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Experimental Comparison the Effect of Mn_2O_3 and Co_3O_4 Nano Additives on the Performance and Emission of SI Gasoline Fueled with Mixture of Ethanol and Gasoline

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ABSTRCT

In this paper, the use of gasoline combinations with ethanol and nano oxide particles has been studied in gasoline-based SI EF7 engines. The mixtures are prepared in five emulsions of gasoline with 10% ethanol, gasoline with 10% ethanol and 10ppm nano Mn_2O_3, gasoline with 10% ethanol and 20ppm nano Mn_2O_3, gasoline with 10% ethanol and 10ppm nano Co_3O_4, gasoline with 10% ethanol and 20ppm nano Co_3O_4. An ultrasonic cleaner device is used to obtain a homogeneous gasoline combination with ethanol and additives of nano oxides during the test. To measure the output power of the engine, the Eddy current dynamometer has been coupled to the engine and to determine the emissions, an AVL gas analyzer is used. The results indicate that ethanol addition by 10% lead to 2.6% increase in brake power (BP), but interestingly 10 ppm Mn_2O_3 nano-additive raise the BP to 14.38% and 20 ppm nano-additive led to 19.56% increase of BP. While the BP with 10ppm and 20ppm nano-additives of Co_3O_4 has increased by 7.96% and 11.5%, respectively. With regard to emissions, ethanol presence with nano additives in the blend reduces CO, UHC, and NO_x whereas increases CO_2. The best blend is gasoline-10% ethanol-20ppm Mn_2O_3.

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NOMENCLATURE

P	Brake Power	UHC	Unburned hydrocarbons
T	Torque	CO	Carbon mono oxide
Bsfc	Brake specific fuel consumption	CO_2	Carbon dioxide
$\dot{P}_{shaft}$	The transferred energy through work output of the shaft	NO_X	Nitrogen oxide
$\dot{Q}_{cw}$	The transferred energy through cooling water	$\dot{m}_f$	Fuel mass flow
$\dot{Q}_{eg}$	The transferred energy through exhaust gases	$\dot{m}_{eth}$	Ethanol mass flow
$\dot{Q}_{uncounted}$	Immeasurable dissipated energy	$\dot{m}_n$	Nano oxide mass flow
C_{peg}	pressure constant heat capacity of the exhaust gas	$\dot{m}_{eg}$	Exhaust gas mass flow
C_{pw}	pressure constant heat capacity of water	$\dot{m}_w$	Water mass flow

1. INTRODUCTION

Automotive engines are facing the rigorous regulation legislations ratified on restricting the hazardous emissions issued from internal combustion engines [1]. Numerical investigation on performance of SI engine with gasoline and ethanol blended fuel showed that NOx and CO_2 was increased while the CO and HC concentration was decreased when gasoline and ethanol blended are used in SI engines [2,3]. In recent years, the nanotechnology has made its way in industrial centers such as engines through fuel synthesis. The nano-scaled particles with oxidation and catalytic properties enhance the thermal efficiency during combustion thanks to enlarging the surface area to volume ratio. Various studies have been devoted to analyze the effect of nano-particle addition to pure fuel or blended fuel. Chen et al.

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[4] explored the fuel blend with aluminium oxide, carbon nanotubes, and silicon oxide to observe how it affects the combustion characteristics, engine performance, and emissions. The results indicated that silicon oxide outperforms aluminium oxide blend in terms of higher pressure and lower brake specific fuel consumption and CO emission. Guru et al. [5] experimented blends of manganese and copper nano-particles with diesel fuel and reported that a proper dosage of manganese oxide (MnO) can contribute to 4.37% in cetane number increase while reducing the viscosity by 5.26% with these carbon monoxide and sulphur dioxide decrease significantly in engine. Sukhtesaraee et al. [6,7] have used silver nano-particles and CeO_2 nano-particles in blend with diesel and the outcome showed that in case of metallic silver, they can increase the heat transfer and shortening the ignition delay that led to CO and NOx reduction by 20.5% and 13%. However, with CeO_2 presence, the CO emission was conversely increased. For instance, Jiaqiang et al. [8] considered a marine diesel engine fuelled by water biodiesel-diesel emulsification in the presence of cerium oxide nano-particle. The results revealed that water-diesel-biodiesel+CeO_2 compound leads to an improved mixing process due to micro-explosion incident. The catalytic activity of nano-particles improved the engine performance by increasing the brake power and brake thermal efficiency due to elevated combustion process. The improved combustion process because of enhanced oxidation process of nano-particles have been mentioned frequently in literature [9,10]. Following, Ettefaghi et al. [11] performed an investigation on Bio-Nano emulsion to improve the engine performance and reduce emission, so they conducted the experiment with diesel-biodiesel-water-biodegradeble nanoparticle. They proved that by using B15 fuel containing 5% water and 60 ppm carbon quantum dots a 21% increase of engine power can be obtained compared to B15 fuel. Mirzajanzadeh et al. [12] fabricated a combined CeO_2/CNT fuel trying to boost the engine efficiency as well as to reduce the emissions of HC, CO, and smoke. They emphasized that nano-particle addition to diesel-biodiesel is influential towards better combustion implementation. Ahmed Ali et al. [13] carried out a research when a gasoline engine is fed with Al_2O_3/TiO_2 nanomaterial and it was revealed that by nano application, the total friction power losses were dropped by 5-7%, while the mechanical efficiency augmented within 1.7-2.5% range. Besides. El-Seesy et al. [14] in another study tested the effect of Aluminium oxide particles added to Jojoba methyl ester-diesel fuel to detect the trend in emission and performance. The peak pressure and pressure was increased while the fuel consumption decreased by 12% with new synthesized fuel.

