EFFECT OF ZINC OXIDE NANO-ADDITIVE ON EMISSION PROPERTIES OF DISEL ENGINE

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Abstract: New research focusing on the impact of the sheet-like ZnO nanostructures biodiesel-fuelled VCR engine emission properties. ZnO nanostructure synthesis was achieved using zinc nitrate salt. The nanostructures of the synthesized ZnO were characterized for X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Energy dispersive spectra (EDS), and UV-visible spectra etc. XRD have confirmed the formation of ZnO. The morphological investigation exposes ZnO's sheet-like nanostructure. The different blends of Nano fuels prepared using mixture of biodiesel and diesel (30% vol : 70% vol). The large surface area of ZnO nanostructures helps to minimize CO_2 emissions by mixtures of Nano fuels.

***Key Words* – Nano fluid, ZnO, Emission, Diesel Engine, Biodiesel.**

1. INTRODUCTION

New situation, which raises fuel prices and fossil fuel depletion day by day, raises the market for industrial biofuels as well as heavy duty diesel engines. Big alternating source of clean and green energy for today's world's sustainable development is nothing but biofuels [1]. This renewable and clean fuel decreasing emissions of HC, CO, CO_2, NO_x and smoke on the contrary these renewable fuels with low calorific value and high brake-specific fuel consumption (BSFC) can also decrease emissions by incorporating sufficient nano-additives and enhancing the brake thermal efficiency (BTE) [2].

Biodiesel is one of the best green fuel with low carbon emissions as well as reduced NOx emissions and high density for fossil fuels biofuel. In this report, we concentrate on the alternative to fossil fuels using biofuel and diesel mixture based on nano-additives. In the current situation, the structure, properties and extra ordinary properties of nanoparticles help to achieve the necessary target. The Nano fluid decreases the emission properties and increases the efficiency and other parameters needed.

2. EXPERIMENTAL

2.1 Preparation of ZnO nanostructures

The nanostructures of Zinc oxide synthesized for the preparation of different biodiesel blends. Zinc nitrate salt is dissolved in 50 ml of distilled water, in this synthesis. To this solution were added 4.82 gm of malic acid. Using magnetic stirrer this mixture is stirred at room temperature for 15 min to get clear mixture of zinc salt. The above mixture was then applied dropwise to 0.2 M NaOH solution. There is formation of precipitated zinc hydroxide. Sonochemically this solution is kept at room temperature for 2 hrs. Material type is centrifuged and washed with water after application. The precipitate obtained during 12 hours was dried at 55°C.

2.2 Preparation of different bends of Nano fuels

The as-synthesized sheet-like nanostructures of ZnO are blended into biodiesel and diesel mixture (30% vol: 70% vol) to form 10 ppm of ZnO, 30 ppm of ZnO, 50 ppm of ZnO and 70 ppm of ZnO. Produced the four ZnO Nano fuels blend.

3. CHARACTERIZATION

The crystallinity of sheet-like zinc oxide nanostructures was determined by using Powder X-ray diffraction (XRD) on the Philips (Xpert) X-ray diffractometer using Cu kα wavelength 1.540 Å. Morphology and Energy dispersive spectra of as-synthesized ZnO samples were defined by JEOL JSM-7600F FEG-SEM. The optical characterization of zinc oxide sample was performed using JASCOV-570 spectrophotometer. The emission properties of Nano fuels were tested on VCR DI-CI water cooled diesel engine.

4. RESULTS AND DISCUSSION

4.1 XRD

Zinc oxide nanostructures were phase-identified using X-ray diffraction analysis. The sheet-like ZnO XRD spectra is shown in Figure 1. From the figure, the high (hkl) peaks of 30.89, 33.49, 34.88, 46.42, 54.79 and 60.87 corresponding to the lattice planes (100), (002), (101), (102), (110), and (103), respectively. The spectral data is in good agreement with JCPDS card no. 036-1451 and shows that the products are in the pure hexagonal process of wurtzite ZnO. The solid and sharp peak demonstrates the crystallinity of a sample of zinc oxide. The average size of ZnO in crystallite was determined by Debye Scherer method.

$$D = \frac{0.9\lambda}{\beta \cos \theta} \qquad \text{--------- (1)}$$

Where D is the size of the crystal, where λ is the wavelength of the X-ray, where θ is the angle of the Braggs in the radians, and β is the full width in the radians at half the limit.

