Eurasian Journal of Analytical Chemistry
ISSN: 1306-3057

Improvement Of The Vocational Training Of Students In The Direction Of "Technology Of Transport Processes" In The Field Of Resource Efficiency System Management Of Motor Vehicles Under The Conditions Of The Far North

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Received 14 June 2017 ▪ Revised 23 August 2017 ▪ Accepted 24 September 2017

ABSTRACT: *The state's transport link is one of the key tasks of the government. It gives economic advantages, such as transit of goods, carriage of passengers, access to any place in the country. However, the development of transport systems is associated with a number of problems, primarily with the climate. For the Arctic zone of the Russian Federation the development of the transport system is the most important task for the region development as a whole. To solve this problem, the state needs relevant specialists. However, modern vocational training requires changes. Thus, the purpose of this research is to improve the preparation of bachelors in the direction of "Technology of transport processes" by providing a new approach to training. In our research we used the analysis of scientific, technical and methodological literature, as well as mathematical modeling of new calculation systems.*

The considered training approach is a new approach to data calculations. It allows students to acquire specific knowledge, skills and abilities to manage the resource efficiency system of vehicles.

Key words: *training of specialists, transport system, Arctic territories, vehicles, resource supply.*

INTRODUCTION

Efficient use of the natural resource potential of the Arctic zone of the Russian Federation ensures the sustainability of the long-term socio-economic development of the individual territories and the country as a whole. Developed transport system is one of the main socio-economic components of the modern infrastructure of the Arctic territories (Kozlov et al., 2017; Kulakovskiy & Vinogradova, 2013; Lagkueva & Gurieva, 2015). At the same time, one of the main directions of socio-economic development is the management of the vehicle resource efficiency system, including special equipment of the oil and gas industry and the civil and industrial construction in the Arctic territories.

The factors arising from the specifics of climatic and road conditions associated with low temperatures, snowstorms and the limited roads create additional demands for the resource efficiency system of vehicle (including special equipment of the oil and gas industry and civil and industrial construction) in the Arctic zone. The development of the transport system (infrastructure) of the Arctic zone of the Russian Federation is impossible without a formed multilevel transport strategy for the resource efficiency system of vehicles (including special equipment for the oil and gas industry and civil-industrial construction) that reduces transport costs and increases the availability of transport services in the Arctic zone regions (Lapteva & Bondarovskaya, 2016; Levchenko, Rychkova & Smirnov, 2016).

The urgency of the problem of studying a multilevel transport strategy for the resource efficiency of vehicles (including special equipment in the oil and gas industry and civil and industrial construction) of the Arctic zone enterprises stems from the transition

to market relations. They are certain catalysts for the decentralization processes of transport technical systems management. In the context of decentralization, the role of costs for the effective functioning of road transport enterprises has increased. In this connection, global prerequisites for their reduction have arisen. They are related to the need:

- carrying out technical and economic activities that increase fuel efficiency of vehicles (including special equipment for the oil and gas industry and civil and industrial construction);

- studies of the impact of the transport process organization on fuel consumption;

- the use of different fuel and lubricant materials, taking into account the structural features of vehicles and their operating conditions.

Consequently, the urgency of the problem of managing the resource efficiency system, which makes it possible to reduce transport costs and increase the availability of transport services in the Arctic zone, is increasing at the present stage.

Noting the undeniable value of the research on the problems of developing the theoretical foundations of professional education (Y.K. Vasiliev, G.P. Kornev, Y.A. Kustov, V.S. Lednev, I.Y. Lerner, M.N. Skatkin, A.P. Belyaev, B.S. Gershunsky and others), it should be mentioned that the current development stage of vocational education requires a deep analysis of the accumulated experience and theoretical approaches in finding ways to improve the training of bachelors of a technical profile.

Foreign experience shows that research in this area is practically not carried out. Scientists consider problems related to the Arctic zone, but in education these issues are not given enough attention.

The article (Bergström, Erikstad & Ehlers, 2017) is devoted to the development of the Arctic Maritime Transport System (AMTS), which allows us to determine the appropriate level of model accuracy in relation to the estimation of transport capacity and ice load, as well as to understand and manage the associated engineering uncertainties.

The article (Fu et al., 2018) considers risk factors that affect the safety of vessels operating in Arctic waters.

The authors (Gil Gómez et al., 2017) consider drivability in winter conditions.

However, in Russia there is a particular interest in the Arctic zone. Russian scientists are considering various issues related to the peculiarities of living and working in the conditions of the Far North. In their studies, they analyze the operation of cars in winter conditions, develop requirements for design features and types of southern and mountain car versions, investigate the influence of low temperatures on the vehicle's fuel efficiency, evaluate fuel economy and optimize driving modes.

