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Studies of the periodicity of the service Volvo excavator service EW 145 b

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Abstract. At present, the efficient and economical use of road construction machines in the construction, repair and maintenance of roads is a very urgent task. On this aspect of studying and researching the effective and economical use of newly arriving road equipment, incl . single-bucket excavators of foreign countries, when there is no regulatory documentation for their technical operation, is an urgent task. This study is aimed at studying the technical characteristics and frequency of maintenance of a VOLVO single-bucket excavator EW 145B _ By fuel consumption and machine output.

1 Introduction

This study is aimed at studying the technical characteristics and frequency of maintenance of a VOLVO single-bucket excavator EW 145B _ By fuel consumption and machine output.

It is known that one of the main requirements for road construction machines is fuel efficiency, i.e. saving energy resource. The study of fuel consumption and existing regulatory documentation for a shovel excavator of foreign countries and the CIS in the construction and operation of roads allows specific directions for this study and an assessment of the acceptability of existing fuel consumption standards.

It is known that the efficient use of machines depends on many organizational, technical, technological and operational factors that are closely related, especially the main main parameters characterizing their relationship in the technological process during the construction and repair of roads. Excavators are earth-moving machines that are designed to excavate soil and other road construction materials with their subsequent loading of vehicles or unloading into a dump.

The hourly operational productivity (production) of a single-bucket excavator is determined by the formula:

$$П_ч^э = \frac{3600 * q_к * k_н}{t_ц * k_р} * k_в * k_Т \text{, m}^3/\text{h} \quad (1)$$

where $q_к$ is the capacity of the excavator bucket, m ^{3} ; $k_н$ - bucket filling factor, $k_н = 0,9 \div 1,25$; $k_в$ - coefficient of use of internal time , $k_в = 0,8 \div 0,85$; $k_Т$ - coefficient of

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transition from technical productivity to operational, $k_{\text{т}} = 0,6 \div 0,7$; $t_{\text{ц}}$ - duration of one cycle of the excavator, sec; $k_{\text{р}}$ - soil loosening coefficient, $k_{\text{р}} = 1,1 \div 1,3$.

The duration of the working cycle of a single-bucket excavator, depending on the capacity of the bucket, can be taken from table 1.

Table 1. Working cycle time $t_{\text{ц}}$ of single-bucket excavators

No.	Bucket capacity $q_{\text{к}}$, m^3	Cycle time $t_{\text{ц}}$, h
1	$\langle 0,65$	0.0045
2	$0.65 \div 0.80$	0.0055
3	$\rangle 0,80$	0.0065

The duration of one cycle of operation of a single-bucket excavator can also be determined by conducting an experimental-chronometric method of studying the working process when performing a specific type of work. The work of a single-bucket excavator when loading soil or other road construction materials of vehicles or unloading onto a dump.

The results of experimental timing for determining the duration of one cycle of operation of a single-bucket excavator can be entered in Table 3.2.

Table 2. The results of the experimental timing of the determinationexcavator cycle

No.	Timing of the loading process		Number of cycles for full vehicle loading	Duration of one cycle of the excavator	
	$t_{\text{ц}}$, min	$t_{\text{ц}}$, sec	n	$t_{\text{ц}}$, sec	$t_{\text{ц}}$, hour
1					
2					

It is known that according to the developed and recommended documentation for the operation of road equipment of the company, companies and the manufacturer, indicators are given for the frequency of service maintenance (in engine hours), as well as other meters, such as a month, a week and a day.

However , it is not always possible to control the frequency of service maintenance (SO) in motto-hours, since if the moto-meter malfunctions, it will be impossible to monitor the operating time of road equipment in their further operation, there is simply no indication of the operating time of the machines.

This study is devoted to determining the frequency of service maintenance in other meters.

Determining the frequency of SS in terms of fuel consumption and output (productivity) of machines, or rather, in terms of the physical volume of work performed.

