International Journal of Engineering

Journal Homepage: www.ije.ir

Experimental Study of Management Systems for Emission Reduction in Ignition Engines

A. Fekari[a], N. Javani*[b], S. Jafarmadar[c]

[a] *Department of Mechanical Engineering, Bonab Branch, Islamic Azad University, Bonab, Iran*
[b] *Faculty of Mechanical Engineering, Yildiz Technical University, Besiktas, Istanbul, Turkey*
[c] *Department of Mechanical Engineering, Urmia University, Urmia, Iran*

PAPER INFO

Paper history:
Received 04 January 2020
Received in revised form 20 January 2020
Accepted 05 March 2020

Keywords:
Engine Management System
Exhaust Gases
Exhaust Gases Emission
Spark Advance

ABSTRACT

The present study aims to investigate the amount of exhaust gases emissions of a 4-cylinder gasoline-ignition engine. An experimental study of an ignition engine management system has been conducted for emissions optimization, using Winols specialized software. In order to achieve a steady state conditions in the experiments, the temperature of the water and engine oil before each test reached the engine's working temperature (90°C) to allow various parts of the engine to remain stable and the tests are performed in in-line engine operation. Two sets of tests with idle (850-900 rpm) and mid-range (2500 rpm) are considered. Experiments were performed for three identical engines with different mileages and obtained results were discussed. According to the obtained results, after applying changes to the engine management system, a 22% reduction in the unburned hydrocarbon emission in both cases was obtained. Furthermore, it is found that 31 and 5% reduction in carbon monoxide emissions in the idle and mid-range were obtained, respectively. As a result of applying these changes, there was a reduction of 1.4% in NOx emission in the idle case and a decrease in about 19% at 2500 rpm.

***doi**: 10.5829/ije.2020.33.07a.22*

NOMENCLATURE

AFR	Air-fuel ratio	P_{air}	Inlet manifold air pressure
AVL	Anstalt fur Verbrennungskraft machinen list	T_{air}	Intake manifold air temperature
TNM	Tarahan Novin Madar programmer	P_{ex}	Exhaust manifold gas pressure
PM	Particulate material	T_{ex}	Exhaust manifold gas temperature
RPM	Revolution per minute	MAP	Manifold air pressure

1. INTRODUCTION

Environmental protection is one of the most important global concerns and international organizations are trying to tackle the unfavorable side effects. In this regard, reducing air pollution has become a global concern, due to increased fuel consumption, especially in transportation section. Diesel engines and spark ignition for various vehicles are one of the main sources of air pollution. The exhaust gases of spark ignition engines include nitrogen oxide (NO) and NO_2 known as NOx, carbon monoxide (CO) and organic components, which include unburned or incomplete combusted hydrocarbons (HC). The amount of these gases depend on engine design and its operating conditions. The spark ignition engine is typically close to the stoichiometric state, or inclined to a rich fuel, to ensure smooth and reliable operation of the engine [1, 2].

Many researchers have conducted studies about the effect of gasoline fuel in internal combustion engines [3]. Jafarmadar et al. [4] stated that NOx emissions and soot formation depend intensely on engine temperature and equivalence ratio. There are specific controlling methods to reduce the emissions and to achieve acceptable average values [1]. Hsiao-Chi Chuang et al. [5] have studied the effects of vehicle exhaust particles

*Corresponding Author's Institutional Email: *njavani@yildiz.edu.tr* (N. Javani)

Please cite this article as: A. Fekari, N. Javani, S. Jafarmadar, Experimental Study of Management Systems for Emission Reduction in Ignition Engines, International Journal of Engineering (IJE), IJE TRANSACTIONS A: Basics Vol. 33, No. 7, (July 2020) 1347-1353

on cardiovascular health. Mohebbi et al. [6] have studied external exhaust gas recirculation (EGR) method and deduced that it will decrease combustion temperature and also decrease in NOx emissions. Kousoulidou et al. [7] used a Portable Emission Measurement System (PEMS) to develop and validate automobile emission factors. Six different vehicles were studied; under different driving standards and two different driving paths in the region of Lombardy, Italy were tested.

