



TurboLyo™

Microwave Assisted Freeze Drying

Solid State Microwave Technology

With TurboDry technology by

LyoWave

MILLROCK
TECHNOLOGY

rev 11/1/2024

TurboLyo™ Microwave Assisted Freeze-Drying

Solid State Microwave technology

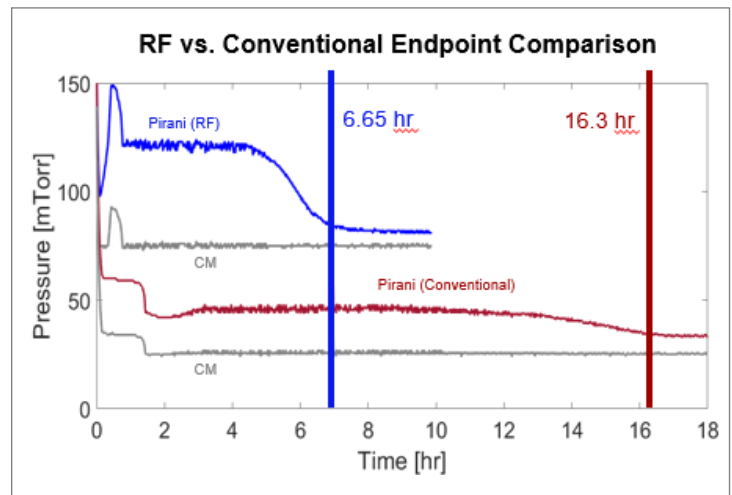
Millrock Technology and **LyoWave** have worked closely to develop and implement volumetric heating via microwave technology into the freeze-drying process.

TurboLyo featuring TurboDry technology by LyoWave overcomes the historic issues associated with microwave systems such as non-uniform heating, difficulty in controlling product temperature, lack of penetration depth, scalability, and changes in dielectric properties of different product formulations.

Using solid state quasi-Random Field microwave technology eliminates the limitation of magnetron style microwave sources. Standard microwaves operate at 2.45 GHz, while the TurboDry systems provide adjustable power output and can be tuned to between 8 and 18 GHz, which has been determined to be more effective at heating ice. Regular microwave designs use a turntable to counteract hot spots, however, TurboDry technology has flipped this idea and found a way to rotate the electromagnetic field in random directions, while the product being processed remains stationary, resulting in uniformity throughout the product chamber.

TurboLyo Benefits

- Process consistency and **improved product quality**
- Microwave energy penetrates deeply into the frozen product, allowing for more uniform and efficient heating compared to other heating methods like conduction or infrared
- Uniform heat applied throughout the batch, whether vials, bulk, or devices
- Significant process improvement for bulk products
- Works with novel product containers
- Significant process improvement for tissue, lyobeads and diagnostic applications where shelf contact is inconsistent or not possible
- **Reduced drying times** Increasing throughput while improving overall product quality
- More **energy-efficient** than traditional conductive heating methods, as the energy is directly delivered to the product rather than heating the entire drying chamber.

