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Energy Workforce Oil & Gas 101

Overview of Completions and Well Interventions

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October 6, 2022

Outline

Background
Drivers affecting selection of completion types
Major completion components
Examples of completion types
Evolving Technologies

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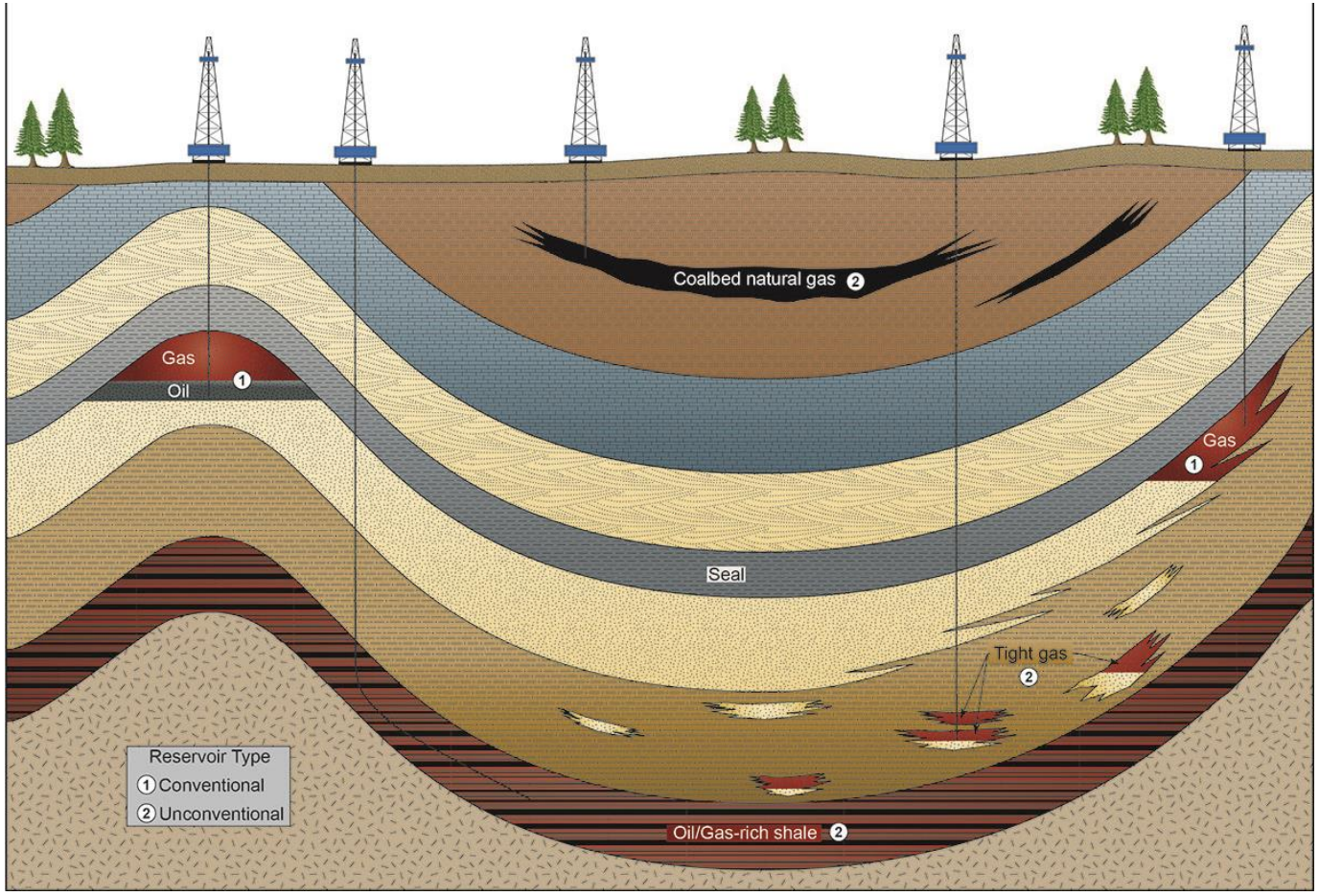
Oil and Gas Reservoirs



Source: Wyoming State University

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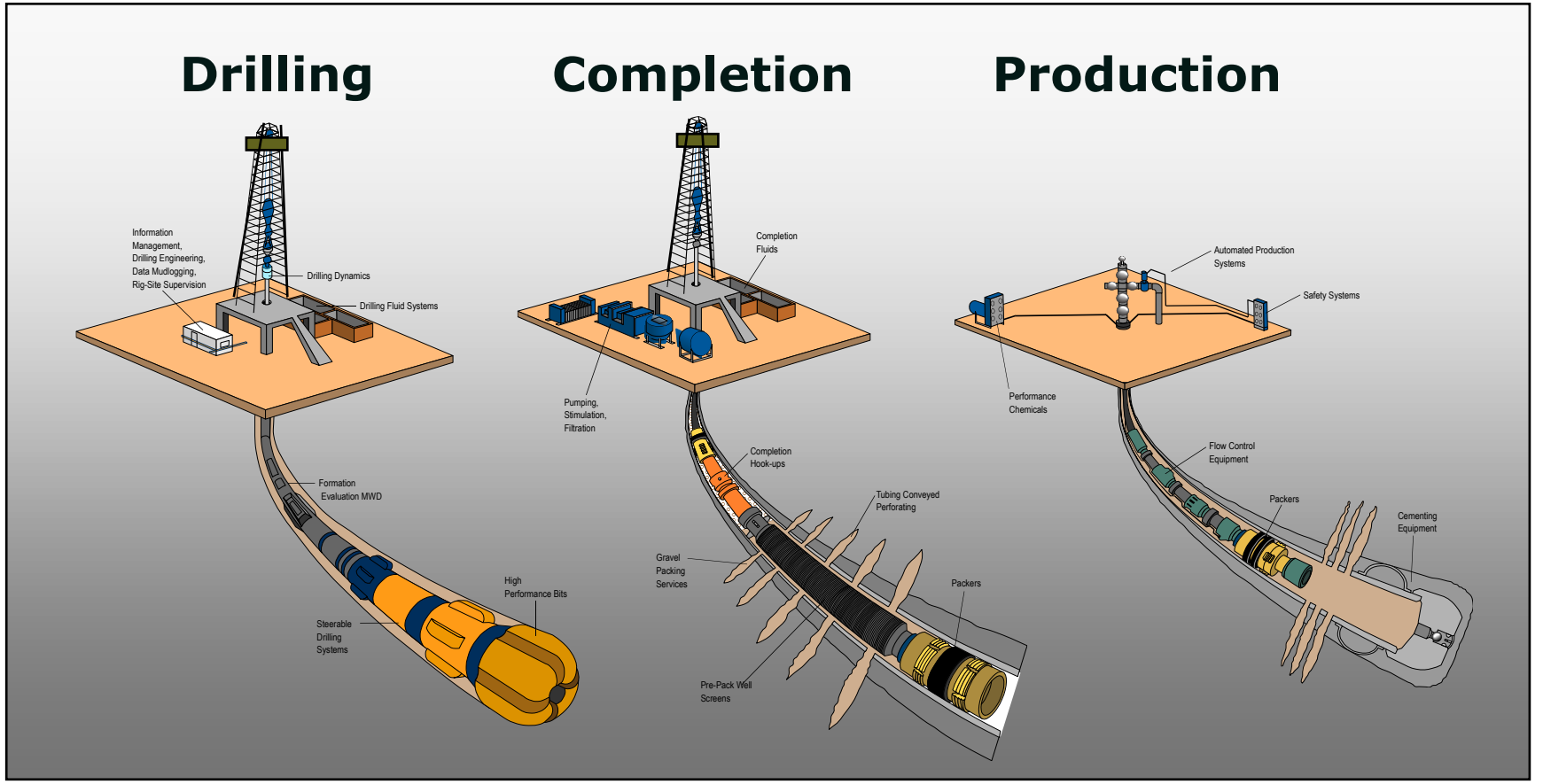
Well Life Cycle



