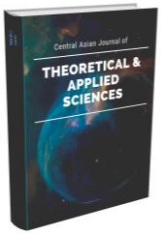

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*Article*

# Digitalization of the Calculation of the Need for Fuel and Oil Products of Fire Engines

**N.Y.Makhkamov[1], E.V.Abdullayev[2]**

1. Professor of the Academy of the Ministry of Emergency Situations, PhD in Technical Sciences
2. Instructor Capitan

* Correspondence: email@gmail.com

**Abstract:** this article studied the procedure for calculating the fuel and oil consumption standards of fire-fighting and Accident-Rescue vehicles, carried out analyzes and proposals for the effective use of modern Information Communication Technologies in the implementation of accounting work.

**Keywords:** IoT (Internet of Things), calculation of fuel consumption, digitization

## 1. Introduction

Today, the effectiveness of fire and rescue units depends on the readiness of technical resources, their constant state of operation and uninterrupted supply of fuel and oil products. Timely arrival and efficient operation of firefighting techniques in the event of a fire or emergency is one of the important factors. But the fuel consumption of cars has still been calculated by traditional methods, which prevents the effective use of resources, complicates maintenance processes and creates a significant deficit of fuel at the time of the calculation by the end of the month.

Problem:

Currently, insufficient automation of the systems for calculating the need for fuel-oil products for a vehicle in the system of the Ministry of emergency situations creates difficulties in controlling fuel consumption. As a result of this, there is a problem of excessive consumption of fuel-oil products or a deficit.[1]

Goal:

The main purpose of this article is to propose a digitized system that provides an accurate calculation of the fuel needs of fire engines. This system is aimed at saving fuel consumption of fire fighting and Accident-Rescue vehicles in the Ministry system, efficient use of resources and automation of management. The subject was also studied and analyzed scientific works, master's dissertations, relevant orders of the Ministry of emergency situations, decisions of the Cabinet of Ministers and the requirements of the state Attestation Commission.

Literature review

The calculation of the fuel needs of fire engines, international experiments on its management (Table 1) indicate the effectiveness of digitization in this area.

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Table 1. Comparison table of international experiments on the calculation of the fuel needs of fire engines.

| Country | Work on calculating the fuel needs of fire engines |
|---|---|
| **USA** | With the help of IoT (Internet of Things) technologies and telemetry systems, real-time monitoring of the technical condition, fuel consumption and direction of movement of cars in Fire-Rescue units is carried out. These systems make it possible to accurately calculate fuel consumption and optimally control cars. In this direction, a professor at the Massachusetts Institute of Technology, a leading specialist in the fuel efficiency of internal combustion engines and vehicles, Dr.John B.Heywood as well as Ohio State University professor Dr.Giorgio Rizzoni has conducted research on automotive systems engineering and fuel efficiency [6]. |
| **Germany** | On the basis of technical passports of Fire-Rescue cars, special algorithms have been developed, focusing on optimizing fuel consumption. In the process of digitization, special software is used. In Germany, professor Dr., Professor at the Technische Universität Darmstadt, author of scientific works on automotive engineering and vehicle efficiency. Ing. Hermann Winner as well as professor Dr. at the Technische Universität Aaxen (RWTH Aachen). Ing. Lutz Ecksteins has conducted research on automotive technology and fuel consumption optimization [4]. |
| **Russia** | Special fuel sensors are installed on Fire-Rescue cars, and the amount and consumption in the fuel tank are monitored in real time. This method can help prevent fuel theft or adverse use situations. The data obtained through the sensor is transmitted and analyzed to the central control system. In this area, professor Vladimir Kozlov, a professor at Moscow Highway State Technical University, a specialist in fuel efficiency and environmental safety of vehicles, and Sergei Alekseev, an associate professor at St. Petersburg State Transport University, author of scientific works on reducing automobile engines and fuel consumption, conducted scientific research [3]. |
| **Uzbekiston** | In the system of the Ministry of emergency situations, digitization processes are being introduced in stages. But the organization of fire and Rescue Service Activities, in particular, fuel need calculation systems, are still based on many manual processes. This creates the need for a wider application of automation to the industry. In order to digitize the calculation of fuel consumption in parts by professors and teachers of the Academy of the Ministry of emergency situations, a mobile application called “lifeguard-driver instruction” was created [7]. |

## 2. Materials and Methods

The following methodology was used to digitize the calculation of the fuel-oil product needs of fire engines:

Digitization approach

Data collection. Based on the data quoted in the technical passport of cars (fuel capacity, engine power, average fuel consumption) and their practical actions, the main parameters are determined.

