



Wireline Lubricants

Frank J. Hayes

Product Specialist

CLS, CLGS, MLA-I, MLT-I, OMA-I



Frank J. Hayes

Product Specialist

CLS, OMA-I, MLA-I, MLT-I, CLGS
CITGO Petroleum Corporation

Houston, TX

(832) 486-1519

fhayes@citgo.com

- **Joined CITGO Petroleum Company in Lubricants Technology as a Product Specialist in 2022**
- Hydrotex, Division Partner (2021 – 2022)
- Petro-Canada Lubricants, Sr. Technical Services Advisor (2010 – 2021)
- Plains All-American Pipeline, Technical Services Engineer (2007 - 2010)
- Independent Construction Contractor (2002 - 2007)
- Polaris Laboratories, Service and Sales Rep (2001 - 2002)
- Conoco, Lubrication Engineer (1993 - 2001)
- Conoco, Refinery Engineer (1990 - 1993)
- Aerojet General, Liquid Fueled Rocket Combustion Analyst (1988 - 1990)

- Bachelor of Science in Mechanical Engineering from Prairie View A&M University (1988)

- Certified Lubrication Specialist (CLS), Oil Monitoring Analyst (OMA), Machinery Lubrication Analyst (MLA), Machinery Lubrication Technician (MLT), Certified Lubricating Grease Specialist (CLGS), and CRC Engine Rater

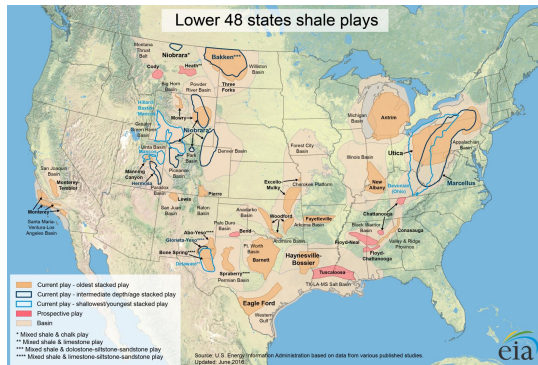
Content

Wireline service market segment

Oil well extraction and production

Wireline equipment and their lubrication requirements

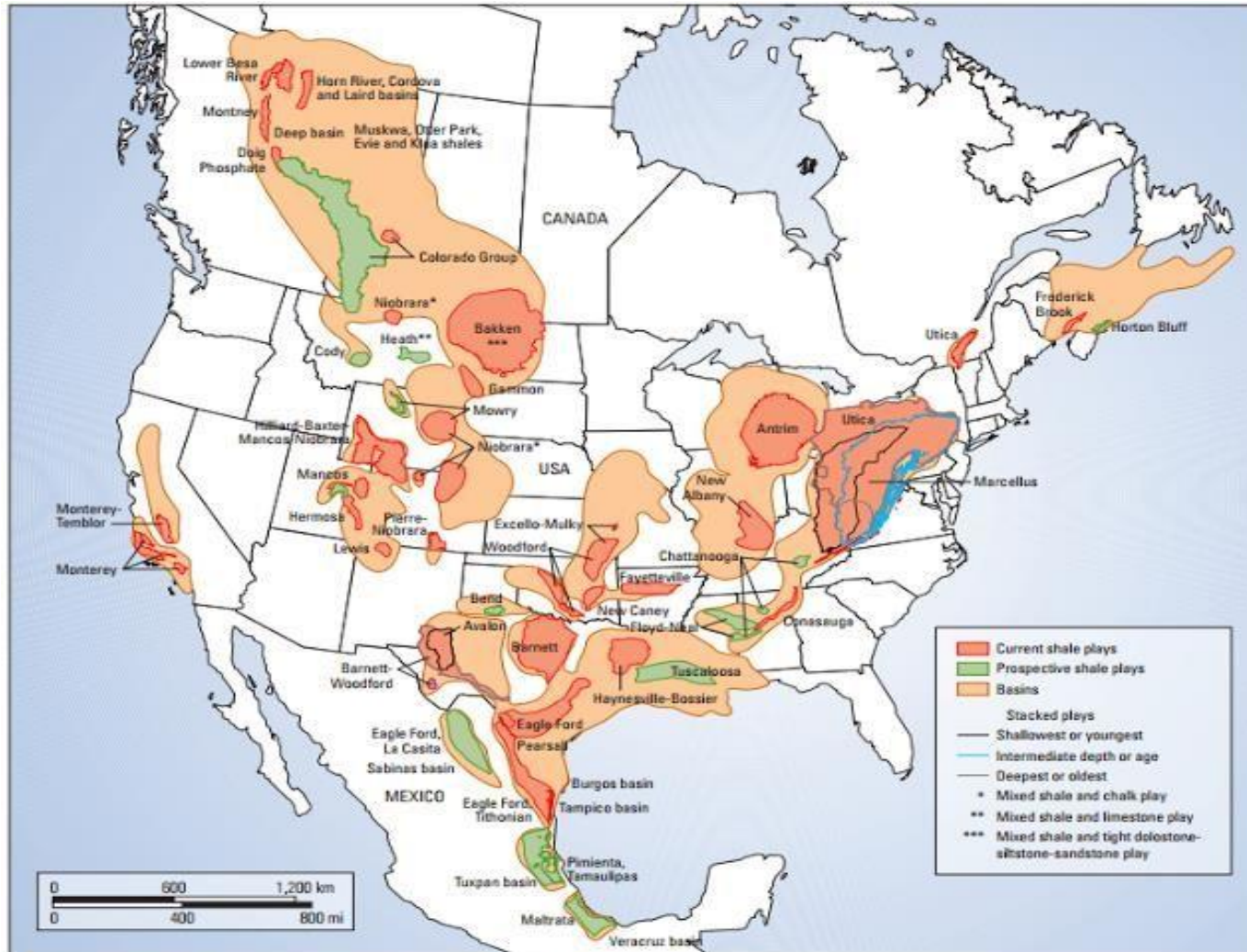
CITGO line of wireline lubricants and their applications



Wireline Service Market Trends

- The North American wireline **logging** services market is expected to witness a Compound Annual Growth Rate (CAGR) of more than 4.1% during 2022-2027.
- The North American **wireline services** market is expected to register a CAGR of over 3% during 2020–2025.
- The wireline logging services market is largely driven by the **growth in exploration and production activities** in the oil and gas industry and **increasing investments in offshore petroleum production activities** in the United States and Canada.
- The **onshore segment** is expected to have a **majority share** in the market. Onshore drilling encompasses all the drilling sites on dry land and accounts for over **70% of worldwide oil production**.

Wireline Service Market Segment

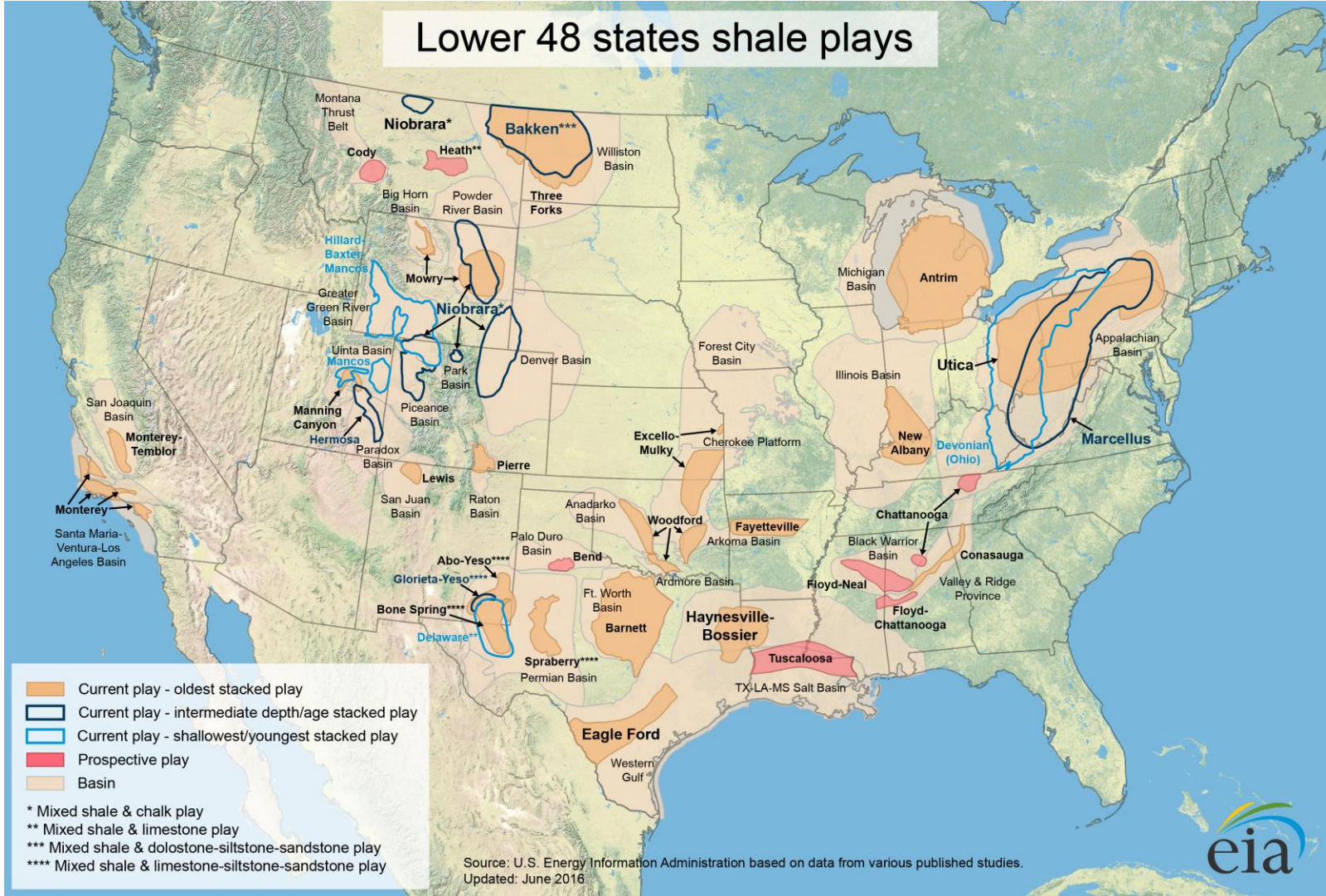


^ North America shale plays. (Adapted from Kuuskraa et al, reference 6.)