Karnaukhova V.N., Gavaeva A.S., Belova A.G. devoted their studies to the formation of transport strategies in the regions of Siberia and the Far North. These studies reveal certain aspects of saving fuel and energy resources during the operation of motor vehicles in low-temperature conditions.

It is important to note that the foreign system of higher education has accumulated a lot of experience in improving the training of students on the basis of an integrative approach to learning.

A preliminary analysis of the state of the problem of improving vocational training of students in “Technology of transport processes” revealed the following shortcomings: students have not sufficiently formed their professional competence in managing resource efficiency systems of motor vehicles under the conditions of the Far North. Organizational and methodical approaches to the management of the resource efficiency system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction) have not been developed, which allow reducing fuel and lubricants costs, as well as maintenance and repair costs of the rolling stock, depreciation charges for the rolling stock of the enterprises.

The objective requirements for improving vocational training of technical profile students and the insufficient development of organizational and methodological approaches to managing the resource efficiency system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction) determined the choice and relevance of the topic of our research: "Improvement of the vocational training of students in the direction of "Technology of transport processes" in the field of resource efficiency system management of motor vehicles under the conditions of the Far North". The contribution of our research to the world pedagogical science in the direction of "Theory and Methodology of Vocational Education" is that the innovative didactic system for improving vocational training of students, which was developed in the targeted, substantial, procedural and organizational aspects, makes it possible to transform scientific knowledge into educational and adapt vocational training to modern requirements in the field of motor vehicle management in the conditions of the Far North.

The purpose of our research is to improve the quality of vocational training of bachelors in "Technology of transport processes" n the field of resource efficiency system management of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction) of the Arctic zone enterprises.

In the course of the research, the following tasks were set and solved:

- the analysis of the operating conditions of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction), the climatic conditions of motor vehicles operation (including special equipment of the oil and gas industry and civil and industrial construction), existing integral indicators of severity, which take into account the influence of various climatic factors, as well as the influence of the vehicle operating conditions on the fuel economy in the Arctic zone;

- technological support has been developed for the implementation of technical and economic measures that increase the fuel efficiency of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction). It consists of the study of the influence of the transport process organization on fuel consumption, the use of fuel and lubricants in accordance with design features of cars and their operating conditions in the Arctic zone of the Russian Federation;

- measures on saving fuel and lubricant materials of vehicles have been evaluated on the basis of methods for fuel consumption rationing, including: fuel and lubricant consumption rates; the organization of performance tests that determine fuel consumption; methods of calculating the basic fuel consumption standards for road transport based on statistical methods, the calculation program and the parameters of the vehicles, taken into account when determining basic fuel consumption; standard typed routes for various categories of the rolling stock;

- mathematical and computer modeling of transport and technological processes based on the use of alternative fuel and lubricant materials was carried out;

- production and maintenance plan has been developed for the trucks (including special equipment of the oil and gas industry and civil and industrial construction) of the Arctic zone enterprises, including the calculation of depreciation costs of the rolling stock and the tire maintenance costs.

METHODS

To achieve the goal of the research and solve its tasks, a set of research methods was applied: methods of studying and analyzing scientific and technical, methodological Russian and foreign literature on managing the resource efficiency system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction) in the Arctic zone of the Russian Federation; production methods of studying the resource efficiency system management of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction) in the Arctic zone of the Russian Federation in actual conditions, taking into account the effects of various accidental factors of the external and internal environment; methods of mathematical and computer modeling of transport and technological processes; methods of statistical processing of experimental data.

Reliability and scientific validity of the research result from the development of diagnostic methods which are adequate to the tasks, subject and object of the research, as well as from the sample representativeness, quantitative and qualitative analysis of the experimental data, the use of the research results in pedagogical practice. The quality management of the innovative education included a gradual assessment of professional competence through the rational use of the results of parameters, existing management methods and tools that give a quantitative and qualitative idea of the professional competence of students in organizational and methodological approaches to the resource efficiency system management (including equipment of the oil and gas industry and civil and industrial construction), which allows overall costs reduction.

RESULTS

The hypothesis of the research is in the fact that the technological support of the professional competence formation of bachelors in the field of "Technology of transport processes" in the management of the resource efficiency system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction) of the Arctic zone enterprises will be effective if it is carried out with regard to:

- methods of fuel saving in the operation of vehicles, including differential adjustment of linear fuel consumption;
- recommendations on the use of the most adapted cars depending on the specific climatic conditions of the region;
- determination of the limitations of climatic conditions for the operation of vehicles with a given level of preparedness, the advantages of alternative fuel and lubricants, optimization of the maintenance and repair system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction), taking into account the Arctic zone , technical and economic measures to identify excess fuel consumption rates with due account for the climatic zone and seasonality.

