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# Synthesis of nanoparticles in dual biodiesel and enchancement in performances and emission characteristics

## ABSTRACT

*Biodiesel is being advertised as a realistic alternative fuel. Since it has a lower environmental effect than standard fuel properties, biodiesel has risen in popularity recently, and there has been a lot of study done on it all around the world. Biodiesel is prone to oxidation due to the presence of unsaturated fatty acids in the ester, which has been one of the biggest downsides. When biodiesel comes into contact with oxygen during storage or even with metal impurities, it oxidises. Antioxidants are really helpful in resolving problems with oxidation stability. In this paper, mainly discussed about dual biodiesel (40:60), mixed with $TiO_2$ Nanoparticles at various 25 ppm levels for the blend DBNP20, DBNP40 and DBNP60 respectively. The results implies good performances and emission characteristics with lower SFC and reasonable values are tabulated in the with neat diesel values.*

***Keywords:*** *Oxidation stability, CFPP, $NO_x$, CO, HC, Smoke opacity.*

## 1. INTRODUCTION

Biodiesel materials from natural biological sources like vegetable oils and animal fats is known as sustainable biofuels. It's harmless and disposable, with low emission profiles. Therefore it's good for the environment. During biodiesel manufacturing process, oils and fats were transformed into long-chain mono alkyl esters, or biodiesel. The process of turning those molecules into fatty acid methyl esters is known as esterification (FAME). Biodiesel fuels ignite quality, CFPP, oxidative stability, viscosity, and lubricity all are effected by the structure of the constituent fatty esters.

Biodiesel is a well-known renewable energy source that is an environmentally beneficial, economically competitive, and technically viable alternative to petroleum-derived fuel, and it does not require any mechanical modifications to diesel-powered engines. The blend combining 20:40 rice brain biodiesel and petro diesel fuel, both in volume, seems to be the most effective; unfortunately, the other blends seem to really be unsuitable for diesel engines in use today [1,2]. First-generation biofuels are made from the edible oil seeds sunflower seed, palm seeds etc. [3,4]. The effects of jatropha biodiesel on petrol diesel engines were evaluated and compared. Furthermore, factors influencing Jatropha's long-term biodiesel production capacity, and the emission and performance parameters of diesel engines running on Jatropha biodiesel differ from those of petrol diesel engines [5]. As contrasted to the regular B50, adding 15% of n-pentane per litre resulted in a Brake thermal increased by 7.1%, while brake specific fuel consumption decreased by 6.4%. Furthermore, there was a rise in nitrogen oxides in exhaust gases, which has been related to

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**Nomenclature**

| | | | |
|---|---|---|---|
| CO | Carbon Monoxide | CB | Candle Nut Biodiesel |
| $NO_x$ | Oxide of nitrogen | SB | Soap Nut Biodiesel |
| $CO_2$ | Carbon dioxide | $TiO_2$ | Titanium oxide |
| HC | Hydrocarbon | SFC | Specific Fuel Consumption |
| NP | Titanium Oxide | | |

CSB (DB100) 40% Candlenut Biodiesel + 60% Soapnut biodiesel

| | |
|---|---|
| DBNP 20 | 20% CSB+ 80% Diesel+ 25PPM (NP) |
| DBNP 40 | 40% CSB+ 60% Diesel+ 25PPM (NP) |
| DBNP 60 | 60% CSB+ 40% Diesel+ 25PPM (NP) |

