3M Science. Applied to Life.™

Microesferas de vidrio para cementación.

Diseñadas para funcionar bajo presión.

Alcance global de 3M™ para satisfacer las necesidades del mercado

Capacidades de fabricación global: Microesferas de vidrio de 3M™

Servimos a más de 50 países a través de nuestras 5 plantas.

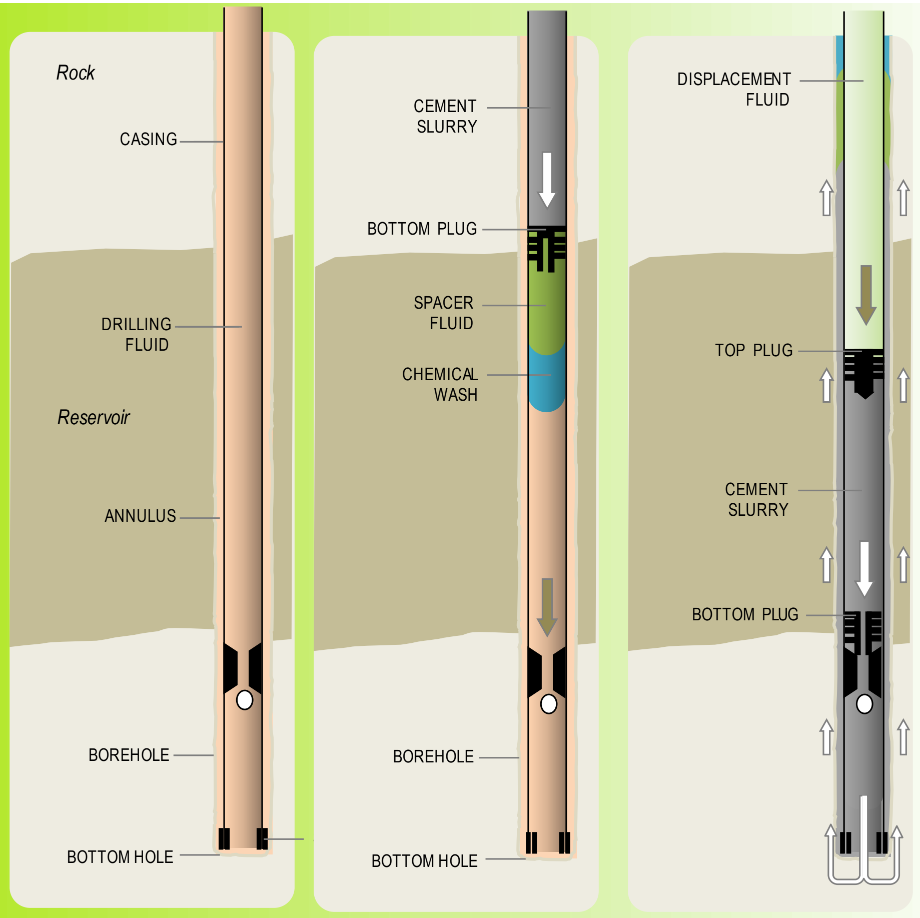
Menor costo en uso.
Calidad consistente.

Almacenamiento reducido y consistencia en costos.

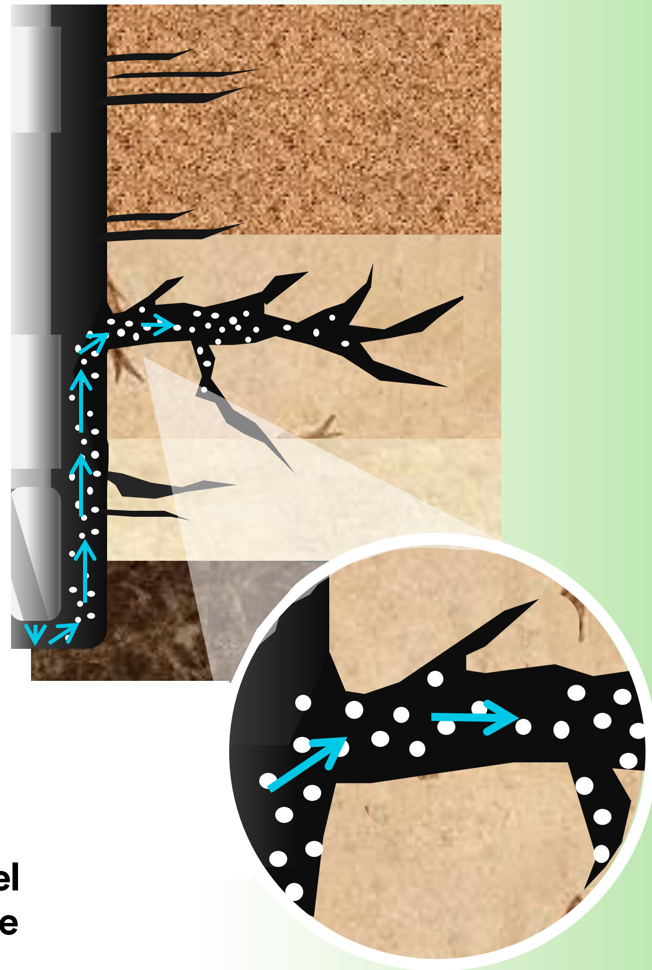
3M puede ofrecer una relación costo-beneficio con todas las ventajas de un producto fabricado, acceso a tecnología futura, suministro confiable y soporte de calidad constante.

