Entrepreneur teams with scientists to bring vaccines to far reaches of the world

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Sandia National Laboratories chemist Eric Coker, left, looks over shipping containers developed by Santa Fe businessman Bruce McCormick that safely transport and store temperature-sensitive vaccines and biopharmaceuticals. Coker helped McCormick create a solar thermal icemaker to provide cooling for the containers. They worked together through the New Mexico Small Business

Assistance Program. Credit: Randy Montoya

Getting life-saving vaccines to the most remote parts of the world is no easy feat. Biopharmaceuticals are highly sensitive to heat and cold and can perish if their temperature shifts a few degrees.

"The vast majority of the world's population lives in areas where electricity and refrigeration are not reliable," said Bruce McCormick, president of SAVSU Technologies of Santa Fe. "It is difficult to get vaccines to these areas. We're talking several billion people."

McCormick, an inventor, knew about the obstacles in vaccine distribution in developing countries. Vaccines and other biologic materials, such as blood, tissue, genes, stem cells and proteins are made of living organisms that degrade in warm temperatures until they are no longer effective. And freezing is an even bigger danger. "Seventeen to 39 percent of all vaccines are exposed to freezing temperatures through improper storage, and it kills them," he said.

With technical help from Sandia National Laboratories through the New Mexico Small Business Assistance Program (NMSBA), McCormick has developed a solar thermal icemaker to cool high-performance shipping containers that safely transport and store temperature-sensitive vaccines and biopharmaceuticals. Thousands of the systems are now being used throughout the world.

Ice can cause inadvertent freezing

Vaccines are often transported to remote places in coolers not powered by electricity or fuel, but using some form of ice. For most vaccines, the temperature must stay between 2 and 8 degrees Celsius (36 and 46

Fahrenheit).

"Inadvertent freezing is the result of good intentions," McCormick said. "The vaccines are in a cooler going from point A to point B. Ice is the primary means of thermal storage, and the feeling is that more is better. The vaccines end up freezing."

Transportation is hard to manage, and the range of vaccine distribution is limited by how long a cooler can maintain the proper temperature. "If you have a cooler that can keep the vaccine alive for 24 hours, that's how long you have to load, bring it to the village, community or health care center and administer," McCormick said. "As a result there are complicated logistics in moving the vaccines from, for example, a national distribution facility where they have reliable electricity to a remote clinic. But they have to get there. It's referred to as the last mile."

Five years ago, the Program for Applied Technology in Health (PATH), a Seattle-based nongovernmental organization that promotes new health technology globally, issued a challenge to industry to improve vaccine transport.

McCormick, who has experience building insulated products and working with nanoporous materials, formed SAVSU (State of the Art Vaccine Storage Unit), teamed with a company that does industrial coatings, put together a prototype—and won the challenge.

His first container, the NanoQ, is a box that holds separate cases for ice and the vaccine payload, designed with super-insulating materials that reduce heat transfer. It stores vaccines in hot environments for up to 10 days. A thermal buffer keeps the contents from inadvertently freezing.

The system uses ice because it goes to places where there are no special resources and water is common. "It's simple to operate. People don't need to be trained," McCormick said.

PATH asked if the box could store medicines longer than 10 days if the ice was swapped out. Replacing the ice would require refrigeration in areas where electricity is unreliable. "Even in big cities there are power outages," McCormick said. "You have to have power running 24/7 with no interruption when you use standard refrigeration systems."

Chemist gives entrepreneur a hand

McCormick turned to NMSBA, , which pairs entrepreneurs with scientists at Sandia and Los Alamos national laboratories. The state-funded program was established in 2000 by the New Mexico Legislature to help small businesses get technical support from the labs. It has provided $39 million in assistance to 2,195 companies in 33 counties. The help is free of charge to the business.

The challenge was to make the NanoQ a long-term storage device instead of just a transportation container. Ice would have to be made in the field. "I found information about a large solar icemaker made at Sandia in the 1980s using a refrigeration technology called adsorption," McCormick said. "I wanted to find one of the original engineers on the project."

They had retired and the project was defunct, but through NMSBA McCormick was paired in 2011 with Sandia engineer Brian Iverson, who found an old version of the solar icemaker at the labs. Brian took it apart, studied the design and the notes of the original team, and set about making a better one using new technology.

"Bruce needed a passively driven refrigeration system," said Iverson, now a professor at Brigham Young University. "I started digging into who had worked on the project, what the system's components were made of, and the process by which ice is made using solar energy."

Sandia physical chemist Eric Coker joined the project. "Brian did the engineering and I took his recommendations and applied chemical knowledge to fill in the design gaps," Coker said. "I researched what materials would make it work at the scale Bruce needed. It had to be portable and completely off grid with the only inputs being sunlight and water."

Coker and Iverson delivered a workable design. The icemaker has a 1-meter-square solar collection area, a condenser and evaporator. Thermal energy is collected and the heat drives a fluid, in this case methanol, out of a porous carbon material.

The fluid moves by gravity to the condenser where it liquefies. At night, when heat is no longer driving fluid off the carbon, the condensed liquid evaporates and the gas is absorbed back into the carbon, drawing heat from the environment. That reaction has a cooling effect that freezes water in a trough, creating from 2 to 12 pounds of ice a day. "It needs no electricity or photovoltaic cells. It's a refrigeration cycle," Iverson said.

McCormick said the icemaker is key to SAVSU's ability to offer the NanoQ to international agencies as a permanent replacement for costly, impractical refrigeration systems. "They go together," he said.

Helping Third World get vaccines 'a good feeling'

McCormick has developed two other products, the CryoQ, for materials that need to be shipped at deep-frozen temperatures, and the PHD, for small-volume shipments. SAVSU products transport and store all kinds of biomaterials used to treat disease.

Coker, who has been at Sandia 13 years, said it was exciting to work on a project that saves lives around the world. "It's a really good feeling," he said. "It's very gratifying to think the work I did could help people in Third World countries receive vaccines that are still in good shape."

The NanoQ is used at community health centers in Asia, Africa and Latin America. "We've seen it work," said McCormick. "The purpose of the boxes is to assure that vaccines are available at the community level when outbreaks occur. The NanoQ coupled with the solar thermal icemaker is a game changer in how vaccines are stored and distributed in developing countries."

Provided by Sandia National Laboratories

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