Lecture 5 outline

- Oil field development
- Well Logging
- Oil Production Processes
- Crude conditioning and storage
- Transportation and metering of Crude Oil

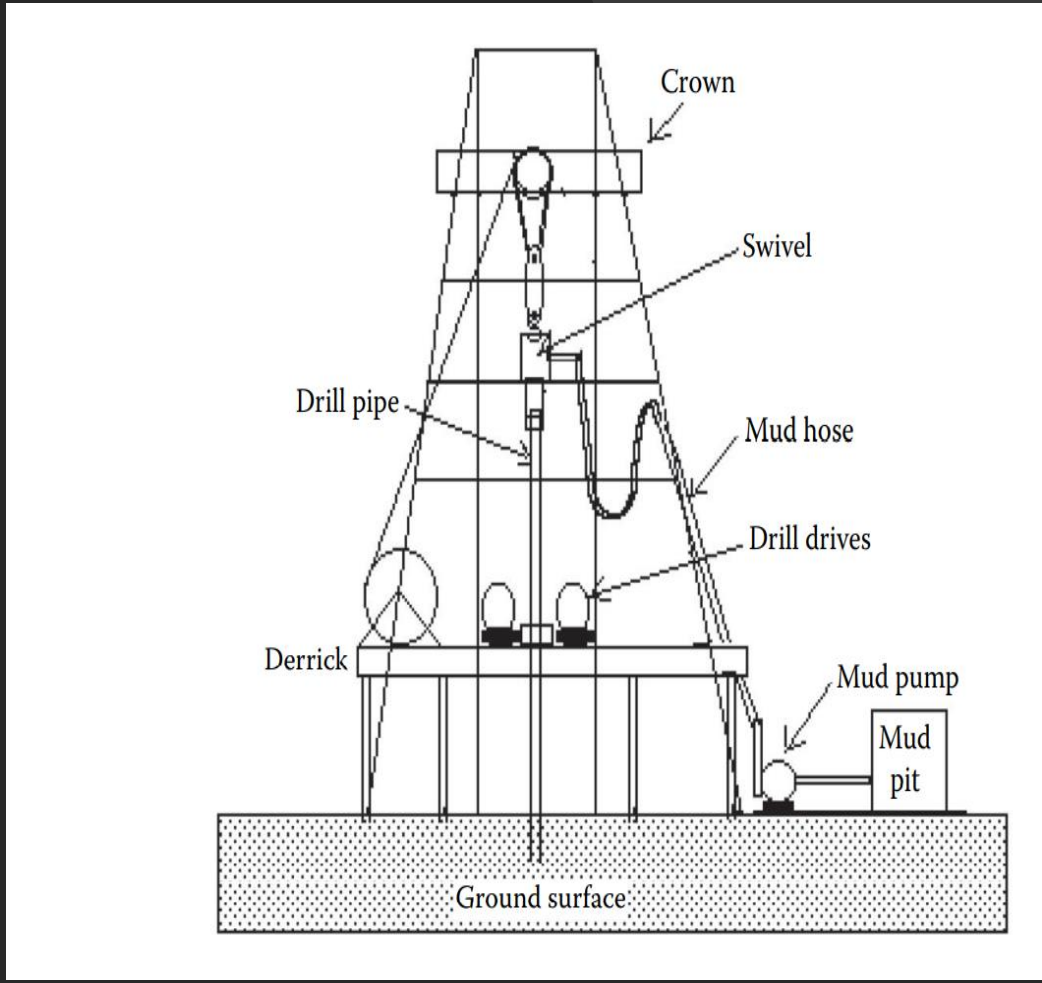
Oil field development

Drilling is done to fracture and penetrate the rocky layers to reach the oil formation below the Earth's surface

