

**SECTION V**

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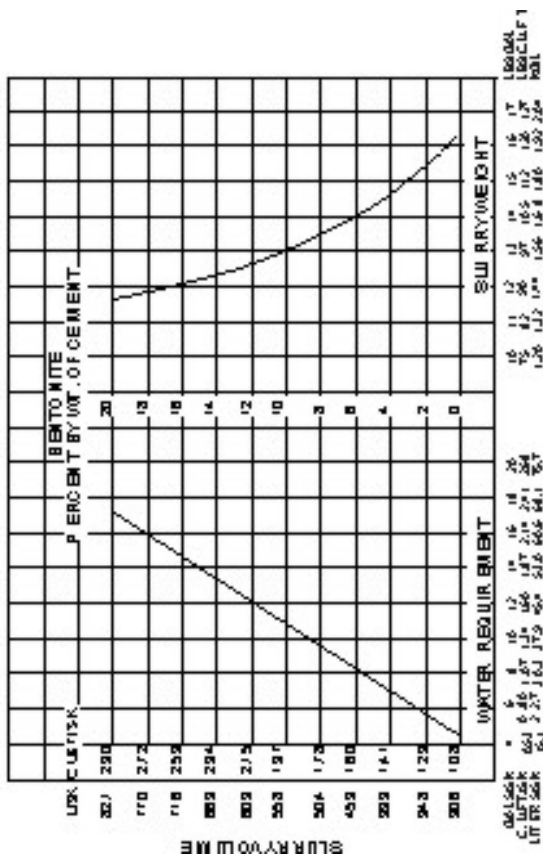
**CLASS H CEMENT**

|                                       | English<br>Units | Metric<br>Units |
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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<br>Per Cent | API<br>Water Requirements |             | Slurry Weight |              | Slurry<br>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<br>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<br>Per Cent | API                        |  | Slurry Weight<br>Kg/L | Slurry<br>Volume<br>L/Sk |
|-----------------------|----------------------------|--|-----------------------|--------------------------|
|                       | Water Requirements<br>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<br>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<br>Per Cent | Curing Time<br>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<br>Per Cent | Water Requirements |             | Slurry Weight |               | Slurry<br>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<br>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<br>Per Cent | Curing Time<br>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<br>Per Cent | Curing Time<br>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<br>Per Cent | Water Requirements<br>L/Sk. | Slurry Weight<br>Kg/L | Slurry<br>Volume<br>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<br>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<br>Per Cent | Curing Time<br>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<br>Additive<br>Percent | Water    |             | Slurry<br>Viscosity—Bc |         | Free<br>Water<br>Percent | Slurry Density |             | Yield<br>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<br>Additive<br>Percent | Slurry Density |            | Thickening Time—Hours:Minutes |                 |                 |
|----------------------------------|----------------|------------|-------------------------------|-----------------|-----------------|
|                                  | Lb./Gal.       | Lb/cu. Ft. | 4,000'<br>103°F               | 6,000'<br>113°F | 8,000'<br>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<br>Percent | Slurry Density |             | Curing<br>Time<br>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<br>Additive<br>Percent | Water<br>L./Sk. | Slurry<br>Viscosity—Bc |         | Free<br>Water<br>Percent | Slurry<br>Density<br>Kg/L. | Yield<br>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<br>Additive<br>Percent | Slurry Density<br>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<br>Percent | Slurry<br>Density<br>Kg/L. | Curing<br>Time<br>Hours | Curing Temperature — °C |                |                |                |
|----------------------|----------------------------|-------------------------|-------------------------|----------------|----------------|----------------|
|                      |                            |                         | 38                      | 60             | 77             | 93             |
|                      |                            |                         | 0                       | 1.97           | 12<br>24       | —<br>17.44     |
| 0                    | 1.87                       | 12<br>24                | —<br>10.34              | 10.62<br>15.51 | 21.58<br>21.58 | 21.58<br>27.10 |
| 2                    | 1.61                       | 12<br>24                | —<br>4.86               | 2.62<br>5.45   | 4.14<br>5.58   | 4.69<br>7.10   |
| 2                    | 1.50                       | 12<br>24                | —<br>1.96               | 1.45<br>2.21   | 1.79<br>2.76   | 2.14<br>3.52   |
| 2                    | 1.41                       | 12<br>24                | —<br>0.72               | 0.90<br>1.24   | 0.83<br>1.38   | 1.03<br>1.45   |
| 2                    | 1.37                       | 12<br>24                | —<br>0.34               | 0.55<br>0.76   | 0.55<br>0.83   | 0.62<br>0.90   |
| 3                    | 1.37                       | 12<br>24                | —<br>0.41               | 0.62<br>0.90   | 0.55<br>0.69   | 0.69<br>0.90   |