El Reto

Evite pérdidas y daños en la formación y reduzca el tiempo improductivo (NPT)



Secuencia operativa desde la perforación hasta la finalización del pozo, destacando las fases en las que puede ocurrir la pérdida de control de fluidos y el daño a la formación.



Cuando la presión dinámica del pozo es mayor que la presión estática del yacimiento, aumenta el ingreso de pérdida de fluido del pozo al yacimiento.

El desafío es reducir la presión de fondo de pozo (BHP) de la columna de fluido durante cualquier operación.

Circulación perdida

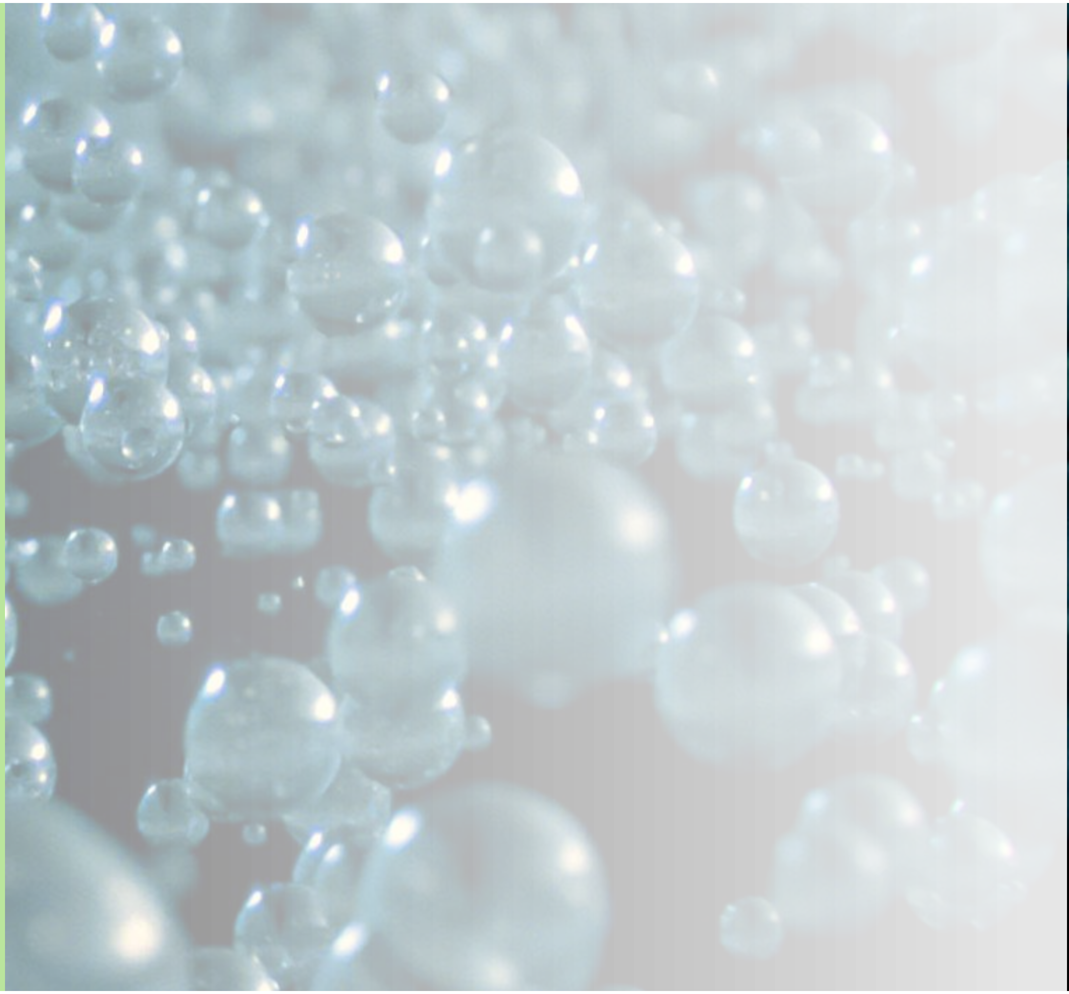
La Solución

Un producto diminuto puede marcar una gran diferencia en su operación

Microesferas de vidrio 3M™

La serie HGS ayuda a lograr y mantener las densidades objetivo cuando se utiliza dentro de la formulación de cemento/fluido en el pozo.

Fluidos de cementación, perforación, terminación y reacondicionamiento



Resolver problemas claves en el campo

Operaciones de cementación

Problemas existentes	Cementos alivianados con Microesferas de vidrio 3M™	Beneficios potenciales

• Pérdida de fluidos/circulación
• Daño a la formación
• Cima de cemento (TOC por sus siglas en inglés) reducida
• Baja calidad del cemento
• Tecnologías alternativas engorrosas y costosas
  ○ Cementos espumados
  ○ Multi-etapa
	• Lograr/mantener el control del pozo
	• Mayor probabilidad de lograr TOC.
	• No hay necesidad de personal/equipos especializados
	• Reducción de espacio requerido (ideal en zonas remotas y costa afuera).
	• Cementos curados de óptima resistencia a la compresión y control de migración de gas
		Reducción de costos
		Mayor integridad y productividad del pozo.
		Tiempo no productivo (NPT por sus siglas en inglés) mínimo