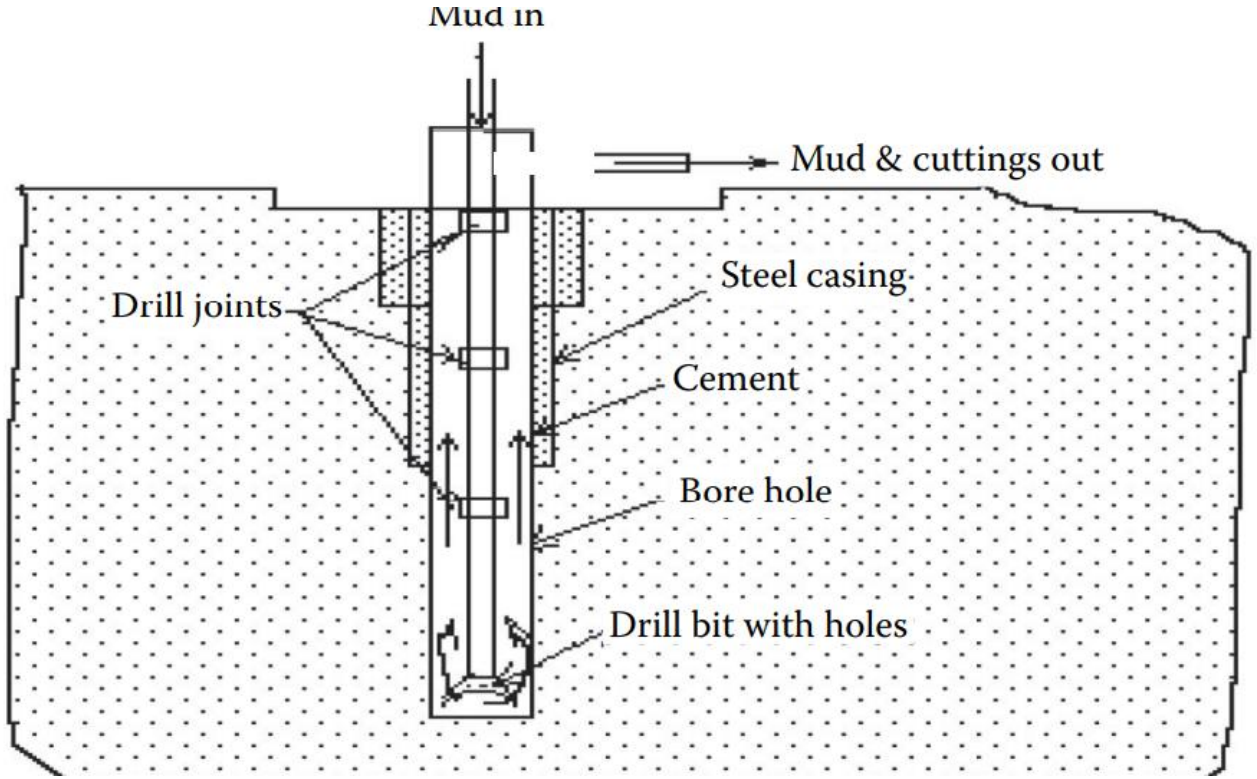
A hollow steel pipe containing the drill bit with perforations at its mouth is used for drilling.

Mud fluid is pumped through the top end of the drill pipe through a hose which moves down with the pipe as the drilling progresses

The drill pipe and the hose are suspended from the crown of a pyramidal structure called a rig.



