POLISHED-ROD DYNAMOMETER

«DDIN-2»

OPERATING MANUAL

Russia

CONTENTS

The operating manual applies to “DDIN-2” polished-rod dynamometer (hereinafter referred to as the device) designed for operation at the wellhead equipped with a sucker-rod pumping unit (SRPU) in oil and gas fields.

The device is explosion-proof designed (intrinsically safe circuit type of protection) in accordance with the requirements of GOST 31610.0-2014 (IEC 60079-0:2011), GOST 31610.11-2014 (IEC 60079-11.), GOST 31610:2011), and have **1Ex ib IIB T3 Gb X** explosion proof mark. “DDIN-2” is designed for indoor and outdoor installation in hazardous areas where atmospheric explosives of IIA, IIB categories and T1, T2, T3 groups can form according to GOST R IEC 60079-20-1-2011 in the operating temperature range from -40 ºC to +50 ºC. The device design is comply with the assigned explosion proof mark, with the requirements of GOST IEC 60079-14-2013 and other regulatory documents governing the use of electrical equipment in hazardous areas.

The operating manual provide the details about technical specifications of the device, delivery set, service life, storage and manufacturer's guarantees, as well as other information about the device used for the operation process.

Observe the requirements of the Federal norms and regulations in the field of industrial safety "Safety rules in oil and gas industry" as well as this manual, when operating, maintaining and repairing the device.

The device may only be operated by specially trained personnel who have studied the operating documentation for the device, received the relevant safety instructions and permission to work.

1. GENERAL PRODUCT INFORMATION

Please read the operating instructions before using the DDIN-2 polished-rod dynamometer.

The device is explosion-proof designed (intrinsically safe circuit type of protection) in accordance with the requirements of GOST 31610.0-2014 (IEC 60079-0:2011), GOST 31610.11-2014 (IEC 60079-11.), GOST 31610:2011), and have **1Ex ib IIB T3 Gb X** explosion proof mark. "DDIN-2" is designed for indoor and outdoor installation in hazardous areas where atmospheric explosives of IIA, IIB categories and T1, T2, T3 groups can form according to GOST R IEC 60079-20-1-2011 in the operating temperature range from -40 ºC to +50 ºC. The device design is comply with the assigned explosion proof mark, with the requirements of GOST IEC 60079-14-2013 and other regulatory documents governing the use of electrical equipment in hazardous areas.

The inter-gaging period recommended for the device is 1 year. To check the device transmission characteristics for compliance with the TS requirements and to bring them into compliance with the TS, calibrate the device on the dynamometer control bench on the expiry of inter-gaging period.

2. SAFE OPERATION GUIDELINES

2.1. General Provisions (regulatory framework)

- The design of the wellhead equipment is to be approved by the Russian Technical Surveillance Agency (RTSA).
- Preparation of the well for tests should be conducted in accordance with the requirements of the current Manual and internal guidelines for maintaining and testing wells approved by the head of the company.
- Test equipment is to be operated according to the operating instructions supplied with the equipment.
- Measures for ensuring safety are regulated by labor protection instructions for respective types of work approved by the Company's Department of Labour Protection and the Safety Regulations in Oil and Gas Industry approved by the RTSA.

2.2. Requirements to Personnel

- Well tests are to be carried out by individuals above 18 who have secondary education and who are medically cleared for work.
- Personnel are to take professional training followed by knowledge checking and have a relevant permit category in accordance with qualification requirements: not below category 5 for oil and gas production operators; not below category 4 for well test operators.
- Personnel are to be trained to work with test equipment.

2.3. Requirements to Test Objects

Pressure measurement and control of fluid level is carried out in oil and gas producing wells of different operational modes (flowing, gas lift, artificial lift, etc.), as well as in injection, intake, control and other wells.

Dynamogram control is carried out on rod pumps of all types and designs.

