Measurement of required cement volume

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1. <u>Aim/Overview of the practical</u>:

Measurement of required cement volume.

2. <u>Task to be done</u>:

To measure the required cement volume required to complete the borehole between a given depth range.

3. <u>Apparatus</u>:

- Well logging data
- Code editor or IDE

4. <u>Algorithm/Flowchart</u>:

- Develop a script, with relevant inputs, for designing the relevant formulation.
- Execute the program and display in the console.

5. Theme/Interests definition:

Caliper log: is a well logging tool used in hydrocarbon exploration that provides a continuous measurement of the size and shape of a borehole along its depth.

Cement: is a chemical mixture used in drilling operations to hold the casing in place and to prevent fluid migration between subsurface formations.

6. Steps for experiment/practical:

- Indicate where likely mud-cake occurs by shading between the caliper and the bit size curves.
- Divide the log into sections which you believe to be of the same, or approximately the same lithology.
- Indicate the possible lithologies down the right hand side of the log. Indicate the most likely lithology of those you have indicated for each lithology section.
- Indicate, if present, zones of caving, sloughing, marl creep.
- Calculate the mean mud-cake thickness in the intervals 2980 m to 3035 m, and 3082 m to 3145 m.
- Determine the approximate borehole volume in the intervals 2900 m to 3250 m in litres.
- Determine the cement volume required to complete the borehole between 2900 m and 3250m with a 7 inches diameter casing liner in litres.

7. Observations/Discussions:

Bit size: 8 ½ inches.

Depth Range: 2900 – 3250 m.

Used well log: Caliper log.

- Mud-cake likely occurs at the following depth ranges: **2911 - 2920 m**; **2990 – 3035 m**; **3070 - 3145 m**.

- Lithology interpretation

Rock lithology	Depth range (m)
Permeable Sandstone	2911 - 2920
	2990 - 3035
	3070 - 3145
Caving Shale / Unconsolidated Sandstone	2900 - 2911
	2930 - 2936
	2948 - 2988
	3035 - 3065
	3145 - 3155
	3165 - 3187
Impermeable limestone	2920 - 2930
	2936 - 2948
	3155 - 3165
	3187 - 3220
	3235 - 3250
Sloughing shale	3220 - 3235

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8. Percentage error (if any or applicable):
   NA

9. Calculations/ Chemical Reactions / Theorems /Formulas used etc:

➕ Formulas

Calculation of mudcake thickness, hmc:

$$hmc = \frac{(dbit - dh)}{2}$$

Measurement of borehole volume, Vh:

$$Vh = \left(\frac{dh^2}{2}\right) + 1.2\%$$

Measurement of required cement volume, Vcement:

$$Vcement = 0.5 \times (dh^2 - d^2 casing) + 1\%$$

Where:

dh = diameter of the hole

dbit = diameter of the bit

dcasing = diameter of the casing

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✚ <u>Calculations</u>

$$hmc\ (2980\ m - 3035\ m) = \frac{8.5 - 7.5}{2} = \boldsymbol{0.5\ in}$$

$$hmc\ (3082\ m - 3145\ m) = \frac{8.5 - 8}{2} = \boldsymbol{0.25\ in}$$

$$Vh\ (2900\ m - 3250\ m) = \left(\frac{8.85^2}{2}\right) + 1.2\% = 39.17\ litres/m$$

$$Vh\ (2900\ m - 3250\ m) = 39.17 \times (3250 - 2900) = \boldsymbol{13710.64\ litres}$$

$$Vcement = 0.5 \times (8.85^2 - 7^2) + 1\% = 14.67\ litres/m$$

$$Vcement = 14.67 \times (3250 - 2900) = \boldsymbol{5134.94\ litres}$$
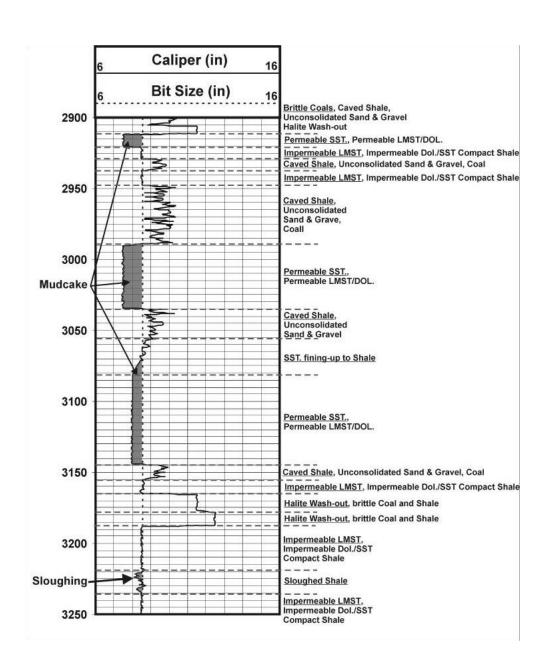
10. <u>Result/Output/Writing Summary</u>:

The approximate borehole volume in the interval 2900 to 3250 m is **13710.64 litres.**

The cement volume required to complete the borehole is **5134.94 litres**.

11. Graphs (If Any):

Caliper (in)	
6	16
Bit Size (in)	
6	16

2900 — Brittle Coals, Caved Shale, Unconsolidated Sand & Gravel, Halite Wash-out
Permeable SST., Permeable LMST/DOL.
Impermeable LMST, Impermeable Dol./SST Compact Shale
Caved Shale, Unconsolidated Sand & Gravel, Coal
Impermeable LMST, Impermeable Dol./SST Compact Shale

2950 — Caved Shale, Unconsolidated Sand & Grave, Coall

3000

Mudcake — Permeable SST., Permeable LMST/DOL.

3050 — Caved Shale, Unconsolidated Sand & Gravel

SST. fining-up to Shale

3100 — Permeable SST., Permeable LMST/DOL.

3150 — Caved Shale, Unconsolidated Sand & Gravel, Coal
Impermeable LMST, Impermeable Dol./SST Compact Shale
Halite Wash-out, brittle Coal and Shale
Halite Wash-out, brittle Coal and Shale

3200 — Impermeable LMST, Impermeable Dol./SST Compact Shale

Sloughing — Sloughed Shale

3250 — Impermeable LMST, Impermeable Dol./SST Compact Shale

12. Learning outcomes (What I have learned)**:**

- Permeable zones can be identified in the caliper log data at depths where there is a decrease in the borehole diameter with respect to the bit size.
- The decrease in diameter of the borehole is due to the formation of a mud cake preceded by the invasion phenomena.
- An increase in the hole diameter indicates "caved shales" in case of shale formations and "washout" in case of permeable sandstone.
- In case of shale formation, a decrease in the borehole diameter is mainly due to clay swelling (Sloughing phenomena).
- Impermeable limestone or hard limestone formations do generally not experience neither washout nor sloughing, and the hole diameter in these zones tends to be similar to the bit size.