

3M Advanced Materials Division

3M™ Glass Bubbles HGS Series for oil & gas applications

Introduction

When drilling and cementing across highly depleted zones and weaker formations, low-density systems are required to prevent/minimize problems associated with excessive overbalance conditions including fluid loss/lost circulation, differential sticking, minimal penetration rates, formation damage, and reduced well productivity.

The use of 3M Glass Bubbles HGS Series as density reducing agents for drilling, completion, work-over fluids, and cement slurries offers the potential for:

- Reduced Non Productive Time (NPT)
- Improved well integrity
- Increased well productivity

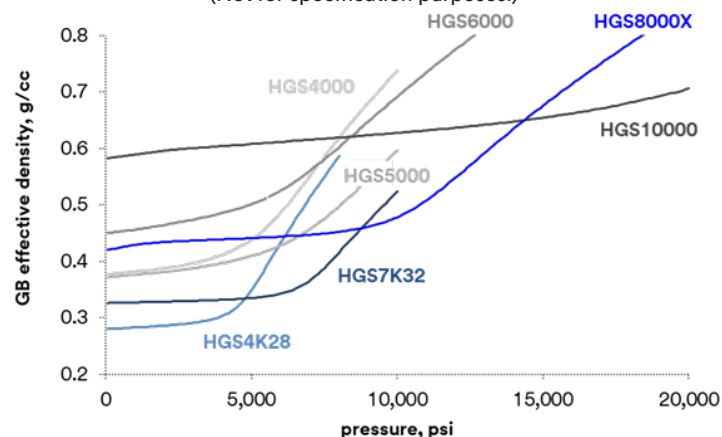
3M Glass Bubbles HGS series are engineered hollow glass spheres specially formulated for a high strength-to-weight ratio. This allows greater survivability under demanding downhole conditions.

Features and benefits

- Successfully and predictably reduce the control fluid density
- Incompressible and more homogeneous control fluid properties compared to aerated systems

3M Glass Bubbles (GB) effective densities at pressure

(Not for specification purposes.)



3M Glass Bubbles HGS Series in drilling, completion and work-over fluids

- Eliminate the need for specialized equipment used in foamed cement
- Compatible with both water and oil based systems
- More economical and allow a greater density reduction window than synthetic oils
- Helps achieve and maintain the target density throughout the drilling operation:

Light – when synthetic oils are used as base fluid, densities as low as 5.5 lb/gal (0.66 kg/l) can be achieved.

Tiny – 3M Glass Bubbles HGS8000X and HGS19K46 remain

in the fluid when circulating through solids control equipment, including shale shakers, hydrocyclones and centrifuges.

Tough – resistant to shear and impact forces when circulating through bit nozzles and impacting formation walls.

- Offer the potential for higher performance through increased rate of penetration (ROP)
- Reduce your cost through reconditioning and reuse of the lightweight fluid

3M™ Glass Bubbles HGS Series in cementing

- Consistency batch-to-batch, location-to-location
- Broad effective density at any pressure
- Improved density reduction capacity – cement slurry density values below 9.0 lb/gal (1.1 kg/l) have been achieved.

Low-density, high-strength 3M Glass Bubbles HGS Series are lighter and stronger and help achieve higher strength-to-weight cement designs.

Light weight cement slurries made with 3M Glass Bubbles HGS series help prevent problems associated with fluid loss/lost circulation such as reduced top of cement (TOC) and thus the need for remedial squeeze. Additional benefits include the potential for:

- Reduced Wait-On-Cement (WOC)
- Reduced need for multi-staging

3M Advanced Materials product realization process and manufacturing sites are aligned to ISO 9001 Quality Systems. Test data is generated by following documented procedures and test methods.

Typical physical properties (Not for specification purposes.)

Isostatic crush strength*

Product	Nominal density (g/cc)	D ₅₀ microns	Isostatic crush strength*	
			Minimum fractional survival	Test pressure (psi)
HGS4K28	0.28	30	80%	4,000
HGS7K32	0.32	22	80%	7,000
HGS8000X	0.42	26	90%	8,000
HGS19K46	0.46	20	80%	19,000
HGS4000	0.38	40	80%	4,000
HGS5000	0.38	40	80%	5,500
HGS6000	0.46	40	80%	6,000
HGS10000	0.60	30	90%	6,000

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

Particle size (micron, by volume) (Not for specification purposes.)

Product	Distribution		
	10th %	50th %	90th %
HGS4K28	20	30	45
HGS7K32	14	22	35
HGS8000X	12	26	43
HGS19K46	12	20	30
HGS4000	15	40	75
HGS5000	16	40	75
HGS6000	15	40	70
HGS10000	15	30	55

True density (Not for specification purposes.)