- Wells are to be tied and operated in accordance with the Safety Regulations in Oil and Gas Industry.
- When controlling the dynamogram, the rod string is to end with a polished rod 16… 39 mm in diameter. The polished rod is to be sealed with SUS1 or SUS2 gasket. The rod and the beam pumping unit are to be connected with a clipping of the wellhead rod of PSH type. In the lowermost point of the rod stroke, the minimal distance from the lower cross bar to the gasket cap is to be 130 mm. The pumping unit control station is to have a mode select switch with the manual control option. The moving parts of the pumping unit (the crank-conrod mechanism, the V-belt drive) are to be properly fenced.

3. BASIC SPECIFICATIONS

2.1 The device is designed for operation at the wellhead equipped with a sucker rod pumping unit (SRPU), in oil and gas fields and provides:

- Measurement of the load change on the polished rod of the SRPU within (0 - 15000) kgf, movement of the polished rod within (0,5 – 9,999) m of at least one oscillation cycle of the SRPU horsehead.

- Measured data record and saving in a non-volatile storage device.
- The attachable dynamometer supports control and transfer of measurement results to the terminal by means of Bluetooth radio channel (or Zig-Bee on demand) at a range of at least 35 meters.

2.2 The device maintains its operability at ambient temperatures from minus 40 C to + 50 C.

2.3 The device operates autonomously and is powered by a special internal battery type EEMB LP103450LC-PCM-LD with 3.6 V or 3.7 V voltage. The minimum operating voltage of the battery which does not lead to a loss of performance of the device is 3.0 V.

2.4 The basic specifications are given in Table 1.

Table 1

Parameter name	**Norm on specifications**
Explosion proof mark	1Ex ib IIB T3 Gb X
Upper limit of load change, kgf	15000
Load channel resolution, (kgf) /displacement, (m)	10 / 0,005
Displacement measurement range, m	0,5 – 9,999
Permissible SRPU horsehead pump speed, SPM	0,4 – 15
Permissible SPRU polished rod diameter, mm	16 – 39
Continuous operation time in registration mode (once a day), at least, day	90

Parameter name	Norm on specifications
Max. working power consumption , mW	250
Weight, kg	1,35
Service life	5

4. ENSURING EXPLOSION-PROOFNESS OF THE PRODUCT.

4.1. Explosion-proofness of the product

Explosion-proofness of the device is provided by the type of protection "intrinsically safe electric circuit" “ib” level, according to the requirements of GOST 31610.11-2014 (IEC 60079-11:2011), which is achieved by the following:

Basic circuit diagram includes the protective component “Fib”. The protective component “Fib” is an intact spark protection unit with the short-circuit current limitation at 1.85 A (maximum), using current limiting resistors and semiconductor fuses in series. Double redundancy is used in the “Fib” protective component to ensure greater reliability. The “Fib” component is integrated into the battery compartment of the device. The design of the protective component “Fib” is met with the requirements of GOST 31610.11-2014 (IEC 60079-11:2011), including leakages and clearances. The minimum width of conductors on the PCB is 0.2 mm, copper thickness is not less than 18 μm. Thus, the electrical circuit coming out of the battery compartment of the device is intrinsically safe.

The electrical circuit principal and applied third party components provide maximum power consumption not more than 0.25 W from the internal battery with maximum possible voltage on it 3.7 V. The total maximum capacity of the electrical circuit is 10 μF, maximum inductance is not more than 20 μGn. The maximum current in the circuit during normal operation is not more than 70 mA.

The device is powered by a special internal battery type EEMB LP103450LC-PCM-LD according to GOST 31610.11-2014 (IEC 60079-11:2011).

The battery has special made contacts which exclude the possibility of its incorrect switching on (polarity reversal) and is located in the internal battery compartment of the device. The design of the battery compartment ensures that the battery does not fall out of the device. Do not replace the battery and do not charge it in the hazardous area. For this reason, in order to inform the user about special conditions of use of the device, the identification plate of the device is marked with an "X" sign indicating special conditions of safe operation.

2.5 The "X" symbol in the explosion proof marking indicates special conditions for safe operation:

1) Do not open the instrument cover and therefore the battery compartment cover in hazardous areas;

2) Do not replace the battery and operate the computer in hazardous areas;

3) Do not charge the battery in explosion hazard area;

4) Only the types of batteries specified in the manufacturer's technical documentation may be used as power sources;

5) Constituents and circuits ensuring intrinsically safe design shall not be repaired and in case of failure shall be replaced by new ones supplied by the manufacturer;

6) The device's operability is maintained at ambient temperature from minus 40 to plus 50ºC.