the low oxygen content in B50 and the substantial increase in exhaust temperature In comparison to carbon dioxide emissions, which climbed by 22.3% over B50, greenhouse gas emissions declined by 7.2%. In comparison to B50, the quantities of carbon monoxide and oxygen in exhaust gases fell by 17.35% and 9.5%, respectively. Major improvements in pressure development and heat release statistics were discovered, that are reliant just on role of n-pentane inside the blended fuel mix [6]. 100% RA, 100% MU, and other RM blends such as BL20, BL40, BL60, and BL80, as well as diesel, are all part of the test research. According to the author's results, the BL20 blend performed best and is the most similar to diesel fuel. As per the testing data, the BTE of the BL20 mix was likewise determined to be 2.79 points lower than diesel fuel. BL20 emits 20.66% less CO, 8.56% less HC, and 6.9% less smoke as diesel at maximum load. The $NO_x$ emission, on the other hand, was somewhat higher by 3.77% t than that of diesel fuel [7]. Performance data for the DICI engine are tested at different loads at full throttle although brake specific energy consumption (BSEC) and exhaust gas temperature (EGT) are higher, performance metrics for air/fuel ratio, brake thermal, mechanical, and volumetric are found to be lowers when compared with plain diesel [8]. Whenever the blend D90 + JB5+NB5 is applied, the CO reduction is the maximum (46.91%). All of the mixtures in discussion emit more $CO_2$ than plain diesel [9]. At Compression Ratio 16.5:1 sample blends B10 to B40 showed somewhat better brake power and mechanical efficiency (0.15–1.58%) and (1.07–12.42%) respectively. Based on the overall characterisation, it was determined that B20 had the best characteristics and blend percentage of all the tested samples, making it a better substitute fuel for mineral diesel [10]. Author clearly explains about getting prepared for Dual Biodiesel and its performances characteristics of engine due to combined biodiesels. The amount of hydrocarbon and carbon monoxide in the atmosphere is decreasing [11]. The integration of Nano alumina at higher concentrations resulted in significant reductions in emissions. Nano alumina contains oxygen molecules, which react with carbon monoxide to produce carbon dioxide. In nanoparticles integrated biodiesel blends, the aforesaid technique considerably reduces carbon monoxide emissions[12]. It's also corrosive, surpassing crude oil in this regard. The use of biodiesel does have the ability to ruin engine components. Due to its corrosive nature [13,14]. The experiment evaluated the effectiveness of combining the gasoline with diesel. By combining non-edible oil and straight diesel, the fuel's characteristics are enhanced. The use of a candle and soap nut oil as a combined fuel source was explored [15].The results Implies that there is a reduction in BTE for RB10 and KB10 as that of diesel. And there is delay in ignition 1.83%, 2.02% for RB10& KB10 Respectively. In addition, there was a decrease in smoke and nitrogen oxide generation, and increase in carbon dioxide emission [16]. Furthermore, using bio diesel does not necessitate any modifications to the CI engine. Bio diesel has qualities that are extremely comparable to regular diesel. Bio diesel also has the advantages of being a renewable energy source, a clean source of energy, biodegradable, environmentally acceptable, emitting less pollutants, and being non-explosive [17,18]. Author It is stated explicitly that performance and emission parameters have improved in an acceptable manner that Candlenut when it is combined with cerium oxide [19]. Author explained that Biodiesel Can be also prepared from animal Fats through Transertification process and showed good improvements and concluded that it can be used as biodiesel [20,21]. A work was performed to explore the impact of alumina nanoparticles ($Al_2O_3$) in the Mahua biodiesel-diesel B20 fuel mix [22,23]. Dual biodiesel are blended in similar proportions by volume with the dual biodiesel. The testing was carried out under various load circumstances The biodiesels utilised here were made by a transesterification procedure, and a new biodiesel (RM) was created by blending equal amounts of Rapeseed and Mahua biodiesel (1:1) [24]. The author studied that by combining a two biodiesel made from Lemongrass & Mint oil, as well as $CeO_2$ as an ingredient to find out performance and emission characteristics of engine [25]. The performance and emission properties of Grape Seed Oil Bio-diesel were investigated in this study (GSO). Additives are used to enhance the biodiesel's combustion parameters. Biodiesel mixed with aluminium oxide additives [26]. The author experimented with Waste cooking oil doped with Iron and cerium oxide and tabulated the result [27]. The author explains the impact of various nanoparticle doses and sizes on diesel engine behaviour using characterisation techniques, and using a variety of strategies to increase the stability of biodiesel [28]. Author conducted the experiments in cerium Oxide as Nanoparticles and hydrogen peroxide as additives the results implies there is a reduced emission Characteristics when BTE increased [29].

In this present work Mixed fuel in the ratio of 40:60 (i.e. Candlenut and soapnut) is blended with 25 PPM of $TiO_2$ Nanoparticles is added for various proportions (DBNP20 ,DBNP40 & DBNP60 ) Along with Diesel. Overall Performance and emissions characteristics is Carried out in this work.