Wireline Service Market Trends

- However, the **global energy transition towards renewables**, particularly solar and wind, has the vibe to hit the oil and gas upstream sector and also reduce the demand for oilfield services.
- The **increasing exploration activity in the region to compensate for aging mature oil and gas fields and rising production from shale plays** is expected to offer significant opportunities for the wireline logging service providers.
- The **United States is expected to dominate the market** due to the increased drilling activity in shale plays. The recent development of shale plays, **horizontal drilling, and fracking has increased demand for wireline services.**

Wireline Service Market Segment





Wireline Service Market Trends

Key Highlights

- Open-hole logging is likely to grow at a faster rate across the region during the forecast period due to its higher accuracy and reliability.
- The technological advancements in the field of well logging, such as the implementation of acoustic Logs and caliper Logs, pose a great opportunity for the growth of the wireline logging services market.
- The United States is expected to be the fastest-growing market across the region due to the upcoming upstream projects.

Competitive Landscape

The North American wireline services market is moderately consolidated. Some of the major players in this market include Schlumberger Limited, Halliburton Company, Nextier Oilfield Solutions Inc., Expro Group, Liberty Energy, Weatherford PLC, and Baker Hughes Co.



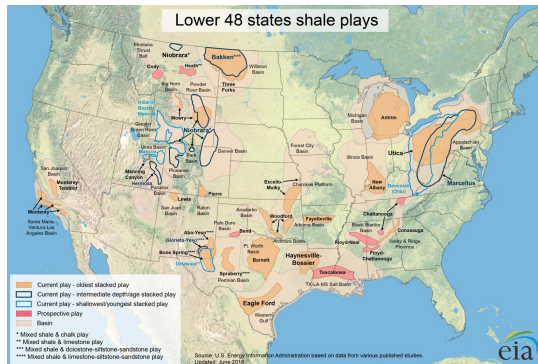
Content

Wireline service market segment

Oil well extraction and production

Wireline equipment and their lubrication requirements

CITGO line of wireline lubricants and their applications





Petroleum Products – Oil Well to Market

- **Exploration**
 - Find and log crude oil and natural gas
- **Extraction**
 - Drill and bring to surface, crude oil and natural gas
- **Production**
 - Maintain supply of crude oil and natural gas, and initial conversion to marketable products
- Gathering and Transportation
 - Move petroleum products to processing plants near and far
- Storage
 - Above ground and below ground facilities close to areas of demand ensure uninterrupted supply
- Distribution
 - Movement of finished petroleum products to terminals and destination of use
- Marketing
 - Sell of intermediate and finished petroleum products to end users

Extraction and Production

• Drilling

- Manual Rig
 - Kelly Drilling Rig
 - Roughnecks handling pipes and pipe clamps
- Automated Rig:
 - New Generation Rig
 - Manual intervention is minimized
 - Pipe wrangler replaces manual handling of tubes
 - Casing Running Tool and Iron Roughneck replaces Roughneck
 - Hydraulic slips to set pipe
 - Safer operation
 - Minimize surface disturbance
- Open-hole Wireline Logging



Extraction and Production

- **Completions**

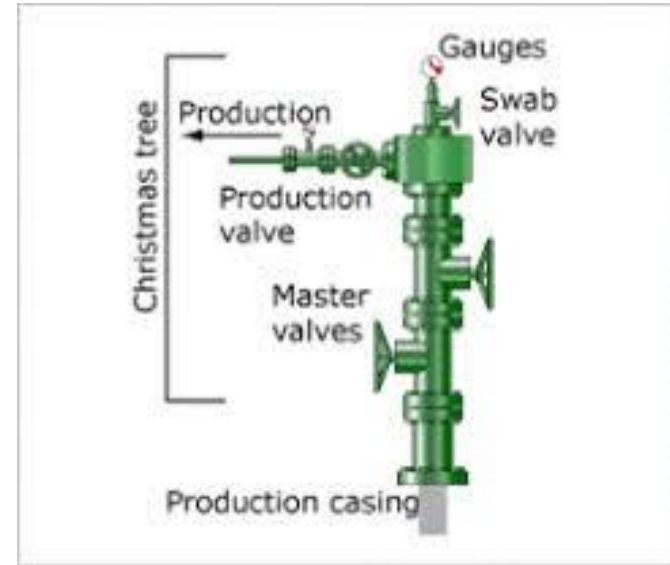
- Casing
- Wireline/Slickline Service
- Coiled Tubing
- Production Tree (Christmas Tree)

- **Fracking Operation**

- Wireline Service
- Frac Pumps

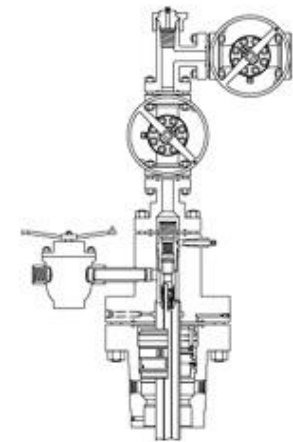
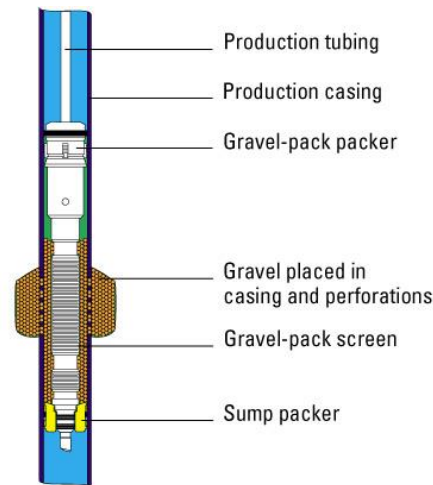
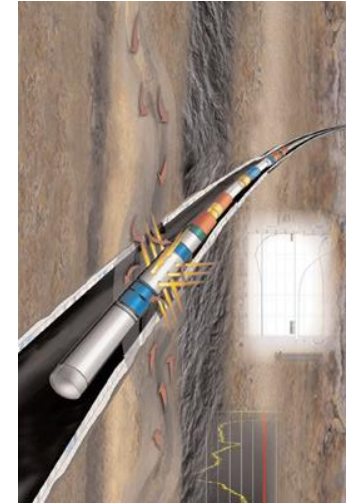
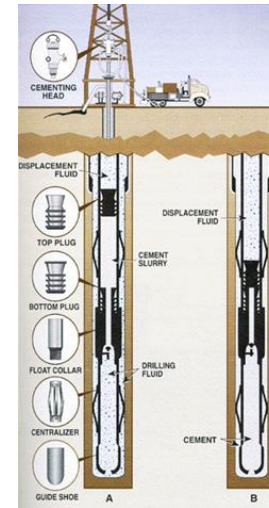
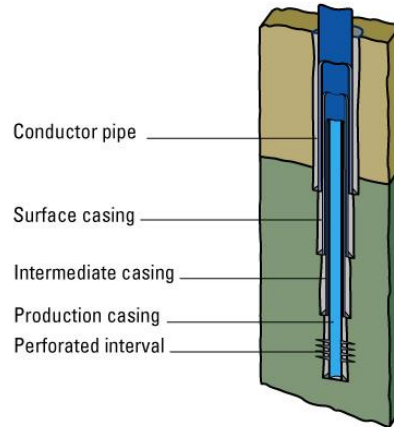
- **Pumping**

- Pumpjack



Completions Process

- Casing
- Cementing
- Open-Hole Completion
- Cased-Hole Completion
- Perforation
- Gravel Pack
- Production Tree (Christmas Tree)