In current study, synthesized manganese and cobalt nano-oxides were prepared by microscopic electronic SEM method. Experimental test was performed on EF7 SI. The tests samples are taken in six different blends to determine the effect of ethanol and nano-particle addition separately. These blends were baseline gasoline, gasoline with 10% vol. ethanol (combined), gasoline with 10% ethanol plus 10 ppm manganese nano oxide (combined+10ppm Mn_2O_3), gasoline with 10% ethanol plus 20ppm manganese nano oxide (combined+20ppm Mn_2O_3), gasoline with 10% ethanol plus 10 ppm cobalt nano oxide (combined+10ppm Co_3O_4) and gasoline with 10% ethanol plus 20 ppm cobalt nano oxide (combined+20ppm Co_3O_4). The effect of using ethanol as an alternative fuel and Mn_2O_3 and Co_3O_4 as nano-catalysts was studied on the engine performance and emissions.

2. METHODOLOGY

2. 1. Mn_2O_3 Nano-particle Synthesis To synthesis of Mn_2O_3 nano-particle, manganese nitrate was used as Mn source. Briefly, manganese nitrate was dissolved in ethanol in a beaker. Then, a stoichiometric amount of oxalic acid as chelate agent was dissolved in ethanol and added to the beaker solution under constant stirring. Afterwards, the manganese (II) chloride dihydrate solution was mixed with a solution under stirring at room temperature. The obtained products were dried at 80 °C under vacuum for 1 hour, then calcinated at 600 °C for 3 hours in a conventional furnace in air atmosphere. The surface morphology of the synthesized nanoparticles is imaged using SEM technique (see Figure 1)

2. 2. Co_3O_4 Nano-particle Synthesis The synthesis of Co_3O_4 nano-particle, in a typical experiment, 1.2 g $CoCl_2{\cdot}6H_2O$ was dissolved in 10 ml distilled water to form a 0.005 M solution. Then, trisodium citrate (2.94 g, 0.01 M) was separately dissolved in 10 ml distilled water. The solutions were mixed together and vigorously agitated at room temperature for 6 h. The formed precipitate was separated by centrifuging for 2 min. The product was washed with distilled water and dried under vacuum.

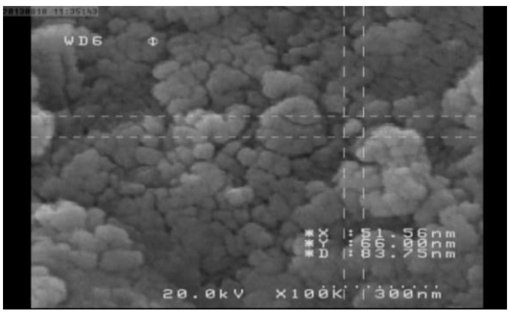

Figure 1. The SEM image of Mn_2O_3 nano-particle

Finally, 1.5 g dried powder was calcinated at 580–600°C in a high-temperature muffle furnace in air for 2 h, and stored in the furnace until cooled to room temperature. More, the surface morphology of the synthesized Co_3O_4 nanoparticles is imaged using SEM technique (see Figure 2).

Co_3O_4 and Mn_2O_3 nanocatalysts are poisonous and dangerous. But in this study, they work in combination with gasoline and ethanol as fuel catalysts, and showed the positive effects in reduction of emissions during the combustion process. Therefore, in the catalyst state, combustion fuels have no harmful environmental effects.

2. 3. Homogenizing the Fuel Blend with Mn_2O_3 and Co_3O_4 Nano-particle In this study, however, the ultrasonic unit known as ultrasonic cleaner provides a homogenous nano-particle emulsion to prevent the particle agglomerate. This electronic device by use of series of piezoelectric generators creates the ultrasound waves in the frequency range of 37 kHz contribute as anti-agglomeration factor. These ultrasound waves in the solvent or water in the bath creates the cavitation phenomena. Cavitation in scientific terms denotes to the process of millions of tiny bubbles when the pressure dropped to the saturation evaporation pressure. The collapse of bubbles in the proximity of the surface exerts high pressure and release energy to homogenize the solution in microscopic level.

