Optimization of the Work of Road Transport With the Help of Navigation Equipment on the Example of the Branch of "Mostostroy-11", JSC, TF "Mostootryad-36"

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Abstract. The article deals with the control of fuel consumption in automotive engineering with the help of navigation equipment. As a result of the experiment on trucks VOLVO FMX 6x4 and Mercedes-Benz Actros 3346S it was found out that the actual fuel consumption is 2-16% lower than the standard. Thus, using the complex of navigation equipment in transport of the company allows not only to significantly reduce fuel costs, but also to optimize control over road flight performance, and also the regime of work and rest of the drivers. As a result of the economic calculation, it was established that the equipment costs are paid off in less than 1 month.

1. Introduction
The development of the organization of the transport process largely depends on the level of efficiency of the management activities of its management. At the same time, the costs of organizing transportation are formed from a number of different factors: the type of rolling stock, the price of fuels and lubricants, maintenance and repairing, staff salaries, etc. [1-6].

In order to be competitive in the market of services, motor transport enterprises need to optimize the cost of operating vehicles. One of the methods is the adjustment of fuel consumption rates. In our country there are several methods of accounting for such norms:

1. According to the order of the Ministry of Transport of Russia of March 14, 2008 No. AM-23-r (ed. No. IA-159-r of September 20, 2018) "On the implementation of the methodological recommendations "Consumption rates of fuels and lubricants for automobiles transport""

2. With the help of electronic control of fuel consumption according to the order of the Ministry of Transport of the Russian Federation dated July 31, 2012 No. 285 "On approval of requirements for navigation means operating using navigation signals of the GLONASS or GLONASS / GPS systems and intended for the mandatory equipment of vehicles of category M, used for the commercial passenger traffic and category N used for the transport of dangerous goods".

In connection with the development of information technology, using of navigation equipment in transport to control fuel consumption (both online and offline) has an advantage over regulatory for several reasons [7-12].

In determining the actual consumption rates of fuels of a specific make and model of a car using order No. AM-23-r, many factors must be taken into account:

1. Natural and climatic conditions (ambient temperature, wind speed and direction, humidity, precipitation, etc.).

2. Road conditions (road category, type of roadway, slope and curvature of the road, height above the sea level, etc.).
3. Transport conditions (mass and type of cargo transported, use of a trailer or semi-trailer, speed conditions for cargo delivery, presence of traffic lights, traffic flow, etc.).

4. Technical characteristics of the vehicle (age, mileage, type of fuel used, etc.).

This effect is expressed in the form of appropriate surcharges to fuel consumption rates.

There is no need to take into account all the above factors if we use the navigation equipment, because the fuel consumption monitoring system shows the consumption in actual operating conditions.

But installing navigation equipment is a very expensive procedure. Accordingly, it is necessary to carry out research in the field of economic feasibility of using such equipment. Therefore, for motor transport enterprises engaged in the carriage of goods and passengers, automating the process of controlling fuel consumption is an urgent task, which makes it possible to optimize the cost of fuel.

An experiment in our work will be presented on the use of satellite monitoring of vehicles based on the Russian satellite navigation system GLONASS (Global Navigation Satellite System) for controlling moving objects.

The installation of such equipment allows in real-time do the monitoring of vehicle performance, including fuel consumption and the schedule of drivers. The research was carried out on the transport branch of the company JSC "Mostostroy-11" TF "Mostootryad-36" in Tyumen (Russia).

2. Methodology

For the effective operation of the navigation equipment the work of the vehicle fleet was automated with the help of the integrated transport information system "TIS-online". In fig. 1 is a screenshot of the main program window. This program keeps track of the movement of fuel, speed control, receipt and processing of applications from objects, electronic waybills with the possibility of automatic calculation of fuel consumption and driving time.

![Figure 1 – Program "TIS-online"](image)

The purpose of the research - the optimization of the auto enterprise by reducing the cost of fuel with the help of using the navigation equipment. The period of our research is from 08/01/18 to 12/27/18. There were four new cars of 2018, which were tested by the engine, components and assemblies within a month. Conducting an experiment on new cars minimizes errors in determining the actual fuel consumption caused by their technical condition.