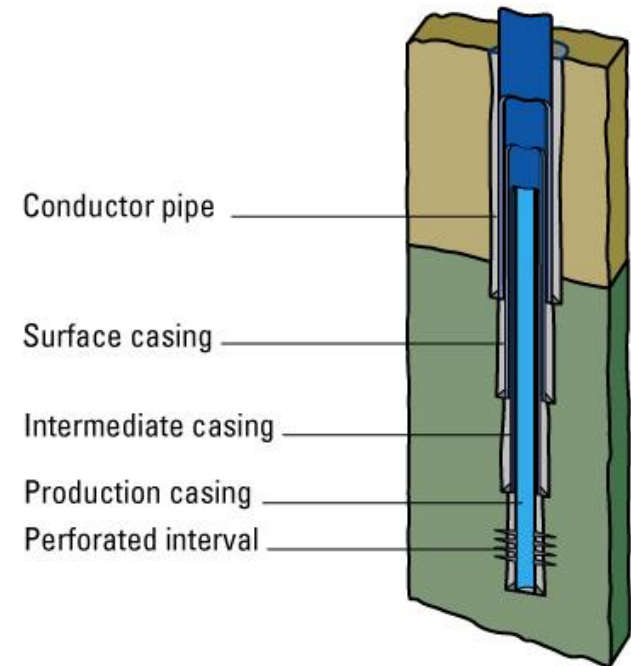


Coil Tubing Wellhead and Christmas Tree Assembly

Completions Process

Casing

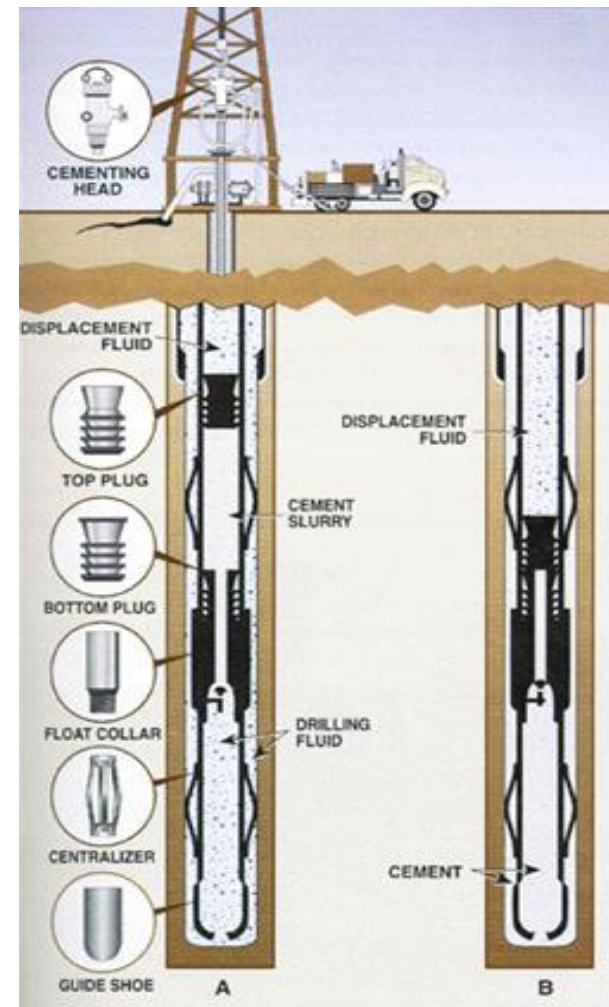
- The first step in completing a well
- Ensures that the well will not close in upon itself
- Protects the well stream from water and sand
- Protects water table from production fluids
- Consisting of steel pipe that is joined together to make a continuous hollow tube
- The different levels of the well define what diameter of casing will be installed (Casing Program)
 - Production casing
 - Intermediate casing
 - Surface casing
 - Conductor casing



Completions Process

Cementing

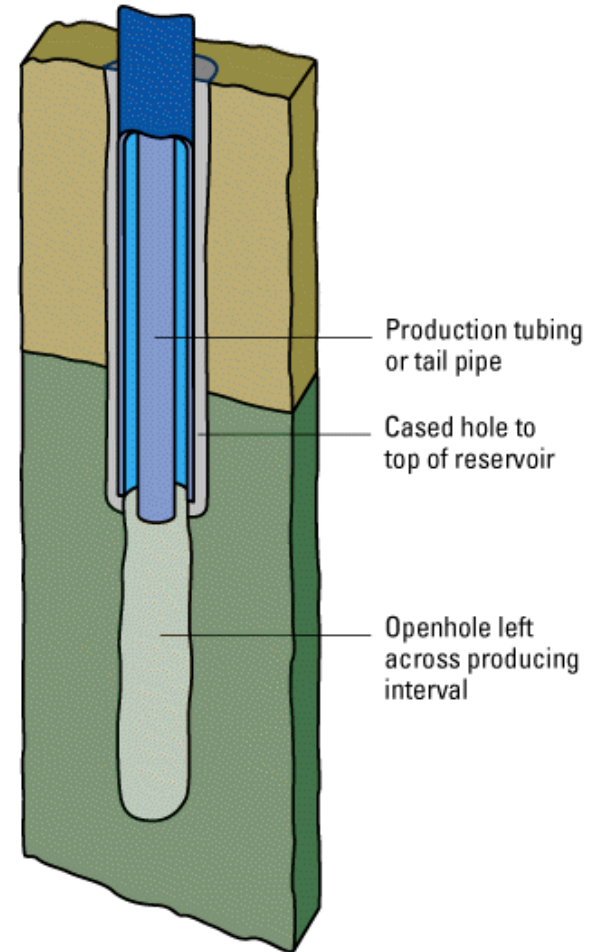
- Next step after casing
- Protects casing from non-hydrocarbons
- Permanently positions the casing into place
- Cement Slurry:
 - Special mixture of additives and cement
 - Pumped through the well casing
 - Displace existing drilling fluids
 - Fill in the space between the casing and the actual sides of the drilled well
 - Cement slurry is left to harden



Completions Process

Open-Hole Completions

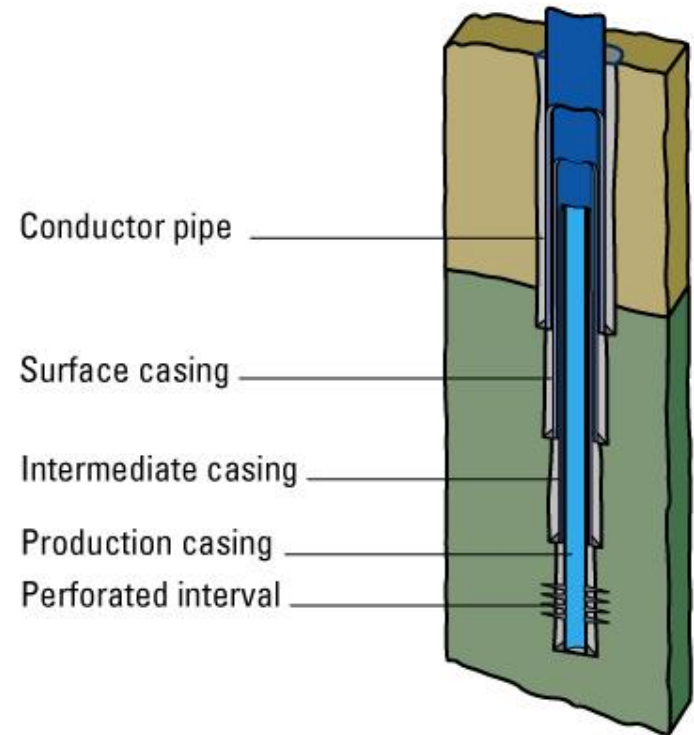
- Two types of completion methods used on wells:
 - Open-hole
 - Cased-hole
- Open-hole Completion
 - A.K.A.: Top Sets and Barefoot Completion
 - Used to reduce cost of casing where the reservoir is solid and well-known
 - Well is drilled and cased to the top of the hydrocarbon reservoir.
 - Well is left open at the bottom



Completions Process

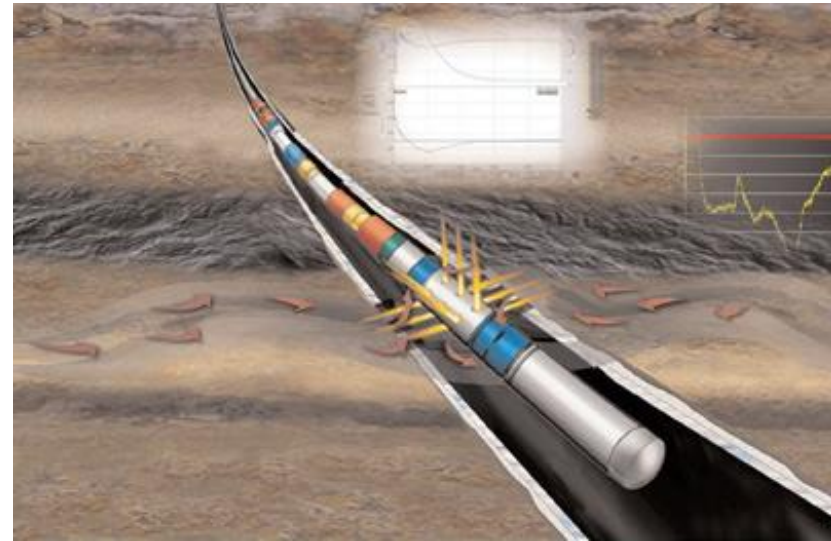
Cased-Hole Completions

- Two types of completion methods used on wells:
 - Open-hole
 - Cased-hole
- Cased-hole Completion
 - A.K.A.: Closed-hole completion
 - Used reservoir is not stable
 - Well is drilled and cased through the production zone/hydrocarbon reservoir.
 - Well is closed at the bottom
 - Connection between well bore and formation is made by perforating



