The impact of decarbonization on IC engine performance

Zoran Ćurguz, Miroslav Pavlović, Milan Eremija

Faculty of Transport and Traffic Engineering, Vojvode Mišića 52, 74000 DOBOJ, Bosnia and Herzegovina

Abstract

Measurement of vehicle parameters before and after the decarbonization process is the main subject of research of this paper. Before the decarbonization process, a laboratory test of the passenger vehicle was performed, after the laboratory test, the decarbonization process was performed with a device based on water and electricity, without the use of chemicals to avoid harmful by-products, after which the laboratory test of the vehicle was performed again. The paper presents the results of vehicle performance testing in terms of exhaust emissions, engine power and fuel consumption before and after the decarbonization process. After the obtained results, a comparative analysis was performed, which aims to show the extent to which the decarbonization process contributes to the reduction of harmful gas emissions, as well as the impact of decarbonization on the power of the propulsion engine and fuel consumption. The obtained results indicate the possibility of further research in this field, due to the benefits that this process brings to vehicles, owners and the environment.

Keywords: *IC engine, decarbonization, exhaust emissions, engine power, fuel consumption.*

1 Introduction

The accelerating economic growth and development in the world is causing a rapid growth of road traffic, which leaves undesirable and unpredictable consequences for man and the environment. According to research, the largest and most toxic pollutant from motor vehicles is carbon monoxide (CO), which creates air pollution of more than 60%, followed by hydrocarbons (CH) 17%, sulfur oxide 14% and other oxides 5-8% [3]. The most obvious negative health impact of car emissions is on the respiratory system. It is estimated that air pollution, of which vehicle emissions are the main exponent, is responsible for 24000 premature deaths in the UK each year [3]. Many of these deaths are due to asthma, bronchitis and other diseases of the respiratory system - all of which are known to be aggravated by exposure to harmful gases from cars. In order to reduce exhaust emissions, the European Union is introducing standards that set limits on exhaust emissions. Also, the use of alternative fuels is becoming popular, and procedures are being used to reduce harmful emissions of diesel engines, such as measures on the engine itself and subsequent treatment of exhaust gases.

Speed characteristics represent the dependence of power, torque, consumption and other parameters on the speed of rotation. Speed characteristics are of general importance because they show the behavior of the number of revolutions and loads, and they are especially important for motor vehicles [1].

The economy of engine operation is driven by the specific effective fuel consumption. The specific effective fuel consumption is inversely proportional to the effective efficiency.

According to the above, all further research in the field of motor vehicles is aimed at reducing environmental pollution and economic viability. One of the factors that enables these theses, both in terms of reducing environmental pollution and reducing fuel consumption, and in extending the service life of IC engines is the process of decarbonization of engines [2].

In this paper, a test was performed on a passenger vehicle in terms of exhaust emissions, fuel consumption and engine power. The testing of the mentioned performances was initially performed in the Technical-Laboratory Center, after which the process of decarbonization of the engine was performed. Then a re-measurement was performed based on the mentioned performances.

2 Research methodology

The test process was performed on a Renualt passenger car. Initially, the exhaust emission test was performed on a device that is part of the installation of the technical inspection station, it is a test to which all vehicles are subject to regular technical inspection. The obtained results indicate the amount of CO_2 emissions as well as other gases. Then, the vehicle was placed on the installation within the Technical-Laboratory Center, where the test regarding the power and fuel consumption of the motor vehicle was performed. The laboratory in which the testing was performed is one of the three laboratories within the Technical-Laboratory Center. It is a laboratory for testing vehicles, in addition to which there is also a laboratory for testing engines, as well as a laboratory for combustion and environmental protection.

The laboratory for testing motor vehicles is equipped with a chassis dynamometer "AVL Roadsim Chassis Dyno 48" manufactured by AVL Austria. Some of the parameters that determine the obtained available energy for driving a motor vehicle on its wheels can be calculated, ie. to predict, but some of them are not always predictable in a simple way, for this reason an executive laboratory test is necessary. Tests of the traction characteristics of the vehicle, ie. its performance, can be performed on the road (polygon), or they can be tested in stationary conditions. Devices that enable tests of traction characteristics in stationary conditions are called dynamometers. The main purpose of testing motor vehicles on a chassis dynamometer is to accurately map the load conditions of the vehicle, as in real driving conditions on the road.