The maximum temperature of overheating of components and connections in the circuit diagram during normal operation is 15 °C max. Thus, the surface temperature of conductors and elements during operation and at maximum operating temperature plus 50 ° C is not more than 65 ° C. Device enclosures are made with the degree of protection against external influences not lower than IP54 according to GOST 14254-2015.

4.2. Measures to ensure and keep the device explosion-proofness during the assembly, disassembly and repair of the device.

4.2.1 Measures to ensure explosion-proofness before the production process:

- The elements used in the protective component of “Fib” are subjected to an acceptance test:
  - resistors are tested for their nominal resistance;
  - the fuses are checked against the short-circuit current limit;
- Materials used for casting the protective component “Fib” are subjected to an acceptance test according to the certificates presented.

4.2.2 Measures to ensure explosion-proofness during production:

- The protective component “Fib” with the installed battery is subjected to an outgoing inspection:
  - the short-circuit current and open circuit voltage at the output of the protective component are checked;
  - visual inspection of the filling location is carried out in order to confirm the absence of any foreign inclusions, bubbles, cracks or stratification.

4.2.3 Measures to ensure explosion-proofness during operation:

- Check that the cover of the battery compartment and the compartment itself (including the threaded connection) are free from mechanical damage and corrosion. In case of corrosion or mechanical damage, do not operate the device;
- meet the requirements specified by the "X" sign in the explosion proof mark.

4.2.4 Measures to ensure explosion-proofness during repair:

- the device must be repaired only by the employees of the manufacturer.

Repair by third parties or individuals is prohibited.

- the protective component “Fib” is not to be repaired. It is made intact and must be replaced in case of failure. Repair of the “Fib” component is not permitted.

- after repair, the device must be tested according to the test procedure, with the “Fib” component tested for short-circuit current and open-circuit voltage (together with the battery installed).

5. DELIVERY SET

The device is supplied according to the set shown in Table 2.

Table 2

Title	Q-ty
1. Polished-Rod Dynamometer «DDIN-2»	1
2. Certificate	1
3. Operating manual	1
4. Conformity certificate (copy)	1

6. PREPARATION OF TEST OBJECTS FOR DYNAMOMETRY

- Make sure that in the lowermost point of the rod stroke, the minimal distance from the lower cross bar to the gasket cap is 130 mm.
- Warning! If the above distance is smaller than 130 mm, the dynamometer is not to be installed!
- Stop the sucker- rod pumping unit in the lower position of the suspension and anchor it with the brake.
- Grind the polished rod in the place of device installation to bare metal.

6.1. Dynamometer Installation

- Place the device into the installation area parallel to the cross bar surface pressing the lips to the polished rod.
- Tighten the screw of the device until you hear a click.

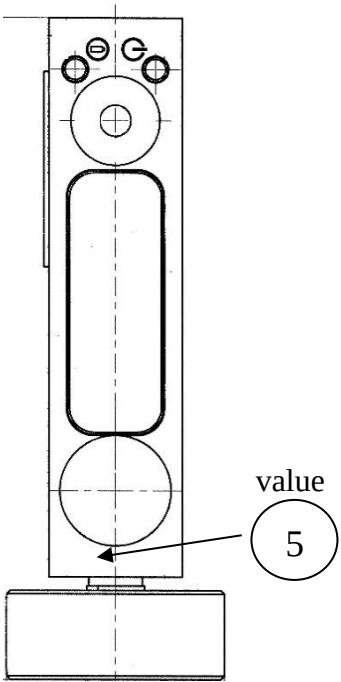
6.2. Dynamometer Removal

- Stop the sucker- rod pumping unit in the lower position of the suspension and anchor it with the brake.
- By holding the device, loosen the screw until you release the polished rod; then remove and switch off the device.
- Clean the device and put it into the bag.
- Start up the sucker-rod pumping unit.

