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The Influence of Various Operation Modes on Diesel Passenger Cars CO_2 Emissions

The amount of emissions released into the atmosphere by polluting sources was significantly reduced due to the limitations introduced by the EU. Since one of the main sources affecting air quality is the car, researches regarding the influence of various factors on exhaust emissions are carried out. As CO_2 is the main pollutant responsible for the greenhouse effect, the article treats the influence of vehicle load and traffic levels, running modes, the electric consumer's utilization, and driving style on CO_2 emissions for cars equipped with diesel engine. The results from the conducted study can contribute to adopt solutions in order to decrease the concentration of CO_2 emissions from cars equipped with diesel engines.

Keywords: *CO_2, passenger car, greenhouse effect, operation mode, diesel engine*

1. Introduction

A very important global problem from ecological point of view is the greenhouse effect whose main reason is the huge concentrations of carbon dioxide (CO_2) and other greenhouse gases released into the atmosphere [1], [2]. One of the major contributors to the greenhouse effect, with negative implications on the environment is road transport sector. The growing concern of global warming due to the greenhouse effect has increased the pressure exerted on car manufacturers in order to reduce their CO_2 emissions concentrations [3].

In recent decades, researches on environmental quality aimed to establish the main factors that influence the pollutant emissions generated by internal combustion engines. Conducted alongside by research institutes and also by engine and car manufacturers, these researches have reveled not only the influences on emissions but they also identified and innovated a number of measures in order to reduce the pollutants. The correlation factors – measures has become so common that at a less attention can generate confusion between the two terms [4].

In this regard, an increase attention has to be paid to all factors influencing CO_2 emissions, among which there are: the application nature and passenger car operation modes (vehicle load and traffic levels, running modes, the electric consumer's utilization, and driving style) [4].

Comparative studies performed regarding the vehicle load and traffic levels, running modes, the electric consumer's utilization, and driving style on CO_2 emissions exhausted by passenger cars equipped with diesel engines revealed increases in emission concentrations for urban running mode [5], [6], [7], [8].

The driving style can significantly influence the fuel consumption with consequences in terms of pollutant emission concentrations. By adapting the driving style of the passenger car there can be avoided its excessive loading which leads to a decrease in fuel consumption and as a result to CO_2 emissions reduction. Thus, the driver dynamic behavior reflects in the way that vehicle commands act, such as: acceleration, clutch, brake, gear shift and wheel [9].

Generally, the reduction measures of pollutants limited by the existed legislation generated increases in fuel consumption, which involves a compromise way to be found.

2. The simulation of CO_2 emissions reduction exhausted by passenger cars equipped with diesel engines depending on the running modes

When operating a car, CO_2 emissions do not represent a static entity. They depend on the conditions under which the car operates and the driver style.

In order to estimate the CO_2 emissions reduction, there were analyzed three types of diesel cars, for which there were taken under consideration the following initial data:

Small car – diesel fuel medium consumption: 5l/100km;
Medium car - diesel fuel medium consumption: 7,5l/100km;
Big car - diesel fuel medium consumption: 10/100km.

For the above three cases, the CO_2 emissions were calculated considering a running distance of 15000 km /year in two traffic modes (urban/extraurban), their weight ranging from exclusive urban to almost exclusively extraurban.

The passenger cars are operated in five different modes, as it follows:

- Passenger car with empty trunk, (Fig. 1) [10];

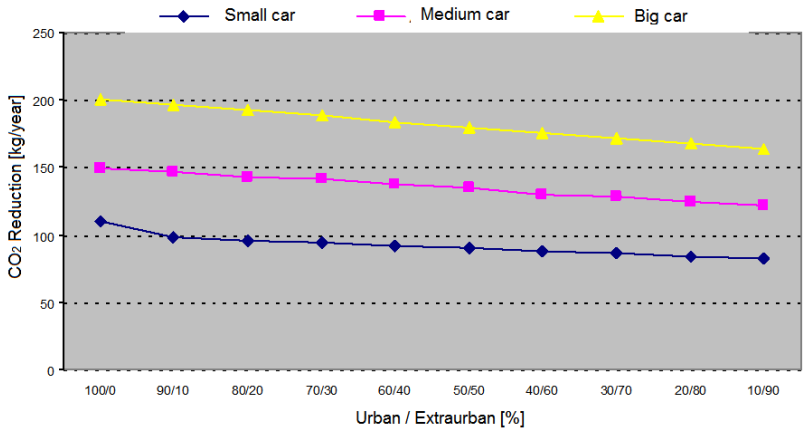

Figure 1. CO_2 emission reduction for the 3 diesel cars with empty trunk, depending the traffic mode weight.