When solving the research problem, we relied on:
1. Methods of studying and analyzing scientific and technical, methodological domestic and foreign literature on the management of the recourse efficiency system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction) in the Arctic zone of the Russian Federation.
2. Production methods of studying the process of managing the recourse efficiency system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction) in the Arctic zone of the Russian Federation in real conditions, taking into account the effects of various accidental factors of the external and internal environment.
3. Technological approaches to the management of the recourse efficiency system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction) in the Arctic zone of the Russian Federation.
4. Methods of mathematical and computer modeling of transport and technological processes.
5. Methods of statistical processing of experimental data.
The developed content of vocational training, the internal logic of the developed sections of working programs allows students not only to acquire specific knowledge and skills in managing the resource efficiency system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction) in the Arctic zone of the Russian Federation, but also to lay the foundation for understanding general ideas and principles for constructing complex didactic systems to study the technologies of transport processes (Table 1).

Table 1: The content of vocational training of bachelors in the field of the recourse efficiency system management of motor vehicles in the conditions of the Far North

No.	**Section**	**Contents**
1	Fuel consumption rates for cars	Passenger cars
		Buses
		Cargo lorries
		Tractive vehicles
		Dump trucks
		Fuel consumption rates for special operation vehicles
		Lubricant consumption rates
		Special fluids
		The value of winter surcharges to the ratess of fuel consumption in the regions of Russia, depending on climatic regions
		Application of winter surcharges to the fuel consumption rates
2	Analysis and evaluation of measures for the resource efficiency of motor vehicles in the conditions of the Far	Measures for the resource efficiency of motor vehicles in the Far North
		Determination of the production program and the plan for the operation of motor vehicle enterprises in the conditions

	North	of the Far North
		Motor vehicle enterprise cost planning
		Natural gas as an alternative fuel
		Calculation of depreciation charges for the rolling stock
		Calculation of the cost of tire remoulding and repair in the Far North

The calculation of the rolling stock depreciation of the enterprise, the cost of tire remoulding and repair was carried out taking into account the costs of alternative fuel and lubricants. As an example, we will calculate the cost of fuel for KamAZ-5410 equipped with a semi-trailer, gas cylinders and lubricants.

Calculation of the fuel cost for KAMAZ-5410 with a semi-trailer, gas cylinders and lubricants.
Vehicle miles travelled:

$$\frac{34\times62750}{100} = 21335\ l.$$

For operation:

$$\frac{1{,}3\times482296}{100} = 8151\ l$$

Total fuel consumption according to the standards, *l*:
21335 + 8151 = 29486 *l.*
Additional fuel consumption in winter

$$\frac{29486\times18\times6{,}5}{100\times12} = 2874{,}9\ l.$$

Additional fuel consumption when operating in difficult road conditions:

$$\frac{29486\times35\times1}{100\times12} = 860\ l$$

Additional expenses for inside garage trips and technical needs of the motor vehicle enterprise:

$$\frac{29486\times1}{100} = 294{,}8\ l..$$

Fuel consumption taking into account the surcharges:

$$29486 + 2874{,}9 + 860 + 294{,}8 = 33515{,}7\ l.$$

Fuel costs are determined based on the calculated amount and price of fuel:

$$33515{,}7 \times 16 = 536251{,}2 \text{ rubles.}$$

Thus, the calculation of the fuel cost for KAMAZ-5410 showed a reduction in methane compared to diesel fuel by 32 33.8%.

The rates of consumption of lubricants for road transport are designed for operational accounting when justifying the need for them to motor vehicle enterprises.

The lubricant consumption rates are set in proportion to the total fuel consumption calculated for the vehicle. The oil consumption rates are in liters per 100 liters of fuel consumption, the consumption rates of lubricants are respectively in kilograms per 100 liters of fuel consumption.

Table 2 gives a brief description of the indicators. Table 3 presents the makes of the enterprise's vehicles. The calculation of the cost of lubricants is presented in Table 4q.

