AZERBAIJAN REPUBLIC MINISTRY OF EDUCATION

KHAZAR UNIVERSITY

Graduate School of Science, Art and Technology

Specialty: Petroleum Engineering

Master thesis

Applying modern logging for minimize production risks in oil and gas wells.

Student: Azar Najafzade

Supervisor: Elvin Ahmadov (PhD in Earth Science)

Baku – 2021

AZƏRBAYCAN RESPUBLİKASI TƏHSİL NAZİRLİYİ

XƏZƏR UNİVERSİTETİ

TƏBİƏT ELMLƏRİ, SƏNƏT VƏ TEXNOLOGİYA YÜKSƏK TƏHSİL FAKÜLTƏSİ

İxtisas: Neft-qaz Mühəndisliyi

Magistr Buraxılış İşi

Neft və qaz quyularında hasilat risklərinin azaldılması üçün müasir karotaj üsullarının tətbiqi

Tələbə: Azər Nəcəfzadə

Supervayzer: Elvin Əhmədov (Yer Elmləri üzrə fəlsəfə doktoru)

Baku – 2021

Reference

Clearly, everyone who works in oil and gas field knows that logging operations are very important to produce our oil and gas without any risks and undesirable incidents. There are many different purposes to use logging in our well. For instance, one of them is to find out our production point in oil and gas well. After the logging operation, the report paper of logging operation shows us where our resource is located. According to this, we can decide how many meters our well deep. Other reason using log is to determine curing time of cement. After running casing, immediately, cementing engineers come to the field to pump the cement to free space between the casings or casing and wellbore. These are different operations that's why we use different kind of the log to analyze. Therefore, cement logging also is important. In this thesis, we are going to analyze and observe real cases and results of the logging operations in oil and gas fields. Mainly, in production zones logging operations should be done because undesirable incidents and risks are more than other zones. Currently, we use the most modern logging in our fields to ensure that everything is okay, and we can continue other operations. Production zone which is perforated is more dangerous zone because perforated zones may be banned, and it may cause well lost. As a result, production engineers lost their production zone, company is out of pocket and loss well structure. Learning about logs and logging operations and how to use with them helps to improve technical operations, also we don't waste time with undesirable accidents, safety factor increases in the field. The most main thing in the oil and gas field is safety. Improving our capability and knowledge about using logs to maximize safety in the platform.

Referat

Aydındır ki, neft və qaz sahəsində çalışan hər kəs, koratak əməliyyatlarının neft və qazımızı heç bir risk və arzuolunmaz hadisələr olmadan çıxarmaq üçün çox vacib olduğunu bilir. Quyumuzda koratak əməliyyatlarının istifadə etmək üçün müxtəlif məqsədlər var. Məsələn, bunlardan biri neft və qaz quyusundakı hasilat nöqtəmizi öyrənməkdir. Korataj əməliyyatından sonra, qeyd əməliyyatının hesabat kağızı bizə hasilatın harada yerləşdiyini göstərir. Buna əsasən quyumuzun neçə metr dərinliyinə qərar verə bilərik. Gündəlikdən istifadənin digər səbəbi sementin bərkimə müddətini təyin etməkdir. Kəmər endirildikdən sonra dərhal sement mühəndisləri sementi qoruyucu kəmərlərlər arasına və ya qoruyucu kəmər və quyu arasındakı boş yerə pompalamaq üçün sahəyə gəlirlər. Bunlar fərqli əməliyyatlardır, buna görə analiz etmək üçün müxtəlif növ loglardan istifadə edirik. Bu səbəbdən sement karotajı da vacibdir. Bu tezisdə neft və qaz yataqlarında korataj işlərinin real hallarını və nəticələrini təhlil edəcəyik və müşahidə edəcəyik. Əsasən, istehsal zonalarında arzuolunmaz hadisələr və risklər digər zonalardan daha çox olduğu üçün korataj əməliyyatları aparılmalıdır. Hal-hazırda hər şeyin qaydasında olmasını təmin etmək üçün sahələrimizdəki ən müasir loglardan istifadə edirik və digər əməliyyatlara davam edə bilərik. Perforasiya olunmuş istehsal zonası daha təhlükəlidir, çünki deşikli zonalar tutula bilər və bu da çox itkiyə səbəb ola bilər. Nəticədə istehsal mühəndisləri istehsal bölgələrini itirə, şirkət pul itirə və quyu quruluşunu itirə bilər. Loglar və karotaj əməliyyatları və onlarla necə istifadə ediləcəyini öyrənmək texniki əməliyyatların yaxşılaşdırılmasına kömək edir, istənilməyən qəzalarla vaxt itirmirik, sahədəki təhlükəsizlik faktoru artır. Neft və qaz sahəsində ən əsas şey təhlükəsizlikdir. Platformada təhlükəsizliyi maksimum dərəcədə artırmaq üçün qeydlərdən istifadə etmək qabiliyyətimizi və biliklərimizi inkişaf etdiririk.

Content

Chapter 1

1 Production problems in oil and gas wells.

1.1 Production problems in oil well.

Oil is not always chemically inactive resource under oil production condition. Changes in pressure and temperature in the formation can help to gathering of solid, organic or inorganic in the production system, as well as its result is corrosion of the metal which is directly fluids contact.

Production problems start when oil enter wellbore and when oil arrive the storage. Mainly, oil is not pure in the formation, its physical composition is usually complex during the production crude oil saving the solid. These savings may be banner during the production, they can plug wellbore and valves and production engineers can loss process control and equipment. Solids also can accumulate in separators and pipelines, as a result it causes huge economical cost for a company.

Even in the most meticulously designed wells, issues are nearly guaranteed to arise throughout the drilling process. Because deposits are nonhomogeneous, hole issues may have been observed where no such problems existed previously in places where comparable drilling methods are utilized. As a result, two wells that are close to each other might have completely distinct geological conditions. Drilling plans should be designed on the basis of anticipating future hole issues rather than caution and containment in order to achieve objectives successfully. The weakening of the invisible by the predictable, creating an unknown reduction in the unquantifiable, has been characterized as inflicting formation harm. Formation damage is defined as the harm to the reservoir (lower output) caused by wellbore fluids utilized during drilling/completion and workover operations in a different context.

Main banner for the production is the asphaltene (Paraffin) and Paraffins chemistry vary with field for example, asphaltenes in oil from the well in Azerbaijan field is different from asphaltenes found in North Sea, Venezuela, Russian and another fields. Asphaltenes can be different form in different pressure and temperature. In Figure 1, at the constant temperature but in different pressures is illustrated:

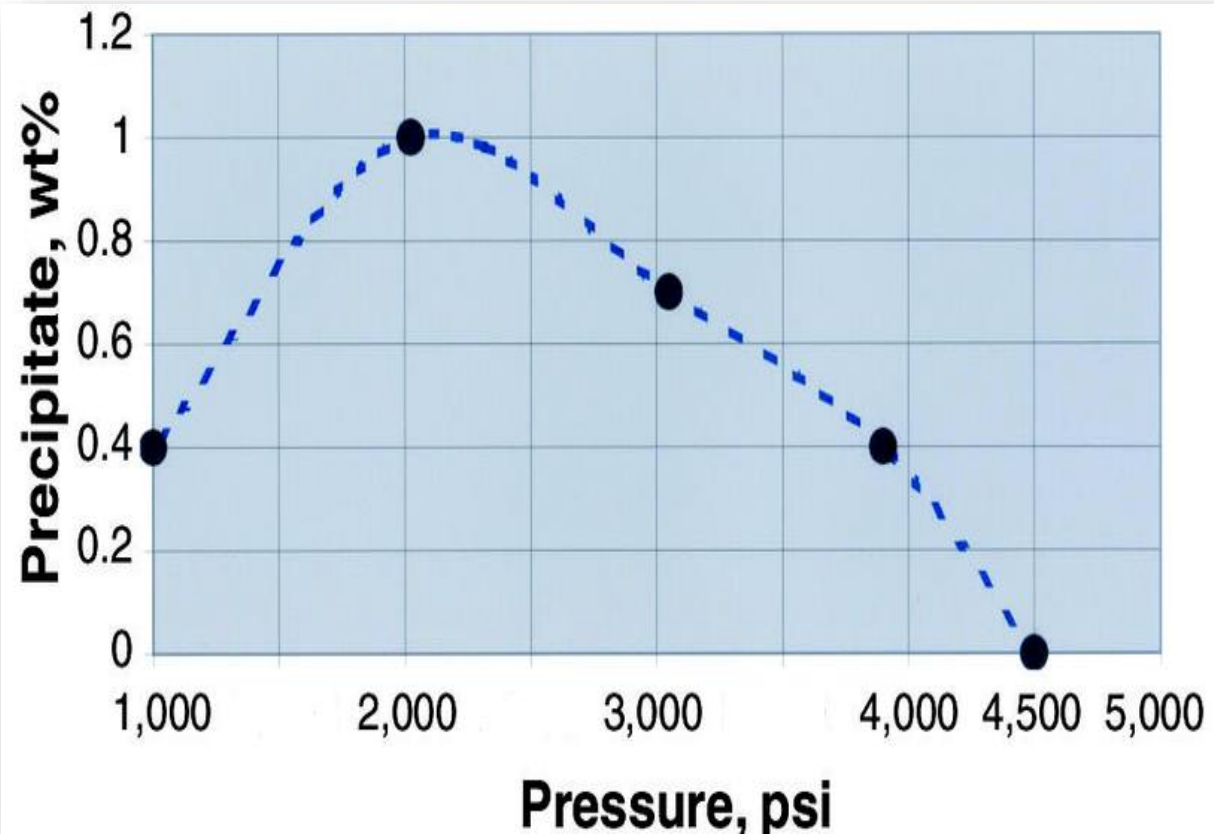

Figure 1 Asphaltene at the constant temperature

As a graph, it's clear that the more precipitate is observed at 2.000 psi in constant temperature (100 C). At the maximum pressure, Precipitate of asphaltene is the minimum.

In oil wells, Production problems is related more with these:

1. Partial Penetration
2. Scales and Precipitates
3. Paraffin (asphaltenes)
4. Decrease permeability
5. Emulsions
6. Collapse of the formation.

Partial Penetration

When oil is flowing from the reservoir to the partial penetration zone may cause large pressure near the wellbore and this does not be good effect, reduce productivity of the well.

Decrease permeability

While the well is produced, Pressure slowly, decrease near the wellbore and decreasing the pressure can help the gas for release in oil reservoir. In soft and badly cemented formations, strong pressure decreasing occurs in the wellbore, and it help to collapse the formation.

Emulsion

Emulsion is also production problem near the wellbore. It would be banner that restrict whole production of the well from the reservoir.

Excess water production problem is also one of the important problems which occurs in productive formations. It's important using new technique and approaches to improve production rates (efficiency) and reduce costs. Mostly, this kind of problem (excess water production) is observed in horizontal oil wells that can be solved by water shut-off technology, it is called gel-based fluids. After injection of water shut-off gels, water production stops, slowly.

These kinds of problems cause both overproduction and underproduction.

In oil wells, these kinds of problems include:

- Sand Production
- Excessive gas production
- Low permeability and Low productivity

Sand Production problem can occur probably by unconsolidated formation or activities on the well imposed by humans. Mainly, mechanical rock failure can cause sand production during the fluid flow from the reservoir or additional stresses can cause by production or drilling. In unconsolidated formations, sand production problem may be occurred during the first flow which is coming from the reservoir.

In case of these types of formations, Sanding may be happened because of the:

1 production rate

2 water breakthroughs

3 change in liquid ratio

But at the end, Sand production problem can lead to different kind of problems during real-time of the wells which is mainly production engineer's problems. For instance, these problems can occur during the lifetime of the well:

- Formation damage
- Casing collapse
- Wellbore instability
- Lost production time because of the Shut-in
- Environmental problems
- Cost, economically, for separating sand from fluid
- Coil tubing (Repair), economically
- Service and surface equipment
- Measures at the production zones
- Collapse by the flowing sand

Clearly, Large sand grains can come out of the formation with fluid. If sand production rate would be great and it may continue during the production, sand grains may accumulate together and can create lower permeability in that case, it can be caused to stop or weak the production rate.

Another result of the sand production is formation damage. Engineers can lose totally wellbore if seriously, formation damage would happen.

From the reservoir, sands come and fill the perforated zones and as a result of high sand production, increase the pressure and therefore, this may cause casing collapse, loss of reserves, loss of productivity, and access may block to production zone.

In the surface, engineers can also deal with problems (mainly, erosion) - difficult wireline operations may be example for this.

Effects of sand accumulation on the surface:

- Loss of capacity
- Sand disposal and separation
- Abnormal Shutdowns
- Break down of control equipment.

To calculate volume of the produced sand from the separator with Clamp ton sand sensor reading every same period of 72 hours.

Removing sand which is co-produced with reservoir fluid include surface sand management systems. Sand can use up pipes and equipment and may be problem during the oil or gas separation process if sand is present in enough volume.

The Sand may be cause to undesirable effects during the process If not removed:

- First, sand volume occupies volume of the oil and gas phase separation as a result, decrease the performance of the productivity and with in oil-in water or water in oil concentration.
- In production well construction, control valves and pumps are not designed for the sand tolerant, that’s why it may cause erode downstream equipment and vessels.
- Removing sand from the fluid and separation is the batch process, generally.

Equipment and Personnel-Related Problems

Personnel

Personnel are the key to the success or failure of drilling/completion operations under similar conditions. Overall well costs can be exceedingly expensive as a result of any drilling/completion difficulty; thus, ongoing education and training for staff directly or indirectly engaged is critical to effective drilling/completion procedures.

Drilling equipment integrity and maintenance are important elements in reducing drilling difficulties.

