Dry Ice Replacement Proves to Be Essential Solution in Rural America

Lately, our world has been facing disaster, disease, and detriment. No one feels the effects more than rural America, as they deal with higher levels of poverty, unemployment, and disability; higher energy costs, a struggling agriculture industry, and low investment in resilient infrastructure; poor disaster preparedness, with small local governments and little to no funding for valuable federal programs (Todoroff, 2020).

While we work to find ways to prevent these extreme hardships from happening, we can also support both urban and rural America by providing the necessary aid before and when they do. Transporting preventative vaccines, lifesaving medicine and blood to clinics and users; collecting and shipping blood samples or other specimens from home visits and smaller satellite facilities; transporting food in times of need to people affected by a local disaster, poor weather, or mobility issues; and maintaining the food's quality during power outages, are all essential to preparing for and recovering from disease, disaster and detriment.

These are essential and often life-saving resources that can travel to these remote locations with safe and effective transportation and storage. This might seem simple until you consider that each of these resources require a shipping environment that maintains different and very specific temperatures.

So, let's just throw in dry ice or an ice pack, right? No. Dry ice can't hold the correct temperatures needed for extended periods of time. It is also a single-use product meaning the receiver can't reuse the dry ice to ship back blood samples if at a clinic or store their food if they received a delivery during a power outage, or simply save the dry ice in case of a future emergency. Standard ice packs aren't even considered in the conversation because they can't meet and maintain the required temperatures to begin with.

The secret is to replace dry ice and ice packs with a cold-chain solution made from phase change materials (PCMs). This looks, feel and freezes like an ice pack, but has unique chemical make-up that can hold specific desired temperatures for long periods of time. These PCMs are known for their thermal capacity – their key value stems from advanced thermal protection when transporting specific types of goods.

When PCMs rise in temperature or decrease in temperature; inducing melting or freezing or transforming from more viscous to solid matter; they continue to hold a steady temperature that is in line with their melting or freezing point. They are intriguing because they have a specific composition enabling them to go from one phase to the next at the right temperatures to be in line with specific goods' requirements.

Vaccine/Medicine Transport

To transport essential vaccines, like the COVID-19 FDA approved vaccines (Moderna and Pfizer), PCMs are equipped to store and release large amounts of energy maintaining the specific temperatures required for both. Moderna requires that it be stored and transported at -20° C and can be refrigerated from 2-8° C for up to 30 days. Pfizer can be transported at -20° C for two weeks and can be refrigerated from 2-8° C for up to 5 days. PCMs can reliably maintain 0° C (refrigerated), -7° C (frozen), -16° C (frozen), and 21° C (ultra-cold) temperatures depending on the application.

Now with new advancements in the COVID-19 vaccine, a nasal spray is available, making vaccination more obtainable – easier transport, store and stop the virus. When the nasal vaccine is released, it is likely to be the most common vaccine delivery system. According to Isabelle Dimier-Poisson, PhD, an expert in the immunology of infectious diseases at the University of Tours, and incoming general and research manager at LoValTech, a start-up that will lead development of the vaccine formulation; "The vaccine can be stored at 39 °F (~4 °C), but survives at room temperature, which makes it ideal for countries where meeting cold-chain requirements can be a challenge" (Moulun, 2022). The higher temperature requirements make storage and transportation easier, but it should also be noted that freezing temperatures will kill the vaccine. Using PCMs, the storage container or tote can maintain ambient temperatures in very hot or cold external environments.

Specimen/Blood Transport

The ease of going to your local lab, giving a blood sample for testing, and awaiting a call from your doctor for follow up and diagnosis, is often taken for granted in urban America.

For rural communities, these tests require much more advanced preparation and safeguards to create a foolproof system for packing, transporting, and storing your specimen for accurate testing once it reaches the lab. Blood is an excellent culture medium for bacterial growth, which is why maintaining a required temperature range during transport is essential to the health of the patient (Rehber, 2021).

A blood sample that is degraded could alter test results, causing a misdiagnosis. Although serious, there are even more dangerous effects from a degraded blood specimen. For instance, if contaminated blood is used for a blood transfusion, it can result in harm or potentially death to the patient. Blood and blood products must be maintained at 1-6° C for storage and 1-10° C for transport. Packed red blood cells (PRBC) that reach 10.1° C or are out of the proper refrigerated temperatures for more than 30 minutes, become unsafe to transfuse and should be disposed of.

Packing blood specimen shipments with a PCM pack creates a safe and reliable environment for transporting the specimens long distances, so that when they arrive at their destination, there is no uncertainty around their quality.

Food Transport

Rural communities make up 63% of counties in the United States and 91% of counties with the highest rates of overall food insecurity, threatening the very communities that feed the rest of America (Feeding America, 2022).

As much of America, especially rural, is feeling the results of an impending food shortage, rural America struggles with how to manage another mass disaster or disease on top of this. Many in rural America may not know what or when their next meal will be.

PCMs can be used to keep food frozen and fresh during transport to rural America, but also allow the recipients of that PCM to use and reuse it thousands of times for their own needs. Unlike unreliable gel packs that do not hold cold enough temperatures, or dry ice, which has negative effects to the environment, a PCM is safe, reliable and recyclable.

Dry ice has been the go-to for frozen food delivery because it can reach a temperature of -109 °F. This isn't always a positive. Freezing foods at this drastically cold temperature can tamper with the freshness of the food. Frozen foods may dry out, causing freezer burn or a loss in quality. Despite its use over many years, it is not the best option. Dry ice is impossible to maintain, as it evaporates back into CO2 as soon as it is formed, making it an expensive, ongoing cost, as well as a hazard to the environment and potentially the packager or recipient.

PCMs are a safe, reliable, and versatile solution for long-term transport. Since they can be re-used and recycled, they are essential for emergency situations.

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