In the present work, an ultrasonic bath is used at each stage of the homogenization of the combined fuel with nanoparticles. In order to keep the composition homogeneous during the experimental tests, the fuel return path to the back is designed as a spray nozzle, which keeps the mixture homogeneous and stable at all stages of test with vibrations are roughly the same as ultrasonic bath vibrations the ultrasonic bath vibrations.

2. 4. The Engine Setup and Instrumentation for Data Collection The EF7 (as national automotive engine) 4-stroke, water-cooled, 4-cylinder engine is utilized to test the blended fuels in SI, gasoline engine. The engine characteristics are shown in Table 1.

In order to measure the power and torque of the engine, it has been incorporated to 191 eddy current

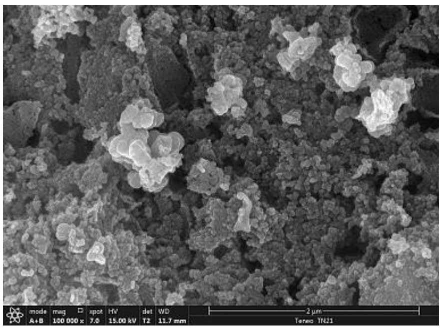

Figure 2. The SEM image of Co_3O_4 nano-particle

TABLE 1. Specification of EF7 SI engine

Specification of EF7 SI engine	
Displacement	1650cm^3
cylinders and valves	4 cylinder- 16 valve
Power (per h.p. and kW)	84kw @ 6000rpm = 112.64 hp
Torque (N.m)	156 (N.M) @3500-4500 rpm
Baseline fuel	Unleaded gasoline with 95 octane number
Combustion chamber volume	36.2 ± 0.5 cm^3
stroke	85 (mm)
Bore	78.6 (0.01 +0.)
Compression ratio	11 ± 0.2:1
Injection system	Multipoint sequential injector injection

dynamometer. The 190 kW eddy current dynamometer is absorption type that is applied for almost every kind of passenger car and this dynamometer is coupled to EF7 engine equipped in Urmia University engine lab. The dynamometer is composed of two major parts: rotor and central shaft that is connected to engine by couplings and the next component is stator and the casing that is absolutely suspended, which is connected via arm to force-meter. The product of measured force in the arm length gives the engine torque. During installation, a meticulous attention is made to make sure the alignment of engine and dynamometer by adopting accurate measuring tools so that overload by shaft eccentricity on the ball bearings is avoided. For calibration of dynamometer proportional to the EF7 engine, the calibration weights approved by the gas company lab were used. For safety reasons, when the test was carried out under full load conditions, the motor shaft protection box was installed on the dynamometer. Load cell calibration was conducted to measure the amount of fuel consumption by the calibrated weights of the gas company. Calibration of the AVL- gas analyzer is performed automatically in each step. After dynamometer-engine coupling, the experimental tests on desired blended fuels with Mn_2O_3 and Co_3O_4 can be performed. In Figure 4, the schematic of engine setup is illustrated.

For measurement of the engine out emissions from the engine the AVL gas analyzer is used to analyze the exhaust gas. After each stage of test, the calibration is implemented.

2. 5. Repeatability of Tests and Errors The stage of the experimental test is repeated in four stages, and 75% of the data having an error accuracy of less than 0.02 was selected and the most logical data having the lowest error range were selected as experimental data that can be cited.

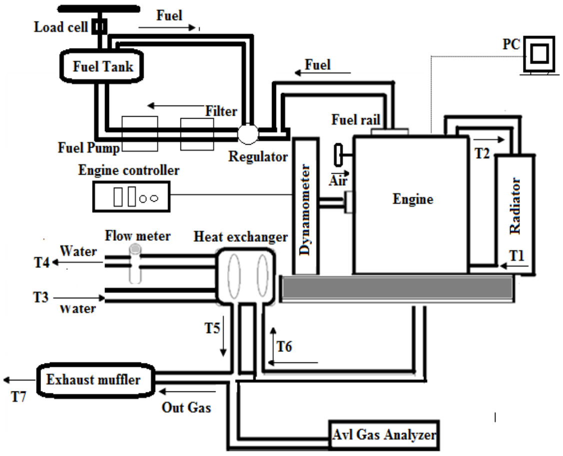

Figure 3. Schematic of engine setup

3. RESULTS AND DISCUSSION

In current research, the performance analytics of fuels including baseline gasoline, blended ethanol and gasoline, and blended gasoline with ethanol and nano-catalyst metal oxides was addressed. For stability of performance and emission parameters during experimental tests, water and oil temperatures must reach to engine's operational condition at 90 °C and to this end, the engine runs at 2500 rpm engine speed for almost 10-15 min in order to let different machine segments stabilized. The tests were implemented at full load, 2800 rpm engine speed with torques ranging 0-100 N.m.

