Primary Cementing

- Concepts
- Casing and Cement Job Types
- Cement placement and job design
- Equipment

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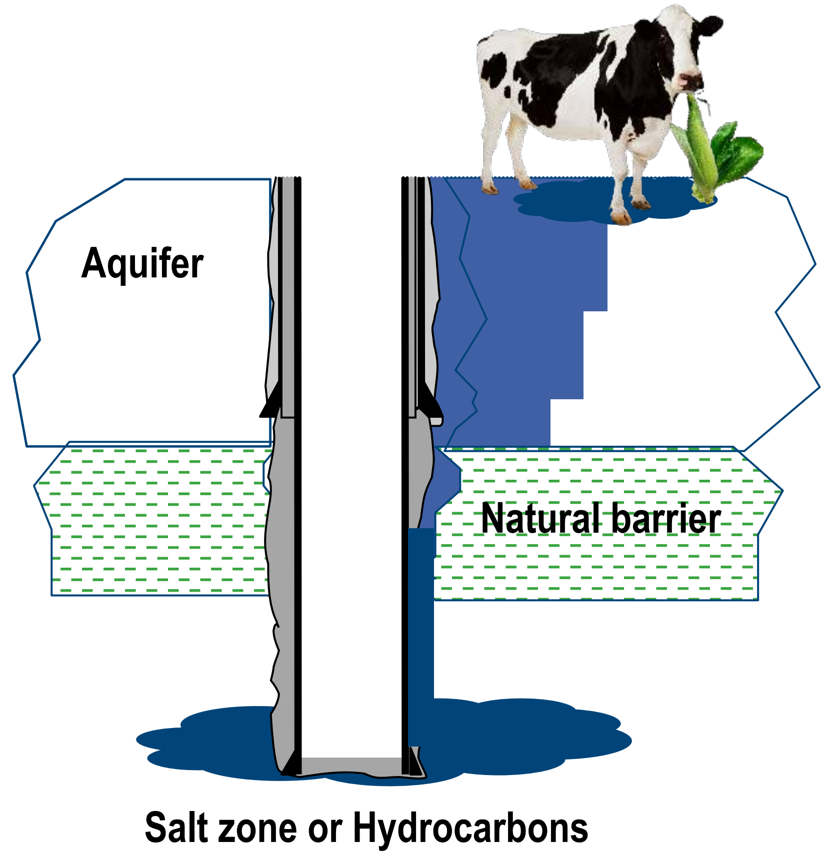
Primary Cementing

Placement of cement in the annulus between casing and open hole or previous casing to provide

- Hydraulic Isolation
- Support and protect casing
- Support the borehole



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Basic Cementing Method

- Cementing is basically:
  - Two-plugs methods to pump and displace cement
  - Job ends with an pressure increase at surface and displacement ends
  - Well remains shut-in to allow cement to set in place before drilling resumes or completion starts

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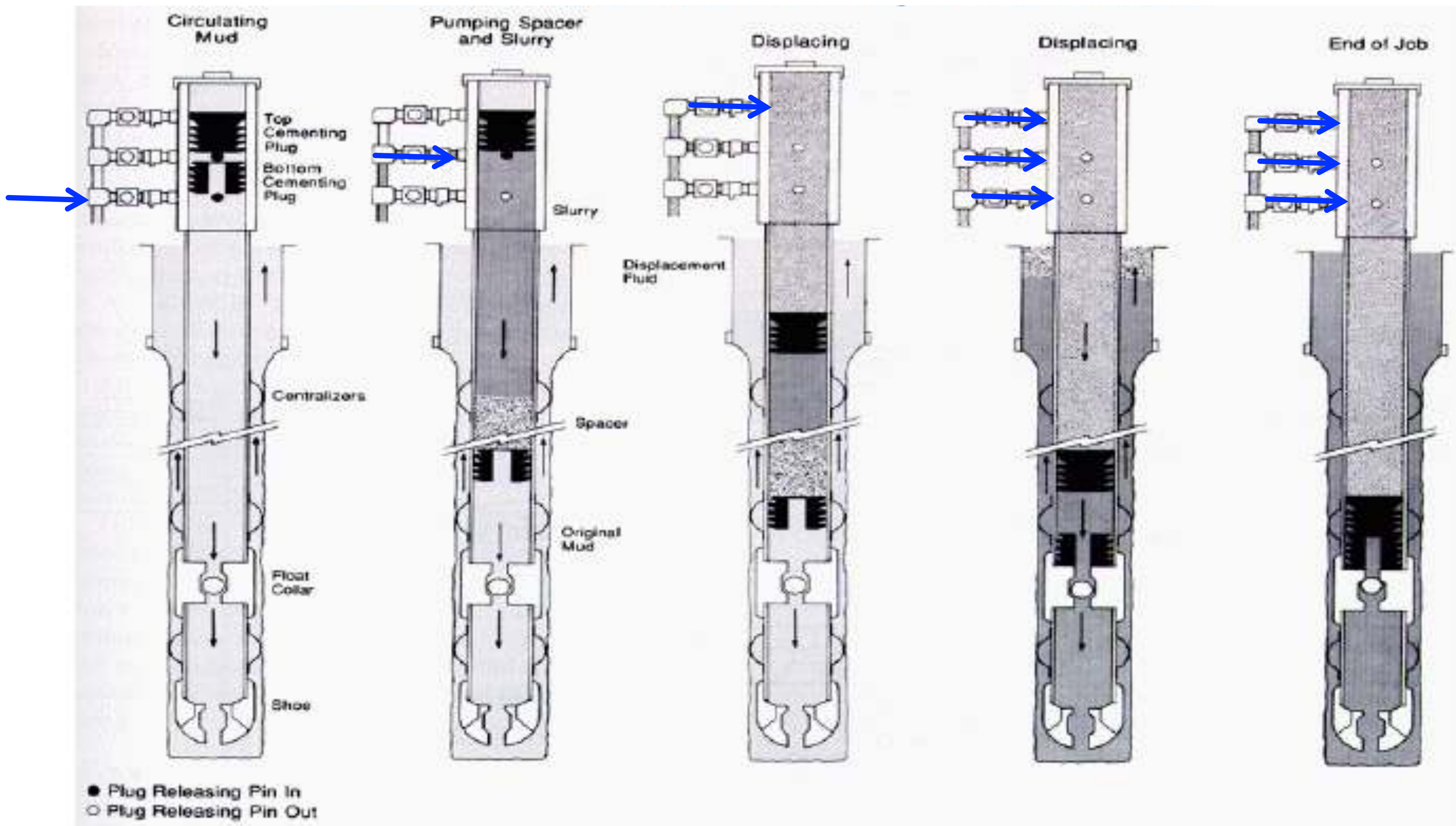
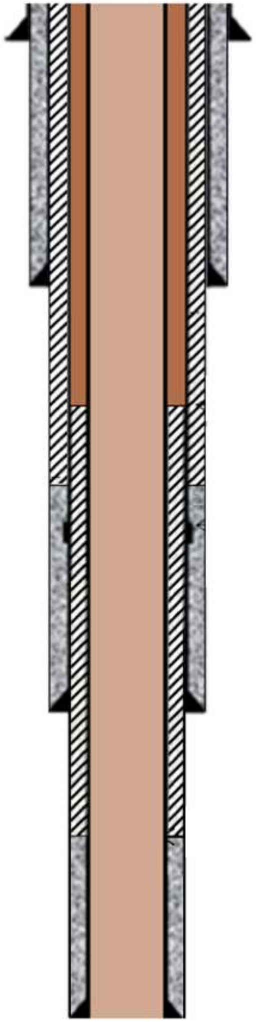
Two-plugs Method



