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Oleh Bundza[1], Olexandr Herasymchuk [2], Viktor Martyniuk [2]

[1] *National University of Water and Environmental Engineering, Rivne, Ukraine*
[2] *Lutsk National Technical University, Lutsk, Ukraine*

SUBSTANTIATION OF A SIGNIFICANT INDICATOR OF THE CHOICE OF TRACTOR-TRAILERS

The volume of transportation organized in agricultural enterprises is constantly growing. At the same time, it is recommended to use tractor transport for transportation carried out on the field and dirt roads. To ensure efficient operation of the tractor unit, which is an energy tool, hitch, and trailer, it is necessary to meet several conditions: 1) rational choice of the range of trailers, taking into account the conditions of their operation; 2) ensuring optimal performance of technical and operational properties of tractor units. As a result of the analysis of the correlation between the technical and operational indicators of trailers and energy indicators of tractors, it was found that the selection of trailers should be carried out using the load capacity of the trailer as an indicator. It is established that the use of this indicator will allow forming a trailer composition taking into account the influence of such indicators as tangential traction force, specific fuel consumption. This, in turn, will allow in the process of substantiating the composition of the transport unit to assess the economic efficiency of its operation.

Key words: tractor, trailer, load capacity, weight, energy saturation

INTRODUCTION

An important component of the infrastructure of the agro-industrial complex, a fleet of tractors, designed most often for transportation within a particular farm. Demand for this type of transport can be explained by its high passability. According to the data of the scientific-analytical review [1], the volumes of transportation carried out by tractor transport makeup 22…27% of the total volume of transportation in agriculture.

One of the indicators that assess the quality of transportation is productivity, to increase which uses a variety of trailers. Given the fact that farms are constantly in need of transportation of goods with different physical and mechanical properties, the range of trailers on the balance of the farm should be wide. In addition, trailers must be equipped with additional means to facilitate loading and unloading, which will ensure the preservation of goods that are easily damaged.

Taking into account the condition of agricultural roads, trailers must meet the requirements for passability, stability, maneuverability.

It should also be noted that the parameters of the trailer and tractor must be agreed upon by justifying the design of the coupling equipment. The problem of determining the rational composition of a tractor train is the optimal combination of technical, operational, and design parameters of the power tool - tractor and trailer. This is a complex and time-consuming task, the solution of which requires, first, a systematic analysis of external factors that affect the operation of tractors with trailers; secondly, the analysis of conditions of operation of trailers, development of the system of indicators of technical and operational properties of trailers. With this in mind, the development of conceptual provisions of the methodology for identifying the optimal set of models of trailers with characteristics consistent with the parameters of the energy tool available in the economy is an urgent scientific and applied problem that needs to be addressed.

ANALYSIS OF LITERATURE SOURCES AND PROBLEM STATEMENT

Studies aimed at substantiating the feasibility of using a particular design of a tractor-trailer are given in the works of M.P. Kholodov [2], N.V. Byshov [3], N.V. Anikin [4]; V.V. Bychkov [5], and others.

M.P. Kholodov [2] developed a method for assessing the stability of a tractor with a wheeled engine with a trailer. The author also analyzes the patterns of distribution of braking forces between the axles of a tractor train.

In [3] the authors noted the important role of transport in agricultural production, in particular, tractors; the results of the analysis of constructive and technical features of a number of modern models of trailers of agricultural purpose are stated. The authors concluded that the need for automation of loading and unloading operations.

In [4, 5] the importance of trailers in agriculture is also revealed. The authors emphasize the prospects for the development and use of heavy-duty trailers (15-30 tons), as well as the feasibility of increasing the transport speed to 40 km / h.

The work of A.I. Bondarenko [6], M.A. Podrygalo [7], N.B. Havron [8], and other scientists is devoted to the issue of the operation of tractor transport and trailers.

