P-SL50

CEMENTING SERVICE BULLETIN

02/ 14/94

P-SL50 (PETROCHEM-SPHERICAL LITE ADDITIVE) TECHNICAL DATA

P-SL50 is a hard, inert, hollow ceramic microsphere with a lower specific gravity (0.71) than water allowing the addition of solid materials while reducing the density of the resulting slurry. The resulting set cement will have higher compressive strengths and lower permeability's than is achievable with chemical extenders, even down to densities as low as 9 lb/gal.

P-SL50 applications range from cementing surface and conductor casings to unconsolidated and low fracture pressure formations. P-SL50 is also useful for mufti-stage cementing, grouting, setting plugs in severe loss circulation formations and insulative cements for permafrost or high temperature cementing such as in geothermal or steam flood situations. However, note the maximum exposed temperature during steam injection or recovery, as above 450^{o}F the long-term properties are not acceptable for zonal isolation.

P-SL50 is the preferred method for extending P-1000 Gas Control or thixotropic slurries, and is applicable through a temperature range of 40^{o}F to 450^{o}F However, when used at temperatures above 230^{o}F it is recommended that 35 % silica flour (BWOC) be included in the design.

P-SL50 requires a minimum of 5 to 10 lb/100 ft^{2} to maintain slurry stability since the P-SL50 is lighter than the water and four times lighter than cement, it can float to the top of the slurry if the yield value is insufficient.

PROPERTIES

PRODUCT	FORM	SP.GR.
P-SL50	Off White Powder	0.71

SAFETY

If the product gets in the eyes flush the eyes with water for at least 15 minutes, and get medical attention. If exposed to the skin, flush skin with soap & water. Inhalation: Move to open air, if irritation persists, get medical attention.

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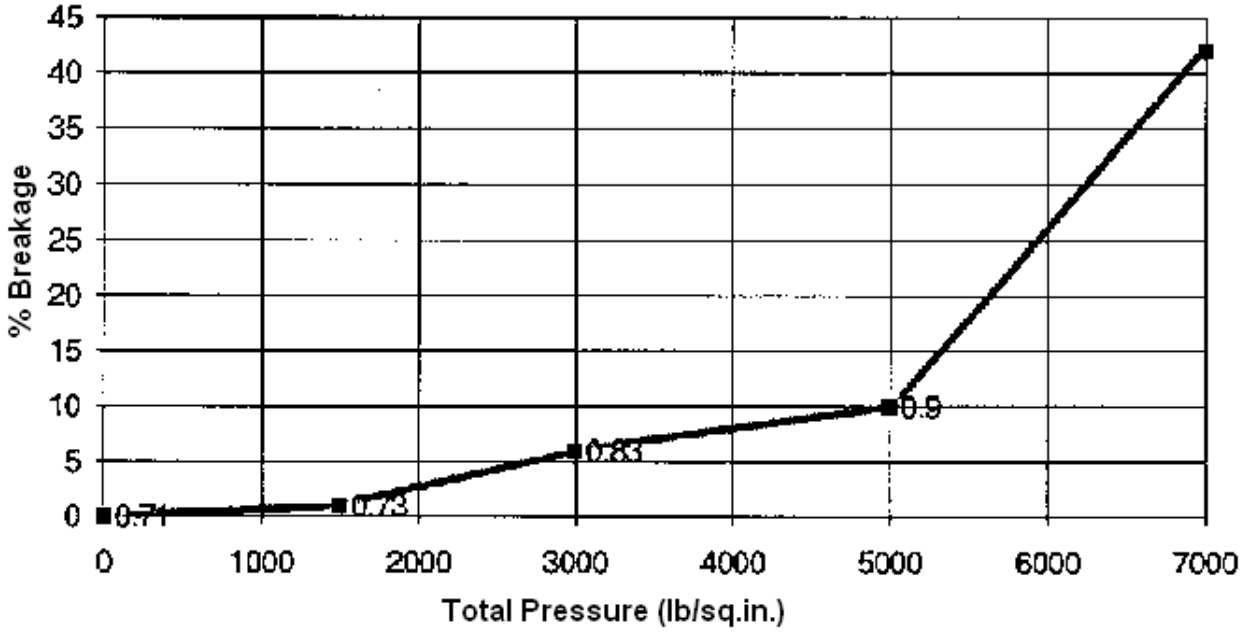
P-SL50 does not normally require a dispersant. In fact the inverse is more likely true, in that maintaining sufficient viscosity is more frequently the problem. P-SL50 slurries can be blended with salt concentrations up to 37% (BWOW). P-SL50 can be mixed with fresh water or seawater, so long as minimum viscosity values are maintained, and compatibility with other additives in the slurry is observed.

The normal application density of P-SL50 is from 9.0 to 12. Lb/gal to maintain cost effective slurry. Since P-SL50 is composed of hollow ceramic microspheres, a percentage of them break under pressure, losing the gas (N_2 and CO_2) trapped in them, subsequently loosing their low specific gravity. The maximum recommended pressure for application is 5000 psi total pressure. At 7000 psi approximately one half of the spheres are broken. Therefore, beyond this pressure other extenders may be more efficient.

As a guide the equivalent specific gravity after exposure can be estimated by the following equation.