## 2. TRANSESTERIFICATION OF OILS INTO BIODIESEL

Transesterification is accomplished in two steps [22] 5g NaOH and 200ml methanol were combined individually using candlenut and soapnut oils. At a normal temperature of 60° C, this combining process takes one hour. To finish the separation, the mixture was put in a separatory funnel for 24 hours, biodiesel and glycerol are stacked in two layers by density. Extraction of the biodiesel, it was washed in a 1/1 ratio in hot water at 80°C, after the washing procedure, in used water is removed. The cleaning process is repeated till the pH of the water post washing equals 7, whereby the biodiesel is heated to 100°C to eliminate all residual water.

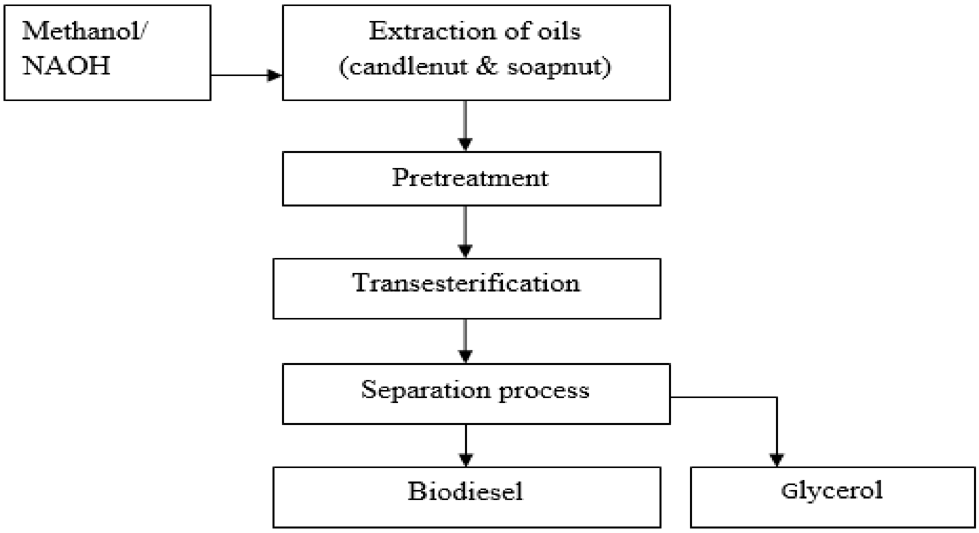


*Figure 1. Preparation of biodiesel*

*Slika 1. Priprema biodizela*

## 3. PRODUCTION AND MANUFACTURING OF NANOMATERIALS

Zinc acetate 2.1g per 100ml, ammonium carbonate 0.96g per 100ml, and polyethylene glycol 5g per 100ml were utilised in the synthesis. In the synthesis, titanium tetrachloride ($TiCl_4$) was used as a starting ingredient. A 50ml $TiCl_4$ solution was gently added to the 200 ml ice cold bath. After removing the beaker from the ice bath, it was allowed to warm up to room temperature. To ensure a homogenous mixture, the beaker was maintained in a magnetic stirrer for one hour. The bath temperature was determined to 150 degrees Celsius and remained there until the nano particle process was completed.

In below Tabulation the physical properties of Biodiesel is compared with pure Diesel And mixed blended format The Values are calculated as per ASTM standards.

*Table1. Properties of biodiesel*

*Tabela 1. Osobine biodizela*

| Sl.No | Parameter | Candlenut Biodiesel | Soapnut Biodiesel | Diesel | Candlenut+Sopnut Biodiesel |
|---|---|---|---|---|---|
| 1. | Cold filter plugging point ºC | 6 | 6 | -8b | 4 ºC |
| 2. | Density @ 40ºC, g/cc | 0.870 | 0.839 | 0.852 | 0.863 |
| 3. | Kinematic Viscosity @ 40ºC, cSt | 2.04 | 4.89 | 3.5 | 3.89 |
| 4. | Flash point ºC | 124 ºC | 167 ºC | 76 ºC | 114 ºC |
| 5. | Fire point ºC | 136 ºC | 16 ºC | 57 ºC | 86 ºC |
| 6 | Caloric value Cal/g | 8033.008 | 3850.009 | 10755.28 | 8334.67 |
| 7 | Oxidation stability 110 ºC H | 17.3 | 15.1 | 1.18b | 7.9 |

b- Obtained from AE Atabani [8]

