DISPERSION OF NANOMATERIALS IN DIESEL: A COMPARATIVE ANALYSIS

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Abstract – In this work, the study on the effect of various nanomaterials in pure diesel has been carried out. The nanomaterials considered in this work are cerium zirconium oxide, cerium oxide and cerium zirconium oxide+cerium oxide. Further, the above said nanomaterials are mixed with diesel using utrasonicator for different dosage of 30 mg, 60 mg, 90 mg and 120 mg. Thereafter, the properties such as flash point, fire point, density, viscosity and calorific value of the diesel dispersed with above said nanomaterials are evaluated. It has seen from the result that flash point can be increased during mixture of Cerium Zirconium Oxide and Diesel (90 mg + 1 litre), fire point can be increased during mixture of Cerium Zirconium Oxide and Diesel (120 mg + 1 litre), Density of prepared sample has slightly increased compared to pure diesel, viscosity of prepared sample can be increased during mixture of Cerium Zirconium Oxide, Cerium Oxide and Diesel (30 mg + 1 litre) and Calorific value of prepared sample can be increased during mixture of Cerium Zirconium Oxide, Cerium Oxide and Diesel (120 mg + 1 litre).

***Key Words*:** Nanomaterials, nanofluids flash point, density,viscocity,calorific value.

1. Introduction

Nanotechnology gives an idea of research to give materials with sizes less than 100 nm called **nanomaterials**. The nanomaterials term consists of nanocrystalline-materials, nanocomposites, & carbon-nanotubes. Because of nanostructural charecteristics, materials exhibit improved mechanical, physical, thermal and chemical properties than traditional materials. Generally, there are 4- types of nanomateials: nanomaterials (carbon based), nanomaterials (Metal based), Dendrimers & Composites. When these nanoparicles included in conventional fluids defined as nanofluids**.** Nanofluids clearly gives increased thermo-physical-properties depends on the volume fraction of nanoparticles, shape & size of the nanomaterials.

Because of limited supply & continous demand, fuel i.e. diesel prices are going up day-by-day. Based on this situation, researchers are plan to increasing the performance of automobiles by using various methods,

1.decreasing the vehicle weight,

2. the engine performance, improvement

3.vehicle vibration reduction,

4. precision electronics control system.

Subsiquently nanotechnology arrived , the nanoparticles are utilized as fuel additives to increase the fuel economy and reduces the exhaust emissions which also increases the combustion because of nanoparticle additives.

2. Synthesis approaches

2.1 Top-Down approaches:

In this approach, the bulk material was used, which is externally controlled for the formation of the nanostructure. Some examples are etching, ball milling, plastic deformation, and cutting.

2.2 Bottom-Up approaches:

In this approach, small-scale components were used, which were self assembly for (atom by atom or molecule by molecule) leading to the formation of the nanostructure

3 Different materials

The cerium zirconium oxide, Cerium oxide material are used in this work.

.The SEM images are as follows:

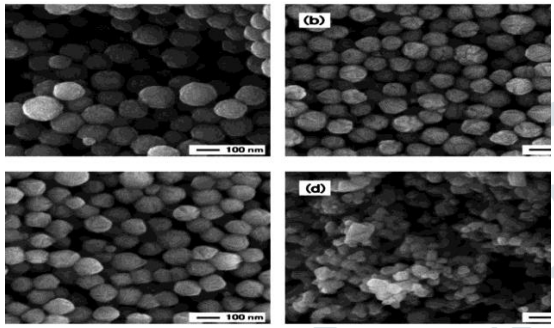

Fig. 1. Cerium zirconium oxide (SEM Image)

Table 1. The specification of CeO_2

Sl. No.	Specifications	Value/Quantity
1.	Molecular Formula	CeO_2
2.	Molecular Weight	172.11 g/mol
3.	Average Particle Size	30-50 nm

Dispersion of nanoparticles into Diesel:

By using Ultrasonicator machine Dispersion of Nano-particles into diesel are done. ultrasonic capitation produce high shear forces, ultrasonic capitation has a ability to break up of particle agglomerates and results in more uniform particles sizes and smaller. The homogenous suspensions created by ultrasonic are used in many industries today. Probe sonication is highly effective for processing nanomaterials. with the help of an ultrasonicator the process of inluding nanoparticles into the fuel is done. This is the best method to disperse the nanoparticles into the diesel fuel, as it helps for agglomerate nanoparticles return to nanometer range.

