



Life Cycle of Oil & Gas Wells

Agenda

- ▶ *Introduction*
- ▶ *Types of the wells*
- ▶ *Life Segments of Oil & Gas Wells*
 - Planning
 - Drilling
 - Completion
 - Production
 - Abandonment

Introduction

- ▶ An **Oil Well** is any boring through the earth surface that is designed to find and acquire Liquid hydrocarbons; Usually some natural gas is produced along with the oil.
- ▶ A **Gas well** that is designed to produce mainly gas, some times may be this gas is associated with oil.

Well Types

► At Production Phase:

- 1 *Oil Wells*
- 2 *Gas Wells*
- 3 *Water Injection Wells*
- 4 *Gas Injection Wells*
- 5 *Naturally Flow NF Producing Wells*
- 6 *Gas Lifted Wells*
- 7 *ESP Wells*
- 8 *Beam Pump Wells*
- 9 *Jet Pump Well*

Life Segments of Oil & Gas Wells

1- Planning

- Objective
- Well-Type Classification
- Formation Pressure

3- Completion

- Design criteria
- Objectives
- Completion Types classification
- Completion Components

5- Abandonment

2- Drilling

- Objectives
- Types of Rigs
- Rig Crew
- Operation
- Types of well casing

4- Production

- Well Intervention
- Well Stimulation
- Well & Reservoir Management

Planning

▶ **Objective:**

- The objective of well planning is to formulate from many variables a program for drilling a well that has the following characteristics: safe, minimum cost, and usable.

Unfortunately, it is not always possible to accomplish these objectives on each well because of constraints based on geology, drilling equipment, temperature, casing limitations, hole sizing, or budget.

➤ **Safety :**

Safety should be the highest priority in well planning; Personnel considerations must be placed above all other aspects of the plan; The second priority involves the safety of the well The well plan must be designed to minimize the risk of blowouts and other factors that could create problems.

➤ **Minimum Cost :**

A valid objective of the well-planning process is to minimize the cost of the well without jeopardizing the safety aspects. In most cases, costs can be reduced to a certain level as additional effort is given to the planning.

➤ **Usable Holes :**

Drilling a hole to the target depth is unsatisfactory if the final well configuration is not usable. In this case, the term "usable" implies the following:

- The hole diameter is sufficiently large so an adequate completion can be made.
- The hole or producing formation is not irreparably damaged.

Planning

▶ Well-Type Classification

- ▶ The drilling engineer is required to plan a variety of well types, including: wildcats, exploratory holes, step-outs, in-fills, and re-entries. Generally, wildcats require more planning than the other types. Infill wells and re-entries require minimum planning in most cases.
- ▶ Wildcat Well :
The process of drilling for oil or natural gas in an unproven area, that has no concrete historic production records and has been unexplored as a site for potential oil and gas output.
- ▶ Exploratory Well :
Site selection based on seismic data or satellite survey.
- ▶ Step-out (Development) Well :
Delineates the reservoir boundaries; drilled after the exploratory discoveries, site selection usually based on seismic data.
- ▶ In-Fill Well :
Adding new wells in an existing field within the original well patterns to accelerate recovery or to test recovery methods; Infill drilling programs are used to confirm the presence of hydrocarbon between the step-out drill holes.
- ▶ Re-entry Well :
Existing well re-entered to deepen, side track, rework, or recomplete; various amount of planning is required, depending on the purpose of the re-entry.

Planning

▶ Formation Pressure

- The formation, or pore, pressure encountered by the well significantly affects the well plan. The pressures may be normal, abnormal (high), or subnormal (low).

➤ Normal-pressure wells :

Generally do not create planning problems; The mud weights are in the range of 8.5 to 9.5 lb./gal. Kicks - and blowout-prevention problems should be minimized; Casing requirements can be stringent even in normal-pressure wells deeper than 20,000 ft. because of tension/collapse design constraints.

➤ Subnormal-pressure wells :

May require setting additional casing strings to cover weak or low-pressure zones; The lower-than-normal pressures may result from geological or tectonic factors or from pressure depletion in producing intervals.

➤ Abnormal pressures :

Affect the well plan in many areas, including: casing and tubing design, mud-weight and type-selection, casing-setting-depth selection, and cement planning; In addition, the following problems must be considered as a result of high formation pressures: kicks and blowouts, differential-pressure pipe sticking, lost circulation resulting from high mud weights.

Drilling:

➤ The well is created by drilling a hole into the earth using a drilling rig that rotates a string with a bit attached.

➤ **To Drill you Need :**

1 A way to descend. (**DRILL PIPE**)

2 A way to rotate the pipe. (**KELLY or Top Drive**)

Kelly or Rotary: rotation is achieved by turning a square or hexagonal pipe (the "Kelly") at drill floor level.

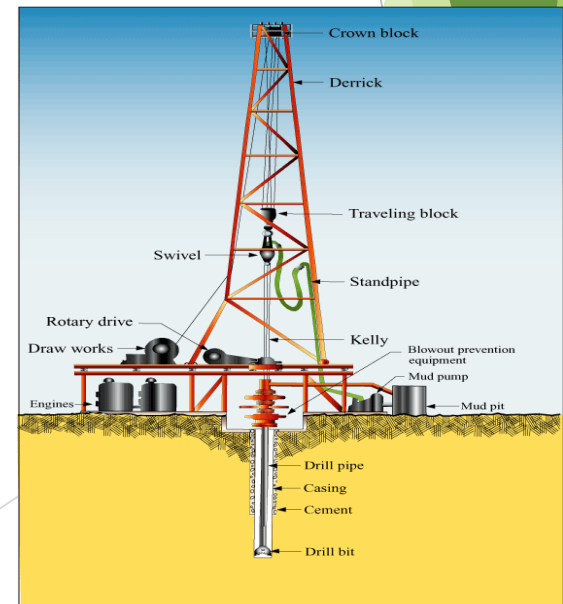
Top Drive: rotation and circulation is done at the top of the drill string, on a motor that moves in a track along the derrick.

3 A place to hold the pipes. (**DERRICK**)

4 A way to raise & lower the pipe. (**DRAW WORKS**)

5 A cutting tool. (**BIT**)

6 A media to remove cuttings. (**MUD**)



Drilling:

➤ Rigs come in a variety of configurations and designs for surface environments that range from Arctic to desert, ocean to midcontinent and just about everything in between.

➤ **Types of Drilling Rigs :**

A- Land or Onshore Rigs.

B- Offshore Rigs which classified to:

- 1 Jack-up Rigs.
- 2 Submersible Rigs.
- 3 Semi-submersible Rigs.
- 4 Platform Rigs.
- 5 Drill Ships.

A- Land or Onshore Rig



B- Off shore RIG : 1- Jack-up Rigs

- A jack-up rig or a self-elevating unit is a type of mobile platform that consists of a buoyant hull fitted with a number of movable legs.
- Depth Range from few feet to over 400 feet.



B- Off shore RIG : 2- Submersible Rigs.

- The submersible drilling platform is supported on large pontoon-like structures. These pontoons provide buoyancy allowing the unit to be towed from location to location.
- Once on the location, the pontoon structure is slowly flooded until it rests securely on its anchors, of which there are usually two per corner.
- The operating deck is elevated 100 feet above the pontoons on large steel columns to provide clearance above the waves.
- After the well is drilled, the water is pumped out of the buoyancy tanks and the vessel is re-floated and towed to the next location.
- Depth range up to 175 feet.



B- Off shore RIG : 3- Semi-submersible Rigs.

- A semi-submersible obtains its buoyancy from ballasted, watertight pontoons located below the ocean surface and wave action.
- The operating deck can be located high above the sea level due to the good stability of the design, and therefore the operating deck is kept well away from the waves.
- Depth range over 7500 Feet.



B- Off shore RIG : 4- Platform Rigs.

- ▶ It is a large structure with facilities to drill wells, to extract and process oil and natural gas, or to temporarily store product until it can be brought to shore for refining and marketing. In many cases, the platform contains facilities to house the workforce as well.
- ▶ Depending on the circumstances, the platform may be fixed to the ocean floor, may consist of an artificial island, or may float.
- ▶ It can drill more than one well from the same location.