The work [6, 7] is devoted to the study of the process of self-braking of wheeled tractors with stepless hydraulic transmission. The dynamics of wheeled machines was also described by A.V. Chernikov [9], who modeled the process of braking a wheeled tractor while maintaining their stability. Continuation and deepening of these studies were obtained in the work of M.P. Kholodov [10]. The author substantiates the method of determining the coefficients of distribution of braking forces between the axles of a tractor train, evaluates the braking efficiency and course stability of a tractor with two trailers.

The work of V.A. Kim [11], Yu. N. Stroganov [12, 13], and others is devoted to the study of ways to improve the operational characteristics of tractor trains. It is noted in the works that the main directions of improving the traction and coupling properties of tractor trains are the modernization of coupling equipment in order to increase the loading area of the trailer platform. Due to the modernization of the coupling equipment, it is also proposed to solve the problem of motion stabilization and oscillation reduction [14-16].

As you can see, many theoretical and experimental studies are devoted to the operation of tractor trains and, in particular, the design features of trailers. The analysis of current research revealed that there is no method of constructing a system for estimating the parameters of the structures of trailers in the composition of tractor trains, which allows you to evaluate the design at different stages of the design of trailers. In this regard, it is necessary:

- first, to substantiate the list of indicators that will allow us to assess the technical and technological level of the tractor train;

- second, to identify the relationship between technical, technological, and operational parameters of the tractor and design and technical characteristics of trailers.

THE AIM OF THE STUDY

The purpose of the research, the results of which are presented in this paper, is to establish the relationship between technical and operational, design parameters of energy vehicles and trailers, based on statistical data.

RESULTS OF THE STUDY

A tractor train is a complex technical system, the design of which, as we noted above, should be based on the interaction of individual parameters. In addition, during the design, it is necessary to take into account the established quantitative effects of system elements and the external environment with which they interact.

Assume that the design process can be greatly simplified by using the results of statistical analysis, which will provide equations that reveal the relationship of design (operational or technological) parameters of the machine with the parameter that should be considered important. Let's accept (conceptually), as a weighty parameter - own weight of the trailer. The curb weight depends on the design parameters of the trailer and varies depending on their change.

In order to ensure wide coverage of the parameters of the tractor train in the process of its design, we will use the results of processing statistical information on the model of trailers.

In order to establish the relationship of a significant parameter with other operational and technological parameters of the components of the tractor train, the regression equation was obtained, the reliability of which was performed by the randomization coefficient, and the correlation coefficients were calculated.

The relationship between the parameters was studied on the basis of the collected statistical database, which contains technical characteristics for 70 models of trailers made in Ukraine, Poland, China, Russia.

Correlation distribution and mathematical models that describe the interaction of power output from the weight of the trailer, the load capacity of the trailer, the load volume (Fig. 1, 2, 3).

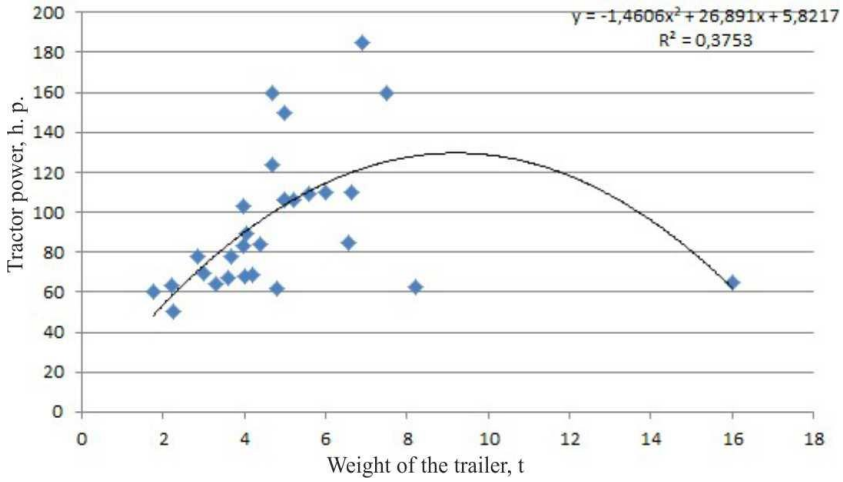

Fig.1. Dependence of tractor power N, h. p. from the weight of the trailer m_p, t

