An Introduction to Oil and Gas Well Servicing

Educational Material from the IOM³ Oil and Gas Division
Introduction

• The Institute of Materials, Minerals & Mining (IOM³) is a major UK professional engineering institution, incorporated by Royal Charter, with over 17,000 members spread across the world.

• IOM³ exists to promote & develop all aspects of: materials science & engineering, metallurgy, geology, mining & associated technologies and petroleum engineering, as a leading authority in the global materials & natural resource community.

• The Oil and Gas Division represents over 1,200 members of the Institute who are interested in the production of Oil and Gas.

• Membership of the Institute provides a range of benefits, including access to globally recognised UK professional engineering qualifications such as Chartered engineer (CEng), see www.iom3.org

• This slide pack is part of a series of educational material produced by the Oil and Gas Division to provide the Public with information on the production of oil and gas.
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The wellhead and Xmas tree contain valves and seals to isolate and access the wellbore and well annuli. An example of a composite Xmas tree (constructed from valves bolted together) on a wellhead is shown opposite.

Pressure in the annuli are monitored to check the status of the annulus seal, confirm that the pressures are within design limits and when a well is on gas lift optimise well performance.

The well operator will specify a maintenance and monitoring regime for the wellhead and Xmas tree. Well service personnel will often undertake routine testing, maintenance and repair of wellhead and Xmas tree equipment, often with a representative from the Original Equipment Manufacturer.
Slickline

- A method of conveying intervention tools into a well typically using 0.108” or 0.125” diameter single strand steel wire. The wire may incorporate fibre or electrical cable, is spooled on a drum and alloys may be used in corrosive wells.

- Most tools are mechanically manipulated, may use batteries.

- Slickline is used for:-
  - Fishing – recovering items left in a well.
  - Debris removal e.g. “cutting” hydrocarbon wax.
  - Pulling, running or operating downhole flow control devices.
  - Perforating.
  - Data acquisition – calipers, downhole pressure and/or well performance data

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Fast rig-up and rig-down, small footprint and typically a 3 person (per shift) crew.</td>
<td>Depth control is hampered by stretch and lack of real time readout (unless using conductive slickline).</td>
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<tr>
<td>Low cost option.</td>
<td>No real-time surface readout (unless using conductive slickline)</td>
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<tr>
<td>Quick.</td>
<td>Limited wire strength (Compared to e-line, braided line and coiled tubing), cannot circulate fluids downhole or rotate tools.</td>
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Braided Line

- Strands of wire braided to form a stronger cable. The most common size of braided line is 3/16-in. diameter, although special heavy applications use 1/4-in. and 5/16-in.
- Used for wireline intervention when a higher tension or weight-carrying ability is required.
- Primarily used for fishing where slickline has insufficient tensile strength. The photograph shows debris recovered from a well comprising: formation, wire and tools.

### Advantages

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<td>Fast rig-up and rig-down, small footprint and typically a 3 person (per shift) crew.</td>
<td>No real time surface readout. cannot circulate fluids downhole or rotate tools.</td>
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<tr>
<td>Low cost, fast option compared to bringing in a rig.</td>
<td>Cannot pull as fast as slickline, relies on straight pull rather than momentum when pulling equipment downhole.</td>
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**Electric Line**

- Braided cable with electrical cable in the middle.
- North Sea typically use a containerised double drum unit containing one drum of 0.125” slickline and one of 7/32” mono conductor. The photograph shows a double drum unit on a North Sea platform.
- Can operate tools real-time with electrical power, typical tools/uses are:-
  - Real-time logging.
  - Perforating.
  - Tractor operations in highly deviated wells and/or where downhole rotation is required.
  - Setting packers.

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<td>High speed real time data transfer. Good depth control.</td>
<td>More complex rig-up than slickline, requires a grease injection head to seal around the braided cable.</td>
</tr>
<tr>
<td>Can access highly deviated wells and apply rotation downhole to undertake a greater range of tasks.</td>
<td>More expensive than slickline.</td>
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Coiled Tubing

- Rolled & welded continuous length of tubing developed by BP to supply fuel direct to the landing beaches in the invasion of Europe, June 1944.
- Adapted for use in oil and gas wells to provide a means to circulate fluids for operations such as cleanouts, stimulation, gas lift, drilling, perforating and fishing.
- Typically reels containing 5000m of 1 3/4” to 2 3/8” OD pipe are used in the North Sea. Coiled tubing up to 3 1/2” diameter may be run as the well completion. Injector head and reel shown opposite.
- The tubing is subject to fatigue and has to be closely monitored then retired before it approaches failure.