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Completion Functions

Provide pathway for fluid from the reservoir into the wellbore

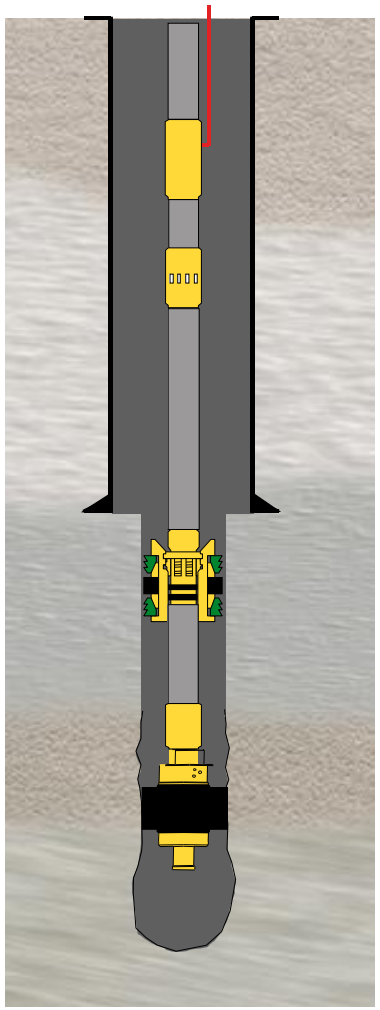
Provide pathway for wellbore fluids to surface

Control the production rate from the reservoir

Isolate problematic sections of the well

Allow access for well maintenance

Facilitate stimulation



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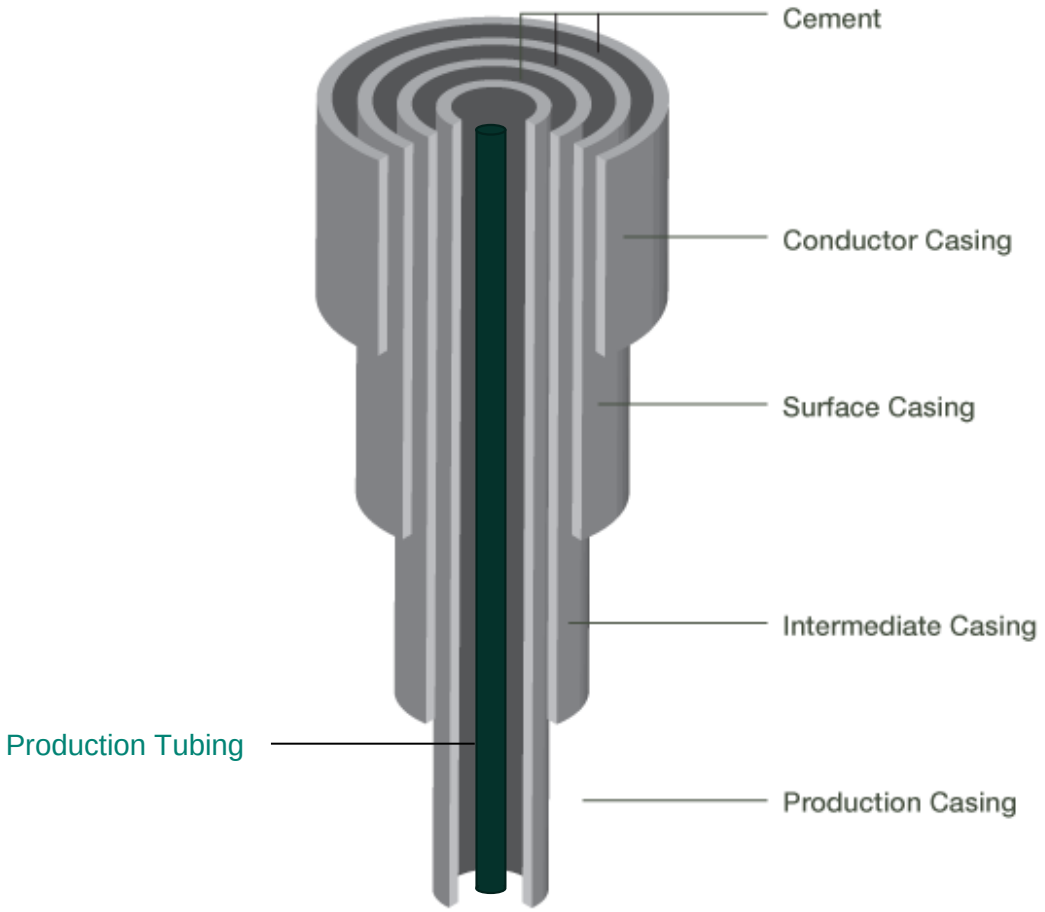
Building A Well: Cross Section



Source: Cabot Oil & Gas – Well Said

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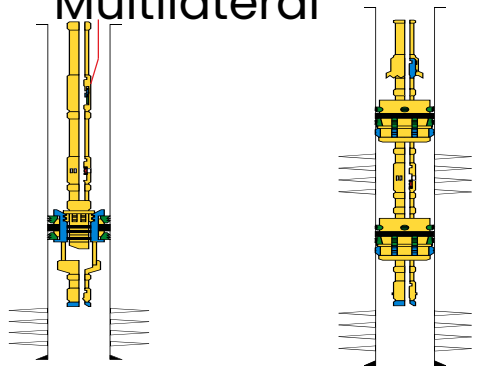
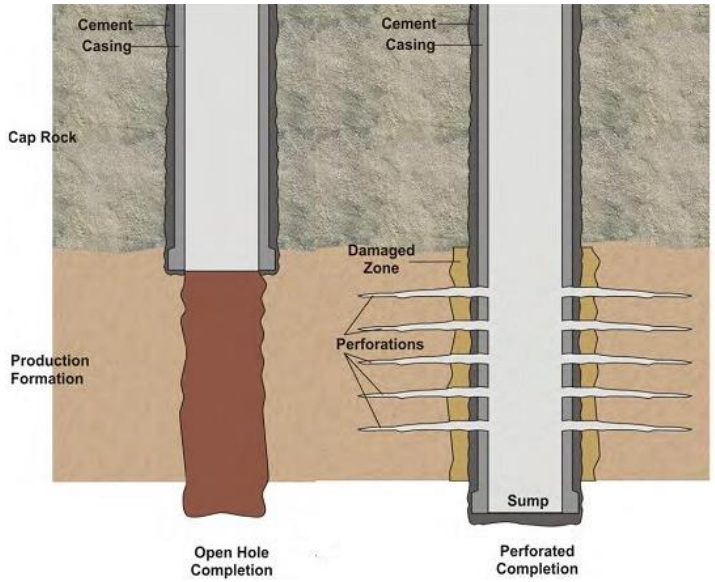
Completion Classifications

Well Path
Vertical
Deviated
Horizontal
Multilateral



- **Number of zones**
  Single
  Multiple

- **Reservoir access**
  Open Hole
  Cased and Perforated



Petro-Tech Consulting and Training Services

Mode of production
Flowing
Artificial lift

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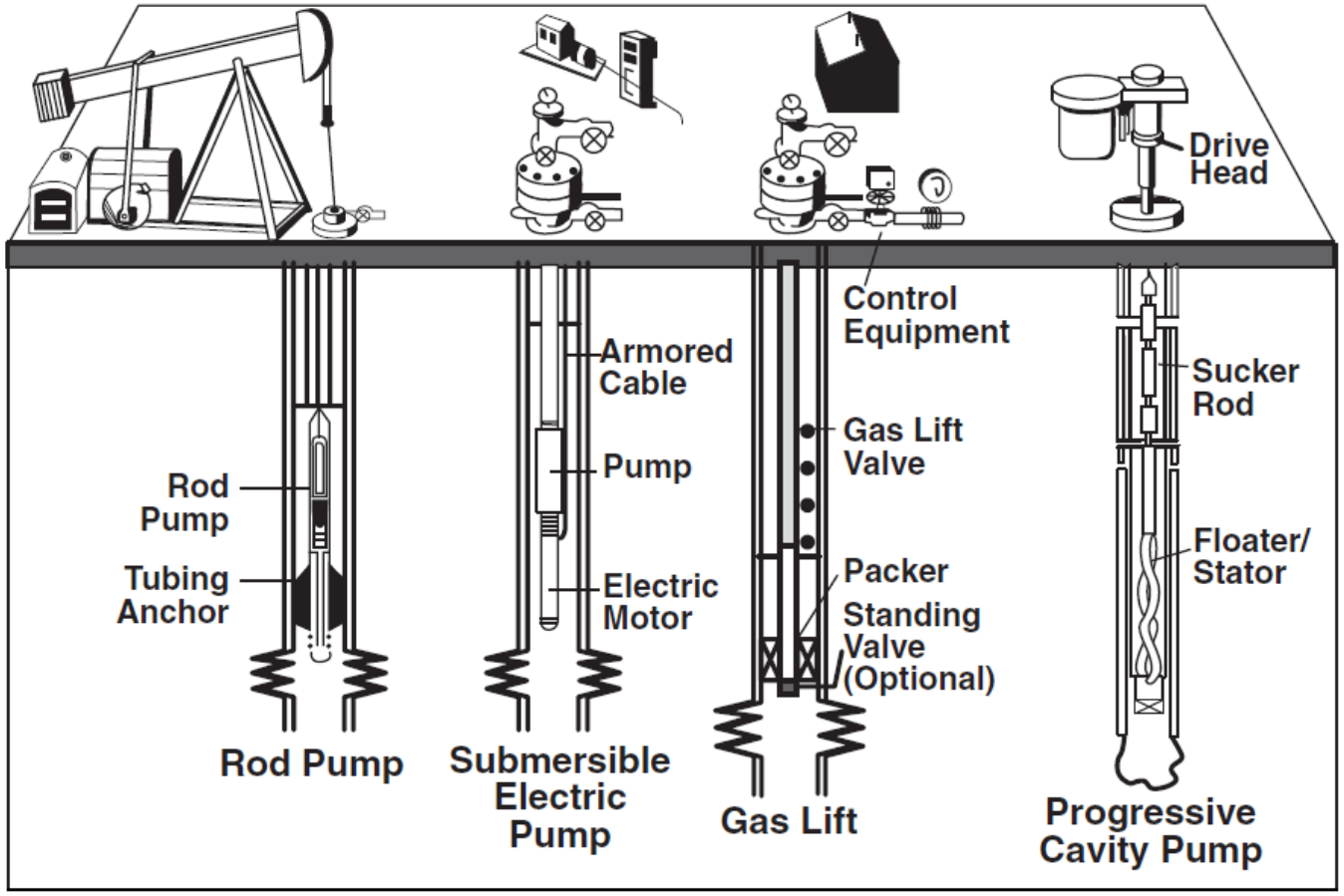
Artificial Lift



