

**SECTION V**

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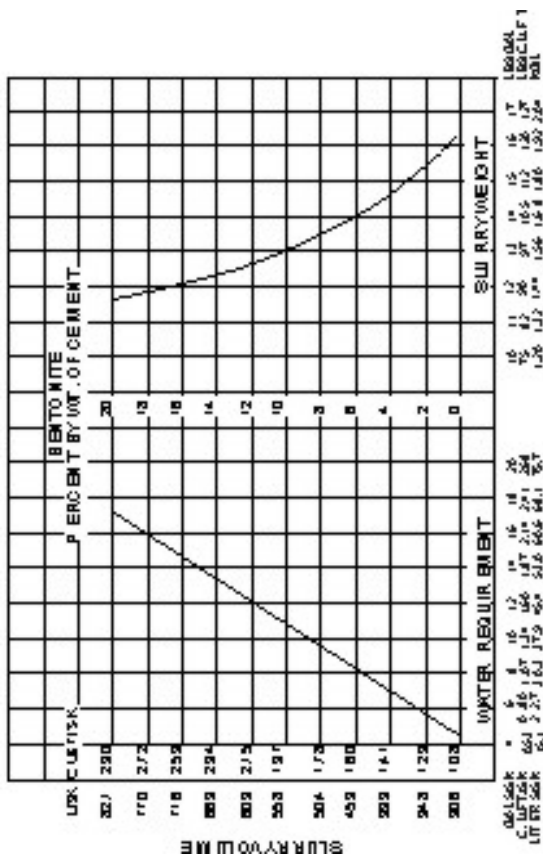
**CLASS H CEMENT**

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*Note: All Class H Cement Data is shown with water requirements of 4.3 (API) and 5.2 gallons (16.28 and 19.68 liters) per sack.*

## ENGLISH / METRIC UNITS

## CLASS H CEMENT



## ENGLISH UNITS CLASS H CEMENT

### SLURRY PROPERTIES

Bentonite Per Cent	API Water Requirements		Slurry Weight		Slurry Volume
	Gal./Sk.	Cu. Ft./Sk.	Lbs./Gal.	Lbs./Cu. Ft.	Cu. Ft./Sk.
0	4.30	0.58	16.4	123	1.06
2	5.49	0.73	15.5	115	1.22
4	6.69	0.89	14.7	110	1.38
6	7.88	1.05	14.1	105	1.55
8	9.07	1.21	13.6	101	1.73
10	10.27	1.37	13.2	99	1.90
12	11.46	1.53	12.9	96	2.07
14	12.66	1.69	12.6	94	2.24
16	13.86	1.85	12.4	93	2.41

### THICKENING TIME — HOURS:MINUTES

(Pressure-Temperature Thickening-Time Test)

Bentonite Per Cent	API CEMENTING SCHEDULES				
	2,000'	4,000'	6,000'	8,000'	10,000'
<b>Squeeze-Cementing Schedules (Plug-Back)</b>					
0	3:20	1:58	1:15	0:50	0:40
<b>Casing-Cementing Schedules</b>					
0	4:10	3:04	2:14	1:35	1:02
2	3:45	2:50	2:00	1:20	0:55
4	3:55	3:05	2:10	1:25	0:55
6	4:00	3:05	2:15	1:25	1:00
8	4:05	3:10	2:15	1:30	1:00
10	4:15	3:20	2:20	1:30	1:05
12	4:25	3:25	2:20	1:35	1:00
14	4:20	3:25	2:20	1:30	1:05
16	4:35	3:30	2:25	1:40	1:10

## METRIC UNITS

# CLASS H CEMENT

### SLURRY PROPERTIES

Bentonite Per Cent	API		Slurry Weight Kg/L	Slurry Volume L/Sk
	Water Requirements L/Sk			
0	16.28		1.96	30.01
2	20.78		1.86	34.54
4	25.32		1.76	39.07
6	29.83		1.69	43.88
8	34.33		1.63	48.98
10	38.88		1.58	53.79
12	43.38		1.55	58.61
14	47.92		1.51	63.42
16	52.47		1.49	68.23

### THICKENING TIME — HOURS:MINUTES

(Pressure-Temperature Thickening-Time Test)

Bentonite Per Cent	API CEMENTING SCHEDULES				
	610m	1 220m	1 830m	2 440m	3 050m
<b>Squeeze-Cementing Schedules (Plug-Back)</b>					
0	3:20	1:58	1:15	0:50	0:40
<b>Casing-Cementing Schedules</b>					
0	4:10	3:04	2:14	1:35	1:02
2	3:45	2:50	2:00	1:20	0:55
4	3:55	3:05	2:10	1:25	0:55
6	4:00	3:05	2:15	1:25	1:00
8	4:05	3:10	2:15	1:30	1:00
10	4:15	3:20	2:20	1:30	1:05
12	4:25	3:25	2:20	1:35	1:00
14	4:20	3:25	2:20	1:30	1:05
16	4:35	3:30	2:25	1:40	1:10

## ENGLISH UNITS

### CLASS H CEMENT

#### COMPRESSIVE STRENGTH — PSI

Bentonite Per Cent	Curing Time Hours	95°F	110°F	140°F	170°F	200°F
		800 psi	1,600 psi	3,000 psi	3,000 psi	3,000 psi
0	8	500	1200	2500	4000	5450
	24	3000	4050	5500	6700	8400
2	8	250	720	1400	2000	2500
	24	1550	2350	3250	3630	3800
4	8	130	450	830	1200	1550
	24	980	1490	2000	2250	2400
6	8	90	380	560	800	1050
	24	650	1000	1400	1650	1800
8	8	75	200	380	560	750
	24	430	700	1025	1150	1250
10	8	74	150	260	380	500
	24	325	500	700	825	900
12	8	70	120	200	280	360
	24	225	355	500	600	675
14	8	60	95	150	200	250
	24	160	270	400	490	550
16	8	50	80	110	170	220
	24	130	245	350	400	475

