



Science.
Applied to Life.™

3M™ Glass Bubbles
For Explosive Formulations

**Force.
Multiplied.**

More firepower, to move more rock.

Tiny, lightweight spheres help you do the heavy lifting.

Faced with rising expenses and slumping commodity prices, virtually every sector of the mining industry is being challenged to improve productivity and reduce costs. 3M™ Glass Bubbles, used as a sensitizer in explosive formulations, can help you meet that challenge, by enabling more powerful, predictable and controllable explosions that move more rock.

The choice of sensitizer is important in determining the effectiveness of an explosive charge, providing the internal voids crucial to efficient detonation. That is essentially what 3M glass bubbles are: perfectly round, low-density, pre-manufactured voids. By using 3M glass bubbles, you can expect high velocity of detonation (VOD) every time.

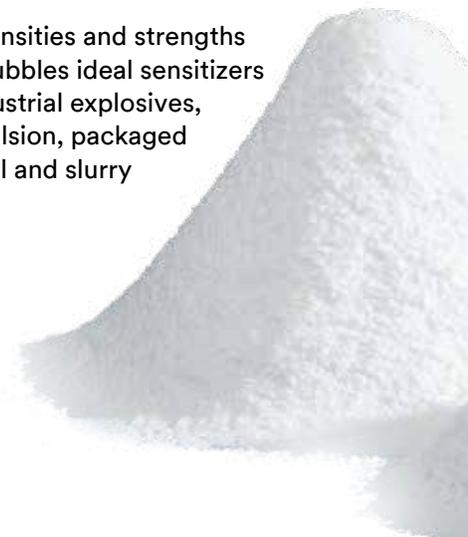
The greater fragmentation provided by high VOD means:

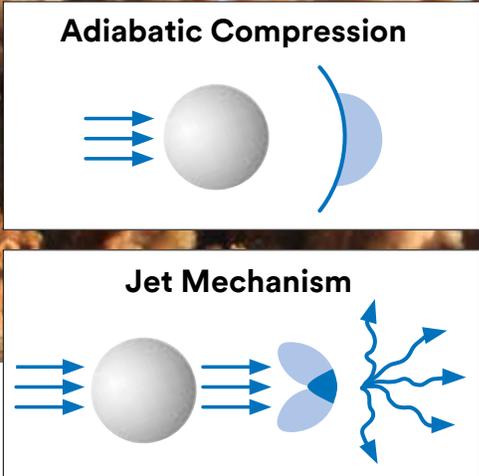
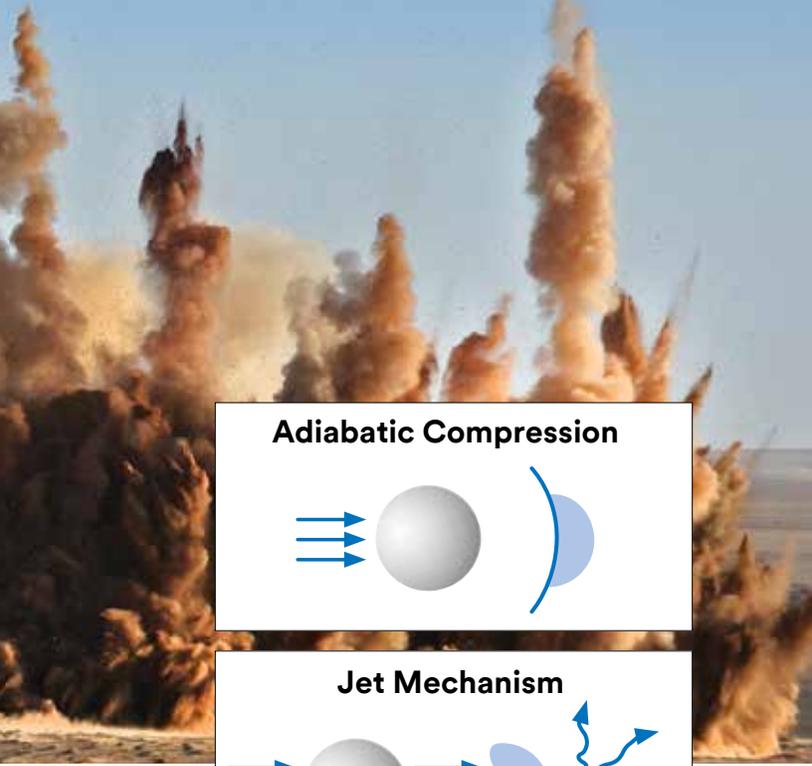
- ▶ Reduced secondary blasting
- ▶ Reduced energy consumption
- ▶ Increased powder factor
- ▶ More tons per hour processed
- ▶ Lower cost per ton of rock moved

In addition, 3M glass bubbles offer stable, consistent performance over a wide timeframe:

- ▶ Pre-manufactured voids mean highly consistent, repeatable performance
- ▶ Rigid-walled, hollow spheres give explosives stability over time, temperature and pressure
- ▶ Discrete particles allow easy addition and uniform distribution
- ▶ Non-coalescing voids allow longer “sleep” time
- ▶ Wide range of available sphere strengths minimizes dead pressing

A wide range of densities and strengths makes 3M glass bubbles ideal sensitizers for a variety of industrial explosives, including bulk emulsion, packaged emulsion, water gel and slurry explosives.





The science behind the blast

All explosives require density discontinuities to sustain the detonation wave and increase the sensitivity. These density discontinuities are commonly referred to as “hot spots”. There are several theories as to how these hot spots function, such as temperature increase by adiabatic compression or energy transfer via a plasma jet. Whichever theory one accepts, it is known that hot spots should be small in size, low in density, homogeneous in distribution and stable over time, temperature and pressure. 3M™ Glass Bubbles satisfy all these requirements.

Bulk explosives

Because dead pressing is not a major concern in bulk emulsion explosives, very high-strength glass bubbles are not necessary. Instead, high VOD and stable, consistent performance can be achieved with more economical, lower density 3M glass bubbles.

3M recommends evaluating and using grades K1, K15 or K20 for best results.

Packaged explosives

For the tight pattern explosions commonly utilized to blast through hard rock, dead pressing is an important issue. 3M recommends evaluating and using a glass bubble sensitizer strong enough to survive the shock wave from an adjacent borehole. 3M™ Glass Bubbles K15, K20, K25, S32 and K37 are ideal sensitizers for packaged explosive applications.

Product	Density g/cc	Strength psi at 90% survival	Suggested Loadings* weight%
K1	0.125	250	1.6
K15	0.15	300	2.0
K20	0.20	500	2.8
K25	0.25	750	3.6
S32	0.32	2000	4.9
K37	0.37	3000	6.0

* Assuming a base emulsion density of 1.40, and a target sensitized density of 1.20. These mixtures could be class 1.1 #8 cap sensitive emulsions. For Class 1.5 blasting agents lower levels of 3M glass bubbles should be evaluated.





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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