## 4. EXPERIMENTAL PROCEDURE

The tests have been carried out with an eddy current dynamometer in a single cylinder four - stroke engine. Before modifying the engine, measurements for different blends are obtained. The governor is set to keep the engine running at a steady speed under various load conditions, as well as to keep track of the fuel consumption. Table 2 shows the engine specifications. In Below flow chart it explains about process flow of mixing dual biodiesel with nanoparticles in blended biodiesels.

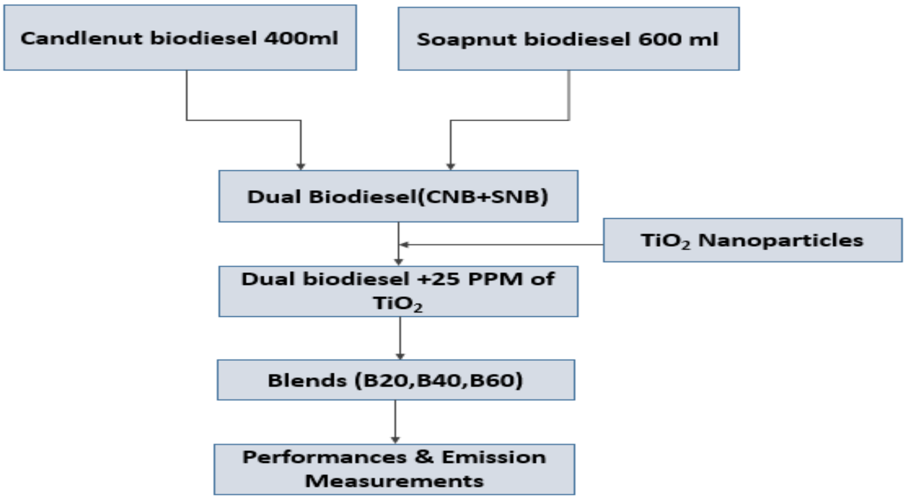


*Figure 2. Dispersion of Nanoparticles with dual Biodiesel process*

*Slika 2. Disperzija nanočestica sa dvostrukim procesom biodizela*

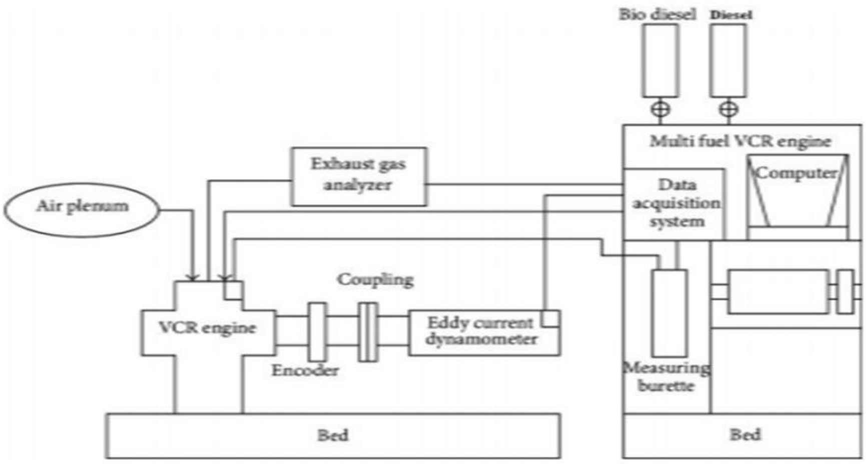


*Figure 3. Experimental Setup*

*Slika 3. Eksperimentalna postavka*

*Table 2. Engine specifications*

*Tabela 2. Specifikacije motora*

| Manufacturer | Kirloskar |
|---|---|
| Type | Direct Diesel Injection |
| Fuel | Diesel |
| Bore * Stroke | 87.5 x 110mm |
| Compression Ratio | 17.5 |
| Nozzle Opening Pressure(Bar) | 200 |
| Rated Power | 5.2kW @ 1500 rpm |
| Cycle | 4 Stroke |
| Cooling | Water Cooled |