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Other Drivers

Reservoir type

Target resource type, extent, depth

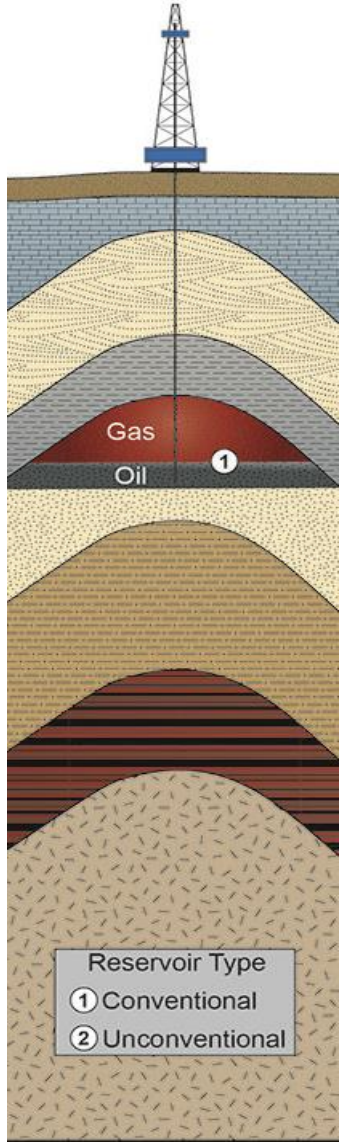
Financial objectives

Regulatory environment

Intervention or re-entry costs in well environment

Expected well performance/life cycle

Monitoring requirements



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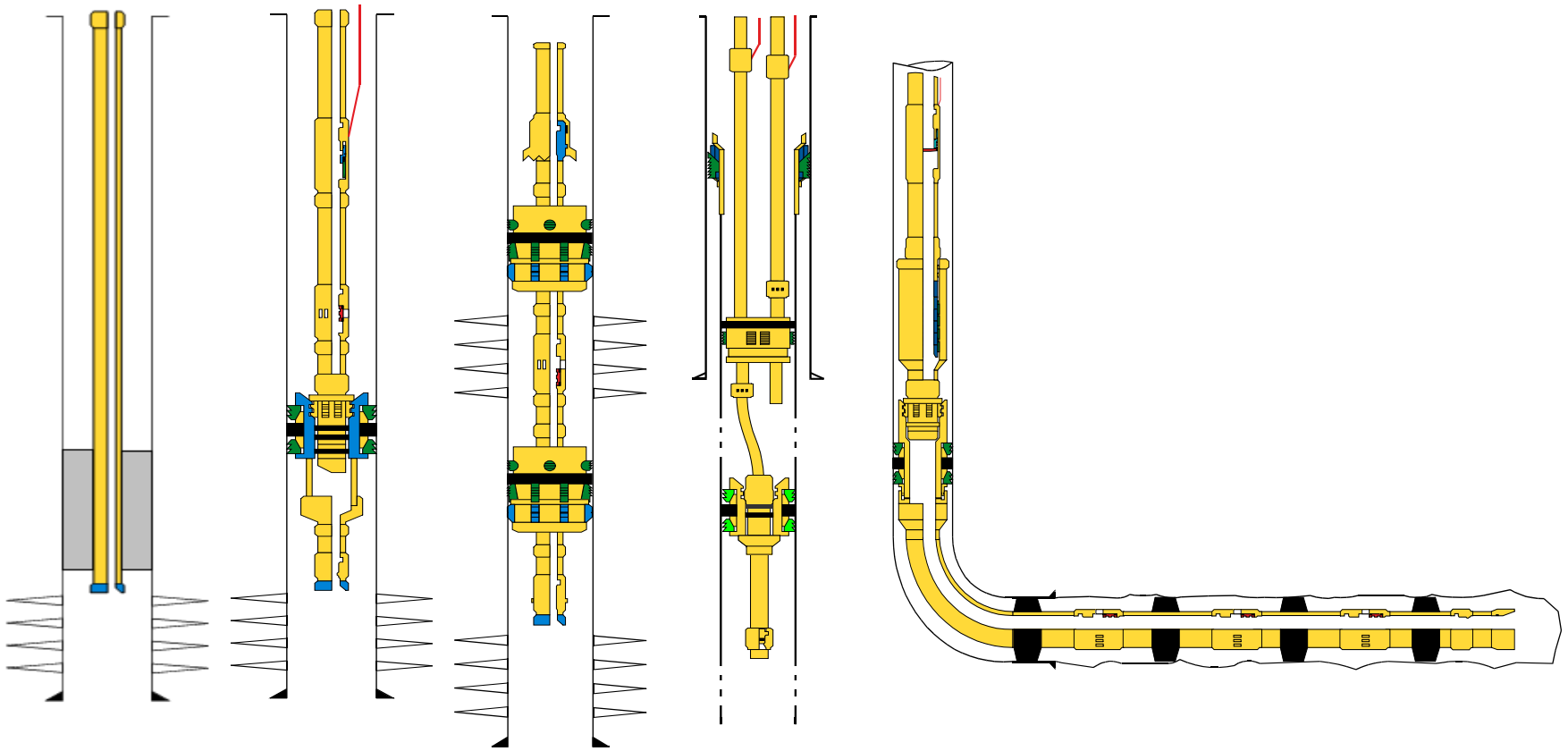
Progression of Completions Through Time



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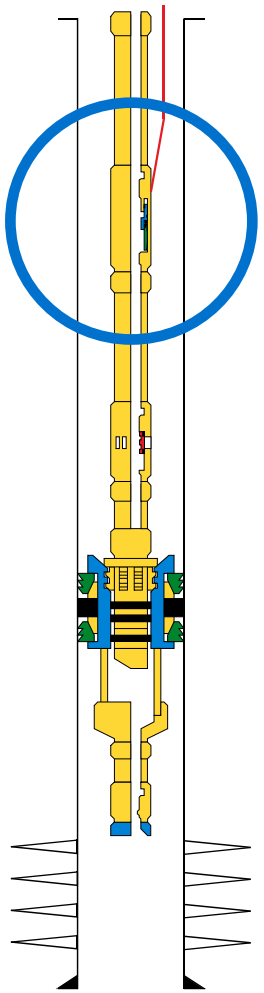
Subsurface Safety Valve



- Deployed on tubing.
- Prevents uncontrolled flow from a well in the case of an emergency.
- Typically shallowest downhole equipment.
- Activated by a change in conditions
- Designs vary by application.
- Most stringently tested product in completions.