(a) Magnetic stirrer (b) Ultrasonicator

Fig 2: Appartus used for the dispersion of Nano-particles with bio diesel

$CeZrO_4$ nanoparticles: The known weight say 30mg, 60mg ,90mg and 120 mg dispersed into the diesel with the use of ultrasonicator @ a frequency of 20 kHz for 50 minutes. The obtained nanoparticles blended diesel is known as diesel + nanomaterial. To check the stability nanomaterial blends were kept in container under static conditions.

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Cerium Zirconium Oxide and Cerium Oxide nanoparticles: a known weight say 30mg, 60mg, 90 mg and 120 mg dispersed into the diesel with the use of ultrasonicator @ a frequency of 20 kHz for 50 minutes. The resulted nanoparticles blended diesel is named as diesel + nanomaterial. To check the stability nanomaterial blends were kept in container under static conditions

4. Results of prepared diesel samples.

To find out fire point, flash point, density, and viscosity by using different experimental setup by testing of the samples have been done

Table 2. Flash point of Cerium Zirconium Oxide and Diesel

Sl. No.	Composition $CeZrO_4$ + Diesel	Temperature in degree Celsius
1	30 mg +1 litre	46
2	60 mg + 1 litre	52
3	90 mg + 1 litre	58
4	120 mg + 1 litre	56

Table 3. Flash point of Cerium Oxide and Diesel

Sl. No.	Composition CeO_2 + Diesel	Temperature in degree Celsius
1	30 mg +1 litre	52
2	60 mg + 1 litre	53
3	90 mg + 1 litre	55
4	120 mg + 1 litre	57

Table 4. Flash point of cerium zirconium oxide + Cerium Oxide and diesel

Sl. No.	Composition ($CeZrO_4$ + CeO_2) + Diesel	Temperature in degree Celsius
1	30 mg +1 litre	57
2	60 mg + 1 litre	57
3	90 mg + 1 litre	55
4	120 mg + 1 litre	54

Table 5. Fire point of Cerium Zirconium Oxide and Diesel

Sl. No.	Composition $CeZrO_4$ + Diesel	Temperature in degree Celsius
1	30 mg +1 litre	52
2	60 mg + 1 litre	58
3	90 mg + 1 litre	62
4	120 mg + 1 litre	70

Table 6. Fire point of Cerium Oxide and Diesel

Sl. No.	Composition CeO_2 + Diesel	Temperature in degree Celsius
1	30 mg +1 litre	58
2	60 mg + 1 litre	59
3	90 mg + 1 litre	62
4	120 mg + 1 litre	68

Table 7. Fire point of Cerium Zirconium Oxide + Cerium Oxide and Diesel

Sl. No.	Composition ($CeZrO_4$ + CeO_2) + Diesel	Temperature in degree Celsius
1	30 mg +1 litre	70
2	60 mg + 1 litre	62
3	90 mg + 1 litre	55
4	120 mg + 1 litre	55

Table 8. Density of Cerium Zirconium Oxide and Diesel.

Sl. No.	$CeZrO_4$ + Diesel	At 40 ^{0}C	At 50 ^{0}C	At 60 ^{0}C
1	30 mg + 1 litre	0.7902	0.803	0.7916
2	60mg + 1 litre	0.7966	0.7896	0.792
3	90 mg + 1 litre	0.7902	0.803	0.8104
4	120 mg + 1 litre	0.8024	0.7866	0.7844

Table 9. Density of Cerium Oxide and Diesel.

Sl. No.	CeO_2 + Diesel	At 40 ^{0}C	At 50 ^{0}C	At 60 ^{0}C
1	30 mg + 1 litre	0.7960	0.7780	0.8180
2	60mg + 1 litre	0.8142	0.8062	0.8152
3	90 mg + 1 litre	0.8162	0.8060	0.8150
4	120 mg + 1 litre	0.8242	0.8124	0.8190

Table 10 Density of Cerium zirconium Oxide Cerium Oxide and Diesel.

Sl. No.	Composition ($CeZrO_4$ +CeO_2)	At 40 ^{0}C	At 50 ^{0}C	At 60 ^{0}C

1	30 mg + 1 litre	0.7992	0.7530	0.7630
2	60mg + 1 litre	0.7968	0.8026	0.8166
3	90 mg + 1 litre	0.7920	0.7938	0.8068
4	120 mg + 1 litre	0.8104	0.8044	0.7924

Table 11. Viscosity of Cerium zirconium Oxide and Diesel.

