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# THE CHOICE OF MOTOR – TRANSMISSION INSTALLATION FOR THE PIPE LAYER

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***Abstract***

*The results of research, which applied character, for an industrial complex, will allow resolving topical and important issues of increase of efficiency of operation of park of special equipment in the course of a production activity, at stages of a project and preparatory work are given in article. In previous articles [1, 2, 3, 4, 5] proposed mathematical model of determination of productivity of the machine -tractor unit (MTU) with industrial function is presented in article during the pipelaying works. The mathematical model coordinates all key technical parameters of the pipelayer and the parameters defining service conditions in uniform dependence. The method of "minimization of duration of a running cycle of the machine" is put in mathematical model, as duration of a running cycle is one of generalizing indicators of technical and operational efficiency of MTU. In other words, productivity of the pipelayer is in inverse relationship with a duration of a running cycle, the less time is spent for pipeline laying, the productivity and efficiency of construction is higher. Various ways of laying of the pipeline define boundary conditions, which form some private models.*

***Keywords****: motor – transmission installation, the pipe layer*

The development of the Russian Federation basically is defined by efficiency of functioning of fuel and energy complex. Pipeline transport is its basis and a link. The Russian Federation has the most extended and branched pipeline infrastructures in the world. For its maintenance in operating state huge amounts of money which considerable part is the share of operation of special equipment at construction new and capital repairs of old pipelines are spent.

The pipe layer is a basic element in system of an insulating and laying column. This type of equipment belongs to hoisting-and-transport cars, usually the crawler tractor made under the bulldozers or agricultural equipment forms base for the pipe layer. The Motor and Transmission Installation (MTI) of such power saturated tractors has the powerful diesel engine and additional knots of transmission (the hydro transformer, a reverse reducer, etc.).

The reference books and the specifications and technical documentation concerning trial and error methods of park of special equipment for installation of pipelines became outdated owing to prompt development of an assortment number of this type of the equipment. The current situation resulted in need of search of the criteria of selection of equipment describing dependence of efficiency of construction of the pipeline on technical and economic indicators of the designed or serially released pipe layer.

In earlier put forward concepts and methods of improvement of the engine and transmission they are considered as independent objects of optimization, isn't paid due attention of stabilization of own characteristics at collaboration in structure as MTI, and all car in general. The practice shows that at design of MTI influence of numerous efficiency, technology and operational factors that leads to a mismatch of characteristics of the engine and transmission, additional growth of losses in processes of a power exchange between them is underestimated. As a result, the characteristic of MTI technical and economic indicators decrease to inadmissible level.

The improvement of technical and economic indicators of the pipe layer is reached by selection of the MTI power parameters due to change-over of the diesel engine from a local maximum

of capacity on constant capacity taking into account influence of efficiency, technology and operational factors.

The technique of two-level calculation of technical and economic indicators is developed. At the first level of calculation incompleteness of using opportunities of motor - transmission installation – efficiency factor is considered, at the second level of calculation feature of the load mode – technology factor is considered.

For the analysis were the pipe layer TG-12,5 is chosen (on the basis of the VT-100D tractor); the designed pipe layer TG-12,5 (on the basis of the VT-100D tractor) intended for replacement of outdated TG-6,2 (on the basis of the DT-75 tractor). For determination of the MTI rational parameters and identification of their influence on technical and economic indicators options of the pipe layers with various types of transmissions (the mechanical transmission (MT) – five-step and hydro mechanical transmission (GMT) – three-stage) with the LG-400-35 hydro transformer installed on the Volgograd DT-175S tractor) and settings of the diesel D-442 engine were calculated (see figure 1).

By researches, it is established that one of the main reasons for deterioration of overall performance of the pipe layer is under exploitation of potential opportunities of MTI. It is caused by sharp change of operational loadings, limited opportunities of the engine with a local maximum of capacity and discretization of the transfer relations of step mechanical transmissions.