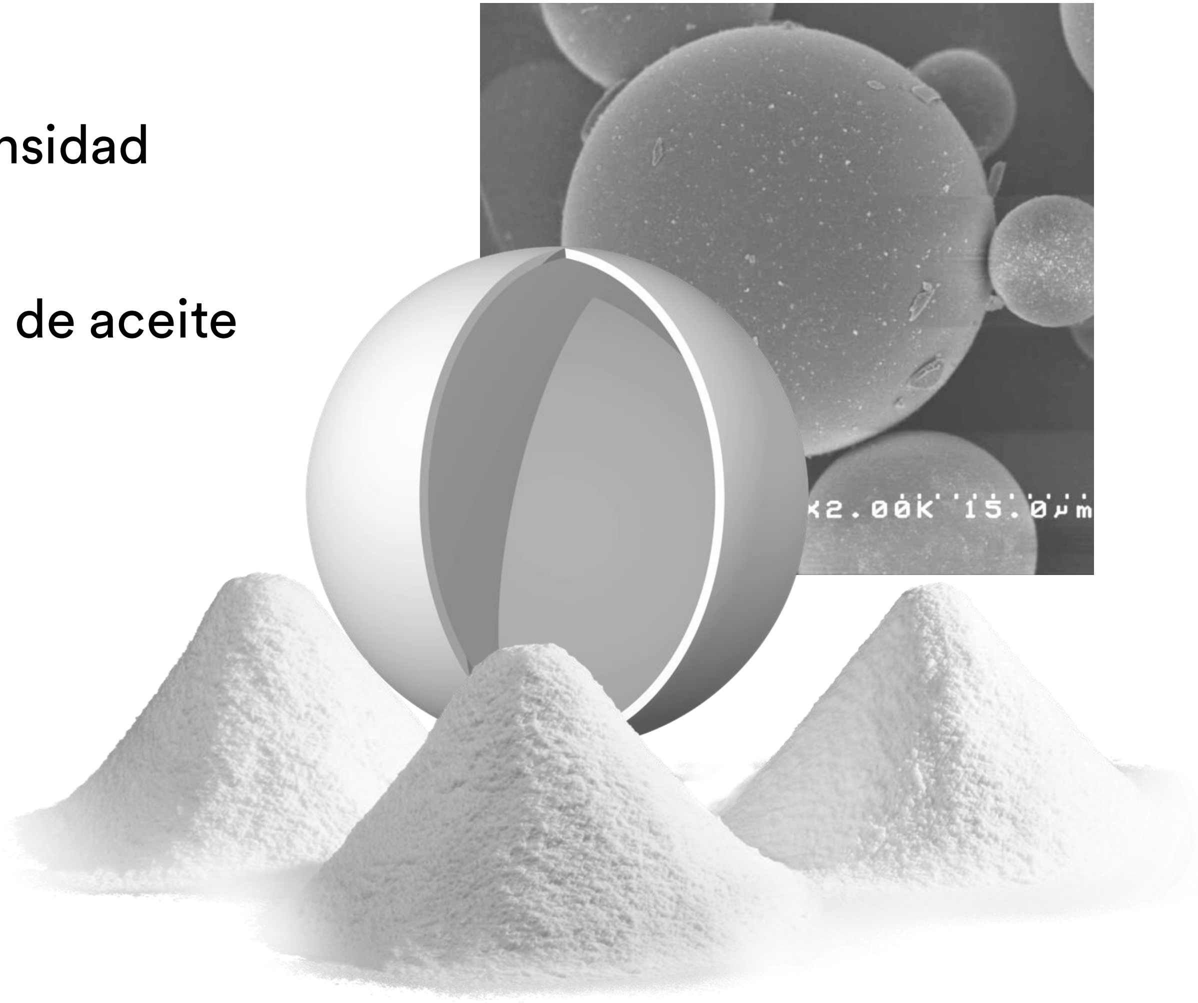
Tecnología 3M™

Descripción general del portafolio

- Microesferas huecas de alta resistencia y baja densidad
- Vidrio de borosilicato de cal sodada
- Compatible con sistemas a base de agua y a base de aceite
- Químicamente inerte, insoluble en agua

Fuerza de aplastamiento, psi	Densidad, g/cc	Tamaño medio de partícula, micras
4000–19,000	0.28–0.60	20–40

Hay grados adicionales disponibles.
Comuníquese con su representante de 3M para obtener más información.