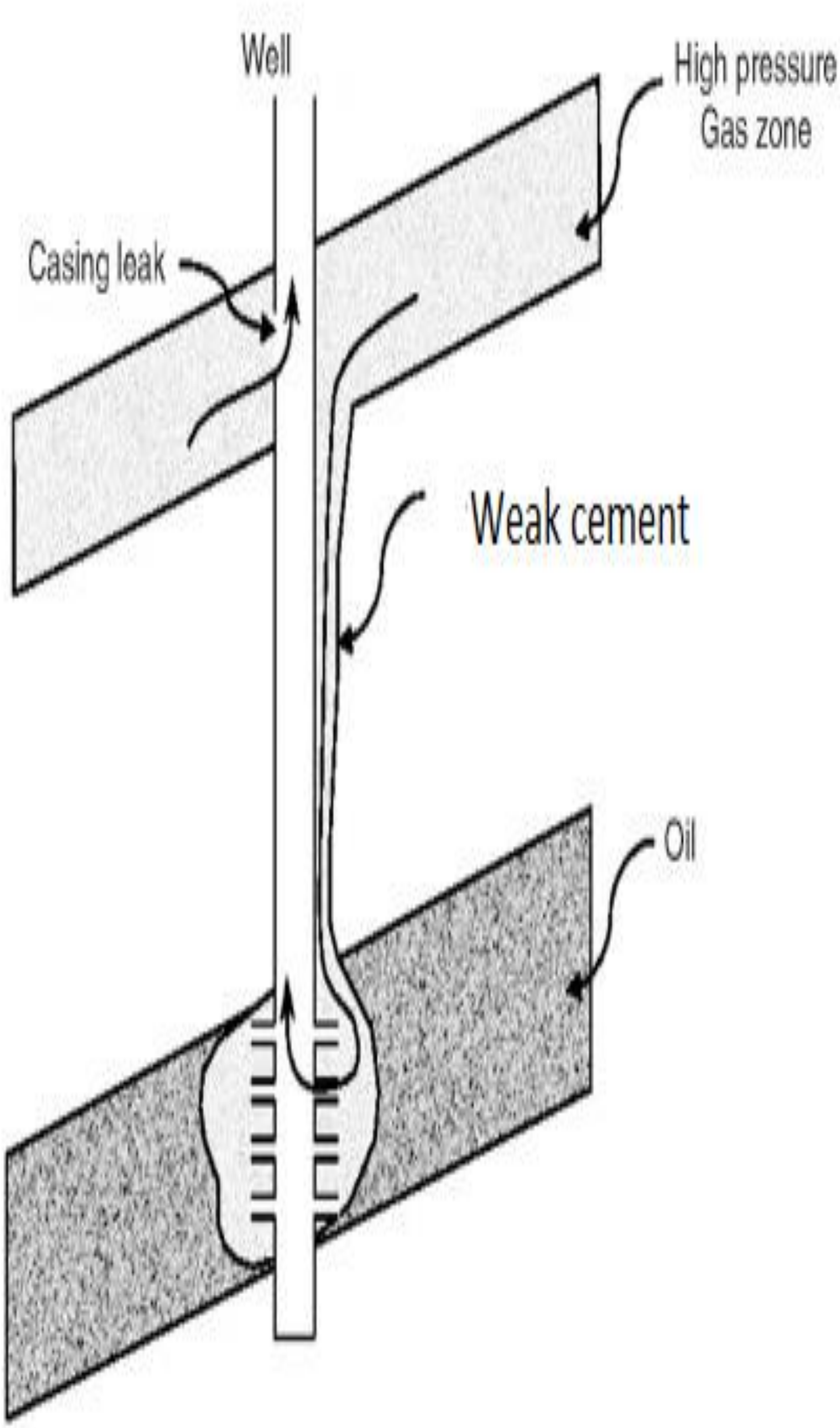

Figure 2 Excessive gas production problem

Excessive gas production usually occurs behind the casing because of the channel between the casing and wellbore.

And it is also possible, after the bad cementing job, gas can escape from the high-pressure gas zone to the wellbore.

If casing damage, gas also can leak from that zone to the well.

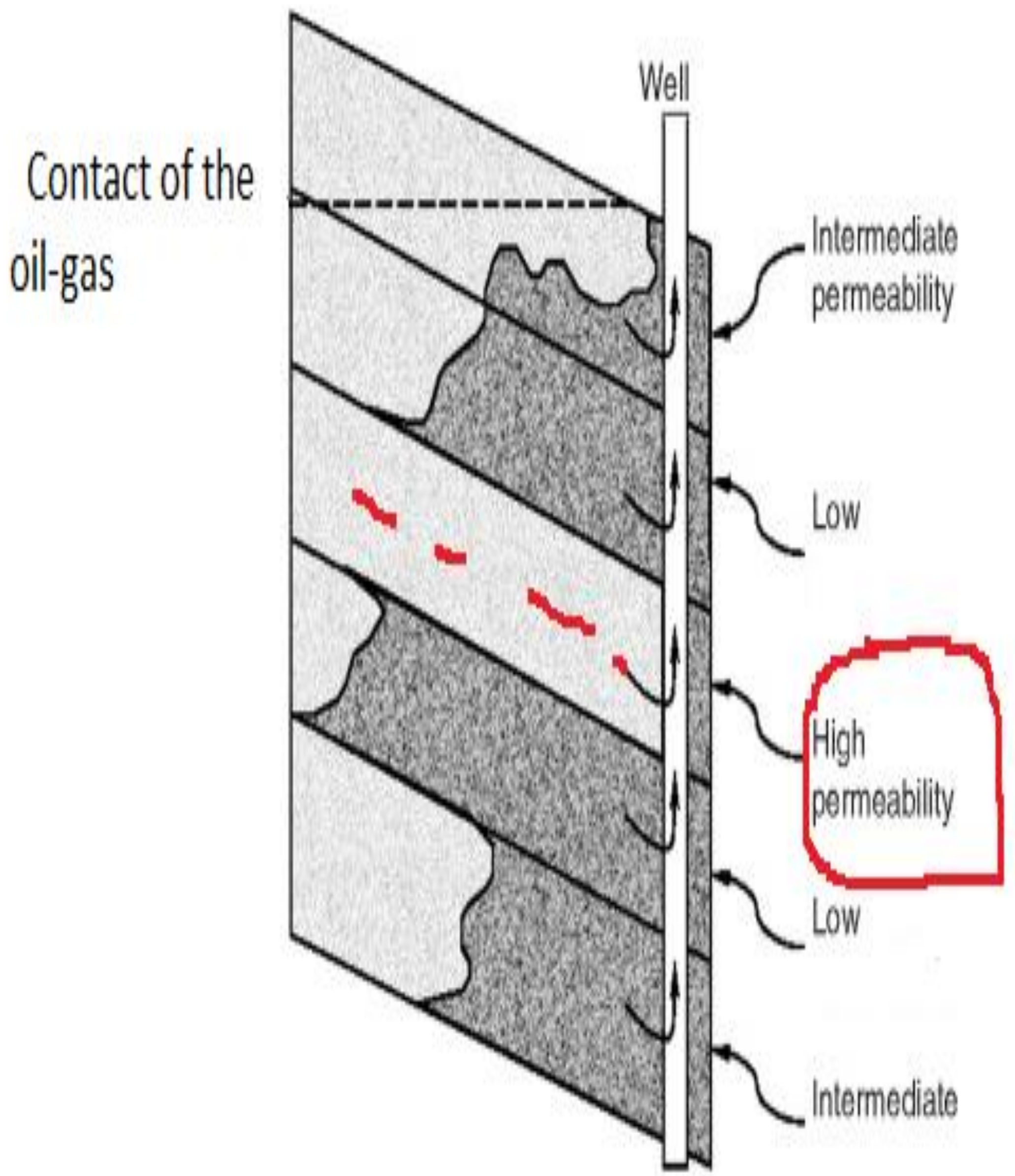

Figure 3 Illustrating excessive gas production according to permeability

Due to the high permeability, gas production. If oil contact is higher than gas contact, gas production possibility would be low as shown in the figure:

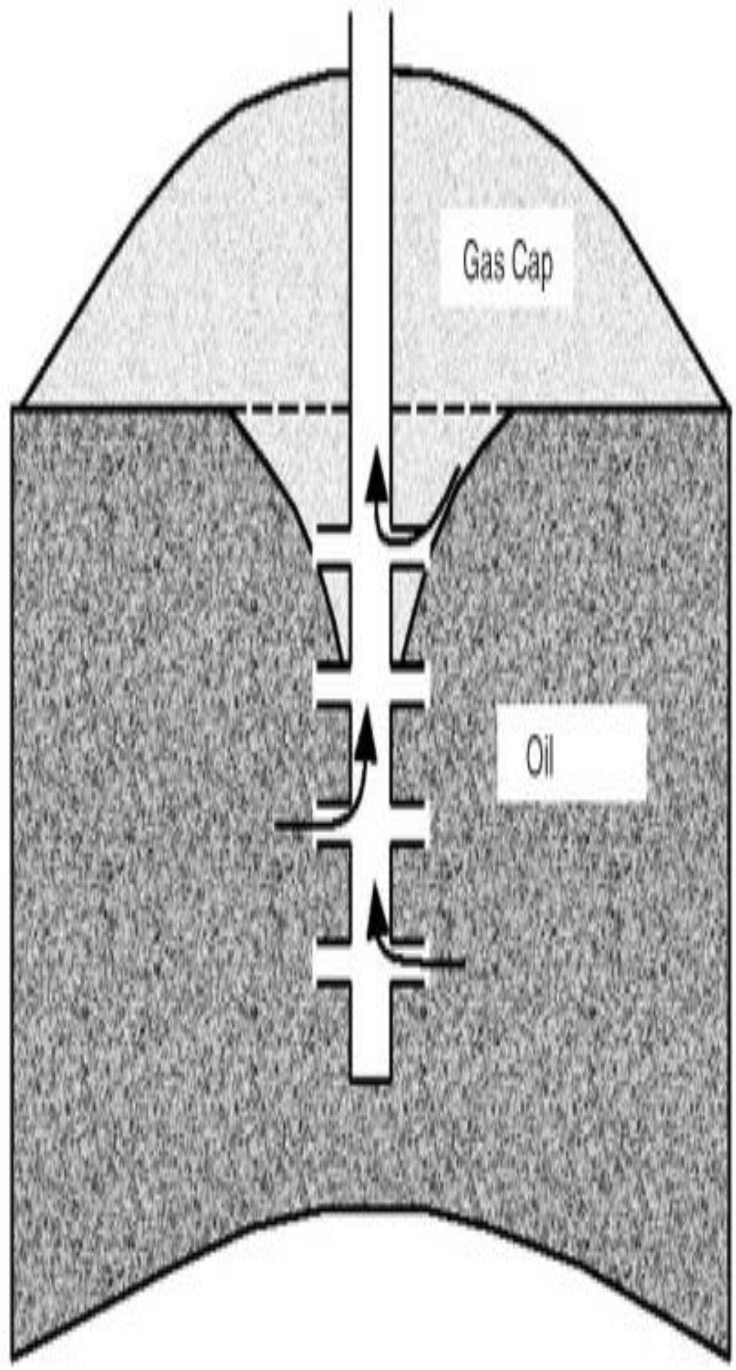

Figure 4 Oil production through gas cap

Gas production problems can be identified with the production logs as noise and temp logs. Both logs can find gas-sand and channel in oil zone.

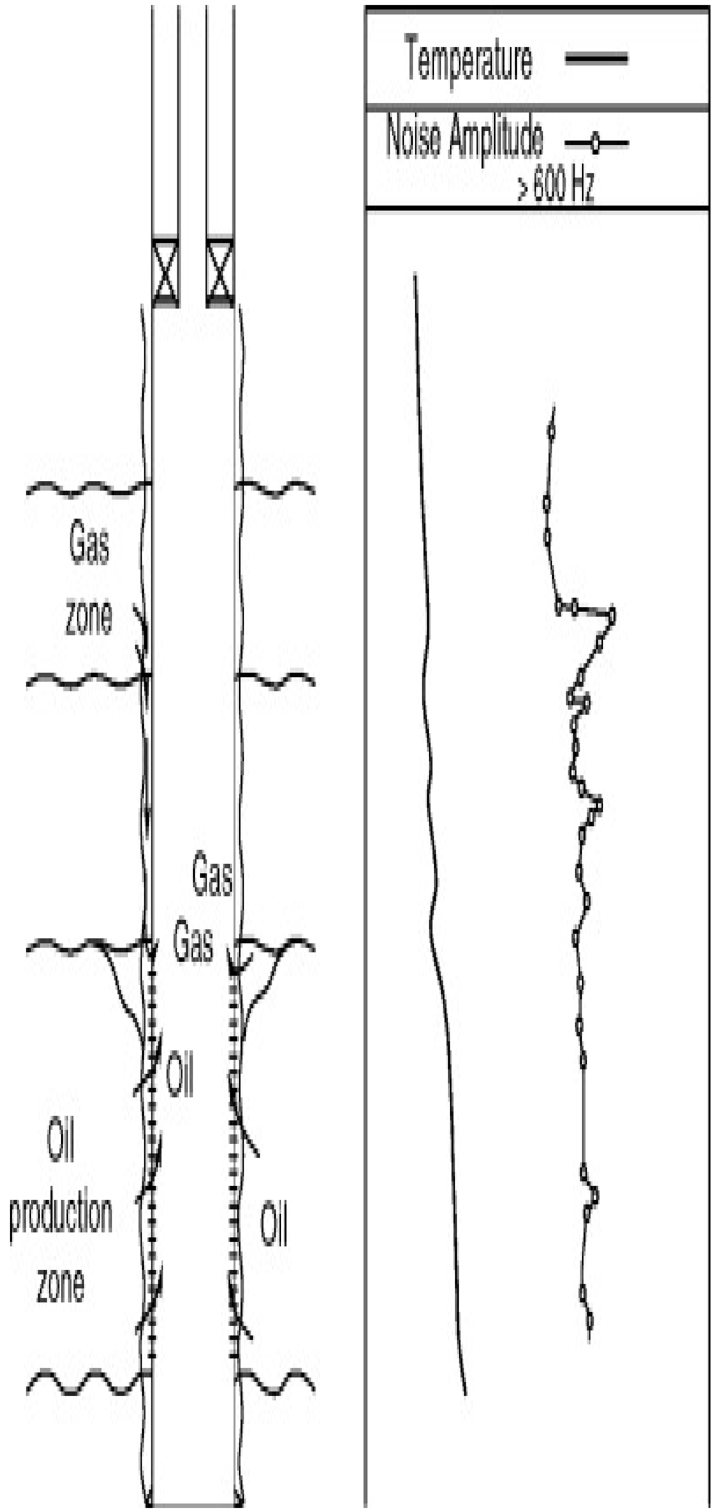

Figure 5 Using log to identify gas production zones

This kind of problem of oil well may occurs in unexpected gas zone. Excessive gas production can be identified with using production logging such as temperature logs.

1.2 **Production problems in gas well.**

Natural-gas Hydrates are ice-like solids formed by the combination of free water and natural gas at high pressure and low temperature. This may happen in both gas and gas/condensate wells as well as oil wells. The location and strength of hydrate accumulations in a well differ and are determined by:

- Fluid composition
- Geothermal gradient in the well
- Design
- Operating regime
- Other factors

Shut-in gas wells are especially vulnerable to significant hydrate issues if the well has been generating some water. Following equilibration of the tube and its contents with cold regions of the rock, the temperature in the hydrate-formation area can be reduced. Hydrate nuclei develop as a result of water films on the tubular walls. Following crystallization, huge plugs of hydrate tens can form.

