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Production Operation for Bean Flowing Analysis using Thermo Set Polymers

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Abstract:

Search for Hydrocarbon resources has led to discovery of several wells which are having High Pressure and High Temperature fields in ONGC. Drilling, completion, Testing and Production in HPHT environment are technically challenging and complex operations with very high risk and exhibits major HSE issue and are further aggravated with the presence of H2S and CO2. This Paper attempts to enumerate the problems & issues related to completion, testing, production and control of oil and gas wells. The challenges during drilling relates to containment of risk associated with, reduction of Non Productive Time (NPT), proper tools, mud system & cementation, casing and liner integrity etc. The objectives of this study are to analyses and characterize exactly the major operations performed during the well testing completion of an oil and gas wells.Present investigation is about the replacement of polymer instead of steel and ceramics in the bean and how the process is to be carried out and how the operation has to be done at the controlled condition.

Keywords: Hermetical test, Choke manifold, Polymer bean, Production Casing

1. Introduction

The Analyze well tests in order to obtain reliable information about well conditions. It provides a basic understanding of well testing techniques and the equipment involved will well testing a clear understanding of the primary objective of surface and down hole well testing, that is, to assess well productivity by measuring the gas, oil and water flow rates from the well under controlled production conditions. Also, understanding of the safe handling of the produced effluents (solids, liquids and gases) at high pressures and temperatures is a key objective and concern within the Well Testing operations. This is achieved by design of equipment and operations including safety margins and protective equipment to guarantee the safety of people and integrity of the involved facilities and the environment. A basic theoretical and practical knowledge of well testing operations. They will also be exposed to different basic well testing analysis techniques and a number of relevant examples will be presented as well. One major purpose of well testing is to determine. it is important to determine the underlying reason for a well's productivity. Subsequent to drilling of a well to its target depth the open hole is logged and based on the log

interpretation the prospective layers / intervals are identified for testing. Accordingly, the open hole is first cased and cemented. Well is then temporarily completed with down hole completion string and surface well control and testing equipment's so that the well can be safely flowed back and tested to ascertain its reservoir potential. The entire gamut of above operations is known as Well Completion and Testing. Well testing is the first major activity to be undertaken after drilling a well in a field. Once well is drilled it is so completed that the well can produce oil/gas safely. Based on the data collected during the test, a reservoir model is created which Is then used to formulate the field development strategy. The main objectives of well testing operations are to: -

1. Identify produced fluids and determine their respective ratios.
2. Measure reservoir pressure and temperature
3. Determine well productivity
4. Obtain samples for analysis
5. Evaluate reservoir parameters
6. Estimate completion efficiency.

2. GENERAL WELL TEST PROGRAMME

The well testing operations commence after a well has been drilled to target depth, logged, cased and cemented. After the well is cleaned and scraped to the required depth, CBL-VDL log is recorded. In case, the cement bondage is good then the well testing operations commence. The major stages of a well test programme are:

- Hermetical testing of production casing
- Perforation of prospective zone/ layer to be tested.
- Testing of perforated interval involving following operations:
  - ✓ Temporary completion of well with down hole production string
  - ✓ Installation of surface equipment set-up and its pressure testing
  - ✓ Activation of the zone
  - ✓ Initial Flow for well cleaning
  - ✓ Reservoir Studies-Flow, Build-up, Gradient Survey, PVT sampling etc.
  - ✓ Killing/Subduing the well
  - ✓ Isolation of the zone tested or Final Production Completion

All the prospective layers identified in a well are tested one by one from bottom to top. Subsequent to testing of all the prospective zones, the well is completed in the best Oil & Gas producing layer for taking production from that well.

3. HERMETICAL TESTING

The hermetical test is carried out to ensure the hermeticity or complete sealing of production casing and to pressures exerted on it from either inside of well or from reservoir side. The casing head and production casing should be pressure tested separately to the maximum expected surface pressure during testing / production. The

annular space between two consecutive casings should be connected to a valve. It should not be plugged otherwise the casing may be subjected to a pressure higher than the intended. The valves should be tested to working pressure. X-mas tree assembly should be complete in all respects as per recommendations of the manufacturer. Pressure gauges and proper pressure bleed off points should be installed for release of pressure during the test. Every well head assembly should be provided with suitable arrangement for recording tubing and annulus pressure.