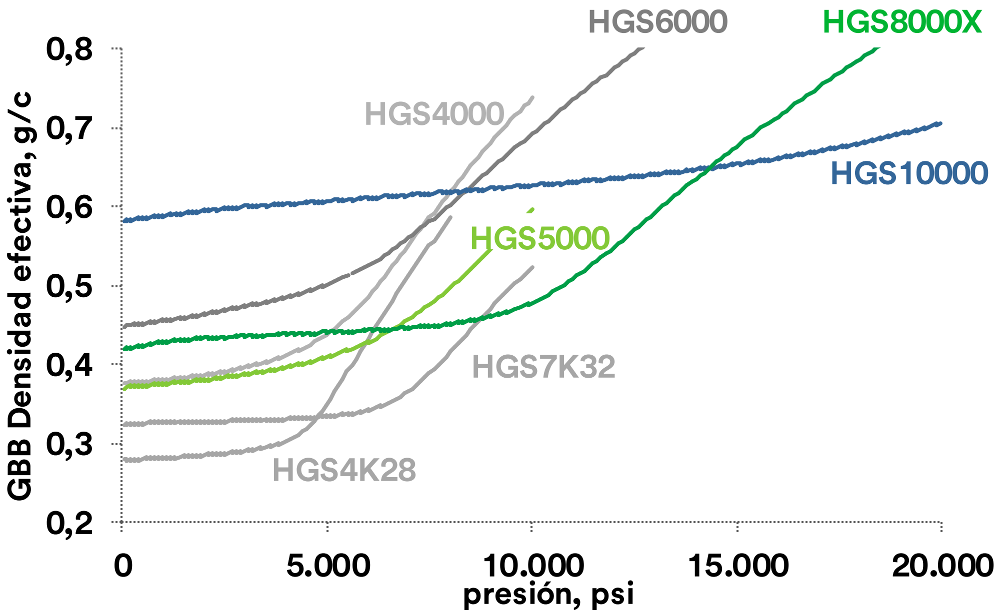
Serie HGS de microesferas de vidrio de 3M™

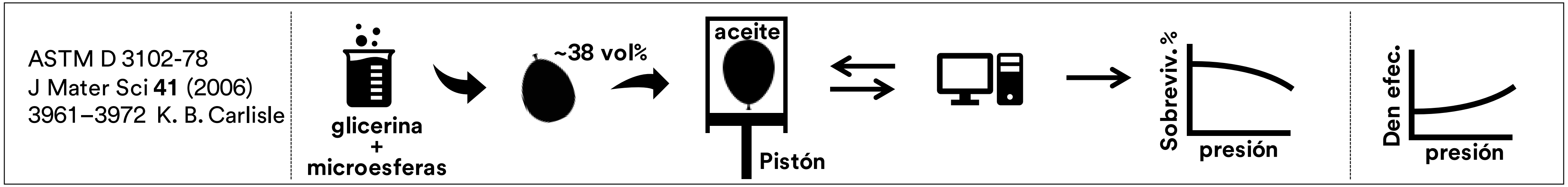
Rendimiento bajo presión

Prueba de fuerza

- A medida que se aplica presión, las microesferas más débiles se rompen y las microesferas rotas se convierten en partículas sólidas.
- La pérdida de microesferas enteras más la ganancia de partículas sólidas dan como resultado un aumento en la densidad promedio de la muestra.
- La densidad media aumentada es la densidad efectiva de microesferas.

No se trata solo de fuerza. Se trata de baja densidad efectiva bajo presión.





Informes técnicos: Aplicaciones de cementación ligera

Europa, Oriente Medio y África (EMEA)	Asia Pacífico y continente australiano (APAC)	Estados Unidos de América y Canadá (USAC)	América Latina (LATAM)	Global/otros
SPE-183681 - An Overview of Experimental Studies Examining the Reliability of Hollow Glass Spheres as a Density Reduction Agent in Oil Field Applications	SPE-196262 - Liquid-Bead Solution for Lightweight Cement Slurries	SPE-190079 - Lightweight and Ultra-Lightweight Cements for Well Cementing - A Review	SPE-176038 - Engineered Highly Crush-Resistant Cement Slurry to Prevent Lost Circulation	SPE-194918 - Comparative Study of the Mechanical Properties of Reduced Density Cements
SPE-175189 - Investigation of Stability of Hollow Glass Spheres in Fluids and Cement Slurries for Potential Field Applications in Saudi Arabia	SPE-182250 - Novel Cementing Solutions to Impede Lost Circulation with Highly Crush-Resistant Lightweight Cement System and Engineered Fibers	SPE-189277 - Impact of Alkali-Silica Reaction ASR on Structural Integrity of Light-Weight Wellbore Cement	SPE-139344 - Methodology for Cementing Low-Fracture-Gradient Gas Wells: Application in Cashiriari Field, Block 88	SPE-193350 - Design and Application of a New High Performance Lightweight Thermal Cement
SPE-166849 - Optimized Particles Size Distribution Lightweight Cement at Low Temperatures: Case Study from Eastern Siberia, Russia	SPE-176063 - Application of Optimized Particle-Sized Lightweight Cement Technology to Improve Integrity on Surface Casings in Myanmar	SPE-182399 - Use of Hollow Glass Spheres in Lightweight Cements - Selection Criteria	SPE-107696 - Engineering Evolution for an Effective Zonal-Isolation Process in Production Casings for the Antonio J. Bermúdez Basin in South Mexico	SPE-181347 - Development and Rheological Characterization of Suspension of Hollow Glass Beads
SPE-134336 - Cementing In Unconsolidated Sand West Delta Deep Marine Fields, A Case History	SPE-165796 - Prehydrating High-strength Microspheres in Lightweight Cement Slurry Creates Value for Offshore Malaysian Operator	SPE-178772 - New Approach In Lifting Cement In Highly Depleted And Naturally Fractured Formations	SPE-104066 - Superior Zonal Isolation Provided by Ultralightweight Cementing Technology Increases Profitability of Wells in Difficult-to-Cement Areas	SPE-119535 - Guidelines for Appropriate Application of Non-Foamed Ultra-Lightweight Cement Slurries
SPE-113090 - Evaluation and Optimization of Low-Density Cement: Laboratory Studies and Field Application	SPE-163083 - Improving Heavy-Oil Well Economics with Hollow Microsphere Cementing Solutions: Case History	SPE-175918 - Achieving Top of Cement; An Engineered Solution for Loss Zone Wells in the Bakken	SPE-102229 - Zonal Isolation Within Highly Fractured Carbonates in Southeastern Mexico—Special Cementing Operations	SPE-106053 - Innovative Ultralightweight Spacer for Cementing Jobs Without Nitrogen or Diesel
	SPE-158092 - High-Strength, Low-Density Cement Pumped On-the-Fly using Volumetric Mixing Achieves Cement to Surface in Heavy Loss Coal Seam Gas Field	OMC-2011-083 - New Class Of Microsphere Improves Economics And Allows Circulation Where Previous Designs Suffered Losses: A Case History	SPE-98124 - Ultralightweight Cementing Technology Sets World Record for Liner Cementing With a 5.4 lbm/gal Slurry Density	SPE-94541 - New Technology for the Delivery of Beaded Lightweight Cements
	SPE-132694 - Designing of Ultralight Slurry for Liner Cementation: Case Study	SPE-114143 - Applications of Ultra Low Density, Operationally Simple, Non–Foamed Cement Slurries — Case Histories	SPE-92970 - New Ultra-lightweight Cementing Technology Proven with Case Studies, Combines Benefits of Current Leading Methodologies	
	SPE-101810 - Lightweight Slurries—A Success Story of Application in Low-Fracture-Gradient and Depleted Fields for Improved Cementation	SPE-97847 - Case Study of Ultralightweight Slurry Design Providing the Required Properties for Zonal Isolation in Devonian and Mississippian Central Appalachian Reservoirs	SPE-92187 - Preventing Lost Circulation Using Lightweight Slurries with Reticular Systems: Depleted Reservoirs in Southern Mexico	
		PETSOC 2003-125 - A Comparison Between Foamed and Lightweight Cements		