Hydrate formation can also occur within a shut-in oil well, producing a solid slurry capable of collecting and blocking the pipe. According to the reasoning, oil will dissolve some water—usually in tiny amounts. The quantities can range from 5 to 10 mol percent (at 300°F) under high temperature/high-pressure (HT/HP) conditions. As the oil rises up the wellbore, the temperature drops, and liquid water emerges from solution, remaining suspended as microdroplets. The microdroplets eventually agglomerate and precipitate in a static state. At the right pressure/volume/temperature (PT) levels, this liquid water is saturated with gas, allowing hydrates to form.

Inhibitors

Inhibitors are an option to production control. These are categorized as follows:

- Thermodynamic inhibitors
- Kinetic inhibitors
- Environmental inhibitors

The most basic “environmental inhibition” approach is to dry the gas before cooling it, removing any water and hydrates that could develop. Adsorption onto silica gel, for example, or cooling and precipitation, water absorption into alcohols, or adsorb onto thixotropic salts are all examples of this.

The most frequent approach for managing gas hydrates has been “thermodynamic inhibition.” There are several alternatives:

- Injecting alcohol or glycol
- Heating the gas
- Decreasing pressure in the system
- Injecting salt solutions

The use of electrical-resistance heating via wires linked to a transformer is one technique of supplying heat to the hydrate-formation zone. Another option is to locate the choke in an area of the production system that is sufficiently hot. Injection of salts (mainly $CaCl2$) decreases hydrate formation by decreasing water's chemical stability and the absorption of gas in water.

Removal of solid hydrates

Many of the same chemicals and technologies that are used to prevent hydrate development are utilized to remove solid hydrates. If feasible, the easiest way is to lower pressure above the hydrate plug sufficiently to reverse the equilibrium process. The most frequent approach is the addition of solvents such as alcohols and glycols (well completions will often provide for a methanol-injection line).

Excessive water production, sand production, liquid loading and low productivity problems occur frequently in gas wells.

Excessive water production stems usually from the water zones. Water go into the wellbore due to hydraulic fractured, casing leaks, with channel behind casing and flow from the high permeability zones.

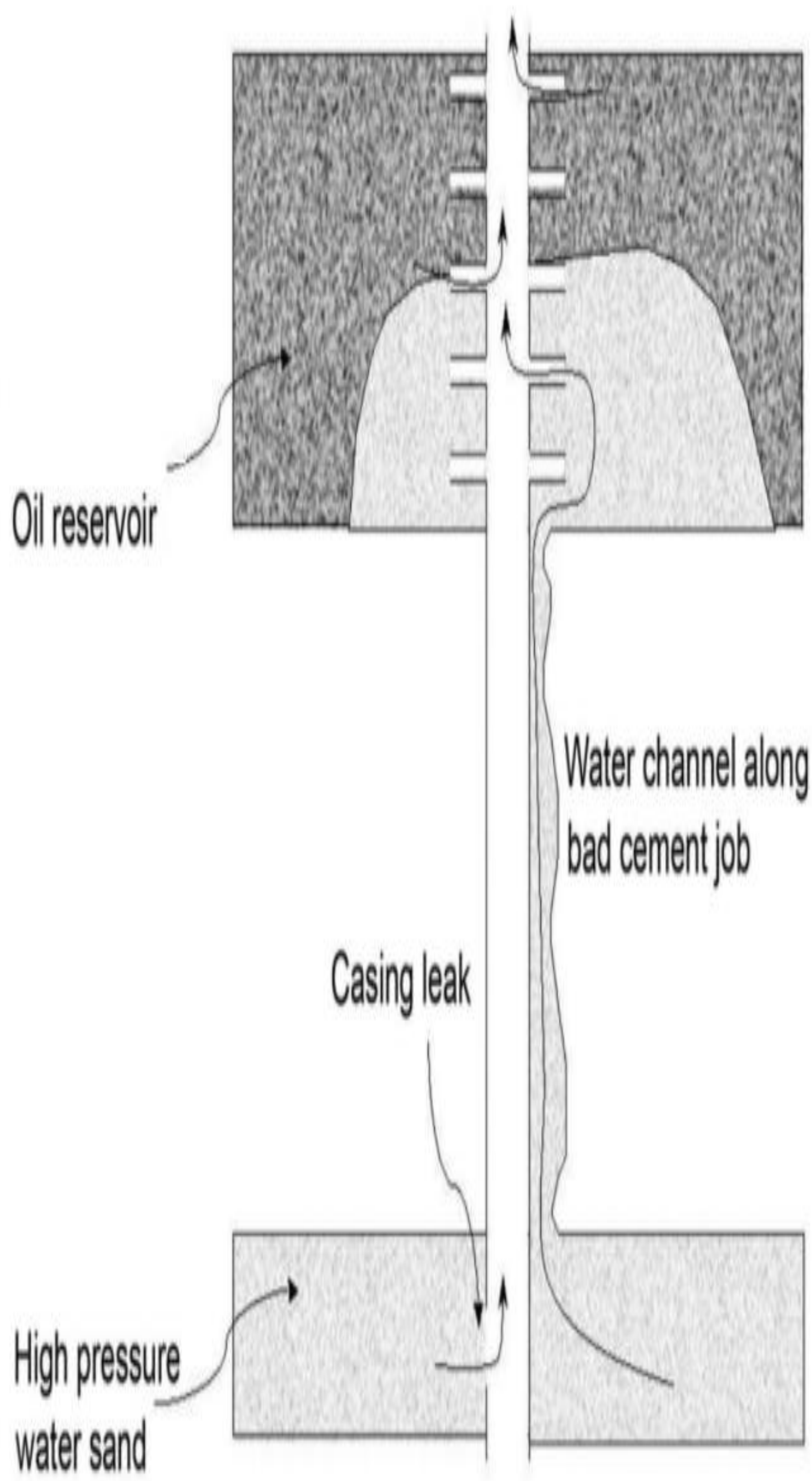

Figure 6 Casing leak and weak cement problem

Using the temperature logs, it is possible to find where hydraulic fractured has occur in water zone

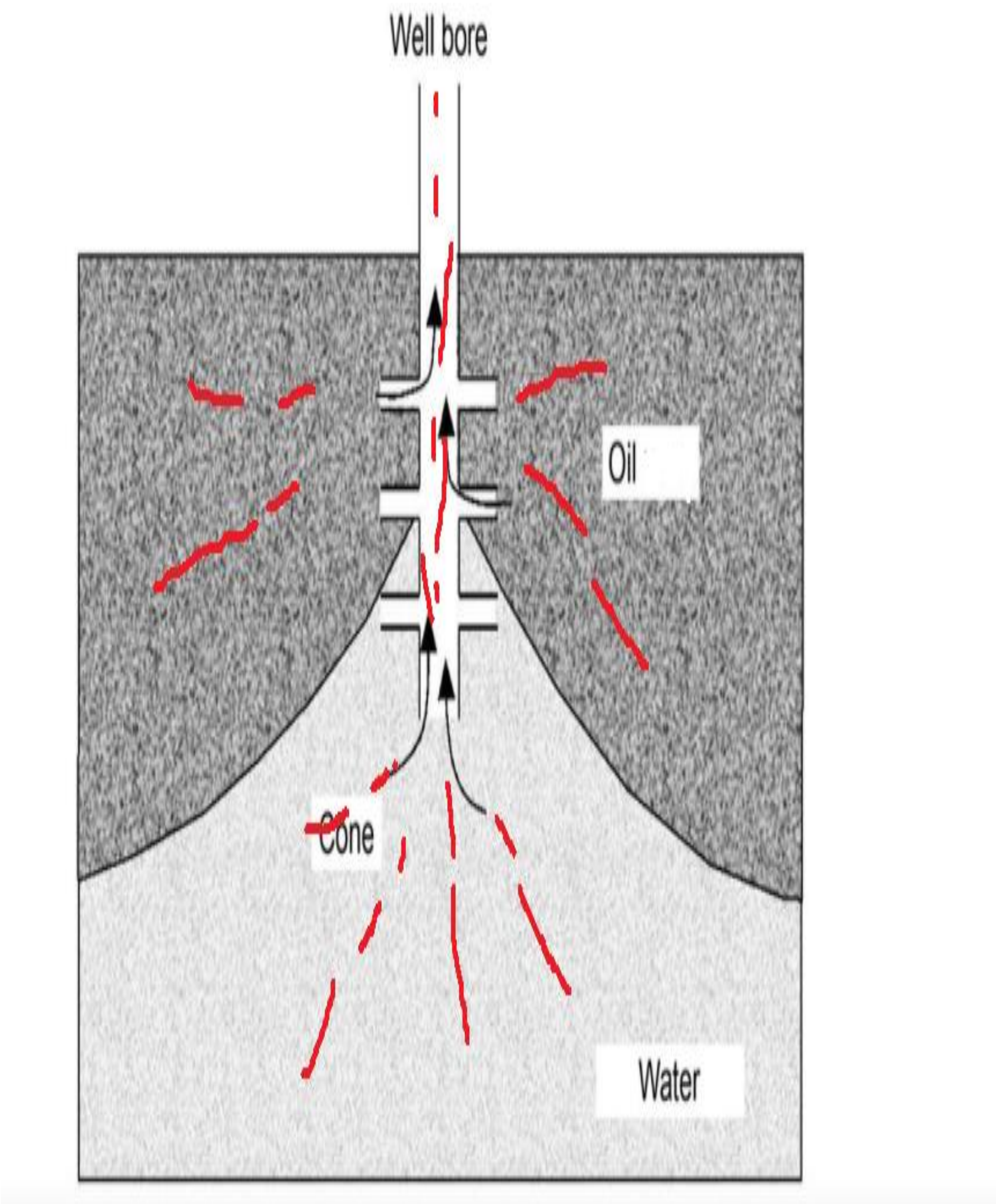

Figure 7 hydraulic fractured has occur in water zone

Other production logs can help to find water-producing zone such as temperature and noise logs. But density logs are specific logs that using to identify water.

Another log for identifying water produced zone is spinner flowmeter log. This log can help to find water zone at the bottom of the well.

Liquid loading in gas wells.

As usual, gas wells produced natural gas with liquid water or condensate. If gas flow velocity decreases in the well, at the same time, reservoir pressure begins to drop and gas carrying capacity decreases. There is critical level of the gas velocity in the well when this happen, liquids begin to increase at the bottom of the well and as a result, liquid loading causes increase bottom hole pressure, which reduces gas production rate.

Different kind of the measuring systems are using to address the liquid loading problem. For instance, foaming the liquid water can be mentioned. It is enabling to lift water from the gas well with using smaller tubing.

Sanding problem in gas and gas condensate wells

Sanding problem in weakly gas reservoirs is affected by flow rate, density and viscosity of the fluid, particle size, acceleration due to gravity, cavity height, borehole and cavity radius and density of sand. Cavity radius depend on production rate if in gas condensate wells, high production would be up to 10000 MSCF/day and above can cause high cavity heights between 31 and 65 ft.

Mainly, breakdown of the rock or disaggregation of the rock can cause sand production in gas wells which sands in small enough to pass through the peroration or screens.

1.3 Well integrity issues

In some cases, the integrity of the wells is violated. Because of these processes, pressure is created behind the pipelines of the wells, threats to the operation process arise, and liquidation work becomes more complicated. Regardless of the reasons for these risks, well integrity management is a priority. Currently BP, TOTAL, STATOIL, etc. Many big operators approach this issue with different standards. The following international standards are available for this: NORSOK D-010, API 90, SF-0.8, etc. In our country engineers use the SF-0.8 standard. However, given the severity of the issue, the job requires delicacy. That is, each well must be approached individually. First, the barriers in contact with the well phases are determined. Such barriers include belt heads, cement stone in the belt shoe, conductors, packer.

Calculations are performed in the following sequence to control wellbore pressure.

1. Eliminate 80% of the splitting and bending (excess) belt pressures. To calculate the values of the overpressure of pipelines included in the API and GOST standards [6, 7], special catalogs are used. Overpressure depends on the grade, material, diameter and thickness of the pipe.

2. The test pressure data for belts, belt heads and packers are used for calculations.

3. Differential pressures in the interbond space are calculated using the following expression:

$$T = \left(\mathrm{Ty} - \frac{(p-pf)H}{10}\right)K$$

T-Pressure, p-density, pf – first density,

Here Ty and T are the differential splitting pressure and differential bending pressure, is the splitting and bending pressure of the pipe, atm, and is, respectively, the density of the liquid behind, in front (inside) of the computational space and in the distance between the belts, q / cm3, H - vertical depth of the shoe, m, k - safety factor, which in most cases is 0.8.

4. The burst pressure of the shoe is determined by the following expression:

To be = PB - Phys (3)

where Pb is the pads check pressure, atm, Phys is the hydrostatic pressure when the pads are checked.

5. Maximum Allowable Belt Pressure - equal to the minimum value of the pressures calculated above for each non-mode space.

6. Maximum Allowable Working Pressure is 80-90% MWIT in accordance with international standards.

During the operation of wells, the pressure in the intercellular space should not exceed the MIVIT value. If the pressures exceed these limits, the pressure in the intermediate space must be released at regular intervals and increased by the same volume of liquid with a higher density.

The application of the theoretical foundations of the process of managing the bottom hole pressure of wells in accordance with international standards in Azerbaijani oil and gas and gas condensate fields is important for the safe and low-risk operation of wells. This approach was used in the process of controlling the annular pressure of gas condensate wells drilled in the Umid field, and preventive technical measures were taken.