B- Off shore RIG : 5- Drill Ships.

- ▶ A drillship is a merchant vessel designed for use in exploratory offshore drilling of new oil and gas wells or for scientific drilling purposes.
- ▶ The drillship can be used as a platform to carry out well maintenance or completion work such as casing and tubing installation.
- ▶ Drill ships are often built to the design specification to meet the requirements set by the oil production company and/or investors.



Drilling: Rig Crew

- The crew who are going to operate the rig consists of the following:
 - 1 Co. Man / Rig Supervisor
 - 2 Tool Pusher & Night Pusher
 - 3- Driller
 - 4- Mechanics & Electricians
 - 5- Derrick Man
 - 6 Crane Operator
 - 7 Floor Men
 - 8 Rough Necks
 - 9 Motor Man

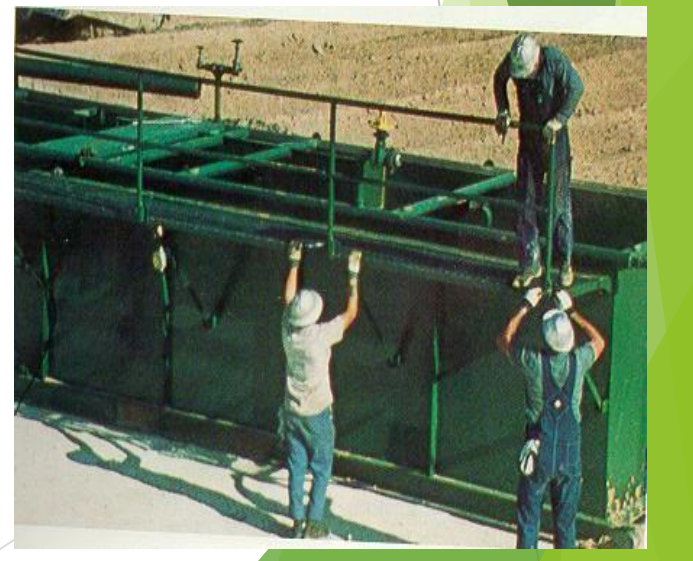
Drilling: Rig Crew



Drilling: Rig Crew

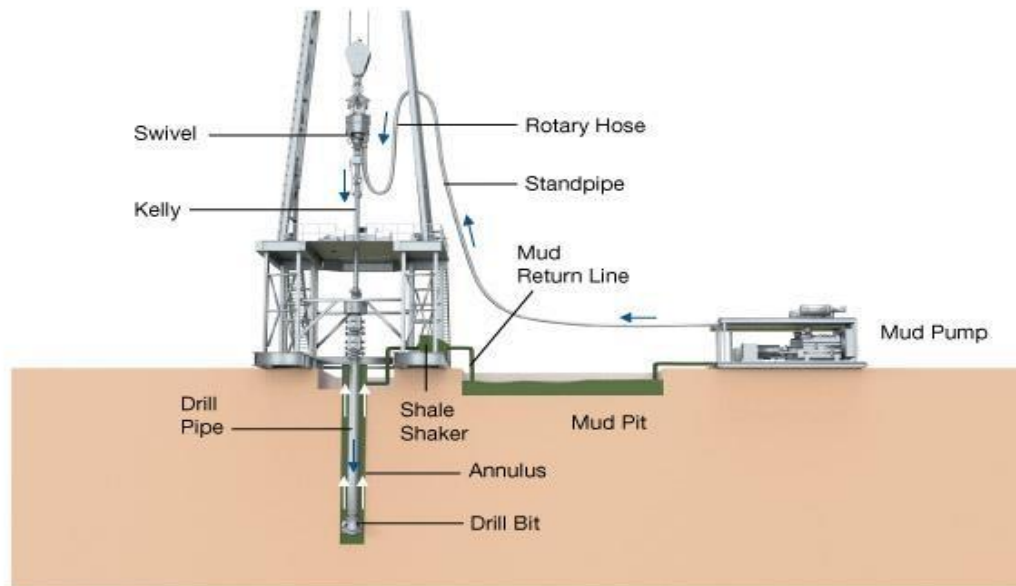


Drilling: Rigging up



Drilling Operations:

- After the hole is drilled, sections of steel pipes (casing) slightly smaller in diameters than the borehole are placed in the hole.
- Cement is placed between the outside of the casing and the borehole to provide structural integrity to a newly drilled well and isolate pressure zones from each other and from the surface.
- Modern wells often have two to five sets of subsequently smallest hole sizes drilled inside one each other. Each is cemented with a casing.



Drilling Operations:

- The drill bit aided by the weight of thick walled pi called “drill Collar” above it, cuts into the rock as the bit turns.



Diamond Bit



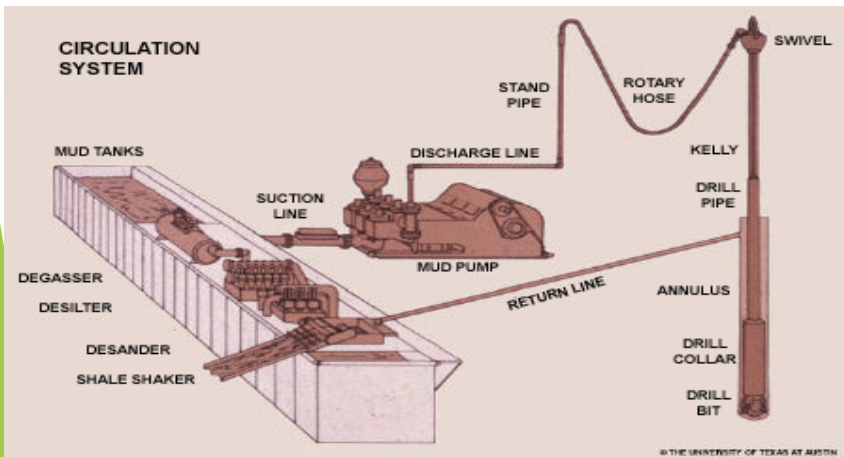
Roller Cone Bit



Polycrystalline
Diamond Compact Bit

Drilling Operations:

- Mud is the drilling fluid pumped down the inside of the drill pipe and exits the drill bit.
- Drilling mud is a complex mixture of fluids, solids and chemicals that must be carefully tailored to provide the correct physical and chemical characteristics required to safely drill the well.
- The fluid then goes through shakers which strain the cuttings from good fluid which is returned to the pit.
- There are two types of Mud :
 - A- Oil Based Mud
 - B- Water Based Mud



Drilling Operations: A- Oil Based Mud

- It is composed of oil as the continuous phase and water as the dispersed phase in conjunction with emulsifiers, and wetting agents. The oil base can be diesel, kerosene, fuel oil, or selected crude oil.

- The advantages are:
 - 1 High drilling rate.
 - 2 Improved Lubrication and anticorrosive properties (to drill bit).
 - 3- Maintains formation at high temperatures.

- The disadvantages are :
 - 1 Can cause toxic fumes that affect the drilling team.
 - 2 Can be very high density/pressure and cause damage to well bore/surrounding formation.
 - 3- Contaminate areas of freshwater aquifers causing environmental damage.
 - 4- Disposal of cuttings in an appropriate place to isolate possible environmental contamination.

- Oil-based muds are expensive, but are worth the cost when drilling through:
 - 1- Troublesome shale that would otherwise swell and disperse in water based mud
 - 2- To drill deep, high temperature holes that dehydrate water based mud,
 - 3- To drill water soluble zones

Drilling Operations: A- Water Based Mud

- Most basic water-based mud systems begin with water, then clays and other chemicals are incorporated into the water to create a homogeneous blend resembling something like chocolate milk (depending on viscosity). (Referred as Gel).

- The advantages are:
 - 1- Non-use of hydrocarbons reduces impact on environment.
 - 2- Viscosity easily controlled.
 - 3- Density easily controlled for low pressure formation well drilling.
 - 4- Drill chips easier removed from fluid at shakers.

- The disadvantages are :
 - 1- Not as an efficient lubricant as OBM Can promote corrosion to drill bit.
 - 2- Not efficient at high temperatures.
 - 3- Does not carry drill chips to the surface as efficiently as OBM.