Perforation

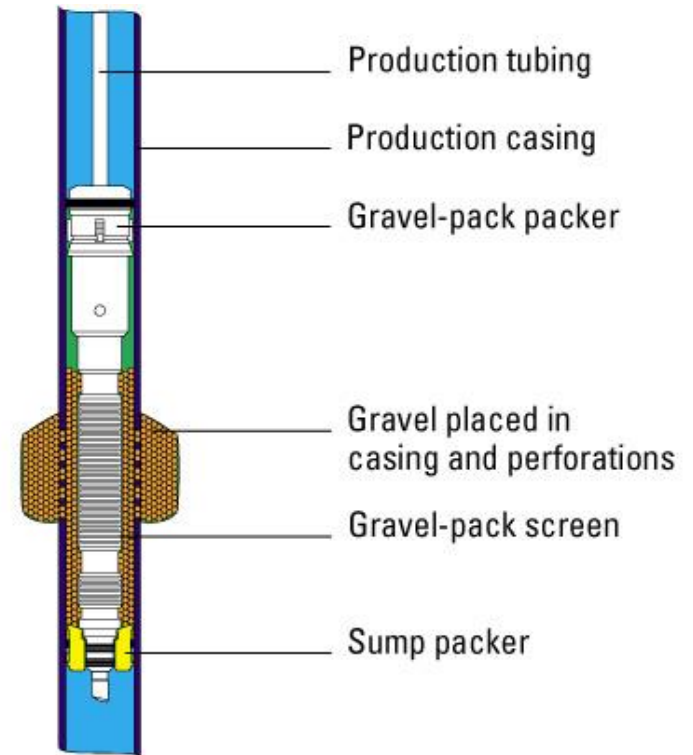
- Necessary to achieve production
- Casing and cement are perforated to allow hydrocarbons to enter the well stream
- Use wireline, slickline or coiled tubing to run perforation gun and reservoir locating device into wellbore
- Perforation at reservoir level
- Allows the hydrocarbons to enter the well stream
- Perforations in casing and cement made by:
 - Firing bullets
 - Discharging flame jets
 - Discharging shaped charges



Completions Process

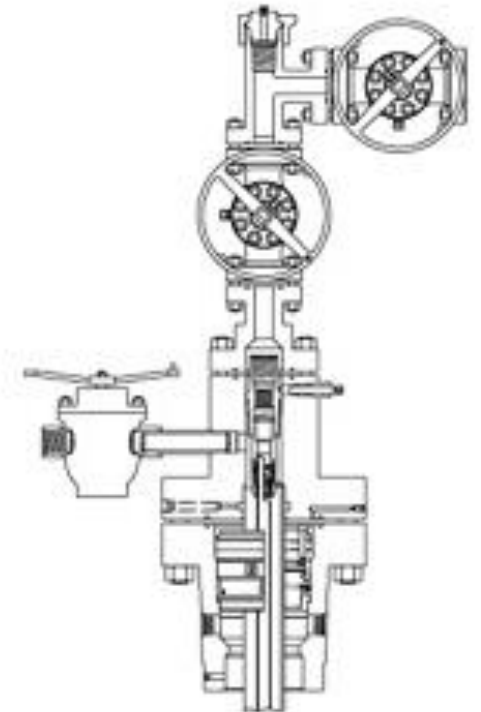
Gravel Pack

- Only used in sandy production zones (i.e., offshore Norway)
- Filtration system to keep wellstream clear of sand
- Slurry of appropriately sized pieces of coarse sand or gravel
- Pumped into the well between the casing perforations and the sides of the wellbore
- Wire screens of the liner and the gravel pack work together to block sand



Completions Process

- Production Tree (Christmas Tree)
 - Last step in completing a well
 - Wellhead installed at the surface of the well
 - Wellhead device (production tree) includes casing heads and a tubing head combined to provide surface control of the subsurface conditions of the well.
- Onshore wells: Production tree or Christmas tree placed on top of wellhead
- Offshore wells
 - Dry trees: Installed above the water's surface on the deck of a platform
 - Wet trees: Installed on the seabed and encased in a solid steel box to protect the valves and gages from the elements
- Wet tree manipulated from surface or ROV via electronic or hydraulic controls



Coil Tubing Wellhead and Christmas Tree Assembly

Fracking

Fracking: The process of injecting liquid at high pressure into subterranean rocks, boreholes, etc. so as to force open existing fissures and extract oil or gas.

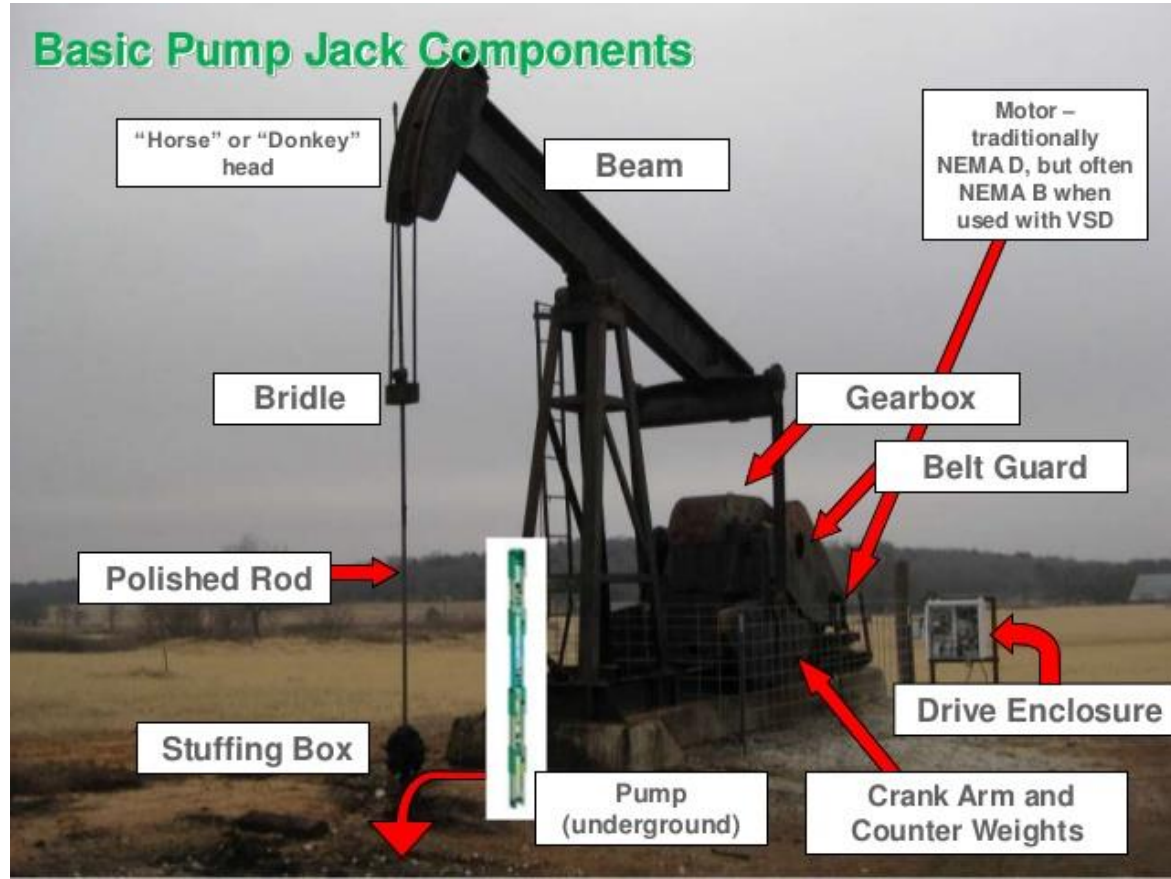
- Operated across a range of different pressures and injection rates specific to the well
 - Pressure up to 15,000 psi
 - Injection rate up to 100 bbls/minute
- Common blend of fracturing fluid (slickwater):
 - 90% water
 - 9.5% sand or other proppants
 - 0.5% chemical additives
 - Blend may vary considerably from well to well
- Wireline Service
 - Integrally used while fracking
 - Plugging
 - Perforation



Pumpjack Components

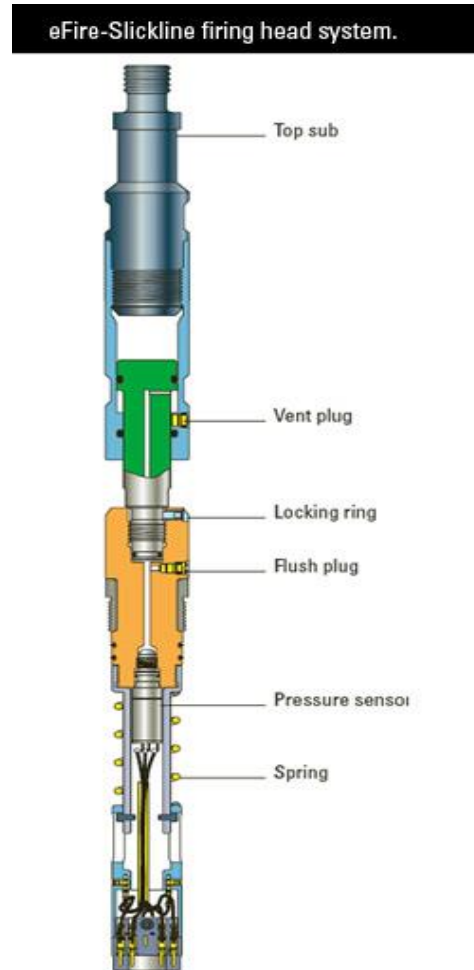
Pumpjack: The aboveground drive for a reciprocating piston pump in an oil well.