Casing Types

Caising are steel pipes used in oil and gas wells to allow deeper drilling by enclosing a hole section.

- Conductor
- Superficial
- Intermediate
- Production casing or liner



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Conductor

- The conductor pipe is most commonly "driven" in (no cement).
- The main reasons for running this type of casing are to prevent washing out of the weak formations just at surface, and to provide an elevation to connect a flow nipple to allow for flow back to the rig tanks.
- The conductor pipe is usually a large size pipe ranging from 36" to 16" and they can be threaded or welded - when they are driven, they are typically welded pipes.

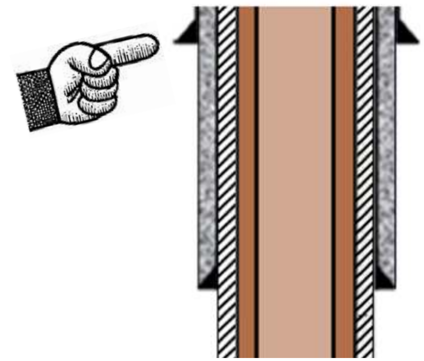
Size & depth:

30" casing x 36'' hole

20" casing x 26" hole

@

30 ft - 100 ft



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Surface Casing

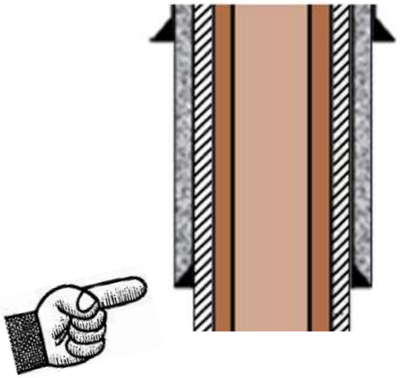
- The main reasons for cementing Surface casings are the following:
  - To protect surface fresh water formations,
  - To case off unconsolidated or lost circulation zones near surface,
  - To support later casing strings,
  - To provide a means of connecting the BOP.
- Typical casing sizes range from 20” to 9 5/8”. They can be set at any depth, the restriction usually being the weight limits of the rig and the types of zones deeper in the well.

Size & depth

16” casing x 20’’ hole

13 3/8” casing x 17 1/2” hole

@
100 ft – 3000 ft



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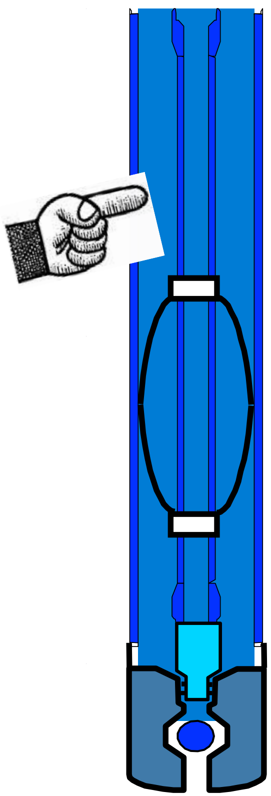
Thru-Drill Pipe Cementing (Stab-in)



- Cement contamination and channelling inside the casing is greatly reduced.
- Smaller displacement volumes and job time.
- No need to worry about the correct cement excess, you can continue mixing and pumping until you have good cement to surface. The only cement that will return is the displacement volume (volume of the DP) which is typically small.
- This technique is used for most large casing sizes (OD > 13 3/8) and typically shallower than 1000 ft

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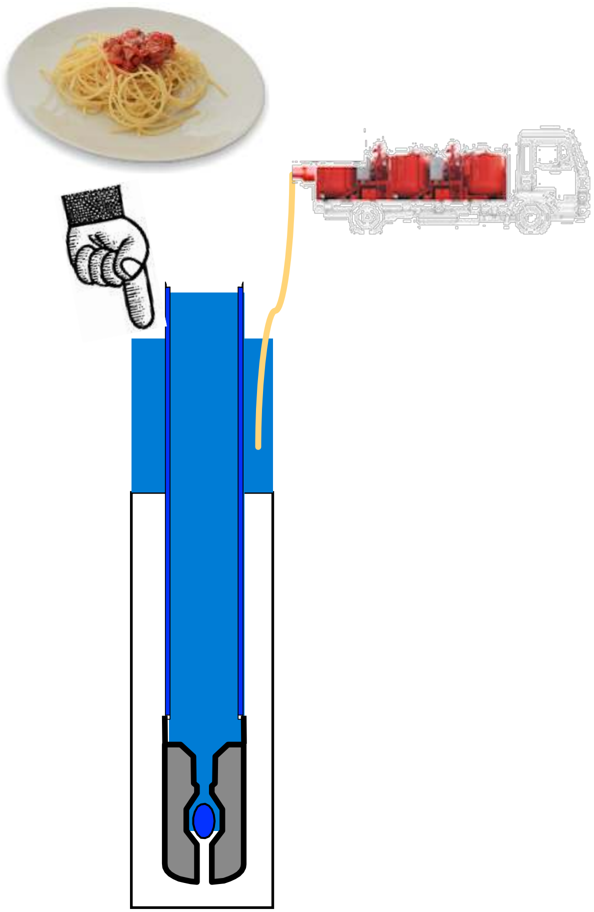
Top Job



