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SATELLITE MONITORING SYSTEM AS AN EFFECTIVE METHOD FOR CONTROLLING THE OPERATION PARAMETERS OF MACHINE-TRACTOR UNITS

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Keywords: machine-tractor units; satellite monitoring; work parameters; control methods.
Abstract. The paper deals with the issue of quality control of machine and tractor units using satellite monitoring systems. The accuracy of the control depends on the quality of the devices used in this case, software and hardware systems and mobile communications. Investigations of the errors in determining the motion parameters have confirmed the system's performance with minimal discrepancies.

СИСТЕМА СПУТНИКОВОГО МОНИТОРИНГА, КАК ЭФФЕКТИВНЫЙ СПОСОБ КОНТРОЛЯ ПАРАМЕТРОВ РАБОТЫ МАШИННО-ТРАКТОРНЫХ АГРЕГАТОВ

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Ключевые слова: агрегаты машинно-тракторные; мониторинг спутниковый; параметры работы; способы контроля
Аннотация. В работе рассматривается вопрос контроля качества работы машинно-тракторных агрегатов с помощью использования систем спутникового мониторинга. Точность контроля зависит от качества используемых при этом приборов, программно-аппаратных комплексов и мобильной связи. Исследования погрешностей определения параметров движения подтвердили работоспособность системы с минимальными расхождениями.

Introduction. Serious attention is paid to monitoring the quality of the work of machine and tractor units, because the cost of agricultural products depends on this. This control can be conducted in a variety of ways. In our opinion, this can be done most efficiently, focusing on the specific fuel consumption (per unit of work performed). The most promising at present is the use of satellite monitoring systems (SMS), which make it possible to control the necessary parameters of the units operation. [1, 2]. The accuracy of the control depends on the quality of the devices used in this case, software and hardware systems and mobile communications. [3, 4].

Objective. Assessment of the accuracy of determining the operating parameters of machine-tractor units using the SMS.

Materials and research methods. The experience of the Bashkir State Agrarian University with SMS systems shows that the most suitable system for agricultural production is the AutoGRAPH system. The dispatching hardware and software complex of this system is installed on the user's computer and can work both online and offline.. The on-board navigation terminals (controllers) of this system are also compatible with other software and hardware systems. The controller installed on mobile equipment consists of three main blocks. The first determines the location, the second ensures the collection of information in a single

package and the third transmits the information to the data collection center. Several different sensors can be connected to the controller, including the CAN-bus of mobile equipment. Equipment tracking is performed both from a stationary computer and from a mobile device.

Research findings. Investigations of the errors in determining the parameters of movement were carried out on a car equipped with the "AutoGRAPH" system. The received data from the controller was analyzed using the dispatching software and hardware complex. The errors of the obtained data were determined by the event timing method (table 1).

Tab. 1. Experimental data for a week of observations

№	The measured indicator	Value
1	Number of cases no signal	0
2	Error relative to odometer readings,%	3,9
3	The error in determining the time of movement,%	1,1
4	Error in determining the maximum speed of movement,%	1,5
5	Single error of location and trajectory of motion, m	up to 30

The presence of mobile coverage areas plays an important role for agricultural production. The analysis of these zones showed that about 30% of the farmland in the Republic of Bashkortostan is located in zones of weak or absent this connection. Taking this into account, a sufficient amount of internal memory of the controller is required. The recording time of the controller of the system in question is more than two months. This period may vary depending on the amount of data received from the additionally connected sensors.

The analysis of the technical characteristics of the equipment and the functional capabilities of the SMS "AutoGRAPH" software was carried out using the passport data. At the same time, the capabilities of the hardware and software complex were taken into account in terms of ensuring the accounting of the design parameters of machine-tractor units and their settings, the use of field maps with the calculation of their areas, the number of template reports used, etc.

Also, the most important parameter is fuel consumption, which depends primarily on the adopted control method. The control method can be determined based on the design features of the fuel system.

Currently, fuel level sensors (FLS) and flow meters are widely used. The FLS is installed in the tank of the car, and the flow-through flow meter installs into the fuel system. Their error, according to literature data, does not exceed one percent. When installing the FLS, it is desirable that the volume of the fuel tank is not less than 100 liters and that it is possible to access its upper part or quickly dismantle it from mobile equipment.

The disadvantage of using FLS is that the fuel level fluctuates during vehicle movement, and the accuracy of readings decreases. The vibration amplitude depends on the tank geometry and the sensor mounting location. It is recommended to install the sensor in the center of the tank. It should be noted that at present, in

the manufacture of fuel tanks, polymer materials have begun to be widely used, confirmed by deformations with fluctuations in the ambient temperature, which leads to a change in the fuel level in the tank. This, in turn, reduces the accuracy of the readings for determining the fuel consumption. Our experimental studies have shown that due to these deformations, the error in determining the fuel consumption reaches 20%.