These above recommended indicators of fuel consumption and production of machines are always systematically taken into account when analyzing the operation of machines, as well as when reporting these indicators as a whole, in the field of analysis of financial and economic indicators on the activities of any enterprises in the national economy, including road enterprises DAK " Uzavtoyul".

In the process of production operation, any equipment will use up fuel and lubricants . For example, most road technicians will use diesel fuel, and, accordingly, certain volumes of road work are performed on these fuel costs, this is naturally natural.

To solve the tasks, it is necessary to perform the following works, namely:

- it is necessary to have a data bank on the production operation of machines;
- it is necessary to have a data bank on the operation of machines in time;

- to analyze the operating time of machines;
- determine and calculate fuel consumption;
- determine and calculate the output of machines;
- to analyze the interconnectedness of the considered indicators and factors, etc.

Calculation of fuel consumption of machines is made taking into account the operating time and hourly fuel consumption of machines. The hourly consumption of machines is determined and established by different methods, and the calculation of fuel consumption in a certain operating time is carried out according to the formula:

$$G_e = t * G_e^{ч}, \text{ l /hour;} \tag{2}$$

or

$$G_e = T_{н} * G_e^{ч}, \text{ l / hour} \tag{3}$$

where $G_e^{ч}$ - hourly fuel consumption, l / h; t - elegant working time of the machine, in machine hours; $T_{н}$ - operating hours of machines, in motto-hour.

The hourly fuel consumption is determined and established experimentally, for which experimental studies are carried out.

It is known that there are different methods for determining the fuel consumption of cars, namely:

- determining the fuel consumption of vehicles by the digital flow meter installed on the vehicle in a certain time;
- tensometric method for determining the fuel consumption of vehicles;
- determination of fuel consumption according to the consumed fuel, by adding fuel to the fuel tank (floor mark);
- measuring the operating time of machines and determining fuel consumption on the scale of the fuel consumption sensor, etc.

Next, we consider the relationship of the studied indicators (t, $T_{н}$, $G_e^{ч}$, $W^{ч}$, G_e, W etc.), function and dependence graphs of factors and parameters.

Measurement of fuel consumption is an important and necessary step in a number of operational tests of machines. In particular, such measurements are necessary when determining the "Indicators of the economical use of raw materials, materials, fuel, energy and labor resources" performed in accordance with the existing GOSTs of the SPKP.

The requirements for the accuracy of measuring fuel consumption are formulated in GOST 14846-93 and are fully supported by this method. Fuel consumption can be measured by volume or by weight.

A schematic diagram of measuring the fuel consumption of machines with diesel engines during operational tests is shown in Fig.1.

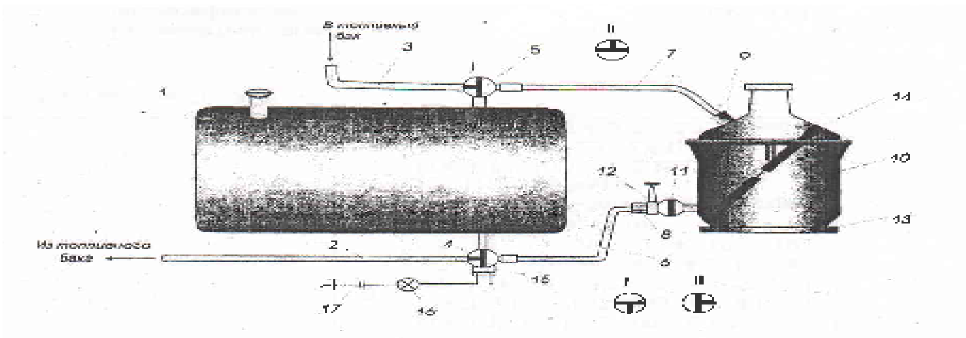


Fig. 1. Scheme for measuring fuel consumption during operational tests of vehicles with diesel internal combustion engines.