## 4. RESULTS AND DISCUSSION

The incomplete combustion process is the key factors for CO and HC emissions as burning rates of biodiesel blends diminishes as the concentration of the blend raises, delaying in combustion rate this is mainly due good viscosity of the biodiesel as shown in the Fig.4 [21]. As the load increases the carbon monoxide this is mainly due to the presence of oxygen in the mixed fuel. From the Value it is clearly observed that 0% to full load condition for the blend DBNP20, DBNP40 & DBNP60 are 0.025%, 0.032% and 0.035% respectively.

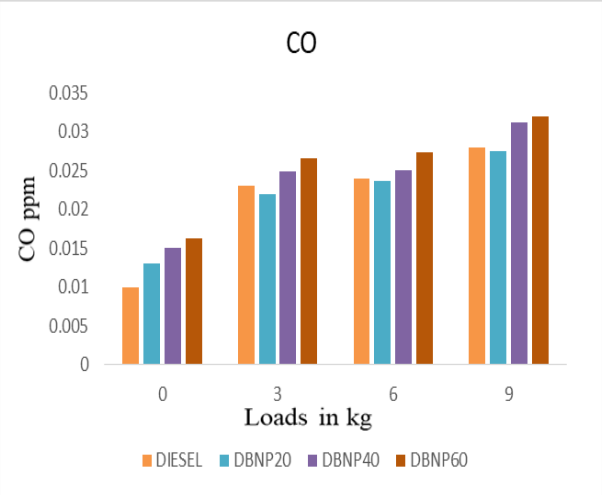


*Figure 4. Load vs CO*

*Slika 4. Opterećenje prema CO*

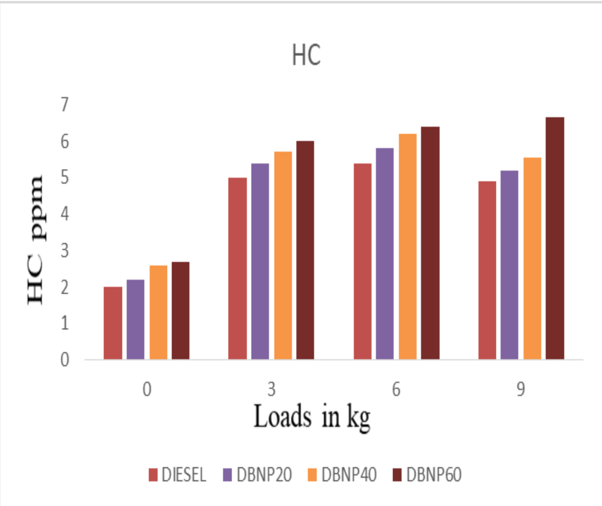


*Figure 5. Load vs HC*

*Slika 5. Opterećenje prema HC*

As the load increases for all blends the hydrocarbon decrease as the results implies it is because of the increased in cylinder temperature, For all combinations had lower HC as shown in the Fig.5 As the cylinder temperatures increases it implies faster combustion, this will be the reason for lower carbon monoxide and HC .The reported values 13%, 16% and 19% respectively.

From the Above Fig 6 it is clearly explains carbon dioxide emissions complete combustion take place for blended fuels. The highest average $CO_2$ emissions values were found for DBNP60, perhaps due to the greater carbon atom concentration compared to diesel. The addition of $TiO_2$ to the gasoline blend raises $CO_2$ emissions on average. On the other hand $NO_x$ increases mainly due increase in cylinder in temperature when it is mixed with nanoparticle. As the load increases Nitrous oxide gets Decreased for the blended fuel (B20, B40&B60).The Reported Values are 11%, 16% and 17% for DBNP20, Blends as drawn in fig.7.

