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THE ISSUES OF SOLVING ENVIRONMENTAL PROBLEMS IN THE FIELD OF ROAD TRANSPORT USING INTELLIGENT TRANSPORT SYSTEMS

Yusupov S.S.[1], Inoyatkhodjaev J.Sh.[2]
[1]Tashkent State Technical University named after Islam Karimov, 100095, 2 str. University, Tashkent, Uzbekistan.
[2]Turin Polytechnic University in Tashkent, 100095, 17, Kichik Khalqa Yuli str, Tashkent, Uzbekistan.

Abstract: In article analyzes the environmental problems in the field of road transport, as well as ways of using modern information technologies in them and the possibility of using intelligent transport systems in the design of cars. It suggested test methods and requirements using an intelligent “start/stop” system based on 1,5L engines of local cars. According to theoretical calculations, using an intelligent “start/stop” system is expected to reduce the operating time of the internal combustion engine by about 10%, by saving 5-10% of fuel in urban environments.

Key words: *start-stop system, energy efficiency, environment, drive cycle.*

Introduction

Today, the development of industrial production is causing environmental crises. Production is based on modern technology. The resource of technology is science. Therefore, environmental challenges are linked to the development of science and technology.

The constantly growing number of cars in the world has a negative impact on the environment and human health. Research has shown that a car produces between 50 and 70 m^3 of exhaust gas within an hour of work and contains more than 200 harmful chemical compounds (carbon monoxide, nitrogen oxides, hydrocarbons, aldehydes, carbon dioxide, sulfur dioxide, dry matter, lead compounds, benzopyrene, etc.) [1].

Carbon monoxide is stored for 4 months in the atmosphere. The amount of exhaust gases emitted in a short time on city highways, especially carbon monoxide, reaches 250-500 mg/m^3. The proportion of CO_2 emitted by cars is not the highest compared to other industries, but it is an important factor (Diagram 1).

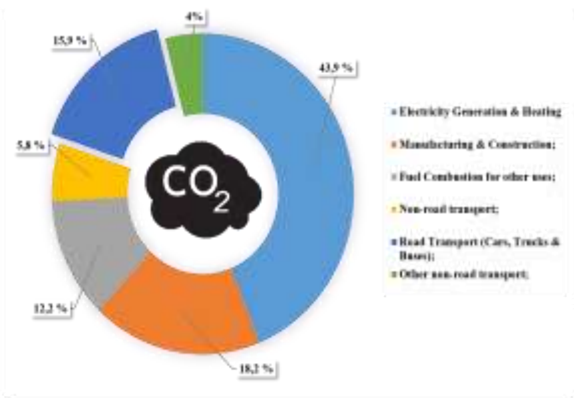

Diagram 1. The share of carbon dioxide (CO_2) in other areas [2].

* Corresponding author: jasursafarov@yahoo.com

Main part

As developing countries require more people mobility, the increase in the number of vehicles is effectively nullifying the gains made in reducing the fuel consumption of new vehicles around the world. The International Energy Agency forecasts an increase in CO_2 emissions from car usage worldwide, in line with average growth rates in other sectors. Therefore, the share of motor transport is expected to remain the same, although the overall problem is much larger [2].

All over the world, road transport is responsible for approximately 16% of atmospheric CO_2 emissions. It is a common misconception that cars and trucks are the main cause of global warming. If we want to solve the problem, we have to understand that there are other more significant sources of CO_2 emissions.

This research corresponds to the priority direction of science and technology of the Republic of Uzbekistan II. “Energy, energy and resource saving”. In the global experience, the leading researchers in the field of automobile design, energy and resource saving, the improvement of electronic control systems through intelligent transport systems, including: Yang Hai, Harry J. Currie, Graham, Mulley, Corinne A, Lam, William H, Nowacki G, Yokota T, Weiland R, and others [3]. Among the scientists in our country are O.V. Lebedev, A.A. Mukhitdinov, S.M. Kadyrov, B.I. Bazarov, J.R. Kulmukhamedov, Sh.K. Khakimov, J.Sh. Inoyatkhodjaev, K.Z. Ziyaev, U.A. Abdurazzokov and others. Research has been carried out to improve vehicle efficiency and road parameters, including to increase fuel and environmental efficiency [4].