Product	True density (g/cc)		
	Typical	Minimum	Maximum
HGS4K28	0.28	0.25	0.31
HGS7K32	0.32	0.29	0.35
HGS8000X	0.42	0.39	0.45
HGS19K46	0.46	0.43	0.49
HGS4000	0.38	0.35	0.41
HGS5000	0.38	0.35	0.41
HGS6000	0.46	0.43	0.49
HGS10000	0.60	0.57	0.63

Typical physical properties (Not for specification purposes.)

(continued)

All values determined at 77°F (25°C) unless otherwise specified

Property	3M™ Glass Bubbles HGS Series
Chemical resistance	In general, the chemical properties of 3M Glass Bubbles resemble those of a soda-lime borosilicate glass.
Packing factor (ratio of bulk density to true particle density)	57%–63%
Stability	Appreciable changes in bubble properties may occur above 1112°F (600°C) depending on temperature and duration of exposure.
Mud acid solubility (% by weight)	99.95%
Alkalinity	Maximum of 0.5 milliequivalents per gram
pH	Because 3M Glass Bubbles are a dry powder, pH is not defined. The pH effect will be determined by the alkalinity as indicated above. When 3M Glass Bubbles are mixed with deionized water at 5 volume percent loading, the resulting pH of the slurry is typically 9.2 to 9.5.
Appearance	White to the unaided eye
Flowability	3M Glass Bubbles remain free flowing for at least two years from the date of manufacture if stored in the original, unopened container in the minimum storage conditions of an unheated warehouse. See recommended storage information.

Packaging and labeling

3M Glass Bubbles HGS Series are packaged in four-foot high, heavy-duty polyolefin bags to help prevent damage during normal handling and shipping, and to protect the product from incidental exposure to outdoor weather conditions. Each container will be labeled with:

1. Name of manufacturer
2. Type of 3M Glass Bubbles
3. Load ID numbers
4. Quantity in pounds
5. Density of product

Processing

3M Glass Bubble breakage may occur if the product is improperly processed. To minimize breakage, avoid high shear processes, point contact shear such as gear pumps or 3-roll mills, and processing pressures above the strength test pressure for each product.

Product storage, handling & safety

Storage: Ideal storage conditions include unopened cartons in a dry and temperature-controlled warehouse.

Extended exposure of 3M Glass Bubbles boxes to high humidity and/or conditions susceptible to condensation may result in some amount of “caking” of the 3M Glass Bubbles. To minimize the potential for caking and thereby maximize storage life, the following suggestions are offered:

1. Carefully re-tie opened bags immediately after use.
2. If the polyethylene bag is punctured during shipping or handling, seal the hole as soon as possible or insert the contents into an undamaged bag.
3. During hot and/or humid months, store boxes in the driest, coolest space available.

If controlled storage conditions are unavailable, carry a minimum inventory and process on a first in/first out basis.

Handling: Due to the low weight and small particle size of 3M Glass Bubbles, dusting may occur while handling and processing. To minimize the dusting potential during handling, consider the following:

1. Do not open 3M Glass Bubbles packages until ready to use.
2. Upon opening, have an air siphon near the opening to pull away airborne particles. (Dust collection equipment may be required – check local OSHA and other applicable regulations.)

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Product storage, handling & safety

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3. Remove 3M™ Glass Bubbles with a suction “wand” (with slight positive pressure aeration) and transfer to a closed mixing tank inside fully contained piping. If a closed mixing tank is not available, use dust collection equipment as close as practical to the point of entry. Pneumatic conveyor systems have been used successfully to transport 3M Glass Bubbles without dusting from shipping containers to batch mixing equipment. Equipment vendors should be consulted for recommendations.
4. Static eliminators should be used to prevent static buildup.

Safety: For worker protection, please follow your company’s procedures for safety and proper PPE, and consider the following:

- Select and use eye/face protection to prevent contact based on the results of an exposure assessment. Safety Glasses with side shields are recommended.
- Wear respiratory protection if ventilation is inadequate to prevent overexposure. An exposure assessment may be needed to decide if a respirator is required. If a respirator is needed, use respirators as part of a full respiratory protection program. Based on the results of the

exposure assessment, select from the following respirator type(s) to reduce inhalation exposure: Half facepiece or full facepiece air-purifying respirator suitable for particulates. (For additional information about personal protective equipment, refer to the product Safety Data Sheet.)

- Provide local exhaust ventilation at transfer points. Use general dilution ventilation and/or local exhaust ventilation to control airborne exposures to below relevant Exposure Limits and/or control dust. If ventilation is not adequate, use respiratory protection equipment.

Additional Information

3M Glass Bubbles are supported by global sales, technical and customer service resources, with fully-staffed technical service laboratories in the U.S., Europe, Japan, Latin America and Southeast Asia. Users benefit from 3M’s broad technology base and continuing attention to product development, performance, safety and environmental issues.

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