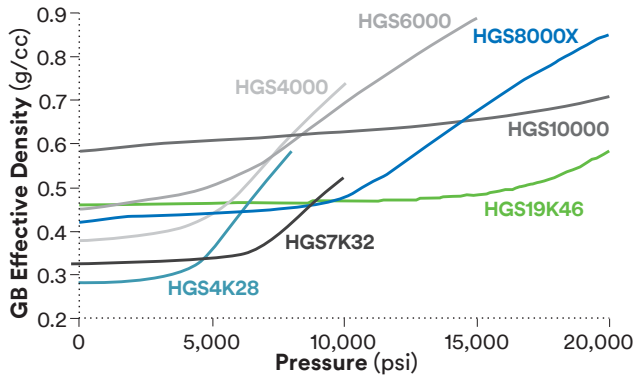


Engineered to Perform Under Pressure

When cementing across highly depleted zones and weaker formations, low-density systems are required to prevent/minimize problems associated with fluid loss/lost circulation, including reduced top-of-cement (TOC) and formation damage/reduced well productivity.

Low-density, high-strength 3M™ Glass Bubbles HGS Series help achieve the highest strength-to-weight cement designs.



3M™ Glass Bubbles Typical Physical Properties (Not for specification purposes.)

Product	Nominal Density (g/cc)	D ₅₀ (Microns)	Isostatic Crush Strength*	
			Minimum Fractional Survival	Test Pressure (psi)
HGS4K28	0.28	30	80%	4,000
HGS4000	0.38	40	80%	4,000
HGS6000	0.46	40	80%	6,000
HGS10000	0.60	30	90%	6,000
HGS7K32	0.32	25	80%	7,000
HGS8000X	0.42	26	90%	8,000
HGS19K46	0.46	20	80%	19,000

* Tests performed in nitrogen for test pressure up to 6000 psi and in glycerol for test pressure 8000 psi and above

Lightweight cementing options

Option	What is added?	Pros	Cons
3M™ Glass Bubbles	3M™ Glass Bubbles HGS Series	<ul style="list-style-type: none"> • Engineered – best in class • Consistency batch-to-batch • Best density reduction capacity • Lowest effective density at any pressure • Highest strength-to-weight cement design and lowest permeability • Reduced Wait-On-Cement (WOC) 	<ul style="list-style-type: none"> • Predetermined slurry target density • Limitations to mixing “on the fly”
Other Microspheres	Cenospheres or other hollow glass spheres	<ul style="list-style-type: none"> • Increased strength-to-weight cement design over water-extended slurries • Reduced WOC and permeability compared to water-extended slurries 	<ul style="list-style-type: none"> • Variability batch-to-batch, location-to-location (cenospheres) • Potential availability issues • Limited density reduction capability • Predetermined slurry target density • Limitations to mixing “on the fly”
Foamed Cement	Nitrogen, compressed air or gas-generating solids	<ul style="list-style-type: none"> • Increased slurry compressibility • Flexibility to vary density during cement slurry placement • Low cost 	<ul style="list-style-type: none"> • Can lack homogeneity • Can vary in density along the column • Requires specialized equipment and experienced operators
Water	Additional water	<ul style="list-style-type: none"> • Low cost 	<ul style="list-style-type: none"> • Requires water-extending additives for stability • Long WOC • Low ultimate compressive strength • Potentially the weakest cement

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