

**LABORATORY INSTALLATION FOR TESTING MEANS AND
METHODS OF HEAT PREPARATION OF AUTOTRACTOR EQUIPMENT**
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Keywords: mobile agricultural machinery, coolant mixed type; steam generation, gas-air heating, heat preparation.

Abstract. This article presents a universal experimental setup intended for testing various units of thermal preparation systems, as well as comparing the data obtained with the proposed installation with calculated data, and the adequacy of the operation of the described installation is justified.

**ЛАБОРАТОРНАЯ УСТАНОВКА ДЛЯ ИСПЫТАНИЯ СРЕДСТВ И
СПОСОБОВ ТЕПЛОВОЙ ПОДГОТОВКИ АВТОТРАКТОРНОЙ
ТЕХНИКИ**

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Ключевые слова: мобильная сельскохозяйственная техника, численные исследования, теплоноситель смешанного типа, тепловая подготовка.

Аннотация. В данной статье приведена универсальная экспериментальная установка, предназначенная для испытания различных узлов систем тепловой подготовки, а также произведено сравнение данных, полученных при помощи предлагаемой установки с расчётными данными, обоснована адекватность работы описываемой установки.

Since the winter period accounts for a significant amount of work in all sectors of the agro-industrial complex of the Russian Federation, including agriculture, and a large number of equipment is stored in open areas or in unheated hangars, the problem of operating the equipment at low temperatures is relevant. At low temperatures, the units of automotive vehicles also have a lower temperature, which leads to a significant change in the viscosity of working hydraulic fluids, which causes incorrect operation of lubrication systems and hydraulic systems of units and increases the risk of failure of modern mobile [1,6].

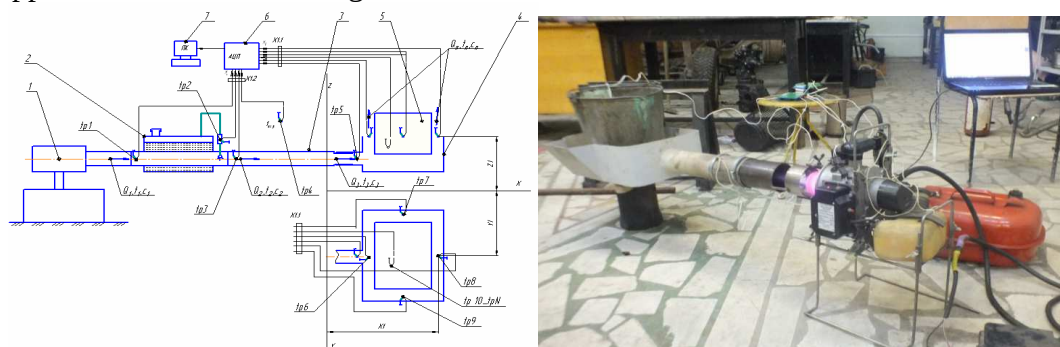
The most obvious and widespread of all known methods of preparing highly loaded units of mobile equipment for accepting the load at low temperatures is to heat the units in order to increase the temperature of the working medium to values that ensure trouble-free operation of the units [2,3] - thermal preparation. As a rule, thermal preparation is carried out by heating the units with a stream of hot gases - a coolant. The most effective means of thermal preparation are devices that use the energy of combustion of liquid fuel [4].

In the thermal preparation of units of various equipment, the selection of the operating mode of the hot gas generator, the water flow rate in the case of using a mixed type coolant [1], and the shape of the guide device (NU), which can be optimized for each specific case, are 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.

At the moment there are several software products that facilitate the optimization of parameters that can be used for the design of heat treatment systems

- KOMPAS 3D, Adapco Star CCM, FlowVision, ANSYS, etc. [5,6]. Moreover, these programs can be used both individually and together, complementing each other. However, after numerical studies, it is necessary to test the heat treatment system, it requires experimental installations, which leads to additional labor costs.

The authors propose an experimental installation for the study of heat treatment systems, which allows for the re-equipment to conduct an experimental study of most of the components and assemblies of heat treatment systems and most accurately recreate the experimental conditions. The installation diagram and its appearance are shown in Figure 1.



1 - ThermMix 15-D-24 hot gas generator; 2 - steam generator; 3 - pipeline; 4 - interchangeable guiding device; 5 - heated unit; 6 - ADC; 7 - computer; tp1 - tp9 - plant thermal converters; tp10 - tpN - thermal converters installed in a heated unit; X, Y, Z - coordinates of the working junction of the thermal converter; Q, t, c - heat carrier flow parameters (volumetric capacity, temperature, water vapor concentration)

Fig. 1. Scheme of the experimental setup and its appearance

A hot gas generator “ThermMix 15-D24” 1 [3] was used as a source of hot hot water, supplying a stream of hot gases with a temperature varying in the range 130 ... 700 ° C to steam generator 2, which supplies water vapor to the hot water supply and then to pipeline 3 and a guiding device 4, which has a configuration corresponding to the heated unit 5. According to the shape of the heated body (object), according to the results of numerical studies, a guiding device was made that provides the most uniform distribution of the DHW flow over n_{kam} heated object. So in addition to the introduction of water and steam in the hot water may decrease the temperature of the coolant flow by means of ejector nozzles. Steam with a temperature of up to 120 ° C comes out of the steam generator 2 and mixes with the hot DHW flow at a distance of 100 ... 150 mm from the steam nozzle, while the temperature of the coolant flow drops to 350 ... 290 ° C and enters the variable-length pipeline, designed to determine maximum water consumption for the formation of a mixed type coolant (TST). After heating the unit 5, the coolant stream leaves the NU and dissipates in the atmosphere. An indicator of the efficiency of the coolant is the difference between the temperature of the hot water supply at the inlet to the guide device and at the outlet of it [6].