Obtenga más información en

3M.com.mx/glassbubbles

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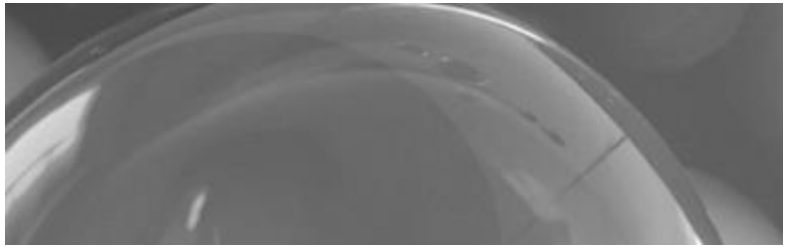
How do 3M™ Glass Bubbles compare?

Density reduction for cement slurries:



Can be achieved by:

- Water extension
- Foaming
- Adding hollow microspheres
    - 3M™ Glass Bubbles
    - Other glass microspheres
    - Cenospheres: byproduct of coal combustion at thermal power plants.

Advantages of 3M™ Glass Bubbles

vs. foamed cements

- More homogeneous slurries
- Do not require specially trained operators and highly energized equipment.

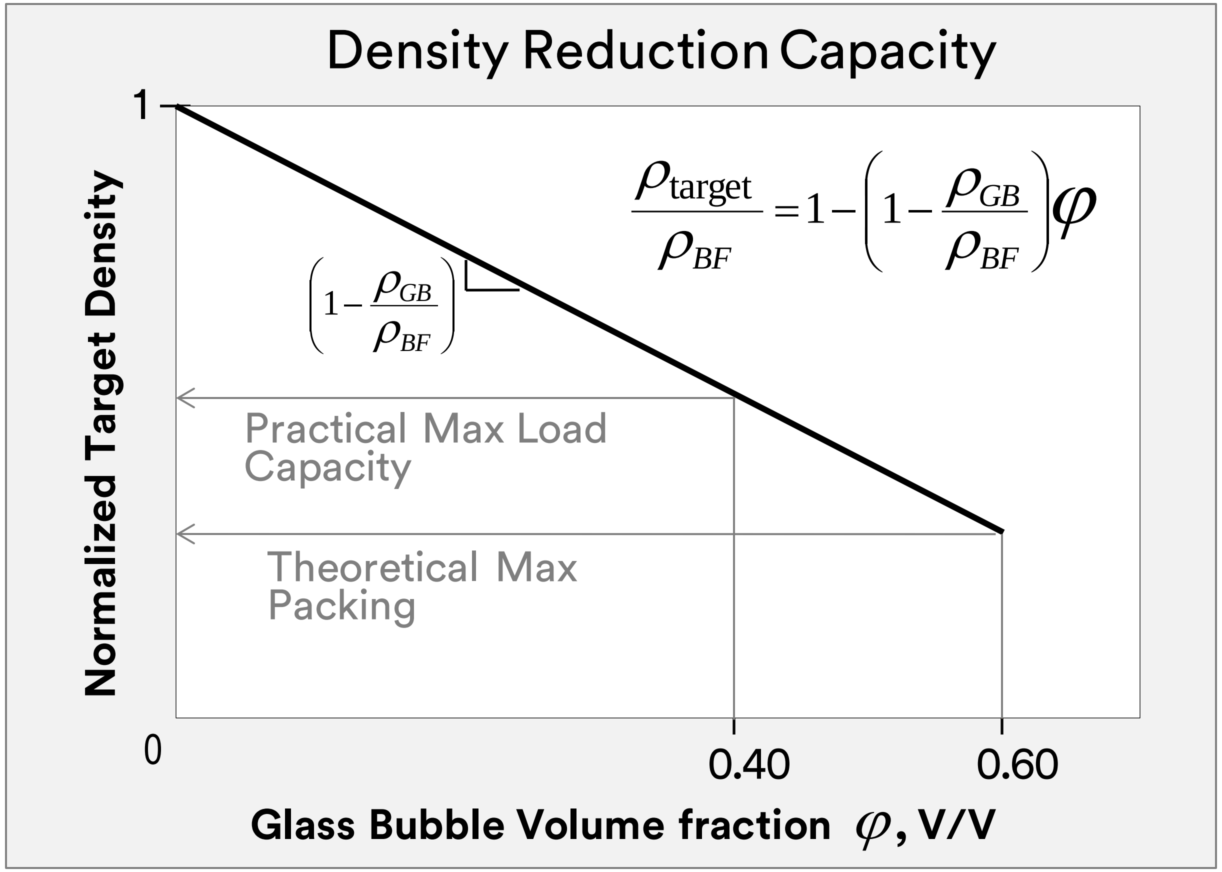
vs. other microspheres

- Consistency batch-to-batch, location to location.
- Greater density reduction capabilities.
- Better performance

Lightweight Drilling Fluids

Formulating with 3M™ HGS Glass Bubbles

- Actual Max Load Capacity will *be dictated by* the ***desired*** drilling fluid rheological properties
- Rheological properties are ***determined and adjusted*** while formulating in the lab
- Practical Max Load Capacity is in the 30-40 volume% range.



Case Studies
Handling, Mixing and Blending

SPE-119535 (2009)

Dry blending and bulk handling