3.1 The procedure for carrying out the hermetical test is as follows:

1. A tubing string with / without scraper is run to the bottom.

2. The drilling mud is displaced with water and through circulation is carried out to ensure that the entire drilling fluid has been displaced with clean water

4. NEGATIVE TEST

The well is kept under observation for 1 hour to ensure that there is no activity / flow back of water from the well thereby indicating that the production casing / liner is hermetical to formation pressures from behind it. Initially there will be some flow back owing to thermal gradients which should not be concluded as failure of negative test. As cold water attains thermal equilibrium with the temperature inside the well (approximately in ½ hour), the flow stops provided the production casing is hermetical. Also, in case the hydrostatic head of water inside the casing is more than the reservoir pressure then some of the water inside the well needs to be knocked out using compressor and / or nitrogen to create pressure differential across the casing for the negative test.

5. POSITIVE TEST

In case the negative test is satisfactory then the well is filled with clean water up to the surface. The pipe rams are closed on the string. A pressure equivalent to maximum expected surface pressure during testing which will be equal to higher of shut-in tubing head pressure assuming well flows only dry gas or maximum expected surface pressure of nitrogen during activation or pressure required to hydrostatically fire TCP guns is applied on casing through tubing. The pressure is normally applied in stages / increments of 500 psi initially up to 3000 psi and then in increments of 200 psi and held for 2 minutes to observe for any pressure drop. The pressure is held for 15 minutes at the final hermetical test pressure. All the annular valves should be kept open during positive test and any activity / flow from them should be closely monitored.

Since hermetical testing involves application of high pressures, it must be ensured that:

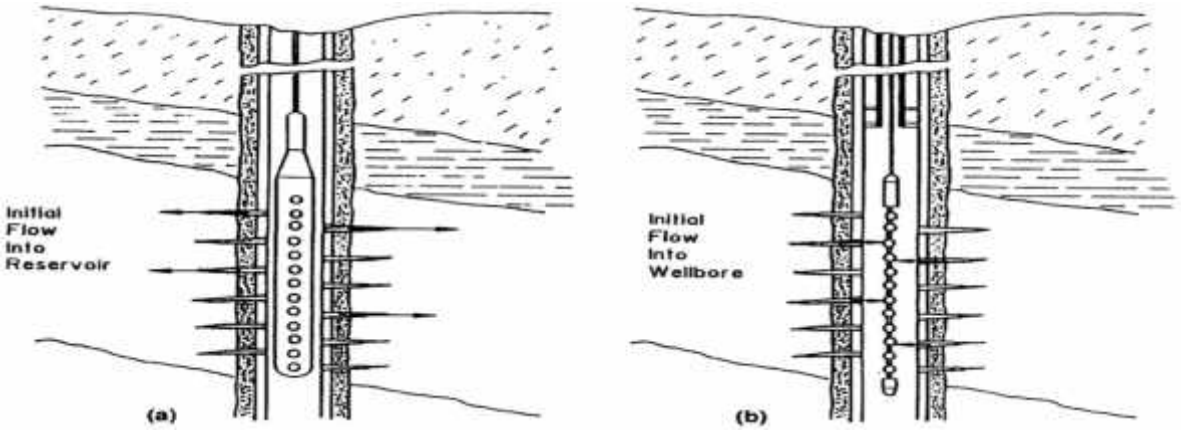
- All the lines being subjected to pressure are properly secured / anchored.
- Unnecessary personnel are removed / restricted from the area.
- People are made aware that pressure-testing operations are in progress.

Subsequent to successful hermetical test, the well volume water is displaced with drilling mud or solid-free completion fluid such as brine of requisite specific gravity and the same is thoroughly circulated and conditioned prior to pulling out the tubing. Now, the well is **ready** for perforation.

6. PERFORATION

A perforation in the context of oil wells refers to a hole punched in the casing or linear of an oil well to connect it to the reservoir. Creating a channel between the Pay Zone and the well bore to cause oil and gas to flow to the well bore easily. In cased hole completions, the well will be drilled down past the section of the formation desired for production and will have casing or a liner run in separating the formation from the well bore. The final stage of the completion will involve running in perforating guns, a string of shaped charges down to the desired depth and firing then to perforate the casing or liner. A typical perforating gun carry many dozens of explosive charges. Commonly perforation guns are run on E-Line as it is traditional to use electrical signals from the surface to fire the guns. In more highly deviated wells, coiled tubing may be used. Newer technologies allow the guns to be run on Slickline. Modern slickline technology embeds fibre optic lines that can transmit two-way data on real-time temperature, pressure and Seismic down-hole tools, including perforation guns.

6. 1 Oil well perforation may be basically classified in two types: -



-(a)Perforating overbalanced with a casing gun and fig-4 (b) perforating underbalanced with a thru tubing gun.

