Oilfield Cement

Primary
Support the casing in the hole.
Seal the annulus

Secondary (Squeeze Job)
Seal off unwanted production (Water or gas zones)
Repair the primary job
Repair casing
Seal off lost circulation zones
Plug off abandoned zones

Classes of cement (table 3.3)
API has 8 classes of cement A-H
Also have sulfate-resistant MSR HSR

With the proper additives cement can be made to meet all downhole conditions.

Class C for shallow jobs, classes G & H for most other conditions.
Properties to control

Density, #/gal
Careful of getting a too heavy slurry weight that can break down formations.
Also most have enough weight to control high pressure zones.

Setting time
Need the cement to set in a timely fashion, lower the WOC time.
In HT wells a retarder is needed to keep the cement in a slurry form till it is placed.
In squeeze jobs, retarding the cement helps in placing the slurry where it needs to be.

Filtration-Control
Controlling the water loss of the slurry minimizes the hydration into water sensitive shale zones and into productions zones that causes formation damage.
Also the loss of water effects the viscosity of the slurry, increasing the pumping pressure.
Can also form bridges in the annulus.
In squeeze jobs it is needed to get the slurry to the desired location in the formation.
Loss circulation materials can be added if necessary.

Viscosity-Control
Cement is a non Newtonian fluid, controlling the vis can lower pumping pressures. Cement needs to be pumped in the turbulent region for a good bond, vis control lowers the rate required.
The additives are measured in weight percent or gallon/sx if liquid.

This % is in relation to the cement, cement is given in sacks, 94#/sx.

So if 5% of bentonite is to be added the amount is needed is 
$0.05 \times 94 = 4.7\ #/sx$

When many additives are mixed in the water requirements change.

Table 3.6 gives the water requirements for API cements. Table 3.9 for the additives.

This are needed to calculate not only the water required for the slurry but the density of the slurry and the yield of the slurry. The yield of the slurry is cubic feet obtain for each sx mixed.

For a class C cement, with 5% bentonite.

Water for the cement is 6.32 gal/sx or 56%
Bentonite is 5.3%/% added

Amount of bentonite needed per sx

$0.05 \times 94 = 4.7\#/sx$

Water needed

$56 + 0.05 \times 5.3 = 72.5\%$

$\frac{0.725 \times 94}{8.33} = 8.18 gal$
Volume of slurry

Specific gravities cement 3.15, ben 2.65

\[
\frac{94}{3.15 \cdot 8.33} + \frac{4.7}{2.65 \cdot 8.33} + 8.18 = 12 \text{ gal/sx}
\]

Yield of the slurry

\[
\frac{12}{7.48 \text{ gal/ft}^3} = 1.6 \text{ ft}^3/sx
\]

Density of the slurry

\[
\frac{94 + 4.7 + 8.33 \cdot 8.18}{12} = 13.9\#/\text{gal}
\]

Need to calculate the total water for the job which includes the mixing of the slurry, and possible the spacer, and displacement.

Homework

Class H cement with 3% bentonite and 2% salt (dry NaCl)