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DIAGNOSTICATION OF THE TECHNICAL STATUS OF HYDRAULIC ENGAGEMENTS

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The technology and equipment for diagnosing hydraulic tractor equipment in the field are presented. The technology of diagnosing, adjusting and routing of units of tractor hydraulic systems in the conditions of a repair shop is described.

Key words: hydrosystem, pressure, pump, valve, operation, test, performance, lubricant.

Introduction. The effectiveness of using agricultural machinery depends on its reliability, quality of operation, maintenance and repair. Maintenance and repair of machines are designed to maintain and restore serviceability and performance, as well as to restore the technical resource of machines. Maintenance of efficiency, renewal of the resource of machines, ensuring their high reliability and efficient use - an important task of repair and servicing production of the agro-industrial complex of the country [1,2].

Problem. To detect the causes and nature of the failure of the work and deviations of the adjustment parameters of aggregates of hydraulic systems of tractors in the process of their operation are used diagnostic devices. These devices include a throttle-flow meter KI-1097B, which allows you to determine the pump performance, pressure of the valve operation and the flow (tightness) of lubrication in the distributors, spool fittings of steering, power cylinders. The oil consumption is measured at a pressure of 5.0 or 10.0 MPa within 10 ... 70 l / min. In assessing the performance of the pump, the inlet opening of the device, located at its end, is connected to the injection lubrication pump, and the drain hole - with a lubrication tank. To check the pressure of the valve operation, the inlet of the device is connected to the main line, parallel to the valve, the outlet - with the drain. Improvement of the device KI -1097B is a prefix, which provides measurement of oil temperature in the zone of throttling. The possibilities of the KI-1097B device are expanded when used with the device, with a locking head with a handle, which can be placed in the open or closed state from the laying method and the meter's size. To connect the device KI-1097B to the pump using the device KI-6272, designed to shut off the pressure lubrication line from the distributor [1,2,3].

The purpose of research. Development of equipment and technologies for diagnosing aggregates of hydraulic equipment of tractors in field conditions.

Research results. Testing of tractor hydraulic equipment in field conditions can also be performed by the device PPG -1M, which allows to check: the state of the pump; automation valves (booster devices) spool valves; tightness of the distributor and power cylinders; hydrosystems of self-propelled combines and excavators on the chassis of the YUMZ-8070 tractors, as well as to regulate the distributor safety valve. Device PPG-1M. simple to use, reliable in operation, does

not require tariors, it can be made in any workshop [2,4]. Device of the device PPG-1M is shown in Fig. 1.

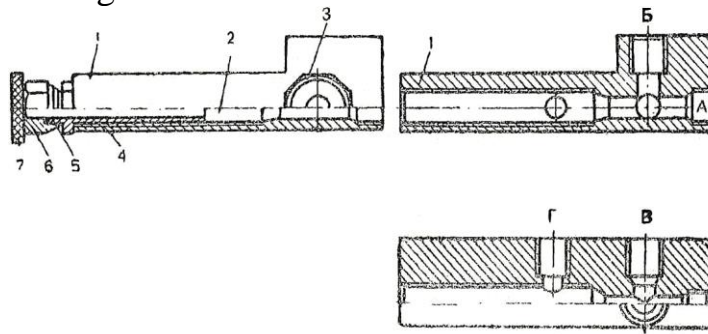


Fig.1 Device device PPG-1M: 1 - body, 2 - sock; 3, 4 - fittings; 5 - seals; 6 - roller nut; 7 - flywheel; A - the entrance hole; B - a hole for a pressure gauge; B - hole in front of the throttle; G - hole after the throttle.