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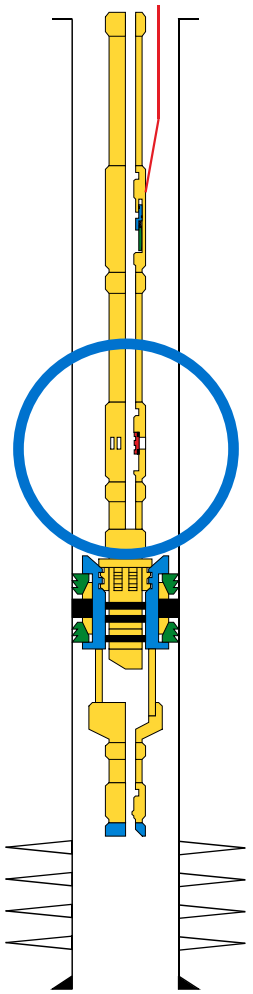
Flow Control Devices – Sleeves



Position-able valves allowing a flow path between the inside and outside of tubing

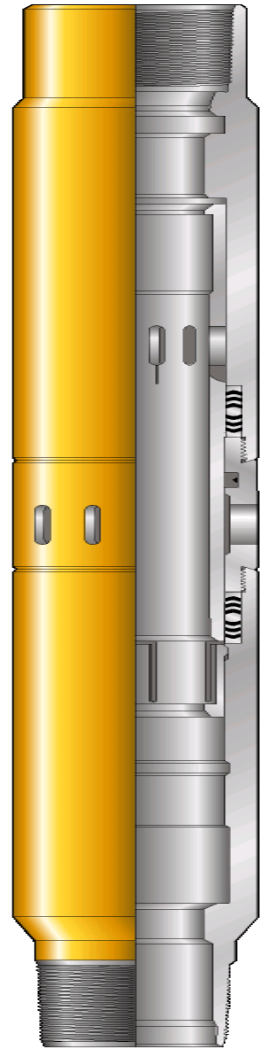
Shifted via several means

Mechanical

Hydraulic

Electric

Multi-cycle and multi-position versions available



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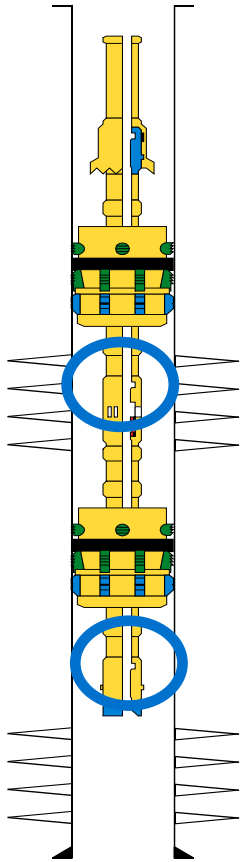
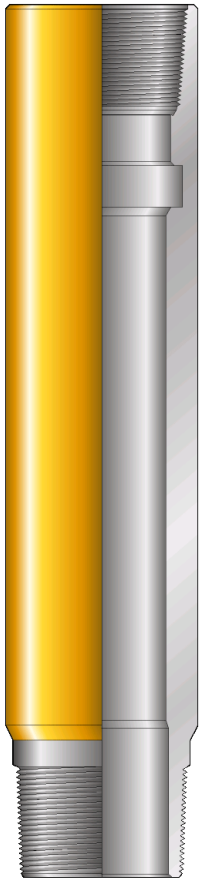
Flow Control Devices – Profile Nipples

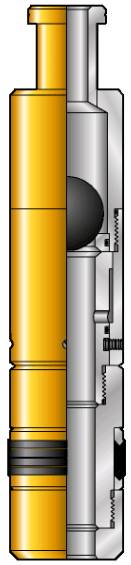


Profiles placed in tubing able to receive latching accessories

Accessories include plugs, chokes, check valves

Accessories typically retrievable





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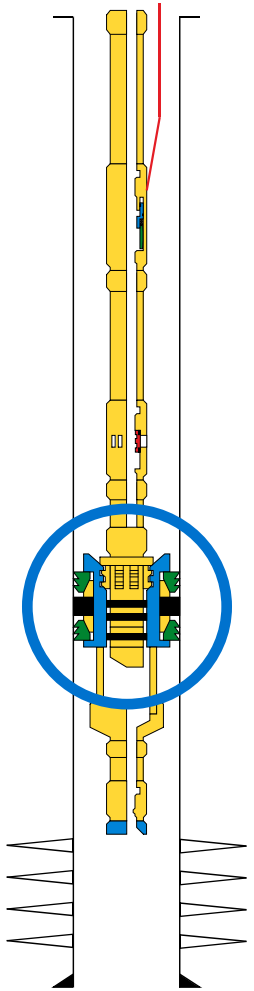
Isolation Devices – Packers



Mechanical device – seal between casing and tubing.

Located above producing zone(s).

Parts

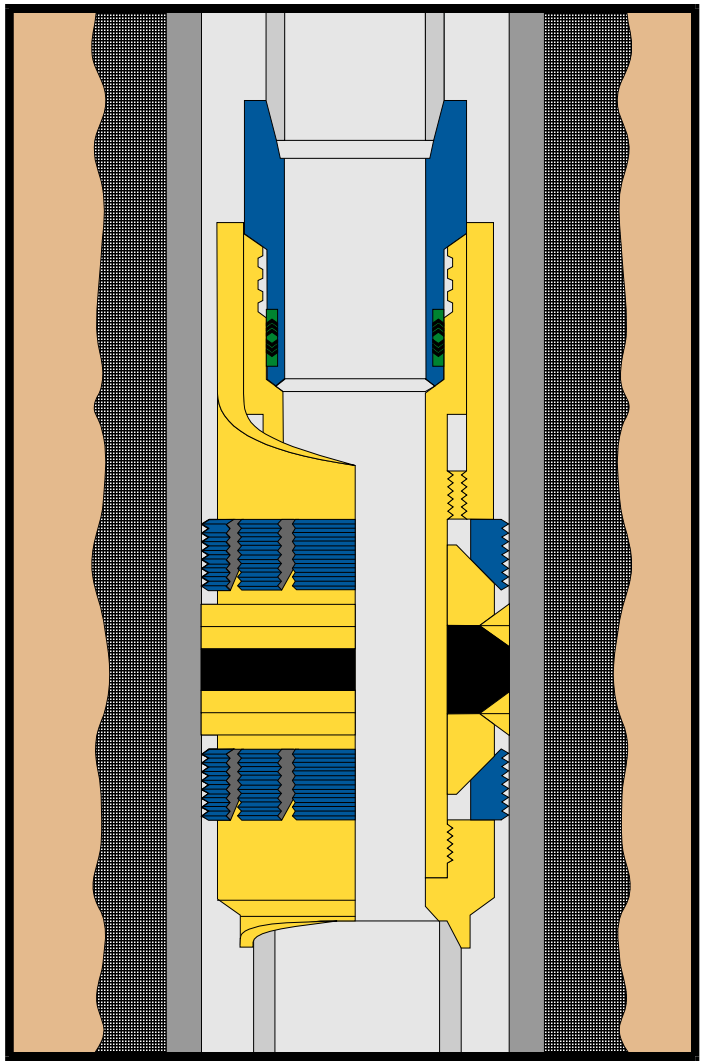
Sealing element.

Slips (anchors).

Various parts and piston areas that allow setting.

Well control.

Corrosion control.



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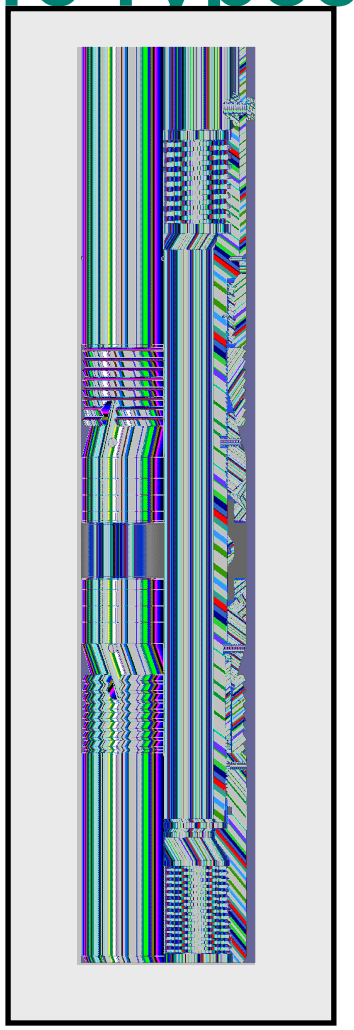
Packers Types