ZnO nanostructures averaged crystallite size was found to be 20.11 nm. This will help to boost the properties of bends of Nano fuels.

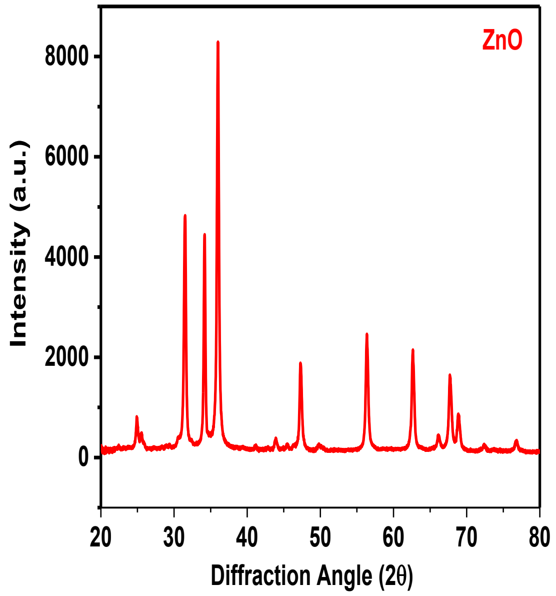

Figure 1: XRD spectra of ZnO.

4.2 SEM

The structural and surface morphological study of the ZnO nanostructures was performed using scanning electron microscopy. Figure 2 showed the SEM image of the ZnO nanostructures as-synthesized. The nanostructure of the ZnO morphology was sheet-like. Nanosheets thickness ranging from 10-15 nm in front and length from 400-500 nm in range. These nanosheets get interlocked to form sheet network. It was due to sonochemical treatment at room temperature that nanostructures formed. The broad surface area for the ZnO nanosheets was observed. This field can improve the performance of bends in Nano fuels.

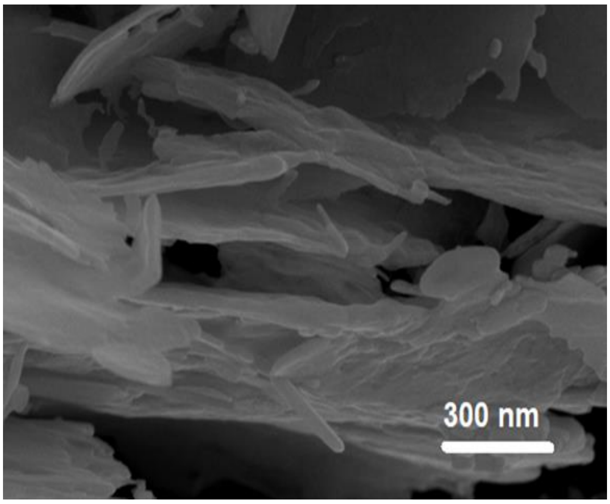

Figure 2: SEM image of ZnO nanostructures

4.3 EDS

To verify the elemental composition of nanomaterials the energy dispersive spectra of ZnO nanostructures are performed. The ZnO nanostructures EDS spectra as shown in Figure 3. The figure only shows peaks caused by zinc and oxygen. The proportion of the Zn and O atomic composition was 58.90 and 41.10 respectively. The no other impurity peaks were observed in ZnO's EDS spectra, which clearly indicated that the as-synthesized sample consisted only of elements Zn and O.

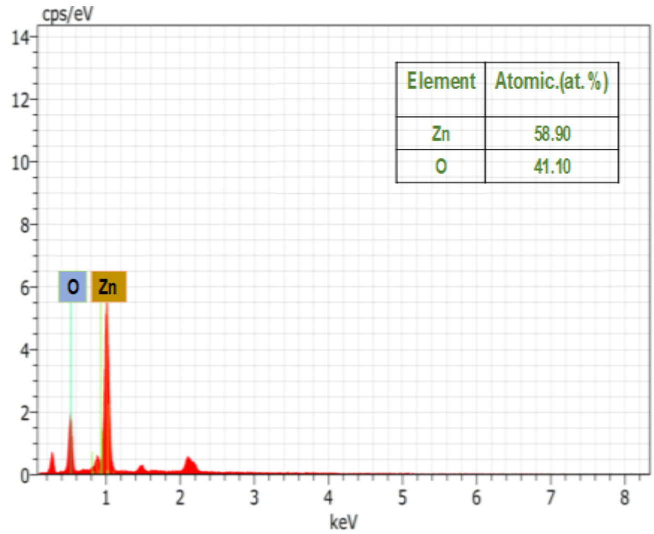

Figure 3: EDS image of ZnO nanostructures.