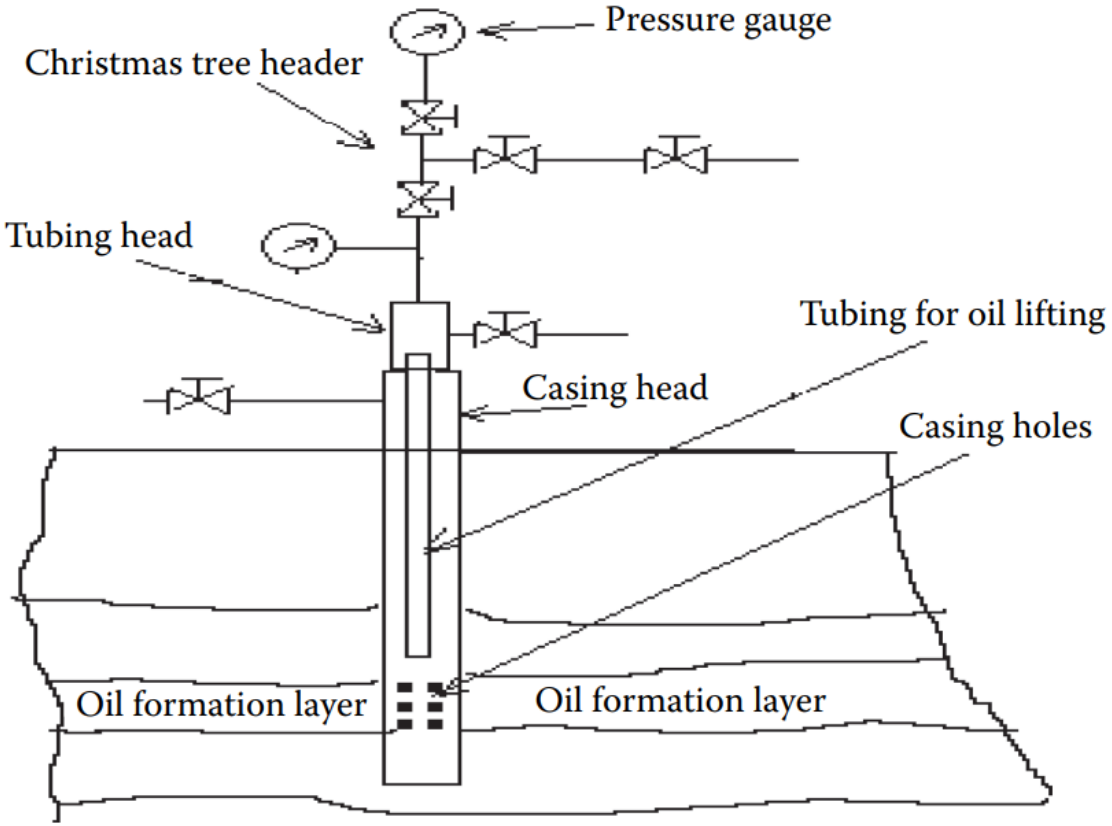
What are the steps that must be done after depth of 30-40 ft?



Drilling operation in a well.

- After drilling to a depth **of 30–40** ft, a steel pipe is introduced into the hole to protect the wall of the hole formed. This is called the ***casing string***, which is then cemented to the wall of the hole by pumping a fast-setting cement solution (usually Portland cement without sand) to the annular space between the pipe casing and the wall of the hole. This casing helps prevent caving of the wall and seepage of water from the layers.