Twigg [8] has investigated the role of catalysts in controlling the exhaust emissions and development of the catalyst in this field. Lozhkin [9] conducted experiments on 13 gasoline-powered and 2 diesel-powered vehicles, ranging from Euro 0 to Euro 5 using gas analyzers to study the percentage of increased exhaust emissions in an environment with poor air-conditioning conditions. Vehicle emissions reduction using alternative fuels have been investigated for the aim of pollutant emission regulations [10]. Another effort to reduce emissions in diesel engines is the employment of light fuels (such as alcohol and diesel) as a diesel fuel supplement, which simultaneously reduces nitrogen oxide (NOx) and particulate material (PM) [11, 12].

There are a few experimental studies in the literature about the affecting parameters in the emissions of engine exhaust gases in the engine management systems. There have also been efforts in various researches to reduce one specific emission by using various additives in the fuel or using various equipment. The purpose of the present study is to reduce all engine exhaust emissions by considering engine performance at minimal cost and without adding extra equipment. Achieving this goal through software optimization of the engine management system makes this investigation different from the other studies in the literature.

2. SYSTEM DESCRIPTION

In the current study, by using an AVL gas analyser, a 4-cylinder ignition engine (EF7- without catalytic converter) exhaust emissions is evaluated. The EF7 series are designed jointly by Iran Khodro powertrain company (IPCO) and F.E.V Gmbh of Germany which was produced in 2008. Tested engine in the current study and the site weather properties are summarized in Table 1.

The main reason for selecting EF7 engine in the current study is its popularity and mass production in the regional market. Domestic automakers have problems to supply catalytic converter due its high costs. On the other hand, this engine is working on the majority of passenger cars without catalytic converter in Iran. Anstalt fur Verbrennungskraft machinen list (AVL) gas analysis device, engine testing device and Tarahan Novin Madar programmer (TNM) were employed for the related measurements. Furthermore, the effect of air-fuel ratio, spark advance, fuel injection time were investigated. In order to obtain their work maps from the engine control unit, the TNM programmer is used for analyzing the program code.

TABLE 1. Test engine properties and site weather properties

Parameter	Value
Model– Type	EF7 – Spark ignited
Each cylinder volume	412.433 cc
Cylinder number	4
Valve number of each cylinder	4
Max power	84 kW @ 6000 rpm
Max torque	155 N.m @ 3500-4500 rpm
Stroke	85 mm
Bore	78.6 mm
Fuel	Gasoline
Charging method	Natural aspirated (sequential)
Combustion ratio	11:1
Test site air pressure	870 mbar
Test site air temperature	300 K

3. RESEARCH METHODOLOGY

The TNM programmer device is used to read the program code of the engine management system by OBD connector. The extracted file format of TNM programmer device is binary that is capable of importing into Winols software. Winols software is also employed for modifications. Then, the air-fuel ratio, spark advance and reduction in starting temperature of the engine cooling fan are changed step by step and their effects are studied in detail to get optimized mode of reduced emissions by measuring the engine exhaust emission. The actual air-fuel ratio (AFR_{actual}) and ideal (stoichiometric) air-fuel ratio (AFR_{ideal}) is called equivalence air-fuel ratio or lambda (λ) which are defines as $AFR = \frac{m_{air}}{m_{fuel}}$ and $\lambda = \frac{AFR_{actual}}{AFR_{ideal}}$.

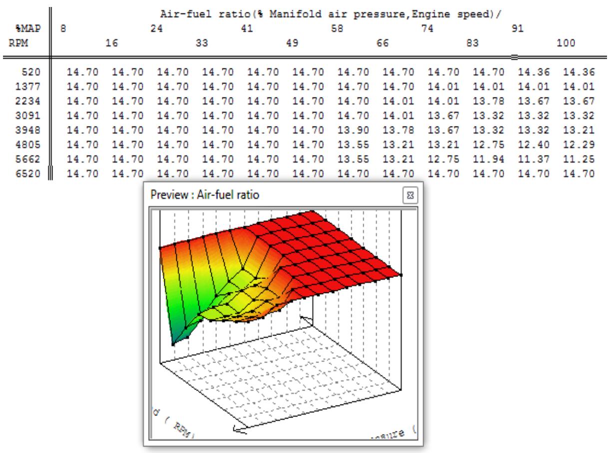
The spark ignition engine typically operates close to the stoichiometric ratio, or somehow close to a rich fuel to ensure the smooth and reliable operation of the engine [1]. The chemical reaction for the combustion of octane-air mixture is as follows [13]:

$$C_8H_{18}+20(O_2+3.76\ N_2) = 8\ CO_2+9\ H_2O + 7.5\ O_2+ 75.2\ N_2 \quad (1)$$