3. 1. Ethanol-gasoline, Gasoline-ethanol- nano Mn_2O_3 and Gasoline-ethanol- nano Co_3O_4 Blended Fuel Effect on the SI Engine's Power

Ethanol addition to gasoline fuel increases the engine power. This can be attributed to hydroxyl radical presence in the ethanol composition, which contributes to a complete combustion consummation. The extra oxygen in molecular structure causes the more chemical energy release as a result of fuel burning that will be converted to thermal energy, therefore we witness increased power and engine torque with blended gasoline-ethanol powered engine. In the meantime, addition of metallic nano-catalyst plays a catalytic role in oxidation process. The metallic oxides act as oxygen storage and the added catalysts to fuel may induce the complete hydrocarbon oxidation as a result the outlet gases contain lower hazardous emissions. Further, as it was reported recently, the nano additives create the micro-explosion that helps further combustion (better fuel burning rate) to take place more efficiently [21]. In the following, this must be noted that Manganese oxide nano additive causes mixture quality increment, thereby the engine power and efficiency would be increased accordingly. They argued that nano additives enhance the combustion while hydrogen production because of nano-particles is ascribed for nano addition. The variation of power with respect to torque for different baseline fuel and blended fuels is sketched in Fig. 4. The results of present research shows that at full load and 2800 rpm when the engine runs with 10% ethanol-10ppm Mn_2O_3 and 10%ethanol-20ppm Mn_2O_3, the engine power increases by 14.38% and 19.56% and the BP with 10ppm and 20ppm nano-additives of Co_3O_4 to gasoline-10% ethanol blended increased by 7.96% and 11.5% compared to that of baseline gasoline fueled engine.

3. 2. Ethanol-gasoline, Gasoline-ethanol- Nano Mn_2O_3 and Gasoline-ethanol - Nano Co_3O_4 Blended Fuel Effect on the SI Engine's BSFC

Figure 5 displays the BSFC variation with torque for different fuel blends and baseline gasoline fuel. The results indicate that at full load condition and 2800 rpm engine speed for torques values of 0 N.m - 100 N.m, the BSFC of engine fueled by gasoline-10% ethanol blend increases as much as 22.81% compared to that of baseline gasoline. Contrarily, it seems that when the engine uses gasoline-10% ethanol-10ppm Mn_2O_3 and gasoline-10% ethanol-20 ppm Mn_2O_3 BSFC reduces 31.86% and 36.72% respectively and application of gasoline-10% ethanol-10ppm Co_3O_4 and gasoline-10% ethanol-20ppm Co_3O_4 the BSFC further reduced 26.74% and 32.49% to that of baseline gasoline.

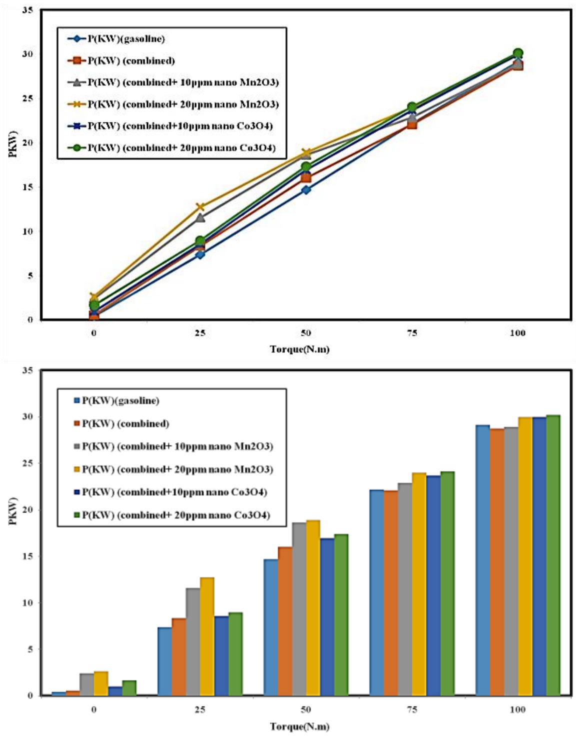

Figure 4. The effect of combined fuel with nano-additives on power output

Along with ethanol addition to gasoline, octane number is improved but since ethanol contains lower heat value than gasoline does, therefore as to maintain the fixed torque at a given engine speed in full load, more fuel needs in ethanol blended fuel needs to be injected than in base gasoline fueled engine mode. Introduction of metallic nano-oxides to ethanol in blend with gasoline causes further fuel consumption. The reason can be such explained that nano-particles with catalytic feature brings about better air-fuel mixing so the declining trend is observed in BSFC with Mn_2O_3 addition. This result is in agreement with previously published papers [10,21] that cerium oxide and aluminum nano-paricles contributed to lowering the BSFC. They argued that the complete combustion as well as hydrogen release because of nano-particles reaction in combustion phase contributes to lowering the BSFC with addition of nano-particle to fuel.

