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Issue Article

Annaguly Rejepovich Deryaev
Scientific Research Institute of Natural Gas of the State Concern „Turkmengas”
Doctor of Technical Sciences, Senior Researcher,
Corresponding Member of International Academy of Theoretical and Applied Sciences,
Ashgabat, Turkmenistan
annagulyderyayew@gmail.com

OPENING OF FORMATIONS AT ABNORMALLY HIGH RESERVOIR PRESSURE, RULES FOR INSTALLATION AND OPERATION OF BLOWOUT EQUIPMENT AT DIRECTIONAL WELL № 707 WEST CHELEKEN FIELDS

Abstract: *The article discusses the opening of formations at abnormally high reservoir pressure (AHRP), the rules for the installation and operation of blowout equipment for the production column of an inclined directional production and evaluation well for the purpose of successful drilling of well No. 707 at the Western Cheleken field in the coastal zones of the coastal waters of the Caspian Sea. For the design of the opening of reservoirs at the AHRP, the rules for the installation and operation of blowout equipment were carried out according to the "Instructions for testing wells for tightness", "Safety rules in the oil and gas industry", as well as calculations for tightness were carried out in accordance with the "Instructions for calculating casing strings for oil and gas wells" (RD 39 - 7/1 - 0001 - 89, Vnitneft) and "Instructions for testing wells for tightness".*

This work on the design of the opening of reservoirs with AHRP, the rules of installation and operation of blowout equipment can be used in order to avoid complications, accidents, gas and oil occurrences and to perform tasks when drilling directional wells and in extremely difficult mining and geological conditions at abnormally high reservoir pressures.

Key words: *repression, hydraulic fracturing, wellhead, drill string, blowout equipment, trap, torch, forged corner, coil, pressure testing, manifold.*

Language: *English*

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Introduction

The creation of repression during the opening of productive formations allows you to maintain safe conditions for drilling a well from the point of view of preventing gas, oil and water shows. This method of opening layers is the main (traditional) in world and domestic practice. In order to avoid disrupting drilling technology and reducing the technical and economic indicators of drilling, the amount of repression is regulated by the "Safety Rules in the Oil and Gas Industry".

Formations with abnormally high reservoir pressure (AHRP) are characterized by an increased anomaly coefficient ($ka \geq 1.2$).

At the same time, as a rule, the higher the anomaly coefficient, the smaller the difference between reservoir pressure and hydraulic fracturing pressure or reservoir absorption pressure. The opening of such formations is carried out using drilling fluids of such density that the minimum necessary repression on the formation is provided (from 5 to 10%, depending on the depth) [1].

Usually in such cases, weighted and super heavy drilling fluids are used. When drilling formations with AHRP, formation fluid from the drilled rock can get into the drilling mud, due to diffusion, mass transfer. Therefore, it is important to monitor the density of the outgoing solution, the content of oil and gas. On the surface, the drilling mud should be well cleaned and degassed. To reduce the danger of oil and gas occurrences, the speed of lifting the drill string during descent and lifting operations (the effect of reciprocating) is limited, the viscosity of the drilling fluid is lowered, the time of finding the well without flushing is limited. In case it is necessary to replace the drilling fluid in the well, there should be a reserve of it in the amount equal to one and a half to two times the volume of the well [2, 3].

An essential condition for opening formations with AHRP is the possibility of sealing the wellhead in case of possible oil and gas occurrences. To do this, on the column from under which the productive layers are being opened, blowout equipment (BE) is mounted in advance according to the schemes approved by GOST 13862-90.

This equipment ensures the sealing of the wellhead both with the drill string lowered into the well and without it. It consists of 1 to 4 preventers of various types (spot, universal, rotating), a killing and throttling unit, diverting working and emergency switch-off lines. When drilling oil wells with a large gas factor and gas wells, the composition of the BE harness includes a trap installation and a torch for burning gas.

The most commonly used BE installation scheme for an oil well is shown in figure.