Rich ratios produce less efficiency but the output power is higher power and the burning temperature is usually a lower temperature. The ratios above the stoichiometry are called lean, where the efficiency is higher, but more nitrogen oxide is produced [2]. The exact setting of the ignition timing has a significant effect on the engine performance and resulted emissions [14]. Due to the fact that the fuel burns at a limited speed and this combustion is also dependents on the environment, spark timing needs to be changed in the engine operating conditions, which also indicates the spark ignition values in the engine control unit. Also, changing spark timing will affect the engine emissions [15]. The maximum cylinder pressure and temperature and engine exhaust emissions are affected by ignition [16]. In the conducted tests, authors have concluded that by increasing the engine temperature, the brake specific fuel consumption will decrease. In addition, nitrogen oxide production with respect to the engine temperatures has been reported. It has also been pointed out that at high temperature of the engine results in increased friction losses and emission [17, 18].

4. RESULTS AND DISCUSSIONS

In the present study, an exhaust gas analyzer is employed to measure the exhaust emissions from an exhaust system of a 4-cylinder ignition engine of a gasoline EF7 model. Furthermore, the effect of air-fuel ratio, spark advance and fuel injection time are considered as the affecting parameters. To obtain their operation values based on the engine control unit, the TNM programmer is used to read the programming codes. Winols software is also used to change the values and thereafter, the effects of parameters variation are studied in detail.


Air-fuel ratio(% Manifold air pressure,Engine speed)/

%MAP / RPM	8	16	24	33	41	49	58	66	74	83	91	100
520	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.36	14.36
1377	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.01	14.01	14.01	14.01
2234	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.01	14.01	13.78	13.67	13.67
3091	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.01	13.67	13.32	13.32	13.32
3948	14.70	14.70	14.70	14.70	14.70	14.70	13.90	13.78	13.67	13.32	13.32	13.21
4805	14.70	14.70	14.70	14.70	14.70	14.70	13.55	13.21	13.21	12.75	12.40	12.29
5662	14.70	14.70	14.70	14.70	14.70	14.70	13.55	13.21	12.75	11.94	11.37	11.25
6520	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70

Figure 1. Air-fuel ratio sample map of the studied engine management system in winols software

First, the required parameters in the original mode are obtained. Figure 1 shows the sample map of the air-fuel ratio of the considered engine for its management system study. This is for comparison and optimization purposes using the gas analyzer and the diagnostic tool of the engine and sensors installed in both the idle and the mid-range operating conditions (Table 2).

By increasing and decreasing the air-fuel ratio from 2.5 to 25 percent compared to the original state, the obtained values were compared with the original mode. According to Figure 2, it can be seen that by increasing the amount of air-fuel ratio from 2.5 to 12.5 percent, there is a noticeable decrease in the emissions of hydrocarbons, which can be due to the leaning of the air and fuel mixture. However, the problem here is the increase of NOx gas, which is due to an increase in combustion temperature.

By shifting to the values beyond 12.5%, there will be an increase in hydrocarbon gases. That is why values over the 12.5% range are ignored due to the engine performance (combustion instability starts which is measured with COVimep). Regarding the NOx variations, as it can be seen from Figure 2, it can be found that by increasing the amount of air-fuel ratio a significant increase in the emission of NOx; which is due to the leaning of the air and fuel mixture, causing high combustion temperature.