Well Development



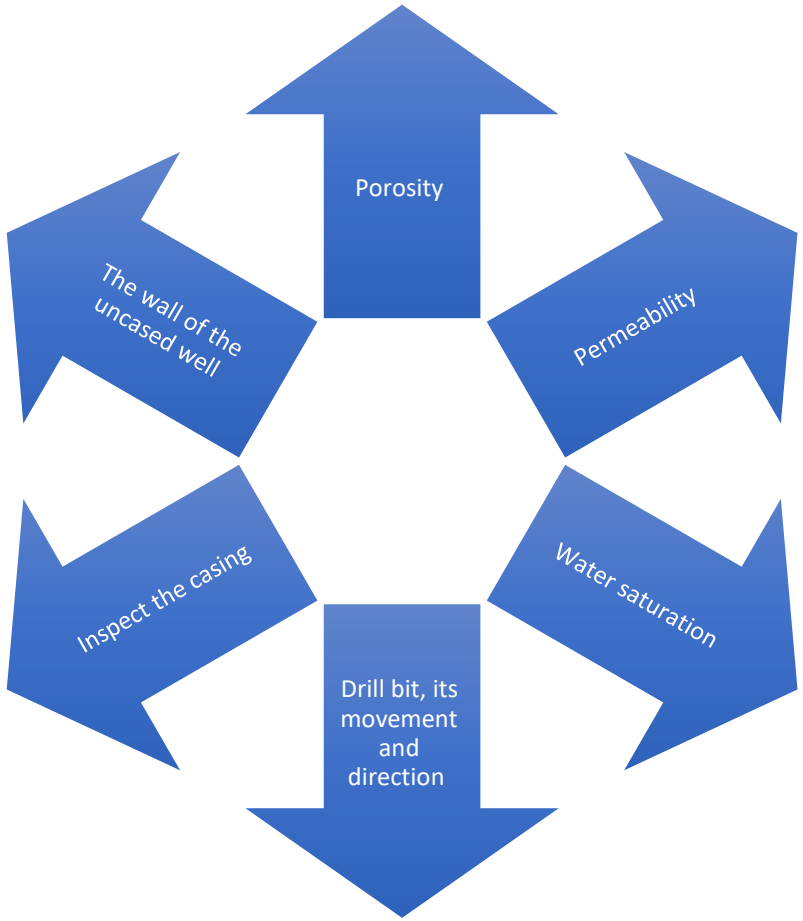
- An additional drill pipe is then joined of sufficient strength to withstand the various static and dynamic stresses for the increasing dead weight of piping, torsional stresses due to rotation, for upward and downward movement, abrasion from sand, fluid friction from mud fluid with cutting and corrosion, etc.
- The drilling operation is then continued and an additional casing pipe of a reduced diameter from the previous one is inserted and cemented at strategically located positions (for easy recovery of casing pipes after the well life is exhausted) until the target depth is reached. The final casing diameter may reach as small as 5–8 in.