It is necessary to conduct theoretical and practical research on scientific and practical problems of synergy between platforms with intelligent transport systems in the design of cars produced in our country. From an environmental point of view, it is difficult to eliminate all the negative effects of cars, but this effect can be considerably reduced. This can be done by accurately selecting the engine mode and setting the fuel supply components, using the engine in a liquefied mixture, optimizing the electronic control system using a neural system and intelligent systems, filtering and also neutralizing exhaust gases before exhausting.

In recent years, the energy and environmental crisis in the world has led to the adoption of regulations governing the toxicity of exhaust gases and liminate fuel consumption in many developed countries, which has strongly encouraged the widespread use of electronic control units (ECU) and intelligent transport systems (ITS). According to these regulatory documents, almost all operating modes of the engine are required to keep the fuel mixture in a stoichiometric composition, to stop the fuel supply to the engine operation during idling mode, to accurately and optimal setting the ignition or injection time. A number of scientific researches have shown that the above requirements are impossible without electronic control systems. Reducing pollution in today's environment requires the development of intelligent transport systems, information and communication technology in vehicle design.

In other words, research in the field of transport, aimed at solving the problems of energy saving, transport efficiency (safe and quality transportation of goods and passengers), congestion, safety, and reliability, identifies significant achievements in the process of changing trends with modern technologies. However, the fact that the level of implementation of these technologies in our conditions is still low. This indicates that resources are available in our country to address the aforementioned problems in the future. According to the European Environment Agency, 27% of total CO_2 gas emissions contribute trucks,

* Corresponding author: jasursafarov@yahoo.com

buses, lorries and 73% from cars and vans [5].

There are 91 786 861 vehicles were produced in the world in 2019 (Diagram 2). Currently, the volume of the car market in the country is about 2,3 million cars, about 0,6 million trucks, buses and special vehicles, and the annual number of new cars is 100,000.

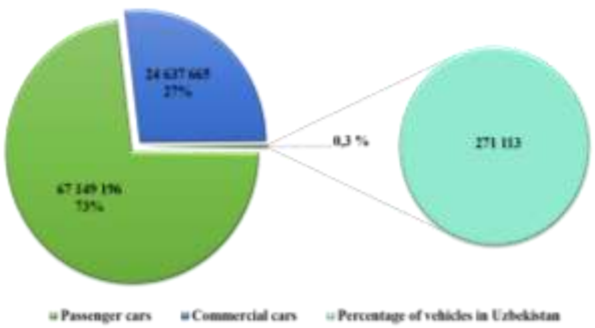

Diagram 2. The percentage of cars produced worldwide in 2019 [6].

Taking into account these indicators, it is necessary to properly organize traffic on existing roads, to optimize routes for the transport of goods and passengers, reducing congestion, reducing idle time of engines, minimizing of road accidents and mitigation of their consequences, increasing safety, reliability, efficiency, the use of intelligent transport systems to increase convenience. For example, there are 1 million vehicles in Tashkent each day. It is complicated to manage these vehicles on the city road. Therefore, the use of communication technologies is very important.

According to experts, about 30% of the fuel is consumed during the idling time of the engine. This mode is more appropriate for waiting time at traffic lights and intersections in urban areas [7].

Many countries such as the USA, Canada, Australia, Germany, Japan, South Korea, China and others have adopted various regulations which limit fuel consumption in the field of road transport, the amount of exhaust gases, leading to the use of new innovative technologies. The greatest challenge facing automakers around the world is the development of various tests to evaluate the energy efficiency and environmental safety of these vehicles. These are the New European Driving Cycle (NEDC) [8] and Worldwide Harmonized Light Vehicles Test Procedure (WLTP) [9] standards (Diagram 2, 3). In this case, the cars are tested for certain conditions (in the city, on highways). In each type of test, the amount of exhaust gases emitted from vehicles is important.