According to the results illustrated in Figure 3, it can be seen that by increasing the amount of air-fuel from 2.5 to 12.5 percent, the carbon monoxide will reduce. This is mainly because of the increasing oxygen and leaning of the mixture of air and fuel. When the air-fuel ratio exceeds 12.5 percent, the amount of carbon monoxide produced will continue to decrease, which is due to a disruption in the proper functioning of the engine. The carbon dioxide variations depend on

TABLE 2. Parameters in original mode for the considered engine

Parameter	Idle speed	Mid-range
AFR	14.21	13.77
Lambda	0.97	0.94
HC (ppm)	79	47
CO (%)	2.34	1.29
CO_2 (%)	14.24	15.62
O_2 (%)	0.71	0.68
NOx (ppm)	33	75
P_{air} (mbar)	400	280
T_{air} (K)	328.15	328.15
P_{ex} (mbar)	880	925
T_{air} (K)	553.15	553.15

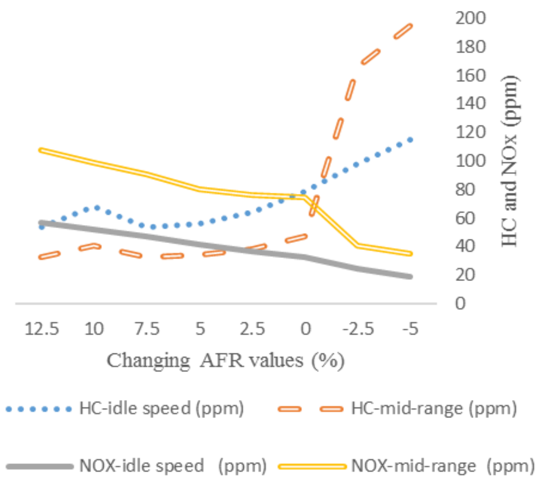


Figure 2. HC and NOx variations compared with changing the AFR values in engine idle speed and mid-range

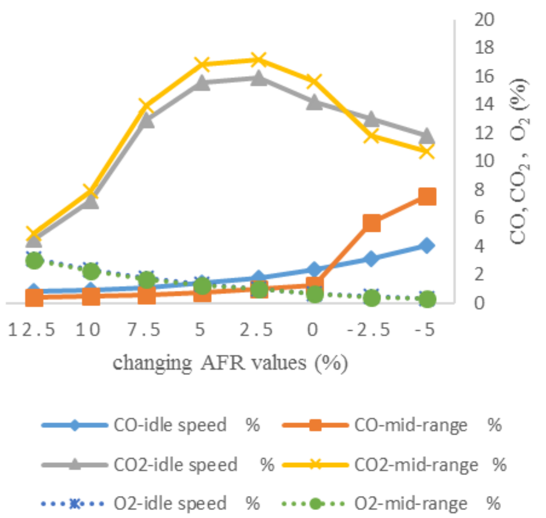
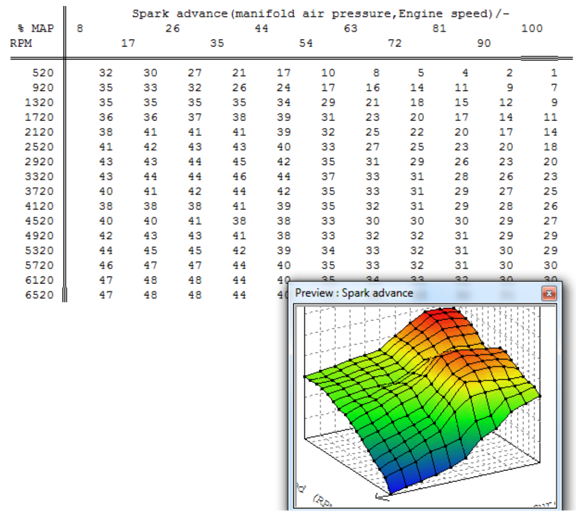


Figure 3. CO, CO_2 and O_2 variations comparing with changing AFR values in engine idle speed and mid-range

AFR and after getting a maximum value, decreases as it can be seen from Figure 3. With an increase in the air-fuel ratio, the amount of CO_2 initially increases due to an increase in the oxygen, but subsequently the carbon dioxide level decreases due to an increase in engine temperature and leaner mixture of air and fuel. Figure 4 shows the sample map of the spark advance of the considered engine for its management system study. From the testing modes, we selected modes 2.5 to 12.5 percent increase in the air-fuel ratio and a decrease of 2.5 percent, based on their reasonable emissions and engine performance. Also increasing and decreasing of the spark timing by 3, 6, and 9 percents, lead to 0.75, 1.5 and 3 degrees of spark timing advance, respectively.