The device has four threaded openings: A - inlet, for supplying lubrication from the pump; B - for setting the pressure gauge; Near - in front of the throttle; G - after the throttle. To determine the degree of pollution of the drain filter of hydraulic tractor systems, the device KI-4798 is intended. This device establishes the expediency of dismantling and washing the filtered elements by the size of the pressure before the filter. To check, adjust and run the aggregates of hydraulic systems of tractors in the conditions of the workshop the stand of the KI-4200 is let out, which allows to check with sufficient accuracy the muds of different productivity, to check and adjust the valves of distributors, to determine the tightness of the distributor and power cylinders. The stand of the KI-4200 is equipped with an electric motor of 14 kW , slot type throttle, gearshift type lubricator, safety valve 15,0-16,5 MPa; Instead of a filter, a centrifuge is used which cools the device with a thermostat to maintain a constant temperature of the working fluid. The stand provides a high-performance clamp that fixes the pump to be tested. Worthy of note when testing the hydrosystems device PDG-1. The device allows to determine the characteristics (performance, volumetric efficiency) of hydraulic pumps with the measurement of pressure, frequency of rotation of the crankshaft of the engine and the temperature of the working fluid. The device can also determine the condition of the oil tank filter on the hydraulic support. It can also be used to determine the magnitude of the pressure of the operation of the distributor valves and their regulation in both stationary and field conditions (at the site of operation) without dismantling of tractor aggregates. Component parts of the device are: tachometer for registration instantaneous frequency of rotation of the crankshaft of the engine; thermometer; flow meter indicating the instantaneous flow of the working fluid; pressure gauges of high (up to 25,0 MPa) and low pressure (up to 1,6 MPa); milliammeter for controlling the supply voltage in the circuit of the flowmeter; throttle [2,4,5]. The specialty of the device's operation is the use of a piezoceramic sensor for registering the frequency of rotation of the crankshaft of the engine. The frequency sensor in measuring the performance of the hydraulic pump is installed on the pressure fuel line connecting the fuel pump with the injector. The sensor of the thermometer is installed in the pressure

manifold of the device. This allows you to fix the temperature of the liquid when checking the hydro aggregates. When checking the hydraulic pump instead of the nozzle connecting the pressure lubrication lead with the distributor, a throttle valve type is installed. From the crane is connected the chain of injection of the device, drainage its main line is connected to the lubrication tank. The volumetric efficiency of the pump is determined by a closed valve. The flowmeter indicator determines the instantaneous actual pump performance at a fixed frequency of the engine's crankshaft. The theoretical performance of the hydraulic pump is calculated according to the formula:

$$Q_{TH} = q_{yH} \cdot i_H \cdot n, \quad (1)$$

where q_{yH} - the specific performance of the pump; i_H - gear ratio from engine to pump; n - frequency of rotation of the crankshaft of the engine.

The ratio of the actual to the theoretical performance determines the volume efficiency of the pump. The device also allows to determine the tightness of the distributor and the power cylinder. To identify the leakage in the distributor, the connecting tap opens. After installing the handle of one of the spools in the position of "lifting" the throttle creates a pressure of 10.0 MPa. At the indicator of the flowmeter determine the performance at the moment. The difference in pump performance measured earlier and at the moment is equal to the size of the leakage. Similarly, leaks in the power cylinder are determined. The device ensures the accuracy of the countdown of productivity - 2 l / min in the range of 10 ... 80 l / min. The accuracy of the reference pressure is 0.5 MPa in the pressure range 1.0 ... 25.0 MPa. Weight of the device - 22 kg, dimensions -500h300h250 mm. The technical condition of the hydraulic units is checked during the TO-3 process or during the elimination of malfunctions that arose during the operation or during major repairs of the tractor. An important and promising way is the seamless method of checking the technical condition of the aggregates of hydrosystems. Any disassembly and assembly of hydro units will reduce their longevity and increase the unproductive labor costs and hours to restore hydrosystem performance, if you take into account that smear is the main constituent parts of the mechanisms of control, transmission and working equipment (hinged systems and drive shaft power take-off) . Disassembly is subject only to those hydraulic units, which in the course of inspection revealed malfunctions. The assessment of the condition of the units and units of tractors is carried out after diagnostic parameters, each of which is determined by devices that are serially manufactured and devices. Diagnosis of the condition is carried out during the maintenance process, when performing the operations of the respective types of service. For simple and universal diagnostic devices, the requirements of the seamless verification of the technical state of the hydrosystems that are responsible, except for KI-1097B, include PPG-1M [2,4,6]. With the PPG-1M device, the state of the pump is checked in two ways. The first method is to determine the magnitude of the pressure developed by the pump corresponding to a certain productivity (l / min). The scheme of connection of the device in this case is shown in Fig. 2, a.