### CLASS H CEMENT

#### SLURRY PROPERTIES

Bentonite Per Cent	Water Requirements		Slurry Weight		Slurry Volume
	Gal./Sk.	Cu. Ft./Sk.	Lbs./Gal.	Lbsw./Cu. Ft.	Cu. Ft./Sk.
0	5.2	0.70	15.6	117	1.18
2	6.5	0.87	14.7	110	1.36
4	7.8	1.04	14.1	105	1.55
8	10.4	1.39	13.1	98	1.92
12	13.0	1.74	12.5	93	2.29

#### THICKENING TIME — HOURS:MINUTES

(Pressure-Temperature Thickening-Time Tests)

Bentonite Per Cent	CASING-CEMENTING SCHEDULES				
	2,000'	4,000'	6,000'	8,000'	10,000'
0	7:05	4:20	3:15	2:25	1:30
2	5:30	3:55	2:55	2:05	1:25
4	5:05	3:40	2:45	2:00	1:20
8	4:40	4:00	2:40	1:55	1:15
12	4:00	3:25	2:05	1:50	1:10

#### COMPRESSIVE STRENGTH — PSI

Bentonite Per Cent	Curing Time Hours	95°F	110°F	140°F	170°F	200°F
		800 psi	1,600 psi	3,000 psi	3,000 psi	3,000 psi
0	8	400	900	1800	3100	3950
	24	1300	2100	4450	5100	5850
2	8	300	600	1200	1600	1900
	24	1250	1750	2600	3250	3600
4	8	180	400	780	1100	1350
	24	830	1200	1850	230	2450
8	8	90	160	300	450	600
	24	400	600	900	1150	1250
12	8	50	95	180	270	350
	24	250	400	550	650	800

## METRIC UNITS

### CLASS H CEMENT

#### COMPRESSIVE STRENGTH — MEGAPASCALS

Bentonite Per Cent	Curing Time Hours	35°C	43°C	60°C	77°C	93°C
		5.51 MPa*	11.03 MPa*	20.68 MPa*	20.68 MPa*	20.68 MPa*
0	8	3.44	8.27	17.23	27.57	37.57
	24	20.68	27.92	37.92	46.19	57.91
2	8	1.72	4.96	9.65	13.78	17.23
	24	10.68	16.20	22.40	25.02	26.20
4	8	0.89	3.10	5.72	8.27	10.68
	24	6.75	10.27	13.78	15.51	16.54
6	8	0.62	2.62	3.86	5.51	7.23
	24	4.48	6.89	9.65	11.37	12.41
8	8	0.51	1.37	2.62	3.86	5.17
	24	2.96	4.82	7.06	7.92	8.61
10	8	0.51	1.03	1.79	2.62	3.44
	24	2.24	3.44	4.82	5.68	6.20
12	8	0.48	0.82	1.37	1.93	2.48
	24	1.41	2.44	3.44	4.13	4.65
14	8	0.41	0.65	1.03	1.37	1.72
	24	1.10	1.86	2.75	3.37	3.79
16	8	0.34	0.55	0.75	1.17	1.51
	24	0.89	1.68	2.41	2.75	3.27

### CLASS H CEMENT SLURRY PROPERTIES

Bentonite Per Cent	Water Requirements L/Sk.	Slurry Weight Kg/L	Slurry Volume L/Sk.
0	19.7	1.87	33.41
2	24.6	1.76	38.50
4	29.5	1.69	43.88
8	39.4	1.57	54.36
12	49.2	1.50	64.83

#### THICKENING TIME — HOURS:MINUTES (Pressure-Temperature Thickening-Time Tests)

Bentonite Per Cent	CASING-CEMENTING SCHEDULES				
	610m	1 220m	1 830m	2 440m	3 050m
0	7:05	4:20	3:15	2:25	1:30
2	5:30	3:55	2:55	2:05	1:25
4	5:05	3:40	2:45	2:00	1:20
8	4:40	4:00	2:40	1:55	1:15
12	4:00	3:25	2:05	1:50	1:10

#### COMPRESSIVE STRENGTH — MEGAPASALS

Bentonite Per Cent	Curing Time Hours	35°C	43°C	60°C	77°C	93°C
		5.51 MPa*	11.03 MPa*	20.68 MPa*	20.68 MPa*	20.68 MPa*
0	8	2.75	6.20	12.41	21.37	27.23
	24	8.96	14.47	30.68	35.16	40.33
2	8	2.06	4.13	8.27	11.03	13.10
	24	8.61	12.06	17.92	22.40	24.82
4	8	1.24	2.75	5.37	7.58	9.30
	24	5.72	8.27	12.75	15.37	16.89
8	8	0.62	1.10	2.06	3.10	4.13
	24	2.75	4.13	6.20	7.92	8.61
12	8	0.34	0.65	1.24	1.86	2.41
	24	1.72	2.75	3.79	4.48	5.51

## ENGLISH UNITS

# CLASS H CEMENT WITH ECONOLITE

### SLURRY PROPERTIES

ECONOLITE Additive Percent	Water		Slurry Viscosity—Bc		Free Water Percent	Slurry Density		Yield Cu. Ft./Sk.
	Gal./Sk.	Cu. Ft./Sk.	Initial	20 Min.		Lb./Gal.	Lb./Cu. Ft.	
0	4.3	0.58	6	8	2.5	16.4	123	1.06
0	5.2	.070	3	4	8.0	15.6	117	1.18
2	9.0	1.20	10	8	0.36	13.4	100	1.68
2	11.8	1.58	8	8	0.96	12.5	94	2.06
2	14.7	1.96	7	7	1.36	11.8	88	2.45
2	17.5	2.34	6	6	1.76	11.4	85	2.82
3	17.5	2.34	3	3	0.68	11.4	85	2.82

### PRESSURE-TEMPERATURE THICKENING TIME TESTS API CASING-CEMENTING SCHEDULES

ECONOLITE Additive Percent	Slurry Density		Thickening Time—Hours:Minutes		
	Lb./Gal.	Lb/cu. Ft.	4,000' 103°F	6,000' 113°F	8,000' 125°F
0	16.4	123	4:10	—	2:02
0	15.6	117	4:00	3:50	3:20
0	13.4	100	1:41	1:26	1:11
2	12.5	94	3:55	4:12	1:28
2	11.8	88	4:00+	4:00+	4:00+
2	11.4	85	4:00+	4:00+	4:00+
3	11.4	85	4:00+	—	4:00+