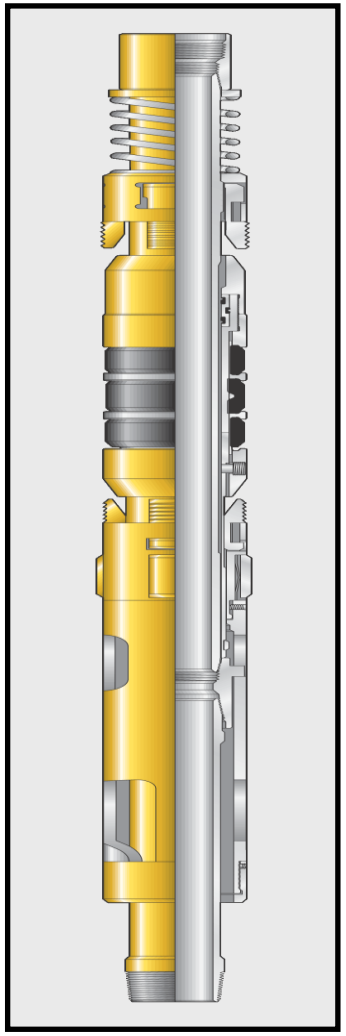


Permanent
Retrievable

Mechanical set
Hydraulic set

Cased Hole
Open Hole

Inflatable
Swelling



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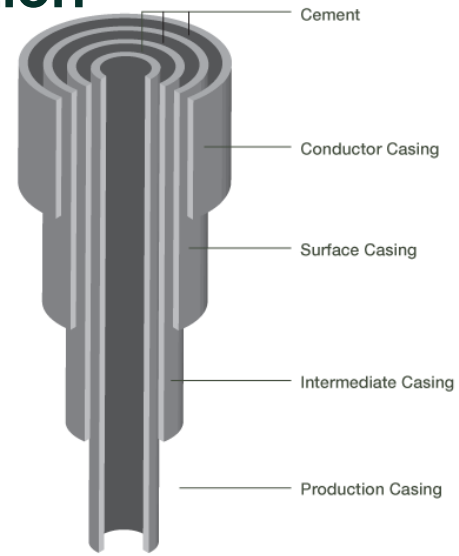
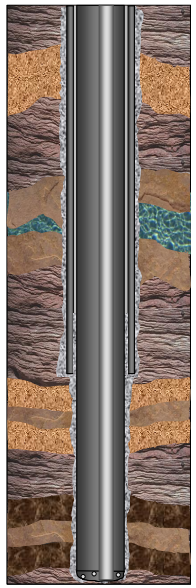
Structural Devices – Hangers

Mechanical devices that anchor sections of pipe

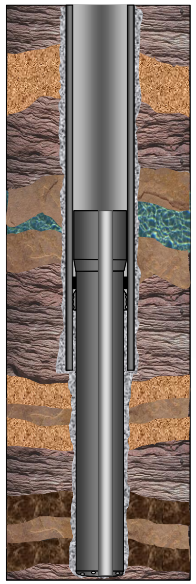
Typically use slips to attach deployed pipe to host pipe

May be run with packer to provide isolation

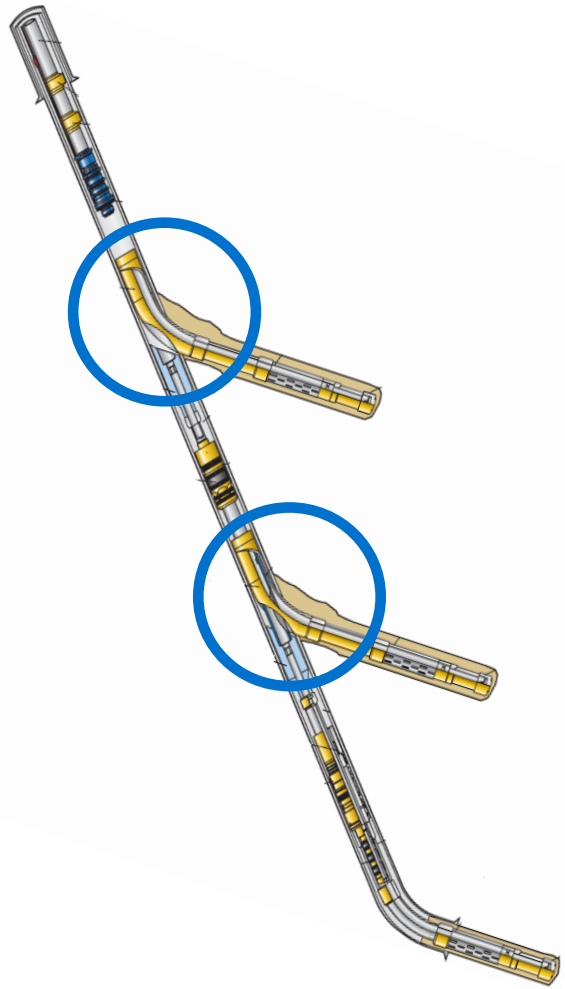




Long String



Liner



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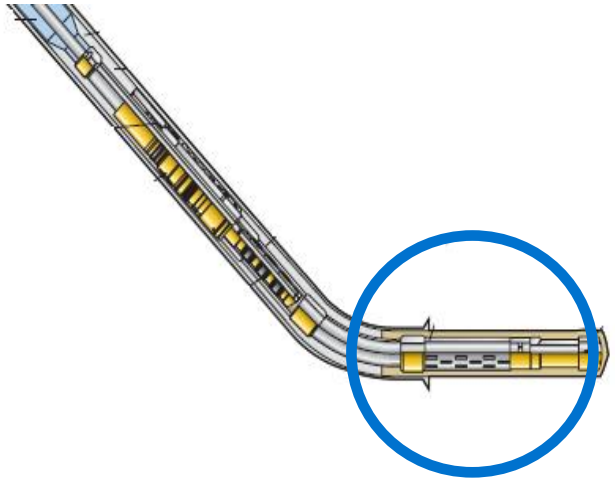
Filtration Devices – Screens

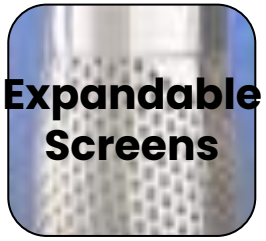
Filters built onto perforated tubing

Intended to limit the size of particles that can be admitted into the tubing

Usable in

- Open-hole
- Perforated casing
- In conjunction with other filter





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Intervention and Recompletion

Cleanup

Removing debris from the wellbore

Isolation

Setting permanent or temporary plugs/ flow barriers

Fishing

Recovering lost equipment or pipe

Casing exits

Creating a new wellbore by milling out of existing casing

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Conveyance or Deployment Methods

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Application Specific Completions

Sand Control Completions

Aimed at limiting production of solids

Unconventional Completions

Enable efficient, multi-stage fracturing treatments and minimize time until production begins

Intelligent Completions

Allow active control of completion subsystems via electric or hydraulic control

Limit need to re-enter well

Sand Control Completions

Tools & services to minimize or prevent sand production in unconsolidated reservoirs

Drivers: reliability, production enhancement, efficiency, long term production

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Controlling Sand Production Minimizes…

