**Cementing Calculations**

**Cement additive calculations**

a. Weight of additive per sack of cement :

Weight (lb) = percent of additive x 94 lb/sk

b. Total water requirement (gal/sk) of cement :

c. Volume of slurry (gal/sk):

d. Slurry yield (ft3/sk):

e. Slurry density (lb/gal):

Sample Case : Class A cement plus 4% bentonite using normal mixing water :

Determine the following :

Amount of bentonite to add  
Total water requirements  
Slurry yield  
Slurry weight

1. Weight of additive :

Weight (lb/sk) = 0.04 x 94 lb/sk

= 3.76 lb/sk

2. Total water requirement :

Water = 5.1 (cement) + 2.6 (bentonite)

= 7.7 gat/sk of cement

3. Volume of slurry :

4. Slurry yield (ft3/sk):

Yield (ft3/sk) = 11.46 gal/sk ÷ 7,48 gal/ft3

= 1.53 ft3/sk

5. Slurry density (lb/gal):

**Water requirements**

a. Weight of materials (lb/sk):

Weight (Ib/sk) = 94 + (8.33 x vol of water (gal))+(% of additive x 94)

b. Volume of slurry (gal/sk):

c. Water requirement using material balance equation :

D1 V1 = D2 V2

Sample Case : Class H cement plus 6% bentonite to be mixed at 14.0

lb/gal  
 Specific gravity of bentonite = 2.65

Determine the following :

Bentonitc requirement (lb/sk)  
 Water requirement (gal/sk)  
 Slurry yield (ft3/sk)  
 Check slurry weight (lb/gal)

1. Weight of materials (lb/sk):

Weight (lb/sk) = 94 + (0.06 x 94) + (8.33 x “y”)

= 94 + 5.64 + 8.33 “y”

= 99.64 + 8.33”y”

2. Volume of slurry (gal/sk)

3. Water requirement using material balance equation :

99.64 + 8.33”y” = (3.86 + “y”) x 14.0

99.64 +.8.33”y” = 54.04 + 14.0”y”

99.64 — 54.04 = 14.O”y” — 8.33”y”

45.6 = 5.67”y”

45.6 : 5.67 = “y”

8.0 = “y” Thus, water requirement = 8.0 gal/sk of cement

4. Slurry yield (ft3/sk):

5. Check slurry density (lb/gal):

**Field cement additive calculations**

When bentonite is to be pre-hydrated, the amount of bentonite added is calculated based on the total amount of mixing water used.

Cement program : 240 sk cement ; slurry density = 13.8 ppg ;  
 8.6 gal/sk mixing water ; 1.5% bentonite to be pre-hydrated

a. Volume of mixing water (gal):

Volume = 240 sk x 8.6 gal/sk

= 2064 gal

b. Total weight (lb) of mixing water

Weight = 2064 gal x 8.33 lb/gal

= 17,193 lb

c. Bentonite requirement (lb):

Bentonite = 17,193 lb x 0.015%

= 257.89 lb

Other additives are calculated based on the weight of the cement :  
Cement program = 240 sk cement ; 0.5% Halad ; 0.40% CFR-2 :

a. Weight of cement :

Weight = 240 sk x 94 lb/sk

= 22,560 lb

b. Halad = 0.5%

Halad = 22,560 lb x 0.005

= 112.8 lb

c. CFR-2 = 0.40%

CFR-2 = 22,560 lb x O.OO4

= 90.24 lb

**Weighted Cement Calculations**

Amount of high density additive required per sack of cement to achieve a required cement slurry density

Where ;

X = additive required pound per sack of cement  
Wt = required slurry density (lb/gal)  
SGc = specific gravity of cement  
CW = water requirement of cement  
AW = water requirement of additive  
SGa = specific gravity of additive

Sample Case : Determine how much hematite (lb/sk) of cement, would be

required to increase the density of Class H cement to 17.5

lb/gal :

Water requirement of cement = 4.3 gal/sk  
Water requirement of additive (hematite) = 0.34 gal/sk  
Specific gravity of cement = 3.14  
Specific gravity of additive (hematite) = 5.02

Solution

**Calculations for the Number of Sacks of Cement Required**

If the number of feet to be cemented is known, use the following :

**Step 1**

Determine the following capacities :

a. Annular capacity (ft3/ft):

b. Casing capacity (ft3/ft) :

c. Casing capacity (bbl/ft) :