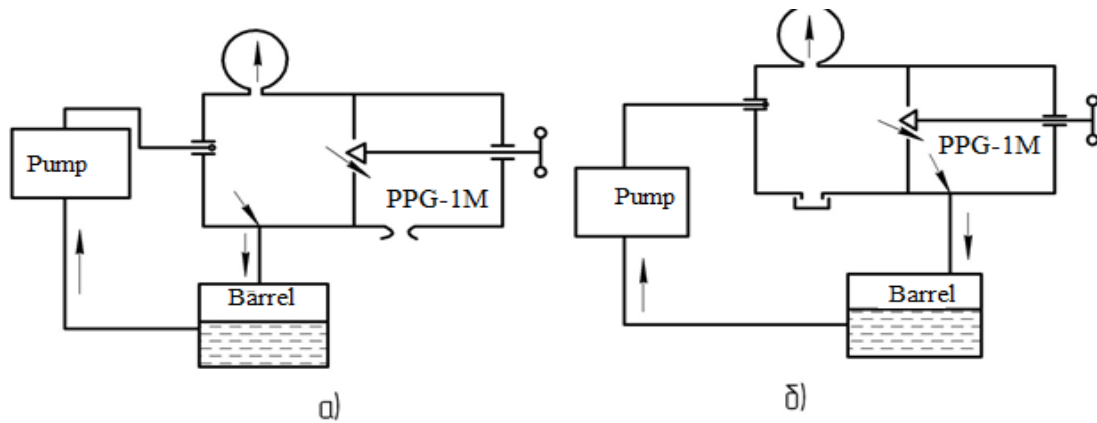


Fig.2 Diagram of connection of the device PPG -1M for checking the pump state: a - definition of productivity; b - Definition develops my pressure.

Near the device set the throttle constant section - washers, the diameter of the holes which correspond to the standard sizes of the pump. Washer with a diameter of a hole of 3.9 mm serve for checking pumps ННН-46, and with a diameter of a hole 4.8 mm - for NH-32. Washers are installed in the hole B, to which the drain plug is connected to the tank. Hole D closes with a stub. The condition of verification for the first and other methods are the same. When checking for the first way, throttle to the end. New pumps NH -46 at nominal revolutions develop an average pressure of 5.0 MPa, which corresponds to the productivity of 66-69 l / min. At a pressure of 2.5-2.7 MPa, the Niii-46 pump produces up to 40 l / min, indicating that the pump is unsuitable for operation and. the need for its repair. When testing pumps ННН-32 a washer with a diameter of a hole of 4.8 mm provides a pressure of 5.0 MPa on new pumps, which corresponds to productivity of 45-47 l / min. When receiving pressure of 2.3-2.6 MPa, the pump is considered unsuitable for operation and is subject to repair. The second method is to determine the maximum pressure that is being developed by the pump. The scheme of connection of the device is shown in Fig. 2, b. Before the opening of the device, the lubricant from the injection pump aperture is connected. Hole B is closed with a stub. From the hole D, the lubricant directs on the drainage lubrication line to the tank of the hydrosystem. The test is carried out as follows: after connecting the device, the engine is started tractor, turning handwheel 7 fully open the throttle device. After reaching the nominal engine speed, the throttle begins to twist until quietly until the gauge's arrow is mounted on any of its divisions. If the maximum value of the pressure evolving by the pump is less than 8.0-10.0 MPa, the pump is considered unsuitable for operation. At a pressure above 13.5 MPa, the pump is suitable for operation. Checking the distributors of the hydraulic system of the hinged equipment determines the value of the pressure of the valve operation and leakage (leakage). To check the pressure of the operation of the valves automatics spools device PPG-1M connected in accordance with the scheme shown in Fig. 3, a. To the hole A of the device is connected the oil pipeline from the injection pump aperture. The hole B of the device is connected to the inlet of the distributor, the hole D is connected with the oil pipeline with the tank of the hydrosystem. The conditions of the checks are the same as for the pump. Checking the valves of spool automation is as follows: turn off the handwheel throttle to the stop.