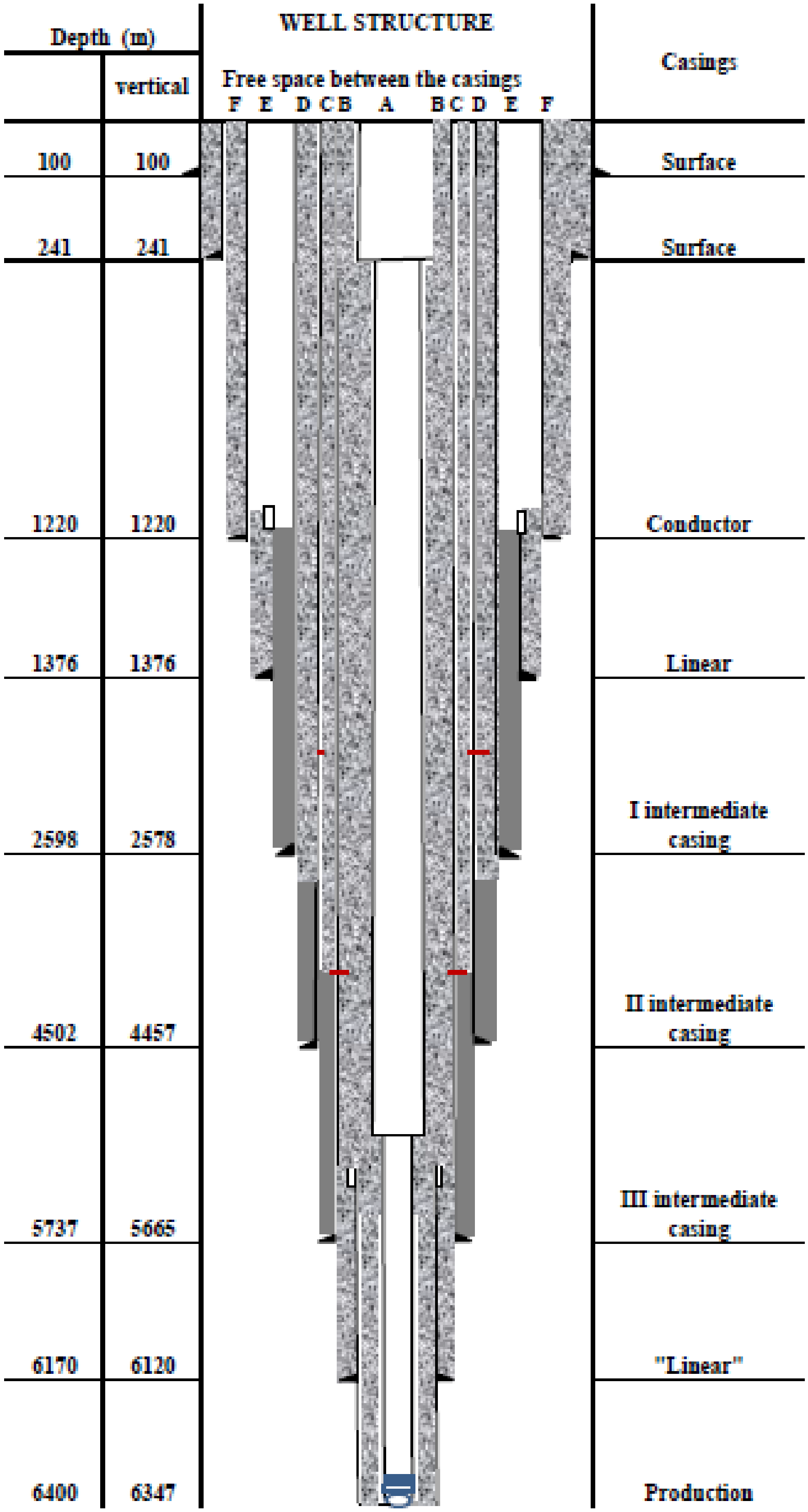

Figure 8 Real well structure

During the discharge from the space behind the pipeline, water with a density of 1007 g / cm3 was observed. According to the results of laboratory studies, this liquid was defined as water formed during the washing of the rocks depleted during drilling with water mixtures of the upper layers of the Balakhanskaya LD and the lower layers of the Sabunchi LD. This water entered the back of the pipeline from layers over 4000 m.

Date	Nonlinear pressure in space C, atm.	Pros
09.04.2012	-	The tightness of the production line is tested at a pressure of 620 atm.
13.05.2012	130	Flushing has been carried out.
17.05.2012	150	Flushing has been carried out.
20.05.2012	177	Flushing has been carried out.
28.05.2012	224	Replacing the drilling fluid with $CaBr_2$ saline solution.
30.05.2012	218	
03.06.2012	238	NKB Run
07.06.2012	278	Casing Pros
08.06.2012	290	Perforation.
01.07.2012	328	Construction of power transmission lines has begun.
04.07.2012	330	
05.07.2012	341	The pressure was dropped from 341 atm to 240 atm.

31.07.2012	330	When the interband pressure rises to 340 atm, 240 atm is released.
19.09.2012	315	The well was put into operation and, in accordance with the procedure, the annular pressure was reduced from 315 to 215 atm.

Table1

Calculations were performed to evaluate the process in accordance with international standards and to determine the MAASP and MOASP for line pressure control. For these calculations, data were collected on the brand, size, gauge pressure, test pressure and test pressure of the shoe flow, as well as the density of the intercellular fluid, which were used to make the belts (Table 2).

Experimentally, this calculation method is described below using the example of the priority space of the C-shaped belt of well No. 10 drilled in the Umid field.

Space C is called the space between belts 10 3 / 4x10 "and 13 5/8". In this space, the flex is designed for 10 and 10 3/4 "belts and the slit is for 13 5/8" belts. As can be seen from Table 2, the burst pressure is assumed to be 654 atm, and the bending pressure is 318 atm for a space without carbon. To determine these pressures, it is necessary to select the minimum values of the overpressure of the belts surrounding the space C. Accordingly, the values of the pipeline depth with the lowest overpressure were used for the calculations. Belts 10 3 / 4x10 "and 13 5/8" were tested at 360 atm and 290 atm, respectively, and the belt heads were tested at 800 atm and 350 atm.

The difference between the densities of the fluid in space C and the fluid in space D is taken into account when calculating the burst pressure differential, and the difference in density between the fluid in space C and the fluid in space B is taken into account. take into account when calculating the bending pressure drop. Thus, the fracture pressure drop of space C is set at 723 atm, and the bend pressure drop is set at 255 atm.

In the next step, the shoe splitting pressure is determined by the following expression. To do this, the difference between the shoe flow test pressure and the current hydrostatic intercellular pressure C after cementing the 13 5/8 in. Pipe was calculated.

$$P_{byt} = P_{bayt} - P_{hy} = 901 - 321 = 580 \text{ atm}$$

As noted, the lowest computation cost should be chosen to define the MAASP. Therefore, the minimum value in space C is set at 80% (254 atm) belt flexure of 10 3/4 inches. MOASP was determined to be 204 atm.

Thus, safe and risk-free well operation can be ensured by maintaining the maximum pressure in space C up to 254 atm and operating pressure up to 204 atm.

After determining the MAASP and MOASP, technical measures were taken to reduce the pressure in phase C of the well. When the intracranial pressure exceeds these limits, the pressure in the C space is released at regular intervals and is increased by the introduction of a fluid with a higher density.

Chapter 2

General information about logs (Cement logs)

2.1 About logging operations.

For years, to collect data about wellbores and subsurface formations, a variety of logs have been created. This chapter explains how different log types relate to different reservoir characteristics. It also includes links to posts that go into more detail on different types of logs and specific applications.

Types of logs

- **Nuclear Logging**
  - ➢ **Gamma ray logs**
  - ➢ **Density Logging**
  - ➢ **Neutron porosity logs**
  - ➢ **Geochemical logs**
  - ➢ **Spectral gamma ray logs**
  - ➢ **Pulsed neutron lifetime logs**
  - ➢ **Carbon oxygen logs**
- **Acoustic logging**
  - ✓ **Cement bond logs**
- **Resistivity and spontaneous (SP) logging**
  - ➢ **Electrode resistivity devices**
  - ➢ **Spontaneous (SP) log**
  - ➢ **Micro resistivity logs**
  - ➢ **Induction logging**
- **Sonic logging**
- **Mud logging**
- **Nuclear magnetic resonance (NMR) logging**
- **Production logging**
  - ➢ **Temp logging**
  - ➢ **Radioactive tracer logging**
  - ➢ **Fluid capacity logging**
  - ➢ **Noise logging**
  - ➢ **Unfocused gamma ray density logging**
  - ➢ **Diverting spinner flowmeter**
- **Specialty logs**
  - ✓ **Downhole magnetic surveys**
  - ✓ **Borehole imaging**

- ✓ **Casing collar locator**
- ✓ **Open hole caliper logs**
- ✓ **Casing inspection logs**

Nuclear Logging

Nuclear logging gives us accurate and necessary data about lithology and rock. Improved technologies for measuring natural and induced nuclear readings have been established as a result of recent technological innovations. Also, with improved device designs, the long-standing issue of logging tools not accurately measuring the formation properties that engineers and Petro physicists use to characterize a reservoir. Sadly, only the gamma ray or neutron counts at cleverly located sensors are measured by nuclear logging devices.

Two kinds of radiation, GR and neutrons, are the only use of nuclear logging instruments. They both adopt general laws of dispersion but have special form and cross sections of reaction.

- ➢ **Gamma ray logs**
- Spectral gamma ray logs
- Density logging
- ➢ **Neutron logs**
- Neutron porosity logs
- Pulsed-neutron-lifetime (PNL) logs

The rocks' radioactivity was used for lithology obtaining for several years. The elements uranium, thorium, potassium, radium and radon along with the minerals in which they are contained provide natural radioactive content (NORM).

The recording of density is another gamma-ray application to collect data for subface formations. Gamma-gamma dispersion or Photoelectrical absorption (PE) was used to record the density.

Production logging

Although many logs are used to describe the wellbore, shape, and fluids prior to well completion, there are a variety of logging techniques available to provide data during production operations. Due to production logging, Wireline engineers can control many hole services: Cement monitoring, formation fluid and corrosion monitoring. When a well has pressure at the surface, it's common to use a short logging cable to:

- Reduce the tool weight
- To seal and keep the wireline cable

Application of the production logs

Production logs are used to assign production to zones, as well as to identify production issues such as cross flow (flow behind pipe).

Temperature logging. At the tool's lower end is a cage that is exposed to the wellbore fluid. A thermistor is located within the cage and detects the temperature of the surrounding fluid. Temperature log’s sensor is the platinum element because of the electrical resistance of the sensor.

Noise logging. Noise logging is a low-cost method of determining if injection or production wells have channeling. Downhole noise is actively "seen" by a noise-logging device. A channeling flow flows often through tight spaces and restrictions behind tubes. These "tight spots" induce high velocity, abrupt reduction in pressure and major flow turbulence. The noise tool listens to the turbulence-related noise. The engineer stops the tool at a certain depth for quality control and expects external noise, such as noise created by tool and logging-cable motion, to slow it down.

Specialty logs

Casing inspection logs

Deformation, physical wear and corrosion can be cause failure of the casing. For the safety production, these kinds of things shouldn’t happen during the production. Due to these problems, engineers use special logs such as casing inspection logs. For the inspection, commonly, are used 4 tools:

Ultrasonic tools

Cased hole caliper

Electromagnetic tools

Flux leakage tools

The quality of the inside casing surface is visualized by echo amplitude and travel time, but casing thickness is determined by travel time.

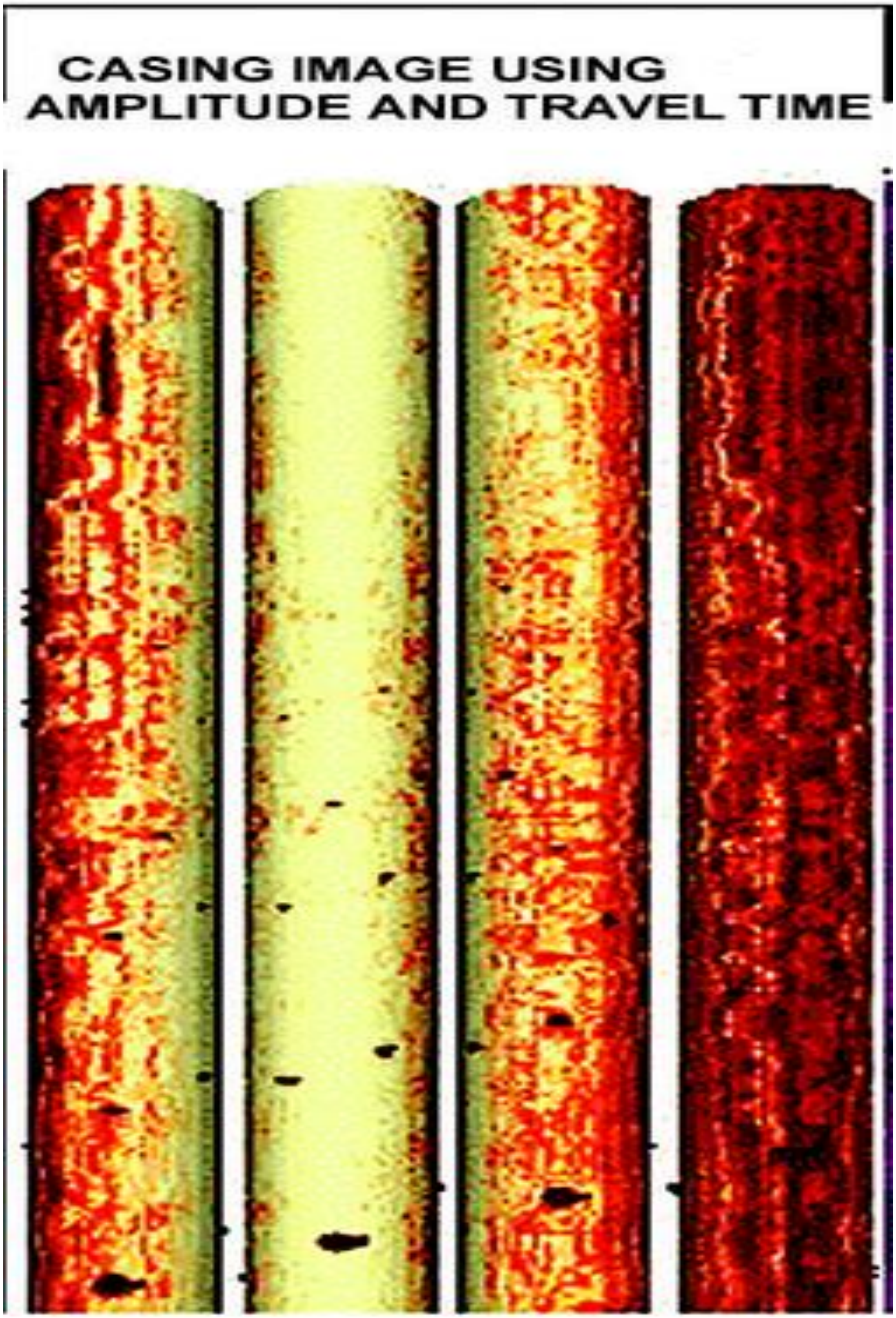

Figure 9 Real casing pics

Ultrasonic tools

A maximum quantified database of radius and thickness is given by the ultrasonic process. The primary ultrasonic casing-inspection apparatuses were the borehole tele viewers, but these as it were "saw" the internal casing surface and their utilize is presently primarily in open hole. Afterward apparatuses had settled ultrasonic transducers, but these were basically coordinated at cement assessment, and they give a fragmented scope of casing-thickness estimations. The sound speed in the wellbore is determined by means of an incorporated reflector on a recognized offset as it flows through the hole.