- Water Based Mud can be used as cooling of the drill bit which is required rather than lubrication.

Drilling Operations: What's the meaning of Kick

- A kick is when the formation pressure at the depth of the bit is more than the hydraulic head of the mud above which if not controlled by closing “Blowout Preventer” and increasing the density of the drilling fluid would allow formation fluids and mud to come up through annulus uncontrollably.

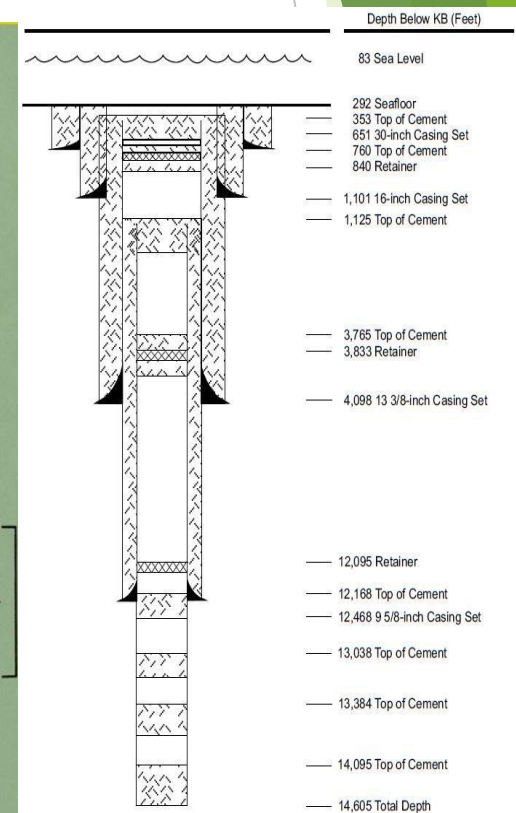
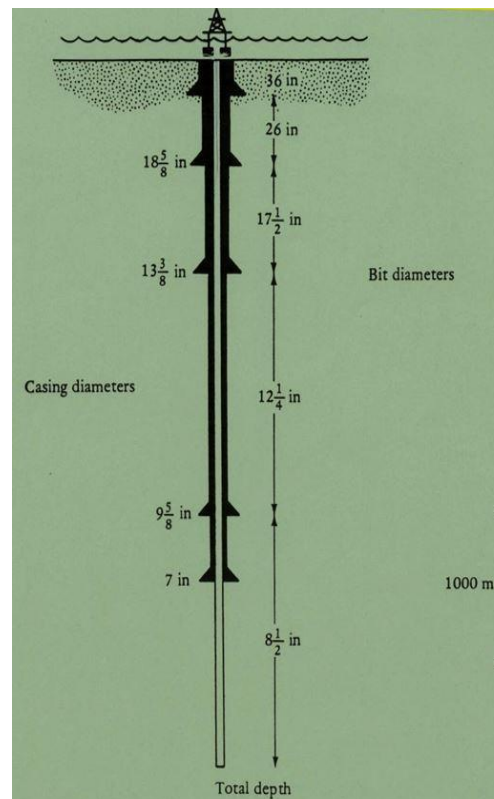
Well Casing

- Installing well casing is an important part of the drilling and completion process.
- Well casing consists of a series of metal tubes installed in the freshly drilled hole.
- Casing strengthens the sides of the well hole, ensures that no oil or natural gas seeps out of the well hole as it is brought to the surface, and keeps other fluids or gases from seeping into the formation through the well.

➤ The type of casing used depends on the subsurface characteristics of the well, including the diameter of the well and the pressures and temperatures experienced throughout the well.

➤ The diameter of the well hole depends on the size of the drill bit used.

➤ In most wells, the diameter of the well hole decreases the deeper it is drilled, leading to a type of conical shape that must be taken into account when installing casing.



Well Casing

- Casing that is cemented in place aids the drilling process in several ways:
 - 1 Prevent contamination of freshwater well zones.
 - 2 Prevent unstable upper formations from caving-in and sticking the drill string or forming large caverns.
 - 3 Provides a strong upper foundation to use high-density drilling fluids to continue drilling deeper.
 - 4 Isolates different zones, that may have different pressures or fluids - known as zone isolation, in the drilled formations from one another.
 - 5 Seals off high pressure zones from the surface, avoiding potential for a blowout.
 - 6 Prevents fluid loss into or contamination of production zones.
 - 7 Provides a smooth internal bore for installing production equipment.

Well Casing

- Well casing is a very important part of the completed well.
- In addition to strengthening the well hole, it provides a conduit to allow hydrocarbons to be extracted without intermingling with other fluids and formations found underground.
- Once the casing has been set, and in most cases cemented into place, proper lifting equipment is installed to bring the hydrocarbons from the formation to the surface.
- After the casing is installed, tubing is inserted inside the casing, running from the opening well at the top to the formation at the bottom.
- The hydrocarbons that are extracted go up this tubing to the surface. This tubing may also be attached to pumping systems for more efficient extraction, should that be necessary.

Well Casing

- There are five different types of well casing. They include:

- 1 *Conductor Casing*
- 2 *Surface Casing*
- 3 *Intermediate Casing*
- 4 *Liner Casing*
- 5 *Production Casing*

Well Casing : 1- Conductor Casing

- Conductor casing is installed first, usually prior to the arrival of the drilling rig.
- The hole for conductor casing is often drilled with a small auger drill.
- Conductor casing is usually no more than 20 to 50 feet long.
- It is installed to prevent the top of the well from caving in and to help in the process of circulating the drilling fluid up from the bottom of the well.
- Onshore, this casing is usually 16 to 20 inches in diameter, while offshore casing usually measures 30 to 42 inches.
- The conductor casing is cemented into place before drilling begins.



Well Casing : 2- Surface Casing

- Surface casing is the next type of casing to be installed. It can be anywhere from a few hundred to 2,000 feet long, and is smaller in diameter than the conductor casing (13 3/8-inch).
- The primary purpose of surface casing is to protect fresh water zones near the surface of the well from being contaminated by leaking hydrocarbons or salt water from deeper underground.
- It also serves as a conduit for drilling mud returning to the surface, and helps protect the drill hole from being damaged during drilling.
- Surface casing, like conductor casing, is cemented into place.
- These intermediate casing areas are also be cemented into place for added protection.

Well Casing : 3- Intermediate Casing

- Intermediate casing is usually the longest section of casing found in a well, and its diameter is 9 5/8-inch.
- Intermediate casing may be necessary on longer drilling intervals where necessary drilling mud weight to prevent blowouts may cause a hydrostatic pressure that can fracture shallower or deeper formations.
- The primary purpose of intermediate casing is to minimize the hazards that come along with subsurface formations that may affect the well.
- Casing placement is selected so that the hydrostatic pressure of the drilling fluid remains at a pressure level that is between formation pore pressures and fracture pressures.
- These include abnormal underground pressure zones, underground shale, and formations that might otherwise contaminate the well, such as underground salt-water deposits.
- Intermediate casing is run as insurance against the possibility of such a formation affecting the well.

Well Casing : 4- Production Casing

- Production casing, alternatively called the 'oil string' or 'long string,' is installed last and is the deepest section of casing in a well.
- This is the casing that provides a conduit from the surface of the well to the petroleum-producing formation.
- The size of the production casing depends on a number of considerations, including the lifting equipment to be used, the number of completions required, and the possibility of deepening the well at a later time.
- For example, if it is expected that the well will be deepened at a later date, then the production casing must be wide enough to allow the passage of a drill bit later on.

Well Casing : 5- Liner Casing

- Liner Casings are sometimes used instead of intermediate casing to reduce cost, It may typically be 7".
- Liner strings are commonly run from the bottom of another type of casing to the open well area.
- However, liner strings are usually attached to the previous casing with 'hangers', instead of being cemented into place.

Completion

- Once the design well depth is reached, the formation must be tested and evaluated to determine whether the well will be completed for production, or plugged and abandoned.
- Completion is the process in which the well is enabled to produce safely oil and / or gas.
- Completion is the process of making a well for production or injection. This involves preparing of the bottom of the hole to the required specification running in the production tubing and its associated down hole tools as well as perforating and stimulation as required.