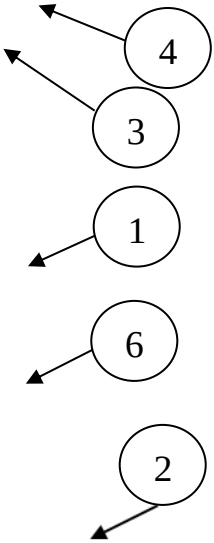
7. PRODUCT DESIGN AND OPERATION

7.1 Dynamometer

The dynamometer is designed for measuring and recording displacement and value



of the load on the polished rod while the sucker-rod pumping unit is in operation.



The dynamometer is made up of the following components:

1 – the case;

2 – the screw;

3 – the ON/OFF button;

4 - the “Power” LED;

5 - the “Charge” LED;

6 - the plug for charging the in-built accumulator

To record a dynamogram, the device is to be installed on the polished rod; no connecting cables are needed.

7.2 Switching On and Switching Off

The device is switched on by short pressing the button. The device is switched off automatically 100 seconds after the button is pressed or the

work with the device via the smartphone is finished. The device can also be switched off for a long time (approx. 3 seconds) by pressing a button.

When the device is connected to an adapter, the "Charging" LED lights up orange. When charging is complete, the "Charge" LED lights up green.

For the correct operation, the device must be held at a temperature of at least 10 min before measuring.

8. DEVICE OPERATION IN THE “DB SIAM” SOFTWARE

8.1. Connecting the Bluetooth device to a computer

The Bluetooth module must be activated on the computer/tablet from which the wireless device will be operated. The first time you use each device with this computer, you must connect the device using Windows - "Add Bluetooth device". The procedure for connecting may vary depending on the OS version.

The device must be turned on and ready for connection. The sign of readiness is the green color of the LED "Power". As a result of the connection, a COM port is created through which the SIAM Database software establishes a connection to the device.

To see which COM port has been created for a specific device, proceed as follows:

- point the mouse cursor over the Bluetooth icon in the right part of the taskbar, click the right mouse button;
- in the appeared context menu select item "Open parameters" (see Figure 1);
- in the appeared Bluetooth Options window on the COM Ports tab, see which outgoing port is assigned to the connected device (see Figure 2).