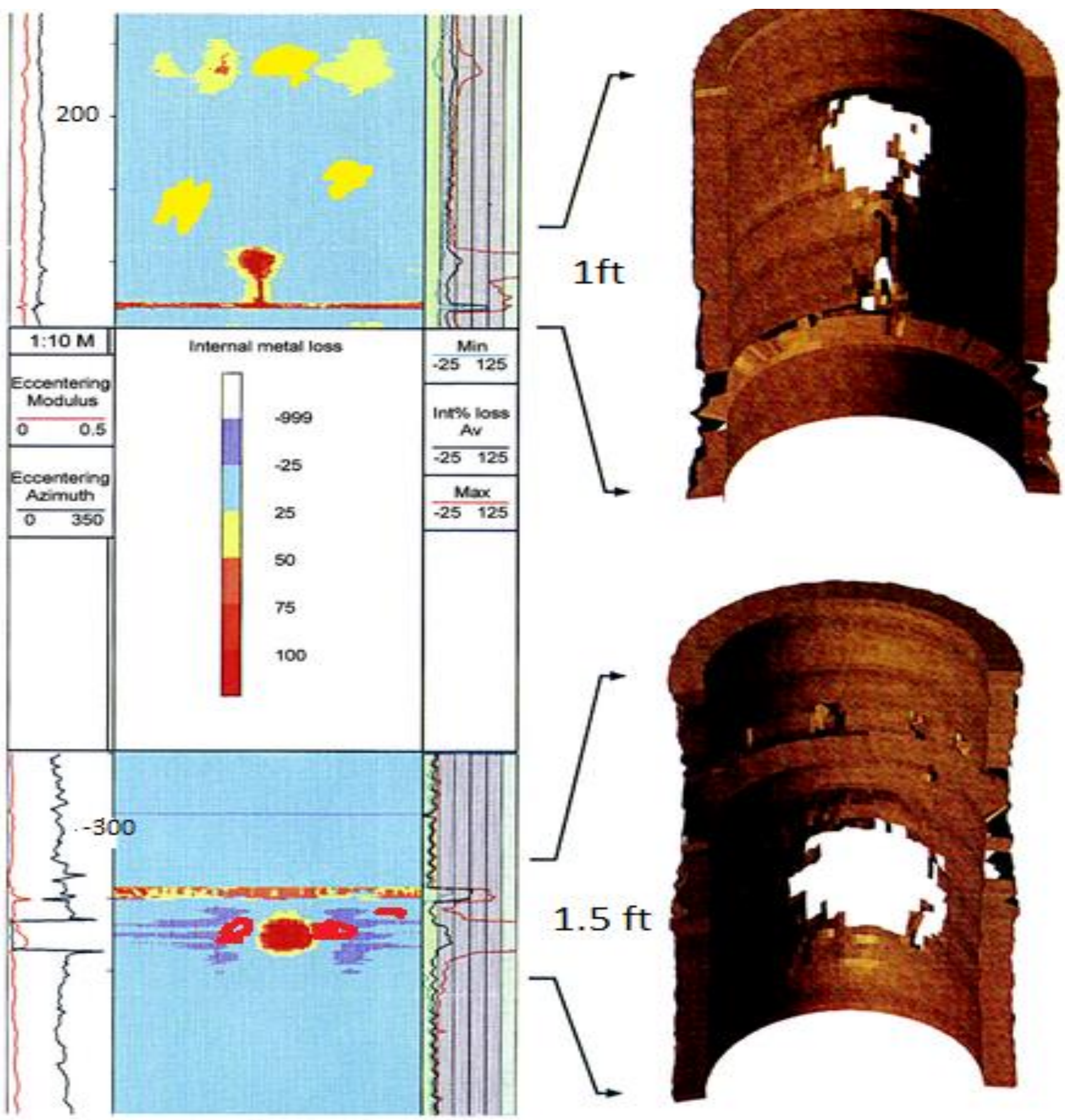

Figure 10 Ultrasonic imager for corrosion

2.2 Cement Logging

Cement bond logs is an evaluation of the integrity of cement work on an oil well during the drilling or completing a well. Cement is injected through the well and rise up between well casing and formation.

Cement logs run on the wireline by a company that detects the bond of the cement to the casing information.

It is necessary to place cement between well casing and the formation:

- To support the steel casing
- To prevent formation fluid from leaking
- For isolating produced zones.

The main means for the evaluation of the functional integrity and consistency of cement bond are acoustic logs.

Evaluating cement

The quality of cement is not directly measured by acoustic logs, but this result is concluded from the acoustic contacting degree of the cement to casing and formation. Cement-bond logs (CBL) give extremely accurate estimates of well integrity and zone separation when properly run and interpreted. Cement-bond logs may differ over time as the cement cures and its properties change, just as filtrate invasion and formation modification may cause variations in formation acoustic properties and therefore difference in acoustic logs over time. Transmitters (one or more) and receivers (two or more) are used in modern acoustic cement-evaluation tools. They work on the theory that in a strong cement bond, acoustic amplitude is quickly attenuated, but not in a partial bond or a free pipe. The below are the measurements taken with these cased-hole wireline tools:

- Attenuation per unit distance
- Compressional wave travel time
- Amplitude

The primary bond measurement is amplitude, which can be calculated directly:

- Bond index
- Quantitative estimation of cement compressive strength
- Interpretation of cement-to-formation interface

The tool's response is determined by the cement's acoustic impedance, which is a function of density and velocity. The log can be precisely calibrated in terms of cement compressive intensity based on scientific evidence. These calibrations, on the other hand, may be incorrect in foamed cements or where exotic additives are used. In both cases, consumers can check with the logging service provider on the proper calibrations.

A continuous-depth time show with full-waveform amplitude displayed as shades of black and white is known as variable density. Positive amplitudes are represented by dark bands, while negative amplitudes are represented by gray or white bands; contrast is proportional to amplitude. On a variable-density log, free pipe and fluid arrivals (if present) are readily marked as straight dark and light lines on either side of the monitor. The formation signal is the zigzag, wavy, or chevron pattern that appears between these two arrivals.

Conventional cement-bond devices measure the attenuation between two transmitters and receivers because of the eliminating:

- **Fluid attenuation**
- **Temperature**
- **Receiver sensitivity**
- **Calibration**
- **Tool accurate**

Modern open-hole display tools are intended to provide traditional concrete-evaluation measures in a cast hole, in addition to advanced cement bond equipment. The sleeve of the cement bonding instrument is usually used to delete and interrupt the tool signal, which otherwise could be confused with major case signal.

TR spacing typically varies between 3 and 5 ft. The shorter distance (e.g. 3 ft.) ensures maximum signal level and precision at high attenuation rates and is usually used in calculations of amplitude and travel time (TT). For a complete shape registration, a longer distance, usually of around 5 feet, is used, since longer TR distances make the cabinet more separate from the formation signal arrival time. This isolation makes the forming-signal strength easier to analyze and is used for monitoring cement-to-formation bonding.

These tools usually run at higher frequencies – between 20 and 30 kHz – than traditional open hole tools. Like open hole devices, cement binding devices need centralization to ensure precise measurements. Centering in the box hole is more important as the more frequent operations (i.e. shorter wavelengths) and the measuring instrument are dependent on signal amplitude. The eccentration of the tool decreases signal amplitude and time.

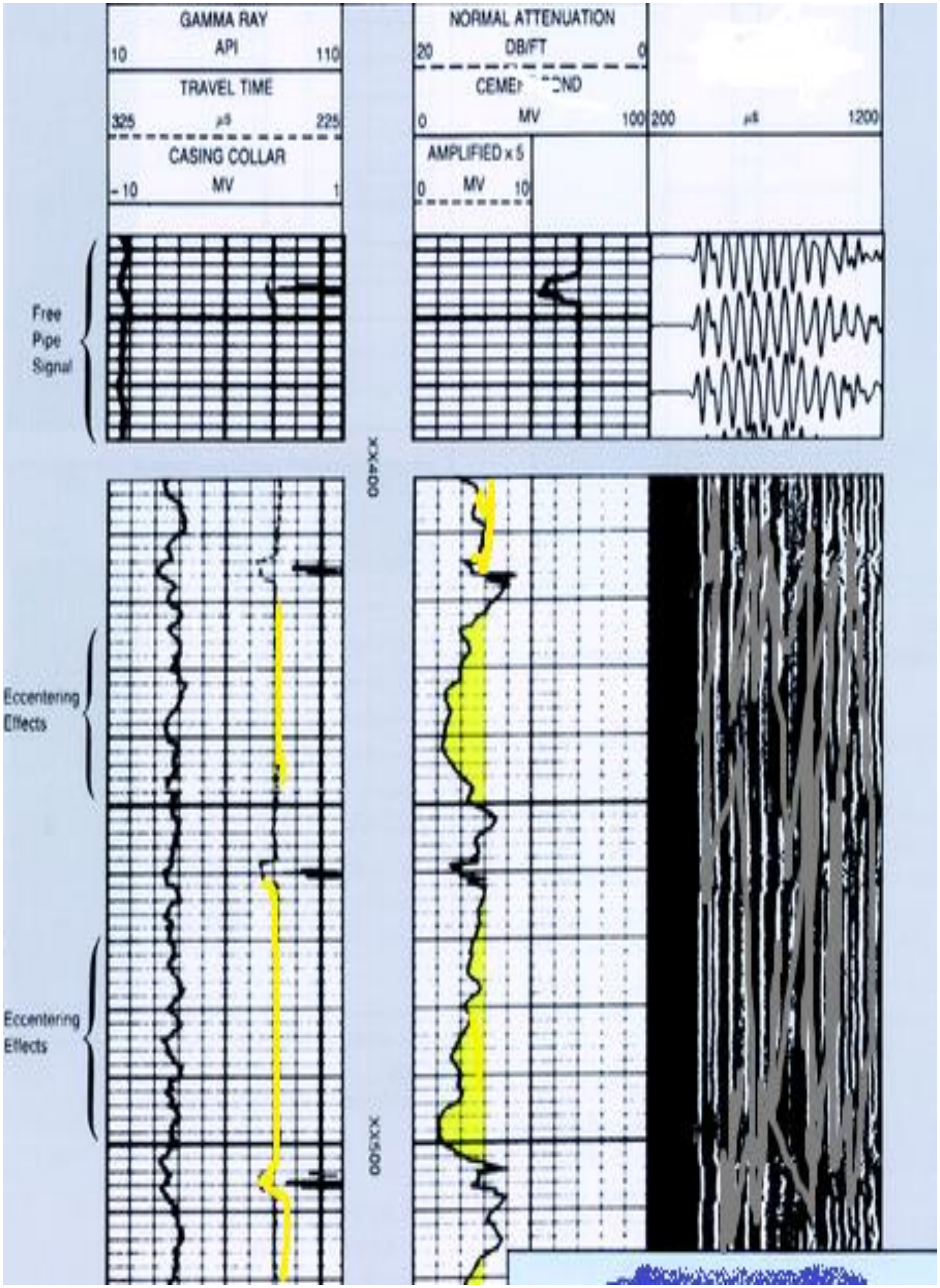

Figure 11 Logging to observe amplitude and time.

Cement bond logging tools use gated structures to calculate the particular sections of the acoustic waveform necessary to measure the primary bond amplitude. Gates are time intervals for measuring – they may be either of the following:

Fixed

Sliding (floating)

For calculations on amplitude and floating ports, fixed gate systems are widely used for measuring journey time. Fixed doors are set to open, stay open and shut at specified times (usually at the well), and the opening times for the doors depend on the size of the case and the speed of the borehole fluid. If the door opening is too big, the signals early and late will interfere. The floating doors are always open, but only an amplitude value greater than the threshold value is used to register.

Channeling is typically local and uniform, which can be detected by changes in the amplitude response in comparatively brief periods. As channeling happens, it occurs. Channeling is essential since hydraulic screening is prevented. Instead, a micro annulus may stretch over a long section of a housing but cannot prevent hydraulic screening (a slight distance between the casing and cement sheath). During cementation or the presence of pollutants such as graft or mill varnish in the outer surface of the case, micro annulus may result from thermal expansion and contraction of the tubes.

A typical method is to use cement bond logs with the box under pressure to extend the box to cement and thus decrease any possible micro annulus. When the original log test was not under pressure and the log shows the weak connection, a second bond log under pressure will test the existence of a micro-annulus and see if there is a discrepancy. Pressing the casing increases the acoustic connection to the formation and decreases the casing signal, and the formation signal becomes more evident. However, the pressing of the case does not substantially alter the log if only channels are available. Knowledge on the type of cement used is important when carrying out a cement evaluation. For example, if regular cement is believed to be part-bonding, foam cements, which purposely produce void space in the cured cement may be misinterpreted.

A precaution concerning the use of the amplitude curve in the bond evaluation: the amplitude of the tube shows the quality of the tubing bond to the cement but does not show the quality of the bond between the cement and the formation. In combination with other log measures (e.g., travel time or complete waveform), amplitude data can be used for a more dependable assessment of the bond wherever possible. For example, the appearance on the full waveform monitor of shear wave amplifiers indicates that the training is well connected with the acoustic.

Transit times less than the casing of formations (57 µsec/ft) can create difficulties reading amplitude curves as an amplitude door can be used to indicate the formation signal. To ensure that the arrival of the formation affects the amplitude curve, it should be investigated VDL.

The Bond Index (BI) is a qualitative signal amplitude-based calculation of cement bond. The calculated attenuation to the full attenuation ratio is this dimensionless quantity:

$$TR = \frac{20}{\mathrm{TR}\log}$$

With a BI value of 1.0 the cement bond is fine. An unfinished bond is seen with a value of less than 1.0. In zones with 100 percent bond and in free pipes, the calculation of attenuation is required.

Radial-cement evaluation

By providing the precise position of partial bond and channeling, radial-cement-evaluation devices were designed to overcome certain limitations of traditional cement-bond instruments and to enable more detailed evaluation of cement delivery behind casing. These instruments assess cement consistency across the casing's diameter using one or more azimuthally responsive transducers. Individual log curves or azimuthal images ("maps") of cement quality created by interpolating between individual azimuthal measurements are provided using data from these methods.