When using flow meters, fuel consumption is determined by the formula

$$Q=n/n_1, \quad (1)$$

where n and n_1 are the number of pulses generated per unit of time and at a fuel consumption of one liter.

The disadvantages of using flow meters include the need to make changes to the fuel system and take into account the return flow of fuel (for diesel engines). Also, these flow meters are demanding on the purity of the fuel and are confirmed by wear (increasing the error of changes) as they work.

On some mobile equipment, it may be acceptable to determine the fuel consumption by a standard fuel level sensor connected to the controller via the CAN bus. In this case, the error is slightly higher, but the cost of equipping the SMS equipment is lower.

Fuel consumption via the CAN bus is determined by the instantaneous fuel consumption of the engine

$$Q=v_1 \cdot t_1 + v_2 \cdot t_2 + \ldots + v_n \cdot t_n, \quad (2)$$

где v_1, $v_2 \ldots v_n$ – fuel consumption per unit of time;

t_1, $t_2 \ldots t_n$ – time intervals.

This method is called calculated. In this case, the fuel consumption is recorded in the on-board computer of the equipment from the moment of its operation.

With the use of the AutoGRAPH SMS, a DFM-90A-P flow meter (manufactured by JV Technoton -ZAO) and FLS TKLS-L (GC Techno-Kom) were investigated [3, 4]. The studies were carried out on a machine-tractor unit (with an Agromash 85TK tractor and a PLN-3-35 plow) with a serial connection of sensors. Fuel from an additional tank equipped with a FLS entered the engine power supply system through a flow-through flow meter (Fig. 1). It was also provided that the engine was supplied with fuel through a three-way valve 3 directly from the main tank of the tractor 5.

Actual fuel consumption was determined by adding fuel to additional tank 1. Fuel consumption was measured during plowing to a depth of 21 ... 23 cm.

Analysis of the obtained experimental data revealed the high accuracy of the sensors under consideration; the error of the readings did not depend on the operating mode of the equipment and did not exceed 1% for the flow and 3% for the FLS.

Fig. 1. The tested tractor with installed sensors: 1 - additional tank with the installed TKLS-L fuel level sensor; 2 - DFM-90A-P flow meter; 3 - three-way valve; 4 - high pressure fuel pump; 5 - regular fuel tank

Conclusions

1. Assessment of the quality of the work of machine and tractor units is more fully implemented in the SMS "AutoGRAPH".

2. In areas with poor mobile communication, it is necessary to use controllers with a larger internal memory, which allow accumulating a significant amount of information about the operation of machine and tractor units.

3. To determine the fuel consumption, both fuel level sensors and flow meters are applicable, with their own advantages and disadvantages.

References

1. Gafurov I.D. Normalizing the production of aggregates based on satellite monitoring data / I.D. Gafurov, M.A. Antonov // Technique in agriculture. – 2013. – Iss. №. 1. – P. 20-22.
2. Gafurov I.D. Regulation of MTU fuel consumption according to satellite monitoring data / I.D. Gafurov, I.M. Akhmadullin // News of IAAE. – 2013. – Iss. №. 17. – P. 164-168.
3. Iofinov P.A. Requirements for satellite monitoring systems of MTS mobile equipment operation / P.A. Iofinov, A.V. Ryabov, I.D. Gafurov, I.M. Mannapov // State, problems and prospects of agro-industrial complex

development: Materials of the international scientific and practical conference dedicated to the 80th anniversary of the Bashkir SAU. – Ufa: Federal State Budgetary Educational Institution of Higher Education Bashkir SAU, 2010. – P. 43-46.
4. Company SC "Technoton"-CJSC [Electronic resource]. URL: http://www.technoton.by.

Список литературы

1. Гафуров И.Д. Нормирование выработки агрегатов на основе данных спутникового мониторинга / И.Д. Гафуров, М.А. Антонов // Техника в сельском хозяйстве. – 2013. – Вып. №1. – С. 20-22.
2. Гафуров И.Д. Нормирование расхода топлива МТА по данным спутникового мониторинга / И.Д. Гафуров, И.М. Ахмадуллин // Известия МААО. – 2013. – Вып. №17. – С. 164-168.
3. Иофинов П.А. Требования к системам спутникового мониторинга работы мобильной техники МТС / П.А. Иофинов, А.В. Рябов, И.Д. Гафуров, И.М. Маннапов // Состояние, проблемы и перспективы развития АПК: Материалы международной научно-практической конференции, посвященной 80-летию ФГОУ ВПО Башкирский ГАУ – Уфа: ФГОУ ВПО Башкирский ГАУ, 2010. – С. 43-46.
4. Компания СП «Технотон»-ЗАО [Электронный ресурс]. URL: http://www.technoton.by.

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