# NEW TECHNOLOGY AND TOOLS FOR GAS WELL TESTING CHIREN UNDERGROUD GAS STORAGE

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#### ABSTRACT

This article describes the technology and equipment for carrying out a complex of geophysical studies and well testing of wells in the underground gas storage of Chiren. A test unit is mounted in the testing line from the well. Data obtained and registered by the measuring unit are used by PC on the well site to calculate the test parameters. The system is reliable and robust. It easy to operate, saves time and money.

A great number of gas wells testing have been carried out in the underground gas storage of Chrien. Most of them are during the period of exploitation of the gas field and in the period of setting up of underground gas storage.

At the period 1992-1993 a extensive gas well testing was performed at the gas storage field. The results of this study were published by Mincheva, Belchev, (1993). In their report the authors presented productivity curves for most of the wells used in the gas storage. The testing equipment for study includes test line, separator, measuring block, diaphragm, valves, and pressure gauges. The measuring block was mounted on the test line from the well. During the test the well flow rate was controlled by the manifold valves installed on the test line. Due to pressure rating of the valves on the separator line (6 MPa) the testing of the wells during injection was not possible (the manifold is rated to 16 MPa). During well testing pressure and temperature data are measured. The obtained data were used to calculate the well coefficients A, B as well as the permeability and the mobility. The curve of the productivity obtained from the calculations did not pass through the origin of coordinate system. In order to account for the unsteady state of the formation/bottom hole pressure coefficients for correcting are involved.

The review of the well testing studies and the analysis of the applied technology lead to the following conclusions:

• All gas well tests carried out in 1992-93 missed out direct measurements of reservoir and bottom hole pressures;

- The well testing reported in excludes measuring of the bottom hole pressure during the test;
- The reservoir pressure was determined by the barometric formula using values of the static head pressure;
- The bottom hole pressure was calculated by the formula of Adamov using the well head pressure. The measured manifold pressure was used to calculate the later;
- The temperature was not measured during the well testing;

 The formation and bottom hole pressure during the testing were not measured but calculated, which lead to erroneous interpretations and bad control of the testing.

An extensive geophysical, well testing and workover program for some of the wells in the storage of Chrien started in 1993. This program included a complex of geophysical studies in order to check the technical state of the casing as well as a well testing. The gas-testing program was aimed to evaluate the reservoir performance, formation characteristics and well damage after well stimulation. The workover program included tubing inspection and change and well stimulation.

The equipment used in this study consists of two units: technological and measuring. It's shown in figure 1.



Figure 1

The technological units includes the following: drilling rig 1; geophysical devices 3 and 4; lubricating device 5; traveling block 7; test line 15; cyclone separators for high and low pressure – 9,10 and collecting and separating liquid and debris vessel 11. The cyclones 9 and 10 and collecting vessel 11 are not used during injection testing.

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The measuring unit included geophysical devices 3, connected to the geophysical station 17 by means of geophysical cable; measuring line 16 fitted up with measuring diaphragm 12, absolute-and differential-pressure gauges 8,18; control PC fitted up with analogue-to-digital converter 14, regulating and closing valves 13.

The pressure of the tubing annulus and well head was measured with pressure gages 8 (Hottinger Baldwin - 1000 bar) and high accuracy manometers (0,4%), calibrated in testing laboratories. After calibration the pressure gages are mounted on a test bench simulating the real test conditions and tested again. A pressure membrane converter "Sapphire" was used to measure the differential pressure. Diaphragms of various sizes were used according to the flow rate of well. The temperature measurements were performed by two thermocouples mounted in the test line. The pressure and temperature data was measured by HP Data Acquisition and Control Unit and stored in PC for further manipulations. This arrangement of the testing line with the measuring devices and the use of the PC enabled the continuous calculation of the flow rate at the well site. Thus it was possible to distinguish the steady state during test regime. Printout from two well tests; well P-2 and E-27 is shown in figure 2. The gas well testing was performed in stabilized and non-stabilized regime of filtration.

The geophysical complex consisted of radiometric study and flow, humidity and noise measurements performed by geophysical station.

The described above equipment was used to study eight wells in the Chiren underground gas storage. The equipment showed robust and reliable work allowing performing different testing regimes. All data obtained during the well testing was used for the necessary calculation.

The following advantages have been observed:

- The schedule enables to study the wells in a several different regimes;
- The loop used for the testing allows determining the effect of the neighboring wells on the well performance;
- Information about the working flow rates, pressures and temperatures is provided by the measuring system during the well testing on the well site. It allows controlling the study;

- The surface manifold loop enables to avoid the possible gas leaks from the manifold's valves, which can influence the results obtained from the testing;
- The testing equipment setup allows simultaneous running geophysical studies and gas well testing.

The study of the eight wells showed that the equipment and setup used are reliable and robust. The testing program used and nesting some of the operations saved considerable amount of time and money.

сондаж Р-2	сондаж Е-27
3:24:03.24 PM	1:22:43.13 PM
P01H=63.570/42H1H	PDIA=66.896112ATA
10HL=25.80	TCHL=19,3C
18UF=39.60	TBUF=31.2C
PBUF=64.16ATA	PBUF=66.87ATA
DP=0.03322MPA	DP=0.00768 <b>M</b> PA
¥=118.3XN3/0	Q=59.6XN3/D
3:29:18.67 PM	1:26:32.74 PM
PDIA=63.359763ATA	PDIA=66.349082ATA
1CHL=25.8C	TCHL=19.9C
TBUF=38.6C	TBUF=26.3C
PBUF=63.78ATA	PBUF=66.75ATA
DP=0.03332NPA	DP=0.00768MPA
Q=118.5XN3/D	Q=60.1XH3/D
3:34:27,16 PH	1:32:19.63 PN
PDIA=63.274494ATA	PDIA=66.731538ATA
TCHL=28.1C	TCHL=20.1C
TBUF=37.6C	TBUF=29.5C
PBUF=63.61ATA	PBUF≈66.83ATA
DP=0.03322MPA	DP=0.00765MPA
Q=118.5XN3/D	Q=59.7XH3/D

Figure 2. Real – time printout from well testing

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