- To achieve a homogeneous dry blend: a layer of 1/3 of cement is added to the batch blender followed by a layer of 1/3 of the microspheres and so on.
- Transfer to the silos should be done at the lowest pressure possible to avoid losing a portion of the microspheres to the vent line or dust collectors.
- Minimize number of transfers from the blending plant silos to the rig silos to prevent segregation.

SPE-158092 (2012)

Volumetric Mixing

- A slurry with 'low rheology' was designed to achieve desired equivalent circulating density ECD.
- The slurry's low solids-to-water ratio (SWR) and large slurry volume required the job to be mixed and pumped on-the-fly using an automated volumetric mixing system rather than using density mixing.
- A successful production casing cement job with returns to surface achieved, setting a new standard in the field.

SPE-196262 (2019)

Liquid bead solution for Lightweight Cement Slurries

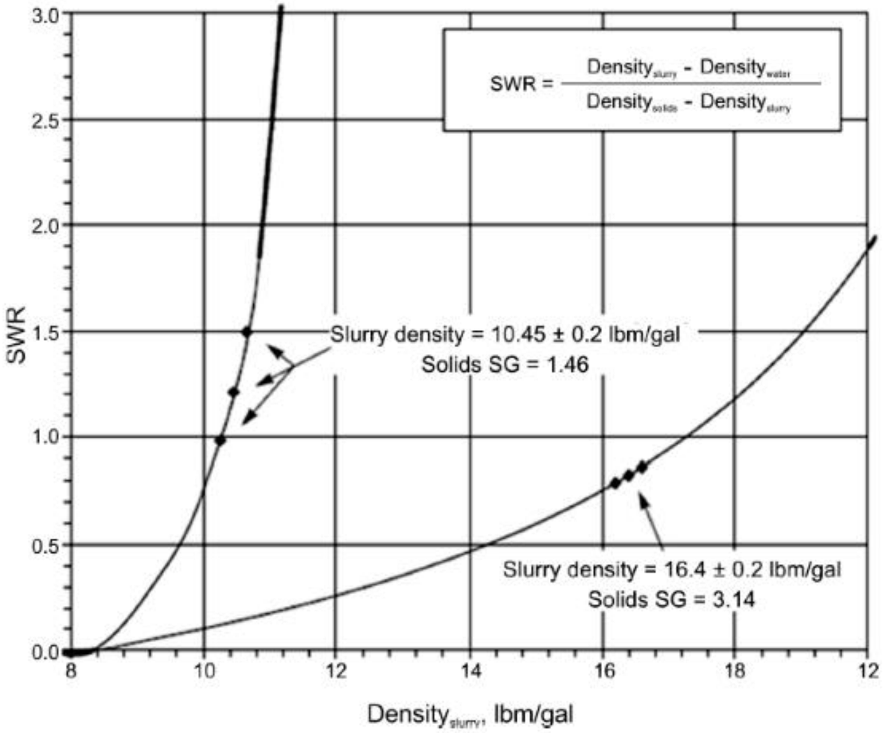
- Help reduce the need for dry bulk blending.
- Beads stabilized within a fluid as another liquid additive.
- Liquid beads can be added to cement slurries using liquid additive pumps.
- Brunei operation: A mobile injection skid developed to inject liquid beads at a predetermined rate into the suction header as the base slurry is mixed and pumped.