### COMPRESSIVE STRENGTH — PSI

ECONOLITE Percent	Slurry Density		Curing Time Hours	Curing Temperature — °F			
	Lb./Gal.	Lb./Cu. Ft.		100	140	170	200
0	16.4	123	12	—	2340	3960	4200
			24	2530	3540	5260	5850
0	15.6	117	12	—	1540	3130	3130
			24	1500	2250	3130	3930
2	13.4	100	12	—	380	600	680
			24	705	790	810	1030
2	12.5	94	12	—	210	260	310
			24	285	320	400	510
2	11.8	88	12	—	130	120	150
			24	105	180	200	210
2	11.4	85	12	—	80	80	90
			24	50	110	120	130
3	11.4	85	12	—	90	80	100
			24	60	130	120	130

## METRIC UNITS

### CLASS H CEMENT WITH ECONOLITE

#### SLURRY PROPERTIES

ECONOLITE Additive Percent	Water L./Sk.	Slurry Viscosity—Bc		Free Water Percent	Slurry Density Kg/L.	Yield Cu. Ft./Sk.
		Initial	20 Min.			
0	16.3	6	8	2.5	1.97	30.02
0	19.7	3	4	8.0	1.87	33.41
2	34.1	10	8	0.36	1.61	47.57
2	44.7	8	8	0.96	1.50	58.33
2	55.6	7	7	1.36	1.41	69.38
2	66.2	6	6	1.76	1.37	79.85
3	66.2	3	3	0.68	1.37	79.85

#### PRESSURE-TEMPERATURE THICKENING TIME TESTS API CASING-CEMENTING SCHEDULES

ECONOLITE Additive Percent	Slurry Density Kg/L.	Thickening Time—Hours:Minutes		
		1 220m	1 830m	2 440m
		39°C	45°C	52°C
0	1.97	4:10	—	2:02
0	1.87	4:00	3:50	3:20
2	1.61	1:41	1:26	1:11
2	1.50	3:55	4:12	1:28
2	1.41	4:00+	4:00+	4:00+
2	1.37	4:00+	4:00+	4:00+
3	1.37	4:00+	—	4:00+

#### COMPRESSIVE STRENGTH — MPa

ECONOLITE Percent	Slurry Density Kg/L.	Curing Time Hours	Curing Temperature — °C			
			38	60	77	93
			0	1.97	12 24	— 17.44
0	1.87	12 24	— 10.34	10.62 15.51	21.58 21.58	21.58 27.10
2	1.61	12 24	— 4.86	2.62 5.45	4.14 5.58	4.69 7.10
2	1.50	12 24	— 1.96	1.45 2.21	1.79 2.76	2.14 3.52
2	1.41	12 24	— 0.72	0.90 1.24	0.83 1.38	1.03 1.45
2	1.37	12 24	— 0.34	0.55 0.76	0.55 0.83	0.62 0.90
3	1.37	12 24	— 0.41	0.62 0.90	0.55 0.69	0.69 0.90



## ENGLISH UNITS

# CLASS H CEMENT WITH SPHERELITE

### SLURRY PROPERTIES

SPHERELITE Lb./Sk.	Water Gal./Sk.	Surface Density Lbs./Gal.	Density @ 3000 PSI Lb./Gal.	Density @ 3000 PSI Cu. Ft./Sk.
21.5	6.45	12.3	13.0	1.74
54.3	9.74	10.0	11.0	2.79
177.0	26.7	8.0	9.0	7.33

### COMPRESSIVE STRENGTH — PSI

Density @ 3000 PSI Lb./Gal.	Curing Time Hours	Cured Under 3000 PSI at Temp.		
		110°F	170°F	230°F
13	12	490*	1480	1900
	24	990*	1500	1910
	36	1690*	2800	2060
11	12	210*	500	950
	24	310*	840	1140
	36	690*	1670	1000
9	12	10*	80	160
	24	20*	160	180
	36	60*	280	340

\*Contained 2% calcium chloride

### THERMAL CONDUCTIVITY OF CLASS H CEMENT WITH SPHERELITE

SPHERELITE Lbs./Sk.	Water Gal./Sk.	Density @ 2000 PSI Cu.Ft./Sk.	Yield @ 2000 PSI Wet*	Thermal Conductivity, k (BTU/Hr. Ft. °F) Dry**
0	4.3	1.06	0.75	—
15	5.0	1.43	0.47	0.19
35	6.8	2.06	0.40	0.16
53	8.9	2.68	0.38	0.13
82	13.5	3.86	0.31	0.13
104	17.5	4.83	0.24	0.12
145	25.8	6.73	0.23	0.08

\*Samples cured 7 days at 90°F in water.

\*\*Wet samples subsequently dried 3 days at 230°F

### SPHERELITE — CLASS H CEMENT

#### LIGHTWEIGHT ADMIXTURE

Basic Composition: Class H cement, 30 Lb./Sk.; Diacel D, 1.5 Lb./Sk.  
CFR-2, 3 Lb./Sk. ECONOLITE, 6 Lb./Sk. CaCl<sub>2</sub>.

SPHERELITE Lbs./Sk.	Water Gal./Sk.	Density @ 1000 PSI Lb./Gal.	Yield @ 1000 PSI Cu.Ft./Sk.	24 Hr. Comp. Strength at 140°F, 1000 PSI (PSI)
0	14.4	12.5	2.71	1380
10	15.0	12.0	2.99	1130
25	17.4	11.2	3.62	730
50	19.2	10.5	4.37	420
75	21.6	10.0	5.20	340
100	24.0	9.6	6.03	270
200	32.4	8.8	9.20	130

NOTE — This data is presented only to demonstrate the performance of SPHERELITE. These compositions are not necessarily recommended as optimal compositions for field use. Generally, combinations of lightweight cement additives are used together to give optimal slurry performance (i.e., pumpability, strength and cost) for specific applications.