There were two brands of cars on which the appropriate navigation equipment was installed - 2 VOLVO FMX 6x4 dump trucks (fuel consumption 52.4 l / 100 km) and 2 truck tractors Mercedes-Benz Actros 3346S (fuel consumption 65 l / 100 km). These vehicles delivered bulk goods (sand and crushed stone) along pendulum routes during the building of an automobile bridge in Tyumen.
In the experiment, a comparative analysis of the fuel consumption obtained according to the navigation equipment during operation and at the rate of the order of the Ministry of Transport No. AM-23-r.

3. The conduct of an experiment

As a result of the conducted research, according to the TIS-online software product, the actual values of fuel consumption for the four vehicles under study were established by months (August-December 2018 for VOLVO and September-December 2018 for Mercedes-Benz), their mileage was received, standard fuel consumption is presented according to the order of the Ministry of Transport of Russia No. AM-23-r, as well as the difference in fuel consumption between the actual and standard value. The error of measuring equipment according to the technical documentation is no more than 3%. This research presents the results taking into account the accuracy of the equipment.

Analysis of the operation of the first dump truck VOLVO FMX 6x4 is presented in Table 1.

Table 1. Summary table for mileage and fuel consumption of the dump truck VOLVO FMX 6x4 №1

| Month    | Distance, km | Standard fuel consumption (52.4 l + surcharge = 55 l per 100 km), l. | Fuel consumption for TIS-online, l | Difference, l |
|----------|--------------|---------------------------------------------------------------------|-----------------------------------|---------------|
| August   | 7815         | 4298                                                                | 3955                              | 343           |
| September| 9221         | 5071                                                                | 4985                              | 86            |
| October  | 7947         | 4371                                                                | 4255                              | 116           |
| November | 6885         | 3787                                                                | 3638                              | 149           |
| December | 5483         | 3016                                                                | 2783                              | 233           |
| Total    | 37351        | 20543                                                               | 19616                             | 927           |

The total surcharge to the fuel consumption rate for a VOLVO FMX 6x4 car is 2.6 l/100 km.
The average actual value of fuel consumption per 100 km. for the first car was:
- in August - 50.6 l. (8% below the standard);
- in September - 54 l. (1.8% below the standard);
- in October - 53.5 l. (2.7% below the standard);
- in November - 52.8 l. (4% below the standard);
- in December - 50.7 l. (7.8% below the standard);
Thus, it has been established that for the first investigated car, for the observed period, the savings amounted to 927 liters.

Analysis of the operation of the second dump truck VOLVO FMX 6x4 is presented in Table 2.

Table 2. Summary table for mileage and fuel consumption of the dump truck VOLVO FMX 6x4 №2

| Month    | Distance, km | Standard fuel consumption (52.4 l + surcharge = 55 l per 100 km), l. | Fuel consumption for TIS-online, l | Difference, l |
|----------|--------------|---------------------------------------------------------------------|-----------------------------------|---------------|
| August   | 7842         | 4313                                                                | 3859                              | 454           |
| September| 10087        | 5548                                                                | 5325                              | 223           |
| October  | 8509         | 4680                                                                | 4679                              | 1             |
| November | 10418        | 5730                                                                | 5208                              | 522           |
| December | 5243         | 2884                                                                | 2779                              | 105           |
| Total    | 42099        | 23155                                                               | 21850                             | 1305          |

The average actual value of fuel consumption per 100 km. for the second car was:
- in August - 50.4 l. (8.4% below the standard);
- in September - 49.4 l. (10.2% below the standard);
- in October - 50 l. (9.1% below the standard);
- in November - 49.9 l. (9.3% below the standard);
- in December - 53 l. (3.6% below the standard);
Thus, it has been established that for the first investigated car, for the observed period, the savings amounted to 1305 liters.
An analysis of the operation of the first Mercedes-Benz Actros 3346S truck tractor is presented in Table 3.