- Used to mechanically lift liquid out of the well if not enough bottom hole pressure exists for the liquid to flow all the way to the surface.
- Commonly used for onshore wells producing little oil
- Common in oil-rich areas
- Used in vertical and directional wells



Workover Operations

- Remedial work on producing wells
 - well clean-up
 - setting plugs
 - production logging
 - perforation through explosives
- Production shut-in may be necessary
- Well-servicing unit (Wireline or Slickline) used to winch items in and out of the wellbore



Coiled Tubing Rigs

- Very long metal pipe spooled on a large reel
- More than 20K feet of lateral length
- Normally 1 to 4" in diameter
- Used for interventions in oil and gas wells
- Used as production tubing in depleted gas wells.
- Used to carry out operations similar to wirelining.
- Benefits over wireline:
 - Ability to pump chemicals through the coil at 10K to 20K psi
 - Ability to push it into the hole rather than relying on gravity
 - Ability to rotate tool



Wireline Service

- Logging, Completions, and Workover of oil and gas wells
- Various Cabling technologies
- Lower equipment or measurement devices (tools) into the well
- Wireline tools travel vertically via gravity
- Wireline tools travel laterally via pressure differential, etc
- Benefits over coil tubing:
 - Faster operation
 - Lower cost
 - Smaller footprint on location



Wireline Well Services

- Reservoir evaluation: Acquisition of Subsurface petrophysical and Geophysical data
- Well Construction Services
- Well Casing Perforation
- Casing Plug Setting
- Well intervention
 - Well Cleaning
 - Pipe Recovery
 - Tool Fishing/Recovery



Slicklines

- Sub-set of wireline service
- Single-strand non-electric cables lowered into oil and gas wells from surface
- Used to place and recover wellbore equipment
 - Plugs
 - Gauges
 - Valves
- Used to adjust valves and sleeves located downhole
- Used to repair tubing within the wellbore
- Wrapped around a hydraulically operated drum on the back of a truck



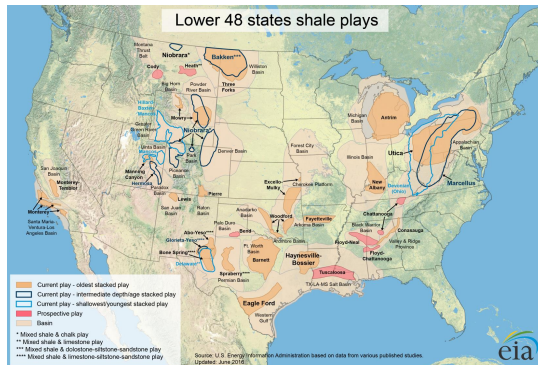
Content

Wireline service market segment

Oil well extraction and production

Wireline equipment and their lubrication requirements

CITGO line of wireline lubricants and their applications



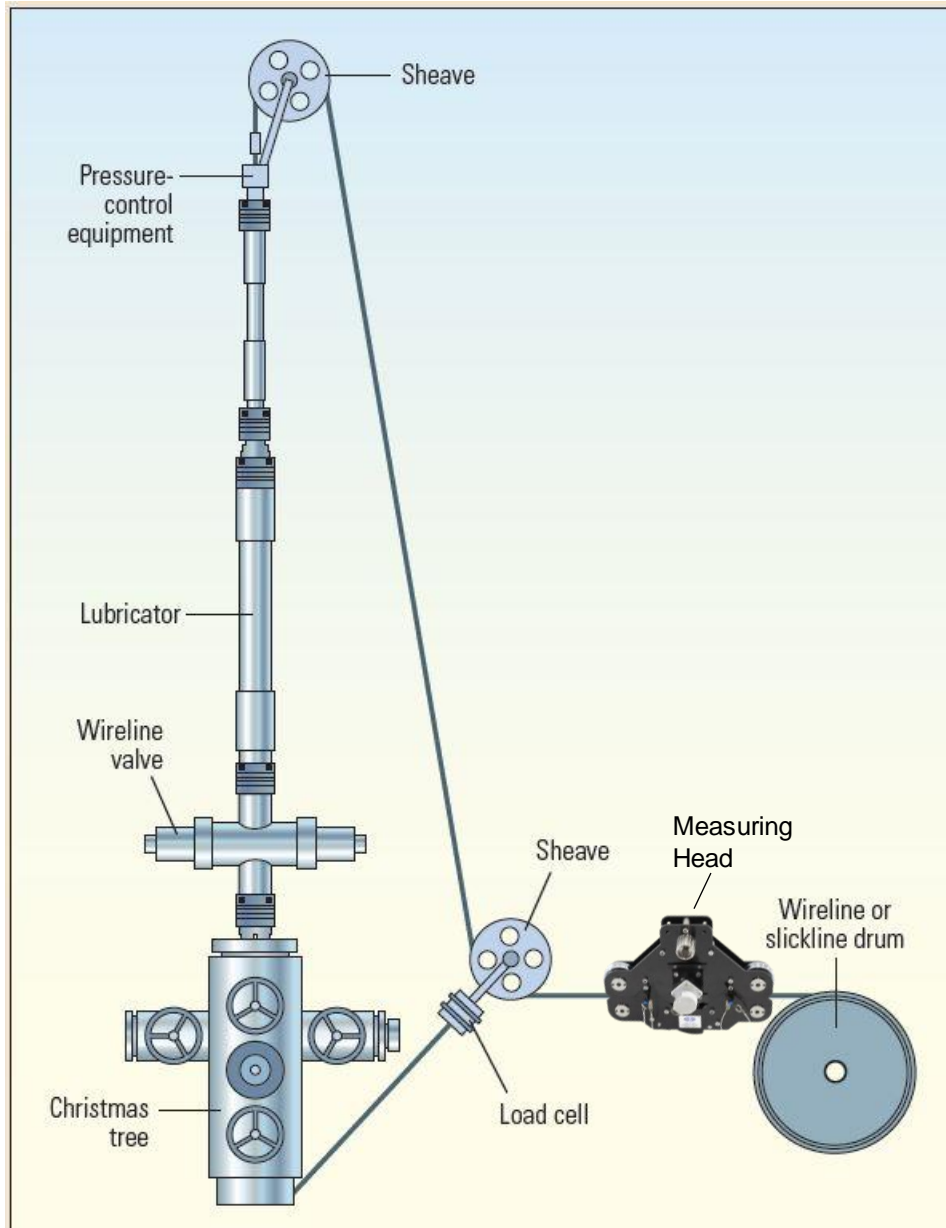
Wireline Equipment and Their Lubrication Requirements



Wireline assembly hoisted by crane or derrick



Wireline Equipment and Their Lubrication Requirements



Wireline Equipment Sequence

1. Wireline Drum
2. Measuring Head
3. Sheaves
4. Pressure Control Equipment
5. Lubricator (Riser)
6. Wireline Valve or BOP
7. Christmas Tree (Well Valves)

Wire Rope Construction

Lay

- A unit of measure
- Full wrap turn of a strand

Regular Lay

- Wires twisted in one direction
- Strands twisted in opposite direction of wires
- Less likely to untwist or kink
- Less subject to crushing or distortion

Lang Lay

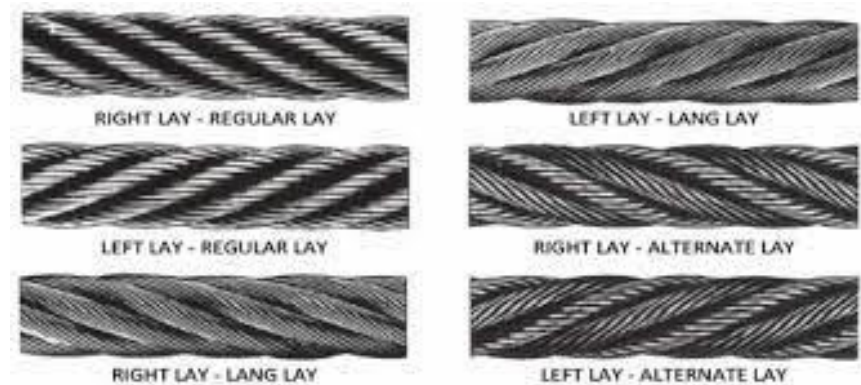
- Wires and strands spiral in same direction
- Greater flexibility
- Greater abrasion resistance
- More likely to twist, kink, and crush