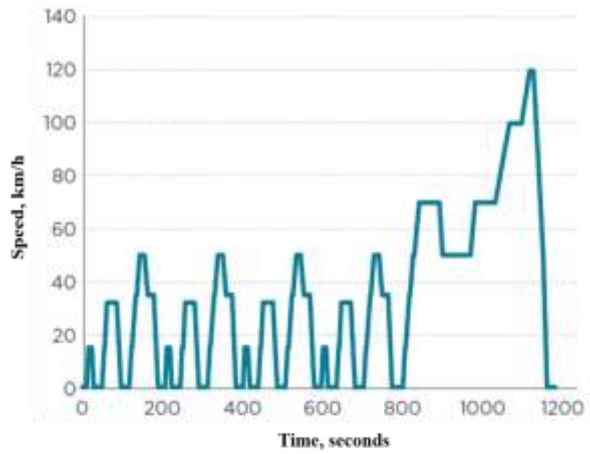

Diagram 2. The New European Driving Cycle (NEDC) [8, 10].

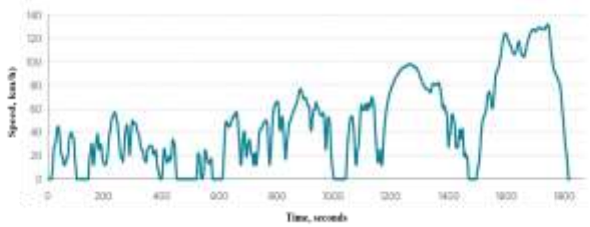

Diagram 3. The Worldwide Harmonized Light Vehicles Test Procedure (WLTP) [9, 10].

According to the approved NEDC standard for determining the energy efficiency and environmental standards of automobiles, to increase the number of exhaust gases to 95 g CO_2 / km for passenger cars by 2020-2021, WLTP the target for 2020 is 100 g CO_2 / km [10]. The parameters for the driving cycles of both standards are shown in Table 1.

* Corresponding author: jasursafarov@yahoo.com

Descriptive parameters of the driving cycles NEDC and WLTC [10].

Table 1.

Name of test process	Units	NEDC	WLTP
Start condition		cold	cold
Duration	s	1180	1800
Distance	km	11.03	23.27
Mean velocity	km/h	33.6	46.5
Max. velocity	km/h	120.0	131.3
Stop phases		14	9
Duration:			
Stop	s	280	226
Constant driving	s	475	66
Acceleration	s	247	789
Deceleration	s	178	719
Shares:			
Stop		23.7 %	12.6 %
Constant driving		40.3 %	3.7 %
Acceleration		20.9 %	43.8 %
Deceleration		15.1 %	39.9 %
Mean positive acceleration	m/s^2	0.59	0.41
Max. positive acceleration	m/s^2	1.04	1.67
Mean positive 'vel * acc' (acceleration phases)	m^2/s^3	4.97	4.54
Mean positive 'vel * acc' (whole cycle)	m^2/s^3	1.04	1.99
Max. positive 'vel * acc'	m^2/s^3	9.22	21.01
Mean deceleration	m/s^2	-0.82	-0.45
Min. deceleration	m/s^2	-1.39	-1.50

Nowadays, cars are equipped with more electronic systems than in the past. Today, vehicles are equipped with hundreds of miniature sensing systems, such as temperature, tire pressure, accelerometer, and speed sensors, etc. Cooperative intelligent vehicle systems constitute a promising way to improving traffic throughput, safety and comfort, and thus are the focus of intensive research and development. Intelligent vehicles can make road traffic safer, more efficient, and cleaner [11].

Car manufacturers are offering electric cars or hybrid technology cars instead of internal combustion engines. These types of cars are expensive and are seldom seen on roads. But in the future, new kinds of cars will be equipped with eco-friendly technologies.

