جامعة الملك سعود
King Saud University

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College Of Engineering

Well Stimulation and Sand Production Management (PGE 489)

Introduction

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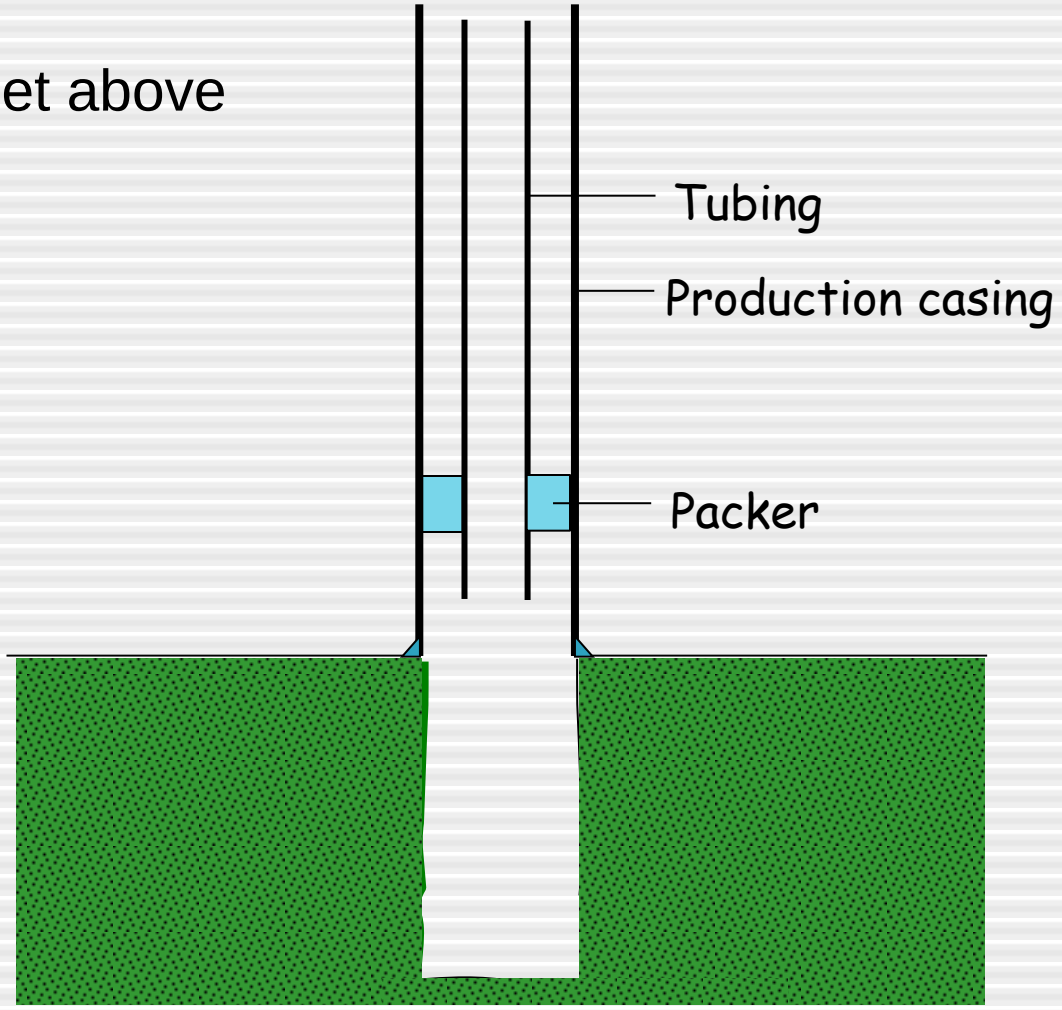
25-01-2016