- Since the first casing is cemented in weak or unconsolidated formations, losses are common or excess cement may not have been enough. This causes the top of cement to be below surface. In these cases, “top jobs” may be performed to ensure good cement at surface to support the casing.
- A small OD pipe or “spaguetti” tubing is used. Usual maximum depths range from 100 to 250 feet.
- Friction pressures are usually very high while pumping and care must be taken to avoid bursting the pipes or the connections (usually made up by the rig welder)

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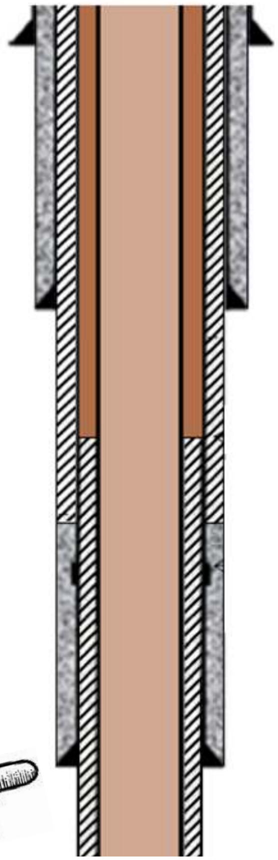
Intermediate Casing



- Intermediate casings are set between the surface casing and the top of the reservoir. Theses sections might be long, with deviated portions. These casings are usually set to isolate problems zones and sometimes requiring especific solutions:
  - Multi-stages jobs
  - Light weight cement (cenosphere-based or foamed cement)
- All drilling events will translate into challengues to cementing

Size & depth

13 3/8" casing x 17 1/2'' hole

9 5/8" casing x 12 1/4" hole

@
3000 ft – 15000 ft(*)

Size & depth would depend on well objective and prosence of problems zones

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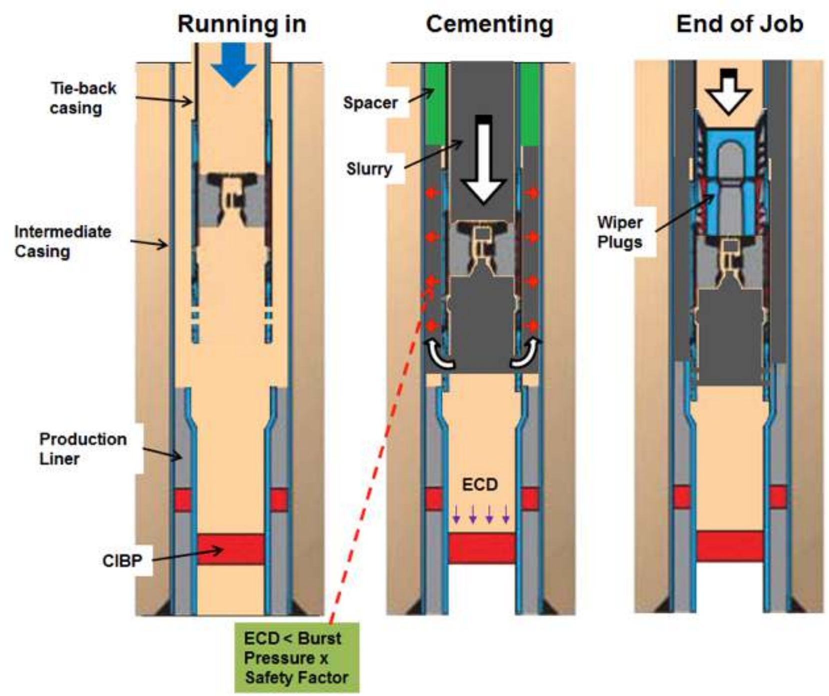
Tieback Cementing

- The dimensions of the tie-back tool shall be properly measured and any restriction to flow shall be properly identified and considered in the cement job simulation.
- The position of the tie-back receptacle before cementing shall account for casing elongation, including the cement column weight, to prevent obstruction or excessive restriction at the circulations ports.
- Plan for adequate number of short joints of casing to prevent the cement head is placed too high on the rig floor.
- The ECD generated during the tie-back cementing operation could leak downwards and/or exceed formation pressure.
- The use of washes and spacers ahead of cement slurries will prevent cement contamination and mixing with the fluid in the hole.
- The condition of the outer-casing shall be properly access. For the cementing simulation, safety factors shall be applied for the outer-casing burst pressure.
- Parameters such as TOC, cement density and rheology shall be selected accordingly to lower the maximum ECD.



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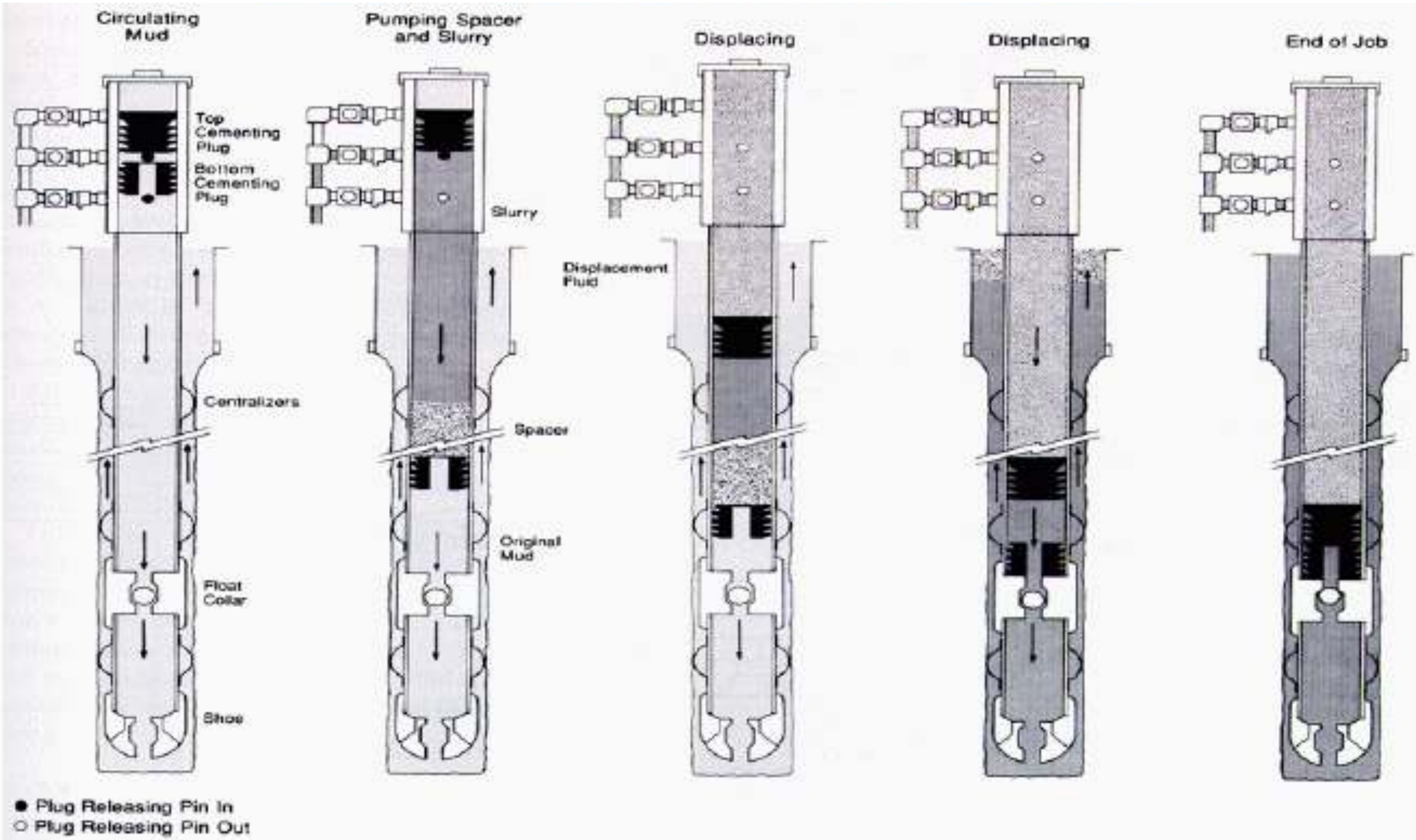
Basic Cementing Process