3. 3. Ethanol-gasoline, Gasoline-ethanol- Nano Mn_2O_3 and Gasoline-ethanol- Nano Co_3O_4 Blended Fuel Effect on the SI Engine's CO Emission Figure 6 plots the CO variation alongside torque for different fuels of baseline gasoline and blended fuels. As can be appreciated in full load before 75 N.m where the timing valve still has not been activated, CO is increasing. However, at 75 N.m that is the time when the inlet-air valve timing is activated and the excess air completes the combustion and thereby CO decreases. The results suggests that at full load, 2800 rpm engine speed for the torques of 0 N.m to 100 N.m, the CO emission is reduced by 6.39%, 21.55% and 24.09% with gasoline-10% ethanol, gasoline-10% ethanol-10ppm Mn_2O_3 and gasoline-10% ethanol-20ppmbMn_2O_3, while with gasoline-10% ethanol, gasoline-10%ethanol-10ppm Co_3O_4 and gasoline-10%ethanol-20ppmCo_3O_4 reduce the CO, 6.39%, 14.35% and 19.58% with respect to baseline gasoline fuel, respectively.

Due to presence of more oxygen content of oxygen in ethanol rather than baseline gasoline or in other words the C/O ratio of ethanol is comparatively lower that gasoline, it is expected to have lower CO concentration in engine out products. This fact about manganese nano-oxide additives is more sensible since more oxygen atom is present in the blended fuel including Mn_2O_3. More, it is known that nano-particles as catalysts expedite the oxidation process during the combustion and the complete combustion leads to lower CO amount. As a result, it can be concluded that the CO amount in gasoline-ethanol blend and gasoline-ethanol-Mn_2O_3 will be decreased significantly in comparison to pure (baseline) gasoline mode of engine run.

3. 4. Ethanol-gasoline, Gasoline-ethanol- Nano Mn_2O_3 and Gasoline-ethanol- Nano Co_3O_4 Blended Fuel Effect on the SI Engine's Unburned HC Emission Figure 7 depicts the unburned hydrocarbons (UHC) against torque for baseline gasoline-fueled engine and various blended fuels.