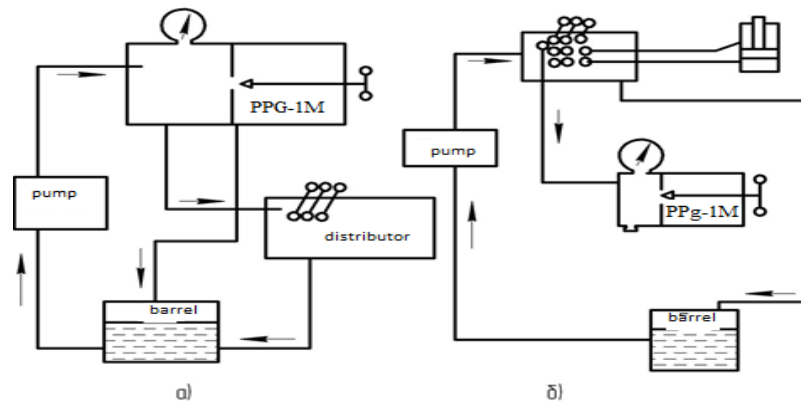


Fig. 3 Diagram of connecting the device for checking the distributor: a, b - checking the valves automatics spools and safety valve.

After installing the handle of one of the spools in the position "lifting" or "lowering" begin to twist the throttle - to increase the pressure in the distributor until quietly until the valve automatics and the valve does not set in a "neutral" position. The moment of operation of the valve of automation of spools is marked by a pressure gauge. Analogically check the valves for automation of all spools. At least three inspections are conducted. If the operating pressure of the valve automation differs from the desired 11 -12.5 MPa, the distributor is removed from the tractor and sent to the workshop for regulation; if necessary, repairs can be made there. The same goes with the distributor, which has spools with non-triggered automatic control valves. The operation of the valves for the operation of the valve on the spool automatics can be checked with this instrument included in the hydraulic system according to the scheme on (Fig. 3, b). The test is carried out in a manner similar to that described above. To check and adjust the safety valve of the distributor, connect the device according to the diagram in Fig. 3. After connecting the device and performing the above general thoughts, the handle of any spool is set in the position "uplift" or "lowering" and supported by hand. Then, by twisting the throttle, increase the pressure in the distributor. The moment of operation of the safety valve is determined by the pressure gauge. If the safety valve operates at a pressure less or greater than $14 \pm 0,5$ MPa, then it must be adjusted without removing the distributor from the tractor and without disconnecting the device. The durability of the aggregates of the hydrosystems depends to a large extent on the state of the main filter installed in the drain line of the lubricant tank. The state of the filters of the hydraulic systems of the hinged equipment, the control of the transmission of tractors are checked by the pressure of the oil in the drain line (in front of the filter) with the help of the device KI - 4798. If the pressure is 0.1 MPa, this indicates a malfunction of the filter. With a pressure above the 0.25 MPa filter, there is a need for filter removal and flushing of its filtered elements. When rinsing the filter, attention is drawn to the constant - the valve valve adjustment. The importance of monitoring the state of the filter in the tank hydrosystems to ensure their efficiency led to the introduction of a filter litter warning. The installation of the signaling device in the hydraulic system of the hinged I will attach the tractor KhtZ-221 with the aim of obtaining constant information about the state of the filter using the built-in diagnostic tool, and not