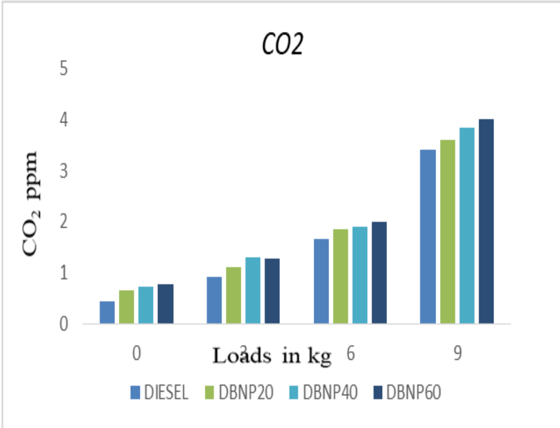


*Figure 6. Load vs $CO_2$*

*Slika 6. Opterećenje prema $CO_2$*

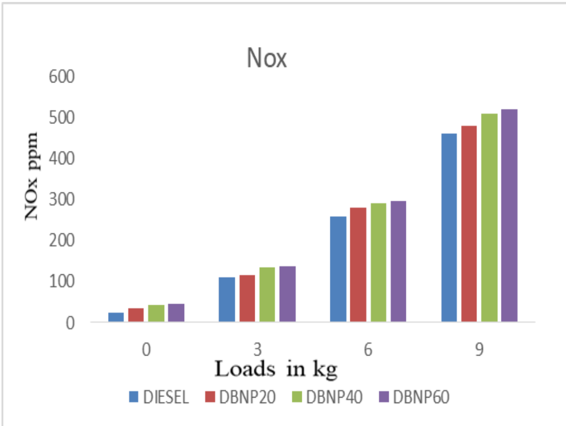


*Figure 7. Load vs $NO_x$*

*Slika 7. Opterećenje prema $NO_x$*

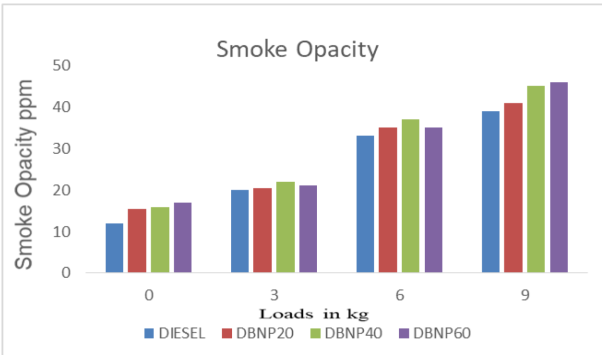


*Figure 8. Load vs Smoke opacity*

*Slika 8. Opterećenje u odnosu na neprozirnost dima*

The smoke opacity is made clear in fig.8 with all biodiesel mixes, increased diffusion reduces the generation of smoke. The smoke opacity was reduced by using bio - diesel and a $TiO_2$ compound that contains more oxygen. As a result, carbon atoms find it easy to interact with oxygen atoms in biodiesel. At initial load condition the smoke opacity was 10%, 12% and 16% respectively. At higher load condition diffusion is higher there is slight formation of smoke when compared with pure diesel are 18%, 19% and 21% respectively.

The BTE improves in direct proportion to the load. In addition, when the engine load rises, the SFC decreases. This is mainly Due to lower calorific values, all blends recorded greater SFC rates at half engine load. The DBNP20 on the other side, had a value that really was nearer to those of neat diesel due to its greater cetane value, as seen in fig.9. The BTE of mixed biodiesel for various load conditions is mostly resulting in higher viscosity and reduced heating values in engine, as shown in Fig. 10 [15]. The Reported values 17%.19% and 20% respectively.