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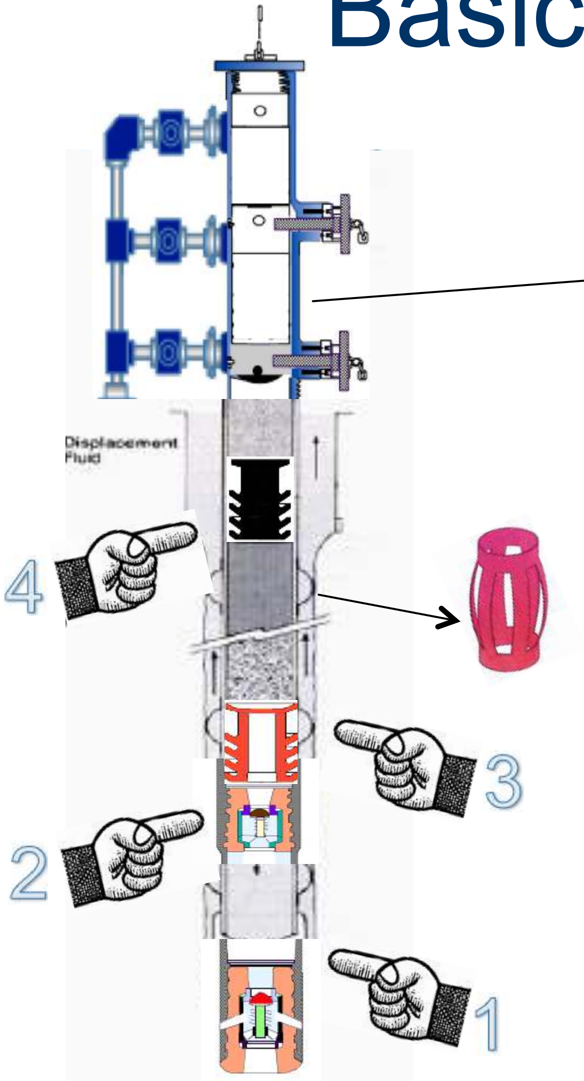
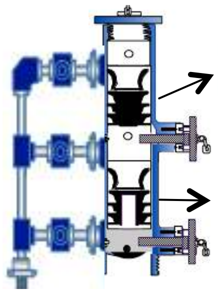
Basic Cementing Process



Before



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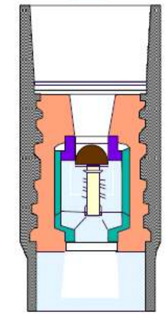

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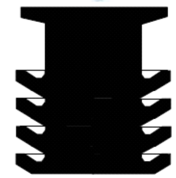

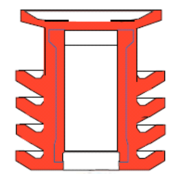

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1

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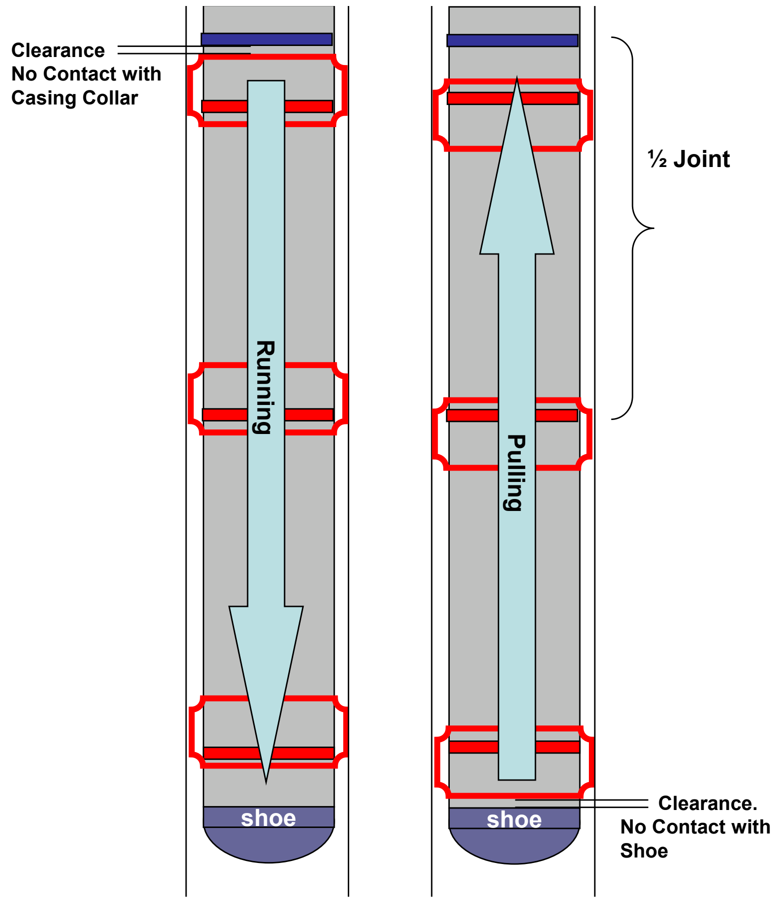
Basic Cementing Process

Bonus: Centralizers Placement

No Expansion on Centralizers due to contact against casing collars or shoe



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Do you see the Rig? Or me?