Table 2: Brief description of the indicators

No.	Indicator	Identification mark	Characteristics of the indicator
1.	Total fuel consumption	I.1.1	-
2.	Motor oil	I.2.1	consumption rate per 100 l of fuel,
		I.2.2	total consumption, l
3.	Transmission oil	I.3.1	consumption rate per 100 l of fuel,
		I.3.2	total consumption, l
4.	Special oil and fluids	I.4.1	consumption rate per 100 l of fuel,
		I.4.2	total consumption, l
5.	Grease lubricant	I.5.1	consumption rate per 100 l of fuel,
		I.5.2	total consumption, l

Table 3: Makes of the enterprise's vehicles

No.	Identification mark	Characteristics of the car (make)
1.	V-1	KAMAZ-43118 (with a skid mounted cement unit CE-32)
2.	V-2	Ural 4320-1912-60 (with vacuum unit VM-10)
3.	V-3	Ural 4320 (with a skid mounted cement unit CE-32)
4.	V-4	KAMAZ -5410 with a semitrailer
5.	V-5	Nissan NP 300

Table 4: Calculation of lubricant costs

No.	Indicator	Make of a vehicle					Total
		V-1	V-2	V-3	V-4	V-5	
1.	I.1.1	32663,1	447543,7	29988,6	34229,4	5116,1	54940,9
2.	I.2.1	2,8	2,8	2,8	2,8	2,5	-
3.	I.2.2	914,6	12531,2	839,8	958,4	127,9	-

4.	I.3.1	0,4	0,4	0,4	0,4	0,4	-
5.	I.3.2	130,6	1790,2	119,9	136,9	20,5	-
6.	I.4.1	0,15	0,15	0.15	0,15	0,1	-
7.	I.4.2	48,9	671,3	44,9	51,3	5,1	-
8.	I.5.1	0,35	0,35	0.35	0,35	0,2	-
9.	I.5.2	114,3	1566,4	104,9	119.8	10,2	-

The total consumption is calculated by multiplying the total fuel consumption by the consumption rate divided by 100.
Oil consumption:
V-1: 32663,1×2,8/100=914,6 l.
V-2:447542,7×2,8/100=12531,2 l.
V-3: 29988,6×2,8/100=839,8 l.
V-4: 34229,4×2,8/100=958,4 l.
V-5: 5116,1×2,5/100=127,9 l.
Transmission oil**:**
V-1:32663,1×0,4/100 =130,6 l.
V-2:447542,7×0,4/100 =1790,2 l.
V-3: 29988,6×0,4/100=119,9 l.
V-4: 34229,4×0,4/100=136,9 l.
V-5: 5116,1×0,4/100 = 20,5 l.
Special oil and fluids**:**
V-1:32663,1×0,15/100=48,9 l.
V-2:447542,7×0,15/100=671,3 l.
V-3: 29988,6×0,15/100=44,9 l.
V-4: 34229,4×0,15/100=51,3 l.
V-5: 5116,1×0,1/100=5,1 l.
Grease lubricant**:**
V-1:32663,1×0,35/100=114,3 l.
V-2:447542,7×0,35/100=1566,4 l.
V-3: 29988,6×0,35/100=104,9 l.
V-4: 34229,4×0,35/100=119,8 l.
V-5: 5116,1×0,2/100=10,2 l.

The calculation of costs of alternative fuel and lubricants was taken into account when calculating the rolling stock depreciation, the cost of tyre remoulding and repair, developing a production program and a plan for operating vehicles, including special equipment of the oil and gas industry and civil and industrial construction.

As an example, let us consider the calculation of the rolling stock depreciation.
Calculation of the rolling stock depreciation of the enterprise.
Depreciation is the compensation of consumption of fixed assets as a result of a gradual transfer of their value to the transport work done. The depreciation charges for trucks are calculated by formula 1 and 2:

$$D = \frac{B_c \times D_r \times L^{\Sigma}_{year} \times A_{cn}}{100 \times 1000} = \frac{B_c \times D_r \times L^{\Sigma}_{year}}{100 \times 1000} \quad (1)$$

or (for trucks with capacity up to 2 tons):

$$D = \frac{B_c \times D_r \times A_{cn}}{100}, \quad (2)$$

where D – depreciation, roubles;
B_c– base cost of one car, roubles;
D_r – depreciation rate of the vehicle cost and per 1000, %.

When choosing the depreciation rate, the number of kilometers driven before the major maintenance is taken into account.
The calculation of the rolling stock depreciation on of the motor enterprise is presented in table 5.