the external, than the device KI-4798. The evaluation of the condition of the hydraulic system of the gearbox of the K-700a, K-701 tractors is carried out with the help of two manometers, one of which is installed in the trunk before the filter, after the filter. If the difference in the manometer's evidence - the pressure differential, characterizing the filter's pollution - exceeds 0.1 MPa, the filter must be disassembled and rinsed in its sections. Diagnosing the steering control of the YUMZ-8240 tractors, in addition to assessing the status of the pump, involves adjusting the safety valve using one of the devices and devices described above. Diagnosing the mechanism of steering of tractors YUMZ-8240, determine the pressure of the operation of the reduction valve, the state of which depends on the accuracy of the system of automatic locking of the rear axle differential. The input connector of devices KI -1097Б or PPG -1M is connected to a reduction valve, the drains from devices are directed in a tank of the hydro-amplifier. At the nominal frequency of rotation of the crankshaft of the engine, the steering wheel rotates one way or another until quietly until the pressure gauge of the operation of the reduction valve is fixed. If the pressure of the reduction valve differs from the normal 0,8 MPa, the valve is regulated with further verification. In the tractor KhTZ-221, in addition to checking the pump, the degree of litter drain filter in lubricating tank, determine the pressure of the operation of the safety valve and the valve costs, which are mounted in one housing. When checking the safety valve from the valve, the charges are screwed off by the discharge pipe and in place of it, the hose of the lubrication inlet is connected to the device KI-1097Б or PPG -1M. Screwing up the valve's full adjustment valve at the nominal speed of the rotation of the knee 1 engine shaft determines the pressure of the operation of the safety valve. If the pressure is $7.0 + 1.0$ MPa, the safety valve is regulated. In the same scheme of connection of the device check and valve costs. The oil consumption should be 20-22 l / min through the valve. On the tractor KhTZ-221 verification of the hydraulic system of the steering involves the assessment of the tightness of the cylinders of the turn. When leaking grease above 10 cm³ / min, cylinder sealing is replaced. Hydraulic rotation of tractors K-700a, K-701 is checked by the device KI-8853, which in an hour of turn indicates a comprehensive assessment; the state of the pump, distributor, valves and cylinders. The normal state of the hydro aggregates according to the KI-8853 is characterized by a time of 1.6 seconds. The diagnosis of the state of the hydraulic control system for tractors KhTZ-5020 involves assessing the pump by the methods described, checking and regulating the safety valve, adjusting the free and. Workflow Controls: Clutch Couplings and Swing Knobs. To check the safety valve (in the event of malfunctions in the operation of the power amplifier it is removed from the tractor and on the stand is adjusted to a pressure of 8.0 MPa. Checking and adjustment of the safety valve can be done with the help of KI-1097B or PPG-1M devices directly on the tractor. Diagnostics of the transmission hydrosystem The tractor KhTZ-221 consists of a check of the performance of pumps MNSh-50 and MNSh-25 with the device KI-1097B complete with a pressure gauge (measuring ranges 0-2,5 MPa, or (0-25 kgf / cm²) and special fittings. The device KI- 1097B to check the connection pumps