The global internal combustion engine (ICE) market demand was pegged at 157,105 thousand units in 2017, and in 2020 it was 179,269 thousand units. According to the annual growth rate, by 2025 there will be 229,439 thousand units, an increase of 4,9% from 2018 to 2025 [12].

Almost 60-75% of these internal combustion engines represent the share of automobile transport. As we mentioned above, there are many ways to reduce the downside of internal combustion engines, including by reducing engine idling time. Because the idling time of the engine is for 30% of its lifetime. Therefore, in our research, we focus on to stop the engine at the red lights of the traffic light. This is one way to reduce engine idle time. The driver stop more than 30 minutes a day at traffic lights in the city. When we colculate it 250 … 365 days * 30 minut = 125 …182,5 hours a year. In this case, we suggest a start -

* Corresponding author: jasursafarov@yahoo.com

stop system to turn the engine on and off in local cars. In the worldwide experience, it is noted that using the start-stop system reduced the fuel consumption and emission of carbon dioxide by 5-10%; taking into account the hybrid cars, this reduction might amount to 10-25% [13].

For cars whose engine capacity is less than or equal to 1,0L, the start-stop system is not effective. Because the purpose of reducing the size of the engine is to reduce fuel consumption.

Nowadays, “UzAuto Motors” JSC manufactures 13 types of light vehicles. These include 23 percent of them 1,5L engines which are Chevrolet Nexia, Chevrolet Cabalt and Chevrolet Lecetti.

The main purpose of this search is to save fuel by using a start-stop system in the Chevrolet Nexia segment. The start-stop system is used as a function of the car engine starting system. The vehicle will also have an additional special intelligent system (Figure. 1, 2). The test procedure is carried out in a special autopolygon according to the NEDC standard. Because this standard is effective for the start-stop system.

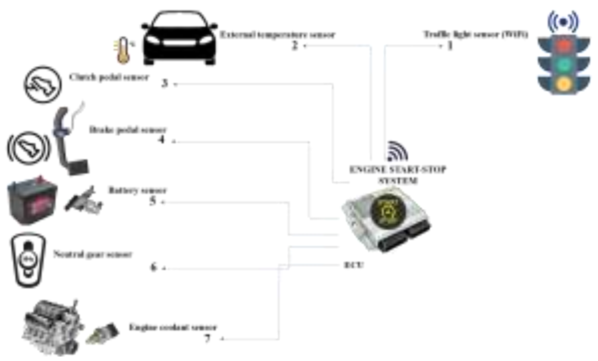

Figure 1. Components of “start/stop” system.

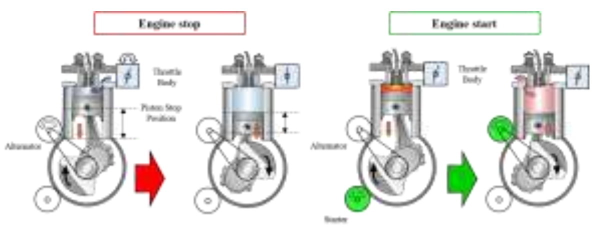

Figure 2. Engine start-stop motion analysis [14, 15].

The testing place was selected in the Piskent district of the Tashkent region. This area is specifically designed for car testing and fully meets all requirements (Figure. 3). To determine the arithmetic mean of the test results, three motions were made on both sides of the specified trajectory.

In urban traffic conditions, the car is required to drive a distance of 25-30 km and passing 45-50 traffic lights to test its fuel economy and environmental performance through the strat-stop system (Figure. 4). It is necessary to test the car with a start-stop system and no start-stop system at the peak time of the day. These times are in the morning, lunch, and evening when people rush to work and back. This method is effective in determining the average fuel consumption and stopping time at the traffic lights of the car per day.