Later on, the values obtained with the original case in terms of reducing the amount of emissions, especially unburned hydrocarbons, carbon monoxide and NOx were compared. It should be noted that by making changes beyond mentioned range in the engine, an impairment in the proper performance of the engine, including the creation of a knock in the engine are observed. Due to the resulted big dataset in different modes, here only number of conducted tests are explained.

Figure 5 reveals that with increasing spark advance, in cases where the air-fuel ratio increases, a reduction for emissions can be deduced. This is due to the enhancement in the time of the flame, resulting in a complete combustion.



Spark advance(manifold air pressure,Engine speed)/-

% MAP / RPM	8	17	26	35	44	54	63	72	81	90	100
520	32	30	27	21	17	10	8	5	4	2	1
920	35	33	32	26	24	17	16	14	11	9	7
1320	35	35	35	35	34	29	21	18	15	12	9
1720	36	36	37	38	39	31	23	20	17	14	11
2120	38	41	41	41	39	32	25	22	20	17	14
2520	41	42	43	43	40	33	27	25	23	20	18
2920	43	43	44	45	42	35	31	29	26	23	20
3320	43	44	44	46	44	37	33	31	28	26	23
3720	40	41	42	44	42	35	33	31	29	27	25
4120	38	38	38	41	39	35	32	31	29	28	26
4520	40	40	41	38	38	33	30	30	30	29	27
4920	42	43	43	41	38	33	32	32	31	29	29
5320	44	45	45	42	39	34	33	32	31	30	29
5720	46	47	47	44	40	35	33	32	31	30	30
6120	47	48	48	44	40	35	34	33	32	30	30
6520	47	48	48	44	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 4. Spark advance sample map of the studied engine management system in winols software

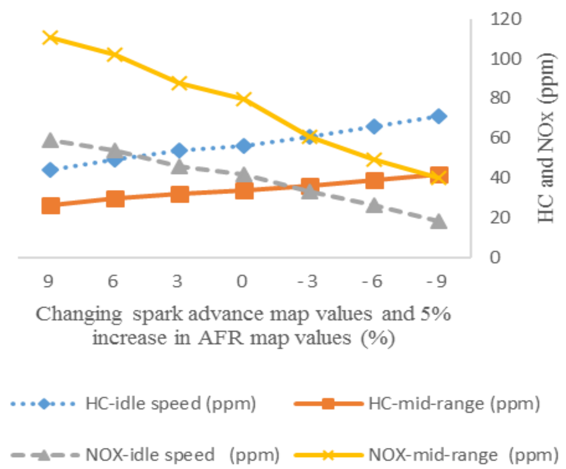


Figure 5. HC and NOx variations comparing with changing spark advance values and 5% increase in AFR values in engine idle speed and mid-range

However, the NOx production is increasing due to the increased combustion temperature. With reducing spark advance values, the amount of emissions of unburned hydrocarbons has begun to increase, which is due to the ignition delay, resulting in an incomplete combustion, but the production of NOx is decreasing because of reducing combustion temperature.

According to Figure 6, it is observed that with increasing spark advance values; there will be a reduction in the carbon monoxide emissions for the increased air-fuel ratios. This is mainly due to complete combustion and the reaction of the existing oxygen with carbon monoxide. Accordingly, with reducing spark advance values, the carbon monoxide emissions increase since the combustion is incomplete.

