

APPLICATION OF MODERN SOFTWARE PRODUCTS FOR RESEARCH OF THE PROCESS OF THERMAL PREPARATION OF AUTOTRACTOR EQUIPMENT

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Keywords: mobile agricultural equipment, local overheating, mixed heat carrier, heat transfer, thermal preparation.

Abstract. In this article the technique of numerical researches of processes of thermal preparation of aggregates of autotractor engineering is resulted and the algorithm of selection of optimum parameters of projected means of thermal preparation is offered.

ПРИМЕНЕНИЕ СОВРЕМЕННЫХ ПРОГРАММНЫХ ПРОДУКТОВ ДЛЯ ИССЛЕДОВАНИЯ ПРОЦЕССА ТЕПЛОВОЙ ПОДГОТОВКИ АВТОТРАКТОРНОЙ ТЕХНИКИ

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Ключевые слова: мобильная сельскохозяйственная техника, локальные перегревы, теплоноситель смешанного типа, теплоотдача, тепловая подготовка.

Аннотация. В данной статье приведена методика численных исследований процессов тепловой подготовки агрегатов автотракторной техники и предложен алгоритм подбора оптимальных параметров проектируемых средств тепловой подготовки.

In many sectors of the agro-industrial complex of the Russian Federation, especially in agriculture, a significant amount of mechanized work falls on the winter period, characterized by low ambient temperatures. A large number of self-propelled equipment is stored in open areas or in unheated hangars. At low ambient temperatures, a significant change in the viscosity of hydraulic fluids is observed, which causes incorrect operation of hydraulic systems and increases the risk of failure of highly loaded units and systems of modern mobile equipment - engines, transmissions, and process equipment [1-3].

The most common and effective of all known methods of preparing highly loaded units of mobile equipment to accept the load at low temperatures is thermal preparation, the purpose of which is to increase their temperature of the working environments of the units to values that ensure trouble-free operation [4,6]. This is achieved by heating the units with a stream of hot gases - coolant. The most effective means of thermal preparation are devices that use the energy of combustion of liquid fuel. [7].

In organizing the thermal preparation of automotive vehicles, the selection of the optimal operating parameters of the thermal preparation system – the operating mode of the hot gas generator, the water flow rate in the case of using a mixed type coolant [5,6], and the shape of the guiding device (NU) is of great importance. The specified parameters should correspond to both the model (modification) of the equipment being prepared and the initial conditions: ambient temperature, wind speed, air humidity and the requirements for thermal preparation of equipment

units, for example, the maximum allowable temperature of the coolant. Obviously, the selection of the optimal parameters of the heat treatment system, even within the framework of a single modification of the technique, requires considerable labor and time for conducting field experiments.

One of the ways to solve this problem is the use of computer simulation of processes that occur during the thermal preparation of units of automotive equipment. To determine the parameters of the heat treatment system, an algorithm for conducting numerical studies has been developed:

1) Modeling of the guide device (NU), providing the optimal heat transfer rate of the heat carrier and the uniform distribution of the heat carrier flow over the surface of the heated unit;

2) Determination of the maximum temperature of the coolant, indicating the places of possible local overheating;

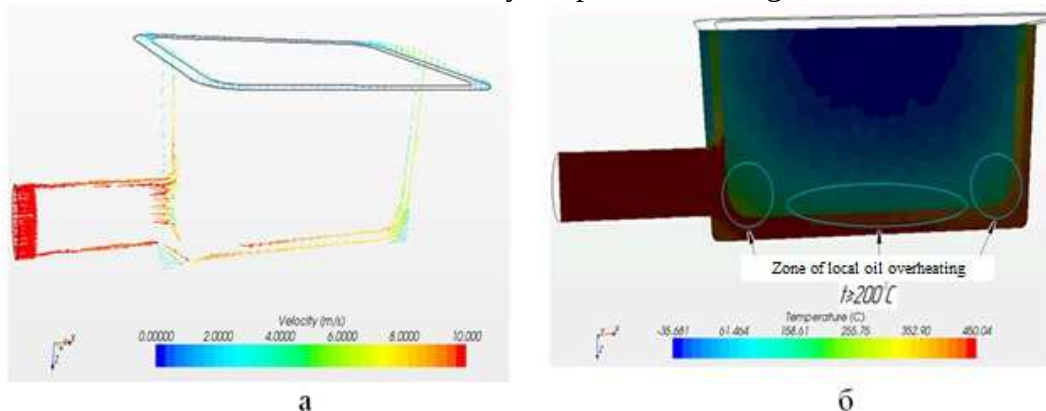
3) Determination of the flow rate of water or mixed air in order to achieve a given temperature of the coolant.