**Step 2**

Determine the number of sacks of LEAD or FILLER cement required :

**Step 3**

Determine the number of sacks of TAIL or NEAT cement required :

**Step 4**

Determine the casing capacity down to the float collar :

**Step 5**

Determine the number of strokes required to bump the plug :

*Strokes = casing capacity (bbl) ÷ pump output (bbl/stk)*

Sample Case : From the data listed below determine the following :

How many sacks of LEAD cement will be required?  
How many sacks of TAIL cement will be required?  
How many barrels of mud will be required to bump the plug?  
How many strokes will be required to bump the top plug?

Data : Casing setting depth = 3000 ft  
 Hole size = I7-1/2 inch  
 Casing — 54.5 lb/ft = 13-3/8 inch  
 Casing ID = 12.615 inch  
 Float collar (number of feet above shoe) = 44 ft  
 Pump (5-1/2 inch by 14 inch duplex @ 90% eff) = 0.112 bbl/stk

Cement program : LEAD cement (13.8 lb/gal) = 2000 ft  
 slurry yield = 1.59 ft3/sk  
 TAIL cement (15.8 lb/gal) = 1000 ft  
 slurry yield = 1.15 ft3/sk  
 Excess volume = 50%

**Step 1**

Determine the following capacities :

a. Annular capacity (ft3/ft):

b. Casing capacity (ft3/ft):

c. Casing capacity (bbl/ft) :

**Step 2**

Determine the number of sacks of LEAD or FILLER cement required :

Sacks required = 2000 ft x 0,6946 ft3/ft x 1.50 ÷ 1.59 ft3/sk

= 1311

**Step 3**

Determine the number of sacks of TAIL or NEAT cement required :

Sacks required annulus = 1000 ft x 0.6946 ft3/ft x 1.50 ÷ 1.15 ft3/sk

= 906

Sacks required casing = 44 ft x 0.8679 ft3/ft ÷ 1.15 ft3/sk

= 33

Total sacks of TAIL cement required :

Sacks = 906 + 33

= 939

**Step 4**

Determine the barrels of mud required to bump the top plug :

Casing capacity (bbl) = (3000 ft — 44 ft) x 0.1545 bbl/ft

= 456.7 bbl

**Step 5**

Determine the number of strokes required to bump the top plug :

Strokes = 456.7 bbl ÷ 0.112 bbl/stk

= 4078

**Calculations for the Number of Feet to be Cemented**

The number of sacks of cement is known, use the following :

**Step 1**

Determine the following capacities :

**Step 2**

Determine the slurry volume (ft3):

**Step 3**

Determine the amount of cement (ft3) to be left in casing :

**Step 4**

Determine the height of cement in the annulus - ft of cement :

**Step 5**

Determine the depth of the top of the cement in the annulus :

*Depth (ft) = (casing setting depth (ft)) – (ft of cement in annulus)*

**Step 6**

Determine the number of barrels of mud required to displace the cement :

*Barrels = (ft of drill pipe) x (drill pipe capacity (bbl/ft))*

**Step 7**

Determine the number of strokes required to displace the cement :

*Strokes = (bbl required to displace cement) : (pump output (bbl/stk))*

Sample Case : From the data listed below, determine the following :

1. Height (ft) of the cement in the annulus  
2. Amount (ft3) of the cement in the casing  
3. Depth (ft) of the top of the cement in the annulus  
4. Number of barrels of mud required to displace the cement  
5. Number of strokes required to displace the cement

Data : Casing setting depth = 3000 ft  
 Hole size = 17-1/2 inch  
 Casing — 54.5 lb/ft = 13-3/8 inch  
 Casing ID = 12.615 inch  
 Drill pipe (5.0 inch — 19.5 lb/ft) = 0.01776 bbl/ft  
 Pump (7 inch by 12 inch triplex ® 95% eff.) = 0.136 bbl/stk  
 Cementing tool (number of feet-above shoe) = 100 ft.

