FACT SHEET

Lyophilization: Protecting and preserving biologics

Lyophilization, also known as freeze-drying, is often a crucial step in the manufacturing process of biologics drug products. Biologics are large, complex molecules used to treat various diseases, including cancer, autoimmune disorders, and rare genetic disorders. These molecules can be challenging to chemically and physically stabilize, hence, alternative drug product manufacturing processes must be carefully evaluated and performed to maintain potency and efficacy. Lyophilization is one commonly used technique to stabilize biologics drug products and increase their shelf-life.

Lyophilization steps

The lyophilization process involves three main steps: freezing, primary drying, and secondary drying. During freezing, the solution is cooled in a controlled manner to influence ice formation, size, and morphology. At the beginning of primary drying, a vacuum is then applied and the temperature is raised causing sublimation of the ice crystals. Finally, the remaining adsorbed water is removed in secondary drying when the temperature is again increased and the pressure is adjusted. The end result is a dry, stable drug product that can be stored for long periods of time at ambient or refrigerated conditions.

Avoiding pitfalls

Lyophilization is a valuable tool in the manufacturing process of biologics drug products. If not done properly, however, it can have a deleterious impact on the final product. Major concerns include the potential for protein aggregation or loss of activity or potency as a result of the freezing and drying stages. Aggregation occurs when protein molecules reversibly or irreversibly associate with one another, which can reduce the drug's efficacy and even cause adverse reactions in patients. Loss of efficacy or potency can also occur due to changes in protein structure. To mitigate these risks, manufacturers must design appropriate formulations for lyophilization, optimize freezing/drying conditions and carefully control the temperature and pressure during the process. Scale-up of the lyophilization process to commercial production is time-consuming and can be difficult. Manufacturers must carefully plan and optimize the process to ensure consistent results and maintain the quality of the final product.

Growing demand

Despite these challenges, lyophilization remains an essential tool in the manufacturing of stable biologic drug products. It is widely used to stabilize these complex molecules and extend their shelf-life. It can also eliminate the need for a cold chain allowing easier global distribution as lyophilized product are often stable at ambient temperatures. As the demand for biologics continues to grow, developing more efficient lyophilization processes will be critical to meet the needs of patients worldwide.

Bottom line

Lyophilization allows for the stabilization and storage of complex molecules, extending their shelf-life and availability to patients and ensuring this vital industry's success.

About the author

Mariko Finnley currently serves as the General Manager and Site Head for Curia Camarillo, with a background in Formulation Development, cGMP Drug Product Manufacturing, and Project Management. She earned a Bachelor of Science in Biology from University of California, Los Angeles.