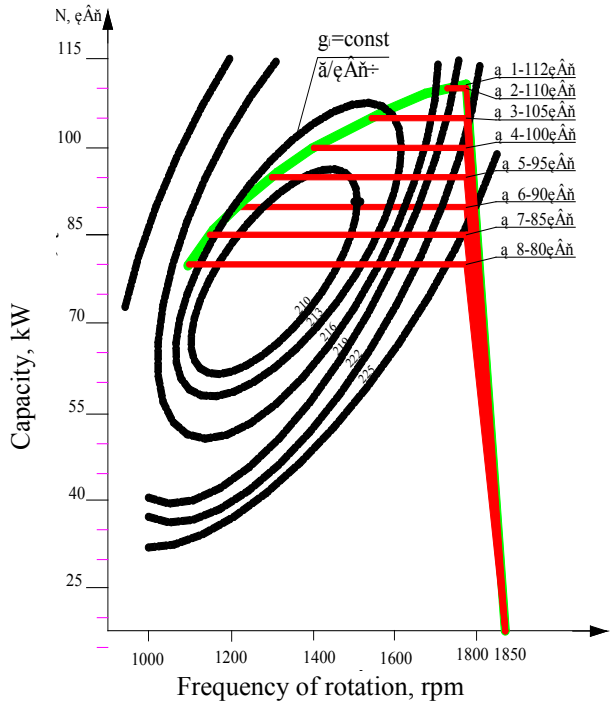


*Fig. 1. Multiparameter characteristic of the D-442 engine*

In figure 1 the multiparameter characteristic of the diesel D-442 engine (VT-100D tractor) with different settings of the fuel equipment is submitted: 1 – $N_{e1}$ – 112 kW (the mode of a local maximum of capacity(LMC)); 2 – $N_{e2}$ – 110 kW with length of shelf constant capacity (SCC)(from 1770 rpm to 1700 rpm); 3 – $N_{e3}$ – 105 kW with length of SCC (from 1770 rpm to 1500 rpm); 4 – $N_{e4}$ – 100 kW with length of SCC (from 1770 rpm to 1400 rpm); 5 – $N_{e5}$ – 95 kW with length of SCC (from 1770 rpm to 1300 rpm); 6 – $N_{e6}$ – 90 kW with length of SCC (from 1770 rpm to 1300 rpm);7 – $N_{e7}$ – 85 kW with length of SCC (from 1770 rpm to 1200 rpm); 8 – $N_{e8}$ – 80 kW with length of SCC (from 1770 rpm to 1100 rpm).

The shift of level of constant capacity of the engine in a zone of the smallest specific fuel consumption – settings 6, 7, 8 leads to decrease in traction specific fuel consumption of the pipe layer at the corresponding settings of the traction to the characteristic.

Operation of the diesel engine in the mode of constant capacity with MT leads to increase in ranges of regulation of traction effort of the pipe layer by 15-20% in comparison with the mode of a local maximum of capacity, and also to decrease in traction specific fuel consumption by 6-10%. The operation of the diesel engine in the mode of constant power with GMT leads to increase in ranges of regulation of traction effort of the pipe layer by 4-8% in comparison with the mode of a local maximum of capacity. However, the range of regulation of traction effort of system the engine – the hydro transformer was within 20-25%. The decrease in excess power to necessary level cuts fuel consumption. It is established that at the pipe layer, unlike digging cars (the bulldozer, the scraper, etc.); the mode corresponding to the maximum traction efficiency according to the potential traction characteristic is most economic.

The indicator estimating incompleteness of use of traction capacity is higher at GMT in comparison with MT on average for 12.6% (see figures 2).

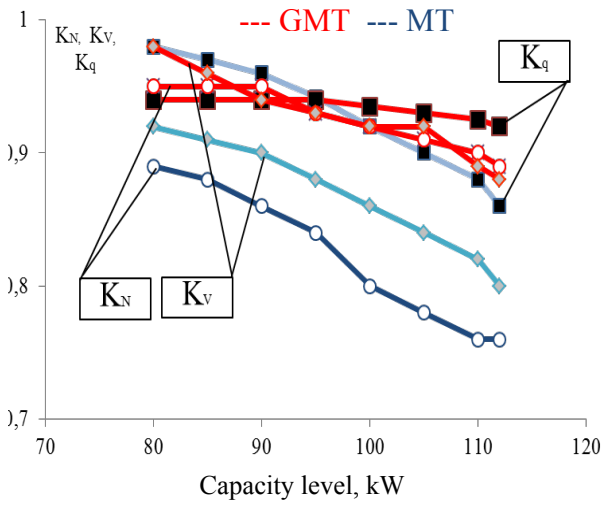


*Fig. 2. Efficiency of traction power, speed, specific fuel consumption for the pipe layer TG-12,5 (on the basis of the VT-100D tractor) with the MTI different types at installation of the pipeline*

The indicator estimating incompleteness of use of speed is higher at GMT in comparison with MT on average for 7% (see figures 2).

The indicator estimating incompleteness of use of fuel profitability is higher at GMT in comparison with MT on average (from 112 to 100 kW) for 4.2% and below on average (from 100 to 80 kW) for 2.4% (sees figures 2).

