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1. GENERAL INFORMATION ON THE TOOL

The **SIDDOS-mini** dynamograph (hereinafter “dynamograph”) is designed for prompt monitoring of the performance of a sucker rod pump. The device provides dynamogram test by the “load – rod position” indirect method when the SRP is in working conditions or the well is start up. All the measurements made in semi-automatic mode can be performed by a single operator.

2. BASIC SPECIFICATIONS

Maximum load	15 000 kg
Allowable polished rod diameter	(16-39) mm
Range of measured stroke length	(0,5-7,5) m
Resolution of load monitoring	10 kg
Exchange Interface type with external devices	RS-232
Operation range of control panel DU in line of sight no less than	6 m
Exchange velocity with external devices	up to 115,2
Records stored in memory	400
Operating temperature range	(-40 +50) °C
Net weight, not more than:	0,8 kg

3. SAFE OPERATION INSTRUCTIONS

3.1. General Provisions

1. The construction of the wellhead equipment should correspond to the scheme approved by the State municipal engineering supervision bodies¹.
2. Preparation of a well for researches and carrying out of the researches should be performed in accordance with the requirements of the Instruction and internal well servicing and researches instructions approved by the head of the enterprise.
3. Research equipment should be operated according to the operational instruction delivered with the equipment by the manufacturing company.
4. Safety measures are regulated by instructions of labor protection for appropriate types of work, approved by the labor protection department of the enterprise and by “Safety regulations for the oil and gas industry” approved by the State municipal engineering supervision body of Russia¹.
5. Make sure that the minimum distance (“dead zone”) between the lower clamp and the gland cap is at least 130 mm in the bottom end of stroke of the polished rod. This is required for mounting the tool. In case this distance is less than 130 mm, it is not allowed to mount the tool.
6. Do not leave dynamograph set on the rod without control of operator (faulty mounting of tool or cycling loads of rod can lead to rearrangement and movement of tool down to rod).

3.2. Personnel Requirements

1. Only people who are 18 years and older, who have a secondary or higher education and are in health conditions allowing them to work in this area are permitted to carry out well researches.
2. The personnel should be professionally trained, examined and have a special permission to conduct the works according to the job specifications.
3. The personnel should be trained to operate on the research equipment. The training is performed by employees of the manufacturing company directly on the work place.

3.3. Test Object Requirements

1. Sucker rod — any length and configuration, if ends with a 16...39 mm diameter polished rod.
2. Sucker rod pumping units of all standard sizes may be used.
3. Sucker rod pumping unit and its electric system should be installed and maintained according to the Safety Regulations for Oil and Gas Industry.

4. Pumping unit control station should have a capability of switching into manual operation mode.
5. Moving parts of the pumping unit (crank drive, v-belt transmission) should be protected by the standard fencing.
6. Gearbox of the pumping unit should be equipped with a functional hand brake.

3.4. Tool Mounting /Dismounting Procedure

3.4.1. Preparing the Research Object

Stop and lock in the bottom position of the bridle;

Make sure that the minimum distance (“dead zone”) between the lower clamp and the gland cap is at least 130 mm in the bottom end of stroke of the polished rod. This is required for mounting the tool. In case this distance is less than 130 mm, it is not allowed to mount the tool.

Scrape the polished rod where the tool is to be mounted until clean metal shows.

3.4.2. Mounting the Tool

Turn on dynamograph, input well identifiers according to Section 5.3.4 (paragraphs 2, 3, 4) and transfer dynamograph in waiting mode of measurement running.

Put the tool where it will be mounted, parallel to the clamp plane and axis, pushing the jacks next to the polished rod. Note that the tool during mounting has to be oriented by display downwards.

Gradually, tighten the main screw by rotating it clockwise while the “SCR” (“tighten”) and “UNS” (“loosen”) messages are displayed on the indicator which means that dynamograph is in the working range of loads.

The dynamograph is ready for operation.