It is also important to note that the physical properties of SPHERELITE cement slurries are pressure dependent. SPHERELITE compositions are, therefore, designed on the basis of maximum downhole pressure.

### EFFECTIVE DENSITY OF SPHERELITE IN CEMENT SLURRY AT VARIOUS PRESURES

Pressure (PSI)	SPHERELITE		Pressure (PSI)	SPHERELITE	
	Density g./ml.	Abs. Vol. Gal./Lb.		Density g./ml.	Abs. Vol. Gal./Lb.
Atm	0.685	0.1753	5000	0.947	0.1268
200	0.741	0.1620	6000	0.986	0.1217
500	0.761	0.1578	8000	1.072	0.1120
1000	0.786	0.1527	10,000	1.154	0.1041
2000	0.830	0.1447	12,000	1.235	0.0972
3000	0.866	0.1386	14,000	1.316	0.0912
4000	0.906	0.1325	15,000	1.355	0.0884

## METRIC UNITS

# CLASS H CEMENT WITH SPHERELITE

### SLURRY PROPERTIES

SPHERELITE Kg./Sk.	Water L/Sk.	Surface Density Kg/L	Density @ 20.68 MPa Kg/L	Density @ 20.68 MPa L/Sk.
9.8	24.4	1.47	1.56	49.27
24.6	36.9	1.20	1.32	79.00
80.3	101.1	0.96	1.08	207.56

### COMPRESSIVE STRENGTH — PSI

Density @ 20.68 MPa Kg/L	Curing Time Hours	Cured Under 20.68 MPa at Temp.		
		43°C	77°C	110°C
1.56	12	3.38*	10.20	13.10
	24	6.83*	10.34	13.18
	36	11.65*	19.31	14.20
1.32	12	1.45*	3.45	6.55
	24	2.14*	5.79	7.86
	36	4.76*	11.52	6.89
1.08	12	0.07*	0.55	1.10
	24	0.14*	1.10	1.24
	36	0.41*	1.93	2.34

\*Contained 2% calcium chloride

### THERMAL CONDUCTIVITY OF CLASS H CEMENT WITH SPHERELITE

SPHERELITE Kg./Sk.	L/Sk.	Water Kg/L	Density @ 13.79 MPa L/Sk.	Yield @ 13.79 MPa Wet*	Thermal Conductivity, k (w/m °C) Dry**
0	16.3	1.97	30.02	1.30	—
6.8	18.9	1.68	40.49	0.81	0.33
15.9	25.7	1.44	58.33	0.69	0.28
24.0	33.7	1.32	75.89	0.66	0.22
37.2	51.1	1.20	109.30	0.54	0.22
47.2	66.2	1.14	136.77	0.42	0.21
65.8	97.7	1.08	190.57	0.40	0.14

\* Samples cured 7 days at 33°C in water.

\*\* Wet samples subsequently dried 3 days at 110°C

### SPHERELITE — CLASS H CEMENT

#### LIGHTWEIGHT ADMIXTURE

Basic Composition: Class H cement, 13.6 Kg/Sk.; Diacel D, 0.7 Kg/Sk.;  
CFR-2, 1.4 Kg/Sk. ECONOLITE, 2.7 Kg/Sk. CaCl<sub>2</sub>.

SPHERELITE Kg./Sk.	Water L/Sk.	Density @ 6.89 MPa Kg/L.	Yield @ 6.89 MPa L/Sk.	24 Hr. Comp. Strength at 60°C, 6.89 MPa (MPa)
0	54.5	1.50	76.74	9.51
4.5	56.8	1.44	84.67	7.79
11.3	65.9	1.34	102.51	5.03
22.7	72.7	1.26	123.74	2.90
34.0	81.8	1.20	147.25	2.34
45.4	90.8	1.15	170.75	1.86
90.7	122.6	1.05	260.51	0.90

NOTE — This data is presented only to demonstrate the performance of SPHERELITE. These compositions are not necessarily recommended as optimal compositions for field use. Generally, combinations of lightweight cement additives are used together to give optimal slurry performance (i.e., pumpability, strength and cost) for specific applications.

It is also important to note that the physical properties of SPHERELITE cement slurries are pressure dependent. SPHERELITE compositions are, therefore, designed on the basis of maximum downhole pressure.

### EFFECTIVE DENSITY OF SPHERELITE IN CEMENT SLURRY AT VARIOUS PRESURES

Pressure (MPa)	SPHERELITE		Pressure (MPa)	SPHERELITE	
	Density Kg./L.	Abs. Vol. L/Kg.		Density Kg./L.	Abs. Vol. L/Kg.
Atm	0.685	1.460	34.5	0.947	1.056
1.4	0.741	1.350	41.4	0.986	1.014
3.4	0.761	1.314	55.2	1.072	0.933
6.9	0.786	1.272	68.9	1.154	0.867
13.8	0.830	1.205	82.7	1.235	0.810
20.7	0.866	1.155	96.5	1.316	0.760
27.6	0.906	1.104	103.4	1.355	0.738

**ENGLISH UNITS**  
**CLASS H CEMENT**  
**WITH SALT**  
**SLURRY PROPERTIES**

Water — 4.3 Gals./Sk.