Left Lay

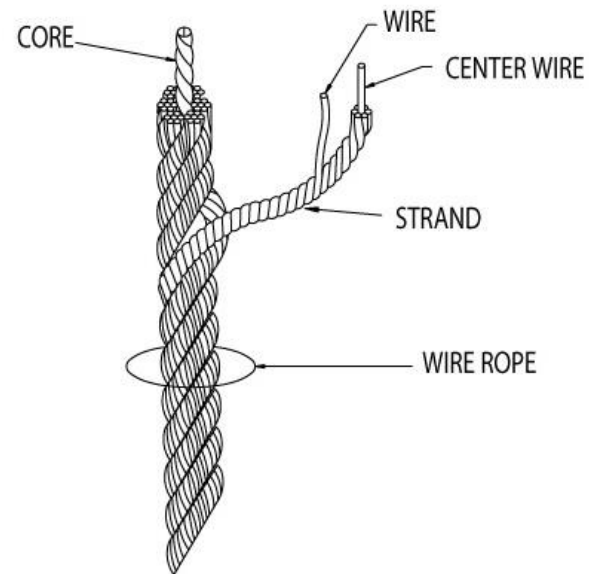
- Strands wrap counterclockwise around the core

Right Lay

- Strands wrap clockwise around the core

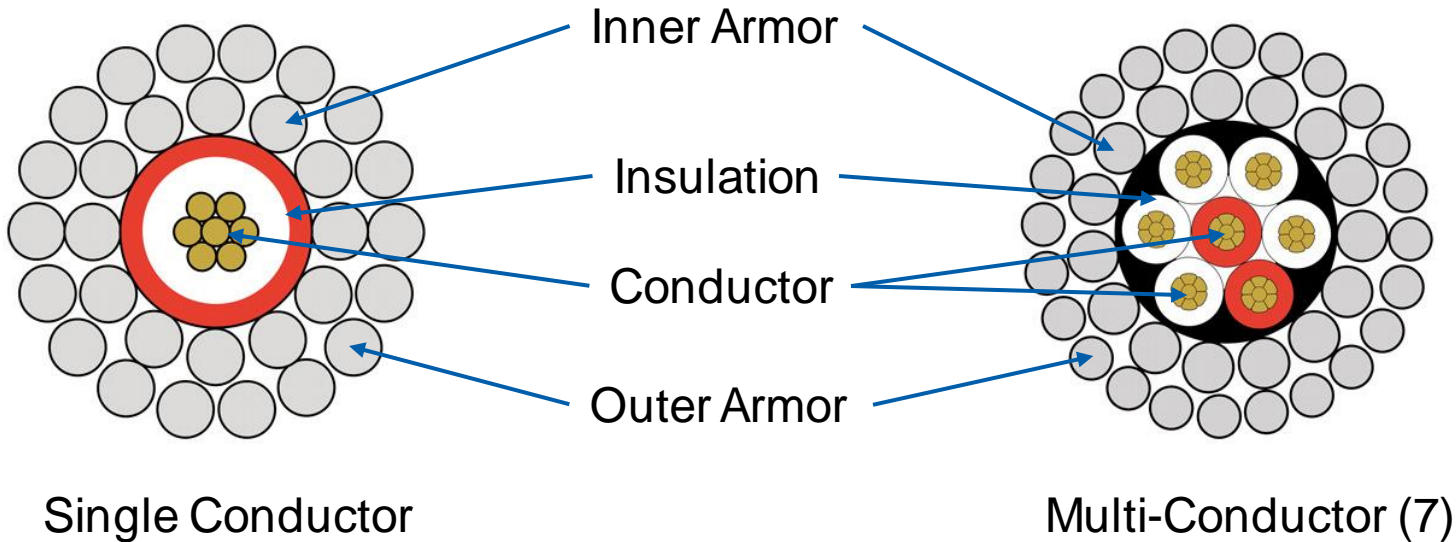


Wire Rope Lays



Simple Wire Rope Construction

Wireline Construction



- Lengths of up to 30,000 feet
- Diameters from .1" to .6"
- Tensile/Breaking strength from 1,000lbf to over 30K lbf
- Insulation max temp rating 300F to 600F
- Copper conductors
- Armor strands are solid or twisted wires
- Inner and outer armors have opposite lays

Wireline Types



Single Conductor Wireline



7 Conductor Wireline – 3D view



Single Conductor Wireline –
Polymer Locked (sheathed)

Polymer Coated Jacketed Wireline

(Game changer for cased hole wireline service)

What

- Cased hole wireline service
- Sheathed
- Polymer jacketed or locked
- Mostly single-conductor
- Slickline
- Limited to 400F bottom hole temperature

Benefits

- Torque balanced
- No wireline grease
- Low volume specialty lubricant for pack-off
- Dual pack-off only for well pressure control
- Reduced cable friction for further travel
- Significantly reduced armor damage and corrosion (varies per brand)
- Less maintenance
- Complete seal from well fluids and gas
- High pressure well control



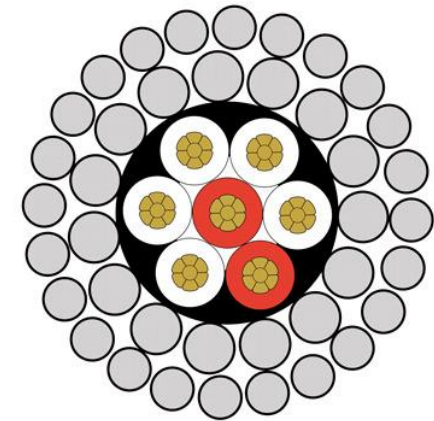
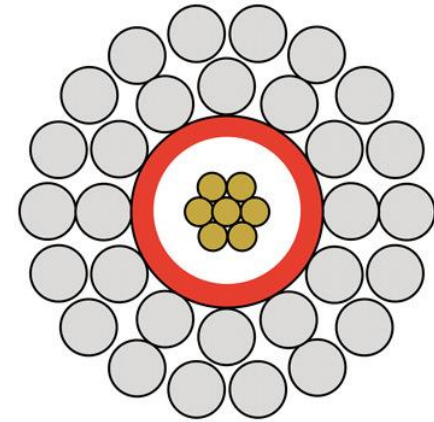
Polymer Coated



Polymer Locked

Wireline Types and Their Service

- **Single Conductor and Multi-Conductor**
 - Cased Hole Logging in pressurized wells
 - Pipe Recovery
 - Perforating
 - Plug Setting
 - Production Logging
 - Noise Logging
 - Pulsed Neutron
 - Production Fluid Sampling
 - Production Flow Monitoring



Wireline Types and Their Service

- **Slickline/Sheathed Slickline**
 - No conductor
 - Light Well Construction
 - Well Maintenance
 - Memory Reliant Subsurface Data Gathering
 - Gauge Emplacement and Recovery
 - Sub-surface Valve Manipulation
 - Well bore cleaning and fishing
- **Braided Slickline (with or w/o power conductor)**
 - Heavy Duty Well Construction
 - Heavy Duty Fishing
 - Well Bore Cleaning
- **Polymer Jacketed Line**
 - Data conductors
 - Power conductors
 - Heavily used for casing perforation

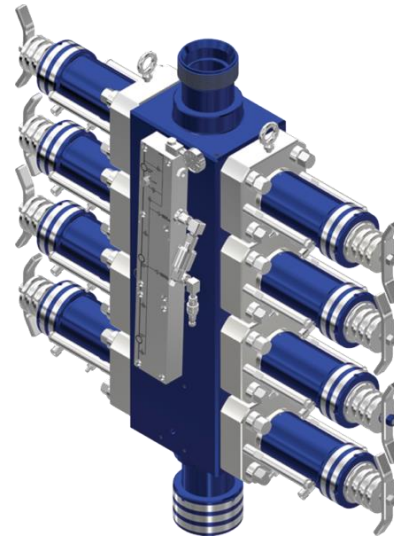
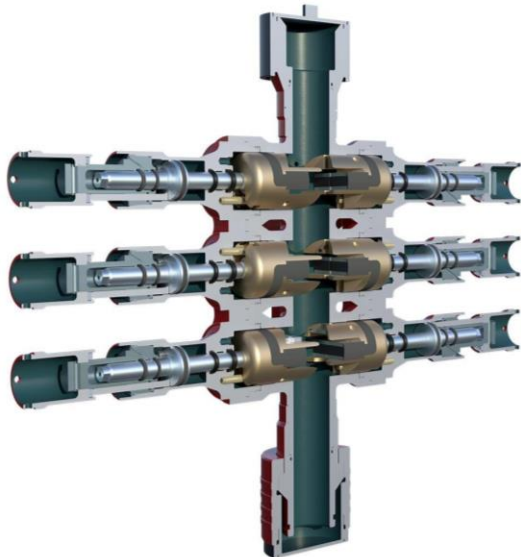
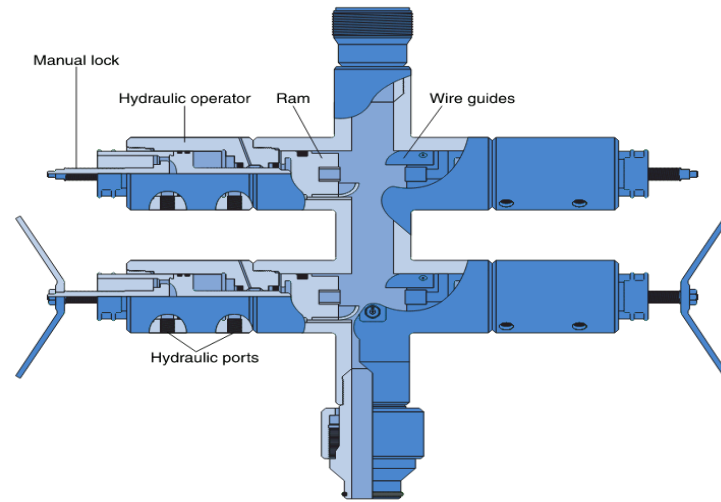
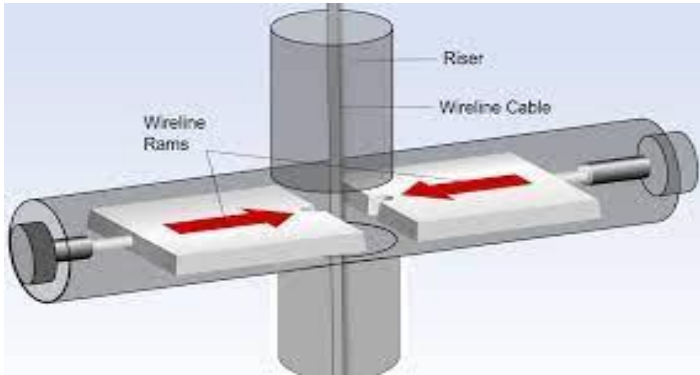