**Table 3. Summary table for mileage and fuel consumption Mercedes-Benz Actros 3346S №1**

| Month     | Distance, km | Standard fuel consumption (65 l + surcharge = 70 l per 100 km), l. | Fuel consumption for TIS-online, l | Difference, l |
|-----------|--------------|---------------------------------------------------------------|-----------------------------------|---------------|
| August    | 1396         | 977                                                           | 859                               | 118           |
| September | 3227         | 2259                                                          | 1884                              | 375           |
| October   | 3634         | 2544                                                          | 2351                              | 193           |
| November  | 3442         | 2409                                                          | 2087                              | 322           |
| December  | 11699        | 8189                                                          | 7181                              | 1008          |

The total premium to the rate of fuel consumption for a Mercedes-Benz Actros 3346S is 5 l / 100 km.

The average actual value of fuel consumption per 100 km. for the first truck tractor:
- in September - 61.5 l. (12% below the standard);
- in October - 58.4 l. (16.6% below the standard);
- in November - 64.7 l. (7.6% below the standard);
- in December - 60.6 l. (13.4% below the standard);

Thus, it was found that for the investigated car, for the observed period, the savings amounted to 1008 liters.

Analysis of the operation of the second Mercedes-Benz Actros 3346S truck tractor is presented in Table 4.

**Table 4. Summary table for mileage and fuel consumption Mercedes-Benz Actros 3346S №2**

| Month     | Distance, km | Standard fuel consumption (65 l + surcharge = 70 l per 100 km), l. | Fuel consumption for TIS-online, l | Difference, l |
|-----------|--------------|------------------------------------------------------------------|------------------------------------|---------------|
| August    | 2989         | 2092                                                             | 1819                               | 273           |
| September | 2564         | 1795                                                             | 1633                               | 162           |
| October   | 1898         | 1329                                                             | 1235                               | 94            |
| November  | 5371         | 3760                                                             | 3207                               | 553           |
| December  | 12822        | 8976                                                             | 7894                               | 1082          |

The average actual value of fuel consumption per 100 km. for the second truck tractor:
- in September - 60.9 l. (13% below the standard);
- in October - 63.7 l. (9% below the standard);
- in November - 65.1 l. (7% below the standard);
- in December - 59.7 liters. (14.7% below the standard);

Thus, it was found that for the investigated car, for the observed period, the savings amounted to 1082 liters.

**4. Conclusions**

After analyzing the fuel consumption of the investigated cars, it can be noted that the actual fuel consumption according to the navigation equipment and the TIS-online software product in all cases turned out to be lower than the standard. This allowed the company to save on fuel costs.

On average, the actual fuel consumption is lower than the standard by 2-16%, depending on the climatic, road and transport conditions.

At the price for diesel fuel 46 rubles. per liter (in prices of January 2019), for the research period, the company saved on the purchase of fuel:
- on the first car VOLVO FMX 6x4 - 42642 rubles.
- on the second car VOLVO FMX 6x4 - 60030 rubles.
- on the first car Mercedes-Benz Actros 3346S - 46368 rubles.
- on the second car Mercedes-Benz Actros 3346S - 49772 rubles.
The cost of installing navigation equipment per vehicle is 40000 rubles. Monthly subscription fee - 700 rubles. Consequently, the payback of using the electronic control of the vehicle is less than a month.

Currently, the company TF "Mostootryad-36" on the entire wheeled vehicles (230 units) installed such navigation equipment, which allows significant savings on fuel costs.

Besides the actual fuel consumption, this equipment allows to fix and control:
- the timing of the trip and the deviations from the specified route of the car;
- places of refueling vehicles, drain or excessive fuel consumption;
- vehicle traffic safety (speed, sharp acceleration and braking, mode of work and rest of drivers, etc.);
- planning and accounting of the passed technical services and car repairs, accounting of installation and removal of tires, the rechargeable battery, etc.

Installation of navigation equipment allows you to automate control over the operation of the automobile fleet of enterprises, which allows you to plan and optimize costs, as well as improve traffic safety.

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