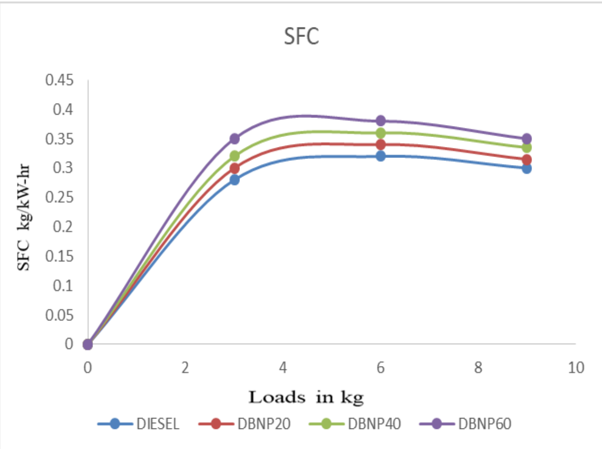


*Figure 9. Load vs SFC*

*Slika 9. Opterećenje prema SFC*

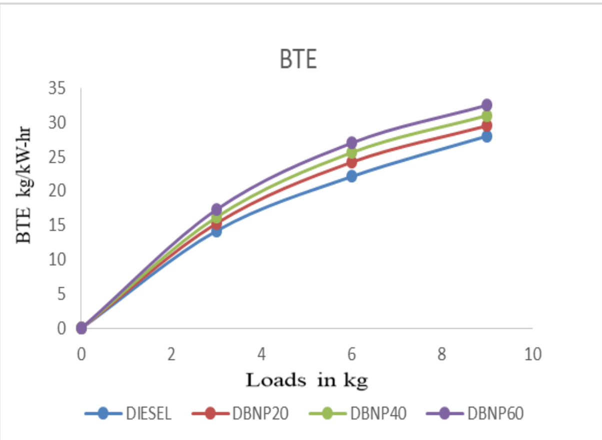


*Figure 10. Load vs BTE*

*Slika 10. Opterećenje prema BTE*

## 5. CONCLUSION

The effects of a mixed fuel concept on the performance, combustion, and emission characteristics of a CI engine were investigated in this study. Furthermore, the Ratio of (40:60) fuel samples found were DBNP20, DBNP40 & DBNP60. Because of its oxidation stability and CFPP, the mixed biodiesel ratio will pass through the engine nozzle without jamming due to climatic variations. The following points concluded

- Because of the oxygen level contained in the biodiesel, carbon monoxide emissions was demonstrated to be decreased throughout all dual biodiesel samples.
- Hydrocarbon emissions were also dramatically decreased in all dual biodiesel Ratio of 40:60 and it more over all values are nearer to pure diesel.
- The values of $NO_x$ is slightly higher is for all loading condition the values is about 17% increases with diesel for DBNP20 Good results in smoke opacity for blended fuel.
- SFC and BTE and showed good improvements in blended fuel when compared with diesel.

The use of nanoparticles in gasoline mixes has enhanced combustion because the huge surface area of nanoparticles increases response surface and heat transfer rate, resulting in a catalytic action during the burning process. According to the present data, the blended dual biodiesel Ratio of 40:60 DBNP20, DBNP40 had improved combustion and emissions qualities at a greater compression ratio. Additionally, in the future, they might be used to replace diesel. Without any changes made in the Engine.

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## IZVOD

## SINTEZA NANOČESTICA U DUALNOM BIODIZELU I POBOLJŠANJE PERFORMANSI I KARAKTERISTIKA EMISIJE

*Biodizel se reklamira kao realno alternativno gorivo. Pošto ima manji uticaj na životnu sredinu od standardnih svojstava goriva, biodizel je postao popularan, a o njemu je rađeno mnogo studija širom sveta. Biodizel je sklon oksidaciji zbog prisustva nezasićenih masnih kiselina u estru, što je jedan od najvećih nedostataka. Kada biodizel dođe u kontakt sa kiseonikom tokom skladištenja ili čak sa metalnim nečistoćama, on oksidira. Antioksidansi su zaista od pomoći u rešavanju problema sa oksidacionom stabilnošću. U ovom radu se uglavnom govori o dvostrukom biodizelu (40:60), pomešanom sa $TiO_2$ nanočesticama na različitim nivoima od 25 ppm za mešavinu DBNP20, DBNP40 i DBNP60. Rezultati impliciraju dobre performanse i karakteristike emisije sa nižim SFC i dobijene vrednosti su tabelarno prikazane u urednim vrednostima dizela.*

***Ključne reči:*** *oksidaciona stabilnost, CFPP, NOk, CO, HC, neprozirnost dima.*

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