Overview of Completions and Well Interventions

Ed O’Malley
Outline

• Background
• Drivers affecting selection of completion types
• Major completion components
• Examples of completion types
• Evolving Technologies
Oil and Gas Reservoirs

Source: Wyoming State University
The Well Life Cycle

- **EXPLORATION & APPRAISAL**
  - WELL CONSTRUCTION OPTIMIZATION
- **DEVELOPMENT**
  - COMPLETION OPTIMIZATION
- **PRODUCTION**
  - PRODUCTION OPTIMIZATION
- **REJUVENATION**
- **DECOMMISSION**
  - PLUG & ABANDONMENT
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 or control problematic sections of the well
- Allow access for well maintenance
- Facilitate stimulation
- Maintain safety
Building A Well: Cross Section

Source: Cabot Oil & Gas – Well Said

- Production Tubing
- Intermediate Casing
- Surface Casing
- Conductor Casing
- Cement
- Production Casing
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Completion Classifications

- **Well Path**
  - Vertical
  - Deviated
  - Horizontal
  - Multilateral

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

- **Number of zones**
  - Single
  - Multiple

- **Mode of production**
  - Flowing
  - Artificial lift
Artificial Lift
Other Drivers

- Reservoir type
- Target resource type, extent, depth
- Financial objectives or constraints
- 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
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.
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
Flow Control Devices – Profile Nipples

- Profiles placed in tubing able to receive latching accessories
  Accessories include plugs, chokes, check valves
  Accessories typically retrievable
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.
Packers Types

- Permanent
- Retrievable
- Mechanical set
- Hydraulic set
- Cased Hole
- Open Hole
- Inflatable
- Swelling
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
Filtration Devices - Screens

• Filters built onto perforated tubing

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

• Usable in
  o Open-hole
  o Perforated casing
  o In conjunction with other filters
Inflow or Injection Control Valves

- Passive or autonomously adjusting devices that help drain, (or distribute fluid to) reservoirs evenly

Figure 1: Coning in a long horizontal well.

Figure 2: Avoiding coning by applying ICDs.

Source: Hanzen Energy Services
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
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
Controlling Sand Production Minimizes...

- Equipment damage
- Maintenance costs
- Well plugging
- Disposal costs
Sand Control Completion
Gravel Packing

Open Hole

Cased Hole
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
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
Unconventional Completions

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

- Drivers: efficiency, reliability, cost
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
Ball Activated Systems

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

- Deepwater multistage fracturing system
- Adapted from onshore unconventional systems
- Allows stimulation and completion of deepwater reservoirs
- Reduces deployment time
- Reduces job complexity
Thank You