Completion Design Criteria:

- **Profitability:** provides production optimization and minimize operating cost over its life.
- **Flexibility:** for handling the current and future problems.
- **Simplicity:** to allow the most efficient installations and maintenance activities.

Objectives of Completion:

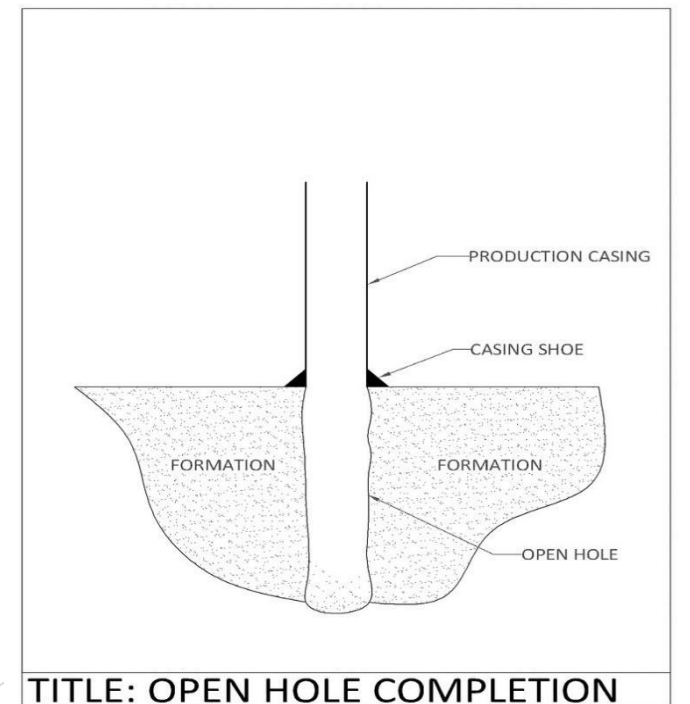
- Provide optimum flow conditions.
- Protect casing.
- Down hole emergency isolation.
- Permit down hole chemical injection.
- Permit down hole measurements.
- Isolate producing zones.

Classifications of Completion:

- There are a number of types of completions, including:
 - 1 Open Hole Completion
 - 2 Cased Perforated Completion
 - 3 Permanent Completion
 - 4 Multiple Zone Completion
- The use of any type of completion depends on the characteristics and location of the hydrocarbon formation.

Classifications of Completion: 1- Open Hole Completion

- Open hole completions are the most basic type and are used in formations that are unlikely to cave in.
- An open hole completion consists of simply running the casing directly down into the formation, leaving the end of the piping open without any other protective filter.
- This designation refers to a range of completions where no casing or liner is cemented in place across the production zone.
- In competent formations, the zone might be left entirely bare, but some sort of sand-control and/or flow-control means are usually incorporated.
- Popular to be used in case of Horizontal Drilling where cemented installations are more expensive and technically more difficult.



Classifications of Completion: 1- Open Hole Completion

➤ Advantages of Open Hole Completions:

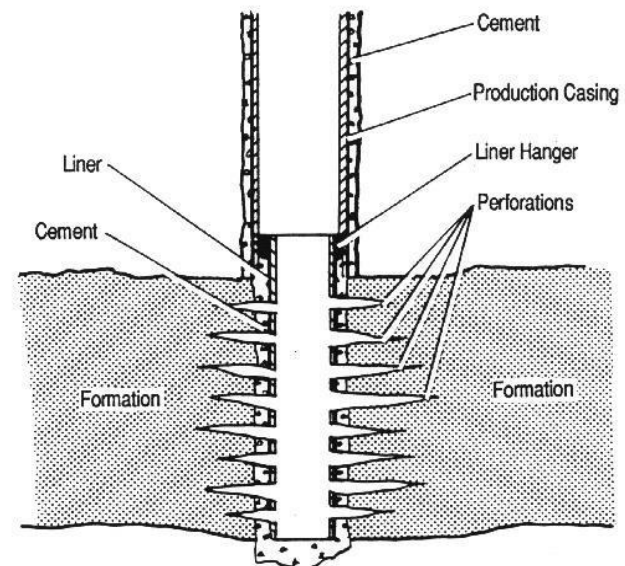
- 1 The entire pay zone is open to the wellbore.
- 2 Perforation expense is eliminated.
- 3 Log interpretation is not critical since the entire interval is open to flow.
- 4 Maximum wellbore diameter is opposite the pay zone(s) - reduced drawdown.
- 5- The well can easily be deepened.
- 6 Easy conversion to liner or perforated casing completion.
- 7 No formation damage caused by cement.

➤ Disadvantages of Open Hole Completions:

- 1 Excessive gas or water production difficult to control because the entire interval is open to flow.
- 2 The casing may need to be set before the pay zone(s) are drilled and logged.
- 3 Separate zones within the completion cannot be selectively fractured or acidized.
- 4- Requires frequent cleanout if producing formations are not completely firm.

Classifications of Completion: 2- Cased Perforated Completion

- It consists of production casing Or Liner casing being run through the formation.
- The sides of this casing are perforated, with tiny holes along the sides facing the formation, which allows for the flow of hydrocarbons into the well hole, but still provides a suitable amount of support and protection for the well hole.
- The process of perforating the casing involves the use of specialized equipment designed to make tiny holes through the casing, cementing, and any other barrier between the formation and the open well.



Classifications of Completion: 2- Cased Perforated Completion

➤ Advantages of Perforated Casing or Liner Completions:-

- 1 Formation damage is minimal.
- 2 Excessive water or gas production may be controlled or eliminated.
- 3 Formation can be selectively stimulated.
- 4 Liner impedes sand influx.
- 5 Well can be easily deepened.
- 6 Safer operations.
- 7 Easier planning of completions.

➤ Disadvantages of Perforated Casing or Liner Completions:-

- 1- Wellbore diameter through the pay zone(s) is restricted.
- 2- Log interpretation critical.
- 3- Liner cementation more difficult to obtain than casing cementation.
- 4- Perforating, cementing and rig time involves additional costs.

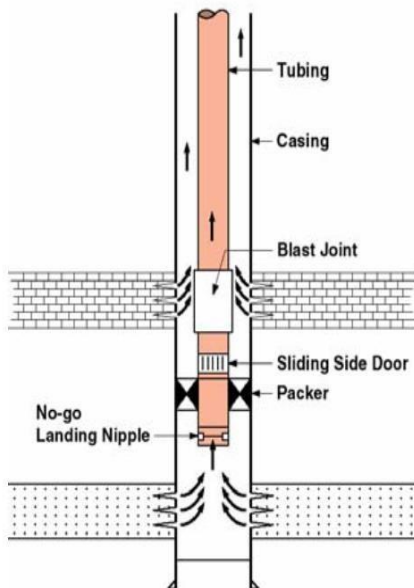
Classifications of Completion: 2- Cased Perforated Completion

- Permanent completions are those in which the components are assembled and installed only once.
- The permanent-type well completion is one in which the tubing and well-head are set in place only once in the life of the well and the completion or remedial work is performed through the tubing with a tubing-type perforator, a retrievable tubing extension, and other wire-line tools.
- Completing a well in this manner can lead to significant cost savings compared to other types.

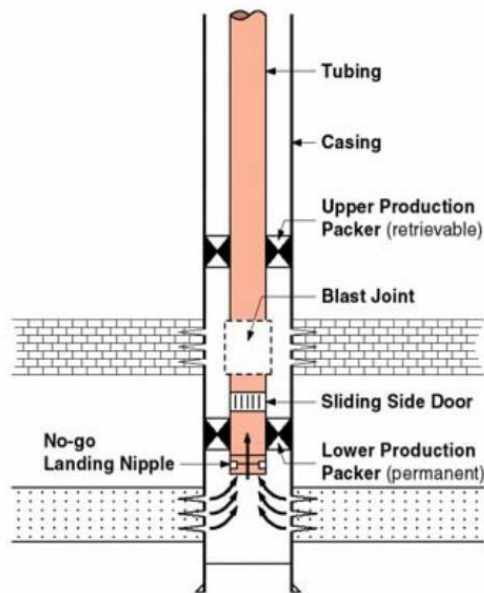
Classifications of Completion: 4- Multiple Zone Completion

- ▶ It is the practice of completing a well so that hydrocarbons from two or more formations may be produced simultaneously or separately.

