TERVES
ENGINEERED RESPONSE

Terves Frac Balls

Next-Generation Materials Improve Completion Performance, Reduce Cost

TervAlloy frac balls— Self-clearing metallic balls eliminate flowback and drillout challenges

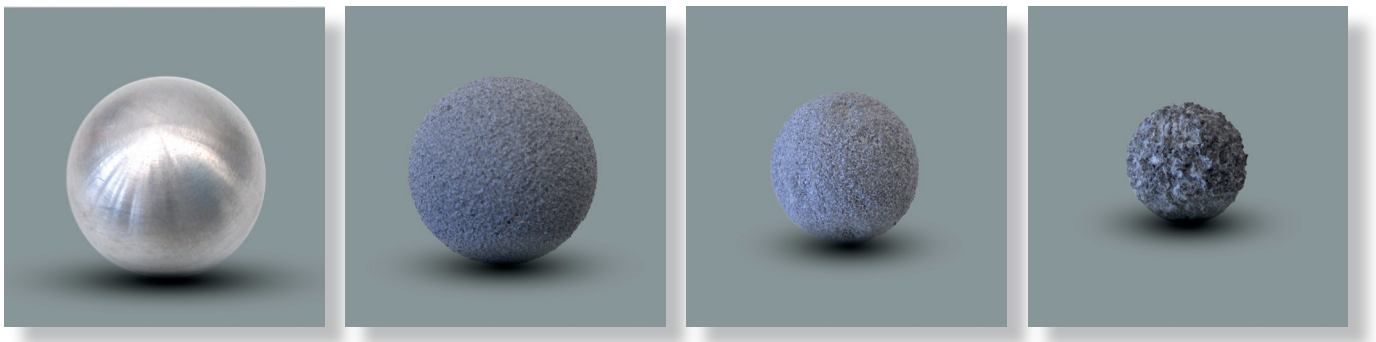
Oil and gas operators in unconventional basins throughout North America have recognized the advantages of dissolvable frac balls in horizontal multistage completions. Now, next-generation and best-value TervAlloy™ frac balls make these interventionless, unconventional completions even more reliable and cost effective. TervAlloy dissolvable magnesium alloy balls save time and reduce completion costs. They eliminate the need for ball flowback, millout and well cleanup operations, and provide unrestricted flow during production. TervAlloy dissolvable metallic balls are designed for sliding sleeve, caged ball and large-ID plug applications, offering industry-leading reliability, cost and performance, particularly in big-ball systems.

Innovative alloys provide the most reliable and cost-effective dissolvable balls

Terves patent-pending TervAlloy alloys are proprietary magnesium alloys that deliver improved performance and value compared to previous dissolvable metals. TervAlloy materials offer high toughness and ductility comparable to aluminum, allowing higher landing velocities in big-bore systems without risk of catastrophic failure. In big-ball (more than 1/16-in. seat overlap) systems, TervAlloy balls consistently test to higher pressures, and show lower failure rates than competing polymer and powder metallurgy fabricated magnesium balls.

Mechanical Properties	TAx-100E	TAx-50E	Z-1000C
Ultimate tensile strength (ksi)	40	40	34
Yield strength (ksi)	30	30	17
%E	8	9.5	5
Specific gravity	1.9	1.9	1.8
Dissolves in	KCl	KCl	Acid
Dissolution rate at 200°F, mg/cm^2 × hr	50	25	990

- Any size may be specified, from 0.75 in. to 4.8 in.
- Standard tolerances are ±0.005 in.; tighter tolerances available upon request
- KCl/brine, acid and freshwater alloys available
- Response™ temperature and chemically triggered coatings available for caged ball and acidizing applications
- Balls machined using modern twin-spindle CNC machines
- All balls are 100% inspected.
- Engineered for better reliability
- Balls do not shrink, swell, distort or balloon.