NOTE: The decimal on the curve represents the P-SL50 specific gravity at the corresponding % breakage and total pressure.

$$BSG = 2.65 \left(\frac{\%\ crushed}{100}\right) + SSG \left(\frac{1 - \%\ crushed}{100}\right)$$

Where:
BSG = specific gravity of the blend
SSG = surface specific gravity of the P-SL50

And the absolute volume in gal/lb is calculated by:

$$BAV = \frac{0.1202}{BSG}$$

Where:
BAV = absolute volume of the blend in gal/lb
BSG = specific gravity of the blend

While P-SL50 is a satisfactory extender alone, it can easily be blended with other extenders to enhance the slurry properties, and offset the cost of using P-SL50 by itself. Properly designed slurries should provide the resulting set cement with higher compressive strengths and lower permeability's than is achievable with chemical extenders, even down to densities of 9.0 lb/gal. P-SL50 is also the preferred method for extending Gas Control (P-1000) or thixotropic (P-TTCL) slurries.

The general concentration range for P-SL50 is between 14% to 85% BWOC at densities ranging from 13.0 lb/gal to 9.4 lb/gal, with water requirements ranging from, 6.8 gal/sk. to 12.6 gal/sk. producing compressive strengths of approximately 1570 psi to 360 psi at 150^{o}F, respectively.

Care should be exercised when adding retarders to P-SL50 slurries since most retarders have a concentration range where dispersion is a secondary effect and over dispersed slurries may cause separation and or settling, rendering the slurry unstable.

Calculation of P-SL50 and water content method assumes 0.8% water per 1.0% P-SL50. In doing hand calculations, you must have some starting point for the water-to-P-SL50 ratio to design a given density. As a starting point in the calculation table, assume an increase of 0.8% mix water for each 1% P-SL50 (both BWOC). Starting with 44% mix water, 94 lbs. cement, and P-SL50 with surface properties of density = 0.71 S.G. and absolute volume = 0.1717 gal/lb, the density/volume table for calculation would look similar to the one below. Correct values for absolute volume of the landed P-SL50 will have to be inserted to replace the value of 0.1717. This table is assuming calculations with fresh water.

PETROCHEM

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Material	Mass lb	Absolute volume gal/lb	Total Volume gal
Cement	94.0	0.0380	3.59
Water	41.36 + 0.8 Y	0.1202	4.97 + 0.0962 Y
P-SL50	Y	0.1717	0.1717 Y
Others	--	--	--
	135.36 + 1.8 Y		8.56 + 0.2679 Y

From this point calculations continue as with conventional slurries, solving for P-SL50 Content in pounds (Y) by setting:

$$\frac{(135.36 + 1.8Y)}{(8.56 + 0.2679Y)} = \text{the design density}$$

Continuing with the value for Y: % P-SL50 BWOC = Y/94
Mix water in gal/sk is solved from 4.97 + 0.0962 Y
Slurry yield in cu ft/sk is solved from $\frac{(8.56 + 0.2679Y)}{7.48}$
Finally, slurry porosity in percent is: $\frac{(4.97 + 0.0962Y)}{(8.56+0.2679Y)} * 100$

Representative Data on P-SL50 Compressive Strengths.

Slurry Density lbm/gal	P-SL50 Concentration % BWOC	Water Content gal/sk	24-hr Compressive Strength at 150 deg F (66 deg C) psi
9.4	85	12.6	360
10.0	63	10.3	620
10.6	47	9.4	660
11.0	36	9.6	750
11.5	30	8.3	870
12.0	23	7.9	1010
13.0	14	6.8	1570

24-hour compressive strengths at surface pressures

P-SL50 S.G. = 0.72 g/cc

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Test Pressure (psi)	Design Density lbm/gal (S.G.)	Measured Density lbm/gal (S.G.)	Water Content gal/sk	P-SL50 Content %BWOC
0	9.0 (1.08)	9.0 (1.08)	19.3	100
1500		9.1 (1.09)		
3000		9.6 (1.15)		
5000		9.9 (1.19)		
0	9.4 (1.13)	9.4 (1.13)	12.6	85
1500		9.55 (1.15)		
3000		10.2 (1.22)		
5000		10.5 (1.26)		
0	10.0 (1.20)	10.0 (1.20)	10.3	63
1500		10.1 (1.21)		
3000		10.6 (1.27)		
5000		10.9 (1.31)		
0	10.6 (1.27)	10.6 (1.27)	9.4	47
1500		10.7 (1.29)		
3000		11.2 (1.35)		
5000		11.5 (1.38)		
0	11.0 (1.32)	10.9 (1.31)	9.6	36
1500		11.0 (1.32)		
3000		11.4 (1.37)		
5000		11.6 (1.39)		
0	11.5 (1.38)	11.5 (1.38)	8.3	30
1500		11.6 (1.39)		
3000		12.0 (1.44)		
5000		12.2 (1.47)		
0	12.0 (1.44)	12.0 (1.44)	7.9	23
1500		12.1 (1.45)		
3000		12.4 (1.49)		
5000		12.6 (1.51)		
0	13.0 (1.56)	13.0 (1.56)	6.8	14
1500		13.0 (1.56)		
3000		13.2 (1.59)		
5000		13.4 (1.61)		

Dyckerhoff G cement mixed with fresh water