3.4.3. Dismounting the Tool

Stop the pumping unit and lock it in the bottom position of the bridle;

Loosen the main screw until the polished rod can be released, remove the tool and switch off the tool;

Clean the tool and put it in the supplied bag;

Start the pumping unit.

4. COMPONENTS AND OPERATION OF THE TOOL

4.1. General Information

The SIDDOS-mini dynamograph distinctive features are mono-unit design, small size/weight, opportunity of examination of measurement results on the graphic display OLED and also identifiers editing of research objects. This tool can operate without moving connection cables, thus allowing more prompt and safe operation. The tool can be used when operating in combination with BVK visual control unit or PC having interface RS232.

The tool is capable of exporting data to a PC. It is supplied with «SIAM DB» software product capable of creating and maintaining databases, as well as more detailed processing and analysis of the measurement results.

4.2. Arrangement, Application and Operation of Tool Components

4.2.1. SIDDOS-mini2 Dynamograph

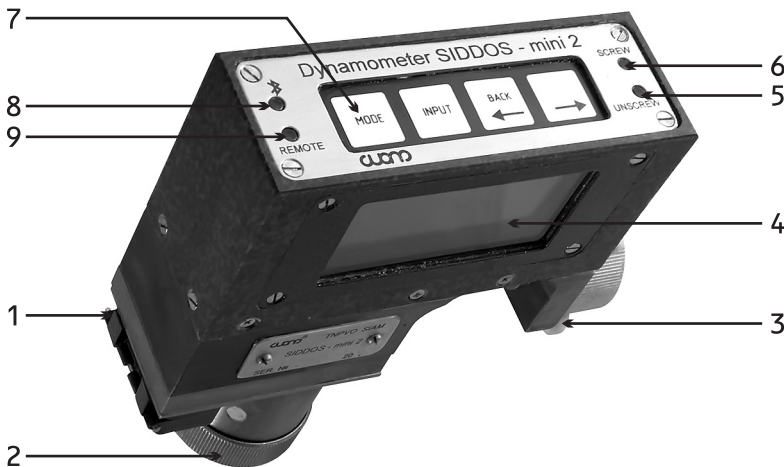


Figure 1. Dynamograph SIDDOS-mini 2

- 1) Slot RS232 for PC connection
- 2) Battery compartment
- 3) Main screw
- 4) Graphic Display
- 5) Load Indicator on polished rod "Loosen"
- 6) Load Indicator on polished rod "Tighten"
- 7) Keyboard
- 8) Tie indicator Bluetooth (option implementation)
- 9) Tie indicator with distance control panel

4.2.2. Accessories



Power adapter



BVK (* optionally delivered and booked)*



Interface cable RS232



Type of Accumulator D

Figure 2. Accessories

4.3. Tool Operation

4.3.1. Operating Principle

Dynamograph intends for measurements of dynamometer cards using indirect method.

Dynamometer card — dependence of polished rod load from rod movement length. When recording dynamometer cards, the tool recalculates rod diameter changes into load changes, simultaneously recording rod movements calculated from the built-in accelerometer with calculation of pumping speed and stroke length. The survey is started from the RC unit in the bottom end of stroke of the pumping unit. During the survey, data received from the sucker rod transducer is processed and stored to memory. Data processing includes filtering, load calculation from the polished rod diameter, polished rod movement, maximum and minimum load on the polished rod, recording pump speed (SPM). Measurements are calculated via two modes: simulation mode of sinusoidal movements (hereinafter referred to as simulation mode) and mode of calculating movements via double integration of acceleration signal (accelerometer mode). Simulation mode is designed for calculation of measurements impossible to record in accelerometer mode (high noisiness of acceleration transducer signal at slow pump speed and heavy blows in SRP system for slow pump speed). When operating in simulation mode it is necessary to enter manually stroke length and mark swinging period at its two lowest points. In accelerometer mode it is required to input the period at two points as well, and stroke length, pump speed and movement diagram is calculated automatically according to accelerometer data.