The most important rules for the installation of BE are as follows:

1. The top of the column on which the BE is mounted must be at least 30 cm above ground level (for the possibility of capturing the column when the open fountain is forcibly silenced).

2. A coil is installed above the upper preventer to install an additional preventer if necessary.

3. The flip-out lines should be directed in different directions. It is allowed to turn the killing line to 1800 with the use of forged corners.

4. The length of the ejection lines should be at least 30 m (and in case of possible blowing - at least 100 m). All lines must have a slope away from the wellhead (to free the lines from the liquid by gravity).

5. The main control panel of the preventer installations and manual control of the spot preventer is carried out at a distance of at least 10 m from the wellhead. An auxiliary control panel must be installed at the driller's workplace.

6. The preventer is pressed to a pressure exceeding not 20-50% of the maximum expected at the wellhead during oil and gas discharge.

The flipping lines of the preventer installations are also pressed at a pressure of 100 kgf / cm^2.

7. In winter, the preventer must be heated.

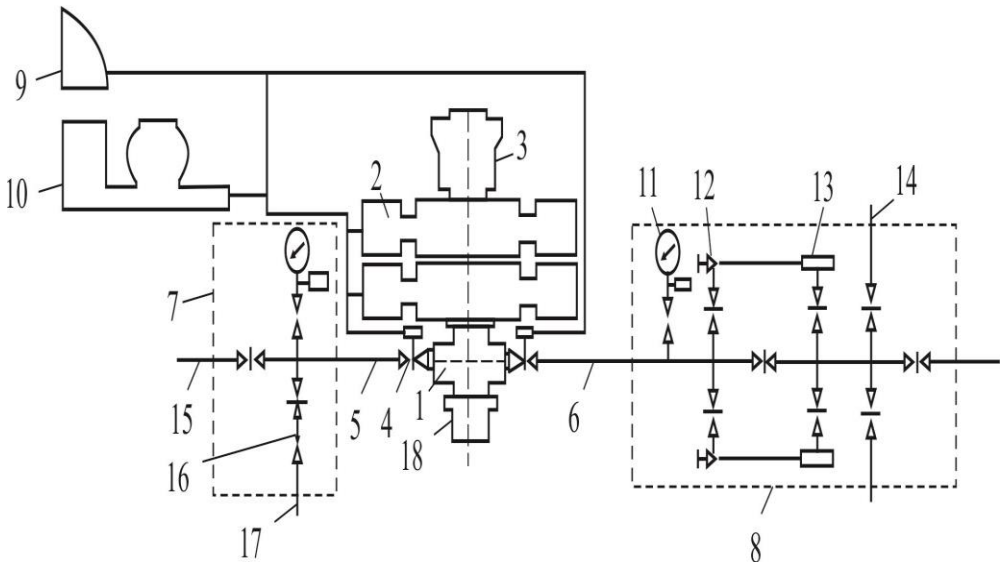

Figure 1. Diagram of blowout equipment with 3–preventers 1-crosspiece; 2–spot preventers; 3-universal (rotating) preventer; 4–hydraulic valves; 5–killing line; 6–throttling line; 7- killing unit; 8–throttling unit; 9–auxiliary control panel; 10–main hydraulic control panel; 11–pressure gauge; 12–adjustable throttle; 13–flow dampener; 14–outlet to the separator; 15–discharge line; 16–check valve; 17–tap for connection of pumping units; 18–wellhead.

When drilling in the intervals of formations with AHRP, a check valve is included in the drill string (under the lead pipe).

When the production column is lowered into the well, the dies in the die preventer must be replaced in accordance with the diameter of the casing pipes, or there must be a translator on the drilling rig to connect the casing pipes to the drill pipes for which the dies are installed in the preventer.

Blowout equipment is installed on the conductor and intermediate column, when drilling below which gas and oil occurrences are possible, as well as on the production column, when working in it with an open productive reservoir [4].

Casing strings are tied together with the help of a column head.

