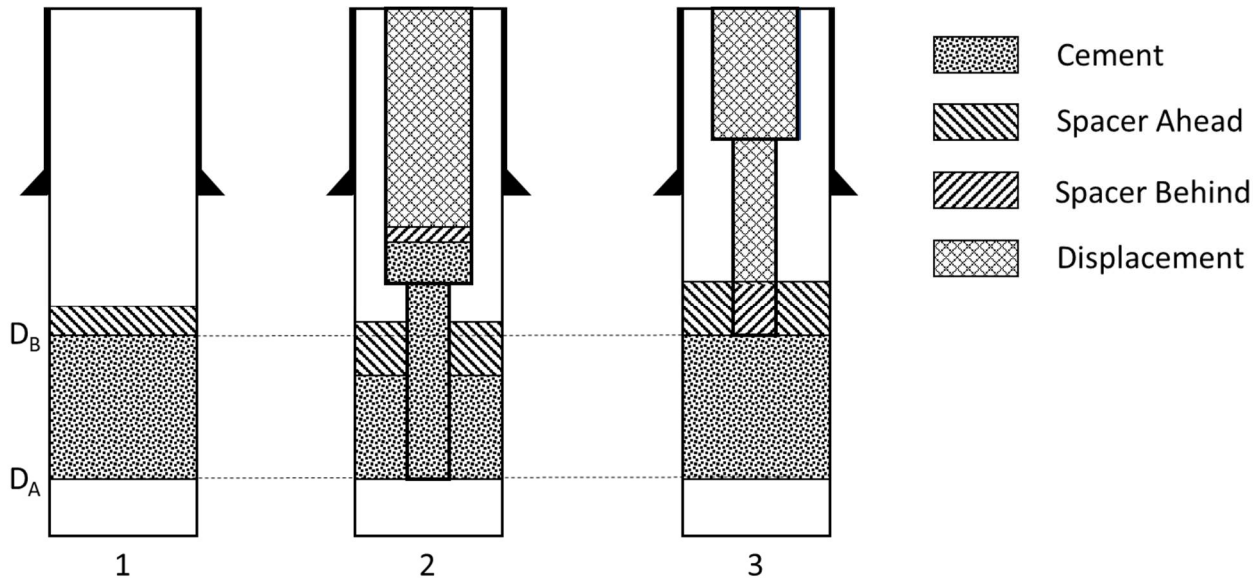


This procedure describes a simple method to calculate the volumes to set a balanced cement plugs with a tapered string. No need to work out string displacements or estimate under-displacement volumes. The calculation ensures the correct volumes are pumped will provide a suitable under-displacement.

The method is that, after pumping the required volume of cement, the cement is displaced with only a volume of fluids required to provide a balanced the system the moment the string is pulled out of the cement. This is illustrated by the following figures:



1. The cement-plug as it is planned
2. String position and fluids in the well during cement pumping and displacement
3. String position and fluids in well after the plug is set and the string is pulled out of the cement

The displacement volume is calculated by four simple calculations. Each calculated item is highlighted in red.

1

Calculate the **Volume of Cement (V<sub>c</sub>)** for the desired length (Depth A to Depth B) of cement-plug.

Calculate the volume using the well-bore capacity (C<sub>OH</sub>) and include any excess (%XS) to compensate for well-bore enlargement.

$$V_c = (D_A - D_B) \times C_{OH} \times \%XS$$

2

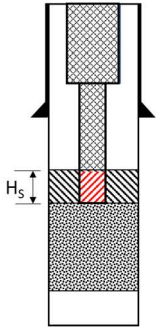
Calculate the **Height of Spacer (H<sub>s</sub>)** pumped ahead of the cement, with the stinger at the top of the cement plug.

The volume of spacer ahead (V<sub>SA</sub>) will be provided by the cement company.

Calculate the height of the spacer based on the Annular Capacity (C<sub>AN</sub>) between the small OD cement-stinger and the well-bore ID.

$$H_s = V_{SA} \div C_{AN}$$

3



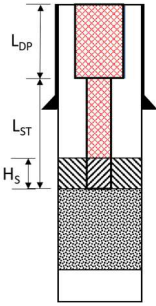
Calculate the **Volume of Spacer ( $V_{SB}$ )** to be pumped behind the cement.

To calculate the volume, multiply the Height ( $H_S$ ) from step 2 with the capacity of the small OD cement-stinger ( $C_{ST}$ ).

$$V_{SB} = H_S \times C_{ST}$$

*Calculated this way the volume of spacer behind is likely to be less than what your cement company will propose, use this volume, you are fine.*

4



Calculate the Volume of Displacement ( $V_D$ ) fluid to fill the string, with the nose of the string at the planned depth ( $D_B$ ) for the top of cement and the top of the string at the rig floor.

The volume of displacement fluid in the cement-stinger is length ( $L_{ST}$ ) of the small OD cement-stinger minus the height of spacer pumped behind the cement, multiplied by the capacity of the stinger ( $C_{ST}$ ),.

The volume of displacement fluid in the drill-pipe is the length ( $L_{DP}$ ) of the drill-pipe multiplied by the capacity of the drill-pipe.

The Volume of Displacement ( $V_D$ ) fluid is the sum of the volume of fluid in the cement-stinger and drill-pie.

$$V_D = (L_{ST} - H_S) \times C_{ST} + L_{DP} \times C_{DP}$$

*The combined volumes of  $V_D$  and  $V_{SB}$  are likely to match the combined volumes for displacement your cement company will give you.*

### Plug setting, sequence of operations:

1. Run in hole with cement stinger to Depth A ( $D_A$ ).
2. Rig up side-entry-sub and cement-hose. Test lines.
3. Pump volume of spacer ahead ( $V_{SA}$ ) of cement, from calculation 2.
4. Mix and pump volume ( $V_C$ ) of cement, from calculation 1.
5. Pump volume of spacer behind ( $V_{SB}$ ) the cement, from calculation 3.
6. Pump volume of displacement ( $V_D$ ) fluid, from calculation 4, plus line volume.
7. Break-off cement-hose, drill-pipe should be on vacuum.
8. Pull slowly out off hole with the drill-pipe.

Keep the annulus full at all times by circulating over the well with the trip-tank.

The volume of displacement ( $V_D$ ) fluid plus the volume of spacer behind ( $V_{SB}$ ) cement provide for a column of fluid inside the drill-pipe that will balance the column of fluid in the annulus the moment the string is pulled out of the cement.

In a perfect situation there should be no flow from the string while pulling the drill-pipe out of the cement. Some flow may be observed due to friction of cement falling out of the cement-stinger or as a result of a higher top of cement-pug (B) due to pumping more cement than necessary (excess).

While pulling out of hole with the drill-pipe always monitor trip thank for correct displacement.