It can be inferred from Figure 7 that, in case where the air-fuel ratio is reduced, increasing spark advance will result in unburned hydrocarbons emission with decreased NOx generation. At the same time, due to the richness of fuel and air mixture, emission is more than the initial value. With reducing spark advance values, the rate of unburned hydrocarbons and nitrogen oxides production will increase which can be explained as the effect of combustion delay, resulting in incomplete ignition and increased combustion temperature. By reducing spark advance values, more increase in carbon monoxide emissions can be observed which is due to a delay in combustion and because of incomplete combustion. For the test conditions, the starting temperature of the engine cooling fan was reduced by 5 degrees. Figure 8 show the sample NOx variations comparing with changing AFR values in different test engines. By reducing the cooling fan starting temperature, a slight increase in the production of unburned hydrocarbons is observed. Also, there is a reduction in NOx production due to the engine

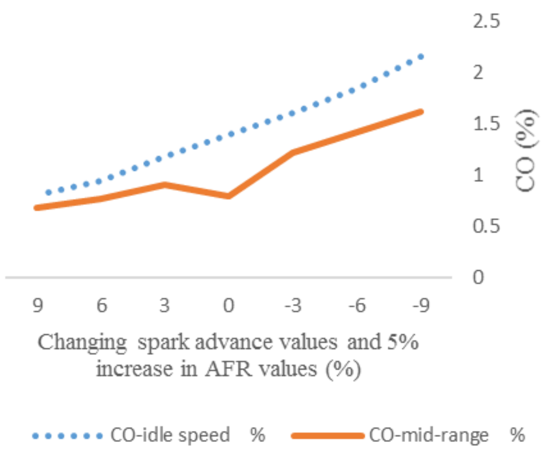


Figure 6. CO variations comparing with changing spark advance values and 5% increase in AFR values in engine idle speed and mid-range

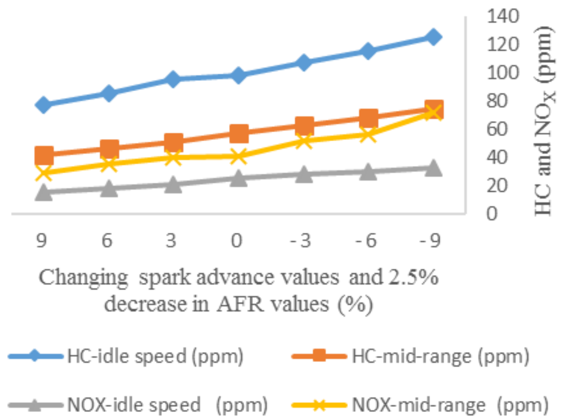


Figure 7. HC and NOx changing comparing with changing spark advance values and 2.5% decrease in AFR values in engine idle speed and mid-range

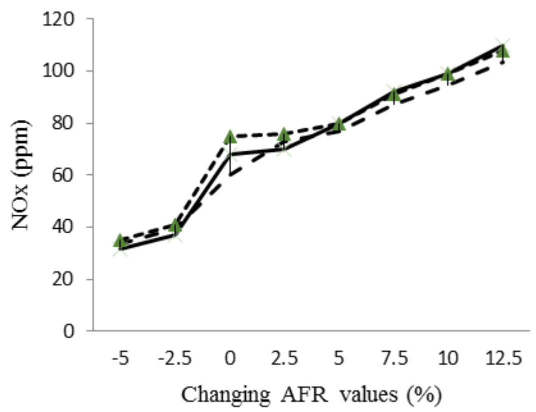


Figure 8. Sample NOx variations comparing with changing AFR values in different test engines mid-range

temperature decrease. NOx generation is decreased for AFR ratios enhancement. The spark advance values changing and the richness or leaning of the fuel play a significant role in this regard.

No particular changes were observed in the production of carbon monoxide by reducing the starting temperature of the cooling fan. It should be noted that the difference observed in the idle speed and mid-range is due to the change in air-fuel ratio, the throttle position openness, air manifold pressure and spark advance. According to the results, in order to reduce all exhaust emissions, it is observed that in conditions of 5% increase in the air-fuel ratio values, a 3% reduction in the amount of spark advance values and 5°C reduction in the starting temperature of the engine cooling fan, the amount of unburned hydrocarbons, carbon monoxide and NOx will decrease 22.4, 31 and 1.4%, respectively, in the idle range and a decrease of 23.3, 5.3 and 18.8%, respectively at 2500 rpm. Also, in the conditions of 12.5% increase in air-fuel ratio values, 9% reduction in spark advance and 5°C reduction in the operating temperature of the engine cooling fan, then, the unburned hydrocarbons, carbon monoxides and NOx will decrease 13, 46.5 and 44.9%, in idle range and 14.2, 27.31 and 46.5 at 2500 rpm, respectively. Brake-specific fuel consumption (BSFC) reduces more than 1.4% in idle speed and 1.2% in medium speed in the experiments at the optimum mode.