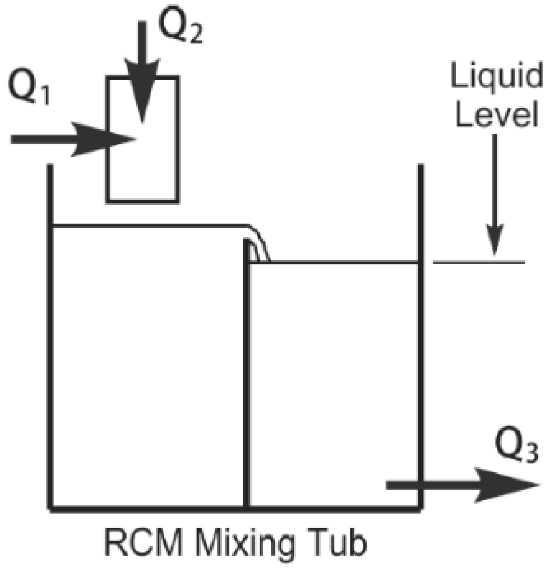
SPE-158092 (2015)

High-Strength, Low-Density Cement Pumped On-the-Fly using Volumetric Mixing Achieves Cement to surface in Heavy Loss Coal Seam Gas Field

B. Tan, SPE; **M. Lang,** SPE, HAL; and **D. Harshad,** SPE, Santos

- For some lightweight slurries, minor density changes can have a drastic impact on the solid water ration (SWR) affecting pump time, viscosity, fluid loss and strength





On-the-fly volume-based mixing examines changes in volume of the mixing tub, and then accordingly changes the volume of solids or mix water.

Case Study – Defining bubble specification

Example Formulation and Grade Selection Criteria

SPE-102220 (2006)

Ultralightweight and gas migration slurries – Excellent solution for gas wells

- Optimized particle size distribution and high packing volume.
- Low water content to minimize porosity and permeability, enhancing zonal isolation in gas wells.
- Use of two anti gas migration additives to reduce permeability, improving mechanical properties.

SPE-182399 (2016)

Glass Bubble grade selection criteria

Microsphere performance at pressure criteria (i.e. effective density vs pressure curves) offer the potential to:

- Maximize the potential for stronger cured cements
- Minimize cost in use by reducing the amount of lightweight additive required to achieve the target density

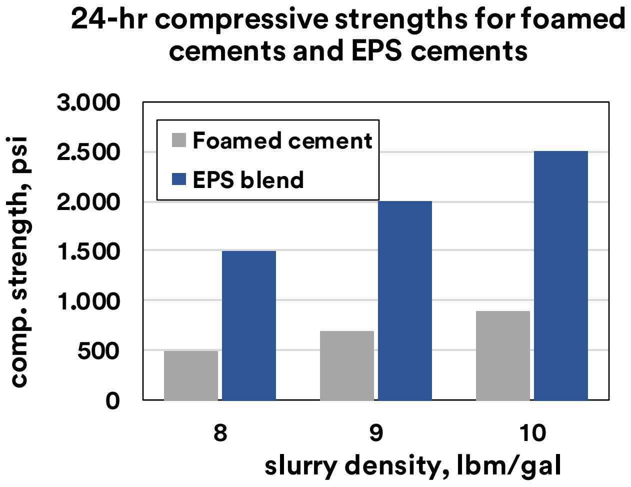
SPE-193350 (2018)

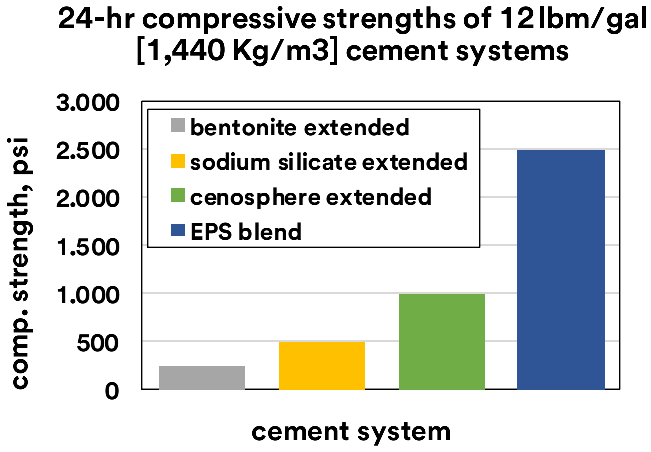
Design and Application of New High Performance Lightweight Thermal Cement

- A high quality lightweight thermal cement with excellent long-term mechanical properties was successfully developed and deployed.
- Desired slurry properties (controllable thickening time, zero free water, low fluid loss and short WOC) was achieved through **cost-effective** additive adjustment.
- After initial optimization of blending process, a 100% success rate was achieved over the course of more than 20 jobs.