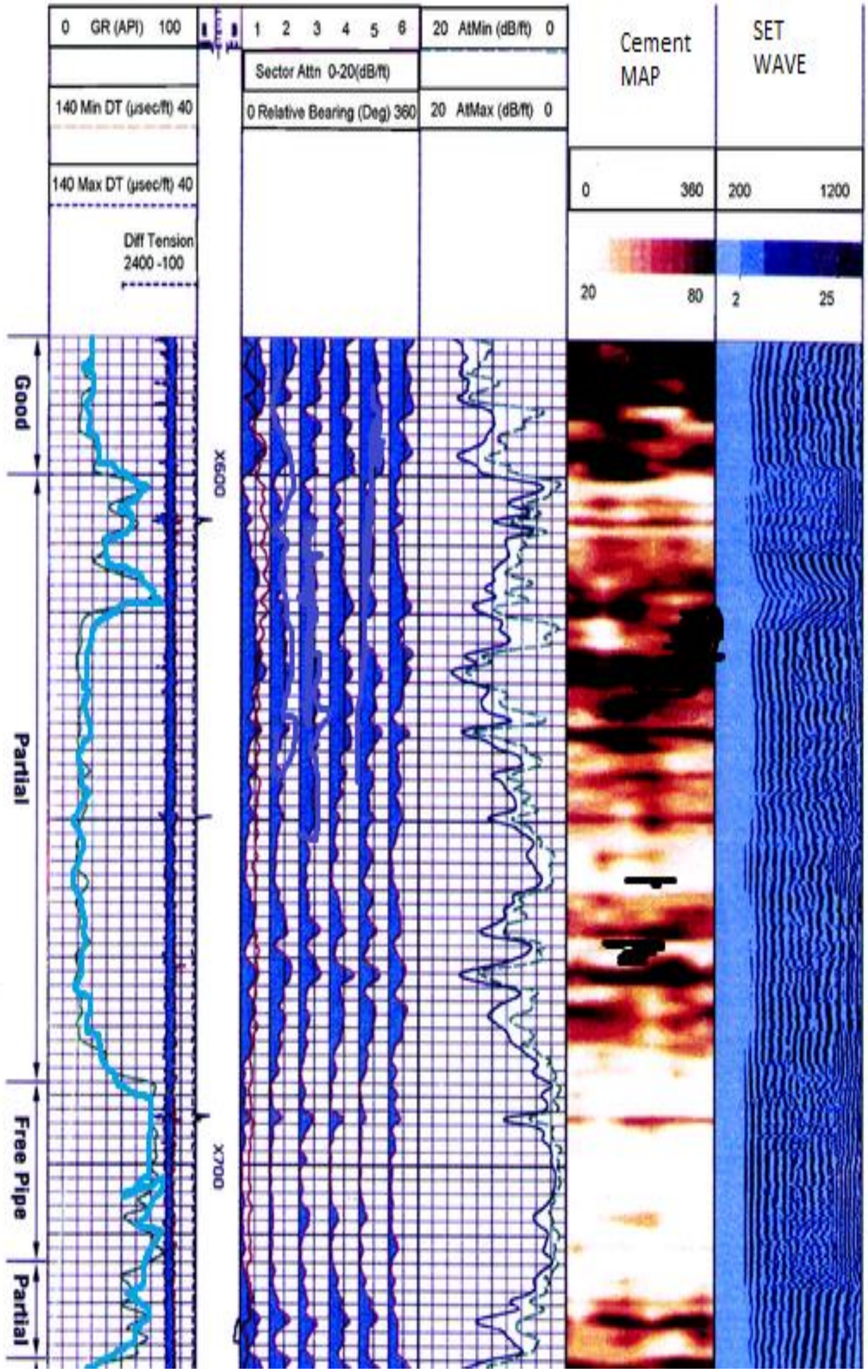

Figure 12 Radial-cement evaluation

There are four different types of radial evaluation tools in use today:

- Six compensated attenuation measurements are given by a multipad instrument.
- The sonde is surrounded by an array of eight TR pairs that have compensated CBL amplitude.
- The sonde is surrounded by ultrasonic pulse/echo transducers that are arranged in a fixed helical pattern.
- Televiewer-types that use a single rotating ultrasonic transduce

The acoustic impedance of the material outside the shell is calculated using ultrasonic methods. The energy level (attenuation) of the decaying reflected wave is determined after periodic acoustic pulses are aimed at the casing to cause it to resonate in its thickness mode. A good cement-to-casing bond causes fast damping (higher impedance) of this resonance; a bad cement-to-casing bond causes the resonance to degrade more slowly (lower impedance). These devices' measurements are determined by the same factors that affect open hole tele-viewer measurements.

The pad unit takes the following measurements:

- Compensated
- Short-spaced
- Azimuthal attenuation

Both the pad transmitters and the VDL transmitter's acoustic-energy output is guided (steered) and enhanced by controlling the transmitting elements and firing sequence. The signal quality of both the casing and cement-to-formation arrivals is improved as a result of this. This method improves VDL interpretation, particularly in soft formations where the traditional VDL can wash out.

New high-performance low-density, foam, and complex cements are becoming more common. The presence of gas in cement slurries, either as an inert component or as pollution, may, however, have a significant impact on ultrasonic tool interpretation. In these settings, new interpretation approaches combine ultrasonic and attenuation measurements from traditional instruments to provide better cement assessment.

The most recent ultrasonic instrument includes a traditional pulse-echo transducer as well as a flexural transmitter and two flexural receivers for greater investigation depth. Beyond the casing-cement bond, interpretation techniques combining these different measurements provide improved evaluation in lightweight cements, particularly in the annulus.

Cement-evaluation logs

Cement-bond logs (CBLs) are composed of a pulsed transmitter and multiple acoustic energy receivers arranged in a vertical series of transducers. Borehole oil, casing, cement, and the formation itself all carry the acoustic signal. A microseismogram is generated by receiving, processing, and displaying the signal. The measured waveforms are seen alongside the travel time and a casing-amplitude curve, which shows the amplitude of the acoustic pulse that has passed through the casing but not the cement or formation. Two bonds can be investigated using the waveform and amplitude data. These are the connections between the casing and the mortar, as well as, to a lesser degree, the cement and the shape. The typical interpretation of a "straight" waveform show is that no cement bonding has occurred. The existence of bonded cement is inferred from variations in the acoustic showing. The application of predictive variance processing to ultrasonic data has improved these displays. CBLs plainly show that there is unbonded piping at the top of the cement, as well as where the pipe is well cemented. They are, however, unreliable as markers of cement hydraulic sealing because they are unable to locate narrow channels within the cement. The fact that traditional CBL transducer arrays are vertical, while bonding issues must be investigated circumferentially, is part of the problem.

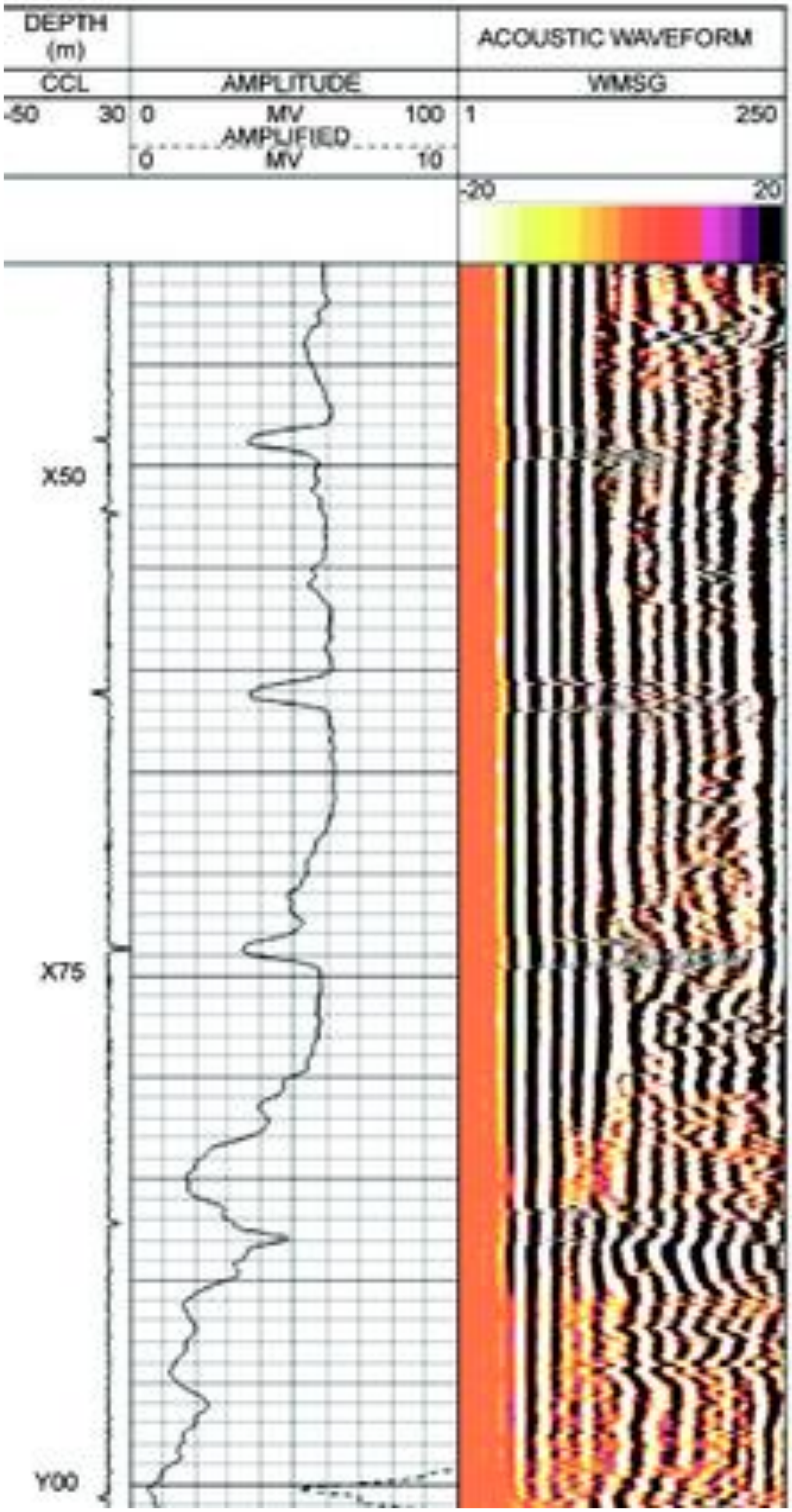

Figure 13 CBL example.

Baker Atlas' Segmented Bond Tool has six pads, each with a transducer arrangement of acoustic energy receivers and transmitters. The pads are pressed against the shell. One pad transmits energy, which is received by an adjacent pad. The wave that has gone through the casing is the first to arrive due to the pad spacing. Each 60° part of the casing diameter can be used to calculate the rate of attenuation. A high degree of attenuation indicates that the cement is well-bonded to the casing and that there are no channels in the cement. The approach allows for the identification of localized areas of strong hydraulic seal that are independent of borehole fluid form. While ultrasonic tools are superior to acoustic CBLs, they are still harmed by heavily attenuating muds. They're sometimes referred to as "cement assessment instruments." The Cement Evaluation Method (CETTM) was the name of one of the first ultrasonic instruments. Schlumberger's instrument consisted of an array of eight ultrasonic transducers that allowed for a minimal radial inspection of the casing and annulus. The latest tools include a single spinning transducer that serves as both a source and a receiver of ultrasonic energy. It is necessary to focus the instrument. On the same logging pass, the data for the circumferential inspection of the casing and the measurement of cement bonding are collected. Acoustic energy is expressed at interfaces where the acoustic impedance varies (the product of acoustic velocity and density). The shell itself is the source of the first reflection. The second reflection may be on the casing's outside. There would be a good reflection if cement is bonded to the casing. There would be a poor reflection where there is unset cement or water behind the casing. An acoustic-impedance map of the cement can be generated by studying the whole waveform.

One such instrument is Schlumberger's Ultrasonic Imager (USITM). It has a frequency range of 200 to 700 Hz and covers the casing and cement integrity in high detail. It is possible to detect channels as small as 1.2 in. [30 mm]. It's used in conjunction with a standard CBL instrument. De Souza Padilha and Da Silva Araujo provided an important example of the complementary existence of these data. It addresses the issue of gas-contaminated cement, which has long been a source of confusion in the industry. The CBL basically detects low-amplitude values in gas-contaminated cements. The USI can't tell the difference between gas-filled cement and fluids, but it can measure the cement's acoustic impedance. As a result, when the CBL is poor and the USI shows fluids, the presence of gas-contaminated cement is implied. The CBL will read high and the USI will reveal gas if there is just gas behind the casing. To differentiate these instances, the CBL and USI were used together. The use of predictive variance processing in conjunction with CBL and ultrasonic impedance data has resulted in a better cement assessment.

Simultaneous casing inspection and cement evaluation

Ultrasonic methods should be used to simultaneously resolve two goals: casing integrity and cement assessment. The Circumferential Acoustic Scanning Tool—Visualization version (CAST-VTM) from Halliburton, for example, allows for independent or parallel casing inspection and cement assessment. (12) The method has two modes of operation:

-The cased-hole mode involves using circumferential maps of casing thickness and acoustic impedance to ensure casing integrity and differentiate between fluids and cement in the annulus.

-The scanner tests only the inner surface of the casing in image mode.

Chapter 3

3.1 Traditional approach

During the drilling of oil and gas and gas-condensate wells due to geological-technological and technical complications (absorption, kick, weak cementation.) in these cases, the integrity of the wells is compromised. Due to this kind of processes, happen pressures between the casings in the well and this causes different problems during the production and solving the any problems getting harder.

Because of these problems, there are some international standards like as:

API 90

SF-0.8

NORSOK D-10

Many well-known operator companies (BP, STATOIL, TOTAL) approach this issue with different standards. In Azerbaijan, SF-0.8 is used.

Calculations are performed in the following sequence to control the wellbore pressures. (real case) The exploration was first carried out in production well No. 10 drilled on the VII horizon in the center of the field. The well structure diagram is illustrated in Figure 8. The vertical depth of the well is 6347 m. After the completion of the well, pressure was created in the C-belt space. During the operation of the well, the pressure between casings reached 340 atm and was discharged up to 240 atm.

Well 10, drilled in the Umid field, is illustrated below in the example of the priority C-belt space.

Barriers and casings	Casing brand	Vertical depth of well shoe	Collapse pressure of casings, atm	Burst pressure of casing, atm	Test pressure of casings, atm	Test pressure of casing heads, atm	Shoe flow check pressure, atm	Burst pressure of casing 80%, atm	Collapse pressure of casing 80%, atm
Packer		6170							
weakest point of NKB		2970							
A space test					70				
2 7/8" NKB	P-110	6170	1403	1431	110			1122	1145
4 1/2" NKB	P-110	2970	1106	1157	110			885	926
5 1/2" A production casing	P-110	6347	1001	1002	620		1209	801	802
6 5/8" A production casing	Q-125	5200	1081	1055	620		990	865	844
7" A production casing	P-110	241	944	898	620	1050	46	755	718
7 5/8" B "linear	P-110	6120	859	754			1166	687	603
10" B casing	P-110	5665	913	842	360		1139	730	674
10 3/4" B casing	P-110	17	611	318	360	800		489	254

13 3/8" C casing	Q-125	4457	654	285	290	350	901	523	228
18" D casing	L - 80	2578	265	72	100	350	461	212	58
18 5/8" D casing	P-110	1820	407	102	100			325	82
18 5/8" D casing	P-110	1692	487	178	100		303	390	142
20 7/8" E "Linear" casing	CT3CP 5	1376	176	82			239	140	65
24" E casing	X - 56	1220	173	60		210	206	138	48
28" F casing									

Table 2 example of the priority C-belt space.

