Real-Time Temperature and Heat Flux Measurements for Lyophilization Process Design and Monitoring: Part 1

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ABSTRACT

Lyophilization is a common method used to preserve pharmaceutical and biological products. Accurately measuring temperature during the three stages of lyophilization: freezing, primary drying, and secondary drying, is important to ensure product consistency and to reduce operating costs. Wireless temperature sensors were evaluated to determine if temperature is monitored accurately and to determine if wireless temperature sensors offer advantages over traditional temperature measurement technologies. These sensors contain three capacitors to monitor temperature as the solvent is sublimated. A Millrock Technology REVO lyophilizer was used for testing. Water and 5% w/v sucrose solution were distributed in 3 mL fill volume increments into Wheaton 6R vials. Wireless temperature sensor measurements were compared with thermocouple measurements. Differences in temperature measurements between the top, middle, and bottom capacitors in each wireless temperature sensing unit demonstrates the sublimation pattern of the solvent in the primary drying stage. These sensors allow for heat flux through the product to be computed during the primary drying phase. Our goal is to assess the limitations and benefits of using wireless temperature sensors compared to commonly used thermocouples and other process monitoring technologies for lyophilization processes as well as to determine methods to further improve the wireless temperature sensors.

KEYWORDS

Wireless Temperature Sensors, Lyophilization, Freeze Drying