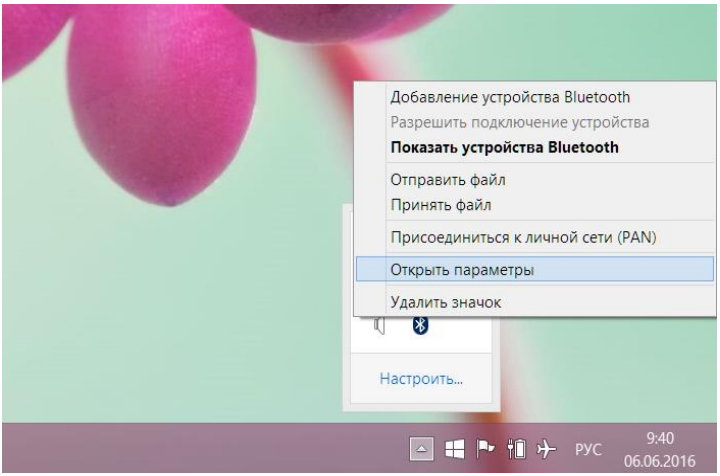


Figure 1: Bluetooth Menu in Windows 7-10

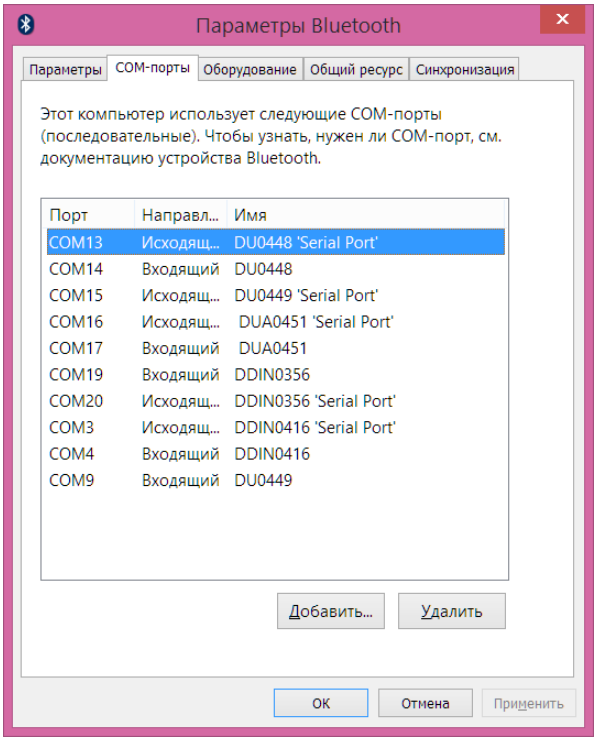


Figure 2. Bluetooth settings. Assigned Bluetooth COM ports to devices.

In figure 2, the outgoing port COM20 is assigned to DDIN No. 356.

8.2. Working with devices in “DB SIAM”

To work with devices with the “DB SIAM” software:

- start the program;
- switch to the “Settings” tab;
- press the “Devices” button (see Fig.3);
- the “Devices” dialog box will appear (see Fig.4):

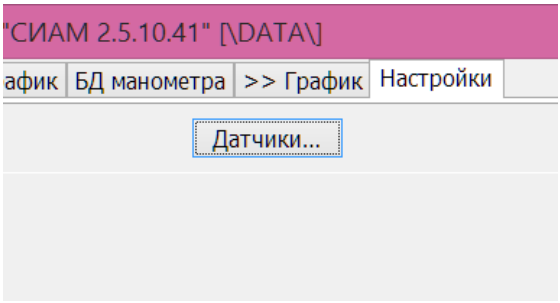


Figure 3. The “Settings” tab in the “DB SIAM”

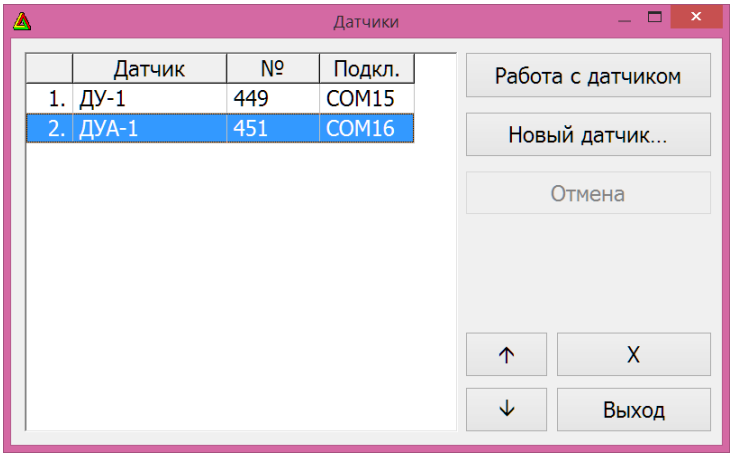


Figure 4. Devices dialog box in “DB SIAM”

If no device is listed or if for some reason the connection port of this device does not correspond to the one assigned in "Bluetooth parameters" (see above), then register the device in the program.

To do this, click to the button "New device ...". A list of all existing Bluetooth COM ports will appear. (see Figure 5).

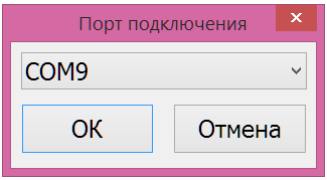


Figure 5. Connecting the device via COM port

In this window you have to select the corresponding device COM port. In case of connection problems, a corresponding warning message appears (see Figure 6).