$$N = -1,4606m_p^2 + 26,891m_p + 5,8217. \qquad (1)$$

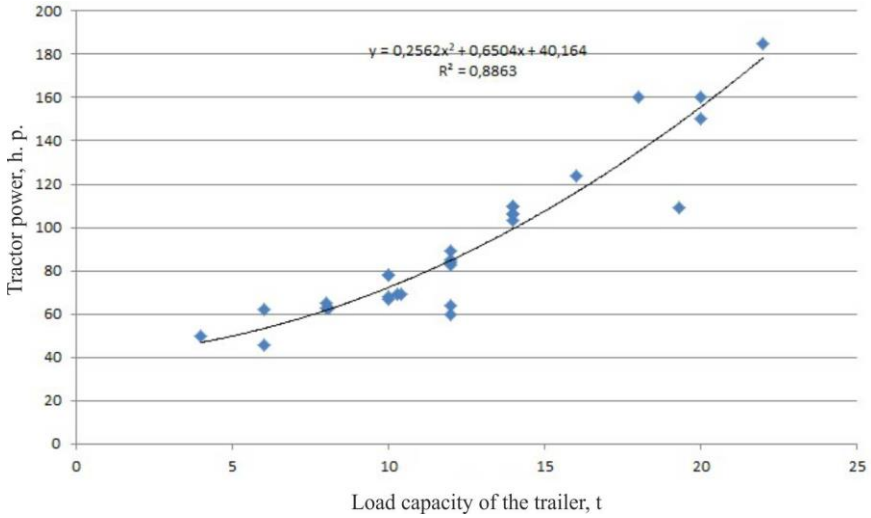

Fig. 2. Dependence of tractor power on the load capacity of the trailer, Q, t

$$N = 0,256Q^2 + 0,65Q + 40,2 \qquad .(2)$$

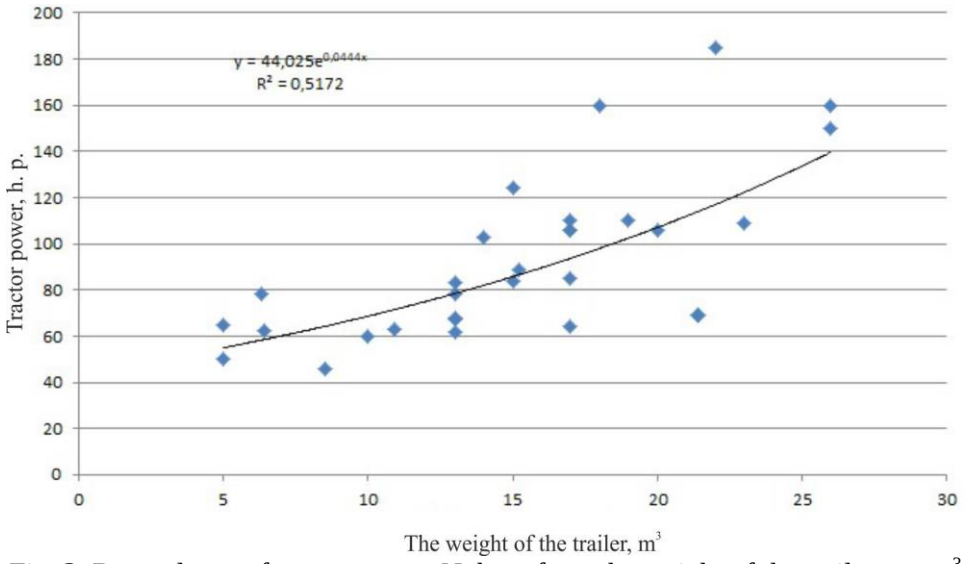

Fig. 3. Dependence of tractor power N, h. p. from the weight of the trailer m_p, m^3