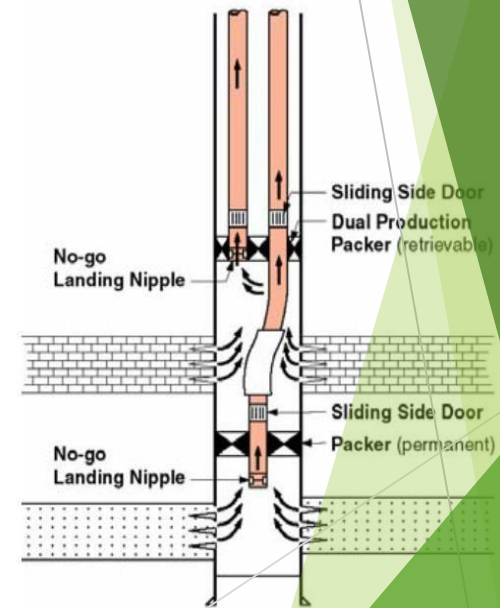
**Single string dual zone,
single packer**



**Single string dual zone,
two packers**



Dual string dual zone



Classifications of Completion: 4- Multiple Zone Completion

➤ Advantage of Multiple Zone Completions:

1- Reduced Cost.

➤ Disadvantages of Multiple Zone Completions:

1 Production casing is exposed to well pressure and corrosive fluids.

2 Tubing can be "cemented" in place due to solids settling from the upper zone.

3The lower zone must be killed or plugged off before work over is done on the upper zone. 4-

The lower zone must be plugged off to measure any flowing bottom hole temperature associated with the upper zone.

Completion Components:

1 Well Head

2 Down hole Safety Valve

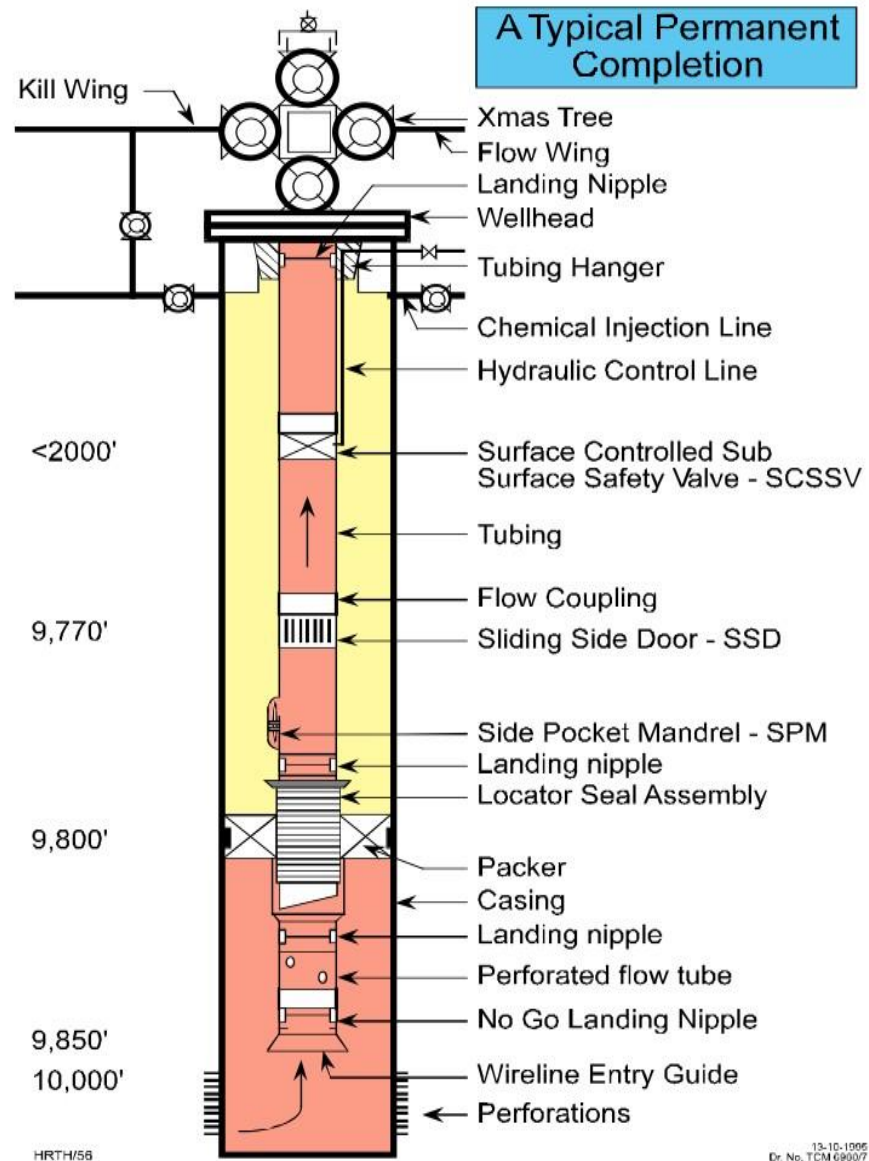
3- Side Pocket Mandrel

4 Sliding Sleeves

5 Landing Nipples

6 Packers

7 Perforated Joint



Completion Components: 1- Well Head

- The wellhead consists of the pieces of equipment mounted at the opening of the well to manage the extraction of hydrocarbons from the underground formation.
- It prevents leaking of oil or natural gas out of the well, and also prevents blowouts caused by high pressure.
- Formations that are under high pressure typically require wellheads that can withstand a great deal of upward pressure from the escaping gases and liquids.
- These wellheads must be able to withstand pressures of up to 20,000 pounds per square inch (psi).
- The wellhead consists of three components:
 - A- The casing head
(Including casing hangers & Casing head spool)
 - B- The tubing head
(Including Tubing hangers & Tubing head spool)
 - C- The 'Christmas tree.'



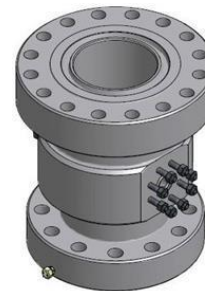
A- Casing Head

- A casing head is a simple metal flange welded or screwed onto the top of the conductor pipe.
- The casing head also serves to support the entire length of casing that is run all the way down the well.
- This piece of equipment typically contains a gripping mechanism that ensures a tight seal between the head and the casing itself.
- Casing Head Spool : used in flanged wellhead assemblies to secure the upper end of a casing string and to suspend and seal the casing.

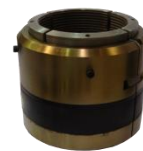
- Casing Hangers: is that portion of a well head assembly which provides support for the casing string when it is lowered into the wellbore.

- When the casing string has been run into the wellbore it is hung off, or suspended, by a casing hanger, which rests on a landing shoulder inside the casing spool.

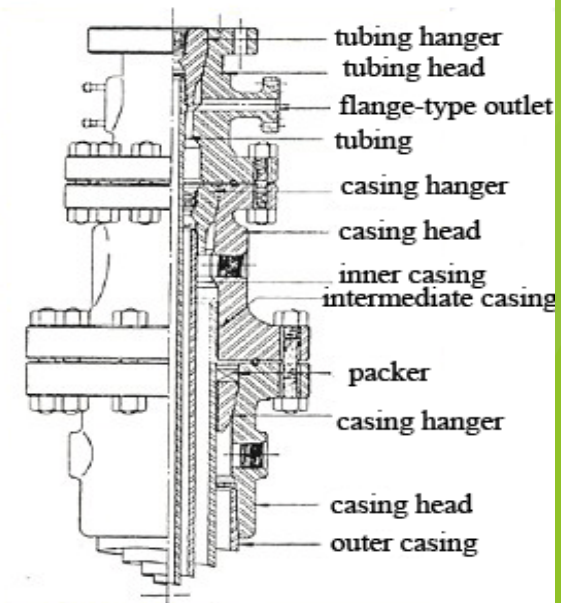
- Casing hangers must be designed to take the full weight of the casing, and provide a seal between the casing hanger and the spool.



