

3M™ Glass Bubbles HGS Series

Introduction

3M™ Glass Bubbles HGS Series are engineered hollow glass spheres for use as a density reducing agent for oil and gas drilling fluids and drilling cements.

The spherical shape of 3M glass bubbles offers a number of important benefits, including lower viscosity and improved flow. The chemically-stable soda-lime-borosilicate glass composition of 3M glass bubbles makes them virtually insoluble in water or oil. They are also non-compressible. Their low alkalinity gives 3M glass bubbles compatibility with most resins, stable viscosity and long shelf life.

3M glass bubbles HGS series are specially formulated for a high strength-to-weight ratio. This allows greater survivability under demanding downhole conditions. 3M glass bubbles are available in varying densities and crush strengths to help meet specific downhole conditions.

In drilling fluids, 3M glass bubbles help attain fluid densities as low as 5.5 pounds per gallon (0.66 kg/l). 3M glass bubbles-based fluids control density efficiently, process easily at rig site and are compatible with surface cleaning and other downhole equipment. These fluids also are ideal for the range of temperatures, pressures and hostile environments found downhole.

Drilling fluids made with 3M glass bubbles provide an economic alternative to aerated drilling fluids. In general, these reduced-density fluids are homogenous, incompressible, stable and allow measurement while drilling (MWD). They provide good borehole stability and excellent hole cleaning. These low density fluids permit at balance, near balance or underbalanced drilling. In general, reduction of differential pressure can result in:

- Higher productivity through increased rate of penetration (ROP)
- Elimination of differential sticking
- Reduction or elimination of lost circulation
- Reduction in formation damage

Drilling cements made with 3M glass bubbles offer the potential to reduce costs and improve performance compared to alternative solutions. In oil well cements, 3M glass bubbles can help reduce slurry density to below nine pounds per gallon (1.1 kg/l). Unlike low density cement slurries made by dilution with water or other techniques, cement slurries made with 3M glass bubbles develop quickly with high compressive strengths, minimizing waiting on cement (WOC).

Also, low density slurries with 3M glass bubbles avoid the multiple staging that is commonly used in wells which require a long column of cement, and where weak exposed formations will not support the hydrostatic head during cementing.

These low density slurries are an economical alternative for cementing wells that pass through low fracture gradient zones and can provide several benefits:

- Reduce rig time required compared to multiple stage cementing
- Reduce the possibility of formation break-down
- Reduce the possibility of lost circulation
- Increase efficiency of mud removal by allowing pipe rotation or reciprocation
- Increase yield per sack of cement
- Eliminate need for remedial squeeze

Low density slurries made with 3M glass bubbles HGS series permit cementing a deep well in a single stage, saving both time and expense while reducing formation damage.

Typical Physical Properties (Not for specification purposes)

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

Properties	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)	Varies from 55% to 68%
Oil Absorption	0.2 - 0.6 g oil/cc of 3M glass bubbles per ASTM D281-84
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%
Volatile Content (3M QCM 1.5.7)	Maximum of 0.5 percent by weight
Alkalinity (3M QCM 55.19)	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 9.1 to 9.9.
Appearance (3M QCM 22.85)	White to the unaided eye
Flowability (3M QCM 22.83)	3M glass bubbles remain free flowing for at least one year 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 on page 3.

Nitrogen Isostatic Crush Strength (3M QCM 14.1.5)

Product	Test Pressure (psi)	Target Fractional Survival	Minimum Fractional Survival
HGS2000	2,000	90%	80%
HGS3000	3,000	90%	80%
HGS4000	4,000	90%	80%
HGS5000	5,500	90%	80%
HGS6000	6,000	90%	80%
HGS8000X	8,000	90%	90%
HGS10000*	10,000	90%	80%
HGS18000*	18,000	90%	80%

*Per 3M QCM 14.1.8 in glycerol.