1 - fuel tank; 2,3 - supply and return pipelines; 4, 5 - three-position fuel valves; 6, 7 - flexible pipelines; 8.9 - easily removable fittings; 10 - measuring tank; 11 – fuel cock; 2 – needle valve; 13 - bracket; 14– quick-release clamp; 15 - limit switch; 16 - signal light; 17 - battery.

4 and *5* , respectively, are installed on the fuel tank *1* of the tested machine in the supply *2 and return 3 pipelines, respectively* , which are connected to the measuring tank *10 by flexible,* petrol- oil-resistant pipelines *6* and *7* through easily removable fittings *8* and *9* . The supply pipeline *6* of the measuring tank *10* , located in its lower part, is additionally equipped with a fuel valve *11* with a needle valve *12* connecting (disconnecting) the internal cavity of the valve *11* with the atmosphere. The measuring tank *10* is mounted on a temporary bracket *13* attached to the body of the tested machine and fixed on it with a quick-release clamp *14* . The three-position fuel valve *4* is equipped with a limit switch *15* , which in turn is electrically connected in series with the signal light *16* and the vehicle battery. The signal light *16* is stopped, respectively, in the operator's cab. The limit switch *15* is configured in such a way that the signal *16* is switched on in position II of the valve *4* , in which the fuel tank *1* of the tested machine is disconnected from the supply pipeline *2,* and the fuel is supplied to the engine from the measuring tank *10* .

The results of experimental timing for determining the duration of one cycle ($t_{ц}$) of the operation of a single-bucket excavator of the VOLVO brand EW 145 B are presented in table 3.

Table 3. The results of experimental timing for determining the excavator operation cycle VOLVO EW 145B

No.	**Cycle time $t_{ц}$ (sec)**	**Cycle time $t_{ц}$ (hour)**	**No.**	**Cycle time $t_{ц}$ (sec)**	**Cycle time $t_{ц}$ (hour)**
1	24	0.0067	16	25	0.0070
2	22	0.0062	17	21	0.0059
3	19	0.0053	18	24	0.0067
4	23	0.0064	19	26	0.0073
5	25	0.0070	20	25	0.0070
6	20	0.0056	21	24	0.0064
7	26	0.0073	22	21	0.0059
8	23	0.0064	23	19	0.0053
9	25	0.0070	24	22	0.0062

Continuation of Table 3.

No.	Cycle time $t_ц$ (sec)	Cycle time $t_ц$ (hour)	No.	Cycle time $t_ц$ (sec)	Cycle time $t_ц$ (hour)
10	24	0.0067	25	25	0.0070
11	21	0.0059	26	21	0.0059
12	25	0.0070	27	24	0.0067
13	23	0.0064	28	20	0.0056
14	20	0.0056	29	22	0.0062
15	22	0.0062	thirty	25	0.0070

Analysis of the results of experimental timing for determining the duration of one cycle of operation ($t_ц$) of a single-bucket excavator of the VOLVO brand EW 145 B , from table 2. it can be seen that the average value of the cycle $t_{ц1}^{cp}$ is

$$t_{ц1}^{cp} = \frac{\sum t_ц}{n} = \frac{686}{30} = 22,87 \text{ sec} \tag{4}$$

To determine the hourly fuel consumption of a single-bucket excavator of the VOLVO brand EW 145 B some of the above methods were used. The results of experimental timing for measuring and determining the hourly fuel consumption of a single-bucket excavator of the VOLVO brand EW 145 B under production conditions are presented in table 4.