CSG head spool



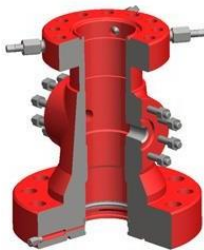
CSG hanger



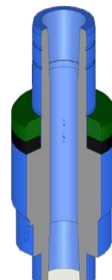
Structure of well equipment

B- Tubing Head

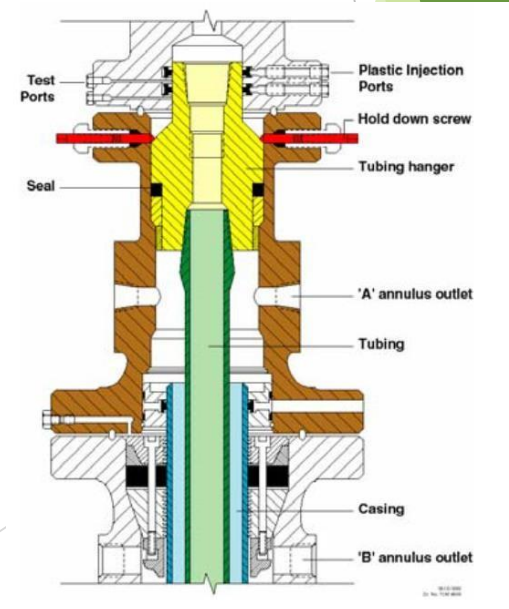
- A spool-type unit or housing attached to the top flange on the uppermost oil-well-casing head to support the tubing string and to seal the annulus between the tubing string and the production casing string.
- Tubing head is a wellhead component that supports the tubing hanger and provides a means of attaching the Christmas tree to the wellhead.
- Tubing Head Spool: Piece of equipment attached to the uppermost casing head or smallest casing string which serves to suspend the tubing and to seal the annular space between the tubing and casing.
- Tubing hanger: is a device attached to the topmost tubing joint in the wellhead to support the tubing string.
- The tubing hanger typically is located in the tubing head, with both components incorporating a sealing system to ensure that the tubing conduit and annulus are hydraulically isolated.



TBG head spool



TBG hanger



C- Christ-mass Tree:

- A Christmas tree (X-mas tree) is an assembly of valves and fittings which forms the top of the completion.
- It is connected to the tubing hanger spool and directs the flow of fluids from the production tubing into the production flow line.
- It also provides vertical access to the production tubing for well servicing and side access to the production tubing for pumping services, i.e. well kill, circulation and chemical injection facility.



C- Christ-mass Tree:

➤ Christ-mass Tree Valves:

1- Upper Maser Valve (UMV):

Is used on moderate to high pressure wells as an emergency shut-in system.

2 Lower Maser Valve (LMV):

Utilized on all Christmas trees for contingency to the UMV to shut off well flow in the event of a leaking UMV or the connection between them.

3 Flowing Wing Valve (FWV):

The FWV permits the passage of well fluids to the choke.

4 Choke Valve:

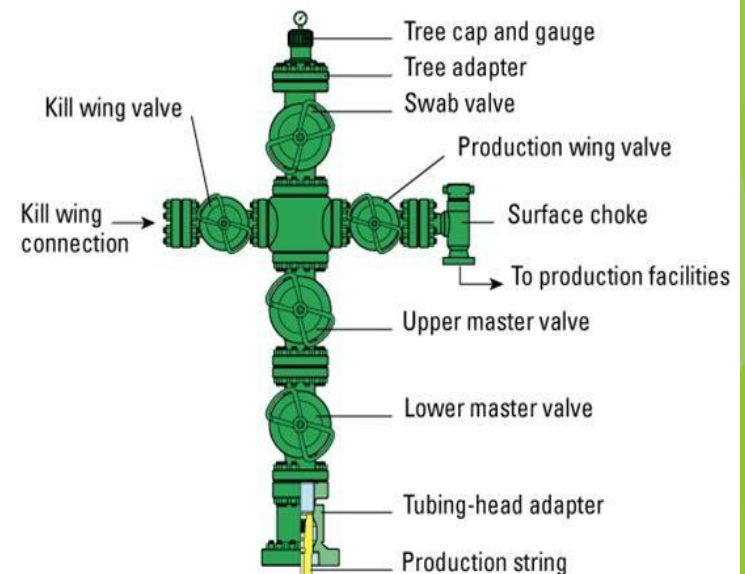
To restrict, control or regulate the flow of hydrocarbons from the well.

5 Killing Wing Valve:

Is used for equalization and permits entry of kill fluid into the completion string.

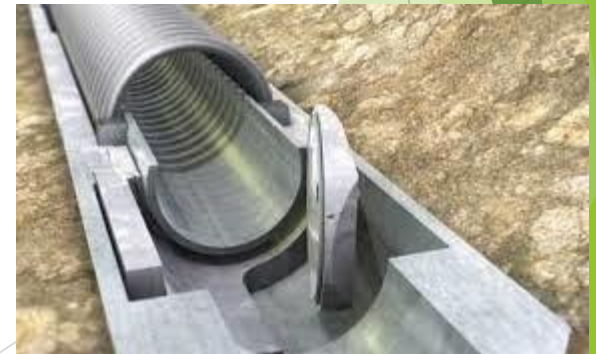
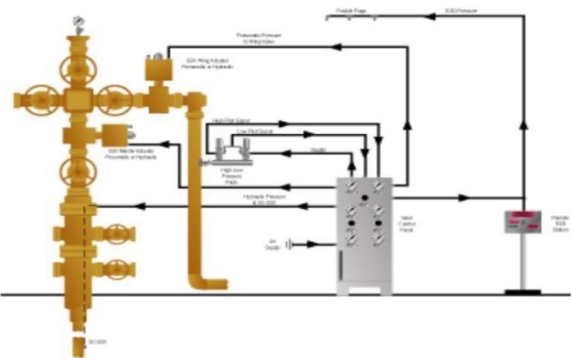
6 Swab Valve:

Permits vertical entry into the well for well servicing Activities.



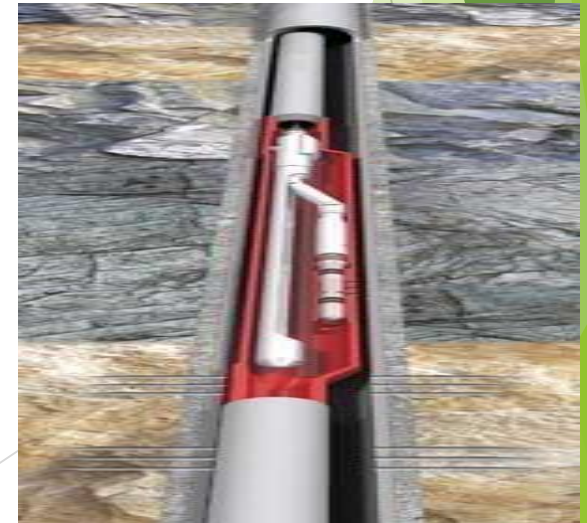
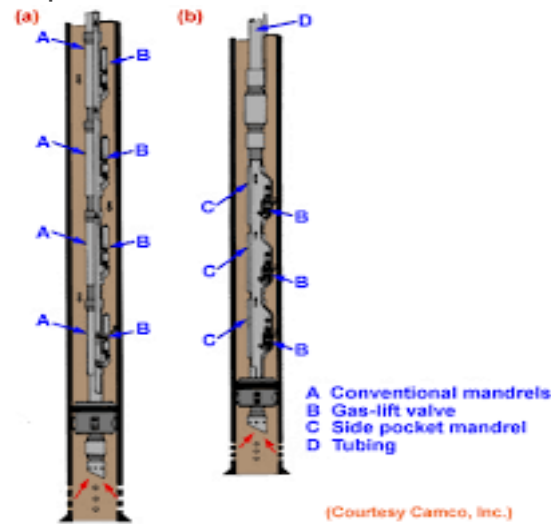
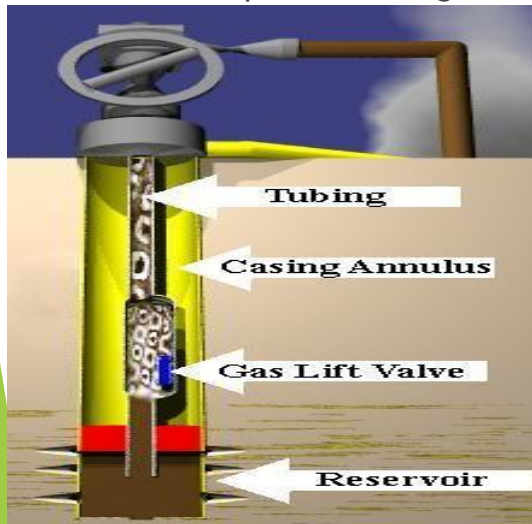
Completion Components: 2- Safety Control Sub-Surface Safety Valve