Per Cent*	Salt	Slurry Weight		Slurry Volume
	Lbs./Sk.	Lbs./Gal.	Lbs./Cu.Ft.	Cu.Ft./Sk.
0	0	16.4	123.0	1.06
5	1.8	16.5	123.5	1.07
10	3.6	16.6	124.1	1.08
18	6.5	16.7	124.8	1.09
Saturated	13.3	16.8	125.8	1.14

**THICKENING TIME — HOURS:MINUTES**

(Pressure-Temperature Thickening-Time Tests)

Salt Per Cent*	API CASING-CEMENTING SCHEDULES				
	2,000'	4,000'	6,000'	8,000'	10,000'
0	4:10	3:04	2:14	1:35	1:02
5	2:45	2:05	1:30	1:00	0:35
10	3:10	2:25	1:40	1:10	0:40
18	5:00	3:30	2:25	1:35	1:05
Saturated	8:00+	8:00+	5:08	3:50	2:00

**COMPRESSIVE STRENGTH — PSI**

Salt Per Cent*	Curing Time Hours	95°F	110°F	140°F	170°F	200°F
		800 psi	1,600 psi	3,000 psi	3,000 psi	3,000 psi
0	8	500	1200	2500	4000	5450
	24	3000	4050	5500	6700	8400
5	8	1350	2400	4000	5000	6100
	24	5000	5300	5900	6200	6550
10	8	1600	2850	4700	5950	6600
	24	5500	5650	6000	6650	7100
18	8	1000	2000	3800	5200	5900
	24	4350	4650	5150	6000	6500
Sat.	8	100	300	1500	2700	4200
	24	2650	3550	4700	4900	5700

\*Per Cent by weight of water.

**METRIC UNITS**  
**CLASS H CEMENT**  
**WITH SALT**  
**SLURRY PROPERTIES**

Water — 16.3 L/Sk.

Salt Per Cent*	Slurry Weight Kg./Sk.	Slurry Volume Kg/L	L/Sk.
0	0.00	1.96	30.01
5	0.81	1.98	30.29
10	1.63	1.99	30.58
18	2.95	2.00	30.86
Saturated (60°C)	6.03	2.01	32.28

**THICKENING TIME — HOURS:MINUTES**

(Pressure-Temperature Thickening-Time Tests)

Salt Per Cent*	API CASING-CEMENTING SCHEDULES				
	610m	1 220m	1 830m	2 440m	3 050m
0	4:10	3:04	2:14	1:35	1:02
5	2:45	2:05	1:30	1:00	0:35
10	3:10	2:25	1:40	1:10	0:40
18	5:00	3:30	2:25	1:35	1:05
Saturated (60°C)	8:00+	8:00+	5:08	3:50	2:00

**COMPRESSIVE STRENGTH — MEGAPASCALS**

Salt Per Cent*	Curing Time Hours	35°C	43°C	60°C	77°C	93°C
		5.51 MPa**	11.03 MPa**	20.68 MPa**	20.68 MPa**	20.68 MPa
0	8	3.44	8.27	17.23	27.57	37.57
	24	20.68	27.92	37.92	46.19	57.91
5	8	9.30	16.54	27.57	34.47	42.05
	24	34.47	36.54	40.67	42.74	45.16
10	8	11.03	19.65	32.40	41.02	45.50
	24	37.92	38.95	41.36	45.85	48.95
18	8	6.89	13.78	26.20	35.85	40.67
	24	29.99	32.06	35.50	41.36	44.81
Sat. (60°C)	8	0.68	2.06	10.34	18.61	28.95
	24	18.27	24.47	32.40	33.78	39.30

\*Per Cent by weight of water.

\*\*Curing Pressure

**ENGLISH UNITS**  
**CLASS H CEMENT**  
**WITH SALT**  
**SLURRY PROPERTIES**

Water — 5.2 Gals./Sk.

Per Cent*	Salt	Slurry Weight		Slurry Volume
	Lbs./Sk.	Lbs./Gal.	Lbs./Cu.Ft.	Cu.Ft./Sk.
0	0	15.6	117.0	1.18
5	2.2	15.7	117.5	1.19
10	4.3	15.8	118.0	1.20
18	7.8	15.9	119.0	1.22
Sat.	16.1	16.1	120.3	1.28

**THICKENING TIME — HOURS:MINUTES**

(Pressure-Temperature Thickening-Time Tests)

**API Cementing Schedules**

Salt Per Cent*	2,000'	4,000'	6,000'	8,000'	10,000'
<b>Casing-Cementing Schedules</b>					
0	7:05	4:20	3:15	2:25	1:30
5	3:44	2:33	1:45	1:17	0:48
10	3:46	2:44	1:56	1:18	1:02
18	6:35	4:11	3:06	1:25	1:23
Sat.	8:00+	8:00+	6:01	4:33	2:36
<b>Squeeze Cementing Schedules</b>					
0	5:10	3:00	1:50	1:10	0:50
5	2:50	1:25	1:05	0:42	—
10	2:43	1:56	0:57	0:51	—
18	3:57	2:35	1:43	1:05	—
Sat.	7:40	5:05	2:23	2:00	—

**COMPRESSIVE STRENGTH — PSI**

Salt Per Cent*	Curing Time Hours	95°F	110°F	140°F	170°F	200°F	230°F
		800 psi	1,600 psi	3,000 psi	3,000 psi	3,000 psi	3,000 psi
0	8	400	900	1800	3100	3950	4200
	24	1300	2100	4450	5100	5850	6250
5	8	860	1500	2310	3400	3950	4425
	24	3100	3500	3700	4300	5900	6000
10	8	890	1700	3225	3725	4175	4600
	24	3100	3950	4400	4650	5925	6050
18	8	540	1325	3070	3800	3900	4100
	24	2650	3100	3450	4025	4625	5185
Sat.	8	Not Set	175	1075	1800	2025	2275
	24	1075	1825	2150	2575	2850	3050

\*Per Cent by weight of water.

**METRIC UNITS**  
**CLASS H CEMENT**  
**WITH SALT**  
**SLURRY PROPERTIES**

Water—19.7 L/Sk.