Table 4. The results of experimental timing for determining the hourly fuel consumption of an excavator VOLVO EW 145B

No.	Measurement time t, hour	Fuel consumption by chronometer - rating G_e, l	Hourly fuel consumption G_e, l / hour	Average hourly fuel consumption G_e^{cp}, l/h	Average hourly fuel consumption G_e^{cp}, kg/hour
1	1.5	17.0	11.33	11.38	8.65
2	1.5	17.4	11.60		
3	2.0	23.1	11.55		
4	1.6	16.9	11.26		
5	1.0	11.40	11.40		
6	1.5	16.7	11.13		

Analysis of the results of experimental timing, determining the hourly fuel consumption according to the presented methodology are presented in table 3. The average hourly fuel consumption of a VOLVO single-bucket excavator EW 145 B is

$$G_e^{cp} = 11,38 \text{ l/h} \tag{5}$$

Or

$$G_e^{cp} = 8,65 \text{ kg/h.} \tag{6}$$

According to the obtained results of fuel consumption (G_e) and machine output (W), which are presented in tables 5, we will construct graphs of the dependence of indicators on the function.

$$G_e = f(T_н) \tag{7}$$

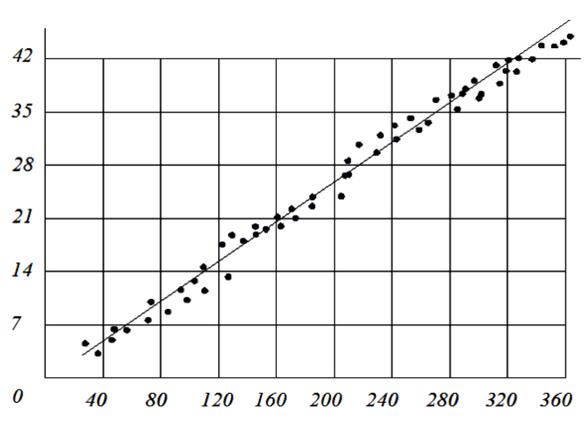
$$W = f(T_н) \tag{8}$$

Table 5. Fuel consumption and output of excavator brand VOLVO E W 145

No.	Machine hours		Fuel consumption of machines		Machine performance	
	t mash .h	$T_н$ moto .h	G_e l / mach.h	G_e m ^{3} / moto .h	W m ^{3} / mash .h	W m ^{3} / moto .h
1	39	25.7	444.6	293.4	2177.4	1437.1
2	174	114.8	1983.6	1309.2	9714.4	6411.5
3	183	120.8	2086.2	1376.9	10216.9	6743.1
4	195	128.7	2223.0	1467.2	10886.9	7185.3
5	205	135.3	2337	1542.4	11445.2	7553.8
6	223	147.2	2542.2	1677.9	12450.1	8217.1
7	219	144.5	2496.6	1647.8	12226.8	8069.7
8	227	140.8	2587.8	1707.9	12673.4	8364.4
9	233	153.8	2656.2	1753.1	13008.4	8585.5
10	168	110.9	1915.2	1264.0	9379.4	6190.4
eleven	144	95.0	1641.6	1083.5	8039.5	5306.1
12	124	81.8	1413.6	933.0	6922.9	4569.1

Constructed graphs of dependence of fuel consumption (G_e) on operating time ($t_н$) of a single-bucket excavator of the VOLVO brand EW 145 B are shown in fig. 2.

$$G_e * 10^2 \, [n] \tag{9}$$



$t[маш. ч]$

Fig. 2. Chart of dependence of fuel consumption G_e on the operating time of a t VOLVO brand excavator E W 145.

The constructed graphs of the dependence of the output of machines (W) on the operating time (t) of a single-bucket excavator of the VOLVO brand EW 145 B are shown in fig. 3.