## ENGLISH UNITS

# CLASS H CEMENT WITH SPHERELITE

### SLURRY PROPERTIES

| SPHERELITE<br>Lb./Sk. | Water<br>Gal./Sk. | Surface<br>Density<br>Lbs./Gal. | Density<br>@ 3000 PSI<br>Lb./Gal. | Density<br>@ 3000 PSI<br>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<br>@ 3000 PSI<br>Lb./Gal. | Curing<br>Time<br>Hours | Cured Under 3000 PSI<br>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<br>Lbs./Sk. | Water<br>Gal./Sk. | Density<br>@ 2000 PSI<br>Cu.Ft./Sk. | Yield<br>@ 2000 PSI<br>Wet* | Thermal Conductivity, k<br>(BTU/Hr. Ft. °F)<br>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<br>Lbs./Sk. | Water<br>Gal./Sk. | Density<br>@ 1000 PSI<br>Lb./Gal. | Yield<br>@ 1000 PSI<br>Cu.Ft./Sk. | 24 Hr. Comp. Strength<br>at 140°F, 1000 PSI<br>(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<br>(PSI) | SPHERELITE        |                       | Pressure<br>(PSI) | SPHERELITE        |                       |
|-------------------|-------------------|-----------------------|-------------------|-------------------|-----------------------|
|                   | Density<br>g./ml. | Abs. Vol.<br>Gal./Lb. |                   | Density<br>g./ml. | Abs. Vol.<br>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<br>Kg./Sk. | Water<br>L/Sk. | Surface<br>Density<br>Kg/L | Density<br>@ 20.68 MPa<br>Kg/L | Density<br>@ 20.68 MPa<br>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<br>@ 20.68 MPa<br>Kg/L | Curing<br>Time<br>Hours | Cured Under 20.68 MPa<br>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<br>Kg./Sk. | L/Sk. | Water<br>Kg/L | Density<br>@ 13.79 MPa<br>L/Sk. | Yield<br>@ 13.79 MPa<br>Wet* | Thermal Conductivity, k<br>(w/m °C)<br>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<br>Kg./Sk. | Water<br>L/Sk. | Density<br>@ 6.89 MPa<br>Kg/L. | Yield<br>@ 6.89 MPa<br>L/Sk. | 24 Hr. Comp. Strength<br>at 60°C, 6.89 MPa<br>(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<br>(MPa) | SPHERELITE        |                    | Pressure<br>(MPa) | SPHERELITE        |                    |
|-------------------|-------------------|--------------------|-------------------|-------------------|--------------------|
|                   | Density<br>Kg./L. | Abs. Vol.<br>L/Kg. |                   | Density<br>Kg./L. | Abs. Vol.<br>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<br>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<br>Per Cent* | Curing Time<br>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<br>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<br>Per Cent* | Curing Time<br>Hours | 95°F       | 110°F        | 140°F        | 170°F        | 200°F        | 230°F        |
|-------------------|----------------------|------------|--------------|--------------|--------------|--------------|--------------|
|                   |                      | 800<br>psi | 1,600<br>psi | 3,000<br>psi | 3,000<br>psi | 3,000<br>psi | 3,000<br>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' |
|---------|---------|---------|---------|
|---------|---------|---------|---------|

#### 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 |
|---------|--------|--------|--------|
|---------|--------|--------|--------|

#### 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 ( )

| CURING TEMPERATURE — °C (20.68 MPa) |             |             |             |
|-------------------------------------|-------------|-------------|-------------|
| 127                                 | 143         | 160         | 177         |
| 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<br>Gal./Sk. | Cu. Ft./Sk. | Slurry Density |             | Slurry Volume<br>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<br>Simulation | BHCT | BHST  | Thickening Time<br>(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.<br>(°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<br>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<br>L/Sk. | Slurry Density<br>Kg./L | Slurry Volume<br>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<br>Simulation | BHCT<br>(°C) | BHST<br>(°C.) | Thickening Time<br>(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<br>Kg./L | Curing<br>Temp.<br>(°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<br>L/Sk. | Slurry Volume<br>L/Sk. | Fluid Loss<br>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.