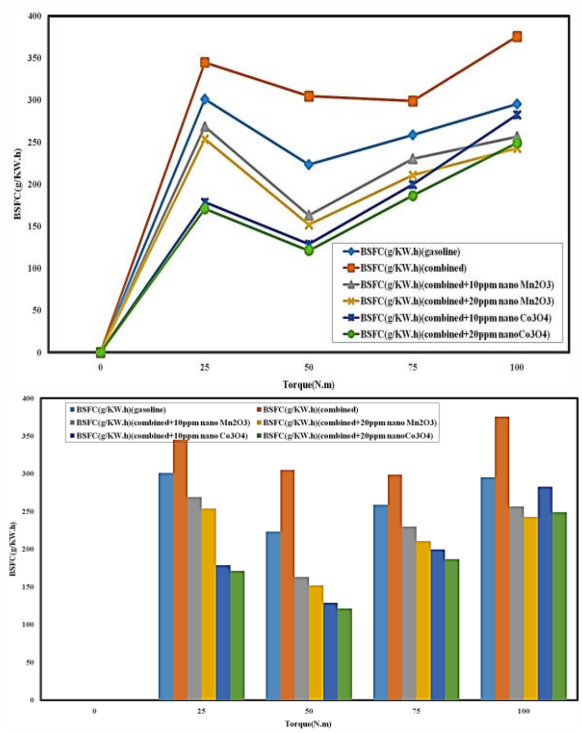

Figure 5. The effect of combined fuel with nano-additives on BSFC

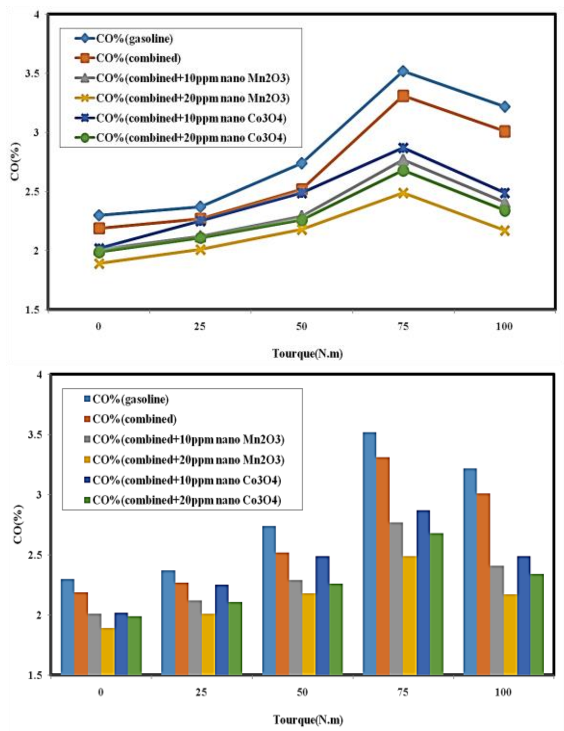

Figure 6. The effect of combined fuel with nano-additives on CO emission

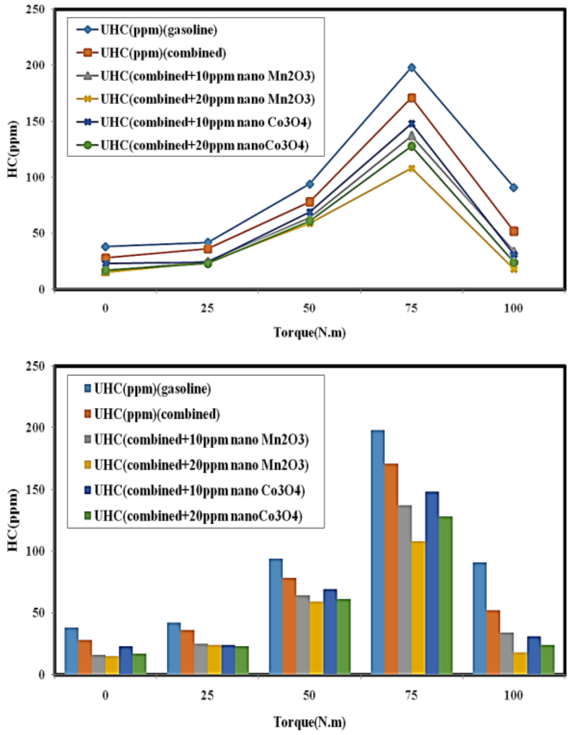

Figure 7. The effect of combined fuel with nano-additives on UHC emission

As shown, the UHC species are increasing at full load before 75 N.m torque that happens due to inactivation of inlet air valve and the insufficient air for oxidation makes UHC decreased, so up to 75 N.m for all cases the UHC will increase. Upon reaching the 75 N.m and with inlet-air valve activation, the excess air induction causes the complete combustion implementation and thereafter the UHC is decreasing. The results are indicative of 21.51%, 40.64%, 51.83%, 36.59% and 45.59% reduction of UHC respectively with gasoline-10%ethanol, gasoline-10%ethanol-10ppm Mn_2O_3, gasoline-10% ethanol-20ppm Mn_2O_3, gasoline-10% ethanol-10ppm Co_3O_4 and gasoline-10% ethanol-20ppm Mn_2O_3 has been achieved compared to that of baseline gasoline when the engine run at full load, 2800 rpm within 0N.m-100N.m torques.

Owing to higher octane number of ethanol compared to gasoline, UHC tends to decrease and this mostly comes from desirable better burning rate of ethanol in the blend that leads a rise in cylinder temperature. As a consequence the quenching of flame front, once it reaches to cylinder wall is retarded, thus the UHC species that are resulted from incomplete fuel combustion have the chance to be oxidized thoroughly. On the other side, the increased combustion chamber temperature induce unburned gas reaction before leaving the outlet valve, which considering high-temperature leaving gas, hydrocarbons find a second chance for better burning rate and oxidation. By introducing the Mn_2O_3 and Co_3O_4 nano additives to fuel, this assists for even better oxidation and burning thanks to catalytic feature of nano-particles enhancing the combustion process. The activation energy of manganese oxide nano-particles acts as a burner of carbon deposits in the cylinder and thereby impedes the sedimentation on the cylinder wall. This, in its own turn will result in hydrocarbon reduction by application of Mn_2O_3 and Co_3O_4 nano-catalyst. Therefore, it is expected to have UHC and soot reduced considerably by increasing the ethanol with Mn_2O_3 and Co_3O_4 nano-catalyst.