From Fig. 1 it can be observed that when the three diesel cars run with empty trunk, the CO_2 emission reduction is with 20% more significant in the urban mode compared with the extraurban one. The emissions reduction weight is almost identical for all the analyzed cars, the values being proportional to the car category.

- Engine off (traffic lights, traffic jams, etc), (Fig.2) [10];

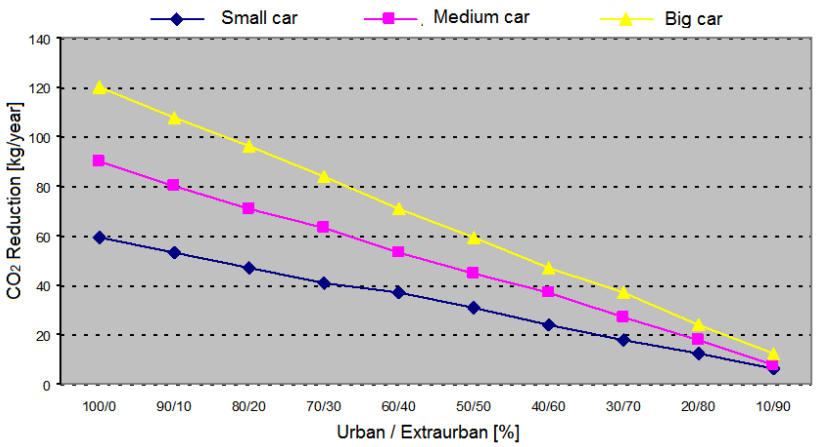

Figure 2. CO_2 emission reduction for the 3 diesel cars with sequential engine stop (traffic lights, traffic jams, etc.), depending the traffic mode weight.

If the engine sequential stop at traffic lights, traffic jams, etc. (Fig.2), is considered the CO_2 reduction is 6 times larger the in urban mode compared with the extraurban one. This fact represents one of the motives for which the automotive firms have widely introduced the Start/Stop systems for all vehicles classes.

- The tires pressure with maximum 0.5 bar over the recommended value, (Fig. 3) [10];

Generally, the car manufacturers recommend certain values of tires pressure depending on the transported load.

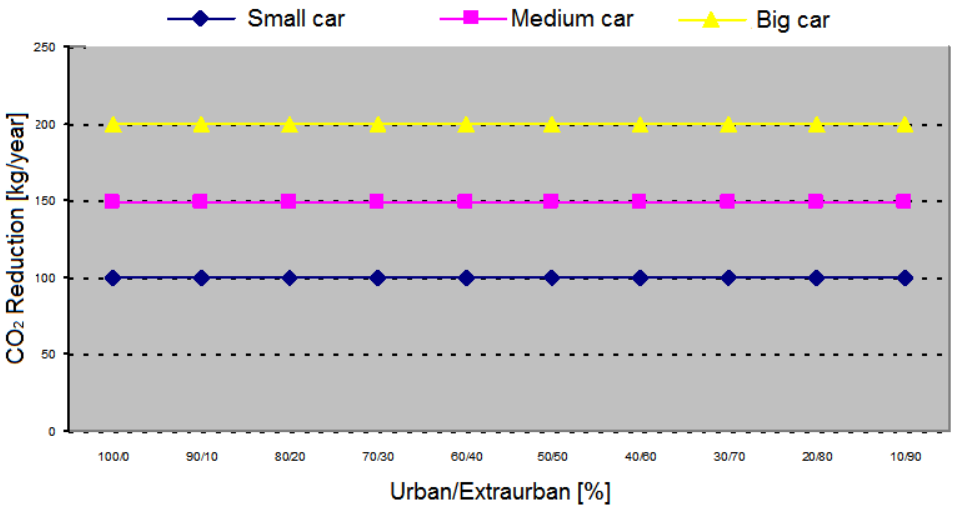

Figure 3. CO_2 emission reduction for the 3 diesel cars with tires pressure with 0.5bar over the recommended one, depending the traffic mode weight.

