

## ADVANCED MATERIALS

### GELS ARE BEST SHAKEN, NOT STIRRED

James Bond believes martinis are better shaken, not stirred. As it turns out, shaking instead of stirring also can produce better gels.

With MDA SBIR funding, Resodyn Corporation (Butte, MT) is building industrial mixers that offer significant performance improvements in gel manufacturing. The mixers use sound instead of rotors to shake gels, improving quality, speed, and safety. They should find use in the pharmaceutical, processed-food, and chemical industries as well as in propellant manufacturing.

The company's technology works by inducing low-frequency resonant sonic (LFRS) energy in a fluid, resulting in an increased rate of energy dissipation per unit mass of the fluid and allowing rapid and efficient dispersion of solids, gases, and immiscible liquids. Resodyn's technology—essentially a vessel with no moving parts inside—runs at approximately 50 to 100 hertz. A proprietary, patent-pending drive system on the outside of the vessel serves as the resonant mechanical driver that radiates an acoustic-energy field that mixes the vessel contents. "You end up in essence causing an earthquake within that material," said Lawrence Farrar, Resodyn's president. "In other words, you are able to fluidize materials as is caused by an earthquake situation. High-G loads are put on that material."

As to safety, Resodyn's method of mixing materials does not require the cleaning of rotors or mixer blades, meaning less handling of potentially hazardous equipment or material by workers. In addition to safety, the technology brings speed. Mixing time can be trimmed from more than an hour to just a few minutes. And compared with conventional propeller-driven mixing, Resodyn's technology brings the benefit of greater density by

reducing the potential for gas bubbles, which can degrade the overall quality of the material being mixed.

MDA funded Resodyn's technology through a \$2.16 million contract to develop a 1-gallon bench-scale machine, with the greater goal of creating a production-scale unit that can handle as much as 50 gallons. The MDA contract focuses on high-density metallized gel propellants for a divert and attitude control system in the Theater High Altitude Area Defense (THAAD) program. Loading gels with metallized nanomaterials increases the burnable surface area within a propellant and generates a higher specific thrust. Gel propellants also are considered safer than liquid propellants because they do not have the same tendency to leak.

Dow Corning already is using a Resodyn industrial machine to mix viscous materials at an extremely pasty 100 million centipoises in five minutes, compared with conventional methods that might take as long as an hour and a half. (The viscosity of water is 1 centipoise. The higher the number, the more viscous the material.) Resodyn makes only the machines, not the gels, and the company expects to fill more orders in coming months, including one from the U.S. Army.

Resodyn officials estimate their market size at hundreds of millions of dollars since many industries have very specific mixing needs for the substances they produce. The pharmaceutical industry, for example, mixes materials that might include fungi, E. coli, or mammalian cells. Conventional mixing methods involving propellers would require running equipment at high speeds to produce the desired high degree of gas-liquid mass transport (the movement of gas into a liquid during the mixing process). But

the high speeds of the propellers can destroy cells being mixed. Resodyn's technology, however, could produce good gas-liquid mass transport with little or no cell damage. The company's technology also should work especially well in mixing fumed silica—a fluffy, light material that is difficult to mix.

Resodyn continues to focus on the challenges of market acceptance for its technology as well as assessing market opportunities. But the 28-person company is preparing for growth and is adding about 15 employees, including biologists, mechanical engineers, and chemical engineers.

—S. Tillett

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**All shook up.** Resodyn's equipment uses sonic energy instead of rotors or blades to mix materials.