Table 5: Calculation of rolling stock depreciation

No.	Indicator	Make a vehicle					Total
		V-1	V-2	V-3	V-4	V-5	
1.	Base cost of one car B_c, roubles.	4635000	3747100	4460000	4090000	1053000	
2.	Total annual mileageL^{Σ}_{year}, km	61620	90650	61050	62750	46420	322490
3.	Depreciation rate R_d, %	0,20	0,20	0,20	0,20	0,30	1,1
4.	Depreciation D, roubles	571217,4	679349,2	544566	499389	97760,52	

The calculation of depreciation charges is presented below.
V-1:$\frac{4635000 \times 0,2 \times 61620}{100 \times 1000} = 571217,4$.

V-2: $\frac{3747100\times0,2\times90650}{100\times1000} = 679349,2.$
V-3: $\frac{4460000\times0,2\times61050}{100\times1000} = 544566.$
V-4: $\frac{4090000\times0,2\times62750}{100\times1000} = 499389.$
V-5: $\frac{1053000\times0,3\times46420}{100\times1000} = 97760,52.$

While developing technical and economic measures to optimize the management of the recourse efficiency system of vehicles, a multi-factor correlation and dispersive analysis of transport and technological processes was carried out taking into account:

- climatic conditions of the Arctic zone and rational intervals of severity of low-temperature operating conditions;
- identified patterns of change in fuel temperature at the engine inlet when operating in low-temperature conditions at different speed;

- the coefficient of adaptation of vehicles (including special equipment of the oil and gas industry and civil and industrial construction) to low ambient temperatures described by the quadratic model of preparedness.

The scientific novelty of the research is to develop the scientific and pedagogical basis and the technological support for the formation of professional competence of bachelors in the direction of "Technology of transport processes" in the field of managing the resource efficiency system of vehicles (including special equipment of the oil and gas industry and civil and industrial construction) of the Arctic zone enterprises, taking into account:

- methods of fuel saving in the operation of vehicles, including differential adjustment of linear fuel consumption;
- recommendations on the use of the most adapted cars depending on the specific climatic conditions of the region;
- determination of the limitations of climatic conditions for the operation of vehicles with a given level of preparedness, the advantages of alternative fuel and lubricants, optimization of the maintenance and repair system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction), taking into account the Arctic zone , technical and economic measures to identify excess fuel consumption rates with due account for the climatic zone and seasonality.

Theoretical relevance of the research is to apply an integrated approach to the management of the recourse efficiency system of vehicles (including special equipment of the oil and gas industry and civil and industrial construction) of the Arctic zone enterprises.

The applied significance of the research is in the fact that the developed organizational and methodological approaches to the management of the recourse efficiency system of vehicles (including special equipment of the oil and gas industry and civil and industrial construction) can reduce the cost of fuel and lubricants, the cost of maintenance and repair of rolling stock, as well as the rolling stock depreciation.

DISCUSSION

In our research we have developed an innovative didactic system for managing the recourse efficiency system of vehicles (including special equipment of the oil and gas industry and civil and industrial construction) of the Arctic zone enterprises. The system was developed in a targeted, substantial, procedural and organizational aspect.

The conducted research cannot provide the scientific description of all the aspects of such a complex process as improving of the vocational training of bachelors in the direction of "Technology of transport processes". The problems which require further development are:

- quantitative and qualitative multi-criteria analysis to optimize the management of the recourse efficiency system of vehicles of the Arctic zone of the Russian Federation;
-development of the algorithm software to manage the recourse efficiency system of vehicles;
-development of methodological recommendations for managing the recourse efficiency system of vehicles (including special equipment of the oil and gas industry and civil and industrial construction), which allows reduction of fuel and lubricant costs, costs for maintenance and repair of the rolling stock, the rolling stock depreciation.

CONCLUSIONS

Pilot and experimental testing of the obtained results confirmed the correctness of the hypothesis. The correctness of its conceptual provisions allows us to draw the following conclusions:

1. Based on the study of the problem of improving vocational training of technical profile students, we have conducted a classification analysis of operating conditions of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction), the natural and climatic conditions of operation of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction), existing severity integral indicators which take into account the joint influence of various climatic factors, as well as the influence of the vehicle operating conditions on the fuel efficiency in the Arctic zone.

2. We have developed organizational and methodological approaches to the implementation of technical and economic measures that increase fuel efficiency of vehicles (including special equipment of the oil and gas industry and civil and industrial construction), including: a study of the transport process impact on fuel and lubricant consumption, the use of fuels and lubricants in accordance with the design features of cars and their operating conditions in the Arctic zone of the Russian Federation.

3. We have performed mathematical and computer modeling of transport and technological processes to optimize the management of the recourse efficiency system of motor vehicles (including special equipment of the oil and gas industry and civil and industrial construction), which reduces the cost of fuel and lubricants, as well as the cost of maintenance and repair of the rolling stock and rolling stock depreciation.

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