The current regulatory documents of the ministry cite the regulatory fuel consumption of cars used in fire and rescue units. The distance traveled by fire engines to extinguish fires, as well as the fuel they spend for the time they work, are carried out according to these standards. Below are examples of regulatory fuel consumption for modern types of fire fighting cars that are currently in use in our Republic. (Table 2

Table 2. Regulatory fuel consumption for fire vehicles.

| **vehicle type and model** | **Fuel consumption in the 100 km range was. (Q), l** | **Fuel consumption when working with a pump ($\tau_{n.b.}$), l/min** | **Fuel consumption when operating without a pump ($\tau_{n.s.}$), l/min** |
|---|---|---|---|
| АЦ-MAN TGM 13.240 | 45 | 0,25 | 0,05 |
| АЦ-Isuzu NQR71PL | 17,6 | 0,15 | 0,03 |
| АЦ-Isuzu FTR33H | 24,2 | 0,183 | 0,033 |
| АЦ-Isuzu FVR23K | 37,4 | 0,233 | 0,037 |

Development of a mathematical model. The fuel consumption of the car can be calculated based on the following formula:

Here:

Ys — total spent fuel (liters);

Q — average fuel consumption (l/100 km)indicated in the technical passport of the car;

D — distance traveled (km);

τn.b. — normative fuel consumption (l/min)when the car works with a pump

tn.s. - normative fuel consumption (l/min)when the car works in a stationary state without a pump

C1-the time the car worked with the pump in the stationary position (minutes).

C2-the time when the car worked without a pump in stationary position (minutes).

This formula is used to calculate fuel consumption for truck base firefighting vehicles, helping to determine fuel consumption depending on how long the fire worked and the distance traveled. [7]

Also, the following formula is used to determine the reserve of fuel and oil products in Fire-Rescue parts:

Here:

Z-fuel reserve (liter);

Yd - the average amount of fuel consumed in a day (liters);

N — number of days (as long as the Reserve is planned for how many days);

R-amount of reserve for unplanned or unforeseen situations

Application of software. To automate fuel consumption calculations, a model can be implemented using the Python programming language and its libraries such as Pandas, NumPy.

## 3. Results

Advantages of applying the system.

1. Increase accuracy. The digitized system provides an accurate calculation of the need for fuel-oil products for cars. In calculations carried out by practical authorities in the traditional way, the approximate receipt of results can lead to a significant reduction in fuel by the end of the month, and an unexpected deficit at the end of the year.

2. Efficiency. Real-time analysis of data optimizes fuel supply processes, in particular, planning, report preparation, deficit detection.

3. Saving organizational resources. The digital system saves time and funds of lifeguards-drivers, senior technicians and other officials of the part by automating calculations.

4.2. Proposed model results

Based on the above formula as well as the data in Table 2, given the following values for the car, the distance traveled until returning to the scene of the fire is determined according to the rules of the urban planning norm, based on the service radius of the Fire-Rescue parts, D=5, 10, 15, 20, 25 km, taking the time of the car with the pump as C1=20 minutes, the time of the car without the pump in the stationary position as C2=10 minutes, we take the accounting work for each car given in the table.

1) the calculation results for the AS-MAN TGM 13.240 car are as follows:

2) Ys= (45/100)x5+20·0,25+10·0,05=7,75 litre,

Ys= (45/100)x10+20·0,25+10·0,05=10 litre,

Ys= (45/100)x15+20·0,25+10·0,05=12,25 litre,

Ys= (45/100)x20+20·0,25+10·0,05=14,5 litre,

Ys= (45/100)x25+20·0,25+10·0,05=16,75 litre,

3) The calculation results for the ATS-Isuzu nqr71pl car are as follows:

4) Ys= (17,6/100)x5+20·0,15+10·0,03=4,18 litre,

Ys= (17,6/100)x10+20·0,15+10·0,03=5,06 litre,

Ys= (17,6/100)x15+20·0,15+10·0,03=5,94 litre,

Ys= (17,6/100)x20+20·0,15+10·0,03=6,82 litre,

Ys= (17,6/100)x25+20·0,15+10·0,03=7,7 litre,

3) The calculation results for the ATS-Isuzu ftr33h car are as follows:

Ys= (24,2/100)x5+20·0,183+10·0,033=5,2 litre,

Ys= (24,2/100)x10+20·0,183+10·0,033=6,41 litre,

Ys= (24,2/100)x15+20·0,183+10·0,033=7,62 litre,

Ys= (24,2/100)x20+20·0,183+10·0,033=8,83 litre,

Ys= (24,2/100)x25+20·0,183+10·0,033=10,04 litre,

4) The calculation results for the ATS-Isuzu fvr23k car are as follows:

Ys= (37,4/100)x5+20·0,233+10·0,037= 6,9 litre,

Ys= (37,4/100)x10+20·0,233+10·0,037= 8,77 litre,

Ys= (37,4/100)x15+20·0,233+10·0,037= 10,64 litre,

Ys= (37,4/100)x20+20·0,233+10·0,037= 12,51 litre,

Ys= (37,4/100)x25+20·0,233+10·0,037= 14,38 litre,

Table 3. Fuel consumed in accordance with the distance traveled.

## 4. Discussion

Table 3. Fuel consumed in accordance with the distance traveled.

| **Distance traveled until going to the scene of the fire and returning, km** | **Total amount of fuel consumed, liters** | | | |
|---|---|---|---|---|
| | АЦ-MAN TGM 13.240 | АЦ-Isuzu NQR71PL | АЦ-Isuzu FTR33H | АЦ-Isuzu FVR23K |
| -5 | 7,75 | 4,18 | 5,2 | 6,9 |
| -10 | 10 | 5,06 | 6,41 | 8,77 |
| -15 | 12,25 | 5,94 | 7,62 | 10,64 |
| -20 | 14,5 | 6,82 | 8,83 | 12,51 |
| -25 | 16,75 | 7,7 | 10,04 | 14,38 |

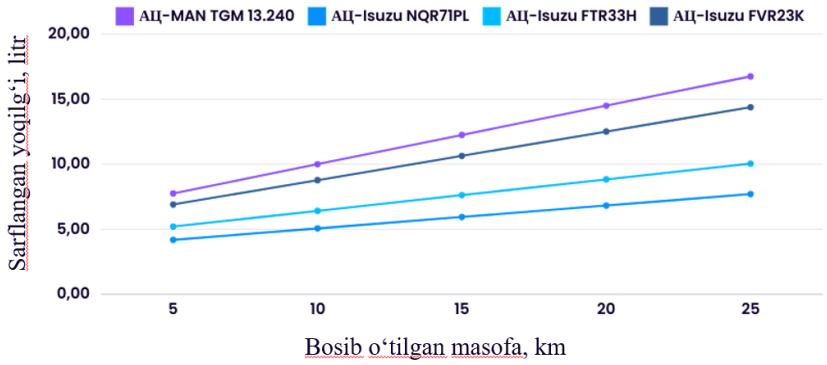


Figure 1. The distance traveled until the fire went to the scene and returned, as well as the total spent fuel based on the time worked

The results show that with the help of a digitized system, the Fire-Rescue car can go to the place of the fire and return, work in a stationary state, all additional costs for the engine can be accurately and reliably calculated. We can also see that the fuel consumption increases in accordance with the distance traveled (Figure 1).

## 5. Conclusion

In this research work, the importance of digitizing the processes of determining and managing the need for fuel and oil products of fire engines was analyzed. The results of the study showed the following:

1. Accurate calculation of fuel consumption. With the help of digitization technologies, the accuracy of determining the need for fuel-oil products has been increased. This process saves labor resources and reduces errors caused by the human factor.

2. Efficient use of resources. Calculations based on the technical characteristics of vehicles, distance and cargo volume ensure the optimization of fuel consumption. This makes it possible to achieve economic efficiency.

3. Emergency preparedness. With the automation of reserve calculations, the constant availability of the necessary fuel oil products for the Fire Rescue Service is ensured.

4. Wide possibilities of digitization. Through the use of IoT, GPS monitoring and analytical applications, the possibilities of monitoring traffic movements, real-time monitoring of fuel consumption and establishing automation will expand.[5]

When the approaches and methods studied in the article are put into practice, the following results can be achieved:

- Reduction of fuel and resource consumption by 10-15 % ;
- Improve technical and economic indicators of vehicles;
- Improve the efficiency of the vehicle service and reduce environmental damage.

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