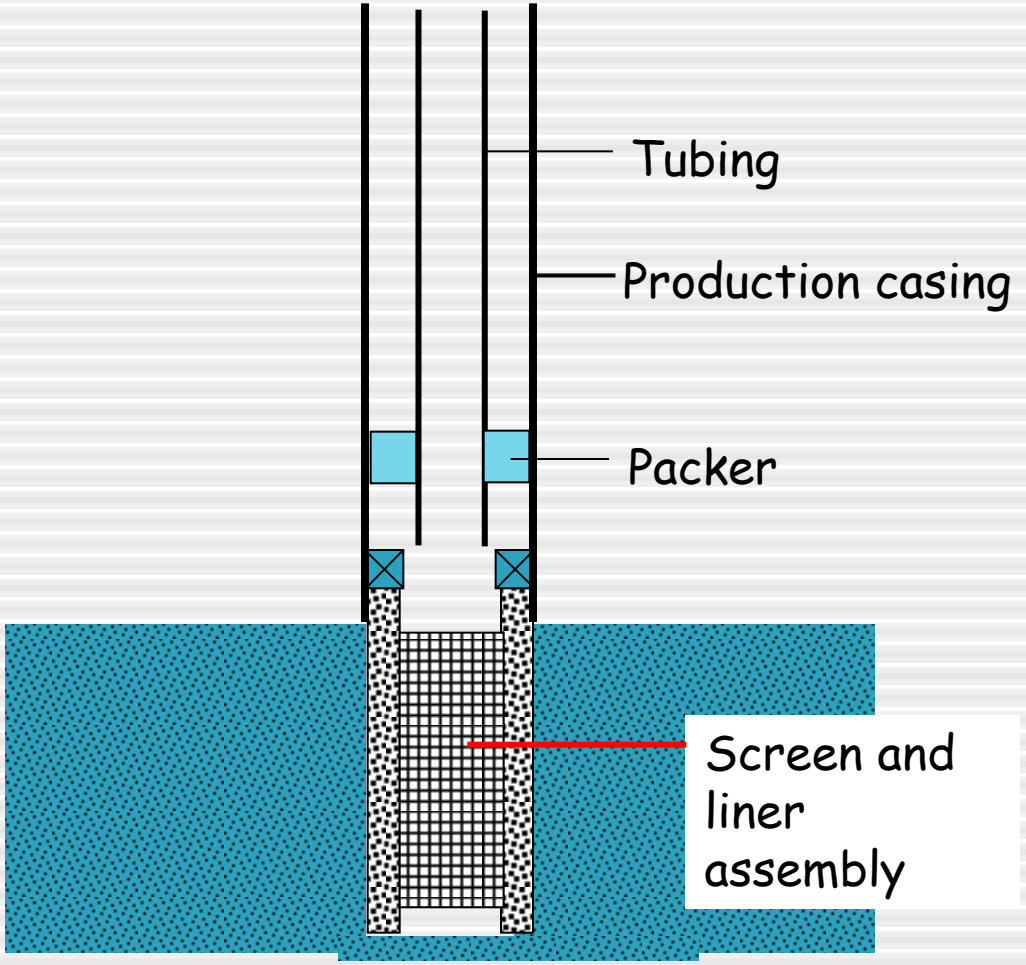
Type of Well Completions

- Open Hole Completions.
  - Production casing to be set above the zone of interests.

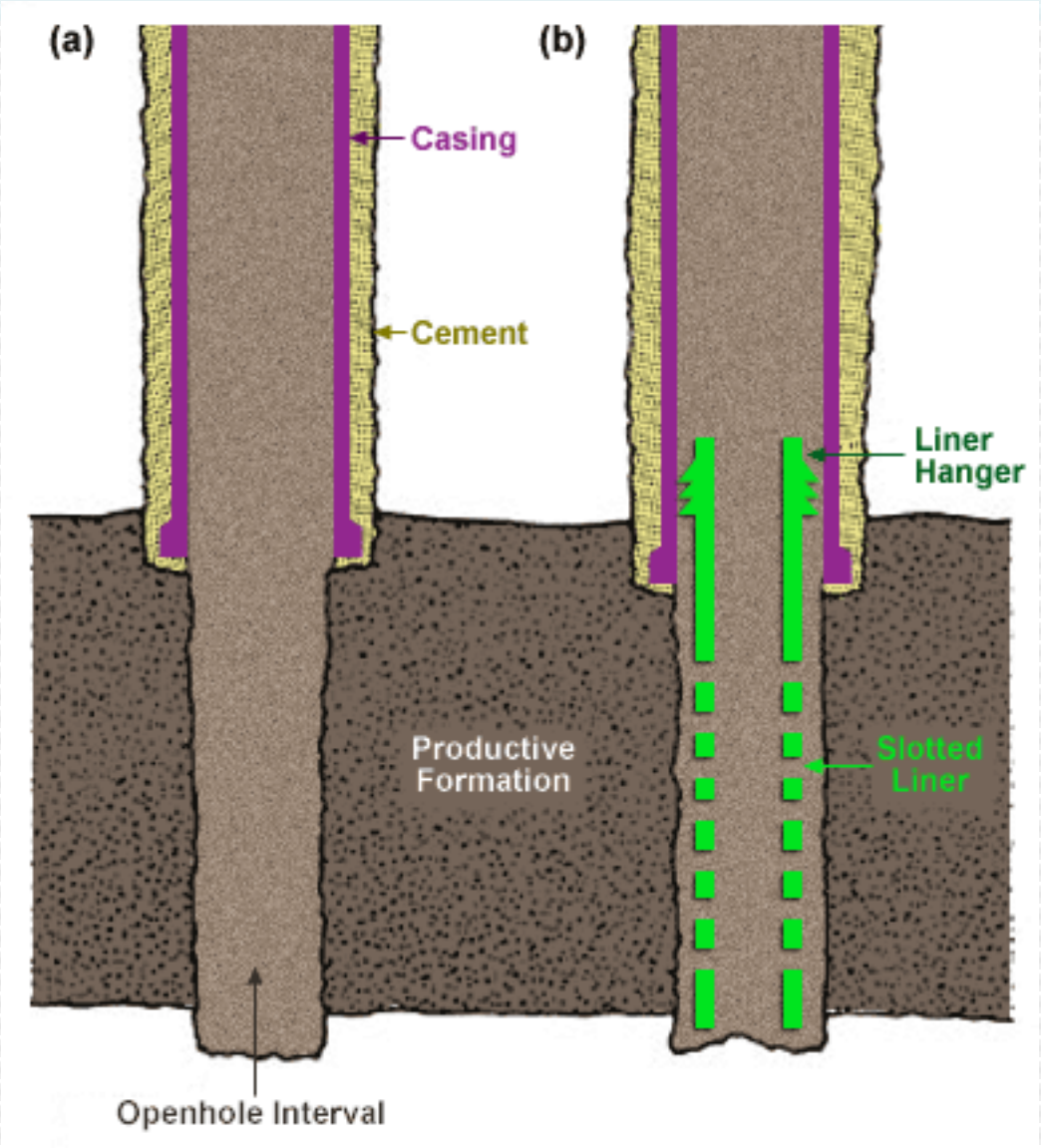


Type of Well Completions

- Liner Completions.
  - A liner is install across the pay zone.
  - Can be divided into two: Screen Liner and Perforated Liner.
  - Screen Liner: Casing is set above the producing zone, and an un-cemented screen and liner assembly is installed across the pay zone