The working pressure of the preventer block and the manifold must be at least the pressure of the pressure column for tightness, calculated at each stage of drilling the well based on the condition of complete replacement of the drilling fluid with reservoir fluid and sealing the wellhead with open blowing.

Blowout equipment is not installed when the section being opened by the well has been studied and has no collectors or is represented by collectors saturated with water with a reservoir pressure not exceeding hydrostatic.

The choice of a preventer installation, manifolds (throttling and killing lines), a hydraulic control station, a throttling panel of a trap-flare installation is carried out depending on specific mining and geological conditions for performing the following technological operations:

- sealing of the wellhead with and without lowered drill pipes;
- leaching of fluid from the well according to the accepted technology;
- suspension of the drill pipe column on the dies of the lower preventer after its closure;
- cutting of the drill string;
- monitoring the condition of the well during its killing;
- pacing of the drill string to prevent its seizure;
- lowering or lifting of a part or the entire drill string with the wellhead hermetically closed.

When the well is opened by the studied section, represented by oil and water (with dissolved gas) formations, with a pressure not exceeding hydrostatic, after the descent of the conductor or intermediate column, the mouth should be equipped with two preventers, including one universal.

Three or four preventers, including one universal and one with cutting dies, are installed on the well when opening gas, oil and water horizons with abnormally high pressure, as well as in the presence of hydrogen sulfide with a volume content of up to 7% [5, 6].

The need to install a preventer with cutting dies at the expected excess pressure at the wellhead below 100 kgf / cm^2 is determined by the drilling company in coordination with the anti-spontaneous service and the bodies of the Main State Service "Turkmenstandardlary", based on the characteristics of the formation (porosity, permeability, fluid composition, flow rate, etc.).

The requirement for installing preventers with cutting dies enters into force after providing drilling organizations with them.

Four or five preventers, including one with cutting dies and one universal, are installed at the mouth in cases of:

- opening of formations with abnormally high reservoir pressure and a volume content of hydrogen sulfide of more than 6%, as well as with the presence of hydrogen sulfide up to 7% and excess pressure at the mouth exceeding 350 kgf / cm^2 (in the presence of hydrogen sulfide, a preventer in a sulfur-resistant design is installed);
- opening of strata at sea;
- using the technology of lowering and lifting pipes at excessive pressure at the sealed mouth.

The discharge lines to the flares from the killing and throttling units must be securely fixed on special supports and directed away from industrial and domestic structures with a slope from the wellhead.

The length of the lines should be:

- for oil wells with a gas factor of less than 200 m^3/m^3 - not less than 30 m;

-for oil wells with a gas factor of more than 200 m^3/m^3, as well as gas and exploration wells - at least 100 m.

The lines and the valves installed on them must have an internal diameter equal to the internal diameter of the crosspiece bends; after the block of valves, an increase in their diameter by no more than 30 mm is allowed.

The distance from the ends of the ejection manifold to all communications and structures not related to the drilling rig facilities should be at least 100 m for all categories of wells.

For wells constructed from a bulk base, stationary offshore platforms and restricted sites, the length of the lines from the killing and throttling units must be established by the contractor in agreement with the customer, the bodies of the Main State Service "Turkmenstandardlary" and the anti-spontaneous service.

At wells where the expected pressure at the wellhead exceeds 350 atm, a factory unit with three adjustable throttles is installed: two with remote and one with manual control.

In all other cases, at least 2 adjustable throttles with remote control are installed.

The installation of a high-pressure separator as part of the strapping of the manifold of blowout equipment is carried out depending on specific conditions and is decided by the management when

approving the strapping scheme and the installation of BE.

When opening layers with the presence of hydrogen sulfide more than 6% by volume, a trap-flare installation is included in the manifold line of the blowout equipment.

Pressure gauges installed on the throttling and killing units must have an upper limit of the measurement range 30% higher than the pressure of the joint crimping of the casing and the blowout equipment [7].