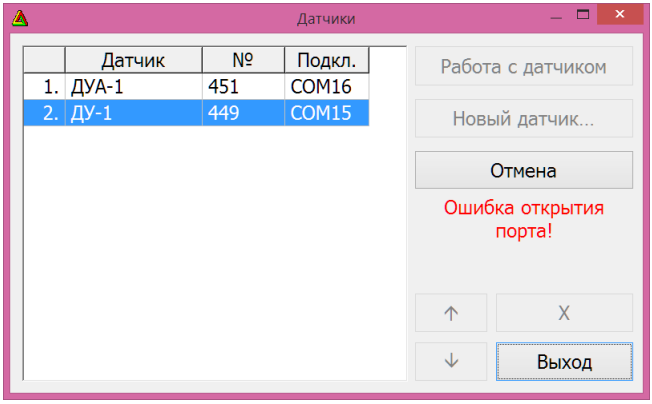


Figure 6: Error of connection to wrong COM port

This happens if the COM port is incorrectly specified or in case of the device is switched off. If the error occurs because the devices has been switched off, switch the devices on and the connection will take place after some time. If, however, an error occurs on the incorrectly specified COM port, the connection must be interrupted by clicking to "Cancel" and the connection must be repeated by clicking to "New Devices...", checking which COM port is assigned to the device.

If the connection is successful, the device control panel appears (see Figure 7).

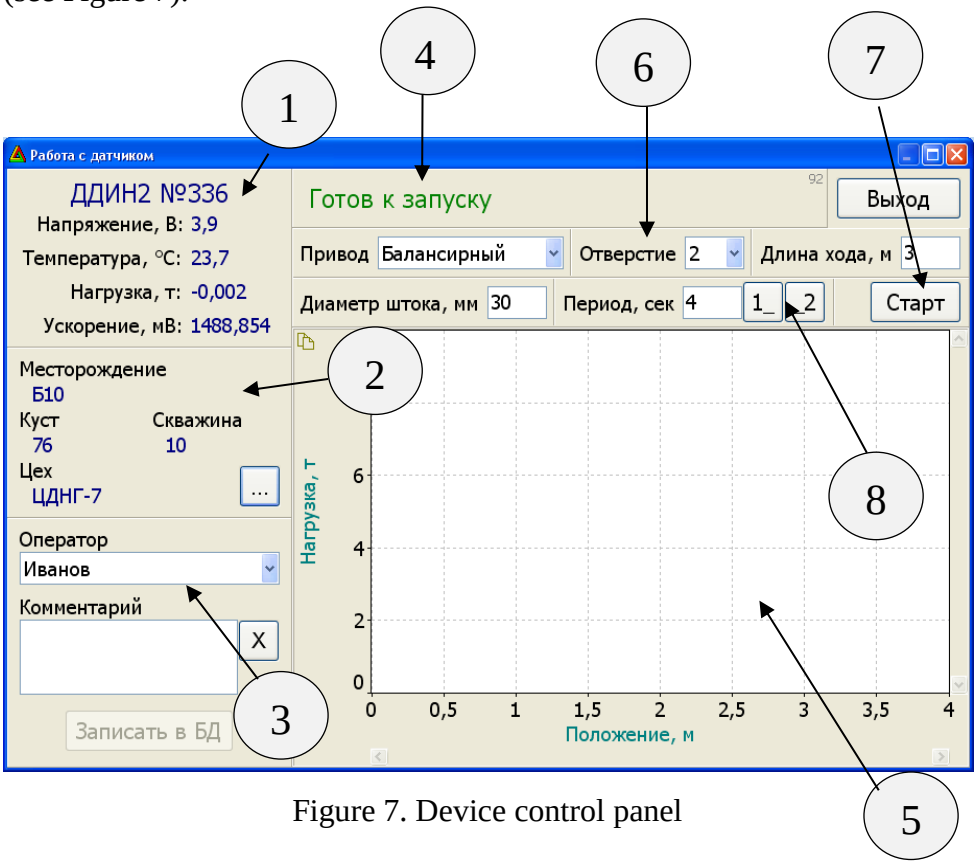


Figure 7. Device control panel

For each device type, the control panel will have a different look.

Panel 1: The name and device number, the current battery voltage, temperature, load and acceleration readings are displayed here;

Panel 2: the well details (field, cluster, well, shop floor) are displayed (if specified) here; after pressing the "..." button it is possible to specify or change the details of the well where the measurement is made.