Sl. No.	$CeZrO_4$ + Diesel	At 40 ^{0}C	At 50 ^{0}C	At 60 ^{0}C
1	30 mg + 1 litre	4.10	3.82	3.61
2	60mg + 1 litre	4.231	4.022	3.801
3	90 mg + 1 litre	4.012	3.901	3.625
4	120 mg + 1 litre	4.371	3.812	3.745

Table 12. Viscosity of Cerium Oxide and Diesel

Sl. No.	CeO_2 + Diesel	At 40 ^{0}C	At 50 ^{0}C	At 60 ^{0}C
1	30 mg + 1 litre	4.118	3.868	3.58
2	60mg + 1 litre	4.208	3.958	3.468
3	90 mg + 1 litre	4.310	4.105	3.554
4	120 mg + 1 litre	4.190	3.630	3.450

Table 13. Viscosity of Cerium zirconium Oxide Cerium Oxide and Diesel.

Sl. No.	Composition ($CeZrO_4$ + CeO_2)	At 40 ^{0}C	At 50 ^{0}C	At 60 ^{0}C
1	30 mg + 1 litre	4.318	3.868	3.613
2	60mg + 1 litre	4.258	3.818	3.418
3	90 mg + 1 litre	3.996	3.496	3.478
4	120 mg + 1 litre	4.096	4.448	3.548

5. RESULTS

5.1. Flash and fire Point

The fuel sample is filled in cup up to the mark. The cup is electrically heated. The increase of temperature is maintained by regulator and increase in temperature on thermometer is regularly watched. Test flame is ignited. The test flame is first applied at a temperature about 100°C. Test for the flash point is carried for every 5°C to 10°C rise. When liquid catches fire is gives the flash point of the fuel. Fire point is observed by further heating at the same rate. observe the ignited temperature at which vapour mixture continue to burn for minimum five seconds when the test flame is brought near to it.

5.2 Viscosity

By using Redwood viscometer the viscosity is measured. The viscosity of oil is measured by pouring it in to a cup surrounded by water jacket. The thermometer is held in position. The empty 50ml measuring flask weight is noted. The temperature of oil in the cup is monitored by switching heater on. When the temperature of oil reaches to required temperature at which viscosity is to be measured, heating is stopped.50ml measuring flask is placed below the jet. When the stop watch is started the ball valve is lifted . The ball valve is closed and stop watch is stopped. when oil in the flask reaches the 50ml mark. The flask with 50ml of oil is noted.

5.3 Comparative study

Table 14. Comparative study of fuel blended with various nanomaterials

Sl. No.	Types of fuel	Flash point (^{0}C)	Fire point (^{0}C)	Density at 40^0 C (gm/m^3)	Viscosity at 40^{0}C (cSt)
1.	$CeZrO_4$ + diesel (30 mg + 1 litre)	46	52	0.7902	4.10
2.	$CeZrO_4$ + diesel (60 mg + 1 litre)	52	58	0.7966	4.231
3.	$CeZrO_4$ + diesel (90 mg + 1 litre)	58	62	0.7902	4.012
4.	$CeZrO_4$ + diesel (120 mg + 1 litre)	56	70	0.8024	4.371
5.	CeO_2 + diesel	52	58	0.7960	4.118

	(30 mg + 1 litre)				
6.	CeO_2 + diesel (60 mg + 1 litre)	53	59	0.8142	4.208
7.	CeO_2 + diesel (90 mg + 1 litre)	55	62	0.8162	4.310
8.	CeO_2 + diesel (120 mg + 1 litre)	57	68	0.8242	4.190
9.	($CeZrO_4$ + CeO_2) + diesel (30 mg + 1 litre)	57	70	0.7992	4.318
10.	($CeZrO_4$ + CeO_2) + diesel (60 mg + 1 litre)	57	62	0.7968	4.258
11.	($CeZrO_4$ + CeO_2) + diesel (90 mg + 1 litre)	55	55	0.7920	3.996
12.	($CeZrO_4$ + CeO_2) + diesel (120 mg + 1 litre)	54	55	0.8104	4.096
13.	Pure Diesel	48	55	0.835	4.10

Conclusions

In this work, various nanomaterials are dispersed in pure diesel has been prepared and properties are evaluated. Further, the conclusions of the work are as follows:

- It has seen from the result that flash point can be increased during mixture of Cerium Zirconium Oxide and Diesel (90 mg + 1 litre).
- The result shows that fire point can be increased during mixture of Cerium Zirconium Oxide and Diesel (120 mg + 1 litre).
- Density of prepared sample has slightly increased compared to pure diesel.
- The viscosity of prepared sample can be increased during mixture of Cerium Zirconium Oxide, Cerium Oxide and Diesel (30 mg + 1 litre).

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