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<td>Much stronger than wireline, can circulate fluid and rotate tools downhole providing a greater range of uses. Can operate in live wells with pressure at surface.</td>
<td>Coiled tubing is relatively heavy and novel ways have to be found to get the tubing onto North Sea platforms. A typical reel will weigh around 20MT.</td>
</tr>
<tr>
<td>Smaller footprint, quicker to rig up/down, smaller crew and much cheaper than a drilling rig.</td>
<td>The tubing is being fatigued through bending and has a relatively short life.</td>
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Hydraulic Workover and Snubbing

- Snubbing is where pipe is forced into a well against pressure.
- Units use conventional joints of drillpipe which are stronger and more durable than coiled tubing. Also not as heavy as coiled tubing reels so easier to transport.
- Used for: fishing, cementing, drilling, gravel packing, perforating, workovers, insert string deployment and cleanouts.
- Personnel make up and break out pipe in the “basket” above the pressure control and snubbing equipment. The photograph shows a typical onshore truck supported unit.

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<td>Much stronger than coiled tubing and breaks down into lighter components.</td>
<td>Personnel work above the pressure control equipment.</td>
</tr>
<tr>
<td>Smaller footprint, quicker to rig up/down, smaller crew and much cheaper than a drilling rig. Can also operate in “live” wells with high surface pressure.</td>
<td>Takes longer to run and pull pipe than coiled tubing.</td>
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Wireline Tractors

- Wireline tools are deployed using gravity, when the wellbore deviation exceeds $70^\circ$ inclination gravity is insufficient to overcome friction and a tractor is required to move the tools. Highly deviated wellbores have become common as operators seek to minimise surface facilities.

- Wireline tractors allow wireline to be used rather than coiled tubing thereby achieving efficiency through smaller crew, reduced footprint and faster rig up/down.

- Typically an electro-hydraulic drive mechanism or mechanical for slickline.

- Used for all electric line operations and also used to provide downhole rotation for operations such as milling and cleanouts.
**Hydraulic Fracturing**

- Where Reservoir permeability is inadequate to support economic production hydraulic fracturing is used.

- Fluid is pumped into the well (see pump trucks opposite) to increase the pressure above fracture pressure in the pay zone. Once the rock fractures (as shown in the downhole photograph) fluid containing proppant is injected into the created fracture. When the pressure is released the proppant stays in place and hold the fracture open (as shown in the schematic).

- Offshore stimulation vessels containing pumps and the relevant fluids are used. Typically chalk reservoirs and shale gas are hydraulically fractured.

- After the fracturing operation it may be necessary to cleanout proppant left in the wellbore using coiled tubing.
Perforating

• Typically the pay zone is isolated with steel pipe and cement. Shaped explosive charges are used to perforate through the steel, cement and any damage to access the pay zone. Often multiple zones, at various depths, are accessed in a single wellbore.

• Typically multiple charges are combined into a “perforating gun” and run in a tube as shown opposite. Perforating guns may be deployed on slickline, electric line, coiled tubing, drillpipe or the completion.

• Safety is paramount, firing mechanisms are designed to eliminate inadvertent initiation e.g. through radio waves.

• Deployment systems are used to run and recover long lengths of perforating guns e.g. 1500m.

• Perforating can also be used to access well annuli for example to enable kill weight fluids to be circulated prior to a workover.

• The explosive charges are designed for the downhole temperature and required perforation length.
Logging

- Logging involves the deployment and recovery of downhole measuring devices to record data against depth. The acquired data is analysed to determine what is downhole.
- Mechanical calipers are used to measure the internal diameter of the wellbore.
- A combination of acoustic, electrical resistivity, spontaneous potential, nuclear and magnetic measurements may be taken to determine the characteristics of the formation (or cement) and fluids present.
- Flowmeters, pressure/temperature gauges, density tools with a gamma ray are typically run in a production log to ascertain the volume and composition of fluids being produced from each zone, along with pressure data. This information is required to optimise and maximise the recovery from each well.
Subsea Well Intervention

- Historically recovery rates from subsea Fields are significantly lower than the recovery from fields developed with “dry” trees due to very limited well servicing.

- Purpose built vessels are available to intervene in subsea wells using wireline, as shown opposite. The capability of these vessels is being continually increased, with coiled tubing deployment an emerging technology.

- Riser and riser-less intervention possible (vessel or semi-submersible). Riserless interventions are significantly quicker and cheaper but their scope is limited.

- Open-water well interventions are now routine in the North Sea and North Atlantic waters in depths up to 461m.
Gas Lift

- As fluids are produced reservoir pressure decreases and production decreases or ceases. Gas may be injected into the wellbore from the annulus through a gas lift valve to reduce the hydrostatic pressure on the Reservoir and maintain/increase production.
- Gas lift valves are installed in side pocket mandrels spaced out in the wellbore, as shown opposite.
- The valves may be accessed on slickline using a kickover tool (as shown opposite) to changeout the valve to effect a repair or replace with a different size valve or a dummy to optimise the well performance.
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The global network for the materials cycle