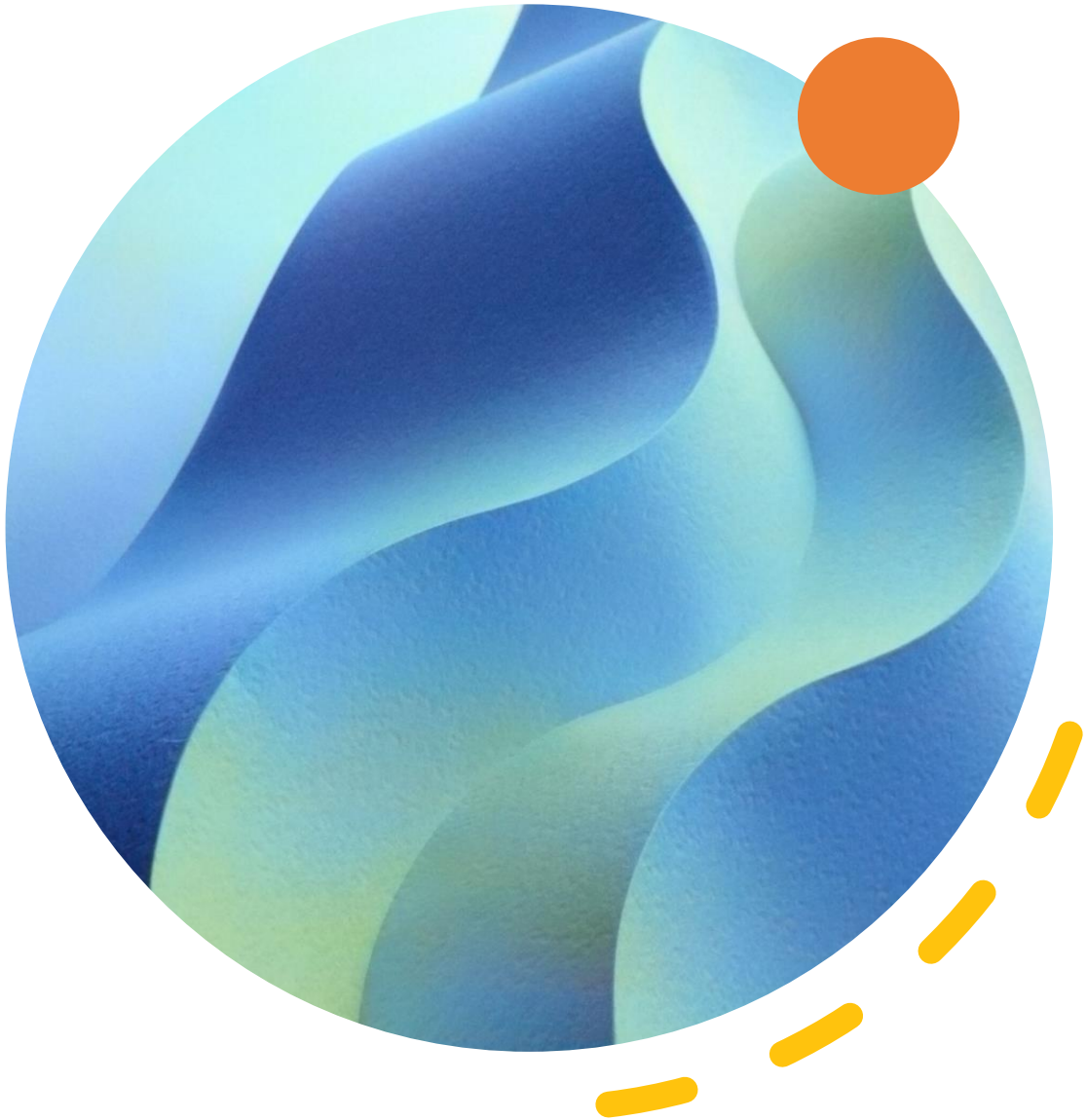
Well Logging

- Well logging is a continuous recording process of the activities during drilling, well development, and production until the closure of the well.
- Well logging is carried out during the drilling operation using:
  - special probes (electrical resistivity, inductance, or magnetic resonance),
  - physical sampling of the drilled soils and rocks,
  - core samples,
  - monitoring drilling fluid,
  - etc.

What are the parameters obtained by the special Probes?

- Various parameters are obtained such as:



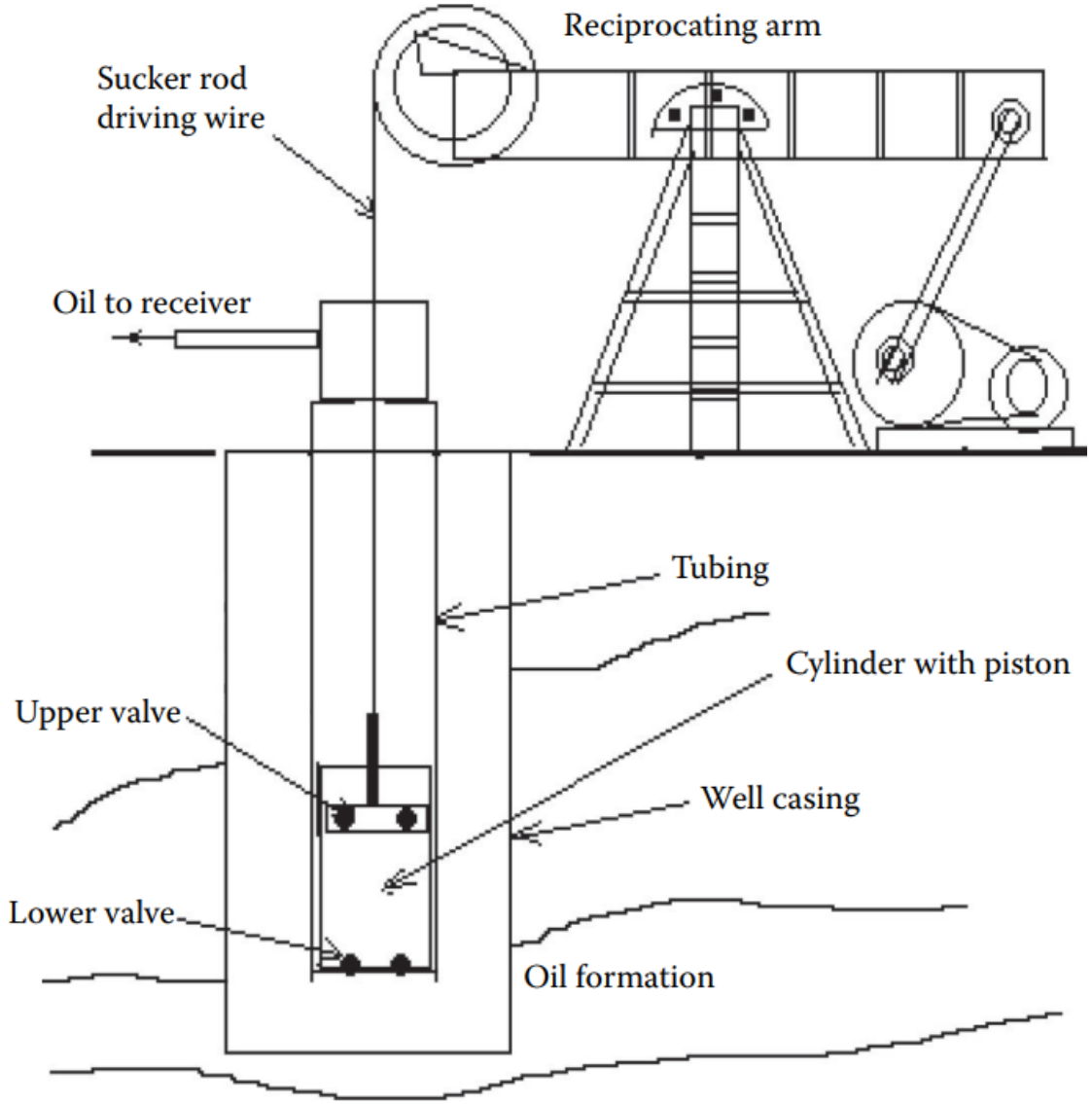


Oil Production Processes

- The ***gas lift*** method employs high pressure gas, usually air or carbon dioxide, which is introduced into the well through the annulus and oil is carried through the inner tubing, leading to the well-head piping.
  - Initially, the well is filled with the mud fluid and the oil cannot move up owing to the hydrostatic head of the mud fluid. As the gas enters the annulus and piping, the density of the mud column decreases and the hydrostatic head decreases, and as a result, the mud fluid is lifted by the oil pressure.
  - A mud–oil mixture is collected and separated on the surface tanks.