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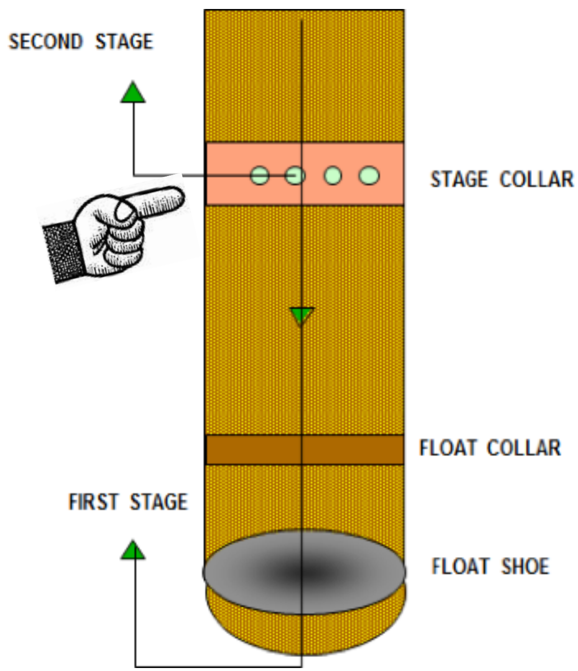
Two Stage Cementing



- Two stage cementing is a technique where a tool called stage collar is placed in a casing string - this collar allows ports or holes to be opened and circulation can be performed through them.

  The stage collar allows to cement the portion below first to isolate a losses or weak formation and then open the ports to cement the part above.

  This is very useful in the following circumstances:

  - To isolate two problems zones within one open hole section, e.g. a high pressure zone and a low fracture pressure zone,
  - To reduce the hydrostatic pressure in the well when a weak formation.
  - In multilateral wells or certain type of completions, it allows to cement only the bottom or upper portion of the casing - with two stage cementing, some part of the hole can be left uncommented.

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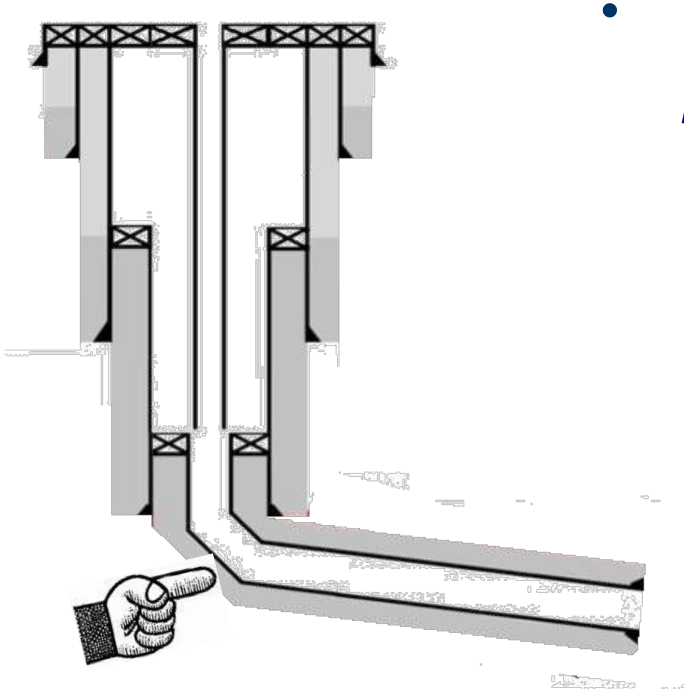
Liner cementing



- *The main reasons for running production casing and liners:*
  - To isolate the pay zones and the fluids in them from other zones
  - A liner allows to save on casing cost
  - To provide a protective housing for subsurface production equipment (completions).
  - To cover worn or damaged intermediate casings.
  - Good cementing practices are required
  - Care should be taken when cementing liners as the annular clearances are very small and rates and pressures are usually restricted to avoid overpressuring the well causing losses.

Diámetros comunes:

4 ½”, 5”, 7’ ’ , 9 5/8”

1500 ft – 25000 ft

Size & depth

4 ½”, 5” or 7”