The pump for MNH-50 has a normal performance of 20 l / min at 1500 rpm and for MNSh-25 at 1600 RPM. In addition to the pump performance, the technical condition of the crane distributors is checked with the help of a pressure gauge, the measuring range is 0-0.6 MPa. If the pressure is found at checking more than 0.1 MPa, the distributor is to be repaired. In the maintenance of the hydraulic control system of tractors T-150-05-09, a check is carried out and regulation of valve control relief pressure. With normal adjustment, after turning the steering wheel into one of the sides until the clutch is pressed and the endurance for 15 seconds, the corresponding pressure gauge on the instrument panel shows the pressure value of 0.09-0.12 MPa. With the deviation of the pressure, from the normal pressure relief valve is necessary. Checking the state of the hydrosystem of the gearbox of the power take-off on tractors T-150-05-09 and HTZ-221 involves determining the pressure of opening the valve of smooth activation (safety valve) with the regulating screw of the valve, which screwed up to the stop, constant, pressure (relief valve). If the operating pressure of the smooth-acting valve differs from 1.2-1.3 MPa, and the valve of constant pressure - from 0.95-1.0 MPa, the valves are regulated. When adjusting the coupling clutch on a tractor KhTZ -5020 the connection of its lever of an exclusion with a pedal is carried out in the following manner. The pedal is moved to the extreme rear position until it stops in the floor plate. The piston of the power amplifier is set so that the distance from the hood of the hydraulic booster to the center of the hole of the fork of the piston is 110 ± 1 mm, then connect the levers of the muffler extinguishing pedal. To ensure the performance of the brakes, install the piston of the hydraulic booster so that the distance from the axis of the hole of the piston plunger to the amplifier end to the end of its lid was equal to 103 ± 1 mm, then connect the traction of the piston with a hydraulic booster. Then adjust the length of the traction and connect the second fork of the hydraulic booster with the control lever, providing the distance to the floor of the floor from the lever 10 ± 1 mm. In addition to these adjustments related to the maintenance of hydraulic power amplifiers, a uniform clearance along the entire arc of the retarding leather belt is restored. After these adjustments, the free running of the control levers must be 50-60 mm, and the full course - 260-370 mm. A pressure gauge is connected to the pressure manifold of the hydraulic booster to check the pressure of the operation of the safety valve. It should not differ from 3.0 MPa in an effort on the control levers of 40N. If the force is above the permissible value, the hydraulic booster is to be disassembled for further rinsing and repair. Repair and maintenance of units of hydraulic tractor systems, elimination of malfunctions that arise during operation, are carried out in workshops, in specialized workplaces. Equipment and adaptations for workplaces in workshops are supplied by the factories in the complete set. The kit includes: rack for faulty hydraulic units; washing bath; metalwork bench; a table for disassembly and control hydro units; stand for inspection, regulation, rotation and testing of hydro units; wardrobe for mounting devices, instrument tools; a cabinet for regulated and repaired hydrosystems aggregates. Equipment in the workplace is located in accordance with the accepted technology of repair and maintenance of hydraulic

units. According to the technology, the hydraulic units are exposed to external light in the washing room (washing-bath) with the use of detergents ML-51 or a tractor. After washing the units hydrosystems are disassembled for repair or adjustment. In the premises where the workplace is located, a booth KI -4200 is installed on which the complex of works on checking of pumps and distributors is carried out. There may be a stand for the same works, but made by own forces. Taking into account the widespread distribution not only in workshops, but also at maintenance points, in the tractor brigades of the device KI-562 for checking and regulating the nozzles, it is offered to him a device for servicing hydrosystems. Fig. 4 shows the device for checking and adjusting the valves for automation of spools of distributors P75-23 and P75-22. Similarly, a device can be made and serviced for the distributor P150 (tractors K-700a, K-701). A throttling machine, the valve of the automaton which operates at a pressure different from the nominal, is extracted from the distributor.

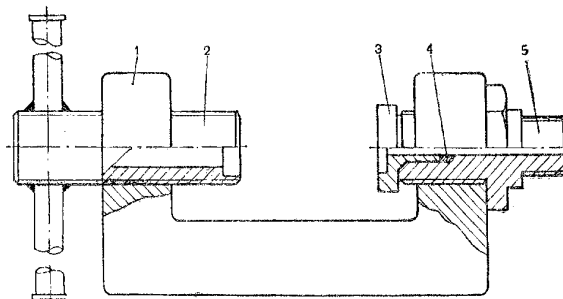


Fig. 4. Adaptations for adjustment of valves of automation of spools of distributors P75-B3A on the device KI -562: 1 - a bracket; 2 clamping screw; 3 - adapter; 4 - ring sealant; 5 – fitting.

The abundance of steamed spools - the body is not allowed. After the spool is pulled out of the housing, it is installed in a special device for compressing the spool spring and turning the cork. This allows you to remove the parts of the return knob from the spool and pull out the parts of the fixation unit from the spool. Then a special screwdriver turns the sleeve of the booster valve. The sleeve with the valve in the assembly is set to adapt to the device KI-562. The cone fitting of the device is replaced by a nozzle 5 (see Fig. 5), on which the bracket 1 is reversed with a clamping screw 2. At the nozzle 5, a seal ring 4 and a boring adapter 3 are installed. The push-pull screw 2 sleeves on the end of the valve seat is sealed in the adapter 3. The manual pump KI-562 creates the required pressure and the pressure gauge notes the moment of operation of the booster spring. By tightening or twisting the adjusting screw through the clamping screw, without removing the sleeve from the adjustment, adjust the booster spring to a working pressure of 11.0-12.5 MPa. After the regulation, the spool is collected in reverse order. By installing a proven spool in the body, you can begin to adjust the other spools in the same way. The control of the valve's condition of the filter is impossible without adjustments for its inspection and adjustment, which is successfully applied to the device KI -562, which allows with sufficient accuracy to check and adjust the valve of the filter. The device is shown in Fig. 5