From Fig. 3, it can be observed that an increase with up to 0.5bar over the recommended value represents a source of CO_2 emissions reduction. This decrease is not influenced by the running mode weights, but its level proportional depends on the car category.

- Air conditioning and electric consumers sustainable utilization, (Fig. 4) [10];

From the air conditioning and electric consumers sustainable utilization point of view, in Fig. 4 can be observed the CO_2 quantitative reduction variation for all analyzed cars.

It can also be seen that between the two traffic modes, urban and extraurban, there is a difference of about 20% in the amount of CO_2 saved for the cars running in the city, (Fig. 5) [10].

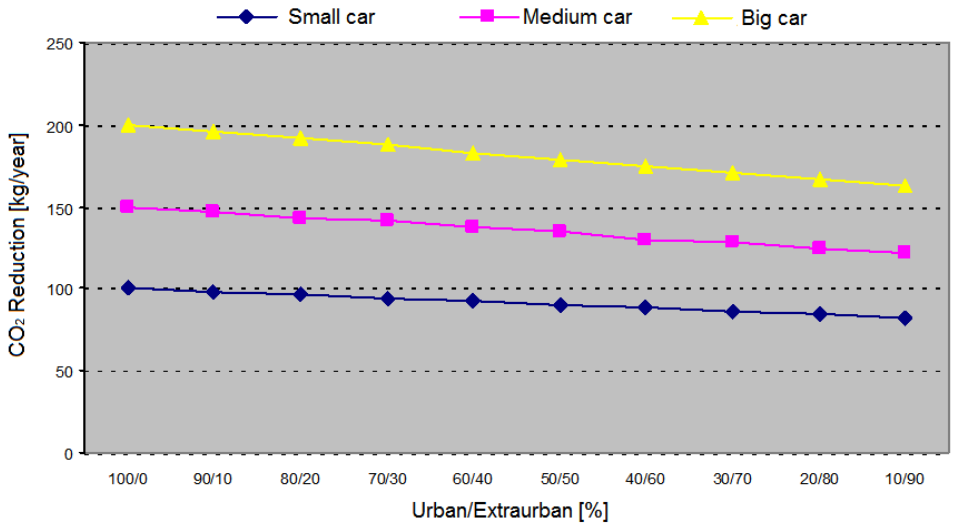

Figure 4. CO_2 emission reduction for the 3 diesel cars with sustainable utilization of air-conditioning and electric consumers, depending the traffic mode weight.

Another important factor that influences the CO_2 concentrations is the car driver style.

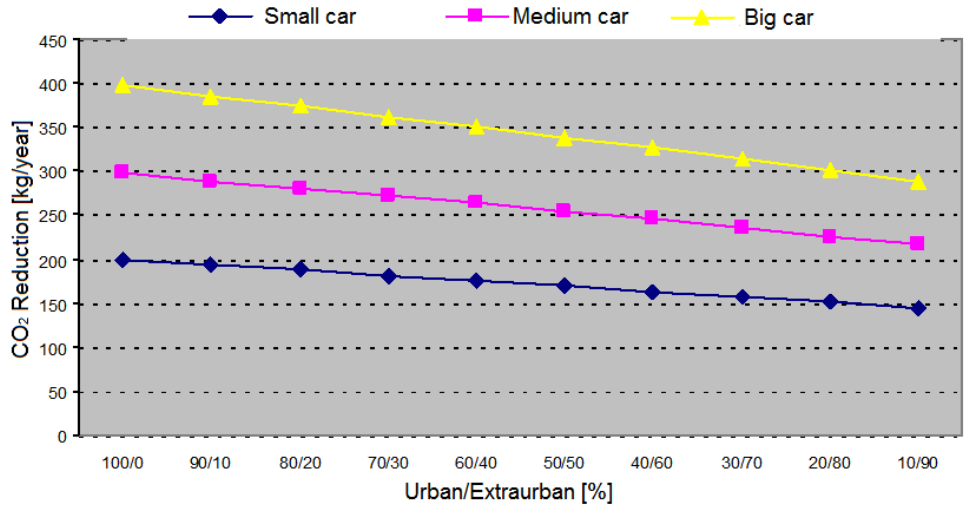

Figure 5. CO_2 emission reduction for the 3 diesel cars driven adapted to economic mode, depending the traffic mode weight.