Differential fracture and collapse pressures of casings for are calculated by formulas 1 and 2. So,

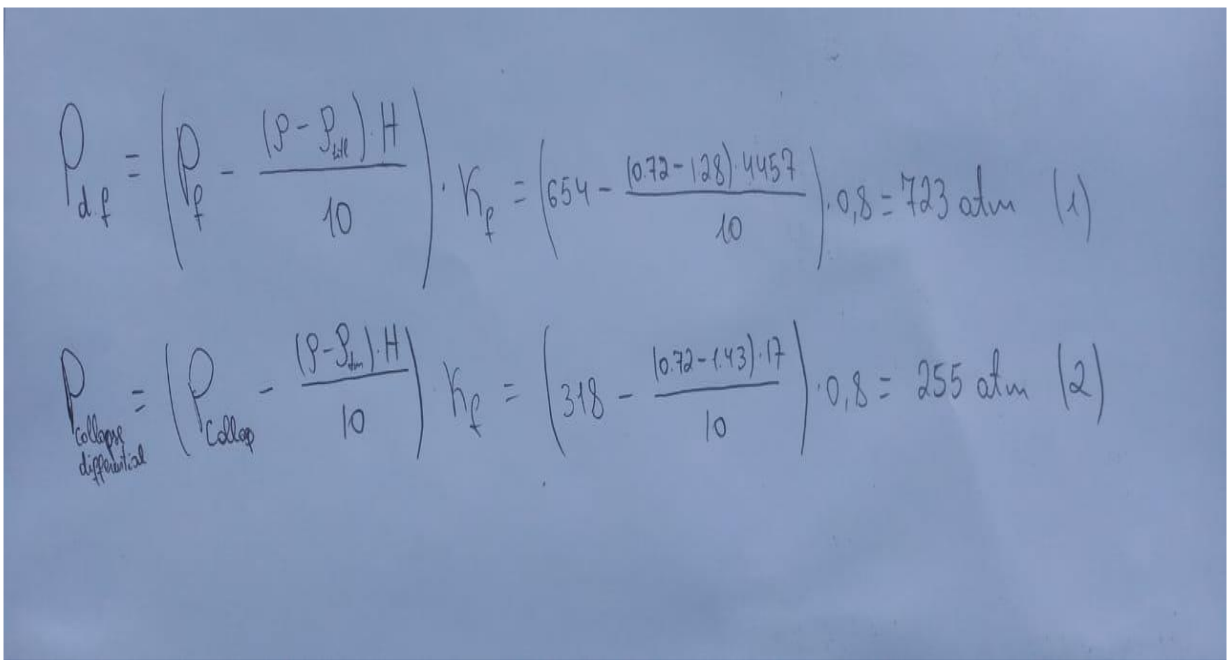

Fig 14 Calculation to find differential fracture and collapse pressure

Fracture pressure of casing shoe is calculated in chapter 1.3. Thus, safe and risk-free well operation can be ensured by maintaining the maximum pressure in space C up to 254 atm and the working pressure up to 204 atm. The calculation results of MAASP and MOASP for other wellbore phases are given in Table 3.

Between casings space	Fluid density, q/sm^3	Depth for fracture, m	Depth for collapse, m	Differential frac pressure, atm	Differential collapse pressure, atm	Frac pressure of the casing shoe, atm	MAASP, atm	MOASP, atm
A space (behind the pipe)	1.47	6170	6170	779	469	302	302	241
B space (51/2x65/8"x7"-10x10 3/4")	1.43	6120	6347	341	824	293	293	234
C space (10x10 3/4"-13 3/8")	0.72	4457	17	723	255	580	254	204
D space (13 3/8"-18x18 3/4")	1.28	2578	4457	216	28	131	28	22
E space (18x18 5/8"-24")	1.30	1220	2578	119	54	51	51	41

Table 3 The calculation results

Following the determination of MAASP and MOASP, technical measures were taken to reduce the pressure in the C phase of the well. As the intracranial pressure exceeds these limits, the pressure in space C is released at intervals and aggravated by the injection of a higher density fluid.

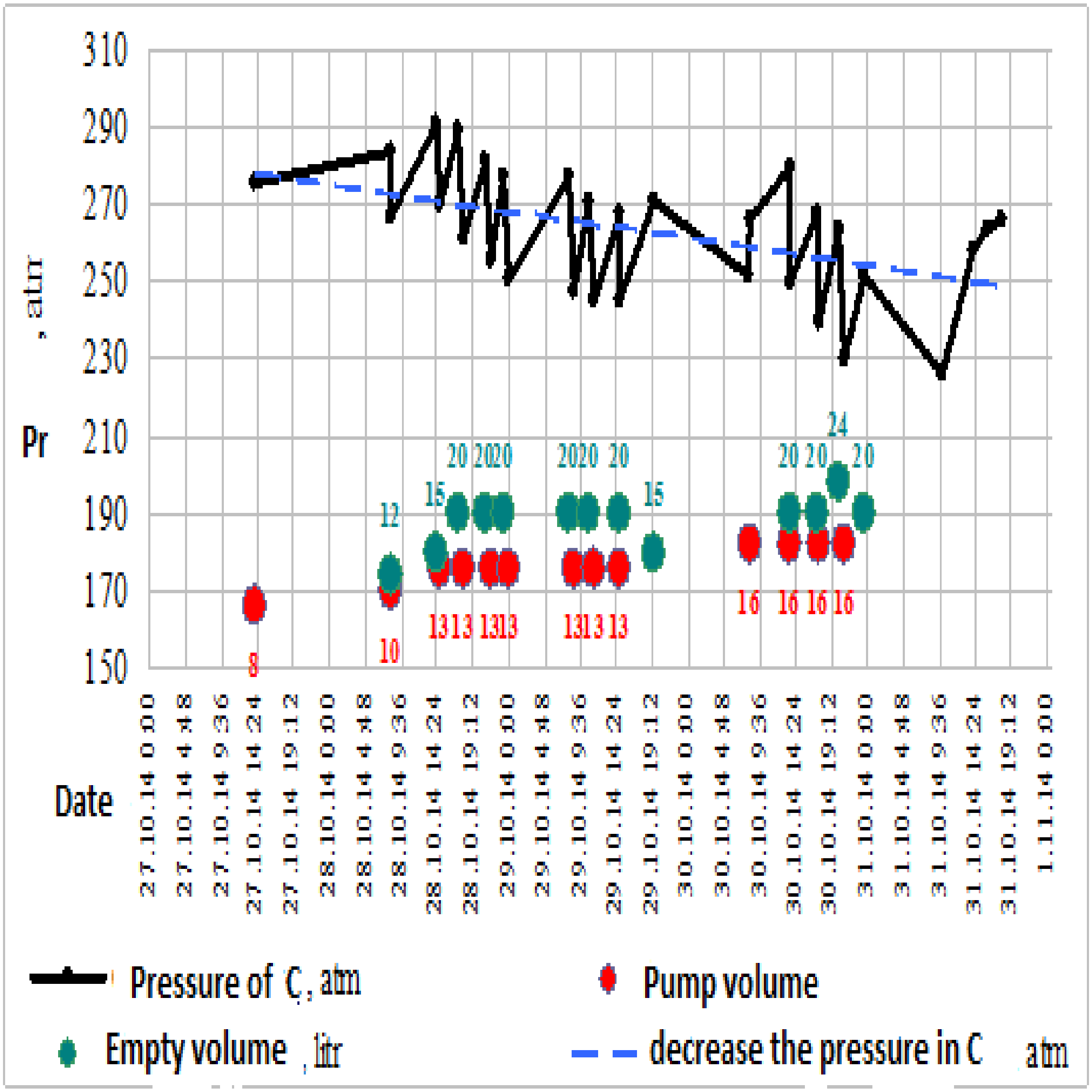

Figure 15 Graph of pressure change in space C during the operation**.**

The event was continued for 4 days, 173 liters of 1.70 g / cm3 flat solution was injected into the non-C space and 246 liters of liquid was discharged.

3.2 Specific approaches to solve problem

A methodical approach to increasing reservoir production

A detailed look at conditions around a basin, as well as the overall output of oil and gas production activities, including current fields, future wells, and supporting structures, is part of a systemic approach to maximizing the viability of a reservoir.

The first move is to figure out how much of a difference there is between existing output trends and what should be done. Knowing what is theoretically possible allows you to develop a strategy and identify steps to close the gap. In most cases, a systematic study of reservoir capacity requires the following:

- Examining subsurface geology and development history in order to determine reservoir production capacity versus current output.
- Identifying technological limits on demand for the end-to-end production method as well as existing wells, such as well facilities.
- Locating bottlenecks in supply, evaluating opportunities to improve output from current wells, and estimating future returns from drilling new wells are also ways to close the gap between production levels and reservoir potential. It is also essential to analyze the infrastructure in order to ascertain its success potential.
- Choosing which levers to pull to increase efficiency. We've identified four recurring output levers (reservoir capacity or oil sweep quality, value from existing wells, value from new wells, and production networks), as well as three cross-functional enablers: Integrated planning and execution, performance improvement, and emerging technology are also examples of integrated planning and delivery.

Short time production terms	a significant shift in recovery	Long term
OPERATIONS • enhancing lifting procedures and modes of operation • determine potential candidates for extra perforation • To satisfy surface limits, handle wel chokes.	• Water injection is being used to improve void age management. • optimizing the design of well stimulation and the success rate • Identify infill well and sidetrack goals	• Design, EOR screening and deployment • Improve drilling through risk-based target selection
ENABLERS • increase the use of predictive analytics and big data regression to forecast performance	• Enhance the use of prediction performance predictive analytical and big data regression • Fix the step-by-step mechanism to speed up incentive	• Optimize portfolio assets and strategy for exploration • Identify clean roles and responsibilities

Table 4 Time horizons and subsurface levers

An example of such a systemic solution is provided by an organization in Eastern Europe. It examined the reservoir's capacity based on regeneration conditions and our knowledge

of the rest of the petroleum area. (The company did have reservoir capacity projections but did not make use of them to monitor the field performance.)

The way the reservoir works shows how it will compare this regeneration to the current output levels. Although production can meet potential recovery rates, we usually see lower production levels. This has also been the case for this reservoir.

Increased oil and gas production in Azerbaijan

Another example of the advantages of an analytical approach to optimal reservoir development is our experience in a business in Azerbaijan. After its success has been examined, the firm has agreed to implement three programs covering two leverage systems: maximize value from existing wells (with an effective response policy and optimize jack-rod pumping) and maximize reservoir capacity (through a waterflood optimization).

Flooding in a reservoir: Modeling and optimizing performance

The corporation was well informed of and composed of the reservoir. The reservoir engineers will calculate the amount of water they need for injection into which reservoir blocks to get the most output by creating an optimization model. Optimizing the performance of waterfloods increases by 15 to 20% in this scenario.

Pump optimization:

The company's goal with the pump intervention was to optimize downhole pressure by finding the correct balance between low pressure and well water breakthrough. Existing processes for determining downhole pressure were found to be inconclusive. The formula for optimum downhole pressure was developed, tested, and perfected before being implemented around the reservoir. As a result, productivity increased by 5%.

Organizational and financial problems will arise by using an analytical approach to maximize reservoir capacity. Many reservoir managers base their expectations on the previous year's events and figures. Breaking through this inertia necessitates a determination to take a fresh look at the reservoir and develop a new “zero-based plan” that does not begin with previous results and activities.

Economic barriers, such as the global energy market and the cost of interventions, can obstruct progress. And if a reservoir has the capacity to increase demand, it will not be cost-effective to do so. However, understanding what the opportunity is and how it can be realized allows an organization to discuss what can be done today and in the future. A increase in oil prices may make new wells commercially feasible, and new technologies may reduce the cost of upgrades. When conditions shift, a business that has established these openings will take advantage of them.

CBR method

Case-Based Reasoning (CBR) is a relatively new method for analyzing knowledge-based problems. CBR is analogous to case mining in that it allows logic based on previously solved problems. As a result, a new problem is solved by recognizing one or more previously solved problems that are close to it. CBR's potential lies in applying existing solutions to current challenges in an area that isn't well understood. CBR technique is not only a problem-solving tool; it can also be used to preserve expertise and allow long-term learning.

A CBR system's general configuration is represented:

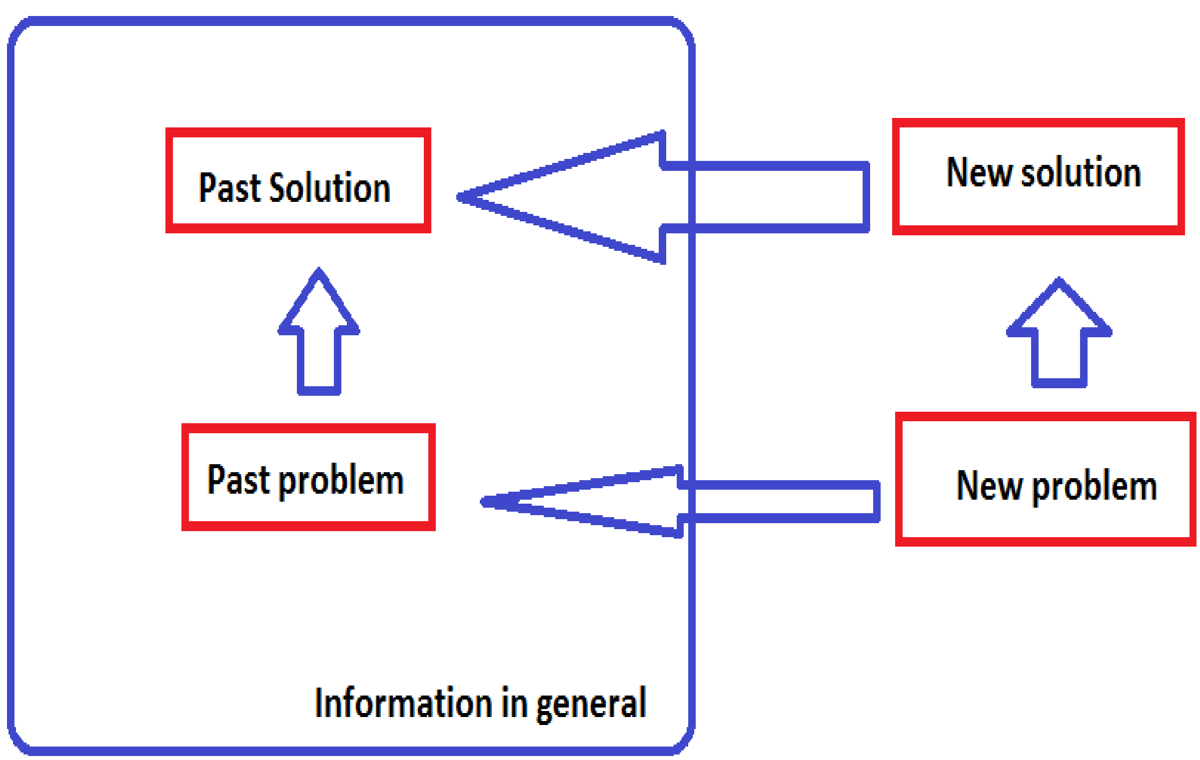

Figure 16 CBR system

The new approach can be applied to the new problem without modification, or it can be modified to account for the variations in the input and output scenarios.