5. CONCLUSION

An experimental study of the EF7 engine management system has been conducted for emissions optimization, using Winols specialized software, TNM programmer device, AVL gas analyzer and etc. Two cases of idle (850-900 rpm) and mid-range (2500 rpm) are considered in the tests and air-fuel ratio, spark advance and starting temperature of engine cooling fan are considered as effective parameters. The key findings of the investigation are summarized as follows:

- Increasing the amount of air-fuel ratio will decrease the emissions of hydrocarbons and carbon monoxide.
- Increasing spark advance leads to a reduction in unburned hydrocarbons and carbon monoxide while there the NOx emission will increase.
- Due to reducing the cooling fan starting temperature, a minor increase in the production of unburned hydrocarbons is observed. Also, there is a reduction in NOx production due to the engine temperature decrease.
- Optimized emission conditions can be achieved by applying software changes in engine management system at a minimal cost. Improving the equipment will obviously have favorable outcomes, but the results show that when there are no changes in the system, modifying and applying control unit's program with TNM or similar programmer devices will lead in decreased emissions of the engine.

6. REFERENCES

1. Fundamentals, I.C.E. and Heywood, J.B., "Mcgraw-hill series in mechanical engineering". 1988, Singapore. https://doi.org/10.1016/B978-0-12-809943-8.00002-9
2. Huang, D.-Y., Jang, J.-H., Lin, P.-H. and Chen, B.-H., "Effect of ignition timing on the emission of internal combustion engine with syngas containing hydrogen using a spark plug reformer system", ***Energy Procedia***, Vol. 105, (2017), 1570-1575. https://doi.org/10.1016/j.egypro.2017.03.499
3. Ebrahimi, R. and Mercier, M., "Experimental study of performance of spark ignition engine with gasoline and natural gas", ***International Journal of Engineering, Transactions B: Applications*** Vol. 24, No. 1, (2011), 65-74. http://www.ije.ir/article_71888.html
4. Jafarmadar, S. and Zehni, A., "Multi-dimensional modeling of the effects of spilt injection scheme on performance and emissions of idi diesel engines", ***International Journal of Engineering-Transactions C: Aspects***, Vol. 25, No. 2, (2012), 135. doi:10.5829/idosi.ije.2012.25.02c.07
5. Chuang, H.-C ,.Lin, L.-Y., Hsu, Y.-W., Ma, C.-M. and Chuang, K.-J., "In-car particles and cardiovascular health: An air conditioning-based intervention study", ***Science of the Total Environment***, Vol. 452, (2013), 309-313. https://doi.org/10.1016/j.scitotenv.2013.02.097
6. Mohebbi, A., Jafarmadar, S., Pashae ,J. and Shirnezhad, M., "Experimental studying of the effect of egr distribution on the combustion, emissions and performance in a turbocharged di diesel engine", ***International Journal of Engineering***, ***Transactions A: Basics***, Vol. 26, No. 1, (2013), 73-82. doi:10.5829/idosi.ije.2013.26.01a.10.
7. Kousoulidou, M., Fontaras, G., Ntziachristos, L., Bonnel, P., Samaras, Z. and Dilara, P., "Use of portable emissions measurement system (PEMS) for the development and validation of passenger car emission factors", ***Atmospheric Environment***, Vol. 64, (2013), 329-338. DOI: 10.1016/j.atmosenv.2012.09.062
8. Twigg, M.V., "Progress and future challenges in controlling automotive exhaust gas emissions", ***Applied Catalysis B: Environmental***, Vol. 70, No. 1-4, (2007), 2-15. https://doi.org/10.1016/j.apcatb.2006.02.029
9. Lozhkin, V., Lozhkina, O. and Dobromirov, V., "A study of air pollution by exhaust gases from cars in well courtyards of saint petersburg", ***Transportation Research Procedia***, Vol. 36, No., (2018), 453-458. https://doi.org/10.1016/j.trpro.2018.12.124
10. Datta, A. and Mandal, B.K., "A comprehensive review of biodiesel as an alternative fuel for compression ignition engine", ***Renewable and Sustainable Energy Reviews***, Vol. 57, (2016), 799-821. https://doi.org/10.1016/j.rser.2015.12.170
11. Ghadikolaei, M.A., "Effect of alcohol blend and fumigation on regulated and unregulated emissions of ic engines—a review", ***Renewable and Sustainable Energy Reviews***, Vol. 57, (2016), 1440-1495. doi: 10.1016/j.rser.2015.12.128
12. Imran, A., Varman, M., Masjuki, H.H. and Kalam, M.A., "Review on alcohol fumigation on diesel engine: A viable alternative dual fuel technology for satisfactory engine performance and reduction of environment concerning emission", ***Renewable and Sustainable Energy Reviews***, Vol. 26, (2013), 739-751. https://doi.org/10.1016/j.rser.2013.05.070
13. Madu, K., "Thermodynamic properties and heat generation potential of octane fuel, under stoichiometric condition", ***Equatorial Journal of Chemical Sciences***, Vol. 2, No. 2, (2018), 14-19. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3197885
14. Meshram, W.H., Chincholkar, S.P., Somankar, V.I. and Suryawanshi, J.G., "Ignition timing investigation on the performance and emissions of spark ignition engine fuelled with gasoline. International Conference On Emanations in Modern Technology and Engineering (ICEMTE-2017), ISSN: 2321-8169.
15. Tunka, L. and Polcar, A., "Effect of various ignition timings on combustion process and performance of gasoline engine", ***Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis***, Vol. 65, No. 2, (2017), 545-554. https://doi.org/10.11118/actaun201765020545
16. Gailis, M. and Pirs, V., "Effect of ignition timing on emissions of spark ignition engine using e85 fuel", ***Research for Rural Development***, Vol. 1, (2014), 212-218. https://www.researchgate.net/publication/287272988_Effect_of_