4.3.2. Controls and Indicators

Tool's controls and indicators include:

1. Graphic OLED Display (position 4; fig 1). Display is used for representing device modes, control of input of identity data and parameters , process of research and research results;
2. Indicator of the tool's clamp tightness (position 8,9; fig 1)of remote control and data transfer;
3. 4-button keyboard (Position 7,fig 1). The keyboard provides input (change) of necessary data, input of operator commands, control of all modes as autonomous operation of device and device communication with external tools. General appearance of keyboard and indicators is shown on fig 3.

The digital indicator is used to read tool operating modes, control input of id data and survey parameters, monitor the survey and display its major numeric results.

The keyboard is used to input (modify) the required parameters, input operator's commands, control all the operation modes both during autonomous operation of the tool and its communication with external devices. General view, layout and notation of the keys are shown in the figure.

Functions of the buttons will be explained in the next section.

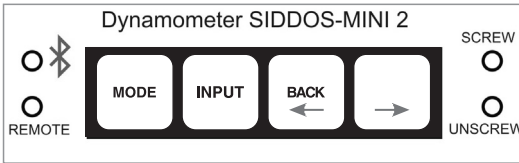


Figure 3. General appearance of keyboard and indicators



1. Turning On/Off
2. Sequential search (by closed cycle) of operation modes.
3. Sequential search of the number of position of blinking of character cell in the display during the input and change of parameters.



1. The alteration of driven parameters values in stepwise search (cycle) of provided variants. The driven (variable) parameter displays by blinking character cell which means the invitation to the input.



1. The button provides the action direction changing for buttons MODE and INPUT-OUTPUT. The button BACK significantly simplifies procedures of choice of particular figure during arrangement of cluster number, well number and other parameters and also allows to correct erratic button press. The back is made by pressing BACK button and button which needs rollback.
2. Movement back through data base of measurements.



1. Transfer forward through data base measurements.
2. Changeover of digital and symbol presentation of well number and cluster number.

4.3.3. General notes

1. This section covers tools operation modes and their respective indicators in the same order as they are cycled through on pressing the MODE key.
2. All the parameters mentioned in this section (number of well and cluster, survey parameters) can be set in any order irrespective of each other; they are stored in the tool automatically and remain in its memory even when the tool is switched off until they are changed again.
3. Set parameters are automatically recorded in alphanumeric reports of each measurement and added to all the records (including transferring data into a PC, etc.).
4. For time saving purposes it is recommended to set the necessary parameters before mounting the tool on a well (on road, etc.).

13:28:09	
02.04.09	
Bat. voltage	2.5
Free memory	399

MODES

Regime display of current parameters(fig 4). Parameters are represented on the display which allow to estimate current state of the tool.

Figure 4

- 1) Current time
- 2) Current date
- 3) Voltage of power supply
- 4) Reminder of spare memory of measurement.

This regime provides the start of measurement pressing the button "INPUT"

Well	1615
Cluster	331
Field	5

2. Mapping mode and editing of identity parameters of well(fig 5).

Identity parameters represent on the display.

Figure 5

- 1) Well number
- 2) Cluster number
- 3) Field number

Type research
Leakage Test

3. Selection mode of research type(fig 6)

There is a choice of research type such as dynamometer card measurement, valve test (leak measurement), pumping.

Figure 6

Rod diam	32
Dyn. time	AUTO
Travel	MANU
Stroke length	2.5

4. Mapping mode and editing of well research parameters (for mode of dynamometer card) (fig 7)

Display parameters respective type of research choosing in paragraph 3.

Measurement mode of dynamometer card

Display well research parameters.

Figure 7

1. Rod diameter, mm.
2. Duration of dynamometer card measurement
3. Measurement mode of movement through the accelerometer movement imitation.
4. Stroke length in imitation mode of movement, meter (parameter display only)

Rod diam	32
Leak. time	15

Mapping mode and editing of well research parameters (for mode of "Valve test") (fig 8)

Figure 8

- 1) Rod diameter, mm.
- 2) Time measurement of leaks, sec.