3. 5. Ethanol-gasoline, Gasoline-ethanol- Nano Mn_2O_3 and Gasoline-ethanol- nano Co_3O_4 Blended Fuel Effect on the SI Engine's NO_x Emission

Figure 8 shows the NO_x emission concentration against torque for the baseline and blended fuels. As seen, the NO_x increases by ethanol addition and contrarily decreases by adding nano-catalysts. The results illustrate 12.54% NO_x increase by 10% ethanol replacement with gasoline, whereas a 23.43%, 32.34%, 21.12% and 30.03% decrease of NO_x with gasoline-10% ethanol-10ppm Mn_2O_3, gasoline-10%ethanol-20ppm Mn_2O_3, gasoline-10% ethanol-10ppm Co_3O_4 and gasoline-10% ethanol-20ppm Co_3O_4 blends, respectively at full load, 2800 rpm, and 0 N.m – 100 N.m torque condition. By adding ethanol to base gasoline fuel in the EF7 SI engine, the volumetric efficiency would increases that this issue comes from high vapor latent heat of ethanol compared to gasoline. To explain, a portion of inlet air's heat in the manifold is absorbed. Thus, the inlet air loses temperature and undergoes density increment. With increase of density, more air is inducted to cylinder that yields higher volumetric efficiency and engine performance. The increase of volumetric efficiency leads to increase of fuel's vapor pressure and therefrom temperature raise and NO_x increase. Other than that, the use of ethanol makes a retarded spark that this too adds up to pressure and temperature increase. One may also needs to notice that the more oxygen atoms of ethanol in its composition create rich oxygen zones to form NO_x. Addition of Mn_2O_3 and Co_3O_4 nano-particles to gasoline-ethanol blend, functions as an oxygen catalyst that provides the required oxygen for CO oxidation, wherein an oxygen shortage for NO_x is sensible. The cobalt and manganese oxide nanoparticles work in combination with gasoline and ethanol as an oxygen catalytic converter. Therefore, it accelerates the combustion process, by reducing the ignition delay time, provides oxygen for oxidation of carbon monoxide, and absorbs it to reduce nitrogen oxides. As a result, nitrogen oxides are reduced despite the improvement of the combustion process by adding nanocatalysts due to the rapid combustion and catalytic role of these nanocatalysts, which does not provide enough time to increase the temperature and increase of the nitrogen oxides.

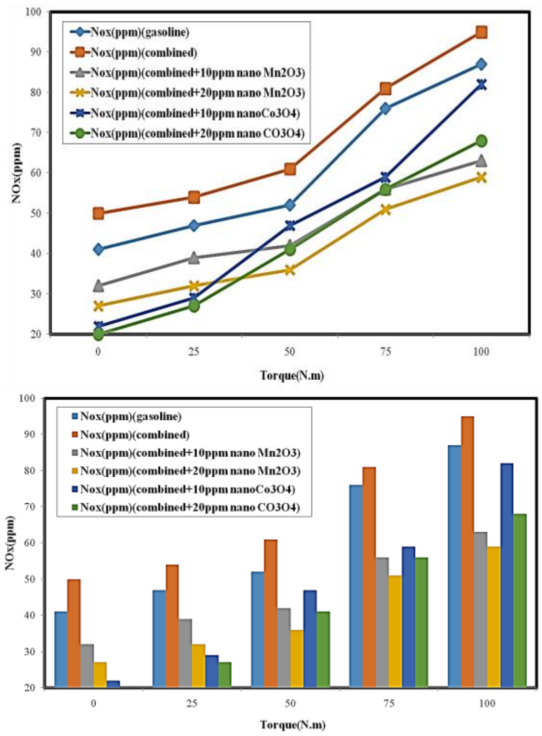

Figure 8. The effect of combined fuel with nano additives on NOx emission

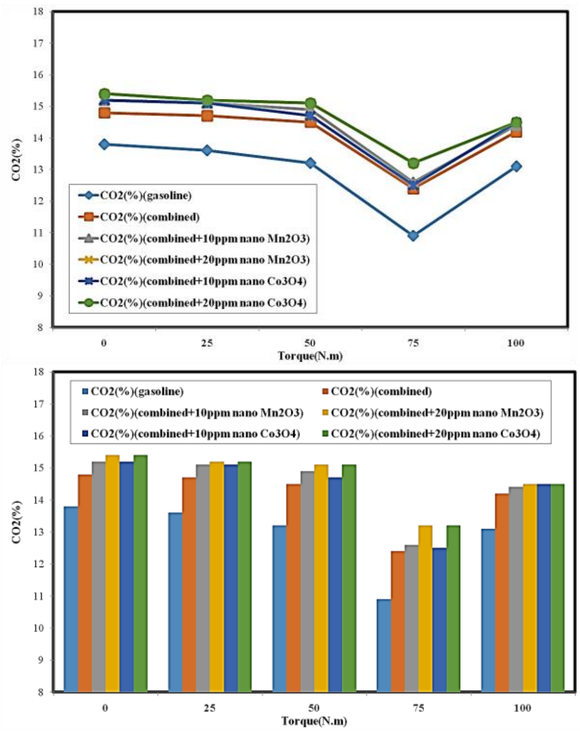

Figure 9. The effect of nano- additives on CO_2 emission

3. 6. Ethanol-gasoline, Gasoline-ethanol- Nano Mn_2O_3 and Gasoline-ethanol- nano Co_3O_4 Blended Fuel Effect on the SI Engine's CO_2 Emission