Flotation (3M QCM 37.2)

Product	Floaters (% by bulk volume)	
	Typical	Minimum
HGS2000	94%	90%
HGS3000	97%	90%
HGS4000	94%	90%
HGS5000	97%	90%
HGS6000	92%	90%
HGS8000X	97%	90%
HGS10000	92%	90%
HGS18000	92%	90%

True Density (3M QCM 14.24.6)

Product	Typical	True Density (g/cc)	
		Minimum	Maximum
HGS2000	0.32	0.29	0.35
HGS3000	0.35	0.32	0.38
HGS4000	0.38	0.35	0.41
HGS5000	0.38	0.35	0.41
HGS6000	0.46	0.43	0.49
HGS8000X	0.42	0.39	0.45
HGS10000	0.60	0.57	0.63
HGS18000	0.60	0.57	0.63

Typical Physical Properties (continued)

(not for specification purposes)

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

Particle Size (microns, by volume) (3M QCM 193.2)

Product	Distribution		Effective Top Size	
	10th%	50th%	90th%	95th%
HGS2000	20	40	75	80
HGS3000	18	40	75	85
HGS4000	15	40	75	85
HGS5000	16	40	75	85
HGS6000	15	40	70	80
HGS8000X	12	26	43	55
HGS10000	15	30	55	65
HGS18000	11	30	50	60

Hard Particles (3M QCM 93.4.3)

No hard particles (e.g., glass slag, flow agent, etc.) greater than U.S. number 40 (420 microns) standard sieve will exist.

Sieve Analysis (using 10 gram sample) 3M QCM 93.4.4

Product	U.S. Standard Sieve Number	Hole Size (Microns)	Max % by Weight Retained on Sieve
HGS2000	140	105	3
HGS3000	80	177	5
HGS4000	80	177	5
HGS5000	80	177	5
HGS6000	100	149	1
HGS8000X	100	149	1
HGS10000	100	149	1
HGS18000	100	149	1

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. Lot number
4. Quantity in pounds
5. Density of product

Processing

Glass bubble breakage may occur if the product is improperly processed. To minimize breakage, avoid high shear processes such as high speed Cowles Dissolvers, point contact shear such as gear pumps or 3-roll mills, and processing pressures above the strength

test pressure for each product.

Storage and Handling

To help ensure ease of storage and handling while maintaining free flowing properties, 3M™ Glass Bubbles have been made from a chemically stable glass and are packaged in a heavy duty polyethylene bag within a cardboard container.

Minimum storage conditions should be unopened cartons in an unheated warehouse.

Under high humidity conditions with the ambient temperature cycling over a wide range, moisture can be drawn into the bag as the temperature drops and the air contracts. The result may be moisture condensation within the bag. Extended exposure to these conditions may result in “caking” of the 3M glass bubbles to various degrees. To minimize the potential for “caking” and prolong the storage life, the following suggestions are made:

1. Carefully re-tie open bags after use.
2. If the polyethylene bag is punctured during shipping or handling, use this bag as soon as possible, patch the hole, or insert the contents into an undamaged bag.
3. During hot and humid months, store in the driest, coolest space available.
4. If controlled storage conditions are unavailable, carry a minimum inventory, and process on a first in/first out basis.

Conditions due to dusting that may occur while handling and processing can be managed or minimized by the following procedures:

1. For eye protection wear chemical safety goggles. For respiratory system protection wear an appropriate NIOSH/MSHA-approved respirator. (For additional information about personal protective equipment, refer to Material Safety Data Sheet.)
2. Use appropriate ventilation in the work area.
3. Pneumatic conveyor systems have been used successfully to transport 3M glass bubbles without dusting from shipping containers to batch mixing equipment. Static eliminators should be used to help prevent static charges.

Diaphragm pumps have been used to successfully convey 3M glass bubbles. Vendors should be consulted for specific recommendations.

Health and Safety Information

For product Health and Safety Information, refer to product label and Material Safety Data Sheet (MSDS) before using product.

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.

For additional technical information on 3M glass bubbles in the United States, call 3M Energy and Advanced Materials Division, 800-367-8905.

For other 3M global offices, and information on additional 3M products, visit our web site at: www.3M.com/microspheres.

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