7. OVER BALANCED PERFORATION

Over balanced perforation is normally carried out with the help of perforating guns or Hollow carriers in over balance perforation the hydrostatic weight of the wellbore column is greater than the Reservoir pressure. Ex: Conventional perforation in which guns are conveyed on wire line.

7.1 UNDER BALANCED PERFORATING

In under balanced perforation the weight of the well bore column is lower than the reservoir pressure. Tubing conveyed perforation **(TCP)** and through tubing perforation are come under this category.Tubing conveyed perforation is a technique in which the guns are lowered into the well along with Tubing and Firing of guns can be done by applying hydraulic pressure from the surface.

7.2 THROUGH TUBING PERFORATION (TTP):

The formation is perforated using a string of individually sealed explosive capsules that are lowered in to the well on wire line through tubing. **TTP** Job can be used for re perforation of zones or extra pay zones perforation

7.3 ACTIVATION OF WELLS

After a Well is Perforated and completion string lowered, well is activated to induce flow of formation fluids in to the well bore. In the process, the hydrostatic head in the well is gradually reduced either by displacing the column of fluids in the well with

lighter fluid or by creating pressure surges through injection compressed air/ high pressure nitrogen gas or by swabbing operation.

Through this process, the hydrostatic head in the well is gradually reduced thereby inducing the flow of formation fluids in the well bore and then into the production string to the surface.

7.3.1 Injection Of Compressed Air Down The Annulus In Wells Completed With Open End Tubing / Packer & GLV.

- In this technique, air is applied through mobile compressor in the annulus i.e. apace between tubing string and production casing which by its pressure displaces fluid as well as mingles with tuning fluid there by reducing its head.
- In case required, prevailing pressure in the annulus is reduced through a bean to induce formation fluids into the well.
- The maximum air pressure that can be applied is restricted to 200ksc (maximum capacity of available compressor) and the method is not suitable for deeper wells or in wells requiring draw down higher than 200ksc

7.3.2 Injection of Nitrogen Gas at High Pressure Down The Annulus In Wells

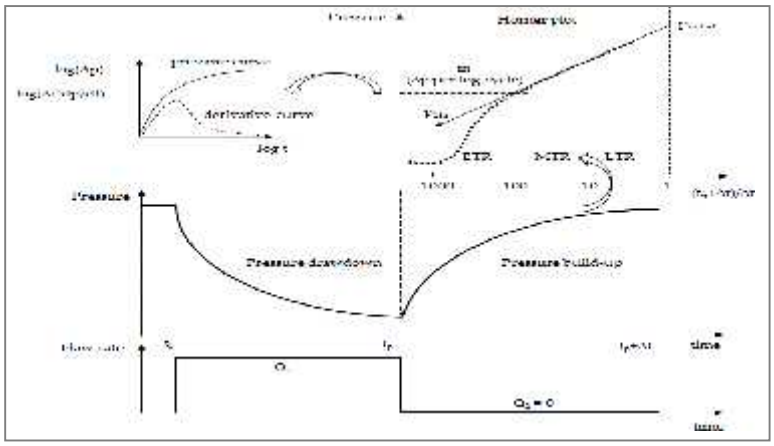
In this method, nitrogen is applied in place of air and the same is pumped through annulus in case of open tubing completion or through CTU in the wells with packer completion.Higher draw down can be applied to the formation while activating the well by applying nitrogen.

8. METHOD AND METHODOLOGY

8.1 **BUILD-UP TEST**

The primary purpose of performing a build-up test is to determine the wellbore damage (skin) and the reservoir permeability. However, during the course of a build-up, it is possible to encounter reservoir boundaries. If all the reservoir's boundaries are contacted during the build-up, the size of the reservoir can also be determined. If the well has been pressure tested before, subsequent testing allows relative material balance calculations (decline curve analysis), as well as the determination of the drive mechanism for the reservoir

Typical plot of pressure response during well testing and application

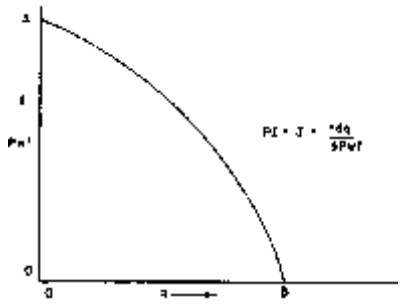


In Flow Performance Relationship - IPR Curves

The Inflow Performance Relationship (IPR) for a well is the relationship between the flow rate of the well q and the flowing pressure of the well p_{wf}. In single phase flow this is a straight line but when gas is moving in the reservoir, at a pressure below the bubble point, this in not a linear relationship.