ignition_timing_on_emissions_of_spark_ignition_engine_using_E85_fuel

17. Hossain, A.K., Smith, D.I. and Davies, P.A., "Effects of engine cooling water temperature on performance and emission characteristics of a compression ignition engine operated with biofuel blend", ***Journal of Sustainable Development of Energy, Water and Environment Systems***, Vol. 5, No. 1, (2017), 46-57. DOI: 10.13044/j.sdewes.d5.0132

18. Virale, A.G. and Nitnaware, P.T., "Experimental analysis of jacket cooling of si engine and study of operating parameters and emissions", ***International Journal of Advances in Engineering & Technology***, Vol. 10, No. 1, (2017), 113. ISSN: 22311963

Persian Abstract

چکیده

مطالعه حاضر با هدف بررسی میزان آلایندگی گازهای خروجی یک موتور احتراقی ٤ سیلندر بنزینی انجام شده است. یک مطالعه تجربی از یک سیستم مدیریت موتور احتراقی برای بهینه سازی آلایندگی ها، با استفاده از نرم افزار تخصصی Winols انجام شده است. به منظور دستیابی به شرایط پایدار در تست ها، دمای آب و روغن موتور قبل از هر آزمایش به دمای کاری موتور (۹۰ درجه سانتیگراد) می رسد تا قطعات مختلف موتور به حالت پایا برسند.. دو حالت دور آیدل (۸۵۰-۹۰۰ دور در دقیقه) و متوسط (۲۵۰۰ دور در دقیقه) در نظر گرفته شده است. آزمایشات برای سه موتور یکسان با کارکردهای مختلف انجام می شود و نتایج به دست آمده مورد بحث قرار می گیرد. با توجه به نتایج به دست آمده، پس از اعمال تغییرات در سیستم مدیریت موتور، در هر دو دور مذکور، شاهد کاهش ۲۲ درصدی آلاینده های هیدروکربن هستیم. علاوه بر این، میزان آلاینده ی مونوکسید کربن ۳۱٪ و ۵٪ در دور آیدل و متوسط کاهش یافت. در نتیجه اعمال این تغییرات، کاهش میزان آلاینده ی NOx در دور آیدل ٤.١٪ و در دور ۲۵۰۰ حدود ۱۹٪ کاهش می یابد.