$$W * 10^{2[м^3]} \tag{10}$$

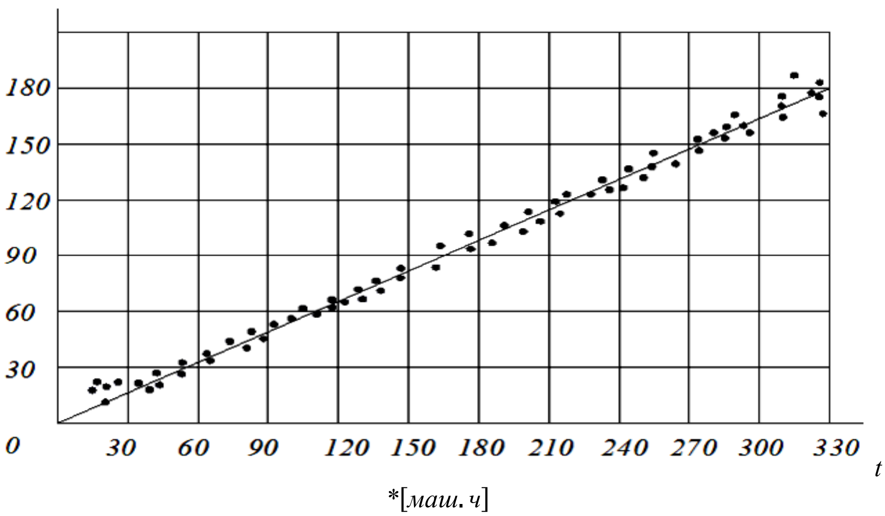


Fig. 3. Graph of the dependence of output $W^г$ on the operating time of a t VOLVO brand excavator EW 145B.

(W^Γ) of machines on fuel consumption (G_e^Γ) of a VOLVO brand excavator was also considered EW 145 B , which is shown in fig. 4.

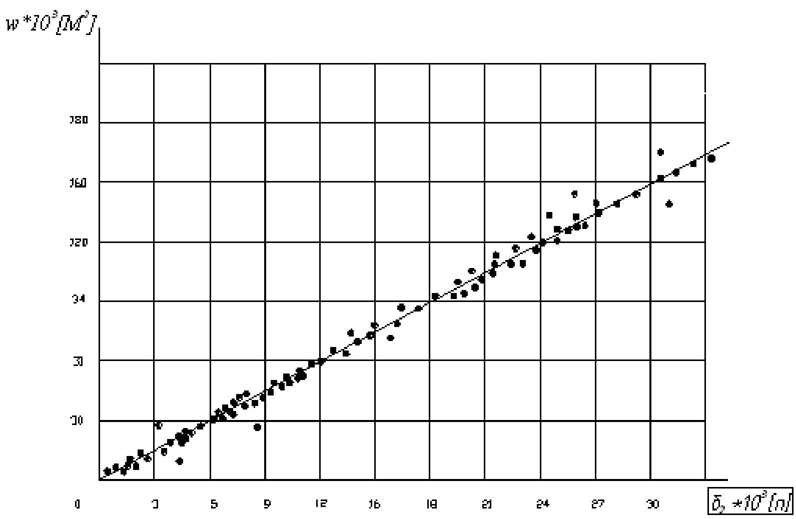


Fig. 4. Graph of the dependence of output W^Γ on fuel consumption of a G_e^Γ VOLVO brand excavator EW 145B.

Further, based on the results of the study, a nomogram was developed for determining the indicator of the service interval mode (CO-1; CO-2; CO-3 and CO-4) in terms of fuel consumption ( ) G_e , machine output (W) and operating time of a single-bucket excavator of the VOLVO brand EW 145 B (machine hour), i.e. in different meters. This circumstance makes it possible to determine the values of the frequency of service maintenance, when one of the indicators of the frequency is missing, you can use the values of other meters (G_e , W , T).

The developed nomogram for determining the indicator of the mode of frequency of service maintenance in terms of fuel consumption (G_e), output (W) and operating time ( ) of a T VOLVO single-bucket excavator EW 145 B is shown in fig. 5.