- A Safety Control Sub-Surface Safety Valve (SCSSV) is a down hole safety device installed in a well which can be closed in emergency.
- An emergency may arise on or around a well from equipment failure, human error, fire, leaks.
- The reason for using an SSSV is to provide protection to site and off-site personnel, surface facilities the environment and the reservoir.
- These valves are commonly uni-directional flapper valves which open downwards such that the flow of wellbore fluids tries to push it shut, while pressure from the surface pushes it open; This means that when closed, it will isolate the reservoir fluids from the surface.
- Most down hole safety valves are controlled hydraulically from the surface, meaning they are opened using a hydraulic connection linked directly to a well control panel.
- When hydraulic pressure is applied down a control line, the hydraulic pressure forces a sleeve within the valve to slide downwards; This movement compresses a large spring and pushes the flapper downwards to open the valve.
- When hydraulic pressure is removed, the spring pushes the sleeve back up and causes the flapper to shut.
- In this way, it will isolate the wellbore in the event of a loss of the wellhead.



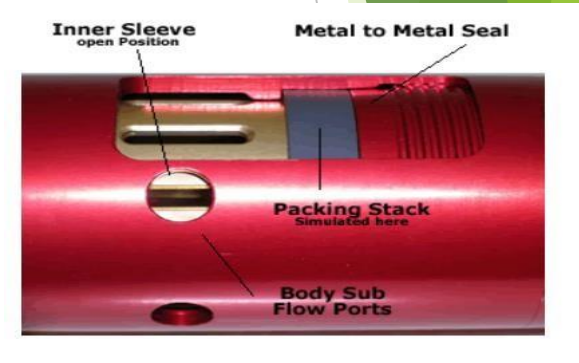
Completion Components: 3- Side Pocket Mandrel

- A completion component that is used to house gas-lift valves and similar devices that require communication with the annulus.
- The design of a side-pocket mandrel is such that the installed components do not obstruct the production flow path, enabling access to the wellbore and completion components below.
- The gas-lift mandrel is a device installed in the tubing string of a gas-lift well onto which or into which a gas-lift valve is fitted.
- There are two common types of mandrels. In a conventional gas-lift mandrel, a gas-lift valve is installed as the tubing is placed in the well. Thus, to replace or repair the valve, the tubing string must be pulled. In the side-pocket mandrel, however, the valve is installed and removed by wire line while the mandrel is still in the well, eliminating the need to pull the tubing to repair or replace the valve.



Completion Components: 4- Sliding Sleeves

- A **sliding sleeve** is a standard component for the completion of an oil or gas well. Their main uses are to shut off flow from one or more reservoir zones or to regulate pressure between zones.
- There are two main categories of sliding sleeves: open/close and choking.
- Open/close sleeves are shifted between a full open position and a closed position. They are used to shut off flow from a zone for economic reasons or to shut off a zone that is depleting or producing too much water. In multi-zone wells, they are used to regulate which zones to produce from and which ones to shut off, also are used with some types of Artificial lift methods.
- Mechanically actuated sleeves are simple and inexpensive but require actuation by a "lock," which must be run in the well on wire line or coiled tubing.
- Hydraulically actuated sleeves are more complicated but can be actuated from a small pump at surface.
- King sleeves can be used to regulate the pressure between two or more zones.
- They are also used to regulate the flow of fluid into a well during proppant fracturing or hydraulic fracturing operations.
- Choking sleeves are all hydraulically actuated and have a much more complex design than open/close sleeves.



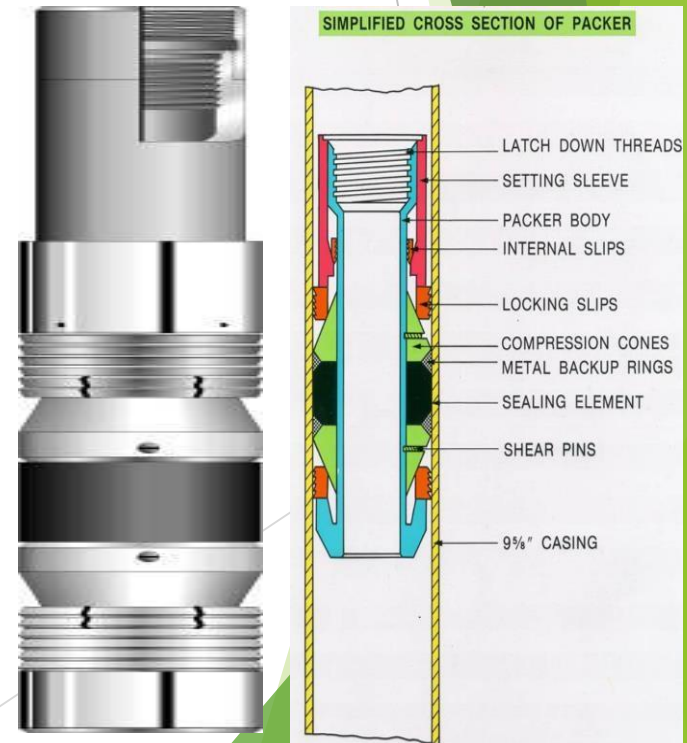
Completion Components: 5- Landing Nipples

- Landing nipples are included in most completions at predetermined intervals to enable the installation of flow-control devices, such as plugs and chokes. Three basic types of landing nipple are commonly used: no-go nipples, selective-landing nipples.
- Selective Landing Nipples (X): They are used in the following applications:
 - 1- Land blanking plugs to shut in well or to test the production tubing
 - 2- Land equalizing check valves
 - 3 Land chokes to reduce surface flowing pressures
 - 4 Land instrument hangers with geophysical devices such as pressure and temperature recorders.
- No-Go Landing Nipples (XN): can be used in the above applications as "X", besides that, it has restricted I.D. catches tools dropping during wire line work.



Completion Components: 6- Packers

- The packer isolates the annulus between the tubing and the inner casing and the foot of the well. This is to stop reservoir fluids from flowing up the full length of the casing and damaging it. It is generally placed close to the foot of the tubing, shortly above the production zone.
- There are two types of Packers; Permanent Packer and Retrievable Packer.
- Most packers are "permanent" and require milling in order to remove them from the casing.
- The main advantages of permanent packers are lower cost and greater sealing and gripping capabilities.
- In situations where a packer must be easily removed from the well, such as secondary recoveries, re-completions, or to change out the production tubing, a retrievable packer must be used.



Completion Components: 7- Perforated Joint

- ▶ This is a length of tubing with holes punched into it. If used, it will normally be positioned below the packer and will offer an alternative entry path for reservoir fluids into the tubing in case the shoe becomes blocked, for example, by a stuck perforation gun.



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Production

- The production stage is the most important segment of the well's life when the oil and gas are produced from the attached reservoir.
- At this stage the rig or the work over installations has moved off the wellbore and the top is fitted through the Christmas Tree to production network.

Well Intervention:

- A Well Intervention is any operation carried out on an oil or gas well during or at the end of its production life which alters the state of the wells and well geometry provides well diagnostics or manages the production of the well.

