International Journal of Natural and Engineering Sciences
Uluslararası Doğa ve Mühendislik Bilimleri Dergisi
E-ISSN: 2146-0086, 11 (1): 01-03, 2017. www.nobel.gen.tr

Effects of $CuNO_3$ Nano Particle on Diesel Fuel-Propanol Blend Fuels

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Received: February 17, 2017
Accepted: April 28, 2017

Abstract

In this experimental study, usage of $CuNO_3$ nanoparticles as diesel fuel additives were studied in order to improve the fuel properties and to decrease pollution emissions. The nano particles were added into blend of 10% i-propanol and 90% diesel fuel (P10) at the rate of 50 ppm and 100 ppm for preparing test fuels. The test fuels were called as dose ratio of nano particles and symbol of nano particle metal such as"P10Cu50". An ultrasonic shaker was used in order to obtain a uniform suspension of the nano particles in P10 fuel. Exhaust emission tests with a four single cylinder direct injection diesel engine were performed at full load conditions. Viscosity, density, Cetane number, copper strip corrosion and heating values of the test fuels were determined. Addition of the nano particles improved Cetane number values of P10. However, the other fuel properties did not change significantly. During the tests, better emission results were obtained with P10Cu100. Smoke opacity, CO and HC emissions decreased by 23.54%, by 31.03% and by 42.85%, respectively. In general, higher NO emissions with addition of nano particles were observed at higher engine speeds.

Keywords: I-propanol, Fuel properties, Alternative fuels, Diesel engine, Exhaust emission

INTRODUCTION

Governments have been promoting use of environmentally beneficial renewable alternative energy sources. Because, vast amount of polluting emissions are released into the environment with usage of fossil based fuels. Main reason of global climate change is these pollution emissions [1-3]. Increasing of the pollution on world is considered by scientists as threat for continuation of life.

Important of alternative energy sources are biomass, wind, solar and geothermal energy [4-5]. One of the biomass energy is using of alcohols as alternative fuel for internal combustion engines. While petroleum based fuels is consist of hundreds of different hydrocarbon chains alcohols are pure substance. Alcohols provide notably higher octane number, low viscosity, higher latent heat of evaporation, higher oxygen content, free aromatic and sulphur content [6-9]. Fuel properties are suitable for spark ignition engines. However, nowadays alcohols have been studied by researchers for compression ignition engines.

In this experimental study, usage of $CuNO_3$ nano particles as fuel additives were studied in order to improve the fuel properties of i-propanol - diesel fuel blends. Fuel properties of the test fuels were determined. Exhaust emission tests were performed with four cylinder direct injection diesel engine at full load conditions.

MATERIALS and METHODS

Test fuels

Preparing of the test fuels were carried out in Petroleum Research and Automotive Engineering Laboratories of the Department of Automotive Engineering at Cukurova University. $CuNO_3$ nano particles were added into blend of 10% i-propanol and 90% diesel fuel (P10) at the rate of 50 ppm and 100 ppm for preparing test fuels. The test fuels were called as dose ratio of nano particles and symbol of nano particle metal such as"P10Cu50". In order to obtain a uniform suspension of the nano particles in P10 fuel, an ultrasonic shaker (Sonic Vibra-Cell VC 750 model ultrasonic processor) was used for 2 hours. The ultrasonic shaker has a frequency of 20 kHz under 750 W working powers.

Engine Test

Schematic diagram of engine test system were shown in Figure 1. The test engine was a four cylinder, direct injection diesel engine. Technical specifications of the test engine were presented in Table 1. Before the test, the engine test system was operated for 20 minutes with diesel fuel to reach steady state operation temperature. During the tests, the engine temperature was kept under the control. Performance and emission tests of the fuels were carried out at full load conditions between 1800 and 3200 rpm with an interval of 200 rpm. Each of the fuels were tested 3 times and the averages of them were calculated as results.

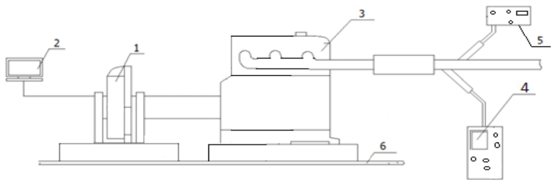

Figure 1. Schematic diagram of engine performance test system (1.Dynamometer, 2. Control panel, 3. Test engine, 4. Diesel emission analyzer, 5. Smoke meter, 6. Platform).