Equipment damage

Maintenance costs

Well plugging

Disposal costs

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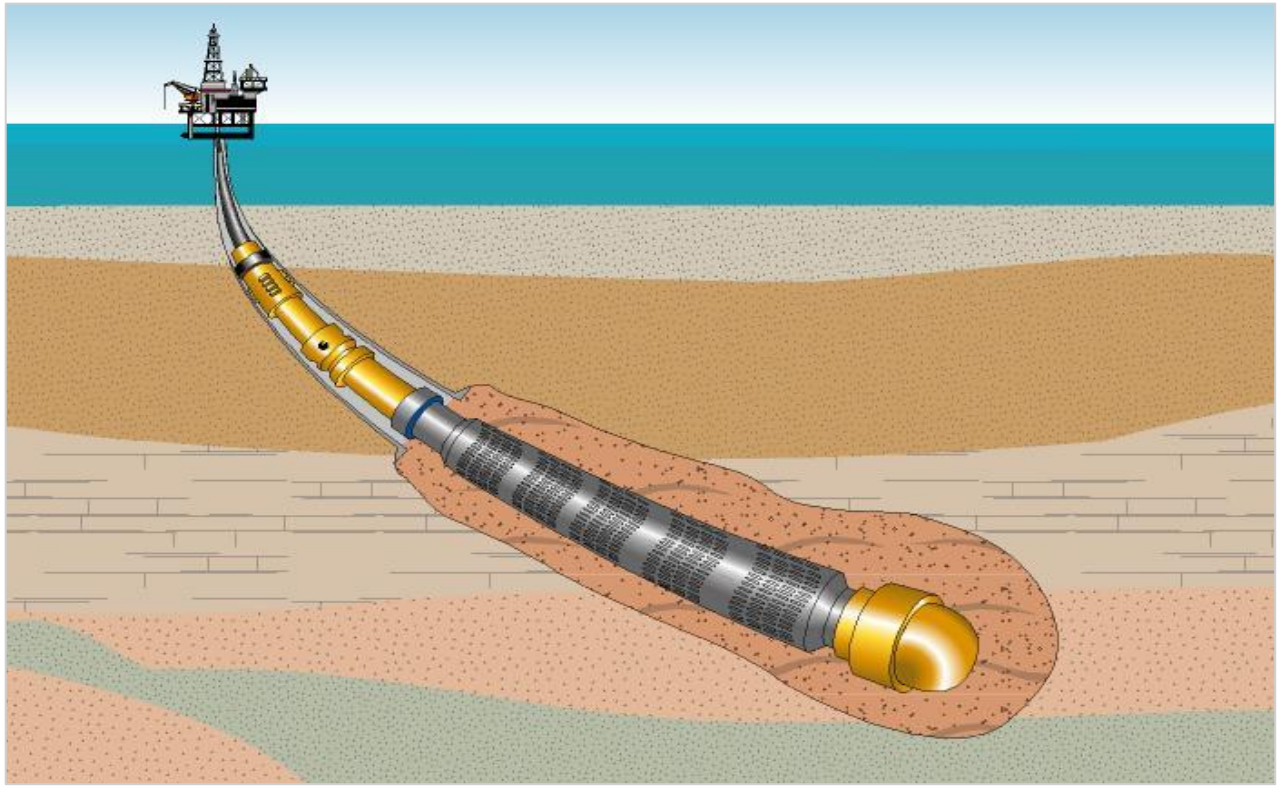
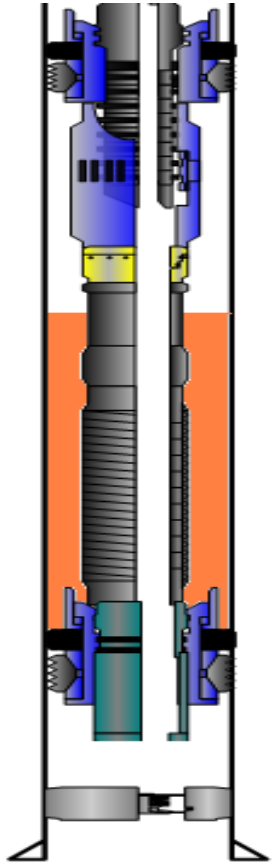
Sand Control Completion





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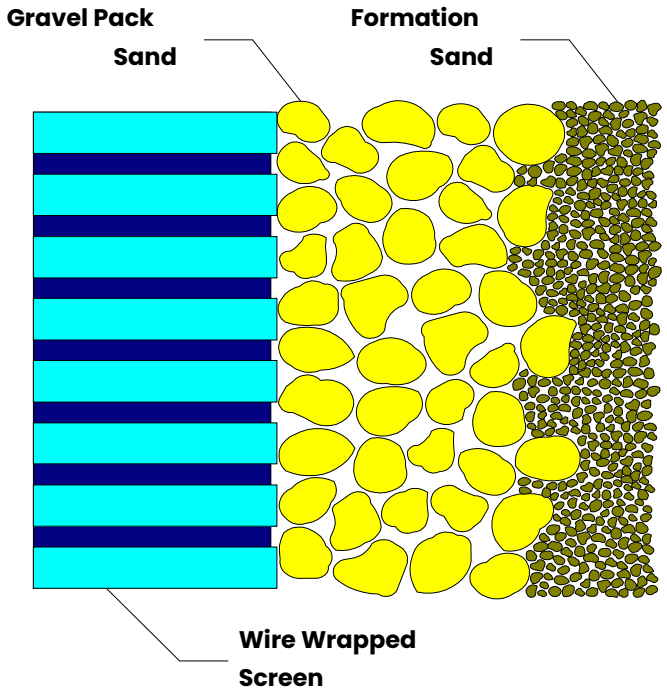
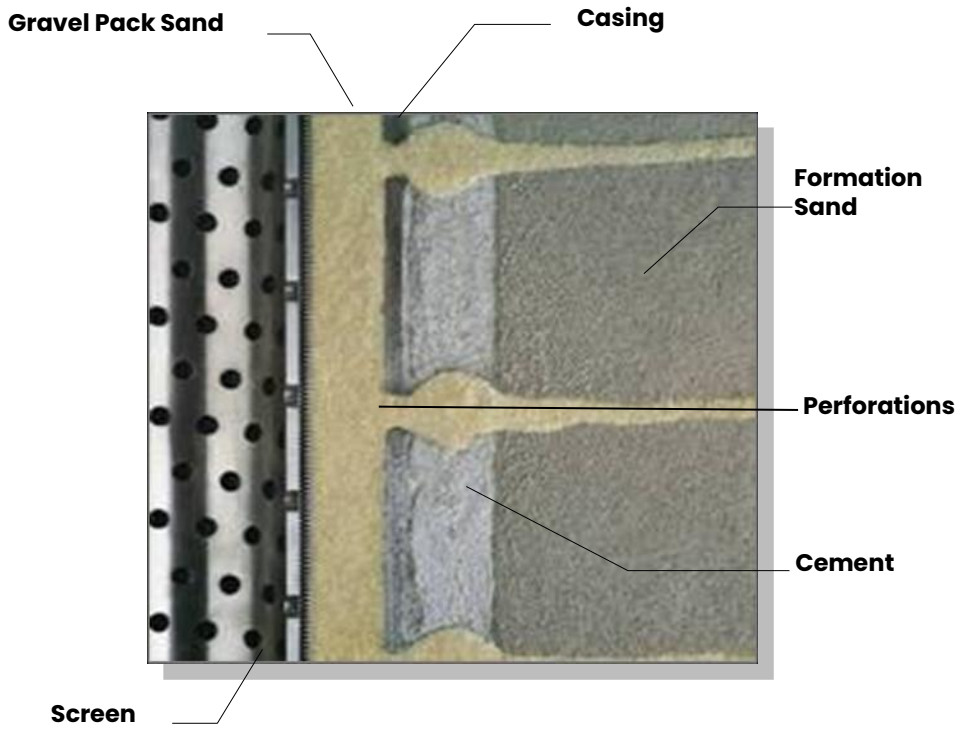
Gravel Packing



Open Hole



Cased
Hole

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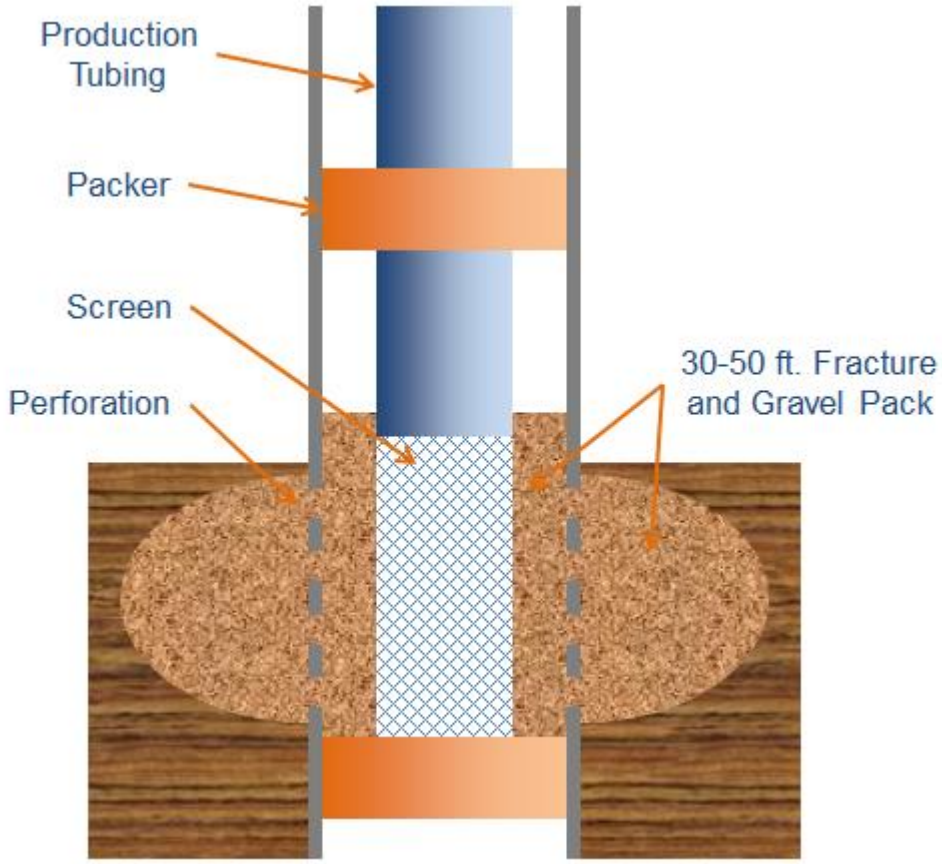
FracPacking