After testing the performance of vehicle in terms of exhaust emissions, fuel consumption and engine power, the process of decarbonization of the engine was performed. Engine decarbonization is based on the principle of filter cleaning. Particles generated during the combustion process of diesel engines can be efficiently removed by a particle filter that is placed in the exhaust manifold. As the filter becomes increasingly saturated with particles, a layer of particles forms on the surface of the walls on the opposite side from the inlet. This provides greater efficiency for the next phase of filtering. The DPF filter can become clogged for a variety of reasons, such as constant city driving and short distances where the DPF filter is unable to reach the desired particle combustion temperature inside, a injector failure where combustion is incomplete, and too rich a mixture of fuel and air. Also an example, if the air flow meter is dirty or damaged, which injects too much fuel, the nozzles can be damaged and inject excess fuel, which causes the engine and engine oil to overheat. If the filter is partially dirty, decarbonization of the engine can help. The introduction of HHO gas (oxy-hydrogen gas) affects the decomposition of carbon deposits that are emitted from the engine in the gaseous state through the exhaust system.

Carbon dioxide deposits, which form on parts of internal combustion engines, are present in every vehicle in traffic. Oil, too much enriched fuel mixture or of poorer quality, the city's 'start-stop' way of driving, all this causes faster carbon accumulation. A thin layer of carbon should not pose major problems, but its accumulation can cause them. Carbon deposits can significantly affect vehicle performance such as reduced power and torque, engine tremors, frequent stagnation in cold weather, increased exhaust gas concentrations, and fuel consumption.

The decarbonization process was performed using a nonCarbon device. NonCarbon devices work by electrolyzing water to create oxygen and hydrogen gases, which are then combined into a new fuel. By using HHO gas, the risks of storage and transport are eliminated because the gas mixture is created on demand, currently on site.

Oxy-hydrogen gas can be used to clean carbon deposits in the engine and thus improve the performance of the vehicle's engine. The only by-product in oxy-hydrogen combustion is water vapor. Neither carbon nor any other toxic substance is produced in the process. Oxy-hydrogen energy can be used as an additive to standard fuels such as gasoline, petroleum, oil, heating oil, acetylene, propane or liquefied petroleum gas. The process of decarbonization on the passenger vehicle lasted 60 minutes.

Finally, after the decarbonization process, a new measurement of exhaust gases was performed at the technical inspection station. Then, the performance of the vehicle in terms of power and exhaust emissions was measured within the Technical-Laboratory Center.

3 Results

Motor vehicles are the largest single source of air pollution. The exhaust gas of a gasoline engine contains a whole range of gases that result from combustion, and can be roughly divided into harmful and non-harmful gases. When emitting harmful gases from motor vehicles, there are two types of gases: motor exhaust gases - combustion products and emission of easily volatile components from fuel.

In order to contribute to the reduction of environmental pollution from the aspect of motor vehicles, one of the factors is the decarbonization of engines.

Therefore, a laboratory test of exhaust emissions was performed in this paper.

The obtained results in terms of exhaust emissions indicate that the decarbonization process has contributed to the reduction of the exhaust content of the motor vehicle. Table 1 shows the data of the degree of blackening before the decarbonization process.

Table 1. Results of degree of blackening before decarbonization

Acceleration N°	Blackening (m^{-1})	Rpm min.	Rpm max.
1	0.17	1110	2020
2	0.19	1200	2400
3	0.13	1150	2830

The results obtained during the first measurement indicate an average degree of blackness in the amount of 0.16 [m^{-1}].

Table 2 shows the results of the degree of blackening after the decarbonization process.

Table 2. Results of degree of blackening after decarbonization

Acceleration N°	Blackening (m^{-1})	Rpm min.	Rpm max.
1	0.05	1010	1710
2	0.01	940	1670
3	0.00	850	1650

The average degree of blackness during repeated measurement (measurement after decarbonization) is 0.02 [m^{-1}].

Comparing the obtained results in terms of the degree of blackening before and after the decarbonization process, they indicate that the degree of blackening was reduced by 0.14 [m^{-1}]. Fuel consumption is a factor that defines the economic viability of the decarbonization process. Fuel consumption testing was performed by road load simulation in real operating conditions at a speed of 80 [km/h] and at 1500 [rpm]. The results of fuel consumption before the decarbonization process are shown in Figure 1.