$$N = 44,025e^{0,04V}. \quad (3)$$

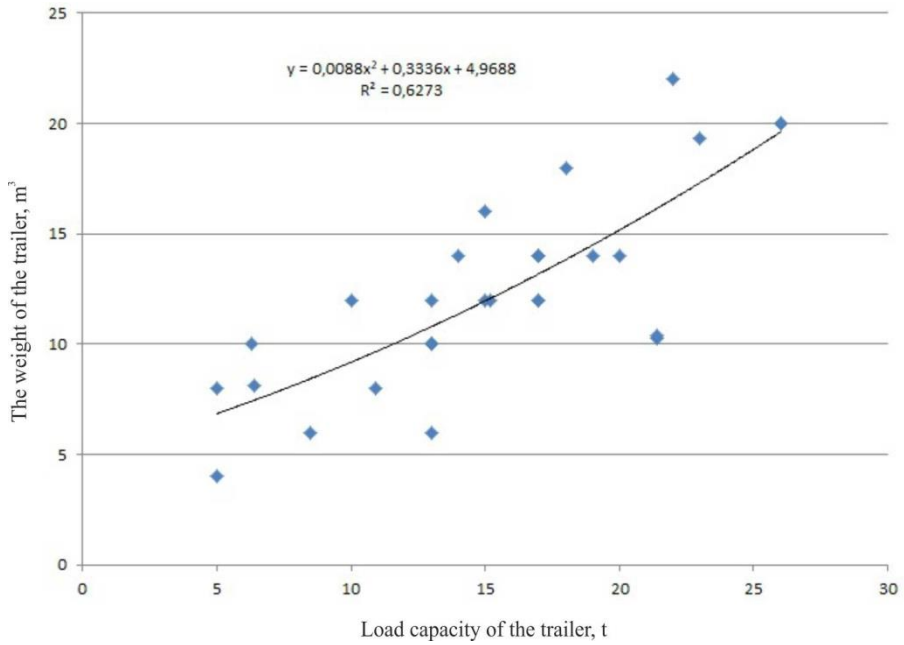

Fig. 4. Dependence of tractor power N, h. p. from the weight of the trailer m_p, t

As you can see, the amount of tractor power is most strongly correlated with the load capacity of the trailer Q, т ($\partial = 0,93$), the smallest connection is traced between the weight of the trailer and the power of the power vehicle (tractor). Based on this, we can conclude that the choice of the trailer should be made not only taking into account the characteristics of the tractor fleet but to a greater extent take into account the following factors:

- list of works;
- physical and mechanical properties of goods;
- dimensions of goods;
- weight of goods and the trailer itself.

The correctness of this conclusion proves that between the indicators - the volume of loading and power of the tractor there is a high relationship ($\partial = 0,7$), (fig.3). The relationship between the load capacity of the trailer and the load volume is described by the equation:

$$V = 0,01Q^2 + 0,334Q + 4,97. \quad (4)$$

Given the above, we believe that the load capacity parameter can be taken as important in the selection of trailers for the formation of transport units. It should also be noted that the load capacity rate affects the efficiency of the transport tractor unit. This proves the dependence (5) [12]:

$$F = \frac{\left(0,4 + 0,6\frac{f\left(C_{yg}\left(q_n\right) + q_n\right)}{P_{kp}^H}\right) g Ц_t}{W_r}. \quad (5)$$

where f – the coefficient of resistance to rolling of the trailer, m;

$C_{yg}\left(q_n\right)$ – the specific metal content of the trailer;

$\left(q_n\right)$ – rated capacity of the trailer;

g – hourly fuel consumption;

$Ц_t$ – complex price of fuel;

P_{kp}^H – tractor traction force;

W_r – hourly productivity.

From the above dependence (5) the value of the specific consumption of fuels and lubricants will be determined:

$$q_H = \frac{\frac{F \cdot W_r \cdot P}{0,6gЦ_t} - 0,4 - fC(q_n)}{f}. \qquad (6)$$

From the above dependence (5) the value of the specific consumption of fuels and lubricants will be determined:

We see that the specific consumption of fuel and lubricants of the tractor-trailer unit depends on the load capacity of the latter and the hourly productivity Wr, which, in turn, can be determined:

$$W_r = \frac{q_n \beta}{T}. \qquad (7)$$

where β – static capacity utilization factor;

T – total time.

