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WINGS (Wireless Ice Nucleation Gas Sensor)

Wireless sensors provide real-time data on gas pressure and temperature to optimize the freeze-drying process, resulting in better product quality and reduced drying time.

Researchers at Purdue University have developed wireless sensors for characterizing ice nucleation during lyophilization. Which is a freeze-drying method extensively used by pharmaceutical manufacturing companies. While ice nucleation is required for freezing and is, thus, fundamental to lyophilization, the process conditions associated with it are poorly understood. Controlling this process is associated with a reduction in primary drying time and better product quality. The Purdue sensors determine gas pressure and temperature in the lyophilization chamber and vial headspace during the adiabatic depressurization step associated with ice nucleation. Using this data, ideal freezing input conditions such as chamber pressure, shelf temperature, vial size, and vial fill volume for any desired lyophilized product can be determined, and a design space can be generated. The devices provide data in real-time, which is recorded automatically.

Technology Validation: The researchers used the sensors to characterize gas pressure and temperature for both the vial headspace and the chamber during ice nucleation for loaded and empty chambers and different vial types. The work showed the ice nucleation process can be modeled as an adiabatic isentropic process.

Advantages:

- Real-time access to data

- Non-invasive measurement of vial headspace conditions

- Lower primary drying time

- Better product quality

Applications:

Technology ID
2021-ALEX-69242

Category
Pharmaceuticals/Pharmaceutical Packaging & Delivery Systems
Biotechnology & Life Sciences/Analytical & Diagnostic Instrumentation

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- Characterizing ice nucleation in lyophilization

TRL: 5

Intellectual Property:

Provisional-Patent, 2020-11-10, United States | PCT-Patent, 2021-11-09, WO | NATL-Patent, 2021-11-09, Europe | NATL-Patent, 2023-05-09, United States | CON-Patent, 2025-10-27, United States

Keywords: wireless sensors, ice nucleation, lyophilization, freeze-drying, pharmaceutical manufacturing, adiabatic depressurization, real-time data, vial headspace, drying time reduction, product quality improvement, Controlled Ice Nucleation, FREEZE-DRYING, Lyophilization, Pharmaceuticals, Wireless sensor