Salt Per Cent*	Slurry Weight Kg./Sk.	Slurry Volume Kg/L	L/Sk.
0	0.00	1.87	33.41
5	1.00	1.88	33.69
10	1.95	1.89	33.97
18	3.54	1.90	34.54
Sat. (60°C)	7.30	1.93	36.24

**THICKENING TIME — HOURS:MINUTES**

(Pressure-Temperature Thickening-Time Tests)

Salt Per Cent*	API CASING-CEMENTING SCHEDULES				
	610m	1 220m	1 830m	2 440m	3 050m

**Casing-Cementing Schedules**

0	7:05	4:20	3:15	2:25	1:30
5	3:44	2:33	1:45	1:17	0:48
10	3:46	2:44	1:56	1:18	1:02
18	6:35	4:11	3:06	1:25	1:23
Sat. (60°C)	8:00+	8:00+	6:01	4:33	2:36

**Squeeze Cementing Schedules**

0	5:10	3:00	1:50	1:10	0:50
5	2:50	1:25	1:05	0:42	—
10	2:43	1:56	0:57	0:51	—
18	3:57	2:35	1:43	1:05	—
Sat. (60°C)	7:40	5:05	2:23	2:00	—

**COMPRESSIVE STRENGTH — MEGAPASCALS**

Salt Per Cent*	Curing Time Hours	35°C	43°C	60°C	77°C	93°C	110°C
		MPa†	MPa†	MPa†	MPa†	MPa†	MPa†
0	8	2.75	6.20	12.41	21.37	27.23	28.95
	24	8.96	14.47	30.68	35.16	40.33	43.09
5	8	5.92	10.34	15.92	23.44	27.23	30.50
	24	21.37	24.13	25.51	29.64	40.67	41.36
10	8	6.13	11.72	22.23	25.68	28.78	31.71
	24	21.37	27.23	30.33	32.06	40.85	41.71
18	8	3.72	9.13	21.16	26.20	26.88	28.26
	24	18.27	21.37	23.78	27.75	31.88	35.74
Sat. (60°C)	8	Not Set	1.20	7.41	12.44	13.96	15.68
	24	7.41	12.58	14.82	17.75	19.65	21.02

\*Per Cent by weight of water.

## ENGLISH UNITS

### CLASS H CEMENT

Silica flour — 35 Per Cent

Hi-Dense No. 3 — 47 Lbs./Sk.

Water — 6.4 Gal./Sk. (0.86 cu. Ft./Sk.)

Slurry Density — 18.0 Lbs./Gal. (134.6 Lbs./Cu. Ft.)

Slurry Volume — 1.69 Cu. Ft./sk.

### THICKENING TIME — HOURS:MINUTES

(Pressure-Temperature Thickening-Time Tests)

#### API CEMENTING SCHEDULES

Per Cent Retarder in ( )

12,000'	14,000'	16,000'	18,000'
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#### CASING SCHEDULES

1:40 (0.10)	2:54 (0.20)	2:50 (0.80)	3:12 (2.00)
3:23 (0.20)	3:26 (0.25)	5:10 (1.00)	3:52 (2.20)

#### SQUEEZE SCHEDULES

2:42 (0.30)	3:21 (0.65)	2:50 (1.00)	2:33 (2.00)
4:10 (0.40)	4:28 (0.80)	3:38 (1.20)	2:48 (2.40)

#### LINER SCHEDULES

2:17 (0.15)	2:20 (0.30)	2:37 (1.00)	2:05 (2.00)
3:36 (0.20)	3:05 (0.35)	3:12 (1.20)	3:32 (2.40)

### 24-HOUR COMPRESSIVE STRENGTH — PSI

Per Cent Retarder in ( )

CURING TEMPERATURE — °F (3,000 psi)			
260	290	320	350
4100 (0.10)	9375 (0.20)	10,000 (0.80)	12,225 (1.60)
3775 (0.20)	9550 (0.30)	9700 (1.00)	11,825 (2.00)
3675 (0.30)	9500 (0.80)	9025 (1.20)	11,100 (2.20)
3475 (0.40)	9150 (1.00)	—	10,250 (2.40)

## METRIC UNITS

### CLASS H CEMENT

Silica flour — 35 Per Cent  
 Hi-Dense No. 3 — 21.3 Kg/Sk.  
 Water — 24.2 L/Sk.  
 Slurry Density — 21.6 Kg/L  
 Slurry Volume — 47.85 L/Sk.

### THICKENING TIME — HOURS:MINUTES

(Pressure-Temperature Thickening-Time Tests)

#### API CEMENTING SCHEDULES

Per Cent Retarder in ( )

3 660 m	4 270m	4 880m	5 490m
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#### CASING SCHEDULES

1:40 (0.10)	2:54 (0.20)	2:50 (0.80)	3:12 (2.00)
3:23 (0.20)	3:26 (0.25)	5:10 (1.00)	3:52 (2.20)

#### SQUEEZE SCHEDULES

2:42 (0.30)	3:21 (0.65)	2:50 (1.00)	2:33 (2.00)
4:10 (0.40)	4:28 (0.80)	3:38 (1.20)	2:48 (2.40)

#### LINER SCHEDULES

2:17 (0.15)	2:20 (0.30)	2:37 (1.00)	2:05 (2.00)
3:36 (0.20)	3:05 (0.35)	3:12 (1.20)	3:32 (2.40)

### 24-HOUR COMPRESSIVE STRENGTH — MEGAPASCALS

Per Cent Retarder in ( )

127	CURING TEMPERATURE — °C (20.68 MPa)			177
	143	160		
28.26(0.10)	64.63(0.20)	68.94(0.80)	84.28(1.60)	
26.02(0.20)	65.84(0.30)	66.87(1.00)	81.53(2.00)	
25.33(0.30)	65.50(0.80)	62.22(1.20)	76.53(2.20)	
23.95(0.40)	63.08(1.00)	—	70.67(2.40)	



## ENGLISH UNITS

### CLASS H CEMENT

Silica Flour — 35 Per Cent

Hi-Dense No. 3 — 33.5 Lbs./Sk.

Dispersant — 0.75 Per Cent

Water — 5.60 Gal./Sk. (0.75 cu. Ft./Sk.)

Slurry Density — 18.0 Lbs./Gal. (134.6 Lbs./Cu. Ft.)

Slurry Volume — 1.54 Cu. Ft./sk.