- Similar to gravel packing
- Higher pumping pressures and rates
- Rock strength or fracture pressure of rock exceeded
- Breaking or ‘Fracturing’ the formation
- Packing near wellbore to similar to gravel packing



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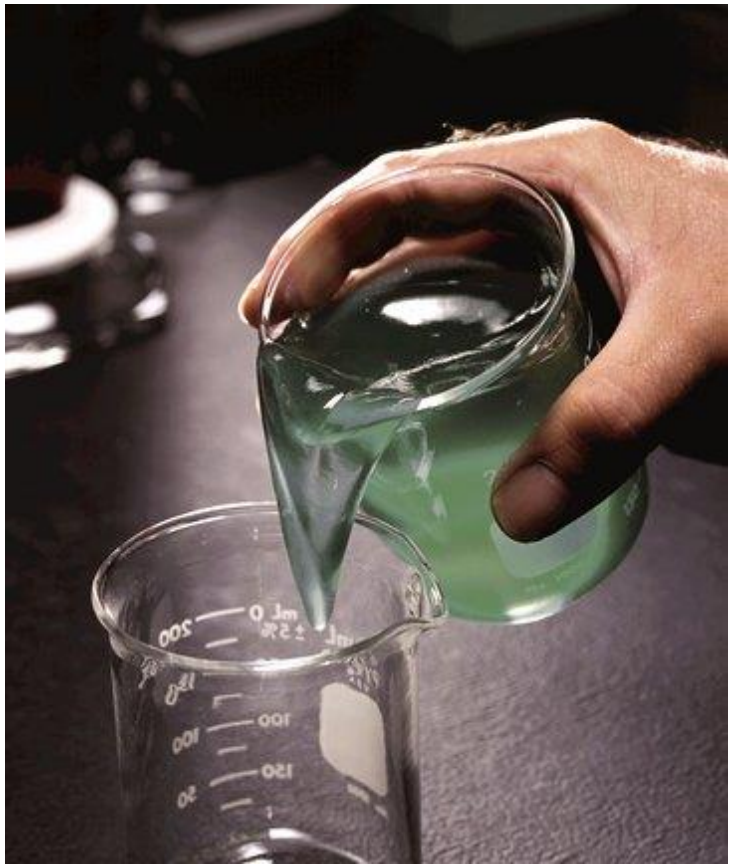
Sand Control Pumping Services



Slurry

Combination of proppant/sand and carrier fluid

Carrier Fluids

Engineered fluids designed to carry proppant with one viscosity, and then “break” to a lower viscosity allowing to return to surface

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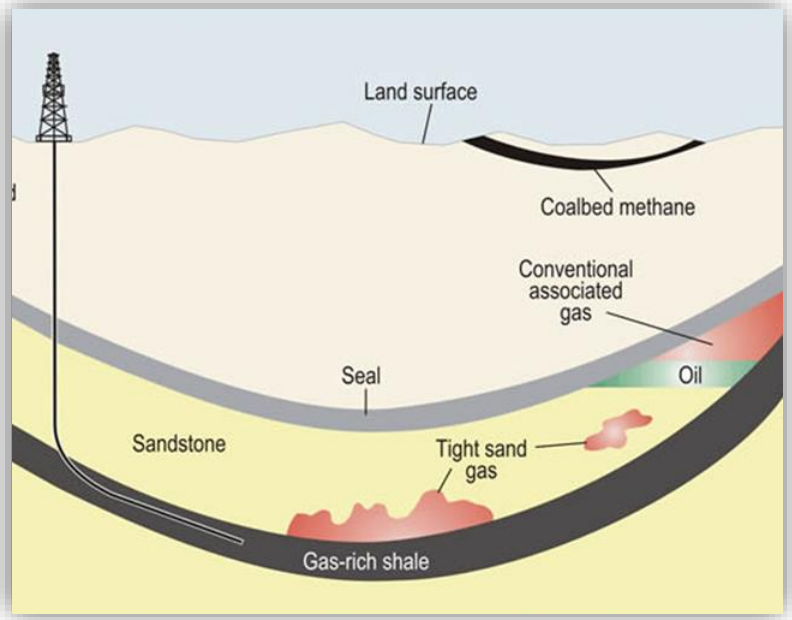
Unconventional Completions

Completion systems enabling access to non-traditional reservoirs – often requiring multistage Hydraulic Fracturing

Drivers: efficiency, reliability, cost



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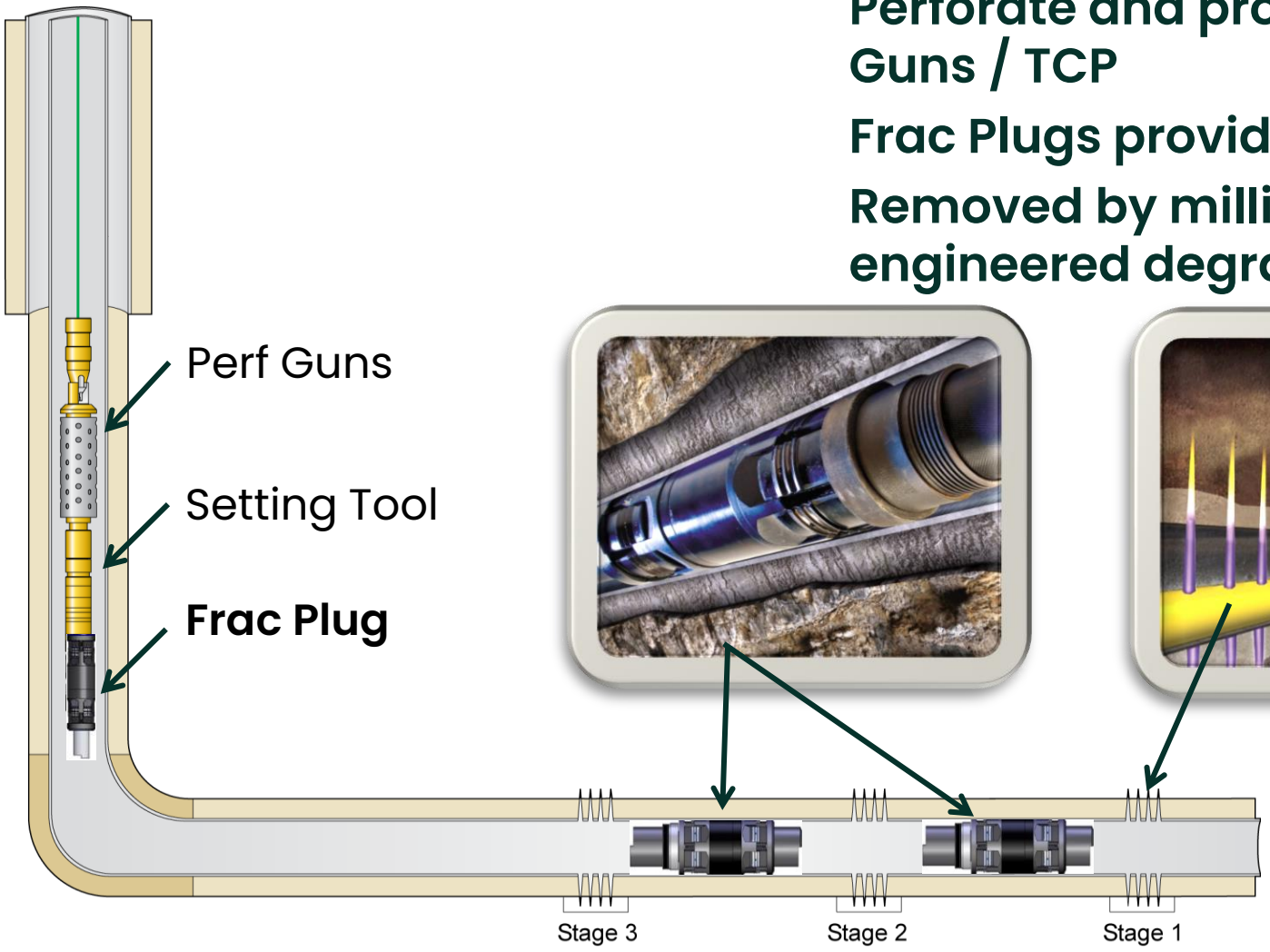
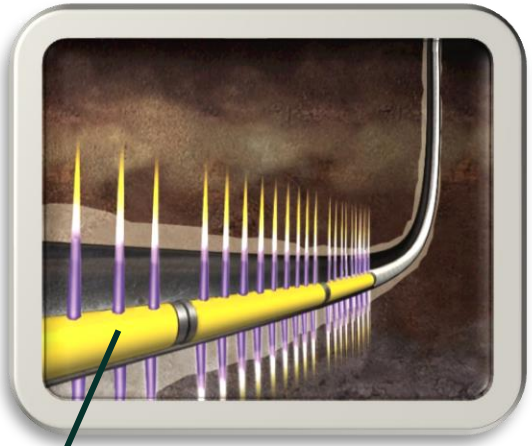
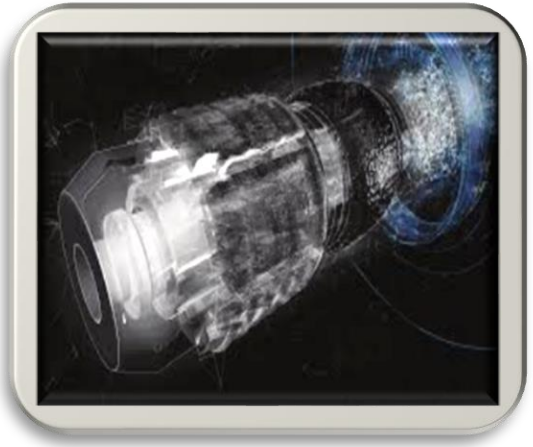
Plug & Perforate