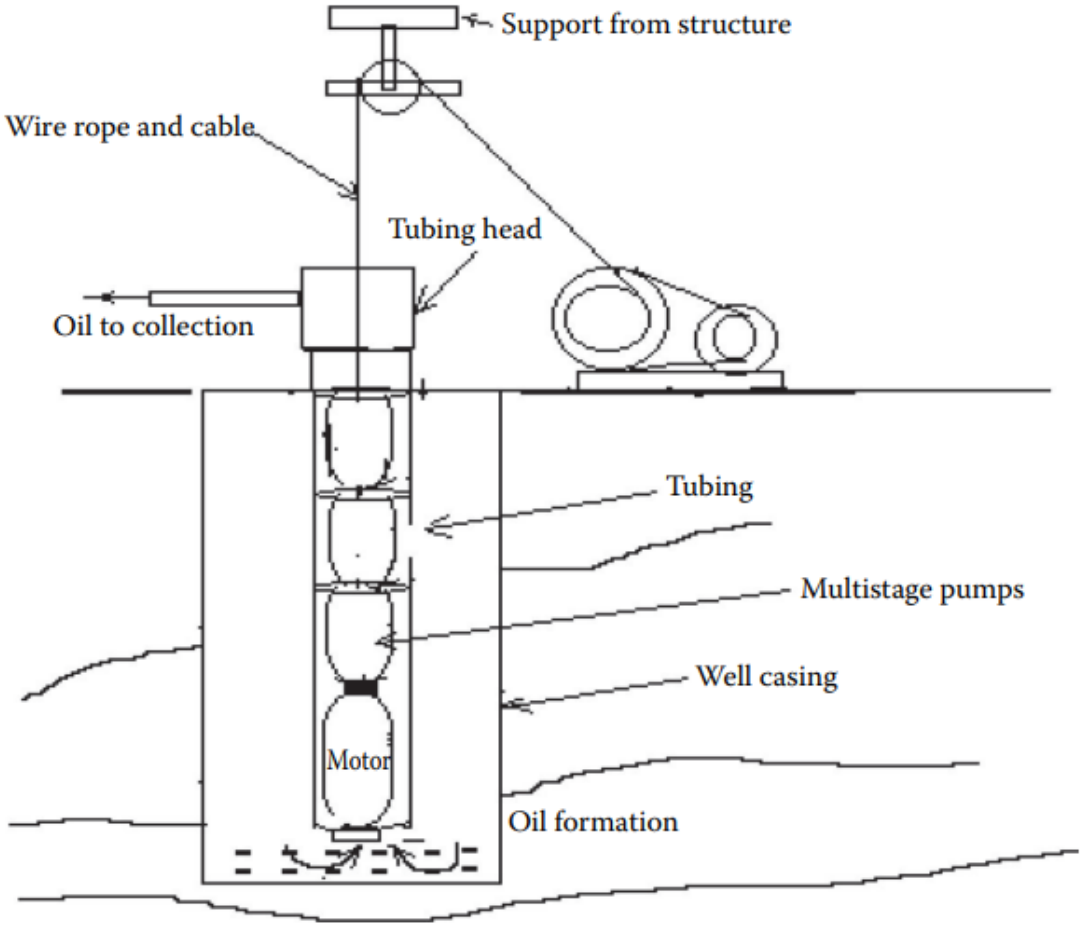
A ***sucker rod lift*** well

- A sucker rod lift well contains a piston (or a plunger) pump lowered into the inner tubing.
- The piston is operated by a metallic wire or rod leading through the tubing and above the well head and connected to a wire rope from a hanger attached with a reciprocating driving system at the base of the well head.
- The piston is contained in a cylinder with non-return valves fitted at both ends. During the upstroke of the piston, the bottom valve opens, keeping the top valve closed and, as a result, the cylinder pressure falls below the reservoir pressure, forcing oil to enter the cylinder. While during the down stroke of the piston, the upper valve opens, and the bottom valve closes and oil in the cylinder is pushed up to the tubing through the upper valve. Thus, the volume of oil displaced upward in the tubing is proportional to the stroke length of the piston.
- When the tubing is filled with oil after repeating the reciprocating operation, oil starts flowing upward and is collected.



A *submersible pump* well

- A *submersible* pump well contains a centrifugal or screw pump installed in the tubing lowered into the borehole.
- Both the electric motor and the pump are submersed in the well bottom. Electric cable sealed in a flameproof arrangement is lowered into the well hole through the tubing.
- The motor is usually kept below the pump in the tubing.
- Pumps are small in diameter (3–6 in), multistage centrifugal or screw pumps.
- Since entrainment of sand particles and gas may cause problems to the centrifugal pumps, modern wells are using high-capacity multistage screw pumps that can carry slurries, viscous oil, and even gas.



Schematic submersible pumping arrangement for oil lifting.

The *hydraulic pumping* method

- The hydraulic pumping method employs a special type of tubing that consists of two tubes.
- The inner tube is of a larger diameter in which the plunger or the diaphragm pump is lowered into the borehole.
- The plunger or the rod of the diaphragm is forced by pumping a liquid over it in a reciprocating manner.
- Oil is discharged through the outer pipe through its annular space and is delivered to the surface tank.
- This method does not require lowering any electrical cable and no wire for actuating the plunger.
- A high-pressure reciprocating surface pump delivers the liquid forced up and down the plunger of the pump in the borehole in a reciprocating manner.
- The plunger pump can be withdrawn on the surface from the inner pipe by forcing liquid through the annular outer pipe.