By following the driver style in driving the car, from Fig. 5 can be observed that if this is adapted to the economic style significant reduction of CO2 emissions

can be obtained, especially for the urban mode. In order to support drivers, the modern cars are equipped with ECO selectable operating modes at driver desire.

For assessing the CO_2 global saving, in Fig. 6 are presented the comparative cases for the three passenger cars when all the 5 operating modes are simultaneously applied.

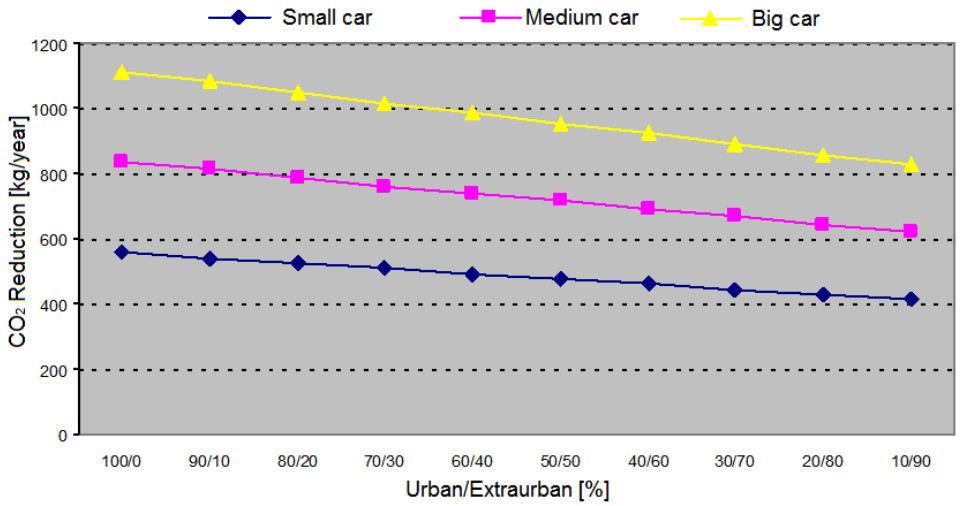

Figure 6. CO_2 emission reduction for the 3 diesel cars when all the 5 operating modes are applied, depending the traffic mode weight.

It can be observed that under urban mode exclusively, the global reduction in CO_2 emissions can reach up to 28-29% and if the operating mode is mostly extrauran this reduction is up to 21%.

3. Conclusions

From the study performed with respect to the influence on CO_2 emissions depending on the five operating modes applied to the three diesel passenger cars of different categories (small/medium/big) there can be concluded the following:

By running a passenger car with 100kg inside the trunk, the concentration of CO_2 emissions increases.

For a more accurate operation of the car, from the CO_2 emission reduction point of view it is recommended to stop the engine at traffic lights and traffic congestion, only if the operating temperature is reached.

The car operating with low tires pressure leads to the increase of rolling resistance with negative effects on pollutant emissions. Therefore, it is recommended that the value of tires pressure to be slightly higher compared to the one prescribed by the manufacturer depending on the car load capacity.

The electrical devices and air-conditioning operation has implicitly negative effects on CO_2 emissions. Thus, the highest values are recorded when the car is running at low speed in urban areas.

The driving style significantly influences the analyzed saving in CO_2 emissions.

For the three analyzed passenger cars running under different weights of traffic modes (urban/extraurban) and exhausting various emission concentrations, it can be noticed that by applying one of the five driving modes, the quantity of emissions is overage globally reduced with 5%. If all five modes are simultaneously applied the CO2 emission overage globally reduction is of 24%, which will increase for modes priority urban upt to 28-29% and decrease to 20% for mainly extraurban modes.

In conclusion, achieving these saving is very important, but not at the cost of harming traffic safety.

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