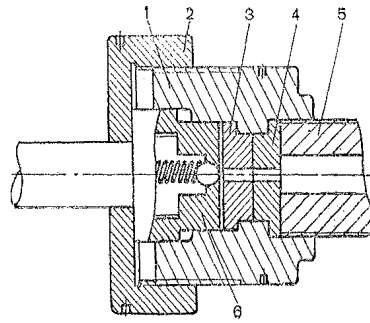


Fig. 5. Adaptation to the device KI -562 for checking and adjustment of valve filters: 1 glass; 2 - a hard nut; 3, 4 - seals sleeves; 5 - fitting; 6 - filter housing.

To install the device on the device KI -562, it is necessary to unfasten the fitting to check the nozzles and to screw into place a fitting fitting 5. For checking and adjusting the valve, it is necessary to pull out the filter 6 from the tank of the hydrosystem, to remove the filtered elements, to install the filter housing in the glass and to wrap the pressure nut 2, the sealing of the valve body and the adjustment is achieved by installing the sleeve of the seal 3, which enters the dense face of the front end of the housing valve and rubber seal ring. To seal the nozzle 5, a sleeve of sealant 4 is installed in the glass. The bushings of sealers 3 and 4 are made of bronze or copper. After the valve body is installed in the device, the manual pump of the device KI-562 creates a pressure of the fluid, the moment of opening the valve is noted by the pressure gauge. For checking and adjusting the valve of the filter the gauge of the device KI -562 with the limits of measurements 0 ... 400 kgf / sm² is replaced by a pressure gauge with limits of measurements 0 ... 10 kgf / sm² and a price of division 0,2 kgf / sm². If the valve pressure of the filter does not meet the prescribed technical conditions, ie 3.0 ± 0.5 kgf / cm², then the valve must be adjusted. To do this, the rotation of the filter tube sets the required pressure.

Conclusions. Testing of tractor hydraulic equipment in field conditions can also be performed by the device PPG -1M, which allows to check: the state of the pump; automation valves (booster devices) spool valves; tightness of the distributor and power cylinders; hydrosystems of self-propelled combines and excavators on the chassis of YUMZ-6 tractors, as well as to regulate the distributor safety valve. Device PPG-1M. easy to use, reliable in operation, does not require tariors, it can be made in any workshop. The device allows to determine the characteristics (performance, volumetric efficiency) of hydraulic pumps with the measurement of pressure, frequency of rotation of the crankshaft of the engine and the temperature of the working fluid. The device can also determine the condition of the oil tank filter on the hydraulic support. It can also be used to determine the magnitude of the pressure of the operation of the distributor valves and their regulation in both stationary and field conditions (at the site of operation) without dismantling of tractor aggregates. The use of such adaptations will allow to increase the quality of maintenance of hydraulic systems of tractors and the durability of hydraulic aggregates.

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ДИАГНОСТИРОВАНИЕ ТЕХНИЧЕСКОГО СОСТОЯНИЯ ГИДРОАГРЕГАТОВ

Уминский С. М., Житков С.С., Уминский Д. С.

Ключевые слова: гидросистема, давление, насос, клапан, эксплуатация, испытания, производительность, масло.

Резюме

Представлена технология и оборудование для диагностирования агрегатов гидравлического оборудования тракторов в полевых условиях. Описано технологию диагностирования, регулирования и обкатки агрегатов гидравлических систем тракторов в условиях ремонтной мастерской.

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Summary

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