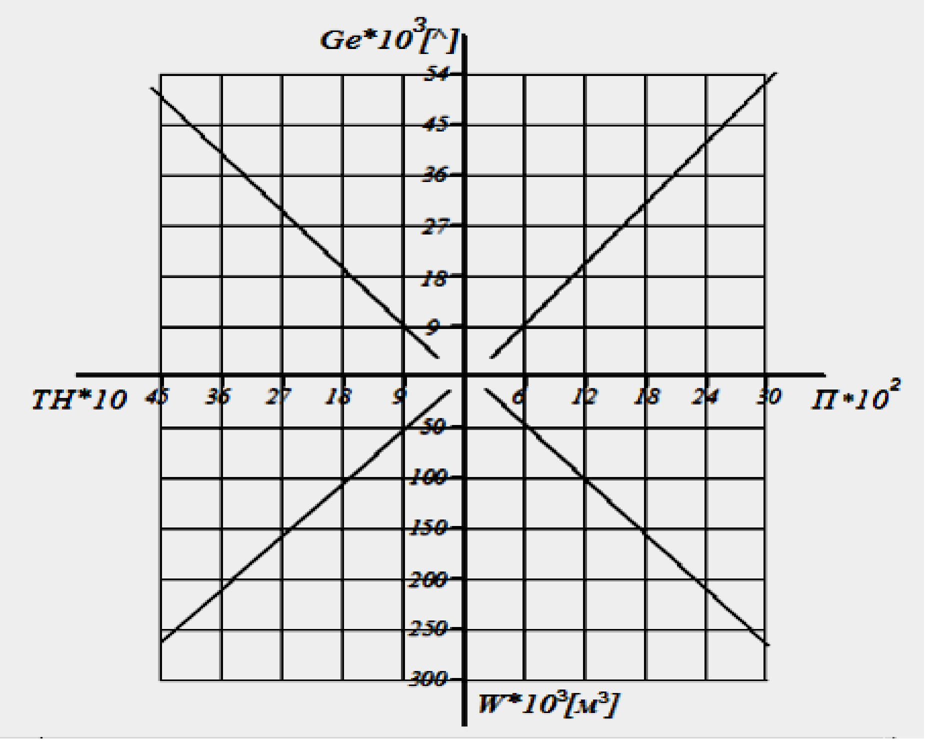


Fig. 5. Nomogram for determining the frequency of service maintenance of the brand excavator VOLVO E W 145 B.

The results obtained are indicators of the mode of periodicity of service maintenance of a single-bucket excavator of the brand VOLVO EW 145 B are presented in table 6.

Table 6. Indicators of the excavator service interval mode stamps VOLVO EW 145 B

No.	**Service types**	**Service intervals**		**Frequency of SS by fuel consumption**		**Frequency of SS for the production of machines**		**Periodicity of conducting SO on working days**	**Periodicity of SS according to calendar time**
		$П_i$ moto .h	$П_i$ mash .h	G_e l/ moto .h	G_e l / mach.h	W m ^{3} / moto .h	W m ^{3} / mash .h	$Д_p$ day	$Д_p$ month
1	CO-1	250	378.8	2850	4318.3	13957.5	21148.4	47	1.5
2	CO-2	500	757.6	5700	8636.3	27915	42295.4	95	3
3	CO-3	1000	1515.2	11400	17272.7	55830	84590.9	189	6
4	CO-4	2000	3030.3	22800	39381.8	111660	169181.8	379	12
5	CO-5	3000	4545.5	34200	51818.2	177490	253772.7	568	18

2 Conclusions

Experimental studies have been carried out to determine the fuel consumption and performance of a single-bucket excavator of the VOLVO brand E W $t_ц$ 145 _ _ _ E W 145. Graphs for determining the dependence of fuel consumption and the output of machines on the operating time of machines have been developed and built: $G_T = f(T_н)$ and $W = f(T_н)$. A nomogram has been developed for determining the frequency of service maintenance (CO-1; CO-2; CO-3 and CO-4) of a VOLVO single-bucket excavator EW 145 B in terms of fuel consumption (G_e), output (W), as well as operating hours ($T_н$) of machines.

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