Mapping mode and editing of well research parameters (for mode of "Pumping mode") (fig 9)

- 1) Rod diameter, mm.
- 2) Time measurement of leaks, sec.

Rod diam	32
Period	1
Cycles	9

Figure 9
5. Mapping mode and identifier operator and workshop (fig 10).

- 1) Operator number;
- 2) Workshop number.

Operator	007
Workshop	15

Figure 10

6. Triggering mode of memory erasing (fig 11)

There is an enter in memory deletion of measurements in this mode. For entering in the mode is necessary to choose the button...

Memory Erasing	N
----------------	---

Figure 11

After triggering of mode and while transferring in first mode the notice is displayed (fig 12)

Pressing the button "INPUT" memory deletion would be done and access to date and time edition would be opened, to cancel memory deletion is necessary to press the button "MODE".

Data will be lost!	
Y(INPUT)	N(MODE)

Figure 12
7. View Mode of research data base

There are views of symbol and graphic statements. Whilst entering in browse mode symbol statement of last research display (fig 13). Research diagram can be browsed pressing the "INPUT" button (fig 14). Pointers provide movement in archive.

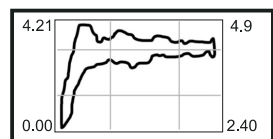
- 1) Research type
- 2) Cluster number
- 3) Well number
- 4) Date and time

Dynamogram	
Cluster	112
Well	2134
17:01:08	16:12

Figure 13

Example of graphic statement:

- 1) 4,21 – maximum load, tone
- 2) 0 – minimum load, tone
- 3) 4,9 – pumping rate, pumping per minute
- 4) 2,40 – Stroke Length, meter.


Figure 14

4.3.4. Turning ON|OFF the tool. Self-test.



Attention! Before switching on dynamograph after prolonged storage and transportation is necessary to charge accumulator. In opposite event tool either may not be switching on or switching off immediately after switching on which is not a criterion of faultiness.

Turning on.

Dynamograph is turning on by pressing the button “MODE”.

Turning off.

Dynamograph is switching off by retention “MODE” more than three seconds. Moreover, the tool is switching off automatically:

- If one of the button have not being pressed more than 3 minutes.
- Any faultinesses arise
- Accumulator voltage decreases to 1,1 Volt.
- In case of turning off all device data save.

4.4. Storage and Transportation of the Tool

Please store the tool in its standard bag in dry heated rooms with the – 10°C to + 40°C temperature range and moisture content of 80% and below.

The tool can be transported in its standard bag using any type of transport at the – 40°C to + 50°C temperature range.

While storing the tool, check the battery voltage every month and recharge it, if necessary.

N.B. In order to avoid measured data lost while changing the battery it is recommended before removing battery from the device to turn off the tool first.

5. PREPARATIONS FOR SURVEY

The procedures required to prepare the tool for survey are listed in the table, with references to the corresponding Sections of the present Manual.

1. Preparing the tool for operation – Section 6.1
2. Checking the tool – Section 4.4.1
3. Mounting the tool – Section 4.4.2

5.1. Preparing the Tool for Operation

1. Turn on the tool by pressing “MODE” button.
2. Set the survey parameters required for this field (Modes 2, 3, 4).
3. Check the battery voltage (Mode 1) and free memory available. If the voltage is not enough for operation (e.g.: If voltage is less than 1,2 V, battery capacity may not be enough for 8 hours of operation), recharge the battery. If the amount of free memory available is less than required, import the data stored to a PC then initialize the tool in order to delete old data (See APPENDIX 2).
4. Adjust the current time (Mode 1). **ATTENTION!** Adjustment of the time has to be only accomplished in memory erasing mode of the tool. If the date and time has to be adjusted or clean out measurement counter save results of measurements in PC or in BVK.
5. Turn off the tool.