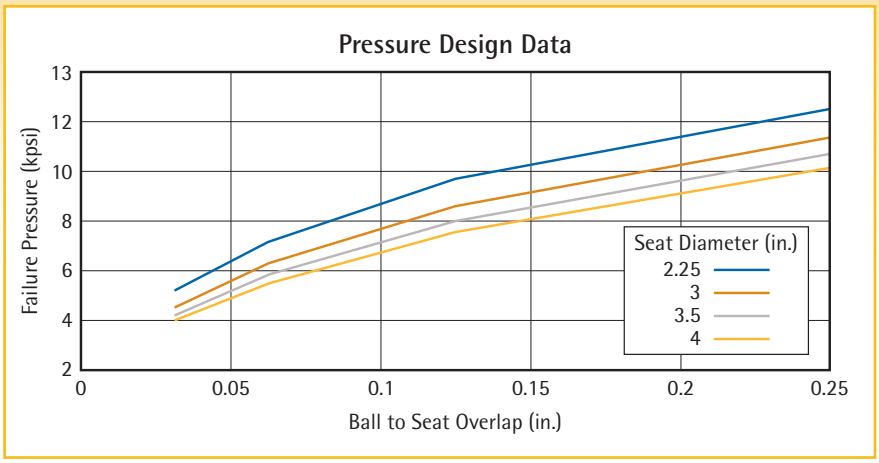
Disintegrating frac balls hold pressure during fracturing and disappear to enable production, reducing the need for milling and well cleanup operations.

Easy to handle, seal at high pressure

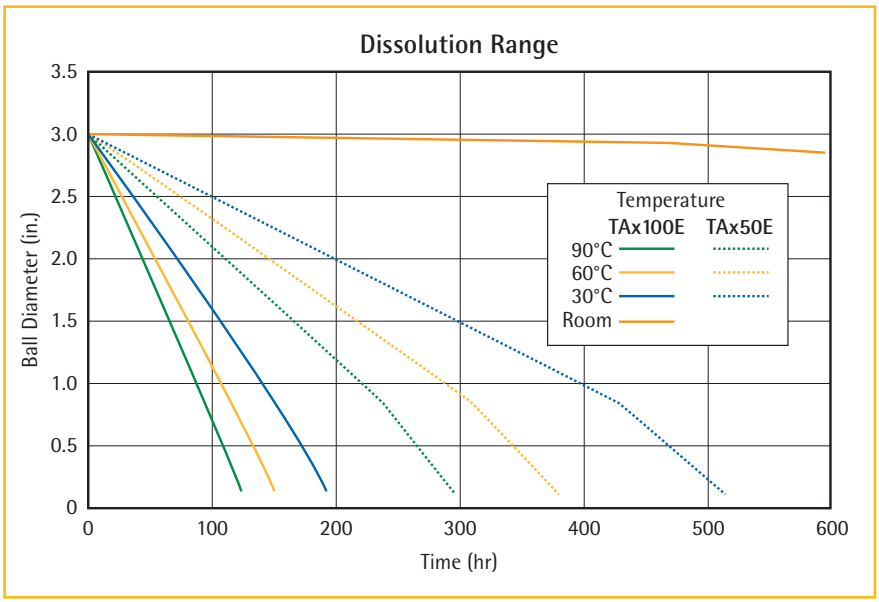
With their high ductility and strength, TervAlloy balls reliably actuate sleeves or seal large-bore frac plugs at pump pressures up to and exceeding 10,000 psi, depending on ball and seat sizes and seat materials. Once deployed, TervAlloy balls respond to wellbore fluid and downhole temperature and dissolve rapidly into nontoxic, environmentally friendly compounds, coming off seat in 4 to 12 hours and dissolving completely over several days. Compared to previous aluminum- and magnesium-based reactive metal composite balls, TervAlloy balls are less likely to hang up, degrade or fracture in ball drop systems, and can be handled and stored without difficulty or special precautions.

Engineered for high strength and controlled dissolution

Using patented alloys and microstructural engineering and design processes, Terves has developed a range of TervAlloy Engineered Response Magnesium Alloys, with usable tensile strengths of 40,000 psi. Different alloys are available with dissolution rates engineered for different completion fluids and well temperatures. TAx-100E, a high-strength alloy with a dissolution rate designed for typical onshore applications, is the most common TervAlloy material used for frac balls. In addition to standard TA100x, slower-rate, acid and freshwater dissolvable alloys are available upon special request.



Recommended pressure rating vs. seat overlap and ball size for TAx-100 alloys based on 30° seat angle.



Dissolution rates for TAx-50 and TAx-100 alloys at select temperatures in 3% KCl solutions.

At Terves, we believe materials should do more and do it without compromise. We engineer our products from the atom up, and tailor them with our customers' input to provide rapid and unique solutions. For more information and to learn how Terves can meet your engineering requirements contact:

Terves, Inc.
24112 Rockwell Drive
Euclid, Ohio 44117
216-404-0053
sales@tervesinc.com

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www.tervesinc.com