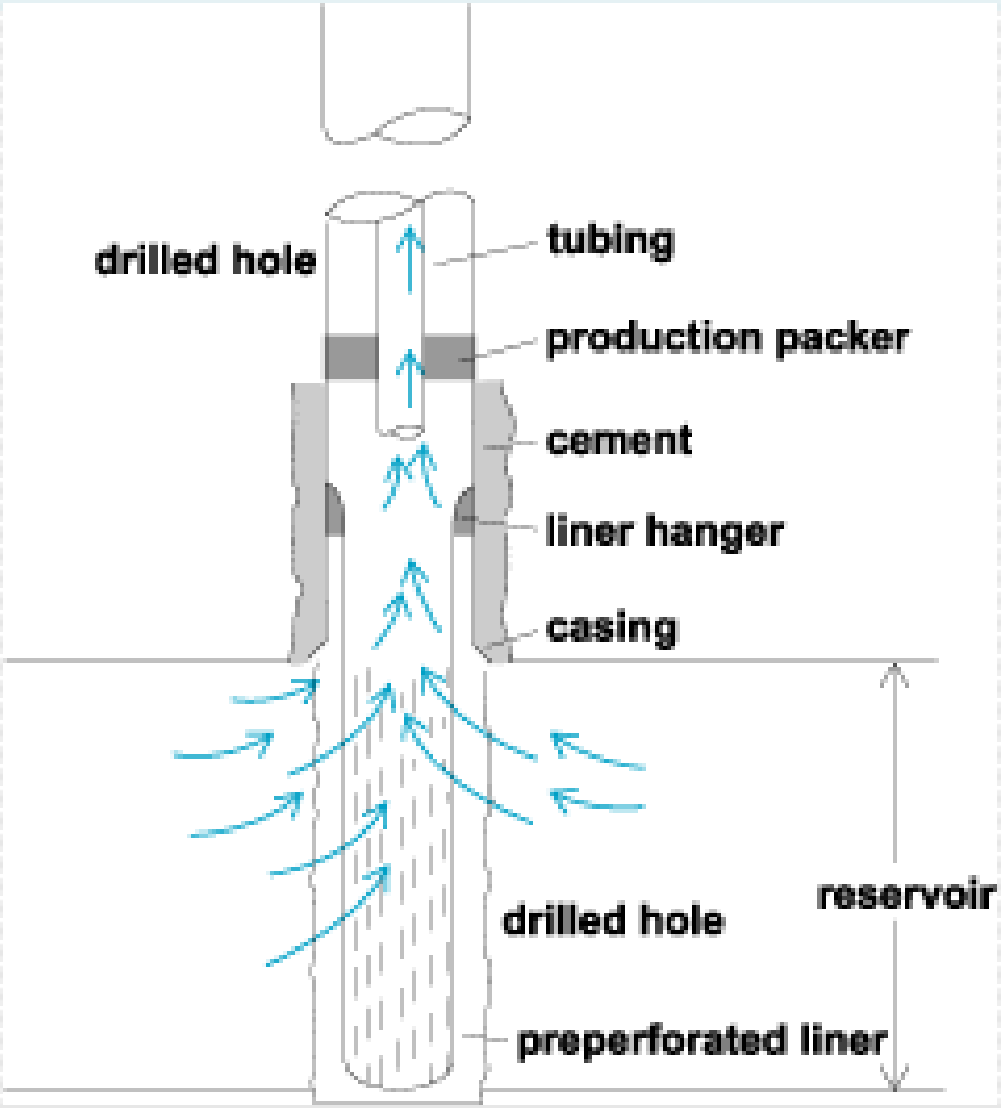


Type of Well Completions



Open Hole and Screen Liner Completion

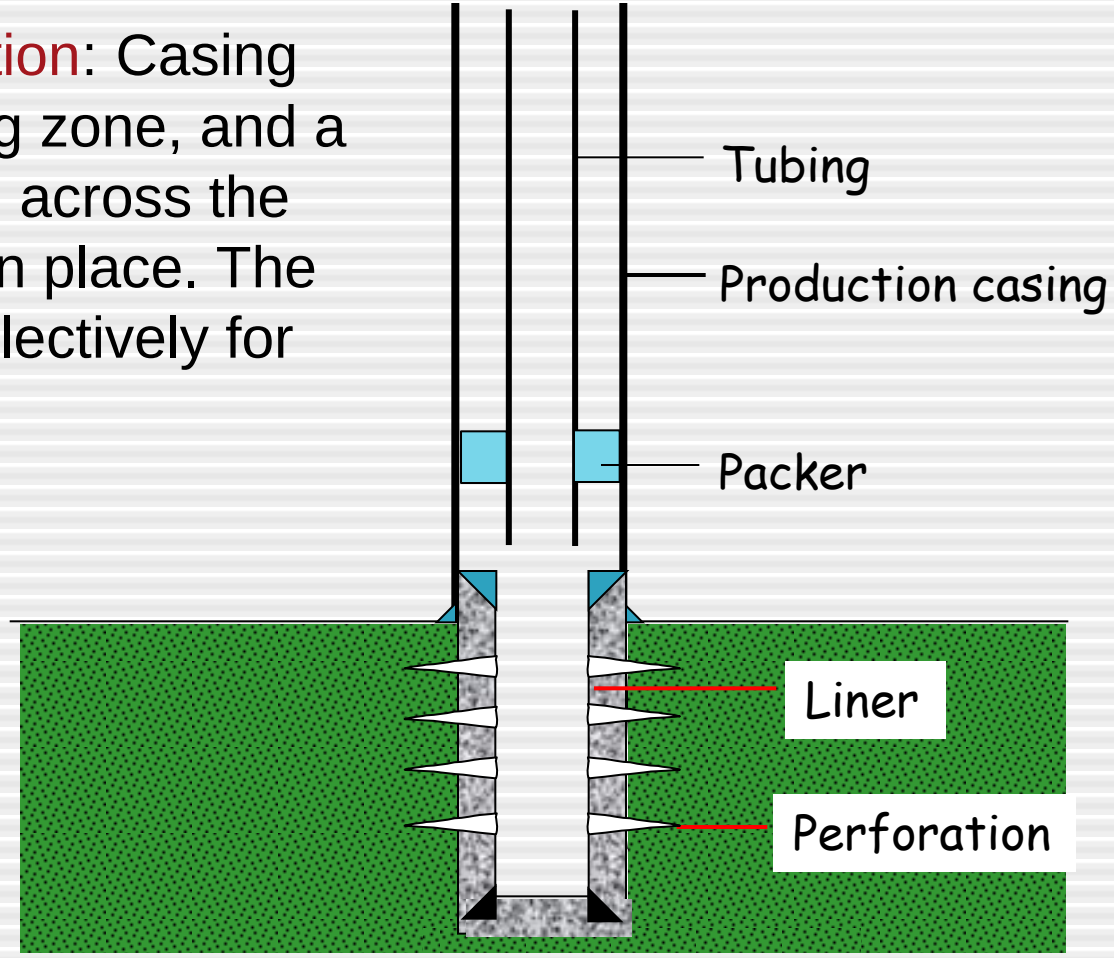
Type of Well Completions



Screen Liner Completion

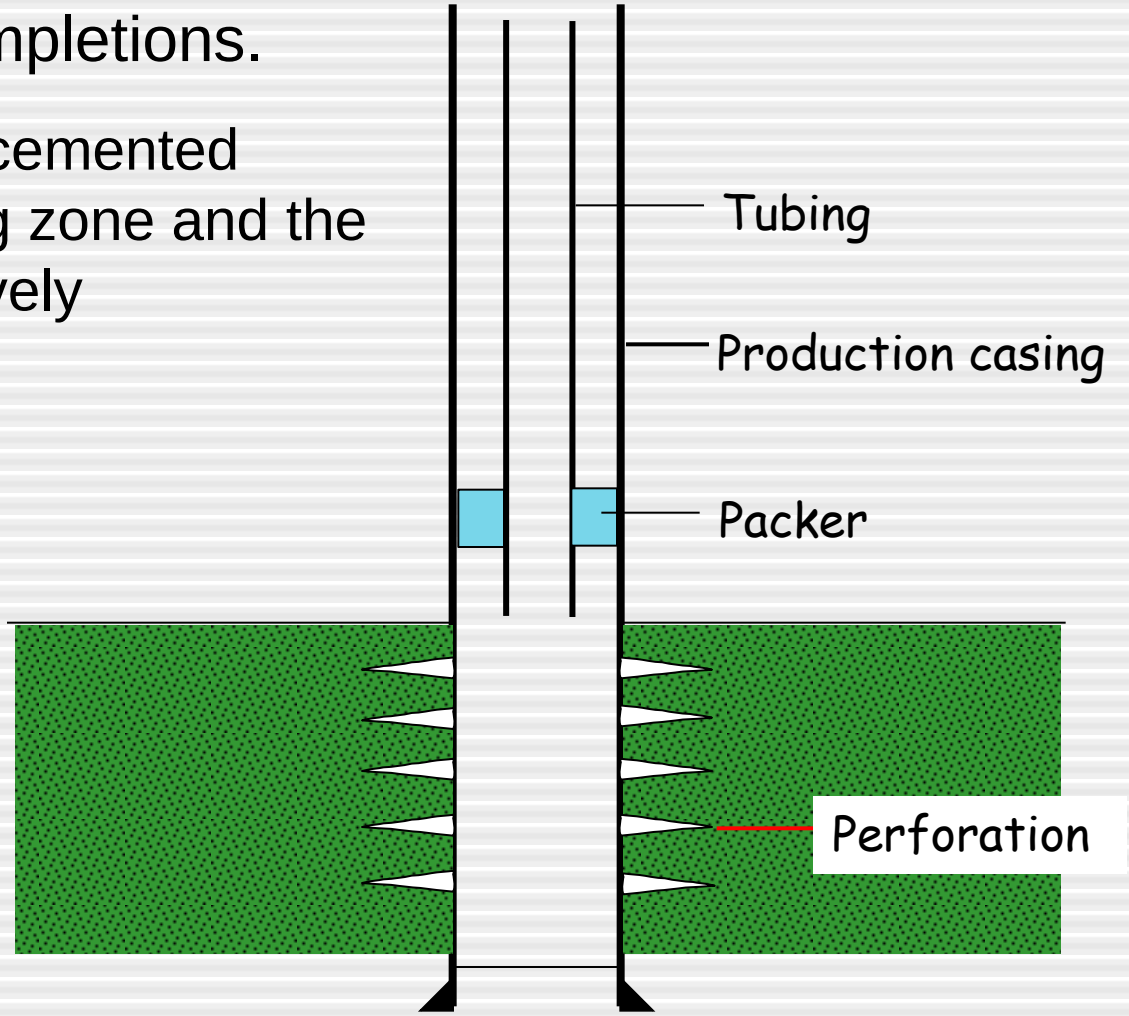
Type of Well Completions