Figure 9 shows CO_2 variation with respect to torque for baseline (pure gasoline) and various blended fuels. It is clear that CO_2 is decreasing with torque (in full load). Before 75 N.m that timing valve has not been activated yet, the CO_2 decreases. However, at 75 N.m that coincides with the inlet-air timing valve, excess air ingress causes a complete combustion process and that point onwards, the CO_2 increases due to better oxidation. The results of present research indicate that in full load, 2800 rpm, and between 0 N.m-100N.m torques, in gasoline in combination with 10% ethanol, gasoline-10% ethanol-10ppm Mn_2O_3, gasoline-10% ehanol-20ppm Mn_2O_3, gasoline-10% ehanol-10ppm Co_3O_4 and gasoline-10% ehanol-20ppm Co_3O_4 lead to 9.29%, 11.76%, 13.27%, 11.45% and 13.47% increases respectively in CO_2 out emission compared to baseline gasoline fuel.

The CO_2 is one of the major products of combustion that although is not counted in as hazardous emission, the CO_2 increase and thereby CO reduction are among our demand to reduce perilous pollutants. The more oxygen content in ethanol chemical composition compared to gasoline accounts for high concentration of CO_2 in ethanol-blended fuel. The same reasoning is applicable for Mn_2O_3 and Co_3O_4 nano-oxide noting the oxygen bonds in their molecular structure. On the other side, Mn_2O_3 and Co_3O_4 nano-catalyst additions make the more complete fuel oxidation; therefore higher CO_2 and lesser CO with nano addition can be justified. It can be concluded that when gasoline is blended with ethanol and Mn_2O_3, Co_3O_4 nano-additive, CO_2 will increase.

4. CONCLUDING REMARKS

An experimental study is performed on a SI engine (EF7 type). To make the blended fuel of nano-additive uniform and the tests credible, the ultrasonic cleaner machine is applied. The engine is powered by baseline gasoline, gasoline-10% ethanol, gasoline-10% ethanol-10ppm Mn_2O_3, gasoline-10% ethanol-20ppm Mn_2O_3 blends. The results indicate that ethanol addition by 10% lead to 2.6% increase in brake power (BP), but interestingly 10-ppm Mn_2O_3 nano-additive raise the BP to 14.38% and 20-ppm nano-additive led to 19.56% increase of BP. While the BP with 10ppm and 20ppm nano-additives of Co_3O_4 increased by 7.96% and 11.5%, respectively. With regard to emissions, ethanol presence with nano-additives in the blend reduces CO, UHC and NOx while CO_2 increases. The best blend is introduced as gasoline-10% ethanol-20ppm Mn_2O_3.

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Experimental Comparison the Effect of Mn_2O_3 and Co_3O_4 Nano Additives on the Performance and Emission of SI Gasoline Fueled with Mixture of Ethanol and Gasoline

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چکیده

در کار حاضر، تآثیر استفاده از نانوذرات افزودنی بر سوخت ترکیبی در موتور اشتعال جرقه‌ای مورد بررسی قرار گرفته است. سوخت در پنج حالت ترکیبی ، بنزین با ۱۰٪ اتانول، بنزین با ۱۰٪ اتانول با ۱۰ppm و ۲۰ppm نانو اکسید منگنز، بنزین با ۱۰٪ اتانول با ۱۰ ppm و ۲۰ppm نانو اکسید کبالت تهیه و تست شده است. از حمام اولتراسونیک، دینامومتر ادی‌کارنت و آنالیزور گاز به ترتیب برای همگن کردن سوخت ترکیبی، اندازه گیری توان خروجی موتور و تعیین آلاینده‌ها استفاده شده است. نتایج نشان می دهد افزودن اتانول به میزان ۱۰٪ منجر به افزایش ۲/۶٪، افزودن ۱۰ppm و ۲۰ppm نانوذرات اکسید منگنز به ترتیب ۱۴/۳۸٪ و ۱۹/۵۶٪ و با افزودن ۱۰ppm و ۲۰ppm نانو ذرات اکسید کبالت به ترتیب سبب افزایش ۷/۹۶٪ و ۱۱/۵٪ توان خروجی موتور نسب به حالت پایه شده است. با افزودن نانوذرات اکسید فلزات به سوخت ترکیبی مونواکسید کربن، هدروکربنهای نسوخته و اکسیدهای نیتروژن کاهش و دی‌اکسیدکربن افزایش می‌یابد.

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