It can be seen that the majority of the pressure drop caused by production is near the wellbore.

Distance from Centerline of Well Bore, ft	Formation Pressure, psig
$\frac{1}{24}$ (sand face)	500
1	576
2	619
5	676
20	762
100	862
932	1000



This is confirmed by the radial flow equation. In this situation even if the average reservoir pressure is above the bubble point, the area around the wellbore is not, which causes the gas to come out of solution in this area causing the relative permeability (which is based on fluid saturation) of the liquids to

Change. As the p_{wf} is lower for a greater flow rate the greater this effect has on the well which causes the IPR Curve to bend down.

8.2 CHOKE MANIFOLD

In Oil and Gas production a choke manifold is used to lower the pressure from the Well Head. It consists of a set of high pressure valves and at least two chokes. These chokes can be Fixed or Adjustable or a mix of both. The redundancy is needed so that if one choke has to be taken out of service, the flow can be directed through another one. By lowering pressure, the retrieved gases can be flared off on site.

Our choke Manifolds are designed to direct flow from the well through the drilling chokes to protect downstream equipment from the high well flow pressures encountered during operations. In addition, our Choke Manifold help to safety manage hydrogen sulphide emissions and prevent release of toxic fluids.

The choke manifold is a necessary piece of equipment used for controlling the well kick and implementing oil-gas well pressure control technologies.

8.3 ADUSTABLE /VARIABLE CHOKE:

Primary function enables the fixed choke to be changed during operations. Secondary function enables greater flexibility for wellbore clean up rates.

8.4 FIXED (POSITIVE) CHOKE: Calibrated choke Beans to give more accurate flow control or predetermined fluid rates at various test conditions.

- Through opening and closing the choke valve it can control certain pressure so as to maintain a bottom hole pressure that is higher than the formation pressure;
- It is also used for blowout protection (BOP) in order to protect the wellhead in the event that in-hole pressure exceeds certain limits;
- The throttle manifold is composed of a choke valve, gate valve, pipeline, fittings, pressure gauge, etc.
- Allows for multiple choke and gate valve configuration.
- Pressure ratings from 5000-15000 psi.
- Available bore sizes 2-1/6 to 4-1/6-in.
- Adaptable for all location requirements

8.5 POSITIVE CHOKES

Positive chokes and suitable for well testing, high pressure drilling and production accompanied with sour gas or / and sand. These positive chokes are designed, manufactured and tested in accordance with API spec.

8.5.1 Choke Bean - Ceramic Choke Bean - Tungsten Carbide Choke Bean

Choke bean is often used in the positive choke valve for controlling the flow, choke bean, body Material: 410SS, lined with Tungsten Carbide (C10 or C25) or ceramic, to protect them from corrosive and abrasive wear.

On one side of the choke manifold, calibrated choke beans are used to control flow rate through the fixed choke box. Each bean is a specific diameter, usually in graduations of 1/64-inch, and is screwed into the choke box.

- These are the most common sizes (in inches) of choke beans used:
- 1/8, 3/16, 1/4, 5/16, 3/8, 7/16, 1/2, 9/16, 5/8, 3/4, 7/8, 1, 1-1/4, and 1-1/2.

Depending on the type of equipment used, the size of the choke bean can be as large as 3 inches. The beam can be made up of steel or ceramics that to be oil for steel and gas flow from ceramics fthe steel and ceramics has a small hole for the flow of fluid due to continuous process of fluid flow the hole will enlarged and become damaged within a year. So instead of steel and ceramics the replacement of polymers can be used for a better optimize flow rate a long period of time

8.6 POLYMERS:

A substance which has a molecular structure build by chiefly or completely from a large number of similar units bonded together .e.g. (much synthetic organic matter used as plastic and resins)

Extreme heat resistance is one of the defining properties of high temperature plastic known as thermo sets. Long touted for their light-weight and chemical-resistant properties, it is the high heat-resistance that makes the performance of thermo set polymers exceptional in demanding applications and environments. The whole family of heat-resistant thermo set plastics can operate effectively at temperatures exceeding 120° C and up to 800° C

8.6.1 TYPES OF POLYMERS

The premium and special Polymers mainly used for this for e.g. When impact resistance is a must, design engineers can rely on Polydicyclopentadiene, or PDCPD, for short, for its extreme impact resistance and thermal stability. PDCPD is an extensively cross-linked polymer with heat-resistance and high heat deflection temperature of up to 120° C. The engineered thermo set polymer possesses exceptional mechanical and physical properties with chemical and corrosion resistance, stiffness, high tensile strength, impact resistance, and heat resistance. The molding flexibility of PDCPD has characteristics that are similar to expensive engineered thermoplastics and offers design freedom with virtually no limitation.