The described procedures are not time-consuming and it is advisable that they are made on a daily (shift) basis before starting the work shift, and the one listed in Paragraph 3 should be made beforehand so that there is enough time to recharge the battery, if required.



6. PERFORMING A SURVEY

! **ATTENTION!** During work at well site, it is strongly recommended to follow the Safe Operation Instruction.

! **ATTENTION!** AT LOW TEMPERATURES IT IS REQUIRED TO KEEP THE DEVICE UNDER THE ENVIRONMENTAL TEMPERATURE FOR NOT LESS THAN 10 MINUTES TO BRING THE BODY OF A TRANSDUCER INTO THE OPERATING MODE

1. Setting-up procedures (see section 6.1)
2. Equipment preparation (see section 4.4.1)
3. Survey parameters set-up (see section 5.3.3)
4. The tool mounting — (see section 4.4.2)

6.1. Measurement in automatic mode

1. Turn on the dynamograph;
2. Enter the well ids: cluster number, well number and field number (mode 3, Section 5.3.3);
3. Set the research type “Dynamometer Card” (mode 3, Section 5.3.3);
4. Set rod diameter, research time (duration of research has to be at least 2 times longer than the time of pumping) and automatic mode of movement determination;
5. Stop the SRP unit (see section 4.1.1);
6. To start the measurement process, press any button on remote control unit or “INPUT” button on the tool keyboard;
7. Mount the tool on the polished rod (see section 4.2.2).
8. Tighten the screw, paying attention to the message displayed on the indicator: OK — OK tightness (fig 15) and two LEDs of tightening (position 5, 6. Fig 1) have to be blinked.

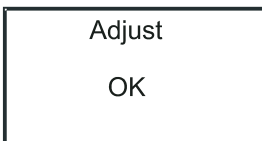


Figure 15. Tool adjustment mode (tightening)

9. Start SRP unit and miss out three-five pumping cycles.
10. When the polished rod approaches its lowest position start measurement pressing any button of remote control unit. While running of measurement indicator DU (position 9 on fig 1), start flashing in a discontinuous manner and display message offering determine the second point of the swing period (fig 16).

When the polished rod approaches its lowest position for the second time, press once again any button on the remote control. Meanwhile, indicator DU start blinking continuously, time counting display until the end of a record (fig 17). If tightening of dynamograph would loosen and reading of load would exceed scope of measurements indicator “Tight” would be lighted up.

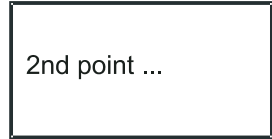


Figure 16

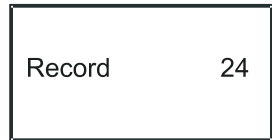


Figure 17

11. When the survey is completed the indicator DU switches off and display shows measured chart (Dynamometer card).

12. When the research is completed the start of measurement can be repeated by the remote control until the full filling of memory (see Section 8)

The interruption of the survey can be done by pressing “MODE” button.

13. After the survey the dynamograph has to be turned off and dismantled. (see section 4.4.3)

6.2. Dynamometer measurement in imitation movement mode

This mode is for researches on the SRP with slow pumping speed, impacts in the pumping unit, uneven stroke of rod and other cases when measurements getting from automatic movement determination mode give incorrect results.

First of all, it is necessary to turn on imitation movement mode (Mode 4, section 5.3.3 parameter RUC). When parameter is set the offer appears to introduce the length of polished rod stroke. Put into the stroke length of machine (determine on apertures of crank, some kinds of machines and compliance apertures with stroke length can be seen in Appendix 3). Further measurement operates similarly with Section 7.1. Pay attention to pressing of the buttons of remote control rigorously in the low positions of polished rod stroke.

6.3. Valve Test Measurements

This mode is for researches in the pump units for leaks determinations in valves of pump or piston pair in static state, according to presence of important changes of loads on the bracket in the time after piston stop.