Size & depth would depend on well objective and prosence of problems zones

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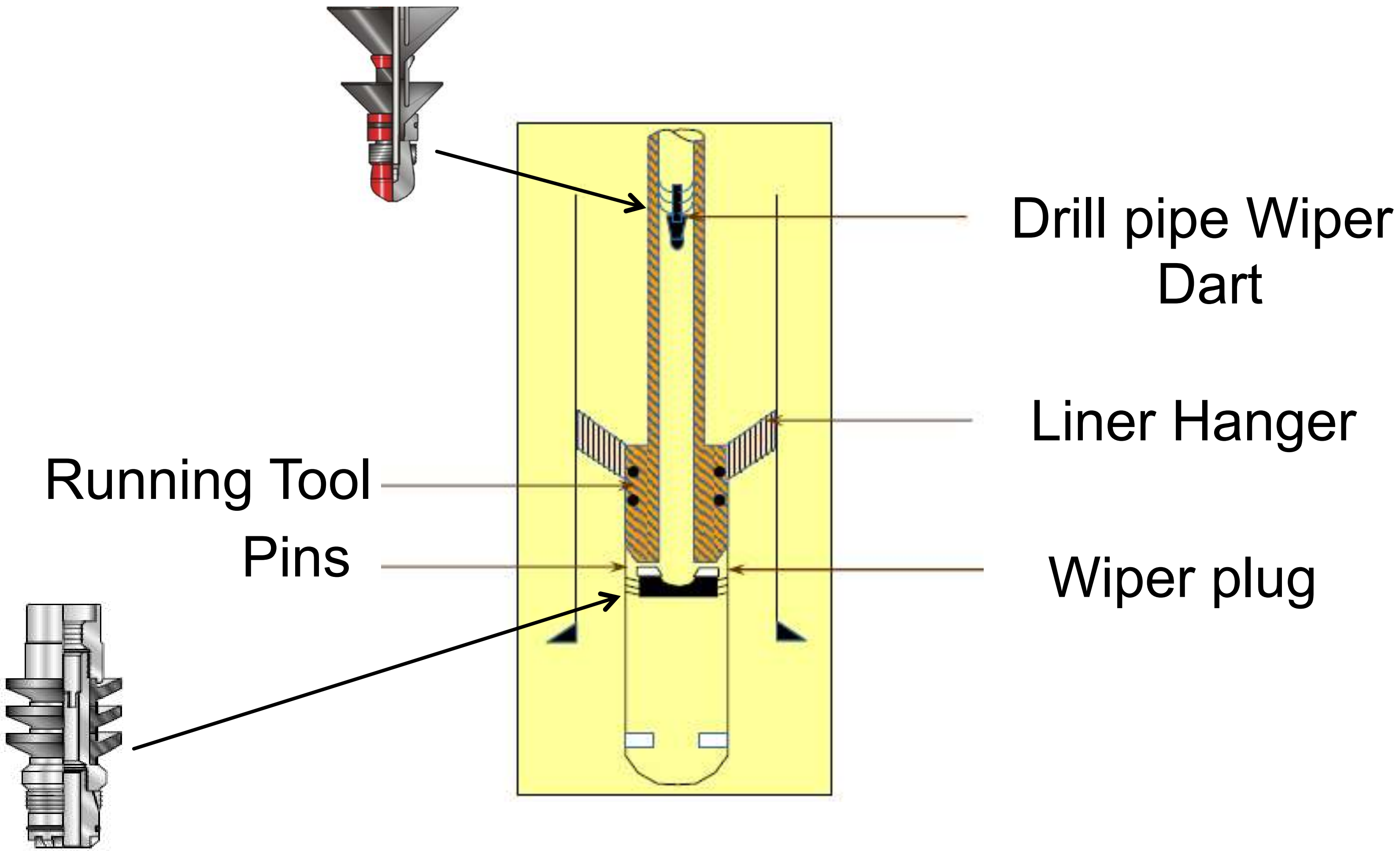
Liner Basic Schematic



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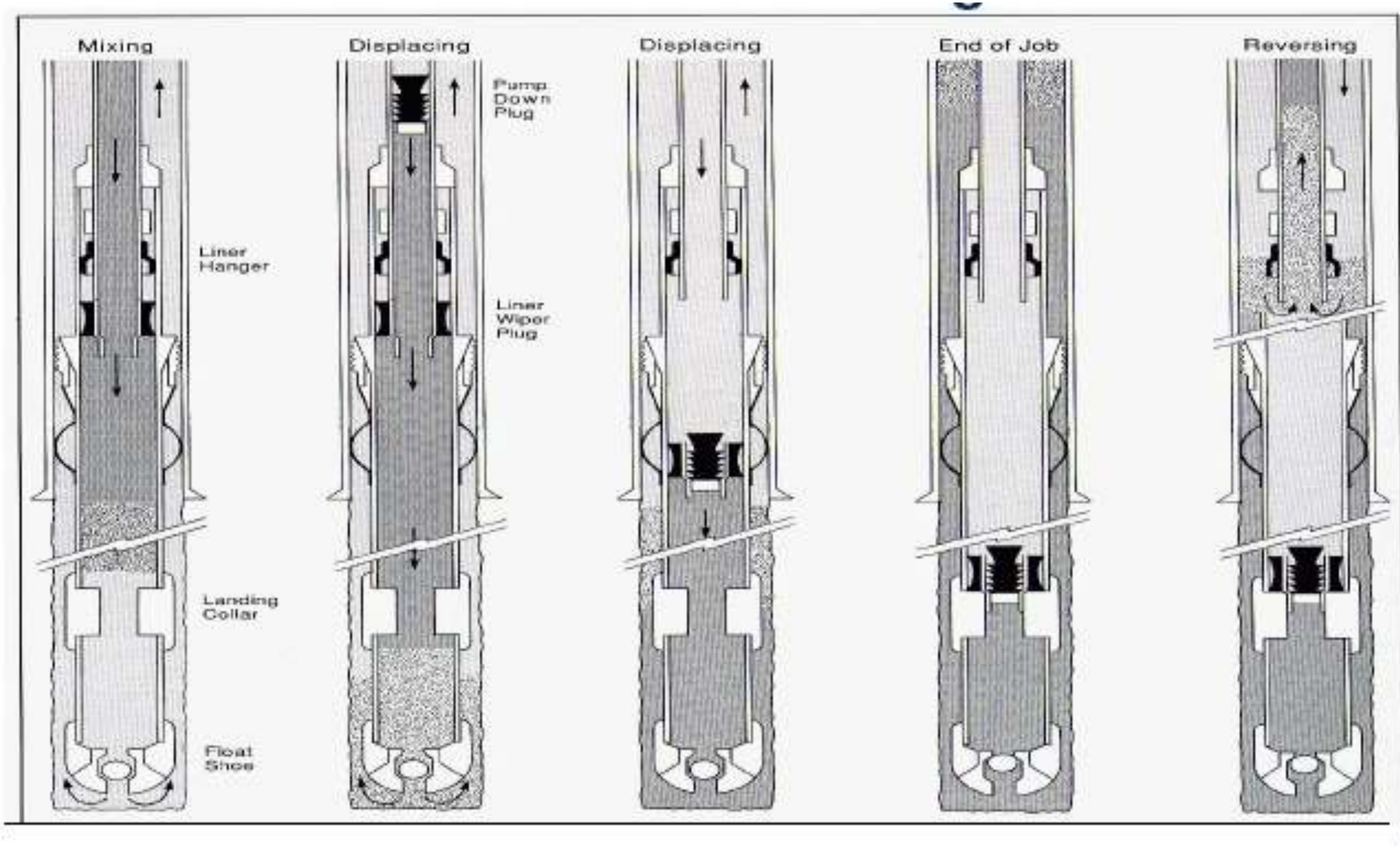
Liner Cementing