The scheme of installation and strapping of blowout equipment is developed by the drilling company and approved by a higher organization in coordination with the customer, the anti-spontaneous service and the bodies of the Main State Service "Turkmenstandardlary".

Blowout equipment must be assembled from factory-made components and parts of domestic or imported delivery.

In agreement with the anti-spontaneous service, it is allowed to use individual parts and assemblies manufactured at the production service bases of enterprises in accordance with approved specifications.

Manufactured components and parts must have passports.

To control the preventers and hydraulic valves, the main and auxiliary consoles are installed: the main one - at a distance of at least 10 m from the wellhead in a convenient and safe place; the auxiliary one - directly near the driller's console, which is included in the operational readiness mode when opening productive or gas-oil-producing formations.

The handlebars for manual fixation of the preventer dies are installed in an easily accessible place.

When opening reservoirs saturated with oil and gas, it is necessary to have two ball valves on the drilling rig. One is installed between the working pipe and its safety adapter, the second is a spare.

When opening gas formations with abnormally high pressure, hydrogen sulfide-containing formations and when drilling wells at sea, the drilling rig must be equipped with three cranes. One ball valve is installed between the working pipe and the swivel, the second - between the working pipe and the drill string, the third is a spare.

All ball valves must be in the open state.

In addition to ball valves, it is necessary to have two check valves on the drilling rig with a device for installing them in the open position, one of which is working, and the second is a backup.

The manual backup steering wheel of the preventer should be placed in a mobile metal booth or behind a shield with a canopy of boards with a thickness of at least 40 mm.

In front of the steering wheel in the booth or on the shield, the direction of rotation and the number of revolutions required to completely close the preventer at the last turn of the steering wheel must be indicated.

For drilling rigs of universal mounting capacity, it is allowed to place the hand controls of hydraulic preventer units on the outside of the longitudinal beam of the tower-winch unit.

The preventers, together with the crosspieces and root valves, are pressed with water to the working pressure specified in the passport before installation at the wellhead, and after repairs related to welding and turning of the housing, to the test pressure.

The preventer with cutting dies must be pressed on the stand for working pressure with the dies closed, and the operability of the preventer is checked by opening and closing the dies.

The results of the crimping are formalized by an act.

After the installation of the preventer unit or the descent of the next casing, including the countersunk, before drilling the cement cup, the preventer unit to the end valves of the high-pressure manifolds must be pressed with water or nitrogen to the pressure of the casing pressure.

The discharge lines after the end valves are pressed with water at a pressure of:

50 kgf / cm^2 - for blowout equipment designed for a pressure of 210 kgf / cm^2,

100 kgf/cm^2 - for blowout equipment designed for pressure above 210 kgf/cm^2.

After the installation and crimping of the preventer unit together with the casing, as well as the crimping of the cement ring, further drilling of the well can be continued only with the permission of a representative of the emergency service [8].

Preventers should be periodically checked for serviceability, closing and opening. The frequency of inspection is set by the drilling company.

When the pressure horizons are opened, the operability of the preventers for closing and opening should be carried out every time after the tool is lowered into the shoe of the column. The results of the check must be reflected in a special journal.

When replacing the parts of the preventer that have come out of standing or one of the components of the preventer assembly and changing the dies at the mouth, the preventer installation is subjected to additional crimping by the pressure value of the column test.

The dies of the preventers installed at the wellhead must correspond to the diameter of the drill pipes used.

Blind dies are installed in the lower preventer when there is no preventer with cutting dies in the assembly.

With a multi-sized tool on the bridge, it is necessary to have a special crimped drill pipe, painted red, with a translator and a ball valve in diameter and strength characteristics corresponding to the upper section of the drill string used.

Before the descent of the casing string in open formations with a possible gas-oil occurrence, the dies of one of the preventers must correspond to the diameter of the descending column. There should be a drill pipe with a translator and a ball valve (painted red) on the catwalk.