Well Bore Pressure Control

- **Why?**
 - Well Kicking in open hole bores
 - Production pressures in cased (closed) hole wells
- **Grease Injection Control Head**
 - Mitigates risk of hydrocarbon release during well interventions
 - Primary well control barrier
 - Allows intervention well access under pressure
 - Positioned at the upper most point of pressure control string
 - Combination of stuffing box and line wiper
 - Concentric flow tubes fit tightly around wireline and support the assembly

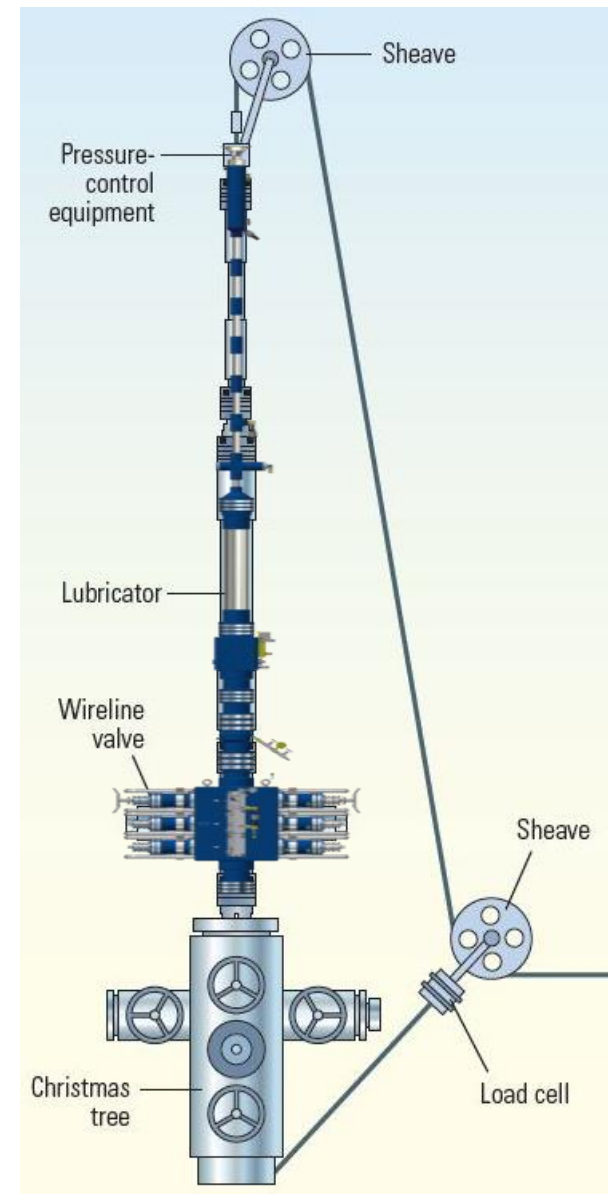


Wireline Control Valve / Blowout Preventer (BOP)



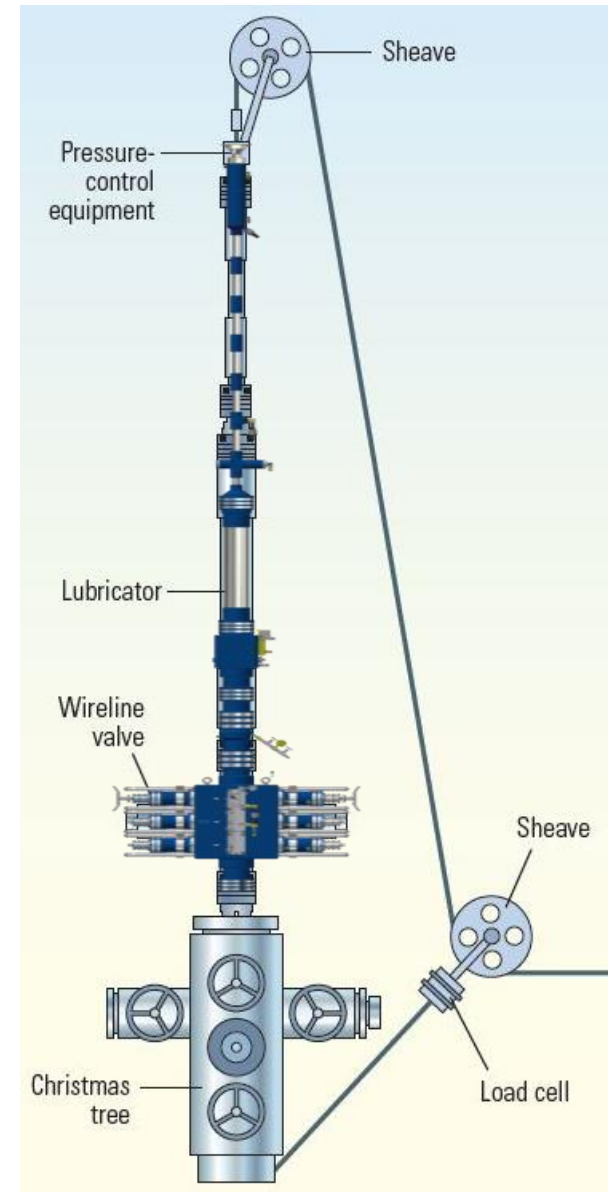
Well Bore Pressure Control Components

- **Grease Injector Head** contains well pressure while running into hole
 - **Line Wiper** to wipe of excess well fluids and lubricant
 - **Pack-off** compress rubber seal around the wireline
 - **Ball-check valve** in grease head to seal of well pressure if wireline severed from tool
 - **Flow tubes** for wireline lubricant pressure control.
 - Number of flow tubes and injection points depend on well pressure and well fluids
 - Grease flows from bottom to top, with a 2K psi drop per tube.
 - 2K psi drop per flow tube
 - 2K psi above well pressure



Well Bore Pressure Control Components

- **Quick Test Sub** for pressure testing pressure control equipment
- **Pump-in Sub** to pump in fluids for Pressure Testing, Pressure Bleed off, and Kill fluids for wild well
- **Head Catcher** at top of lubricator section to grab tool if forced to top of lubricator section
- **Lubricators (risers)** to seal in/hold tool string. Enable tool string to be introduced or retrieved from a wellbore under pressure. Formerly used to grease tools for service in wood casings.
- **Tool Trap** is a big flapper between lubricator and Christmas tree (well control valves) to prevent unintentional dropping of tool in well.
- **Wireline control valve**/blow out preventer (BOP)
- **Quick connect sub-assembly** on top of BOP to save time
- **Adapter** on top of Christmas Tree