Table 1. Specification of the test engine

Model of engine	Mitsubishi Canter/4D34-2A
Cylinder number	4
Cylinder volume	3907 cm3
Bore	104 mm
Stroke	115 mm

Measurement of smoke emission was measured by using MRU OPTRANS 1600 smoke meter. CO, HC and NO emission values were measured by using MRU DELTA 1600 V gas analyzer. Specification of the smoke meter and the gas analyzer was given in Table 2 and Table 3, respectively.

Table 2. Technical specification of MRU OPTRANS 1600 gas analyzer

Accuracy	+/- 2 % relative
Resolution	0,1 %
Ambient temperature	+ 5° C to + 45° C
Storage temperature	- 32° C to + 50° C
Sample extraction	Partial stream technique
Measuring principle	Absorption photometry

Table 3. Technical specification of MRU DELTA 1600 V gas analyzer

CO	0-10%
CO_2	0-20%
HC	0-20000 ppm
O_2	0-22%
NO	0-4000 ppm
NO_2	0-1000 ppm
Lambda	0-9.99
Accuracy	According to OIML-class 1

RESULTS and DISCUSSION

As can be shown from Table 4, fuel properties of blend fuels were similar to those of diesel fuel. In comparison with diesel fuel values, viscosity, density, Cetane index and lower heating values showed decreasing trend. This situation is because of chemical and physical properties of i-propanol. Usage of $CuNO_3$ nano particles as fuel additives in P10 fuel improved Cetane index, lower heating value and viscosity. Lower Cetane number and lower heating value were important disadvantages of the blend fuels.

Table 4. Fuel properties of test fuels

Parameters	Diesel	P10	P10Cu50	P10Cu100
Viscosity, 40 °C (mm^2/s)	2,745	2,469	2,459	2,409
Density, 16 °C (kg/m^3)	837,1	832,8	832,8	833,5
Cetane index	54,025	50,105	51,447	53,718
Lower heating value (MJ/Kg)	46,27	43,89	43,99	44,309
Copper strip corrosion	1A	1A	1A	1A

CO emissions of the test fuels were given in Figure 2. CO emission values with addition of $CuNO_3$ nano particles were found to be lower than the diesel fuel and P10 values. This situation is probably due to catalyst effect of $CuNO_3$ nano particles during the combustion process. The catalyst effect improved combustion and promoted complete combustion. According to diesel fuel, maximum reduction ratio with P10Cu50 and P10Cu100 were 31.03% and 24.14% at 3000 rpm, respectively. Average reduction ratios were 12.65% with P10Cu50 and 13.69% with P10Cu100. The highest CO emission values were obtained with all fuel blends at 1200 rpm engine speed.

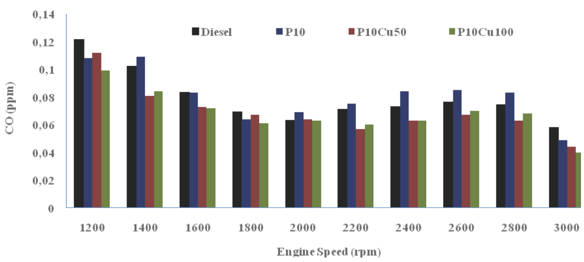

Figure 2. Variation of CO emission with test fuels

NO emission values of the test fuels are given in Figure 3. In general, NO emission values showed increasing trend with addition of $CuNO_3$ nano particles at high engine speeds in comparison with diesel fuel. However, NO emission values with P10Cu50 and P10Cu100 decreased slightly at low engine speeds. According to diesel fuel values, maximum decreasing ratio of P10, P10Cu50 and P10Cu100 were 7.52%, 26.60% and 10.14%, respectively.

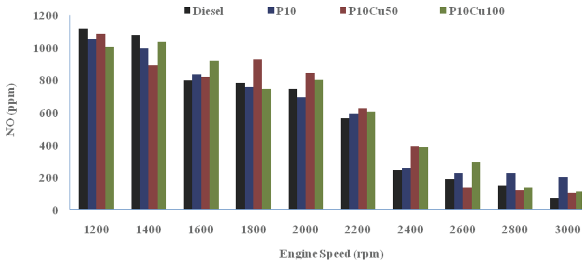

Figure 3. Variation of NO emission with test fuels

Influence of $CuNO_3$ nano particles on HC emission values are shown in Figure 4. In comparison with diesel fuel, HC emission values with P10Cu50 and P10Cu100 fuels decreased significantly at all engine speeds. Maximum reduction ratios of HC emission level with P10Cu50 and P10Cu100 fuels were 35.71% at 3000 rpm and 42.86% at 3000 rpm, respectively. However, HC emission values of P10 increased slightly between 1400 and 2400 rpm.

