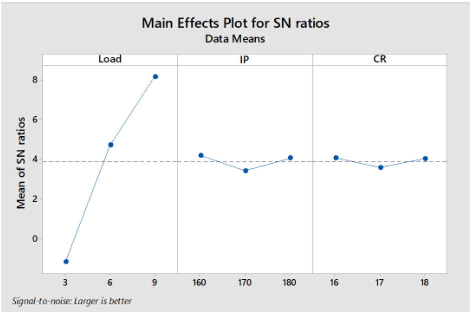
Properties	Diesel	Diesel + cerium oxide
Kinematic Viscosity @ 40°C,cSt	2	2.35
Density @ 15°C, gm/cc	0.83	0.8275
Flash Point, °C	50	11
Fire Point, °C	56	14
Cetane Number	46	44.6
Net calorific value, MJ/kg	42.3	39

Table-2: Taguchi L9 array

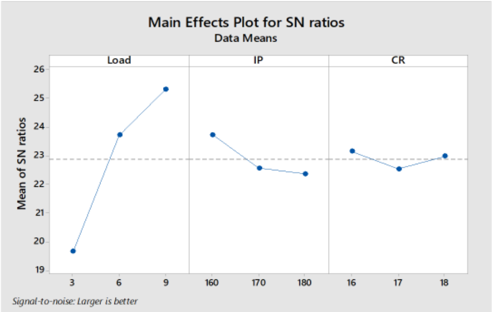
Sr no	A	B	C
1.	1	1	1
2.	1	2	2
3.	1	3	3
4.	2	1	2
5.	2	2	3
6.	2	3	1
7.	3	1	3
8.	3	2	1
9.	3	3	2

Table-3: Result table

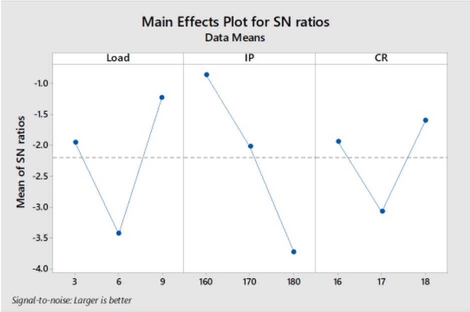
load	IP	cr	BP Kw	BTHE %	SFC Kg/Kw-Hr	Torque Nm
3	160	16	0.95	11.14	0.73	5.9
3	170	17	0.76	8.55	0.76	4.74
3	180	18	0.92	9.28	0.92	5.7
6	160	17	1.75	16.5	0.91	10.92
6	170	18	1.7	15.26	0.56	10.68
6	180	16	1.71	14.3	0.6	10.72
9	160	18	2.58	19.74	1.12	16.23
9	170	16	2.53	18.59	1.17	16.23
9	180	17	2.59	17.04	0.5	16.33



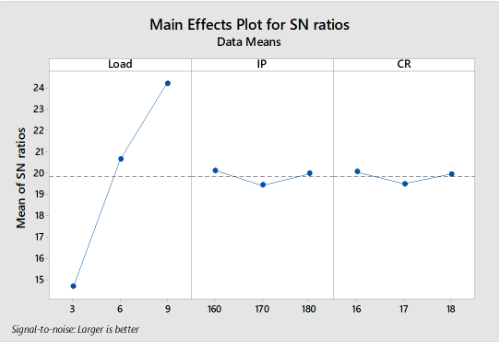
Graph-1 S/N ratio BP KW



Graph-2 S/N ratio BTHE %



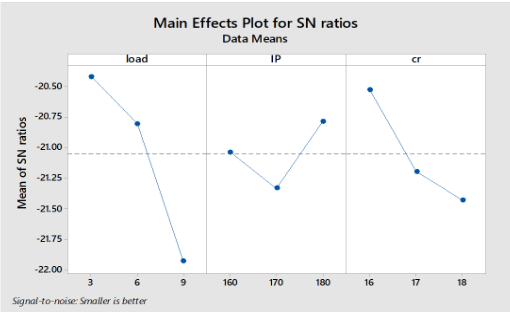
Graph-3 S/N ratio SFC Kg/Kw-Hr



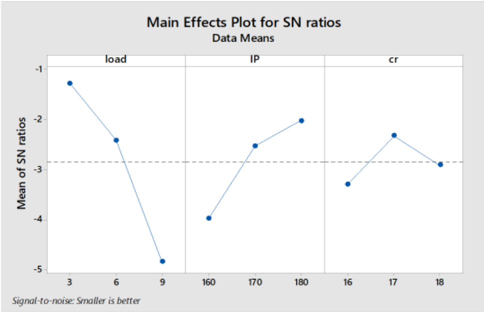
Graph-4 S/N ratio Torque Nm

Table-4: Emission result table

load	IP	cr	CO_2 (%)	CO (%)
3	160	16	10	1.3
3	170	17	11	1
3	180	18	10.5	1.2
6	160	17	11	1.6
6	170	18	12	1.2
6	180	16	10	1.2
9	160	18	13	1.9
9	170	16	12	2
9	180	17	12.5	1.4



Graph-5 S/N ratio CO2 (%)



Graph-6 S/N ratio CO (%)

8. OPTIMUM PARAMETER

The term optimum parameters reflect an only optimum combination of a parameter which will give maximum efficiency. For the engine performance, the response variable BTE and Torque Nm was higher the better. And for CO2 (%), CO (%) lower is better The criteria for optimization of the response parameters was based on the Higher-the better S/N ratio and Smaller -the better S/N ratio respectively is selected.

Table-5: Optimum parameter for each response variables

Controllable factor	BP Kw	BTHE %	SFC Kg/Kw-Hr	Torque Nm	CO_2 (%)	CO (%)
load	9	9	9	9	9	9
IP	160	160	160	160	170	160
CR	16	16	18	16	18	16

9. CONCLUSION

The Taguchi method is used to find the optimum parameter and result comes out are as follow. The result shows a significant increase in performance compares to plane diesel.

1) For BP KW optimum parameter is 9, 160, and 16.

2) For BTHE % optimum parameter is 9, 160, and 16.

3) For SFC Kg/Kw-Hr optimum parameter is 9, 160, and 18.

4) For Torque Nm optimum parameter is 9, 160, and 16.

5) For CO2 (%) optimum parameter is 9, 170, and 18.

6) For CO (%) optimum parameter is 9, 160, and 16.

10. REFERENCES

[1] Nitin Samuel, Muhammed Saffek K: performance and emission characteristics of ci engine with cerium oxide nanoparticle as an additive to diesel. International Journal of Science and Research (Ijsr) (Online):2319-7064.
[2] J. Sadhik Basha, Rb. Anand B: "Performance, Emission And Combustion Characteristics Of A Diesel Engine Using Carbon Nanotubes Blended Jatropha Methyl Ester Emulsions". Alexandria Engineering Journal (2014).
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