For the practical application of the proposed algorithm, the parameters of the thermal preparation system of the SMD-62 engine installed on the T-156K wheel loader are selected.

In order to optimize the parameters, three-dimensional solid-state models of NU and the heated part of the engine oil pan were created. In the program “Adapco Star CCM”, a simulation of the motion of the coolant flow was carried out and the shape of the NU was adjusted. The results are shown in Figure 1a.

According to the simulation, the optimal value of the DHW flow rate was established within 1.8 ... 2 m / s [7].

Also, in the Adapco Star CCM program, a simulation of the process of heating oil with a coolant at the inlet to a guide device with a temperature of 450 ° C was carried out, the results of the study are presented in Figure 1b.

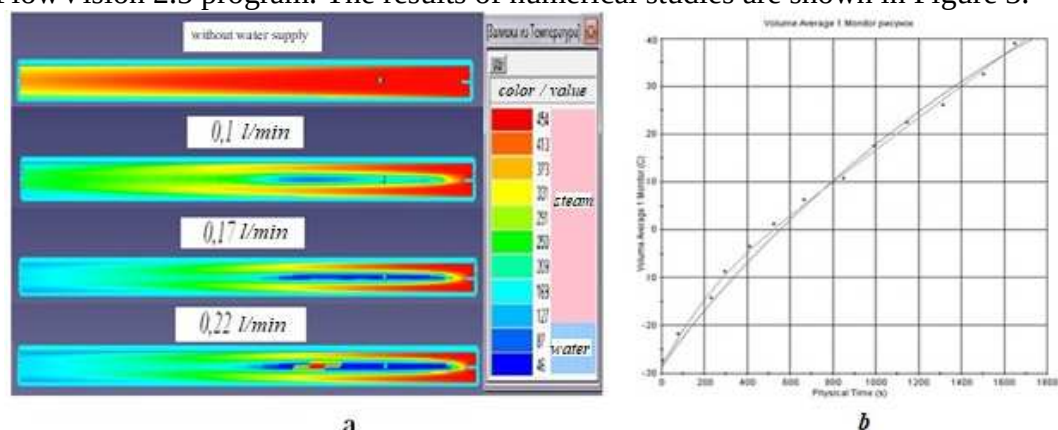


a) Distribution of DHW flow rates in the guiding device after adjusting its shape; b) The results of computer simulation of heating the oil pan of the engine crankcase SMD-62 coolant with a temperature of 450 ° C

Fig. 1. Simulation results for the Adapco Star CCM program

In Figure 2, zones of local overheating are clearly visible - the volumes in which the oil warmed up to a temperature of more than 200 ° C. Therefore, it is necessary to limit the temperature of the hot water supply at the entrance to the NU; the studies performed have revealed this value - 280 ° C. To obtain a coolant with the required parameters, the method of formation of a mixed type coolant (TST) was chosen - water supply to the stream of hot gases.

To obtain a TST, a three-dimensional solid-state model of the supply pipe with a water spray installed in it was built. This model was investigated in the FlowVision 2.5 program. The results of numerical studies are shown in Figure 3.



green line - experimental data; red line - simulation results

Fig. 2 a - simulation results of the process of formation of TST; b - comparison of the data obtained by modeling in "Adapco Star CCM" and experimental data

A clear dependence of the temperature of the coolant flow on the water supply to the DHW flow is visible. For thermal preparation of the engine SMD 62, the optimal value of the water supply is 0.1 l / min, which allows to obtain TST with a temperature of 280 ° C.

The operation of the heat treatment system modeled in the Adapco Star CCM program was tested experimentally in a test installation [2]. The results of a comparison of numerical and experimental studies are shown in Figure 4.

As can be seen from Figure 2b, the results of computer simulations are confirmed experimentally

Thus, the proposed search algorithm for the optimal parameters of the heat treatment system can significantly reduce labor costs when designing heat treatment systems for a wide range of automotive and self-propelled agricultural machinery. The NU form was optimized for the SMD 62 engine, ensuring uniform distribution of the coolant flow at a speed of 1.8 ... 2 m / s, the maximum coolant temperature was determined, excluding local oil overheating, equal to 280 ° C, the mixed type coolant was selected and the water supply was set to 0, 1 l / min. Experimental studies conducted under similar conditions yielded results that coincided with numerical studies, which confirms the correctness of the proposed algorithm for designing heat treatment systems.

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Received 26.09.2019