For unhindered access of maintenance personnel to the blowout equipment installed at the mouth, a solid flooring must be constructed under the drilling rig.

All schemes of blowout binding of the wellhead in the upper part should include a pressed flange coil and a detachable chute to facilitate work on the elimination of open fountains.

The blowout lines of the preventer should be straight, at least 30 m long, with the possibility of blowing the well with gas - at least 100 m, firmly fixed and directed away from the carriageways, power lines, boiler houses and other industrial and household structures.

Turns of the switch-off lines of the preventer strapping are allowed in exceptional cases and only with the use of massive forged corners with threads or tees with a buffer device, pre-pressed to the maximum pressure of the crimping of the preventer installation.

Laying of switch lines under the receiving bridge and overhead structures is prohibited.

After installation, inspection and testing of blowout equipment, drilling of the well can be continued with the permission of a representative of paramilitary units and detachments to prevent the occurrence and elimination of open gas and oil fountains.

The drilling foreman is obliged to personally check the operability of the installed preventers and valves at least once a week, and enter the result of the check in the log of checking the technical condition of the equipment. When passing formations with oil and gas occurrences, the serviceability of preventers and valves should be checked before each descent of drill pipes into the well and lifting of the tool from the well.

Drilling in intervals with possible oil and gas occurrences is allowed only with dies installed in the preventer corresponding to the diameter of drill pipes in the well.

When a well appears and a gas-oil fountain occurs, the management of the drilling enterprise, a higher organization, the bodies of the Main State Service "Turkmenstandardlary" and the anti-spontaneous service must be notified. Measures should be taken in accordance with the instructions for the prevention and elimination of oil and gas occurrences and the plan for the elimination of accidents

The preventer should be closed when the drill string is suspended on the talus system and only when the valves on its ejection are open.

The pressure at the blowout of the preventer, created during the sealing of the well, should be reduced gradually (3-4 kgf / cm^2 in 1 min); venting pressure at the gas outlet should be continued until the liquid appears at the mouth.

The preventer is pressed to a pressure exceeding not 20-50% of the maximum expected at the mouth during oil and gas discharge.

The ejection lines of the preventer units are also pressed at a pressure of 100 kgf/ cm^2. In winter, the preventers should be heated [9, 12].

When drilling in the intervals of formations with AHRP, a check valve is included in the drill string (under the lead pipe).

When the production column is lowered into the well, the dies in the die preventer must be replaced in accordance with the diameter of the casing pipes, or there must be a translator on the drilling rig to connect the casing pipes to the drill pipes for which the dies are installed in the preventer.

The wellhead equipment listed in Table 1 (Specification of wellhead equipment and BE) was selected at directional well No. 707 of the West Cheleken field.

The test of conductors and intermediate columns for tightness is carried out by crimping with filling them with water from the mouth to a depth of 20-25 m, and in the rest - with drilling mud, which was used to sell the plugging mixture. Before crimping, it is allowed to completely replace the entire selling liquid with water or a liquid of a lower density compared to the mixture used for selling during the cementing process.

The production column is tested for tightness by crimping with preliminary replacement of the drilling fluid with water. In wells, at the mouth of which there may not be excessive pressure, the production column must additionally be tested for tightness by lowering the water level.

In the process of testing the columns for tightness by crimping, the internal pressure created on the pipes must exceed by at least 10% the possible pressure arising from the elimination of oil and gas occurrences and open fountains, as well as during testing and operation of the well.

The conductor and intermediate columns, together with the blowout equipment installed on them, after drilling the cement cup and exiting from under the shoe by 1-3 m, are repeatedly pressed by pumping water into the bottom in a volume that ensures its rise by 10-20 m above the shoe.

After drilling the cement cups in the conductors, intermediate and secret columns and deepening the well 15-20 m below the shoe, it is necessary to test the open part to determine the possibility of hydraulic fracturing.

Table 1.

