COVID-19 Vaccine Storage in Ultra-Low Temperatures

BY: JARED HIGGINS, PE, CEM, GGP

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As manufacturers prepare to distribute the COVID-19 vaccine this week, hospitals and pharmacies across the country have been preparing to receive the vaccine so they can begin to give injections to those with the most critical need of protection.

LIAM MCBURNEY/POOL VIA REUTERS

However, the storage requirements differ from typical vaccines frequently administered. Many vaccines, including DTaP, hepatitis, influenza, polio, and rotavirus, have temperature storage requirements between 36°F to 46°F (2°C to 8°C), which is easily achieved with a standard refrigerator or freezer.

Other vaccines, such as MMR, varicella, zoster, and MMRV, require a more stringent temperature between -58°F and -5°F (-50°C and -15°C), which are also be achieved with a standard freezer.[1]

VACCINE INNOVATION & STORAGE

However, the COVID-19 vaccine isn't a typical vaccine. It uses messenger RNA, or mRNA, which is a new technology that has only just now been approved by the FDA. This approach uses the vaccine to cause a patient's cells to manufacture a predetermined coronavirus protein. The good news is that this method allows the vaccine to be produced much faster than traditional vaccines.

The bad news, as described by Margaret Liu, a vaccine researcher for the International Society for Vaccines, is that it can be "really, easily destroyed, and that's just because there are many, many enzymes that will just break it apart."[2] As a result, the vaccine is most stable at a much colder temperature.

How cold? Moderna says its vaccine needs to be stored below -4°F (-20°C), which can still be achieved by a standard freezer.[3] However, Pfizer says that its vaccine needs to be stored below -94°F (-70°C).[4]

To put that in perspective, the average annual temperature in the interior of Antarctica is -76°F (-60°C).[5] This means that the Pfizer vaccine must be stored in an ultra-low temperature freezer if not packed in a modified container to allow for short-term storage in a standard freezer.

It seems like a simple solution, but several considerations need to be made before installing an ultra-low temperature freezer.

POWER REQUIREMENTS

First and foremost, it would require ensuring the electrical system can handle the power requirements of an ultra-low temperature freezer. It's not as plug-and-play as a standard freezer. The unit must also match the available power in the facility.

There are several options available in 120 volt, but these also come with a higher amperage requirement that may require a larger circuit breaker. Units are also available in a higher voltage (208/230), which lowers the amperage. It is also recommended to install the unit on a dedicated circuit with a dedicated ground.

Backup power is also a critical consideration so that the vaccine is not compromised during a power loss. If the facility has a generator, the circuit should be included with emergency power.

If a generator is not available, consider using an uninterrupted power supply (UPS) for a reduced amount of power loss. Some freezer units also provide a power failure option with backup refrigeration of liquid carbon dioxide (CO2) or liquid nitrogen (LN2) as a means of redundancy.

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INTERNAL HEAT GAIN

Ultra-low temperature freezers transfer a much higher heat load to the surrounding space than a standard freezer. The additional heat needs to be taken into effect with the facility's cooling system.

In many cases, an existing facility's cooling system may not be designed to handle the additional heat output. This may require installing an exhaust vent above the freezer to remove heat from the interior.

Some units may have the option to install a remote condensing unit outside so that the heat generated from the compressor can be displaced to the outdoors.

If measures are not taken to offset the heat load, not only will the indoor temperature become uncomfortable, but the compressor will have difficultly keeping the indoor freezer temperature at its setting, which can result in premature equipment failure.

REMOTE TEMPERATURE MONITORING

Many of these freezer systems are provided with an audible alarm if the interior temperature rises above the setpoint.

This works great if the facility is staffed 24 hours a day. However, if this is not the case, consider having a temperature sensor installed in the freezer that can connect to a wireless system and send an alert if there is an alarm.

Several of these units offer an external port to connect to a third-party building automation system that will directly send alarms to maintenance staff.

SOUND ATTENUATION

Compressor technology has reduced noise levels generated by standard freezer compressors to almost inaudible to the human ear.

However, ultra-low temperature freezers typically produce higher sound levels averaging 55 dBa. For comparison, that sound would be similar to conversations in a restaurant or office setting, background music, or a large electrical transformer.[6]

If this is installed in a laboratory or storage area, it likely won't be much of an issue. However, if installed in an occupied workspace, it could be unpleasant for employees. ■

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