The information collection system is designed to record the temperature using thermocouples 7 installed in the flame tube TP1, after the ejector and steam generator TP2, in the heated object TP10 - TP14 and in the guide device TP5 - TP9.

Figure 2 shows the results obtained experimentally in the described setup in comparison with the calculated data.

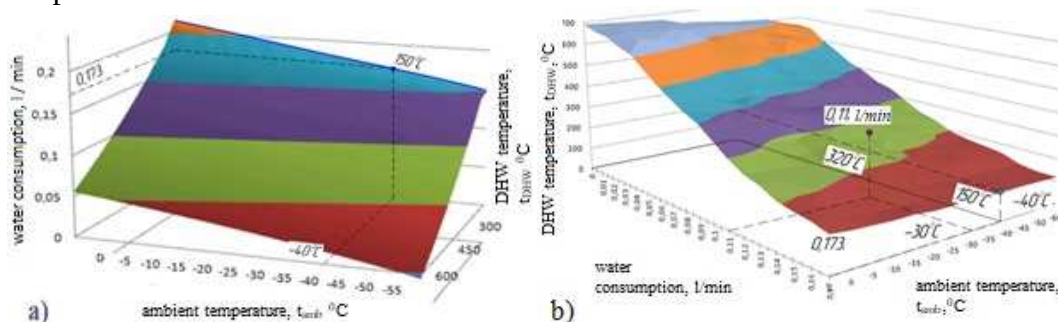


Fig. 2. Comparison of the theoretical dependences of the required mass of water to ensure a given DHW temperature (a) and the resulting DHW temperature on water flow (b) at different ambient temperatures with experimental data obtained on the proposed experimental setup

The data obtained in the course of experimental studies showed good convergence with the data obtained by calculation. Thus, the obtained dependences, which make it possible to determine the necessary operating modes of the heater and the steam generator for realizing the required temperature of the coolant during the heat treatment of MSHT units, can be considered reliable.

Findings:

1. The relevance of creating a universal installation that allows you to explore a wide range of components of heat treatment systems in a wide range of operating conditions is substantiated.

2. An experimental study of the dependences of the required mass of water was carried out to ensure the set DHW temperature and the resulting DHW temperature on the water flow at different ambient temperatures on the proposed universal installation.

3. The data obtained by calculation with the experimental data are compared and the correctness of the obtained experimental data and the adequacy of the installation are proved.

References

1. Negovora A.V., Razyapov M. M., Filippov Yu.K. Pre-start preparation of the engine and transmission units of the car to take the load // News of MAAO. – 2012. – Vol. 1, No. 14. – P. 265-270.
2. Patent №2480617 RU. Device for thermal preparation of car units / Gabitov I.I., Negovora A.V., Razyapov M.M., Gusev D.A. – Publ. 27.04.2012, Bull. No. 13.
3. Negovora A.V., Gusev D.A. The method of intensification of the thermal preparation of car units // Materials of the All-Russian scientific and practical conference "FONTiTM-APK-13". 2013. – P. 233-237.
4. Negovora A.V., Gusev D.A. The use of a mixed type coolant to increase the efficiency of thermal preparation of automotive vehicles // News of the International Academy of Agricultural Education. 2013. Vol. 4, №16. P. 196-198.

5. Gusev D.A., Razyapov M.M. Optimization of mixed-type coolant parameters // Youth Science and Agroindustrial Complex: Problems and Prospects Materials of the VII All-Russian Scientific and Practical Conference of Young Scientists. Bashkir State Agrarian University, 2014. – P. 24-28.
6. Gabitov I.I., Negovora A.V. Advanced technologies for maintenance and repair of diesel fuel equipment // Bulletin of Bashkir State Agrarian University. 2015. No 3 (35). P. 40-44.

Список литературы

1. Неговора А.В., Разяпов М.М., Филиппов Ю.К. Предпусковая подготовка двигателя и агрегатов трансмиссии автомобиля к принятию нагрузки // Известия МААО. – 2012. – Т. 1, №14. – С. 265-270.
2. Патент № 2480617 РФ. Устройство для тепловой подготовки агрегатов автомобилей / Габитов И.И., Неговора А.В., Разяпов М.М., Гусев Д.А. – Оpubл. 27.04.2012, Бюл. №13.
3. Неговора А.В., Гусев Д.А. Способ интенсификации тепловой подготовки агрегатов автомобиля // Материалы всероссийской научно-практической конференции «ФОНТиТМ-АПК-13». 2013. – С. 233-237.
4. Неговора А.В., Гусев Д.А. Применение теплоносителя смешанного типа для повышения эффективности тепловой подготовки автотракторной техники // Известия Международной академии аграрного образования. 2013. Т. 4, № 16. С. 196-198.
5. Гусев Д.А., Разяпов М.М. Оптимизация параметров теплоносителя смешанного типа // Молодежная наука и АПК: проблемы и перспективы материалы VII Всероссийской научно-практической конференции молодых ученых. БГАУ, 2014. – С. 24-28.
6. Габитов И.И., Неговора А.В. Передовые технологии технического обслуживания и ремонта топливной аппаратуры дизелей // Вестник Башкирского государственного аграрного университета. 2015. №3(35). С. 40-44.

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