- Cemented casing liner or full string
- Perforate and produce multiple pay zones with Perf Guns / TCP
- Frac Plugs provide isolation
- Removed by milling with coil or pipe, or via engineered degradation







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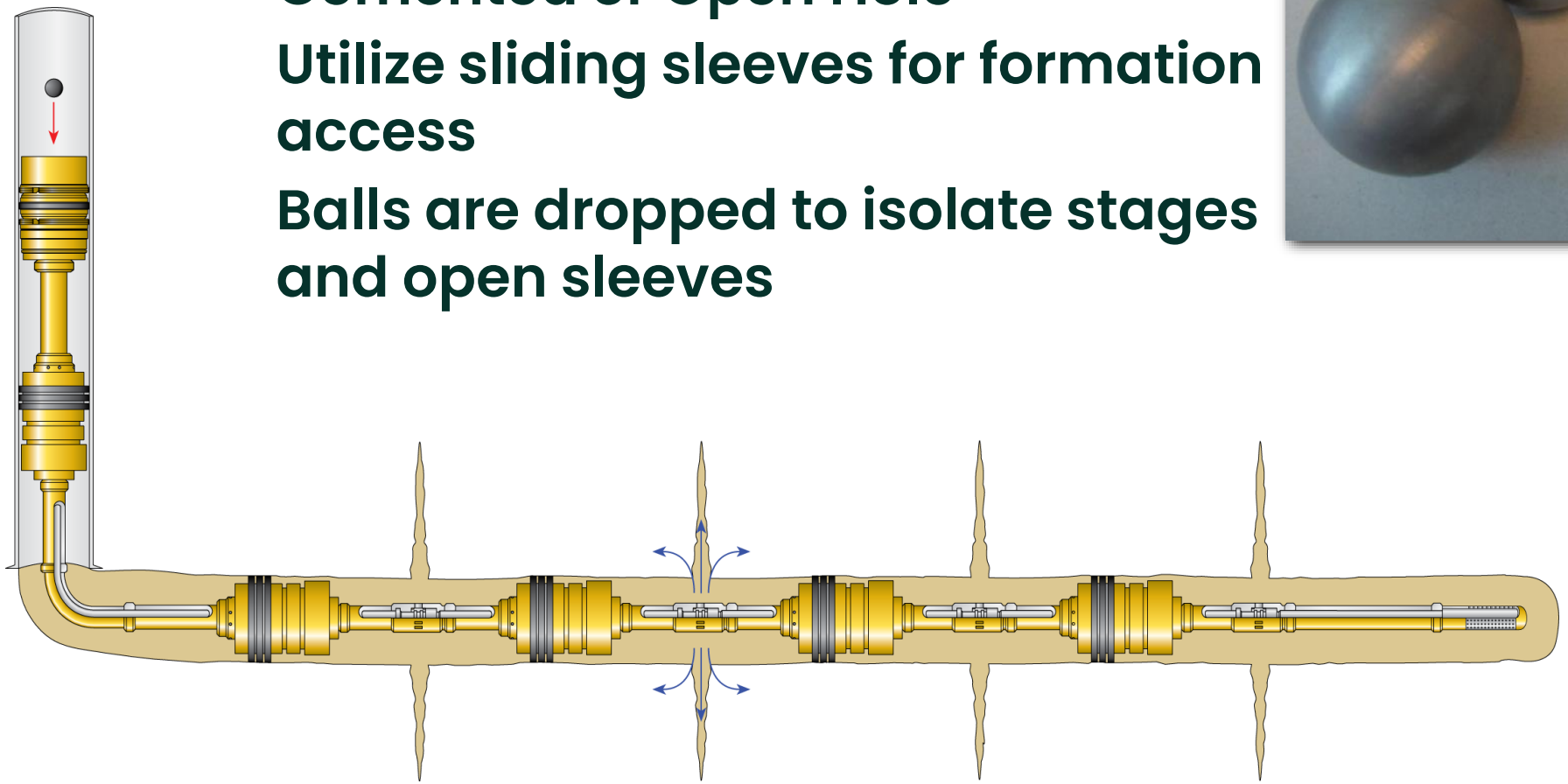
Ball Activated Systems

- Cemented or Open Hole
- Utilize sliding sleeves for formation access
- Balls are dropped to isolate stages and open sleeves



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Coiled Tubing Annular Fracturing

- Cemented or Open Hole
- Utilize sliding sleeves or sand jet perforating
- Coiled Tubing is used to convey a packer assembly to provide isolation and access to reservoir

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Intelligent Well Systems

Wells able to monitor and adjust the condition of downhole devices

Often in offshore environments, where cost of re-entry is prohibitive

Enhancements of previously discussed equipment

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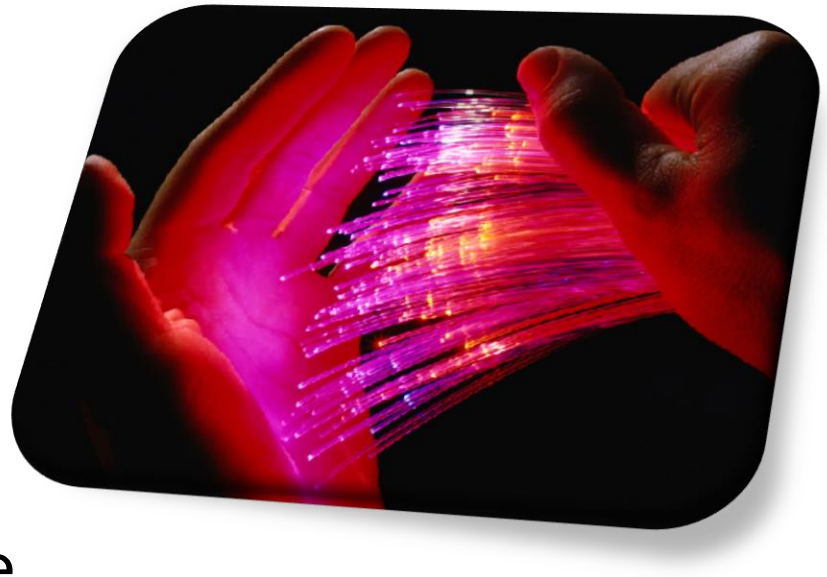
Well Monitoring

- **Discrete Gauges permanently installed on completion assembly to measure real time**
  - Discrete Pressure
  - Discrete Temperature
  - Flow Rate
  - Water Cut
  - Density



Distributed measurements

- Fiber Optic Distributed Temperature
- Distributed acoustic

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Evolving Technologies

- Better Sand Control Performance
- Wellbore Integrity
- Reduced Well site Footprint
- Reduced Personnel
- Reduced Cost
- Reduced HSE Risk

Thank You

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