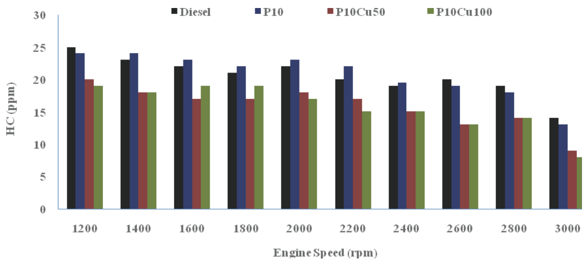

Figure 4. Variation of HC emission with test fuels

The effects of the test fuels on smoke emissions are shown in Figure 5. In general, smoke emission with $CuNO_3$ nano particles reduced. Reduction ratios with the P10Cu100 fuel were more than those with P10Cu50 fuel. Smoke emission values of P10Cu50 fuel were similar to those of diesel fuel. Maximum reduction ratio with P10Cu50 and P10Cu100 fuels were 3.03.87% at 2000 rpm and 23.55% at 2400 rpm, respectively. According to diesel fuel, at all engine speeds, smoke emission values of P10 were more than those of diesel fuel. The reduction in smoke emission with $CuNO_3$ nano particles is due to reduction of oxidation temperature with the metallic based catalyst during the combustion process.

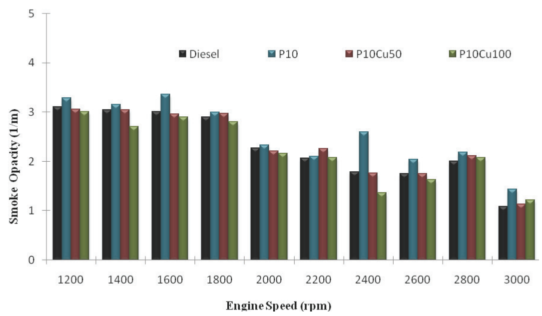

Figure 5. Variation of smoke emission with test fuels

CONCLUSIONS

The following results are concluded from the experimental study;

- Fuel properties of blend fuels were similar to those of diesel fuel. In comparison with diesel fuel values, viscosity, density, Cetane index and lower heating values showed decreasing trend. Addition of $CuNO_3$ nano particles as fuel additives improved fuel properties of P10 fuel.

• HC and CO emission values with P10Cu50 and P10Cu100 decreased slightly at all engine speeds in comparison with diesel fuel. The reductions are probably due to catalyst effect of $CuNO_3$ nano particles during the combustion process.

• NO emission values showed increasing trend with addition of $CuNO_3$ nano particles at high engine speeds. However, NO emission values with $CuNO_3$ nano particles decreased slightly at low engine speeds.

• According to diesel fuel values, smoke emission values with addition of $CuNO_3$ nano particles showed decreasing trend. However, smoke emission values of P10 increased at all test.

REFERENCES

[1] Resitoglu, I.A., Altınısık, K., Keskin, A. 2015. The pollutant emissions from diesel-engine vehicles and exhaust aftertreatment systems. Clean Techn Environ Policy, Vol.17, pp. 15–27.

[2] Agarwal, A.K. 2007. Biofuels (alcohols and biodiesel) Applications as Fuels for Internal Combustion Engines. Progress in Energy and Combustion Science, Vol.33, pp. 233-271.

[3] Keskin, A., Ocakoglu, K., Resitoglu, I.A., Avsar, G., Emen, F.M., Buldum, B. 2015. Using Pd(II) and Ni(II) complexes with N,N-dimethyl-N1-2-chlorobenzoylthiourea ligand as fuel additives in diesel engine. Fuel, Vol.162, pp. 202–206.

[4] Lund, H. 2007. Renewable energy strategies for sustainable development. Energy, Vol.32, pp. 912-919.

[5] Koroneos, C., Spachos, T., Moussiopoulos, N. 2003. Exergy analysis of renewable energy sources. Renewable Energy, Vol.28, pp. 295-310.

[6] Surisetty, V.R., Dalai, A.K., Kozinski, J. 2011. Alcohols as alternative fuels: An overview, Applied Catalysis A: General, Vol.404, pp. 1-11.

[7] Caroa, P.S., Moulounguia, Z., Vaitilingomb, G., Berge, J.C. 2001. Interest of combining an additive with diesel–ethanol blends for use in diesel engines. Fuel, Vol.80, pp. 565–574.

[8] Guru, M., Keskin, A. 2016. Evaluation of Biodiesel Production, Engine Performance, and Emissions. Journal of Electronıc Materıals, Vol.45, pp. 3882-3888.

[9] Lee, S., Speight, J.G., Loyalka, S.K. 2007. Handbook of Alternative Fuel Technologies. Taylor&Francis Group, pp. 297-343 London.