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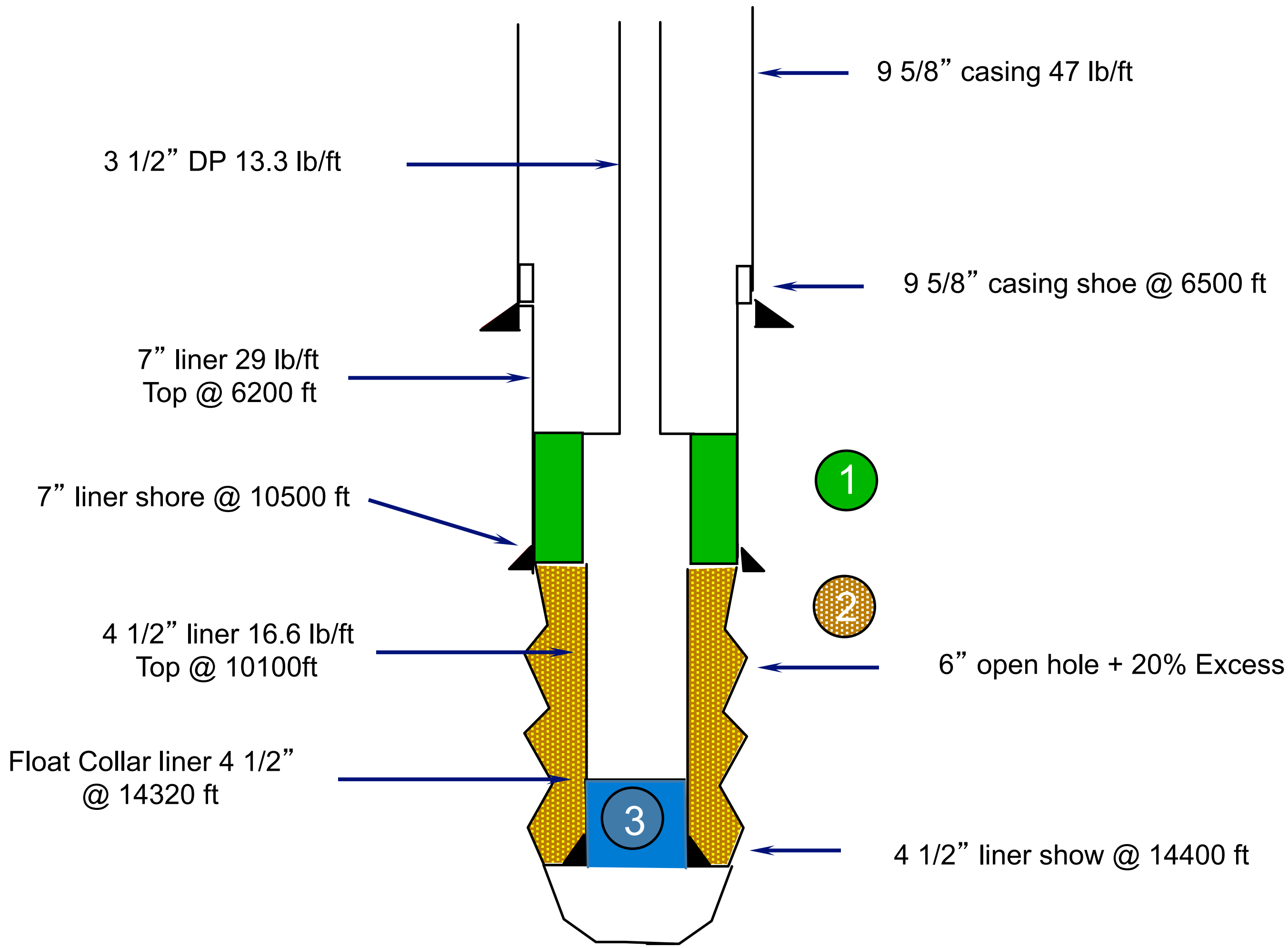
Liner Volume Calculations



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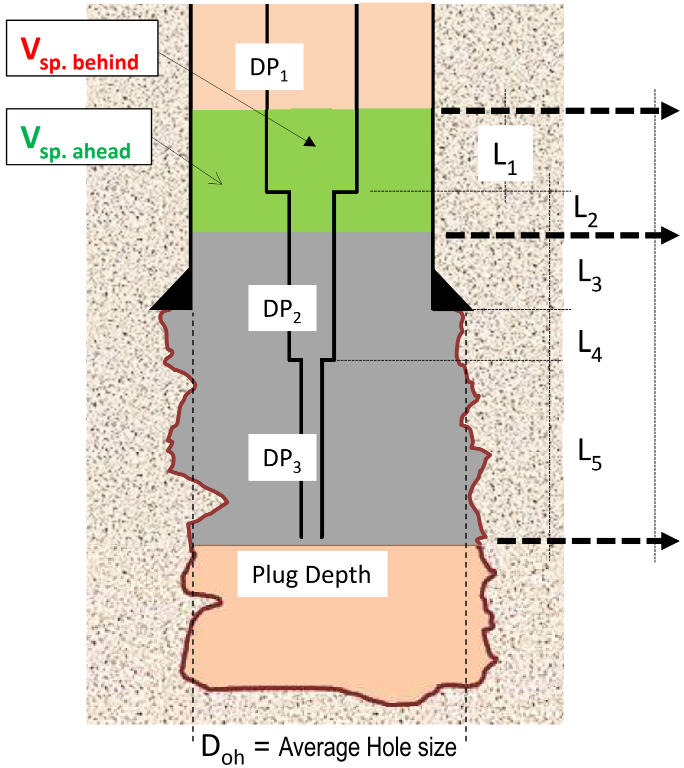
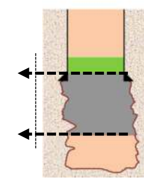
Bonus: Plug Calculations



Length of fluids at end of displacement to balance the cement plug ?