Case Study: Microsphere Cement Systems

Well Cementing – **Nelson and Guillot**, 2^{nd} Edition (2016)





Advantages

- Simple – cement, water, and microspheres (plus regular additives)
- No need for specialized equipment/personnel
- Incompressible – mixing density (surface) equals downhole density
- The design yield equals the actual yield
- Excellent slurry stability over a wide range of temperature
- No pressure/depth limitations (if the right grade is used)
- Optimum cured cement compressive strength and gas migration control
  - EPS (Engineered Particle Size) blends
  - Maximum solid/Min water content

Disadvantages

- Cost of materials (GB vs N2 & surfactants)
- Rig space – large volumes (microsphere/cement blends) to be handled
- Inability to change slurry density "on the fly"

Case Studies - Cementing

3M™ Glass Bubbles Compared to Other Technologies

PETSOC 2003-125

$1.3M saved by switching stage collar jobs to microsphere cement

- A microsphere cement job is 39% less expensive than a similar foamed cement job"
- 100% success at maintaining annular isolation and achieving cement returns (54-well study switching foamed cement microsphere cements)
- Returns and zonal isolation in all cases (51-well study switching stage collar jobs to microsphere cements)

SPE-98124 (2006)

Ultra-Lightweight Cementing Technology Sets World Record for Liner Cementing With 5.4 lb/gal slurry Density

- A special base (microsphere) slurry was developed that would be stable at 7.6 lb/gal and still have enough strength to withstand the strength reduction induced by foaming the cement density down to 5.4 lb/gal.
- Zonal isolation saved 9.3 rig days on Cantarell 3085D at $325,000/day ($2MM total at common offshore rig rates).
- **This success allowed the elimination of a casing string in two of these five wells.**

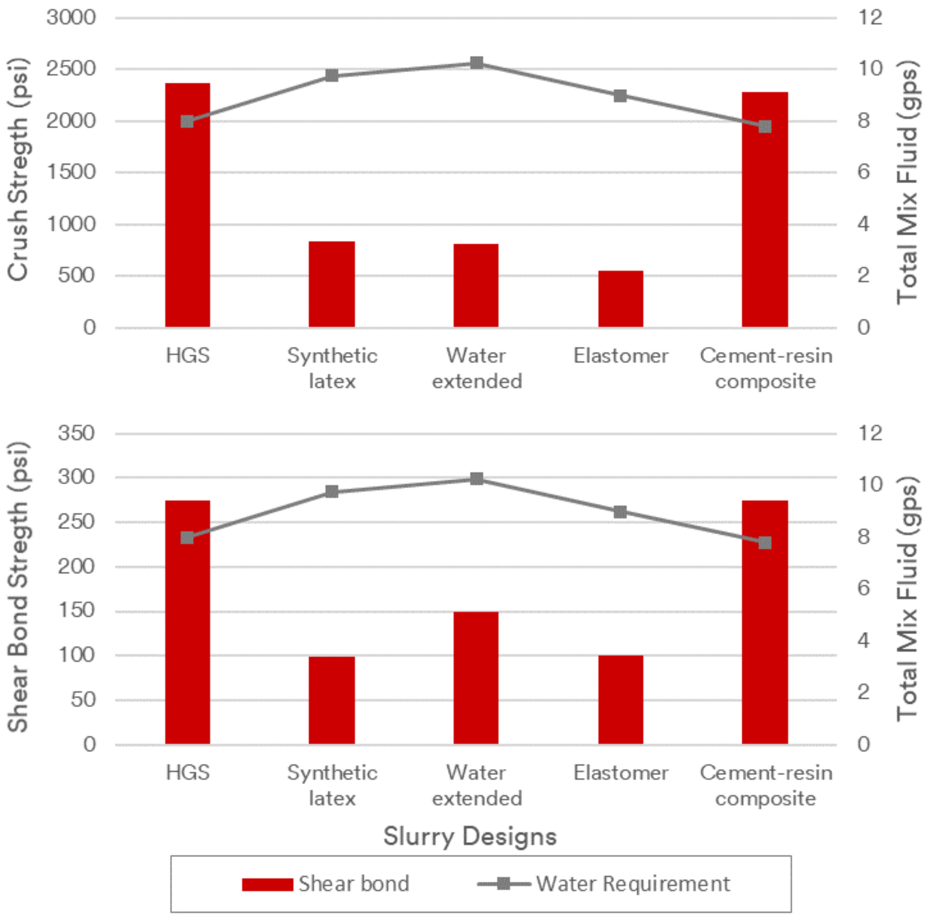
SPE-92187 (2004)

Significant cost savings to the operator compared to foam cements

- The operator cost savings are approximately 150% vs. cost of using foam cements.
- HPLW slurry systems combined with reticular-fiber technology are a highly effective way of combating lost circulation.
- Increase probability to achieve TOC in production-critical cements jobs requiring high quality zonal isolation, avoiding remedial cementing operations.

SPE-194918 (2019)

Comparative Study of the Mechanical Properties of Reduced Density Cements



Figures 3 and 4 – Crush strength (top) , Shear bond (bottom), and water requirement

Tables 3 & 4 – UCA and Braziliant split test results

Slurry Design	Time for 50 psi (hh:mm)	24 Hrs Stregth (psi)	48 Hrs Stregth (psi)	Split Test (psi)
HGS	13:08	1029	1933	155
Synthetic latex	10:59	278	465	84
Water extended	13:10	162	329	86
Elastomer	12:06	422	728	109
Cement-resin composite	9:55	579	1177	103

- **Early Strength** – Development A delay during Crush Strength (CS) development increases WOC, which, in turn, increases rig costs. In this respect, the slurry should develop strength of 500 psi or greater within 24-hours time.
- **Shear Bond** – Low shear bond values indicate poor bonding to casing and cause poor zonal isolation. Additionally, it indicates the possible formation of microchannels causing fluid flow.
- **Tensile Strength** – Cements with lower tensile strength are more prone to failure because of cracking.

➢ To have long-term zonal isolation, it is desired to have good CS.

➢ Increased tensile strength and shear bond favor long-term cement sheath integrity.