9. EXPERIMENT BY THEORETICALLY

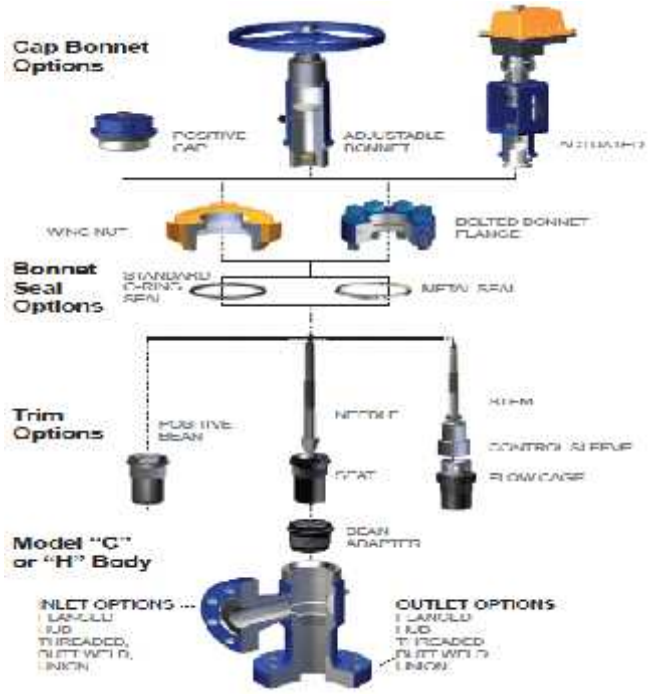
9.1 **BEAN**

Bean is placed at the choke manifold because to get the optimize flow due to high pressure of more than 3500 psi the flow rate will very fast and does not able to control them and the bean is used slow down the flow rate.

Then the bean can control the flow rate and provide an optimize flow rate. The bean can be made up of **Tungsten Carbide** or ceramics

9.2 REPLACEMENT OF POLYMERS

Instead of steel and ceramics been the replacement of polymers can be used for the better process that polymers have durability for continuous flow of both oil and gas for long period because the polymers can be made up of both steel and ceramics. polymers can be used the pipe for wide range for continuous that make easily replacement after the damage occurred in the polymers that process can be carried out easily by removing the polymer substances only manage and save working time. By using a polymer that can be reduced, Rig economic, Rig time, Production constant, and Reservoir economic of optimize flow rate.



10. **RESULTS AND DISCUSSION**

The Completion systems are the components necessary to complete the well after it is drilled and prepare it for production. There are many completion options available to oil and gas producers there are several keys to designing a successful completion system and selecting components that are fit for purpose for. Both the down hole environment and application. Consideration must be given to the various modes under which the completion must operate and the effects any changes in temperature or differential pressure will have on the tubing string and packer. Ultimately, the system must be both efficient and cost-effective to achieve production and financial goals. A key factor in the completion design is the production rate. Mostly the equipment's used in this process are considered API (American Petroleum institute), ASME (American society of mechanical engineers) & ASTM (American standard testing material)To complete a well successfully for taking production and to make a good completion the completion engineer must have a multi-Disciplinary Knowledge. It is very important to perform will testing and completion operations safely successfully and economically. To achieve the above objectives, the

completion engineer must have to work with other Departments like Drilling, Reservoir, Work Over, well-stimulation services, Wire-line engineer, and Cementation parelly. A good well Design or well completion must provide control flow of the Reservoir fluids with proper barriers to Shut-off the well immediately in case of any emergencies. During well completion it is to keep in a mind that any future well Intervention Operations like Reservoir studies, well-logging operations any re-perforation operations, Zone transfer operations, could be done without killing the well It is very challenging to test a well successfully and to complete for further production operation because of its High Temperature and High Pressure Nature even though New Technologies and High pressure safety Equipment up to 15000PSI are available the High Temperature in the Reservoirs makes the things complicated. At the time of production operation testing the flow of crude oil is very aggressive it is controlled by choke manifold. The interior part of the choke manifold is made up of stainless steel. This work concludes that replacement of polymer instead of steel and ceramics bring the optimized flow for long period of time. Also it incurs low operating cost and save the rig time.

11. CONCLUSION

By using of polymer instead of steel and ceramics that can maintain low time consumption easy replacement inside the bean reduced replacement time and the save rig time. For testing flow rate of oil and gas during production operation time. Polymers bean size long life in the low cost by using polymer bean in exploration industry can reduce the cost about this cost.

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