1. Turn on the dynamograph
2. Input identifiers of well: cluster number, well number and field number (mode 3, section 5.3.3).
3. Set the type of research “Valve test” (mode 3, Section 5.3.3)
4. Set the diameter of rod and survey duration (mode 4, Section 5.3.3)
5. Stop SPR unit (see section 4.4.1).
6. Pressing the “INPUT” button. Mode 1 transfers to measurement mode.
 7. Mount the dynamograph on the polished rod (see section 4.4.2)
 8. Tighten the screw, paying attention to the message displayed on the indicator: OK – OK tightness (fig 18) and both LEDS of tightness (position 5,6 fig 1) have to be blinked.
 10. Start SRP unit and miss out three-five pumping cycles for transducer stabilization on the rod.
 11. Stop SRP unit in the position which requires valve test, start measurement by pressing any button of remote control. When measurement starts indicator DU has to be blinked constantly and display time counting until the end of the record (fig 19).
 12. When the survey is completed indicator DU switches off and display shows measure chart.
 13. After the survey it is possible to repeat the measurement start through the remote control until the full filling of memory (see section 8). Press the “Mode” button to change the mode or interrupt the survey.
 14. Gradually, dynamograph has to be turned off and dismounted. (see section 4.4.3)

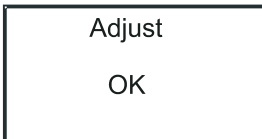


Figure 18

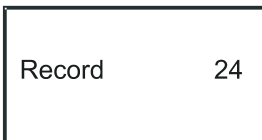


Figure 19

6.4. Pumping mode measurement.

This mode is intended for recording of dynamometer card series. The mode is similar to single dynamometer mode in automatic regime (Section 7.1). The difference is that after first research the tool turns off and then turns on automatically (without remote control DU) through time interval set in parameter menu of pumping mode (see Section 4.3). Additionally, this menu sets up the number of measurements in the research.

6.5. Measurement Errors

When measurement operating is incorrect errors will be generated and displayed.



Indicated while faultiness and incorrect orientation of the tool during mounting.

Error
travel

Indicated if the result of automatic measurement of stroke length would be exceed permissible limits (less than 0,3 meters or more than 7,5 meters)

Error
stroke length
value

Indicated if calculated pumping speed by the tool exceed permissible limits (less than 0,6 pumping/sec or more than 20 pumping/sec).

Error
pump speed
value

Indicated when no shorting of load on dynamometer graph.

Error
not close
rod load curve

Indicated when load parameters are incorrect

Error
not correct rod load

6.6. Base Measurement Examination

Base measurement examination is in mode 7 (section 5.3.3). Interchange through the base is made by pressing button-arrows. Interchange from text to graphic regime and vice versa is made by pressing the button “Input”. Exit to main modes is made by pressing the button “Mode”.



Annexure 1. Transferring Data to a PC

! Attention! To avoid errors during data transfer to a PC, it is required to carefully read and follow the corresponding sections of the User's Manual for the software.

Data transfer procedures are to be performed according to the below following operations.

1. Turn off (if it was on) the tool and connect the supplied interface cable to the interface socket of the tool and serial port of your PC.
2. Launch the required software on your PC.
3. Turn on the tool.
4. Launch import procedure to a PC database.

Annexure 2. Setting up the date and time. Memory erasing

This mode allows to reset time, date and clear up the random-access memory of the tool. In this case all the memory content is deleted without the possibility to recover! To save valuable data before the erasing it is necessary to export them to a PC database or BVK.

During erasing procedure current time and date are not reset automatically and can be kept without any change or just partially edited.

To delete the measurements enter to mode 5. To enter in editing mode of parameter press the button INPUT.

Erase? N

By pressing the button MODE move to MODE 1

While passing to MODE 1 in case of memory erasing is permitted the warning displays.

Data will be lost!
Y(INPUT) N(MODE)