Cementing program : NEAT cement = 500 sk  
 Slurry yield = 1.15 ft3/sk  
 Excess volume = 50%

**Step 1**

Determine the following capacities :

a. Annular capacity between casing and hole (ft3/ft):

b. Casing capacity (ft3/ft):

**Step 2**

Determine the slurry volume (ft3):

Slurry vol (ft3) = 500 sk x 1.15 ft3/sk

= 575 ft3

**Step 3**

Determine the amount of cement (ft3) to be left in the casing :

Cement in casing (ft) = (3000 ft - 2900 ft) x 0.8679 ft3/ft

= 86.79 ft3

**Step 4**

Determine the height of the cement in the annulus — feet of cement :

Feet = (575 ft3 — 86.79 ft3) : 0.6946 ft3/ft : 1.50

= 468.58

**Step 5**

Determine the depth of the top of the cement in the annulus :

Depth = 3000 ft — 468.58 ft

= 2531.42 ft

**Step 6**

Determine the number of barrels of mud required to displace the cement :

Barrels = 2900 ft x 0.01776 bbl/ft

= 51.5

**Step 7**

Determine the number of strokes required to displace the cement :

Strokes = 51.5 bbl ÷ 0.136 bbl/stk

= 379

**Setting a Balanced Cement Plug**

**Step 1**

Determine the following capacities :

a. Annular capacity (ft3/ft) between pipe or tubing and hole or casing :

b. Annular capacity (ft/bbl) between pipe or tubing and hole or casing :

c. Hole or capacity (ft3/ft):

d. Drill pipe or tubing capacity (ft3/ft):

e. Drill pipe or tubing capacity (bbl/ft):

**Step 2**

Determine the number of SACKS of cement required for a given length of plug, OR determine the FEET of plug for a given number of sacks of cement :

a. Determine the number of SACKS of cement required for a given length of

plug :

NOTE : If no excess is to be used, simply omit the excess step.

b. Determine the number of FEET of plug for a given length of sacks of

cement

NOTE : If no excess is to be used, simply omit the excess step.

**Step 3**

Determine the spacer volume (usually water)(bbl) to be pumped behind the slurry to balance the plug :

NOTE : If no excess is to be used, simply omit the excess step.

**Step 4**

Determine the plug length (ft) before the pipe is withdrawn :

NOTE : If no excess is to be used, simply omit the excess step.

**Step 5**

Determine the fluid volume (bbl) required to spot the plug :

Sample Case 1 :

A 300 ft plug is to be placed at a depth of 5000 ft. The open hole size is 8-1/2 inch and the drill pipe is 3-1/2 inch — 13.3 lb/ft ID —2.764 inch. Ten barrels of water are to be pumped ahead of the slurry. Use a sluury yield of 1.15 ft3/sk. Use 25% as excess slurry volume.

Determine the following :

1. Number of sacks of cement required  
2. Volume of water to be pumped behind the slurry to balance the plug  
3. Plug length before the pipe is withdrawn  
4. Amount of mud required to spot the plug plus the spacer behind the plug

**Step l**

Determined the following capacities : .

a. Annular capacity between drill pipe and hole (ft3/ft):

b. Annular capacity between drill pipe and hole (ft/bbl):

c. Hole capacity (ft3/ft) :

d. Drill pipe capacity (bbl/ft):

e. Drill pipe capacity (ft3/ft):

**Step 2**

Determine the number of sacks of cement required :

Sacks of cement = 300 ft x 0.3941 ft3/ft x 1.25 ÷ 1.15 ft3/sk

= 129

**Step 3**

Determine the spacer volume (water)(bbl) to be pumped behind the slurry to balance the plug :

Spacer vo1 (bbl) = 17.1569 ft/bbl : 1.25 x 10 bbl x 0.00742 bbl/ft

= 1.018 bbl

**Step 4**

Determine the plug length (ft) before the pipe is withdrawn :

**Step 5**

Determine the fluid volume (bbl)required to spot the plug :

Volume (bbl) = [(5000 ft — 329 ft) x 0.00742 bbl/ft)] — 1.0 bbl

= 34.66 bbl — 1.0 bbl

= 33.6 bbl

Sample Case 2 :

Determine the number of FEET of plug for a given number of SACKS of cement:   
A cement plug with 100 sk of cement is to be used in an 8-1/2 inch hole. Use 1.15 ft3/sk for the cement slurry yield. The capacity of 8-1/2 inch hole = 0.3941 ft3/ft. Use 50% as excess slurry volume :

Feet = 100 sk x 1.15 ft3/sk ÷ 0.3941 ft’/ft : 1.50

= 194.5