### THICKENING TIME — HOURS:MINUTES

(Pressure-Temperature Thickening-Time Tests)

### API CEMENTING SCHEDULES

12,000'	14,000'	16,000'	18,000'
<b>CASING SCHEDULES</b>			
2:28 (0.03)	3:24 (0.10)	2:38 (0.30)	2:28 (1.20)
3:30 (0.05)	4:46 (0.13)	3:59 (0.40)	2:57 (1.40)
<b>SQUEEZE SCHEDULES</b>			
2:29 (0.10)	2:59 (0.30)	2:48 (0.70)	2:59 (1.20)
4:29 (0.15)	4:14 (0.35)	4:48 (0.80)	3:31 (1.40)
<b>LINER SCHEDULES</b>			
2:57 (0.07)	2:49 (0.20)	2:27 (0.60)	2:32 (1.80)
4:30 (0.10)	4:50 (0.30)	3:19 (0.70)	3:47 (2.00)

### 24-HOUR COMPRESSIVE STRENGTH — PSI

Per Cent Retarder in ( )

260	CURING TEMPERATURE — °F (3,000 psi)			350
	290	320		
4950 (0.05)	10,350 (0.10)	11,500 (0.30)	12,000 (1.20)	
4900 (0.07)	10,325 (0.20)	11,150 (0.40)	12,175 (1.40)	
4875 (0.10)	9950 (0.30)	10,800 (0.60)	12,275 (1.80)	
4675 (0.15)	9625 (0.35)	10,000 (0.80)	11,550 (2.00)	

## METRIC UNITS

### CLASS H CEMENT

Silica Flour — 35 Per Cent

Hi-Dense No. 3 — 15.2 Kg/Sk.

Dispersant — 0.75 Per Cent

Water — 21.20 L/Sk.

Slurry Density — 2.16 Kg/L

Slurry Volume — 43.60 L/Sk.

### THICKENING TIME — HOURS:MINUTES

(Pressure-Temperature Thickening-Time Tests)

### API CEMENTING SCHEDULES

3 660 m	4 270m	4 880m	5 490m
<b>CASING SCHEDULES</b>			
2:28 (0.03)	3:24 (0.10)	2:38 (0.30)	2:28 (1.20)
3:30 (0.05)	4:46 (0.13)	3:59 (0.40)	2:57 (1.40)
<b>SQUEEZE SCHEDULES</b>			
2:29 (0.10)	2:59 (0.30)	2:48 (0.70)	2:59 (1.20)
4:29 (0.15)	4:14 (0.35)	4:48 (0.80)	3:31 (1.40)
<b>LINER SCHEDULES</b>			
2:57 (0.07)	2:49 (0.20)	2:27 (0.60)	2:32 (1.80)
4:30 (0.10)	4:50 (0.30)	3:19 (0.70)	3:47 (2.00)

### 24-HOUR COMPRESSIVE STRENGTH — MEGAPASCALS

Per Cent Retarder in ( )

127°C	CURING TEMPERATURE — °C (20.68 MPa)		
	143°C	160°C	177°C
34.12 (0.05)	71.36 (0.10)	79.29 (0.30)	82.73 (1.20)
33.78 (0.07)	71.18 (0.20)	76.87 (0.40)	83.94 (1.40)
33.61 (0.10)	68.60 (0.30)	74.46 (0.60)	84.63 (1.80)
32.23 (0.15)	66.36 (0.35)	68.94 (0.80)	79.63 (2.00)

## ENGLISH UNITS THIX-SET CEMENT

Halliburton's THIX-SET cement is a thixotropic cementing composition which has been developed to aid in the prevention of several common drilling and cementing problems. A slurry is defined as thixotropic when it will exhibit a low viscosity during pumping, but develops a high viscosity when pumping is stopped. If pumping is resumed the slurry will revert to its initial low viscosity. This characteristic of low-high-low viscosity is repeatable until the cement begins to hydrate.

THIX-SET cement is designed to gel when allowed to set static for a period of less than 5 minutes. The gel can be broken if the slurry is moved again. This stop and start pumping operation can be repeated up to the time the cement starts to hydrate. The longer the slurry is quiescent, the more the slurry will thicken.

The thixotropic properties of THIX-SET cement make it particularly applicable for combating lost circulation problems during drilling. THIX-SET cement can be spotted across a thief zone. While the hydrostatic head balances with the formation pressure the cement will begin to gel into a rigid state that will resist additional fluid movement into the zone of loss. After some set strength has developed, the hole can be loaded and the zone redrilled.

THIX-SET cement is also designed to provide better primary cement jobs in wells having unconsolidated, highly permeable, fractured, vugular or cavernous formations. In a sense, THIX-SET cement improves fill-up by reducing fall-back or loss of the slurry to the formation.

### CLASS H, THIX-SET CEMENT

Class H cement with  
1.0% THIX-SET Component A and 0.25% THIX-SET Component B

#### SLURRY PROPERTIES

Water Gal./Sk.	Cu. Ft./Sk.	Slurry Density		Slurry Volume Cu. Ft./Sk.
		Lb./Gal.	Lb./Cu. Ft.	
5.2	0.70	15.6	117	1.18
7.7	1.03	14.0	105	1.51
10.1	1.35	13.0	97	1.83
13.8	1.84	12.0	90	2.33

### THICKENING TIME — HOURS:MINUTES

(Pressure-Temperature Thickening-Time Tests)

Water — 5.2 Gal./Sk.

Additive	Well Simulation	BHCT	BHST	Thickening Time (Hours:Minutes)
		(°F)	(°F.)	
0.2% CaCl <sub>2</sub>	2,000' Casing	91	110	1:12
None	2,000' Squeeze	100	110	2:56
None	4,000' Squeeze	116	140	2:35
None	8,000' Casing	125	200	2:41
0.2% Retarder	8,000' Casing	125	200	2:59
None	8,000' Squeeze	159	200	1:22
0.3% Retarder	8,000' Squeeze	159	200	2:20
0.4% Retarder	8,000' Squeeze	159	200	3:30+
0.5% Retarder	12,000' Casing	172	260	2:52
0.4% Retarder	14,000' Liner	206	290	2:57
0.6% Retarder	14,000' Liner	206	290	4:12