Panel 3: allows you to specify the well survey operator, the type of survey, add explanations to the survey in the text form. The button "Write to Database" becomes available after receiving the dynamogram from the device and allows the operator to save the study into the database at the moment when he is sure that he has correctly specified the well details and other study parameters. If the operator has not saved the study by pressing the button "Save to Database", it will be saved automatically before the next one or when closing this window of work with the device.

Panel 4: serves to display the status of the device and the connectedness; in the upper right corner is a counter received from the device data packets. If communication with the device is normal, this counter will continuously increase at intervals of 1-2 seconds.

Panel 5: serves for displaying the dynamogram. You can select an area on the dynamogram by swiping your finger from top to bottom and from left to right, framing the desired area, after releasing your finger the selected area will be enlarged - stretched over the entire area of the chart. In this case, scroll bars will be available to access the areas of the dynamogram that are outside the chart zone. In order to return to the initial scale, you should drag your finger anywhere in the chart in the opposite direction - from bottom to top and from right to left.

Panel 6: allows you to enter the swing setting parameters: drive type, bore diameter, stroke length, rod diameter, swing period.

Panel 7: initialization button for dynamogram measurement.

Panel 8: Buttons "1_" and "_2" do not enter the oscillation period directly, but allow the program to define it as the interval between pressing the buttons "1_" and "_2".

8.3. Study procedure

- Check and, if necessary, change the details of the well (p.2 Fig. 7).
- Specify the operator, select the type of survey and enter the explanations (p.3 Figure 7).
- Specify pump setting parameters (p.6 Figure 7).
- Make sure that the device is in the "Ready to start" state (p.4 Figure 10) and press the "Start" button (p.7 Figure 7).
- The “Measurement” state would succeed the state "Initialization" and after 2.5 periods of oscillation the device will be in the state "Calculation".
- After calculation the resulting dynamogram will be displayed (p.5 Figure 7).
- Save the result to the database by pressing the button "Save to database".
- If necessary, repeat the study.
- Finish the work with the device by clicking the "Exit" button located in the upper right corner of the window.

9. STORAGE AND TRANSPORTATION OF THE PRODUCT

Average service life of the device is 5 years.

The storage warranty applies to a period of 6 months commencing from the date of purchase, the operation warranty is 12 months commencing from the date of purchase. Storage time of the device for 6 months prior to start of operation under storage conditions is not included in the warranty period.

The device should be stored in a standard bag in dry heated premises, at the temperatures from -10 to +40 °C and moisture less than 80%.

Product transportation is allowed in a standard bag by any type of transport at the temperature from -50 to +50 °C.

Severe shock and vibration are to be avoided during transportation.

When storing the device, a monthly check of installed accumulator voltage shall be done at least monthly and charged when needed. Charging shall only be done at positive temperatures!

10. CLAIMS

If the “DDIN-2” polished-rod dynamometer malfunctions during the warranty period, the consumer must draw up an act indicating the signs of faults. Act indicating the exact address of the consumer should be sent to the manufacturer.

КОМПАНИЯ СИАМ

TOMSK SCIENTIFIC INDUSTRIAL INTRODUCTION COMPANY “SIAM” LIMITED LIABILITY COMPANY

APPENDIX 1.

Defining Length of Stroke of the Polished Rod along Crank Holes of the Conventional Pumping Unit

Table 1

Hole #	Type of pumping unit						
	6SK6	7SK8	SKD8	PNS-80	SKR-8	UP-9m	UP-12m
	Stroke length, m						
1	0.9	1.67	1.2	1.2	1.2	0.95	1.5
2	1.2	2.1	1.6	1.6	1.6	1.2	2.0
3	1.5	2.5	2.0	2.0	2.1	1.6	2.5
4	1.8	3.0	2.5	2.5	2.5	2.0	3.0
5	2.1	3.5	3.0	3.0	3.0	2.5	

REVISION RECORD SHEET

Revi-sion	Numbers of sheets (pages)				Total sheets (pages) of document	Ref # of docu-ment.	Incoming # of supporting document	Signa-ture	Date
	Revised	Replaced	New	Annulled					