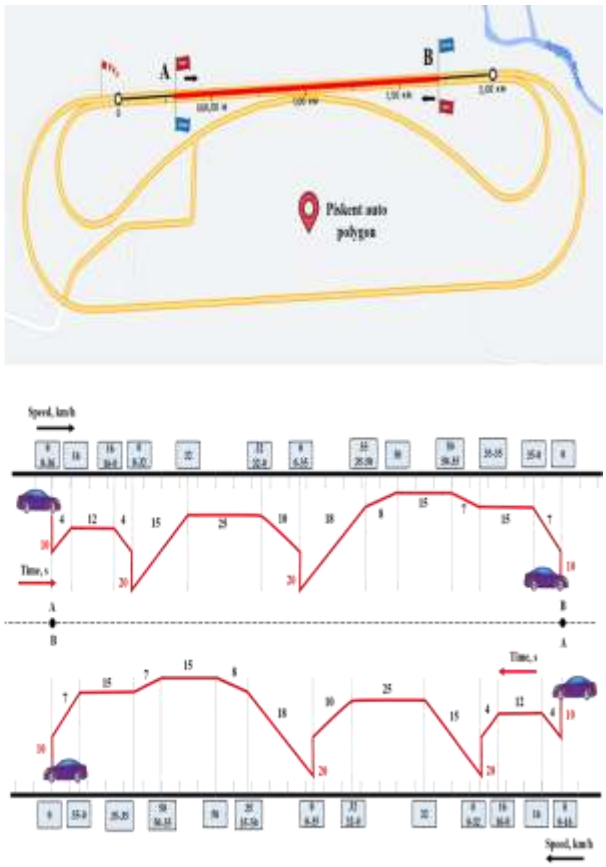

Figure. 3. Auto polygon in the Piskent.

* Corresponding author: jasursafarov@yahoo.com

Figure. 4. Testing start-stop system in the Tashkent city.

Taking into consideration the fact that during complete combustion of 1 kg of gasoline is produced 3.1 kg of carbon dioxide (or, reversing the transformation, to produce 1 kg of CO_2 it is necessary to burn 0,322 kg of fuel), the fuel mass for idling engine operation was determined. The intensity of carbon dioxide emissions in these conditions amounts to 0,76 g/s. On this basis the specific fuel mass during engine operation was estimated:
0,76 g/s CO2 · 0,332 g gasoline/g CO_2 = 0,252 g/s gasoline

Taking into account the gasoline density (ρ = 0,745 g/cm^3), the volumetric fuel consumption per second is determined:

0,76 g/s CO_2 · 0.332 g gasoline/g CO_2 / 0,745 g/cm^3 = 0,33 cm^3/s gasoline [13]

The air excess coefficient (α) in gasoline engines is 0,8...1,2; in diesels it is 1,3 ... 6,0.

If the air excess coefficient is greater than 14.7:1 (α>1,0) is considered a lean mixture, and if it is less than 14.7:1 (α<1,0) is a rich mixture [16, 17].

If the air excess coefficient α is known, the fraction of carbon converted to CO is found using the following formula:

$$\varphi = 2 \cdot (1-\alpha) \cdot \left[1 + \frac{3H}{C}\right]; \quad (1)$$

For example: The air excess coefficient is α = 0,85 … 0,9 in engine idling mode.

$$\varphi = 2 \cdot (1-0{,}9) \cdot \left[1 + \frac{3 \cdot 0{,}145}{0{,}855}\right] = 0{,}302$$

.

That is 30.2% of the carbon is converted to CO.

Conclusion

According to theoretical calculations, the use of the “start-stop” system brings environmental benefits in urban areas. The tests are expected to reduce the operation time of the internal combustion engine by approximately 10%, representing a measurable benefit in reducing fuel consumption. The development of start-stop systems is the reason for an increasing number of vehicles with such a solution to prevent carbon dioxide. This intelligent system can help reduce the CO_2 emissions of vehicles, especially in urban traffic conditions.

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* Corresponding author: jasursafarov@yahoo.com