Fig. 1. Fuel consumption before decarbonization

Fuel consumption in the mentioned operating conditions is 5.00 [l/100km] (Figure 1).

Figure 2 shows the results of fuel consumption after the decarbonization process.

Fig. 2. Fuel consumption after decarbonization

Repeated measurement, under identical operating conditions, indicates a fuel consumption of 4.40 [l/100km] (Figure 2).

Conducted tests in terms of fuel consumption before and after the decarbonization process indicate that the decarbonization process has reduced fuel consumption by 9%.

In addition to the test regarding the emission of exhaust gases and the reduction of fuel consumption, a test was performed regarding the

power at the drive wheels before and after the decarbonization process.

Power tests at the drive wheels were performed during the simulation of real working conditions within the Technical-Laboratory Center. During the test, the air temperature was 4.10 [°C], the atmospheric pressure 1013.60 [mBar], while the humidity was 50%

The test results before the decarbonization process are shown in Figure 3, where the power obtained is 100.018 [kw].

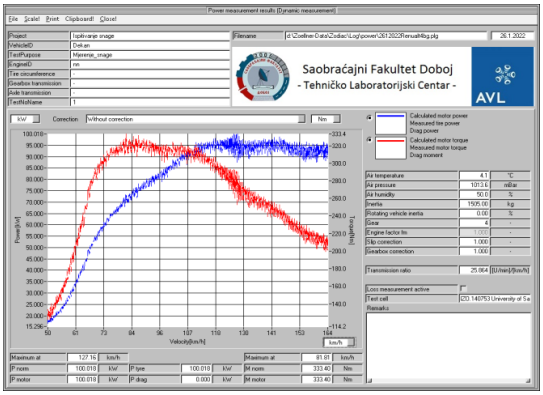

Fig. 3. Engine speed characteristic before decarbonization process

Then a new measurement was performed after the decarbonization process, simulating identical operating conditions as in the first case. The obtained results are shown in Figure 4. The results after the decrabonization process in terms of power indicate an increase in power from 100.018 [kw] to 105.240 [kw].

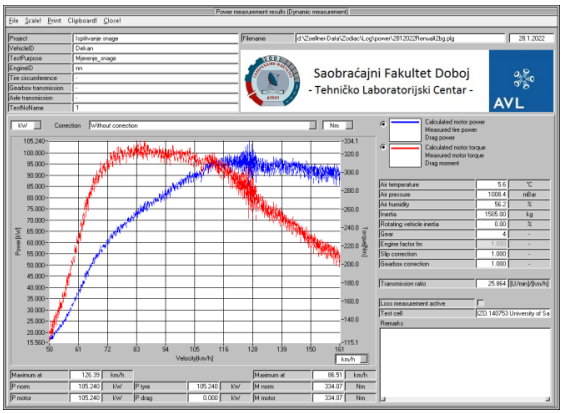

Fig. 4. Engine speed characteristic after decarbonization process

The obtained results also confirm the third thesis that dearbonization based on distilled water, in addition to contributing to the reduction of environmental pollution and reducing fuel consumption, also increases the power of the propulsion engine.

4 Conclusion

Road traffic largely affects the environment, in a way that pollutes the air with exhaust gases. Each liter of combustible fuel causes the release into the atmosphere of about 100 [g] of carbon monoxide, 20 [g] of various organic compounds, 30 [g] of nitrogen oxides, 2500 [g] of carbon dioxide and a number of other compounds [3].

Due to the huge increase in the number of motor vehicles that use internal combustion engines, legislation has long been introduced that limits the level of toxic components of exhaust emissions. One of the measures to reduce environmental pollution and emissions from internal combustion engines is decarbonization of the engine, which leads to a reduction in emissions and the degree of blackening. According to the obtained results, the degree of blackening decreases by 87.50%. In addition to testing the emission of harmful gases during vehicle operation, the basic engine quantities also play an important role: effective power, torque, crankshaft speed, hourly fuel consumption and specific effective fuel consumption. These values are a function of the engine mode, so the characteristics of the engine are the dependence of these values on the engine mode. Based on the conducted research, it can be concluded that the decarbonization process, in addition to reducing fuel consumption, also leads to an increase in some of the vehicle performance, such as fuel consumption and power of the engine. In addition, decarbonization contributes to extending the service life of internal combustion engines.

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