Casing string		Mark diagram of BE	Pressure leak test of wellhead equipment and BE in kgf/cm^2		Name and type of wellhead equipment and BE	Quantity	Working pressure kgf/cm^2
The order of descent of casing columns	Title		Before installation	Before the opening of the AHRP formation			
2	Conductor	1	140	140	OP1 – 350x350	1	350
3	Technical column	2	280	280	OP2 – 280x350	1	350
4	Operational column	-	305	305	AFC 6-80/65-350	1	350
			305	305	OKK2-350-140x245x340	1	350

Note: Casing leak test pressure may vary according to actual conditions

The pressure of pressure testing is determined by the need to ensure tightness under the shoe of the column when closing the wellhead during open blowing.

In gas, gas condensate and oil wells with a high gas factor (200 m^3/m^3 and above), as well as other wells with an excess pressure at the wellhead exceeding 100 kgf /cm^2, the wellhead part of the column together with the column head after crimping with water is compressed with inert gas (nitrogen) at the same pressure as when hydraulic testing.

The inter-column space at the wellhead is pressed with water at a pressure not exceeding the residual strength of the previous column.

Leakproofness testing works should be carried out according to the "Instructions for testing wells for tightness", "Safety rules in the oil and gas industry".

After installing the BE, drill 1-3 meters from the casing shoe to test the cement ring on water.

On the conductor Ø 339.7 mm – perform a test on a drilling mud of 1.47 g/cm^3 with an overpressure of 11 kgf /cm^2;

On an intermediate technical column Ø 244.5 mm – perform a test on a drilling mud of 1.74 g /cm^3 with an overpressure of 7 kgf/cm^2

In all cases, when tested in an open barrel, slowly bring it to the design pressure within 15-20 minutes.

The tightness of the wellhead and BE Ø 339.7 mm of the column conductor is carried out in an appropriate way with a packer or the installation of a cement bridge and is carried out by regulations. The leakproofness test must be carried out once a month [11].

The tightness of the mouth part and the BE Ø 244.5 mm of the intermediate technical column is carried out in an appropriate way with a packer or the installation of a cement bridge and is carried out by regulations. The leakproofness test must be carried out once a month. The leakproofness test must be carried out once a month every 200 m.

Before opening the productive layers, it is necessary to test the tightness of the wellhead and the BE of the casing string [10].

Table 2.

Name of casing strings	Name of the test object	Depth of the well test, m	Type of equipment used for testing		Maximum pressure generated during the test, kgf/cm^2	Duration of work, hour
			Type	Quantity		
Operational column	Drill string	2745	AC - 32	2	300	13,1
Conductor	OP1–350 x 350	800	AC - 32	2	140 on the water	1,53
	Conductor		AC 105/70	1	105 1,47 g/cm^3 on solution	1,53
Intermediate technical column	OP2–280 x 350	2119	AC - 32	2	280 on the water	1,53

	Intermediate technical column		AC 105/70	1	143-1,68 g/cm^3 on solution	1,53
Operational column	AFK6-80/65 – 350	2764	AC -32	2	305 on the water	1,53
	OKK 2 - 350 - 140 x 245 x 340		AC 105/70	1	100-1,81 g/cm^3 on solution	7,00
	Operational column		SD	1		
Testing of cement stone for tightness						
Conductor	Cement Ring	800	AC - 32	1	11-1,47 g/cm^3 on solution	1,53
Intermediate technical column	Cement Ring	2119	AC - 32	1	7-1,74 g/cm^3 on solution	1,53

The leakproofness testing work must be carried out according to the current safety rules, the guiding documents and with the guidance of responsible employees.

The test results are recorded and approved by acts in accordance with the established procedure.

Calculations were carried out in accordance with the "Instructions for the calculation of casing strings for oil and gas wells" (RD 39 - 7/1 - 0001 - 89) and "Instructions for testing wells for tightness".

The leakproofness test and the technique used to perform on the directional operational evaluation well No. 707 at the Western Cheleken field are indicated in Table 2.

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