- Perforated Liner Completion: Casing is set above the producing zone, and a liner assembly is installed across the pay zone and cemented in place. The liner is then perforated selectively for production.



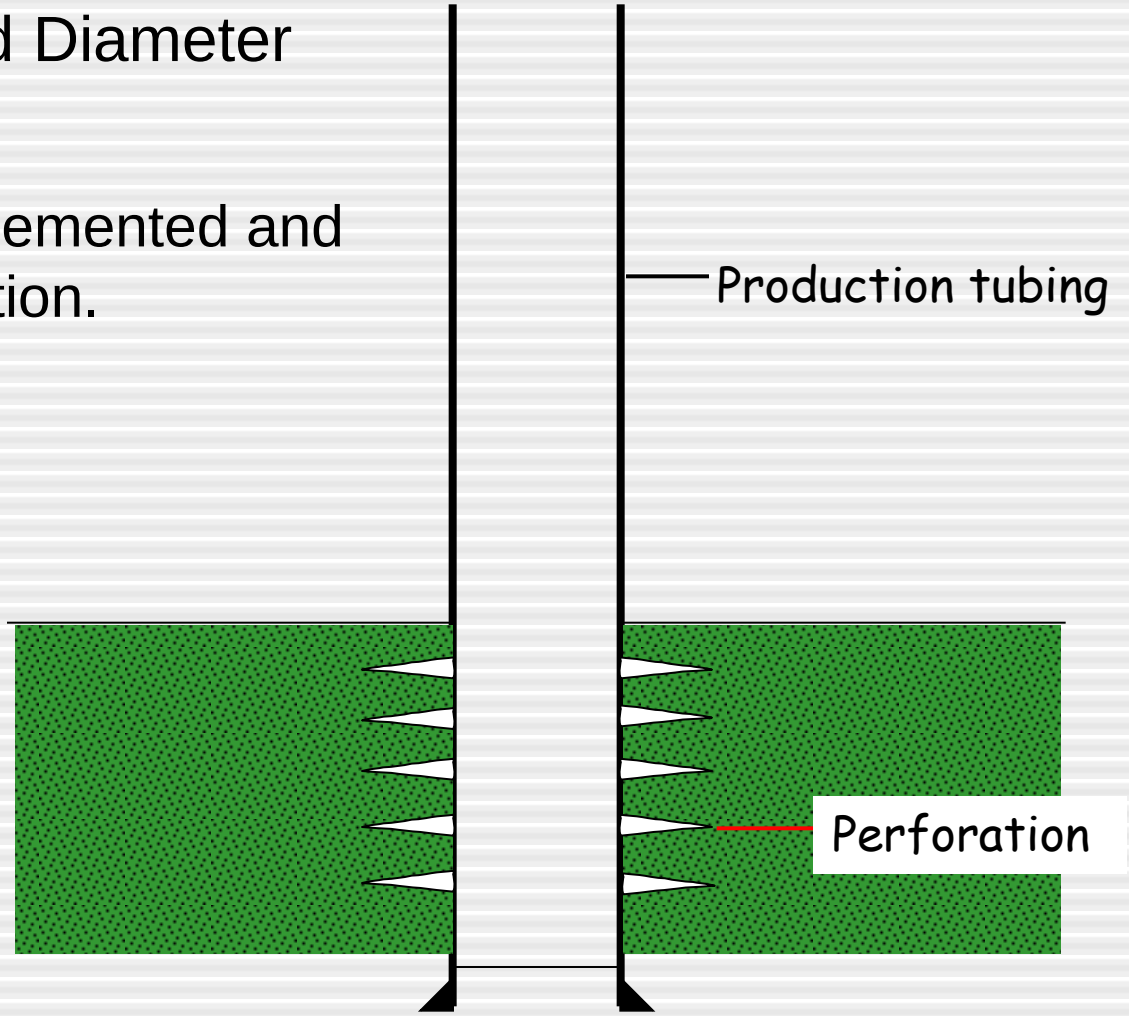
Type of Well Completions

- Perforated Casing Completions.
  - Production casing is cemented through the producing zone and the pay section is selectively perforated.



Type of Well Completions

- Tubingless or Reduced Diameter Completions.
  - Production tubing is cemented and perforated for production.