CBR should not be regarded as a database; rather, it should be regarded as an information base. Digital numbers, symbols, and characters are commonly used in databases. The data must be converted into bits of information.

Model-based reasoning

Another principle in artificial intelligence is model-based reasoning (MBR), which is a type of reasoning system. Awareness is interpreted in MBR using "causal laws," which are based on general rules or hypotheses. MBR is designed for well understood domains (strong theory domains), while CBR is designed for domains of weak theory. MBR focuses on activities that require a lot of common knowledge, while CBR focuses more on situations. Any CBR applications interact with CBR and MBR integration. PROTOS was the first CBR method to integrate general domain knowledge (MBR) and basic case knowledge (CBR).

DATA	**INFORMATION**	**KNOWLEDGE**
61$	High oil price	High oil price cause more drilling activity
100 BAR	Low pore pressure	Low pore pressure cause mud loss

Table 5 Typical explanations of how data becomes information, and information becomes knowledge.

Differential Problems in Well-Logging and Geophysical Applications: A New Approach to Solving Them

A modern approach for solving inverse problems for which there is a broad calibration library composed of pairs of inputs and outputs In the database, different pairs of input and output data correspond to separate states of the underlying physical structure whose properties are the focus of the inversion. The database can be built using scientific calculations or computational computations, such as using a forward model.

RBF (radial basis function) interpolation is a technique for approximating smooth and continuous multivariate functions of several variables. RBF interpolation is used to create a non-linear mapping mechanism from which physical device properties (e.g., crude oils, sandstones, etc.) can be predicted using input measurements that are not stored in the database.

This technique has the advantage of being able to solve well-logging and geophysical inverse problems associated with unexplained forward models, as opposed to the conventional solution of fitting data to a forward model. In other scenarios, if reliable forward models are available, the technique can be used to solve inverse problems in real time, which would either be computationally prohibitive or, in certain practical cases, result in ill-behaved non-linear minimization. For accurate forecasts, a robust database that covers the physical spectrum of input and output data observed in practice is needed. The most difficult aspect of implementing the approach is creating the database.

The approach is self-explanatory and does not actually require extensive preparation. It is simpler to apply than artificial neural network inversion approaches, which require lengthy iterative testing and use non-intuitive multilayered networks.

3.3 Complex approach

Handling unfamiliar complex technological items (such as a new mobile phone, a computer, or a vending machine), managing complex organizations (such as businesses or communities), or generating predictions in complex settings are all examples of Complex Problem Solving (CPS) (like forecasts of the weather, political elections or the stock market, etc.)

Problems can also be complex, and they must be examined in the context of the workplace. To pick a solution that will reach the desired condition, a problem-solving procedure is frequently begun. Determining a suitable solution to the problem from among the potential alternatives becomes a critical issue during the process. Problem characteristics gathered by a production system in such unpredictable situations are generally partial or incomplete. Exploring the context of the problem and the appropriate qualities that provide adaptive knowledge assistance are also important aspects of good problem-solving.

The following are some important problem-solving abilities:

- Analysis
- Decision making
- Research
- Communication
- Dependability
- Creativity
- Team-building
- Active listening

Research

Problem resolution necessitates the ability to do research. As a problem solver, you must be able to identify and comprehend the root cause of the problem. By discussing with other team members, contacting more experienced colleagues, or obtaining expertise through online research or classes, you might begin to acquire additional information about an issue.

Analysis

Analyzing the issue is the first step in fixing any problem. Your analytical abilities will aid you in comprehending challenges and developing effective solutions. During your study, you'll also require analytical abilities to assist you discern between effective and poor ideas.

Communication

Need to know how to explain the problem to others while considering alternative solutions. When requesting support, you'll also need to know which communication methods are most appropriate. Once you've found a solution, make sure you communicate it properly to avoid any misunderstandings and make implementation easier.

Decision-making

Finally, you'll have to decide how to deal with any difficulties that emerge. You might be able to make a rapid judgment at times—especially if you have professional expertise. Those with less expertise in their industry might benefit from strong research and analytical skills. There may also be instances when it is necessary to take some time to think about a solution or to refer the problem to someone who is better equipped to handle it.

Problem-solving abilities are necessary in every profession and at every level. As a result, successful issue solving may need technical abilities particular to the sector or position. When engaging with patients, a registered nurse, for example, will need active listening and communication skills, as well as good technical understanding of illnesses and treatments. As part of the solution, a nurse will often need to know when to consult a doctor about a patient's medical requirements.

Quality of Service (QoS) is an essential factor to consider while determining the best solution to a problem. Employee feedback on an assessment process may be expressed as a utility model, which reflects the happiness a worker experiences as a result of selecting a successful problem-solving method. Before subscribing to a solution, the worker presents a utility model. Background knowledge in the working environment gives abundant indications for issue-solving decision making in a complicated problem circumstance. Uncovering secret analysis is critical since it is based on background information and the relevant qualities of an issue. As a result, contextual data and relevant attribute analysis may be used to quantify all of the various elements' impacts and interactions in order to build a utility model. The discussion utility model of the worker may be used to monitor context data and detailed qualities in order to assess the QoS of the problem-solving solution. By selecting a solution, the worker will receive the predicted value of the problem of interest.

Choosing an acceptable problem-solving solution from a vast group of human solutions based on many topics of interest necessitates a multi-criteria decision analysis. Multi-criteria decision analysis is focused with organizing and addressing multi-criteria decision and planning issues. The goal is to assist decision-makers who are dealing with such issues. Because there is rarely a single best answer for such situations, decision makers must rely on their preferences to distinguish between options. To determine the choosing order of the different available solutions for a given problem, a multi-criteria selection analysis is necessary. The established selection order aids in maximizing a worker's problem-solving abilities.

Problem-solving process

Various issues might arise throughout the production process in the manufacturing industry. Uncertain production systems, poor production performance, and insufficient machine utilization are examples of these challenges. The thinking process that overcomes numerous problems and impediments between the existing situation and the intended solution is known as problem solving. Problem-solving in a complex manufacturing process is often information heavy. Problem-solving can be aided by past experience or knowledge, normal problem-solving methods, and previous judgments. The categories of knowledge studied are utilized for problem-solving, and they propose that knowledge should be circulated to avoid knowledge stagnation. Employees select which solution to employ to solve an issue throughout the problem-solving process. Human wisdom and enterprise expertise are both needed in such a solution. Employees may notice a problem, gather contextual data from the business knowledge repository, investigate probable causes, and determine operating circumstances before deciding on a remedy.

Experimental knowledge base log

As a source of analytical data, we employed the knowledge base log of a high-tech business. In the problem-solving log, important material (documents) retrieved by workers is noted for individual difficulties. Historical codified information (textual records) can also be useful in solving certain issues. To extract the essential phrases of relevant texts for a given topic, information retrieval (IR) and text mining approaches are utilized. The collected key words are utilized to create an issue profile, which is then used to predict the employees' information requirements. Researchers suppose that experts provide a general issue-solving procedure to address a problem or a collection of related problems in a production line. When a problem occurs on the manufacturing line, a problem-solving procedure is begun. Depending on their talents and expertise, different workers may come up with various solutions to the same problem. The problem-solving log keeps track of previous instances of problem-solving.

Context-based utility model and problem-solving solution formalization

People from all corners give problem-solving options when a worker has a problem. To pre-compute a worker's expected list of given solution QoS items and simplify a multi-criterion

decision analysis to identify an appropriate selection order for optimization problems, we utilize problem-solving resolution formalization and a context-based utility model. The first step is to find a solution to the problem. The employee, solution, and solution suppliers are all identified during the formalization process. The employee can then determine the present problem's indications (Quality of Service items). As a basic use case, we exploited anomalous issues in wafer cleaning. For an anomalous problem, the worker specifies Performance, Error Rate, and Duration Time as QoS elements. Then, as can be seen in Table 6, the required specific of the QoS elements and solutions are recorded in a table. The potential solutions A, B, and C are utilized to show the experiments utilizing the suggested technique. Solution A, for example, specifies the anomalous problem as a QoS item, with a High-Performance degree, a Middle Error Rate, and a Slow Duration Time.

	Error rate	Performance	Duration time
Solution A	Middle	High	Long
Solution B	Low	Middle	Normal
Solution C	High	Low	Short

Table 6 Quality of Service item and solutions for an abnormal problem

Following the formalization of the problem-solving activity, a context-based utility model is created to reflect worker satisfaction with the solution acquisition. Each QoS component is scaled to [0, 1] and normalized. Table 6 is then converted into Table 7.

	Error rate	Performance	Duration time
Solution A	0.35	0.40	0.22
Solution B	0.38	0.35	0.35
Solution C	0.27	0.25	0.43

Table 7

Even with the current construction of unconventional reservoirs in the Azerbaijan, where tens of thousands of wells have been drilled and completed, the efficiency and active completion factors in unconventional plays are not well understood.

Since the Marcellus shale is a naturally broken formation, it's critical to account for them in a simulation analysis. The strength of the hydraulic fracture geometry was determined using a discrete fracture network (DFN) model and a 3D mechanical earth model (3D MEM). The hydraulic fracture footprint was constrained by the micro seismic data collected during the hydraulic fracture simulations.

The proposed workflow implements unconventional fracture modeling (UFM) to simulate the propagation of complex hydraulic fracture networks with pre-existing natural fractures, as well as to model the stress shadow impact and lamination effect when separate proppant positioning by form within the fracture is considered. The UFM is calibrated using propped and unpropped fracture half-lengths acquired during history matching. A study of the existing perforation efficiency was conducted using the calibrated model, which revealed that nearly half of the perforations do not contribute to output. A two-well pad was used to optimize well spacing and cluster spacing to account for well disturbance such as crack hits, stress shadow, and degradation after 30 years of output. As opposed to the original planning plan, the recommended well spacing and completion configuration increased performance by up to 20% per well.

Since simplistic analytical models cannot solve well interference problems or account for variability of rock materials, the nuanced approach is becoming the new standard for the successful construction of unconventional reservoirs. The workflow outlined here should be used to reliably test well spacing and interruption in time with future Marcellus wells to further ensure optimum recovery.

Chapter 4

Result & Recommendation and Conclusion

Natural work teams to handle the majority of difficulties that may arise in their daily operations activities. None of team necessitate extraordinary abilities. Instead, they rely on instinct, logic, and innate knowledge. The team having combined experience, expertise, and talents are more than sufficient for success.

In a particular plan, here are some daily problem-solving tips:

- Minimize what may appear to be "little issues" from growing into major issues in the future. The only solution to evaluate tomorrow's issues is to address today's issues while they are still minor.
- Performance measurement and typical work tools can help you spot problems before they become a problem.
- As quickly as feasible, develop the skills, tools, and processes required to address such issues.
- Begin with a 5-Why analysis. To have a better understanding of the core cause of an issue, keep asking "Why?" at various stages.
- Use the PDCA (Plan-Do-Check-Act) method. An organization's operations will not be able to sustain lean if it does not completely comprehend the reason of what is happening in a circumstance.
- Understand that the small problems are a valuable contribution for future results.

Results and suggestions

The results of the research work carried out to solve the existing problem were studied, applied and the following results were obtained.

1. Using specific examples, the process of regulating the pressure downstream of pipelines for various reasons is explained in accordance with international standards.

2. Analysis and research have shown that for an effective and safe solution to the problem, it is necessary to determine the limits of line pressures.

3. If the pressure behind the belts exceeds the specified limit, technical measures must be taken. For this purpose, an exacerbation of the lumbar fluid is proposed.

Discussions

The material rewards in multi-criteria decision-making tasks and the real utility values from the context-based utility model were determined to be the important elements impacting experiment results during the experiment procedure and results analysis. The normalizing utility values and weight values, for example, are identical. This makes it impossible for the approach to find a viable answer to the problem-solving knowledge recommendations. The way the QoS criterion is chosen is influenced by worker feedback. The context-based utility model and multi-criteria decision analysis processes are both dependent on the Quality of Service criterion.

Conclusion

Determining a suitable solution among the numerous candidate alternatives to address a problem is an essential topic in the problem-solving process. Context information gives abundant indications for problem-solving decision-making in such unpredictable situations. As a result, this study employed a selection technique to aid workers in selecting appropriate answers for the optimal problem-solving process. The real utility values of possible solutions were determined using a context-based utility model that examined the problem's contextual information. The real utility values were then used in a multi-criteria decision analysis to identify the best order to choose candidate solutions. The worker is given the chosen order as an adaptive knowledge recommendation. Based on the selected knowledge, the employee comes up with a plausible problem-solving solution. This study makes a contribution by presenting a way for picking a suitable solution that is simple to apply in a problem-solving decision support system.

The experiment was conducted using the knowledge base log of a high-tech business. The real utility values from the context-based utility model and the weight values in a multi-criteria risk assessment task impacted the experimental outcomes, according to the process and result analysis. Future research should focus on developing a worker feedback system for determining QoS requirements. By intelligent tuning and learning, worker input would aid the selection strategy and progressively enhance service quality. To improve the problem-solving knowledge impact, it is suggested that this be combined with more sophisticated procedures, such as collaborative filtering techniques.

Used literature

1. Norsok Standard D-010. Well integrity in drilling and well operations. 2004, Strandveien: The Norwegian Oil Industry Association.
2. ISO TS 16530-2: Well Integrity for the Operational Phase. 2013, The Norwegian Oil Industry Association, 78 p.
3. API RP 90: Annular Casing Pressure Management for Onshore Wells., New-York: American Petroleum Institute, 96 p.
4. Koray Kinik. Risk of well integrity failure due sustained casing pressure. Middle East Technical University,
5. Smolen, J.J. 1996. Cased Hole and Production Log Evaluation, Ch. 10 and 11, 161-213. Tulsa, Oklahoma: PennWell Publishing Co.
6. Hill, A.D. 1990. Cement-Quality Logging. Production Logging—Theoretical and Interpretative Elements. Richardson, SPE.
7. Калинин А.Г., Сердюк Н.И. Расчеты в бурении. 2007, М.: РГГРУ, 668 с.
8. ISO/TS 16530-2:2014. Целостность скважины на этапе эксплуатации. 2014, ООО "ЦНТИ Нормоконтроль", 100 с.
9. Каталог оборудования для строительства скважин и проведения технологических операций ПНП. 2013, Красноярск: Закрытое акционерное общество «ОКБ ЗЕНИТ», 68 с.
10. Tello, L.N. et al. 1995. New Efficient Method for Radial Cement Bond Evaluation. Canadian Well Logging Soc.
11. Expert Systems with Applications, vol. 22, pp. 21-31, 2002. S. H. Liao, “Problem solving and knowledge inertia.”