Basic Wireline Tool String Components

A. **Knuckle joint** – add flexibility to longer wireline tools in highly deviated wells

B. **Hydraulic jars** – upward jarring stroke to add to mechanical jar stroke force

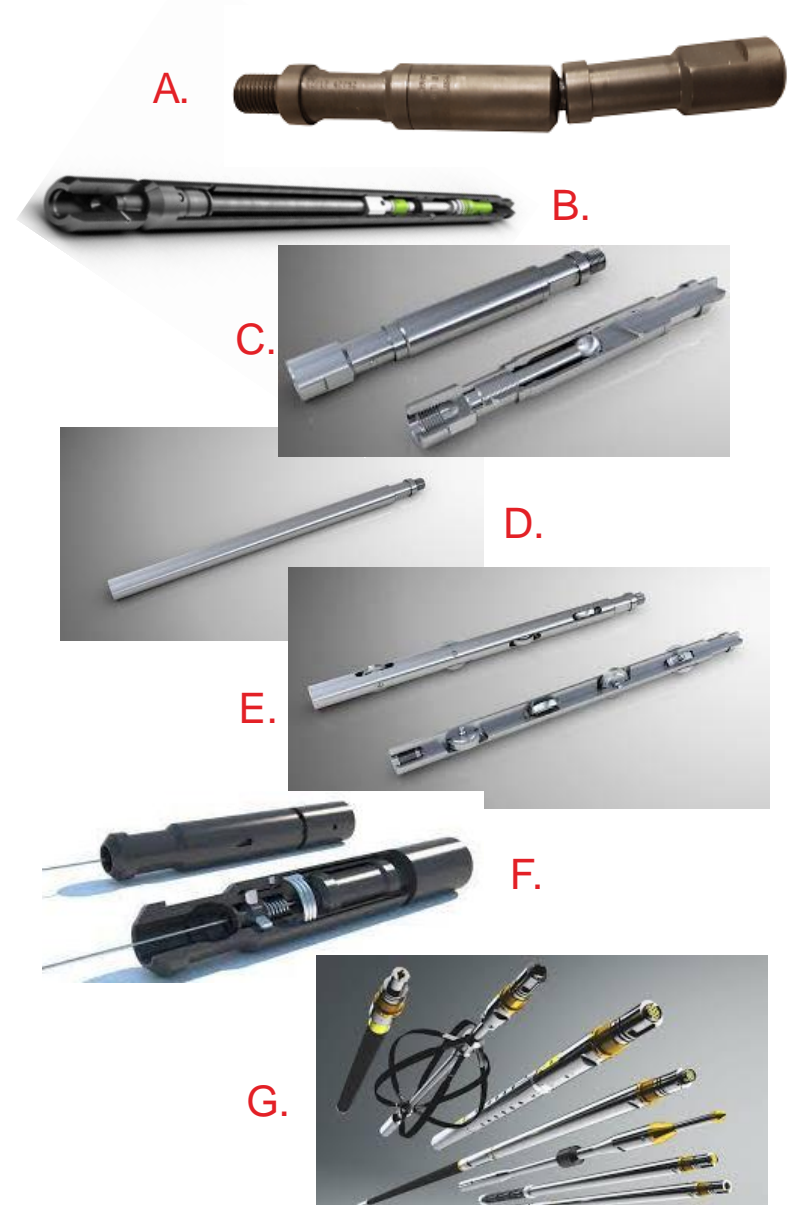
C. **Mechanical jars** – free stuck tools with axial strike

D. **Stem (weight bar)** – add extra weight to the tool string to overcome well pressure and friction

E. **Stem (Roller Bar)** – extra weight and rollers to overcome well friction

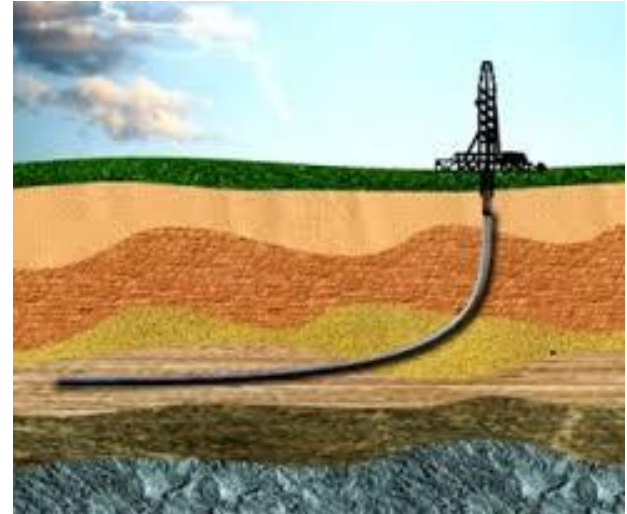
F. **Rope socket (cable head)** – attach and disconnect wireline to and from tool string

G. **Wireline tools** – designed for specific jobs



Tool Conveyance Methods

- Gravity from vertical to 50 degrees from vertical
- “Pressure differential” fluid drag on wireline
- Electrical tractor
- Tough Logging Conditions (TLC)
 - with coil tube
 - open hole



Electrical Tractor

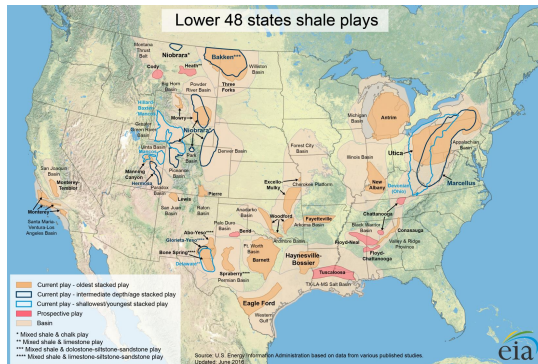
Content

Wireline service market segment

Oil well extraction and production

Wireline equipment and their lubrication requirements

CITGO line of wireline lubricants and their applications





CITGO Wireline Lubricant Characteristics

- Rust and corrosion protection for steel strands and copper conductors from brine water and H₂S.
- Protects against CO₂ viscosity reduction
- Low pour points for winter application
- Transparent for cable visibility
- Adhesive to minimize sling-off and contain well pressure
- Multiple viscosities to contain a variety of production environments
- High viscosity index to help lubricant stay in braids in high temperature and pressure production environments
- Does not separate/bleed (No grease soap)
- CITGO Wireline Lubricant

Lubricants used in Wireline/Slickline Operations

- Hydraulic fluid for tool components
 - CITGO HyDurance AW 32, 46, 68
 - CITGO HyDurance AW All-Temp 32, 46
- Grease for tool components
 - High Temperature Grease
 - Mystik JT-6 High-Temp Grease, #2



Lubricants used in Wireline/Slickline Operations

- Hydraulic fluid for drum operation
 - CITGO HyDurance AW 32, 46, 68
 - CITGO HyDurance AW All-Temp 32, 46
- Lubricants for for wireline rig/truck
 - Heavy Duty Engine Oil
 - Heavy Duty Transmission Fluid
 - Automotive gear oil
 - Grease for hydraulic drum and chassis



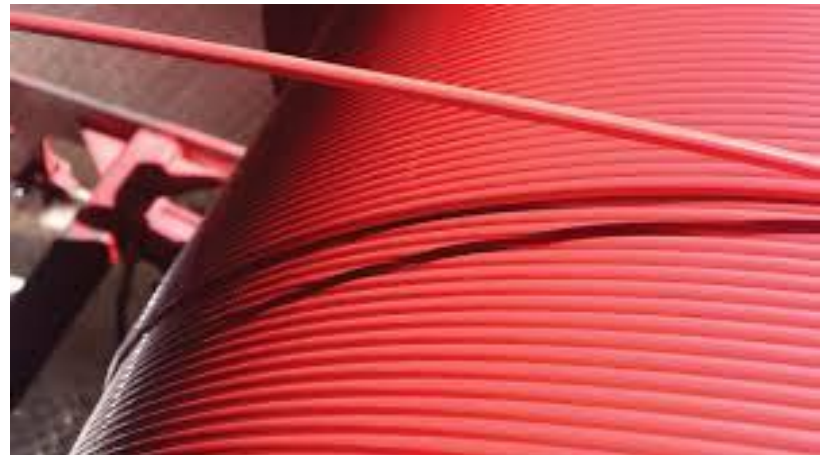
Wireline Lubricant Functionality

- Corrosion Protection
- Wear Protection
- Well Pressure Control
- Displace downhole fluid contaminants



Jacketed Line Lubrication

- Pack-off used in lieu of grease head
- Jacketed line lube not necessary for pressure control
- Jacketed line lubricants are evolving and in development
- Lubricate cable to reduce friction at pack-off rubber seal
- Wireline lubricant consumption rate
 - 15-20 gallons per day
- Jacketed line lube consumption rate
 - 1 gallon per day
- Spray light oil on:
 - drum
 - Tulip
 - Top of pack-off



CITGO Wireline Lubricants

PRODUCT INFORMATION SHEET

CITGO® Wireline Lubricants



CITGO Wireline Lubricant

Viscosity	Package Size (subject to change)
220	330gal tote
680	330gal tote
1500	330gal tote
2500	55gal drum
5000	330gal tote
7500	330gal tote
10000	55gal drum, 330gal tote
12000	330gal tote

Bold Print: Most Used

Wireline Lubricant Viscosity Selection

Starting point

CITGO Wireline Lubricant *	Atmospheric Temperature Range
220	-10F to 20F
680	10F to 40F
1500	30F to 70F
2500	50F to 80F
5000	60F to 95F
7500	70F to 100F
10000	75F to 110F
12000	90F to 130F

* Wireline lubricant selection depends on several variables. Consult with customer to consider operating conditions before settling on a wireline lubricant viscosity.



Wireline Lubricant Viscosity Selection

Factors to Consider

- Ambient temperature
- Wireline design
- Well pressure
- Well fluid temperature
- Well fluid content
- Well fluid quality



Wireline Lubricants

Questions?