Formation Damage

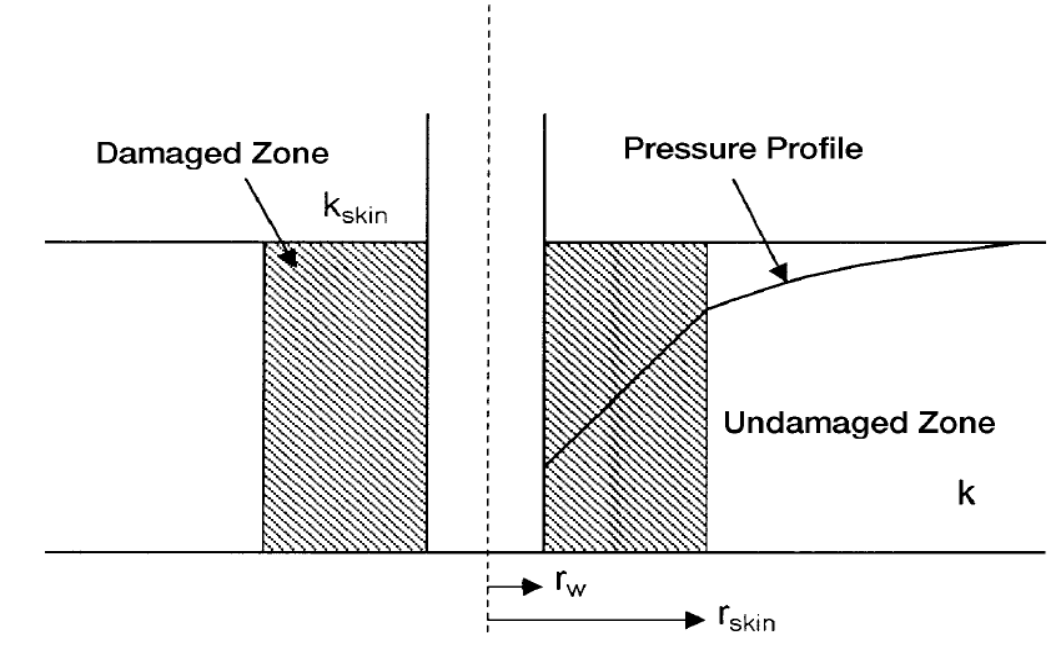
It is not unusual for materials such as mud filtrate, cement slurry, or clay particles to enter the formation during drilling, completion or workover operations and reduce the permeability around the wellbore.

Formation Damage

This effect is commonly referred to as a *wellbore damage* and the region of altered permeability is called the *skin zone.* This zone can extend from a few inches to several feet from the wellbore. Many other wells are stimulated by acidizing or fracturing which in effect increase the permeability near the wellbore. Thus, the permeability near the wellbore is always different from the permeability away from the well where the formation has not been affected by drilling or stimulation. A schematic illustration of the skin zone is shown in the figure (next slide).

Formation Damage

Those factors that cause damage to the formation can produce additional localized pressure drop during flow. This additional pressure drop is commonly referred to as Δp_{skin}. On the other hand, well stimulation techniques will normally enhance the properties of the formation and increase the permeability around the wellbore, so that a decrease in pressure drop is observed.



Formation Damage

- **Positive Skin Factor, s > 0**

When a damaged zone near the wellbore exists, k-skin is less than k and hence s is a positive number. The magnitude of the skin factor increases as k-skin decreases and as the depth of the damage r skin increases.

- **Negative Skin Factor, s < 0**

When the permeability around the well k-skin is higher than that of the formation k, a negative skin factor exists. This negative factor indicates an improved wellbore condition.

- **Zero Skin Factor, s = 0**

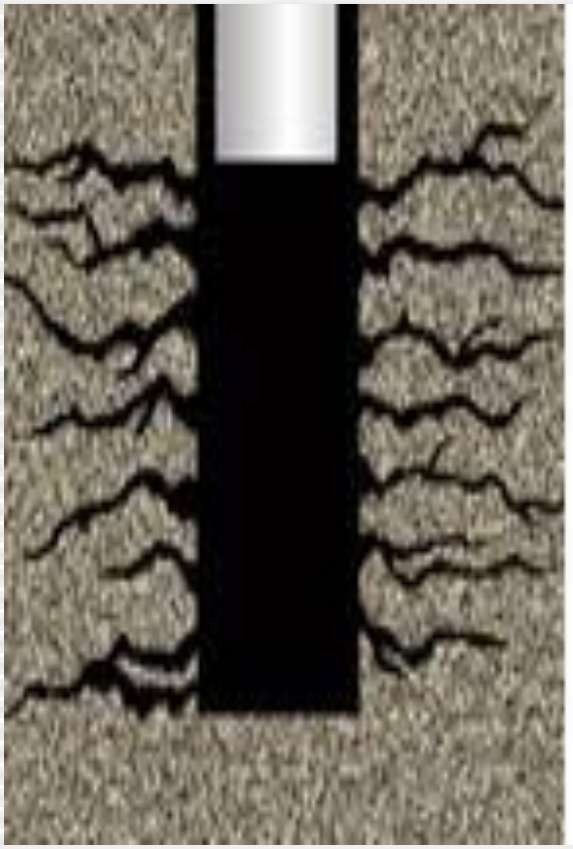
Zero skin factor occurs when no alternation in the permeability around the wellbore is observed, i.e., k-skin $=$ k.

Well Stimulation

- Sometime, petroleum exists in a formation but is unable to flow readily into the well because the formation has very low permeability.
  - Natural low permeability formation.
  - Formation damage around the wellbore caused by invasion of perforation fluid and charge debris.
- Acidizing or fracturing is a methods used to increase the permeability near the wellbore.