The comparison of the obtained data with results of pilot studies of other authors (Gintsburg, Yu. V., Dolgov, I. A., Dormenev, S. I., Krivov, V. G., Kuznetsov, N. G., Kulchenko, N. I., Haritonchik, E. M., Shevchuk, V. P., etc.) confirmed the above results. At the first level of calculation (on the indicators estimating incompleteness of use of opportunities of MTI) the best values settings No. 6, 7, 8 possess (see figures 1).

At three stages of installation of the pipeline, the best indicator the pipe layer possesses (see figures 3):

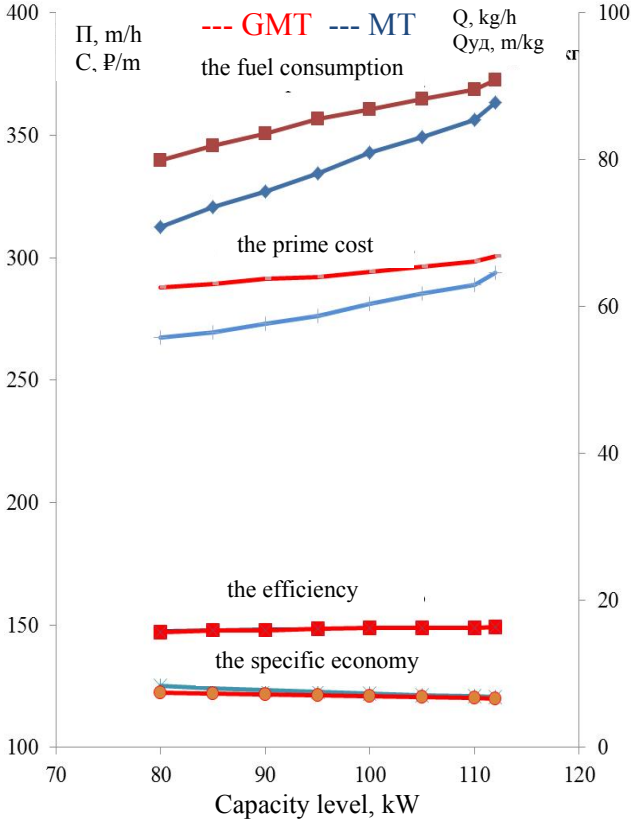


*Fig. 3. Technical and economic indicators of the pipe layer TG-12,5 (on the basis of the VT-100D tractor) in the sum at three stages of installation of the pipeline*

- on productivity:
  - with the constant capacity (CC) engine (control No. 8) and MT;
  - with the CC engine (control No. 8) and GMT;
- on fuel consumption:
  - with the CC engine (control No. 8) and MT;
  - with the CC engine (control No. 8) and GMT;
- on specific profitability:
  - with the CC engine (control No. 8) and MT;
  - with the CC engine (control No. 8) and GMT.
- at cost of work:
  - with the CC engine (control No. 8) and MT;
  - with the CC engine (control No. 8) and GMT

The estimating at total prime cost operation that the pipe layer with various types of transmissions, it is possible to note that at three stages total prime cost is lower at MT in comparison to GMT for 7.8%.

The analysis of the provided schedules testifies that reduction of excess engine capacity of the pipe layer leads to noticeable increase of specific profitability, to decrease in fuel consumption, operational expenses and prime cost at insignificant decline in production. Therefore, high engine capacity is not a sufficient condition of highly effective operation of the pipe layer if it is not used completely.

If in the field, it is impossible (it is not provided by a design) to recustomize the engine on other level of constant capacity, at total cost of work as the best values the pipe layer with setup of the engine No. 8 possesses.

The changeover of the engine from the LMM mode on PM allows reducing total cost of works at installation of the pipeline by 4 – 9%. For this purpose, it is necessary to deforce the engine for 28.5% from nominal capacity (from 112 to 80 kW). The shelf of constant capacity thus will be extended for 61% of the nominal frequency of rotation (from 1770 to 1100 rpm).

The improvement of technical and economic indicators is closely connected with decrease in a zone of under exploitation of opportunities of motor – transmission installation of the pipe layer. This fact testifies that the pipe layer with the engine of constant capacity and any type of transmission works more effectively, than with the engine with a local maximum of capacity.

The results received within this work have applied character. On their basis, the recommendations allowing solving actual and important problems of increase of efficiency of operation of park of special equipment in the course of a production activity at stages of a project and preparatory work are offered. It in turn, raises the questions of optimization of prime cost and fuel profitability at economic activity, which are important in the conditions of the modern market.

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