### COMPRESSIVE STRENGTH — PSI

Curing

Slurry Weight		Temp. (°F)	Curing Time — Hours		
Lb./Gal.	Lb./cu.Ft.		8	24	72
15.6	117	60	Set*	70	930
15.6	117	70	Set	300	1580
15.6	117	80	Set	430	2000
15.6	117	90	40	790	2280
15.6	117	100	90 (1080)**	152 (2130)**	—
14.0	105	100	Set ( 160)	580 ( 730)	—
13.0	97	100	Set ( 150)	410 ( 360)	—
12.0	90	100	Set ( 60)	305 ( 330)	—
15.6	117	200***	2240	3650	—
14.0	105	200	380 ( 680)***	770 (1030)**	—
13.0	97	200	280 ( 490)	560 ( 570)	—
12.0	90	200	20 ( 340)	540 ( 560)	—

### API FLUID LOSS

(325 mesh screen — 1000 PSI — 100°F)

Slurry Weight — 15.6 lb/gal

Additive	Water		Slurry Volume		Fluid Loss cc/30 Min.
	Gal./Sk.	Cu.Ft./Sk.	Cu.Ft./Sk.	Cu.Ft./Sk.	
None	5.2	0.70	1.18	1.18	115
2.0% CaCl <sub>2</sub>	5.2	0.70	1.18	1.18	150
0.3% Retarder	5.2	0.70	1.18	1.18	180
0.4% Retarder	5.2	0.70	1.18	1.18	170
6% Salt	5.36	0.72	1.21	1.21	120
12% Salt	5.49	0.73	1.24	1.24	110
18% Salt	5.62	0.75	1.27	1.27	140
sat. Salt	5.99	0.80	1.39	1.39	200

\*Set but no measurable strength.

\*\*Strengths in ( ) contained 2% CaCl<sub>2</sub>.

\*\*\*Slurries cured at 200°F were cured under 3,000 psi pressure.

**METRIC UNITS****THIX-SET CEMENT**

Halliburton's THIX-SET cement is a thixotropic cementing composition which has been developed to aid in the prevention of several common drilling and cementing problems. A slurry is defined as thixotropic when it will exhibit a low viscosity during pumping, but develops a high viscosity when pumping is stopped. If pumping is resumed the slurry will revert to its initial low viscosity. This characteristic of low-high-low viscosity is repeatable until the cement begins to hydrate.

THIX-SET cement is designed to gel when allowed to set static for a period of less than 5 minutes. The gel can be broken if the slurry is moved again. This stop and start pumping operation can be repeated up to the time the cement starts to hydrate. The longer the slurry is quiescent, the more the slurry will thicken.

The thixotropic properties of THIX-SET cement make it particularly applicable for combating lost circulation problems during drilling. THIX-SET cement can be spotted across a thief zone. While the hydrostatic head balances with the formation pressure the cement will begin to gel into a rigid state that will resist additional fluid movement into the zone of loss. After some set strength has developed, the hole can be loaded and the zone redrilled.

THIX-SET cement is also designed to provide better primary cement jobs in wells having unconsolidated, highly permeable, fractured, vugular or cavernous formations. In a sense, THIX-SET cement improves fill-up by reducing fall-back or loss of the slurry to the formation.

**CLASS H, THIX-SET CEMENT**

Class H cement with  
1.0% THIX-SET Component A and 0.25% THIX-SET Component B

**SLURRY PROPERTIES**

Water L/Sk.	Slurry Density Kg./L	Slurry Volume L/Sk
19.7	1.87	33.41
29.1	1.68	42.76
38.2	1.56	51.82
52.2	1.44	65.98

**THICKENING TIME — HOURS:MINUTES**

(Pressure-Temperature Thickening-Time Tests)

Water — 19.7 L/Sk.

Additive	Well Simulation	BHCT (°C)	BHST (°C.)	Thickening Time (Hours:Minutes)
0.2% CaCl <sub>2</sub>	610m Casing	33	43	1:12
None	610m Squeeze	38	43	2:56
None	1 220m Squeeze	47	60	2:35
None	2 440m Casing	52	93	2:41
0.2% Retarder	2 440m Casing	52	93	2:59
None	2 440m Squeeze	71	93	1:22
0.3% Retarder	2 440m Squeeze	71	93	2:20
0.4% Retarder	2 440m Squeeze	71	93	3:30+
0.5% Retarder	3 660m Casing	78	127	2:52
0.4% Retarder	4 270m Liner	97	143	2:57
0.6% Retarder	4 270m Liner	97	143	4:12

**COMPRESSIVE STRENGTH — PSI**

Slurry Weight Kg./L	Curing Temp. (°C)	Curing Time — Hours		
		8	24	72
1.87	16	Set*	0.48	6.41
1.87	21	Set	2.07	10.89
1.87	27	Set	2.96	13.79
1.87	32	0.28	5.45	15.72
1.87	38	0.62 (7.45)**	10.48 (14.69)**	—
1.68	38	Set (1.10)	4.00 (5.03)	—
1.56	38	Set (1.03)	2.83 (2.48)	—
1.44	38	Set (0.41)	2.10 (2.28)	—
1.87	93***	15.4	25.17	—
1.68	93	2.62 (4.69)**	5.31 (7.10)**	—
1.56	93	1.93 (3.38)	3.86 (3.93)	—
1.44	93	0.14 (2.34)	3.72 (3.86)	—

**API FLUID LOSS**

(45 micrometer screen — 6.89 MPa — 38°C)

Slurry Weight — 1.87 Kg/L

Additive	Water L/Sk.	Slurry Volume L/Sk.	Fluid Loss cc/30 Min.
None	19.7	33.41	115
2.0% CaCl <sub>2</sub>	19.7	33.41	150
0.3% Retarder	19.7	33.41	180
0.4% Retarder	19.7	33.41	170
6% Salt	20.3	34.26	120
12% Salt	20.8	35.11	110
18% Salt	21.3	35.96	140
sat. Salt	22.7	39.36	200

\*Set but no measurable strength.

\*\*Strengths in ( ) contained 2% CaCl<sub>2</sub>.

\*\*\*Slurries cured at 93°C were cured under 20.68 mPa pressure.