Acidizing

- If the formation is composed of rocks that dissolve upon being contacted by acid, such as limestone or dolomite, then a technique known as acidizing may be required.
- Acidizing operation basically consists of pumping from fifty to thousands of gallons of acid down the well.
- The acid travels down the tubing, enters the perforations, and contacts the formation.



Acidizing process

Acidizing

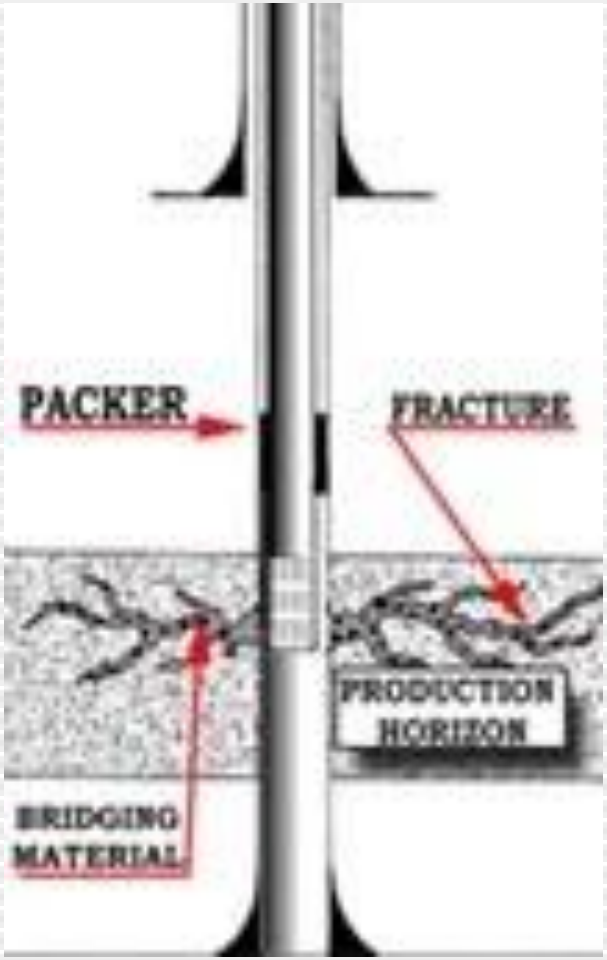
- Continued pumping forces the acid into the formation where it produces channels.
- Channels will provide a way for the formation's oil or gas to enter the well through the perforations.
- The most common acid systems in use are:
  - **Hydrochloric Acid:** This is the most widely used acid in treatments, with concentrations ranging between 7.5% and 28%, the most common is 15%. It will dissolves Calcium Carbonate ($CaCO_3$), Dolomite ($CaMgCO_3$), Siderite ($FeCO_3$), and Iron Oxide (Fe_2O_3).

Acidizing

- **Mud Acid:** This is a mixture of HCl and HF (hydrofluoric acid) and is generally 12% HCl and 3% HF. It will dissolve clay materials in the formation, along with feldspars and quartz. The HF will react with Na, K, Ca and Si in the clays to form insoluble precipitates, so it is advisable to always preflush with HCl.
- **Organic Acids:** These are Acetic and Formic Acids. They are slower acting than HCl, and are generally used in high temperature wells and wells with high alloy tubing to reduce corrosion rates.
- **EDTA:** This is Ethylene Diamine Tetra-Acetic Acid. It dissolves carbonates and sulphates by chelating them. It is more expensive than the other acids and the reaction is slower.

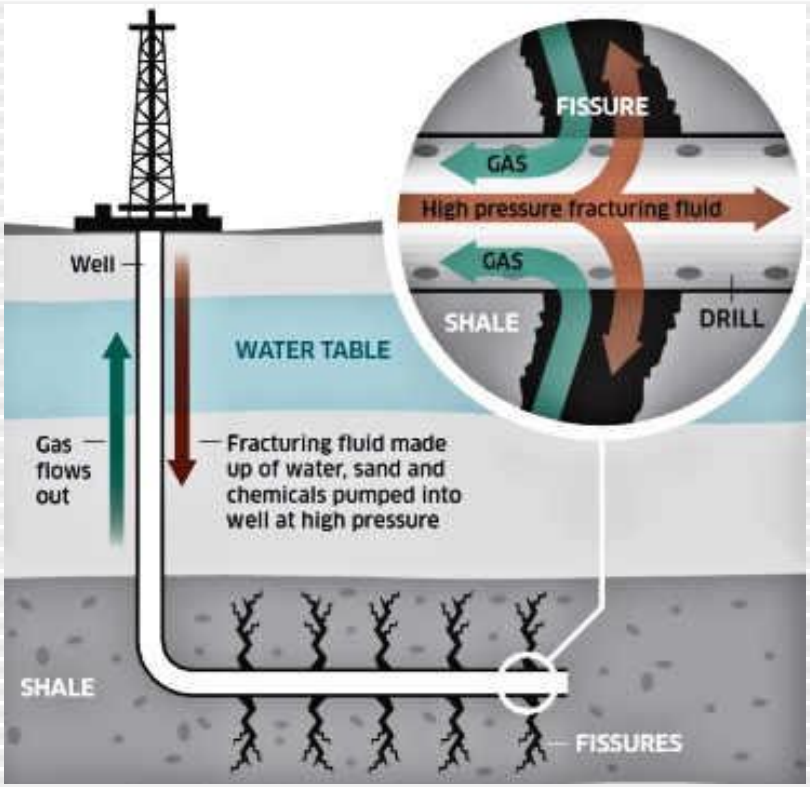
Fracturing

- Fracturing is a process to increase the permeability of reservoir rocks (eg sandstone) by pumping a special blended fluid down the well and into the formation under great pressure.
- Pumping continues until the downhole pressure exceeding fracture pressure of the rocks, formation literally cracks open (with opening between 0.25 – 0.5 inch).
- Meanwhile, sand or aluminum pellets are mixed into the fracturing fluid. These materials are called proppants.