We see that the load capacity is affected by traction and coupling properties (P_{kp}^H) of the tractor.

DISCUSSION OF RESULTS

Summarizing the above, the main indicators of technical and operational properties of agricultural trailers, which are recommended for use during the formation of the tractor-transport unit are load capacity. This indicator makes it possible at the stage of design work aimed at the formation of transport tractor units.

CONCLUSION

Based on the analysis of the correlation between the parameters of agricultural trailers and tractors, the authors proposed to select a trailer for an existing tractor on the farm, using the load capacity, which has a close correlation with the tractor power.

Works it is necessary to develop in addition recommendations concerning the aggregation of trailers by tractors of various traction classes that will provide rational formation and operation of the unit taking into account traction and coupling properties. This is the task of further research.

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Бундза О. З., Герасимчук О. П., Мартинюк В. П. Обґрунтування вагомого показника вибору тракторних причепів

Об’єм перевезень, які організовують у сільськогосподарських підприємствах, зростає постійно. При цьому для здійснення перевезень, які здійснюються по полю й ґрунтовим дорогам, рекомендовано використовувати тракторний транспорт. Для забезпечення ефективної експлуатації тракторного агрегату, який являє собою енергетичний засіб, зчіпку та причіп, необхідним є виконання декількох умов: 1) раціональний вибір номенклатури причепів із урахуванням умов їхньої експлуатації; 2) забезпечення оптимальних показників техніко-експлуатаційних властивостей тракторних агрегатів. Внаслідок аналізу кореляційного зв’язку техніко-експлуатаційних показників причепів і енергетичних показників тракторів встановлено, що підбір причепів доречно проводити з використанням у якості оціночного показника вантажопідйомність причепу. Встановлено, що використання даного показника дозволить сформувати причіпний склад із урахуванням впливу таких показників як дотична тягова сила, питома витрата палива. Це, в свою чергу, дозволить ще у процесі обґрунтування складу транспортного агрегату оцінити економічну ефективність його експлуатації.

Ключові слова: трактор, причіп, вантажопідйомність, маса, енергонасиченість

БУНДЗА Олег Зіновійович, кандидат технічних наук, доцент кафедри будівельних, дорожніх, меліоративних, сільськогосподарських машин і обладнання, Національний університет водного господарства та природокористування, e-mail: o.z.bundza@nuwm.edu.ua, https://orcid.org/0000-0003-3770-0273.

ГЕРАСИМЧУК Олександр Павлович, кандидат технічних наук, доцент кафедри лісового господарства, Луцький національний технічний університет, e-mail: alex_gop_ukr@ukr.net, https://orcid.org/0000-0002-3621-3038.

МАРТИНЮК Віктор Леонідович, кандидат технічних наук, доцент кафедри галузевого машинобудування, Луцький національний технічний університет. e-mail: martyniukviktor77@gmail.com, https://orcid.org/0000-0002-6914-2336.

Oleh BUNDZA, PhD in Eng., associate professor of Building, Road, Reclamation, Agricultural Machinery and Equipment department, National University of Water and Environmental Engineering, e-mail: o.z.bundza@nuwm.edu.ua, https://orcid.org/0000-0003-3770-0273.

Oleksandr HERASYMCHUK, Ph.D. Eng., associate professor of Forestry department, Lutsk National Technical University, Lutsk, Ukraine. e-mail: alex_gop_ukr@ukr.net, https://orcid.org/0000-0002-3621-3038.

Viktor MARTYNIUK, Ph.D. Eng., associate professor of Industrial Mechanical Engineering department, Lutsk National Technical University, e-mail: martyniukviktor77@gmail.com, https://orcid.org/0000-0002-6914-2336.

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