Known variables:

- Open hole diameter, Casing and work-string sizes and weights
- L_{cement} = Desired Cement Length → V_{cem}
- $V_{sp.\ ahead}$ = Required to prevent cement slurry contamination and/or contact with brine



Calculation Target:

1st Displacement volume $V_{Displacement}$

2nd $V_{sp.\ Behind}$ Required ONLY to balance length of spacer ahead

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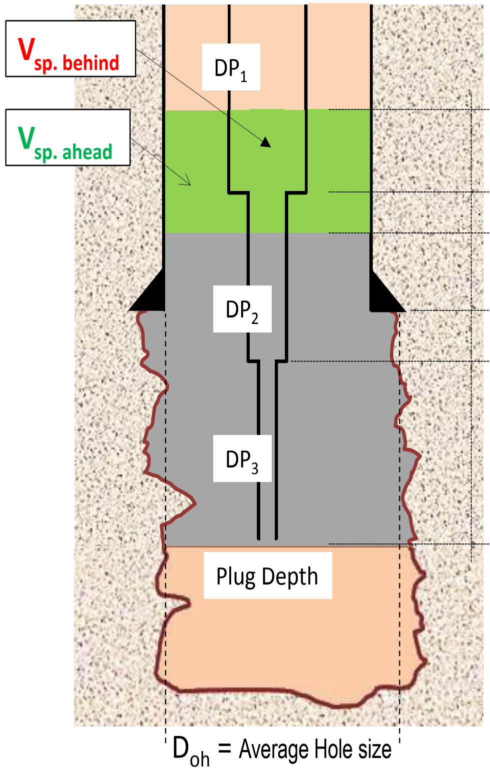
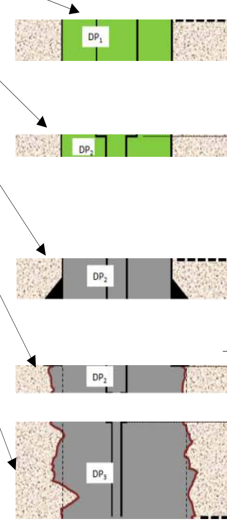
Bonus: Plug Calculations



$V_{Displacement} = (\text{Plug Depth} - L_5 - L_4 - L_3 - L_2 - L_1) * Ca_{DP_1}$ **(7)**

$V_{sp.\ behind} = Ca_{DP_1} * L_1 + Ca_{DP_2} * L_2$ **(6)**



$L_1 = \frac{V_{sp.\ ahead} - V_{ann_2}}{Ca_{ann_1}}$ **(5)**

$V_{ann_2} = Ca_{ann_2} * L_2$ **(4)**

$L_3 = \frac{V_{cem} - V_5 - V_4}{Ca_{ann_3} + Ca_{DP_2}}$ **(3)**

(2)

(1)

Determine Volume by:

$V_{5,4} = (Ca_{ann_{5,4}} + Ca_{DP_{3,2}}) * L_{5,4}$

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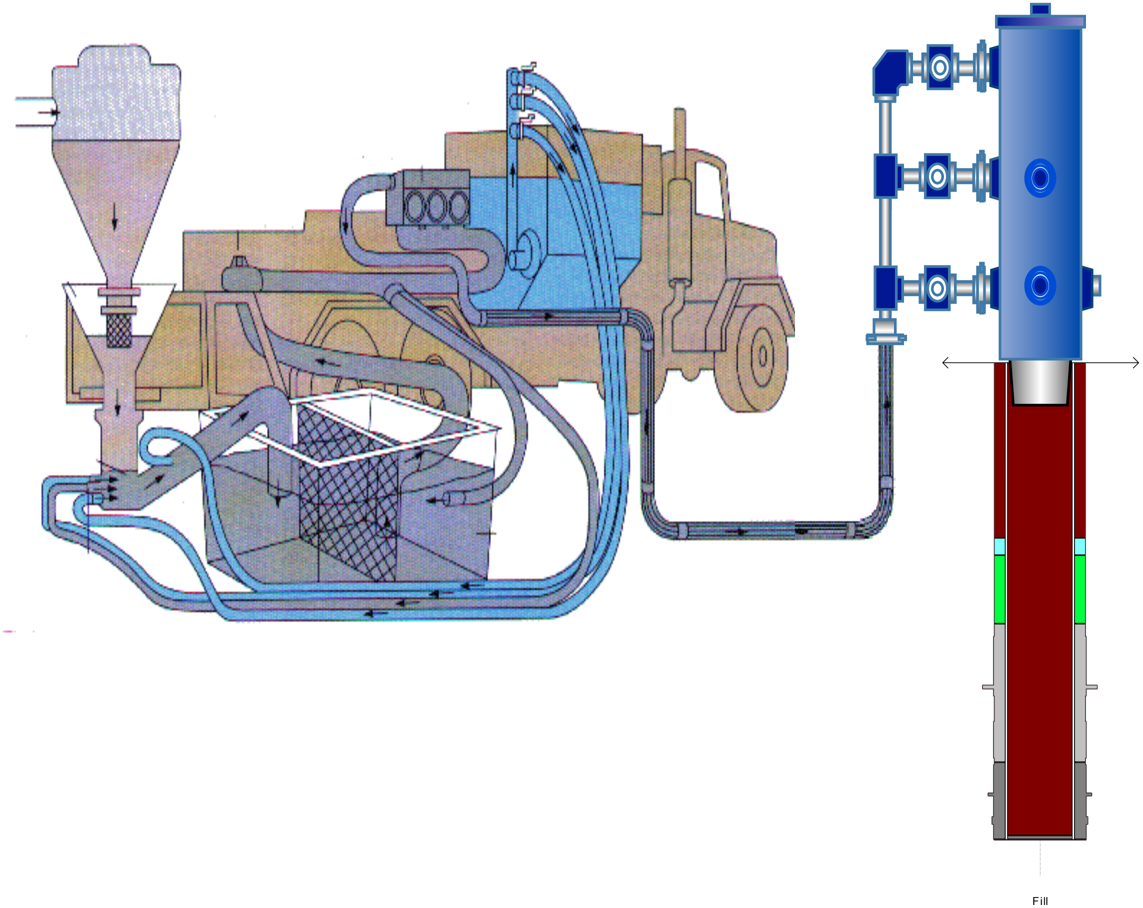
Cementing Equipment

. . . Oops missing some new `pictures



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Cement Job design Considerations

- The fluids that are pumped have varying densities and relatively high “viscosities”. Ensuring that the cement will be placed without fracturing the formation while maintaining all permeable formations overbalanced during all phases of the job.
- It requires accurate pressure predictions that are complicated due to the U-tube - or free fall - effect caused by the difference in density between the various fluids.
- In intermediate casings, the long distance between the shoe of the previous casing and the hole depth produce relatively big temperature differences between the top of the cement and its bottom.
- Very good temperature predictions are therefore required that remain accurate for this complex heat transfer problem. These temperature predictions are used to verify, in the lab, that the cement slurry will not set too soon nor too late.
- When the hole is deviated, the casing has a tendency to lie on the bottom side of the hole, trapping immobile mud underneath it making difficult the mud removal.
- Good centralization ensures good mud removal. A key drawback is that they induce drag force when running the casing in the hole. Specific software is used to help find the best compromise between cost and stand-off while making sure the drag force will not prevent running the string to total depth.

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