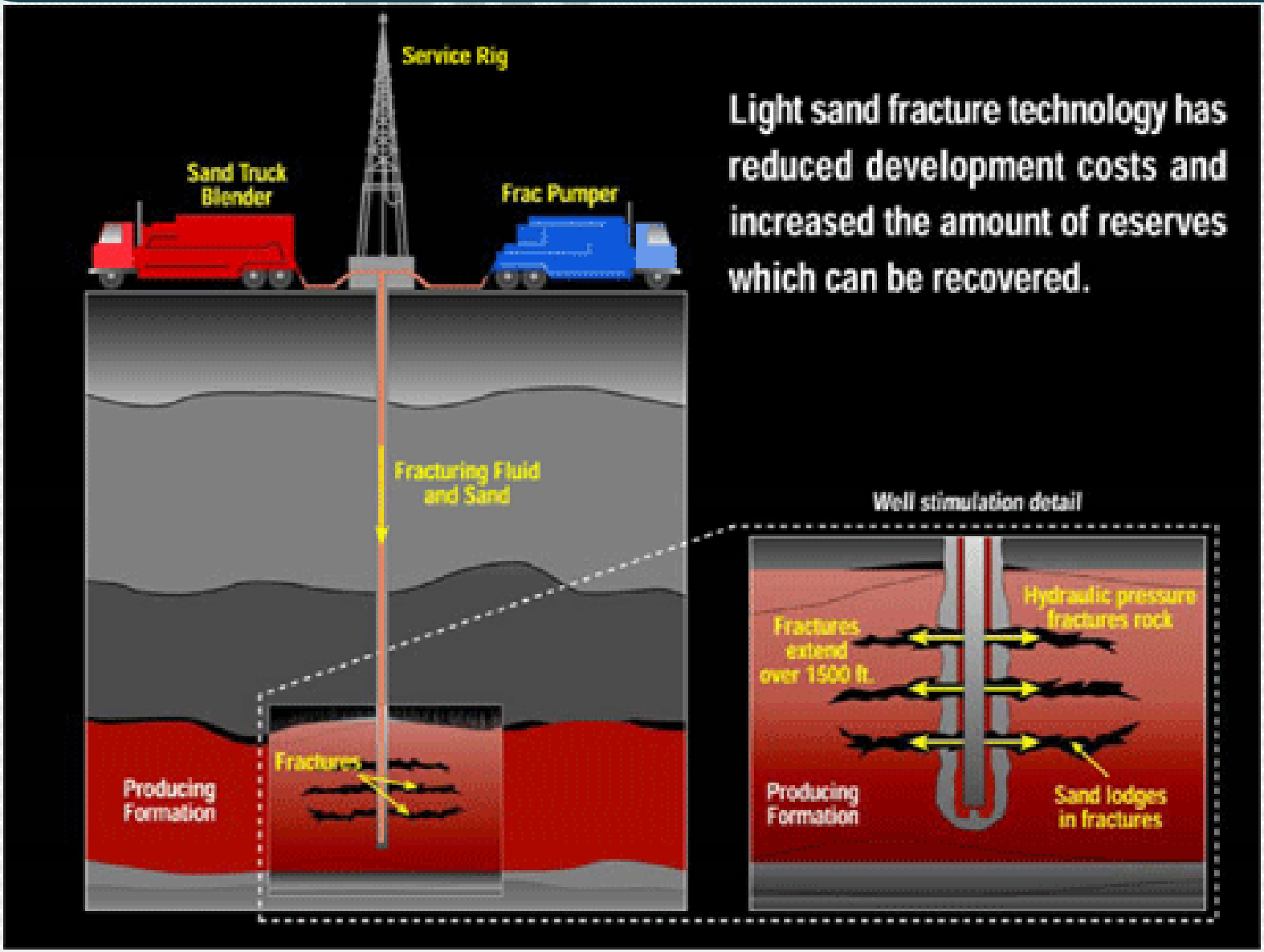


Fracturing

- The proppant enters the fractures in the formation, and, when pumping is stopped and the pressure decreased, the proppant remains in the fractures.
- Since the fractures try to close back together after the pressure on the well is released, the proppant is needed to hold fractures open.
- These propped-open fractures is permeable enough to provide passages for oil or gas to flow into the well.



Fracturing


Service Rig
Sand Truck
Blender
Frac Pumper
Fracturing Fluid
and Sand
Fractures
Producing
Formation
Light sand fracture technology has reduced development costs and increased the amount of reserves which can be recovered.
Well stimulation detail
Hydraulic pressure fractures rock
Fractures extend over 1500 ft.
Producing
Formation
Sand lodges in fractures