4.4 OPTICAL PROPERTIES

The optical properties of ZnO nanostructures that have been tested to identify defects in nanomaterial crystal structure. Figure 4 showed the UV-visible spectra of sheet-like nanostructures in ZnO. The UV-visible spectra give clear information about the absorption by zinc and oxygen of atomic vibrations. The nanostructures of ZnO exhibit strong UV absorption as well as visible region. Because of sheet-like zinc oxide structure the blue shift in absorption was observed.

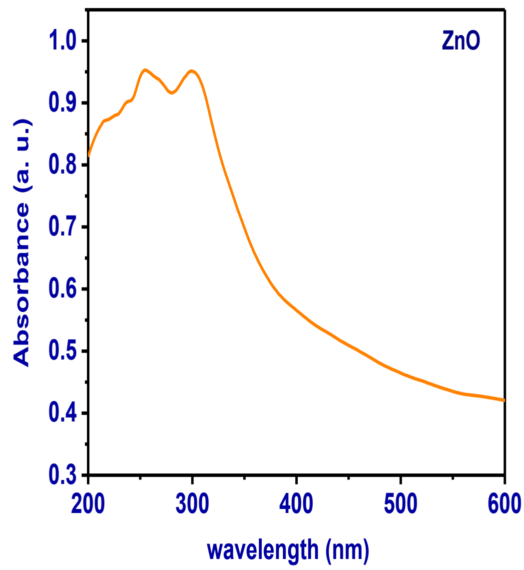

Figure 4: UV Spectra of ZnO.

4.5 EMISSION PROPERTIES

Nano fuels' emission properties were tested with VCR DI-CI water cooled diesel engine. The results obtained for CO_2 emissions were shown in Figure 5. From Figure, the biodiesel shows more CO_2 emissions with increased load. Biodiesel emission results were high when compared to other Nano fuel blends. Compared with all other samples, the CO_2 emission of 50 ppm of ZnO blend is much less. With an improvement of the ZnO nanostructure, the concentrations of 50 ppm and 70 ppm were drastically reduced. Owing to more desperations of nanoparticles in biodiesel and diesel mixture, the again rise in CO_2 emissions was observed after particular ppm.

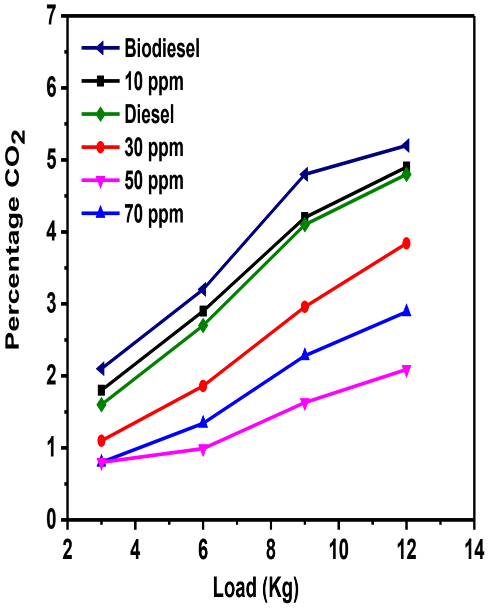

Figure 5: Emission properties of different blends of Nano fuels.

4. Conclusion

The nanostructures for ZnO have been prepared using sonochemical process. In this study, the effect of ZnO nanostructures on biodiesel and diesel emission properties accomplished with variable compression ratio was studied. The sheet-like nanostructure of ZnO reduced CO_2 emissions, which in turn could increase other parameters such as the thermal brake efficiency (BTE). The analysis of ZnO nanostructures were done by using different physicochemical techniques.

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