- Well Intervention Works include:
 - 1 **Pumping:**

The simplest form of intervention like pumping the chemicals into the well.
 - 2 **W/H Maintenance:**

Scheduled works involve greasing, pressure testing of the valves and sometimes pressure testing of SCSSV.
(SIT & WIT)
 - 3 **Slick Line:**

Used for fishing, gauge cutting, setting or removing plugs, deploying or removing wire line retrieval valve and memory logging.
 - 4 **Coiled Tubing:**

Is used when it is desired to pump chemicals directly to the bottom of the well such as circulating operations or chemical works.

It can also be used for tasks normally done by wire line if the deviation in the well is too severe for gravity to lower the tool string and circumstances prevent use of wire line.
 - 5 **Perforation:**

Is the final stage of the well completion to make a connection between the wellbore and the formation.
 - 6 **Workover:**

In some older wells changing the reservoir conditions or deteriorating conditions of the completion may necessitate pulling it out to replace it with a fresh completion or to install any type of Artificial lift Method.

Well Stimulation

➤ Is necessary to achieve the target or planned productivity of the perforated well.

➤ Stimulation Techniques:

1 **Acidizing:**

Involves chemical injection to eat away skin damage cleaning up the formation thereby improving the flow of reservoir fluids. A strong acid (usually HCL) is used to dissolve the rock formation.

2 **Fracturing:**

Creating and extending fractures from the perforation tunnel deeper into the formation increasing the surface area of formation fluids to flow into the well. This done by injection fluids at high pressure.

3 **Nitrogen Circulation:**

Using coiled tubing to pump Nitrogen at high pressure into the bottom of the borehole to circulate the residue of completion fluids or heavy brines from the wellbore.

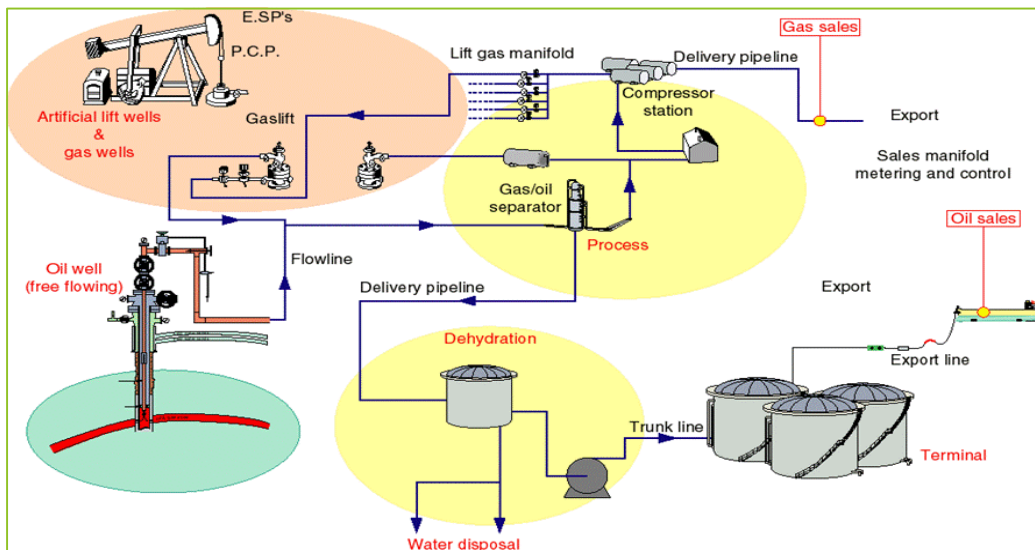


Well & Reservoir Management WRM:

- **Integrated Production System**
- **Production System Optimization**
- **Well Testing & Sampling**
- **Well Test Data Inputs**

Well & Reservoir Management WRM: Integrated Production System

- This shows the interdependence of the various parts of an Integrated Production System.
- We will concentrate on the two bubbles on the left side, which indicate the working areas of a Production Technologist.
- It also shows that what you do down hole, has an effect on the rest of the system.



Well & Reservoir Management WRM: Production System Optimization

- Production system optimization (PSO) is the component of the WRM that identifies opportunities to maximize the values of the IPS.
- This is achieved by a combining a regular surveillance with a clear understanding of production system elements and how they perform in an integrated manner.
- PSO is a proactive and creative process should occur every day to have a data in a quality and quantity for decision making and generate opportunities that are successfully implemented to add value to the business.

Well & Reservoir Management WRM: Well Testing & Sampling

➤ Well Test is a structured and systematic process by which well performance data are obtained:

- 1- Gross liquid flow rate
- 2- BS&W (Water Cut)
- 3- Net (Oil) flow rate
- 4- Water flow rate
- 5 Formation gas flow rate
- 6 Formation gas to oil ration (FGOR)

➤ At Certain operating conditions:

- 1 Choke Setting
- 2 Gas lift rate (for gas lifted wells)
- 3VSD Current & Frequency (for ESP wells) 4-
- Separator operating mode (HP, MP or LP)

Well & Reservoir Management WRM:

Well Testing & Sampling

➤ Well Test Data Inputs:

Test Data should include:

- 1 Test date, time and duration.
- 2 Flow rates for oil/condensate and gas and water cut (BS&W).
- 3- Well parameters: FTHP, FTHT, FLP and choke setting.
- 4- Lift gas rate and CHP for gas lifted wells.
- 5- VSD current & frequency for ESP wells.

➤ Objectives:

- 1 To have basic quality of data on well performance and reservoirs properties.
- 2 To ensure effective well and reservoir management and production optimization.
- 3 To monitor oil, water and gas flow rates using facility like permanent test separators, rental mobile test units or multiphase flow meters.
- 4 To support hydrocarbon allocation, production forecasting and reserves estimation/booking.

➤ Examples on Decision Based on Well Test Data

- 1 Bean back for GOR control.
- 2 Bean back due to declining reservoir pressure.
- 3 Perform well service activities like wax cutting, acid wash, etc.
- 4 Develop swing list to be used for gross constraint, limited gas lift availability, etc.
- 5- Convert wells to artificial lift.

Abandonment

- A well is said to reach an "economic limit" when its most efficient production rate does not cover the operating expenses, including taxes.
- The economic limit for oil and gas wells can be expressed using these formula:

1- Oil fields:

$$EL_{oil} = \frac{WI \times LOE}{NRI[P_o + (P_g \times GOR)/1,000] \times (1 - T)}$$

2- Gas fields:

$$EL_{gas} = \frac{WI \times LOE}{NRI[(P_o \times Y) + P_g] \times (1 - T)}$$

Where:

EL _{oil}	is an oil well's economic limit in oil barrels per month (bbls/month).
EL _{Gas}	is a gas well's economic limit in thousand standard cubic feet per month (MSCF/month).
P _o , P _G	are the current prices of oil and gas in dollars per barrels and dollars per MSCF respectively.
LOE	is the lease operating expenses in dollars per well per month.
WI	working interest, as a fraction.
NRI	net revenue interest, as a fraction.
GOR	gas/oil ratio as SCF/bbl.
Y	condensate yield as barrel/million standard cubic feet.
T	production and severance taxes, as a fraction.

Abandonment

- When the economic limit is raised, the life of the well is shortened and proven oil reserves are lost. Conversely, when the economic limit is lowered, the life of the well is lengthened.
- When the economic limit is reached, the well becomes a liability and is abandoned.
- In this process, tubing is removed from the well and sections of well bore are filled with concrete to isolate the flow path between gas and water zones from each other.
- The surface around the wellhead is then excavated, and the wellhead and casing are cut off, a cap is welded in place and then buried.
- At the economic limit there often is still a significant amount of unrecoverable oil left in the reservoir. It might be tempting to defer physical abandonment for an extended period of time, hoping that the oil price will go up or that new supplemental recovery techniques will be perfected. In these cases, temporary plugs will be placed down hole and locks attached to the wellhead to prevent tampering.
- In theory an abandoned well can be re-entered and restored to production (or converted to injection service for supplemental recovery or for down hole hydrocarbons storage), but re-entry often proves to be difficult mechanically and not cost effective.

Thank You!
😊