Different Proppants, Different Results

By Tina Ding

Historically speaking, hydraulic fracturing can be traced back to the 1940s. Only in recent years, energy exploration and expansion prompted its large scale use. Drilling horizontally from the end of a vertical bore hole offers a stimulation process to extract or mitigate oil from reserves far beneath the earth's surface.

By pumping pressurized water, chemicals and proppants into the well — effectively fracturing the surrounding rock formation — otherwise trapped oil flows freely through the fractures and wellbore back to a production well. The process of mitigation is costly. Gallons upon gallons of water provide the pressure (with chemical additives for increased fluid flow) while proppants prop open the fractures.

Suitable frac sand varies from one company in production to another as well as from one expert consultant to another. Dependent upon the business model or expectation for a given drilling company, the materials used may be inconsistent among wells. Commonalities do, however, exist.

Business owner and consultant for FRACN8R, Monte Besler considers roundness and sphericity of grains to be critical in the selection of proppants so they might stack well, reducing the potential for crushing, thereby closing the path of flow.
"Roundness refers to the smooth, round surface of the proppant, such as an egg," Besler said, "not so much a perfect sphere as much as a round particle free of sharp, irregular edges. On the other hand, sphericity of a proppant describes it's perfect round form; however a sphere might have dimples — such as a golf ball. Having both roundness and sphericity is optimal for free flow of oil."

Further, Besler likens effective proppants to bowling balls. When stacked as a cube (four balls with four balls stacked directly on top), oil flow is optimal. If stacked as a rhombus (four balls stacked with the layer above offset slightly to sit somewhat between the first layer of balls), oil continues to flow, at a slightly reduced rate. The use of mixed sized proppants (such as marbles mixed with golf balls), decreases the flow dramatically, since the varied shapes settle into one another.

Quartz sand works; resin-coated sand works; ceramics work. No matter the product, it must possess strength enough to withhold the pressure and hold open the underground seams — as well as allow oil to flow through for recovery. Therefore, consistency in size, roundness, sphericity and strength become essential considerations.

Irregular edges on typical quartz sand coupled with its susceptibility to crushing could contribute to decreased flow and possible stress on surrounding rock. Still a very viable option for propping, sand coated with resin offers an increase in roundness, greater uniformity and an increase to crush resistance due to the encapsulation of particles, should the sand become crushed.

Silica sand offers roundness and durability to support the task. Smooth edges — again for flow — make this a desirable yet affordable option. Found near the earth's surface, viability for mining is great. Proximity to transportation is another bonus, such as is the case in southeast Minnesota's silica rich ground. Ceramics, although manufactured versus mined and crushed, steps up strength, roundness, sphericity — at a price.
Today's market prices for quartz sand are about 16 cents per pound and about 89 cents per pound for ceramic beads, adding up when some 2 million pounds of proppant are needed for each well.

Associate Director for Research at the University of North Dakota Energy and Environmental Research Center John Harju said, "The North Dakota Industrial Commission recently completed a technical study on materials and their resistance to crush, their productivity as well as longevity as a result of exposure to frac fluids. We found ceramics to maintain a steady sphericity and roundness, even when breaking. The tendency to impede flow due to breakdown is minimal."

Additionally, they considered embedment of the material in the rock surrounding it and learned most proppants will, to some extent, lose effectiveness by crushing into the sand around it. "All are in play at any given time," he said. Further, he said, "In the state, we're looking for the viable sources of parent materials to produce the ceramics in clay from our state; however we'd need to process it to make it a high quality ceramic." Neighboring states provide natural materials not readily found in North Dakota to do the job.

South Dakota holds a variety of sandstone deposits — the Geological Survey has begun work to inventory deposits statewide to find suitable fracking sand for mining.
In Wyoming, frac sand is rail car transported before being transloaded to trucks. In some cases, those sands are trucked to various locations, to include the Bakken play in North Dakota.

Minnesota holds extensive silica sand deposits at land surface; however there are some moratoriums in place. Arguments for lifting them include a potential to provide jobs in rural areas; expansion in the industry could potentially pay better wages; and the possibility of Minnesota becoming part of the thrust to promote and expand the availability of natural gas and oil. Frac sand is also mined in Wisconsin, Iowa and Illinois.

The flip side holds arguments as well: drawing water from aquifers poses a contamination risk to neighbors; silica dust from sand blasting poses occupational risk (inhalation) — contamination to neighbors is not yet determined; truck traffic could be exponentially greater; and a large mine would leave a scar on the surrounding landscape. Anthony Runkel, Chief Geologist for the Minnesota Geological Survey said, "Sand in this area dates back 500 million years. As bedrock, it falls apart into perfectly formed little sand grains. Made of a higher concentration of quartz, 99 percent of the resulting sand grains are spherical."

Harju has seen a steady use of ceramics over time. “Ceramics have proliferated in their use in Bakken drilling and completion,” he said. “More recently, we’re seeing combinations of sand and ceramics. The increase of ceramics over time demonstrates a potential push toward greater performance in well production.” However, he added each producer establishes its goal for performance: some seek faster yields with a higher cost of production, and others seek slower yields with a lower costs of production.

“We’re starting to see niche products evolve,” Besler said. “In the past we’ve seen glass beads (exploded to dust) as well as walnut shells or BBs — and we’re seeing some rod shaped proppants marketed. Another ceramic out there is ‘magnesium silicate’ from the mantle of the earth. Obviously it’s fairly strong and heat tolerant — which fairs well for ceramics.”