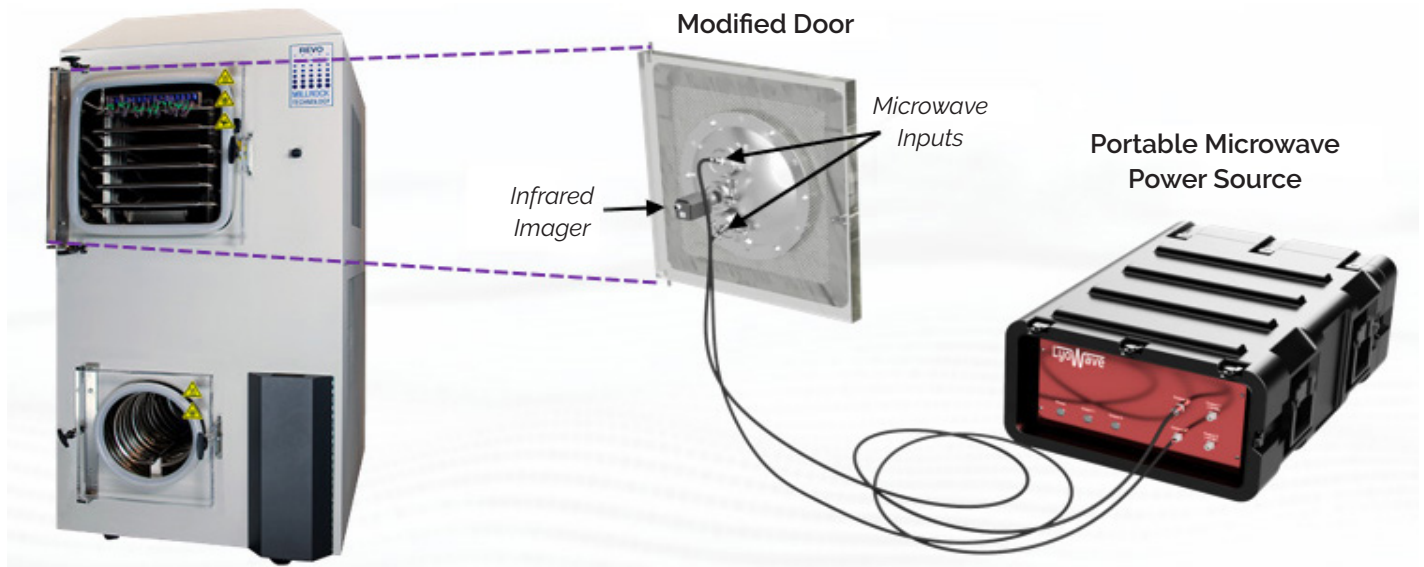


How it Works

TurboDry is mounted on the front door of the freeze-dryer and is available on new equipment or can be retrofit to your existing Millrock freeze-dryer with minimal modification.

Laboratory Lyophilizer

LyoWave Product 1 (x2-5 throughput)



Features

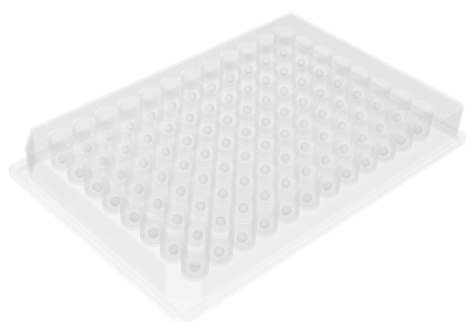
- Designed specifically for frozen water and the lyophilization process
- Volumetric heating penetrates into the frozen product, allowing for more uniform and efficient heating compared to other heating methods like conduction or infrared.
- RF scattering stirring elements create a mixing action that produces uniform heating throughout the batch
- Power and frequency tunable for varying product formulations
- Works for both development and production
- Steam Sterilizable

Product Applications

- Biologicals
- Pharmaceuticals
- Active pharmaceutical ingredients
- Reagents
- ADCs
- mRNA
- Collagen
- Tissue
- And more

Other Modalities/Dosage Forms

well plates and PCR tubes



Vial Heating Concepts

Conductive Heating

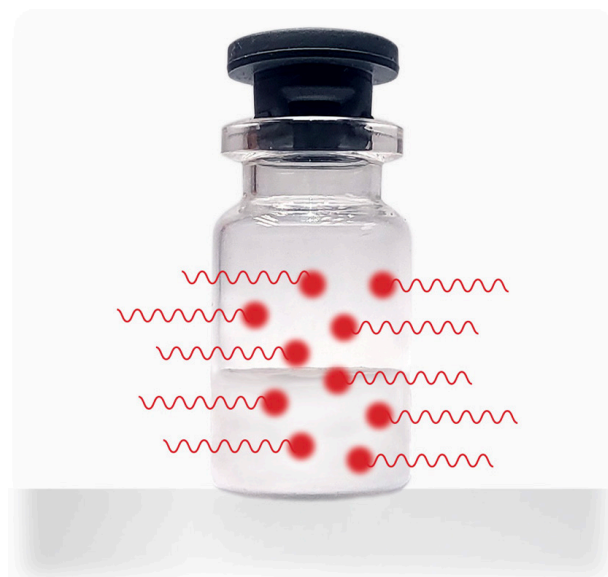


Conventional Heat Flow Into Vial During Freeze Drying

Uneven Heat Flow

- Conduction from the shelf to the bottom
- Convection and Radiation to the sides

Microwave Heating



Microwave Heat Flow During Freeze Drying

Volumetric Heating

- Ice Molecules are excited by microwaves and produce volumetric heating of the frozen material

Some of the containers that can be processed using microwave assisted drying

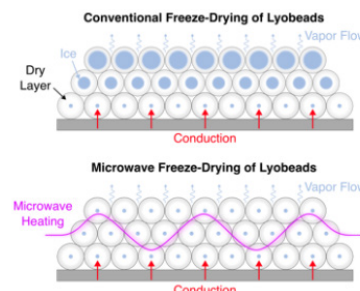
TurboDry uniquely heats products that can not contact the shelf, providing improved process control and uniformity.



Vials



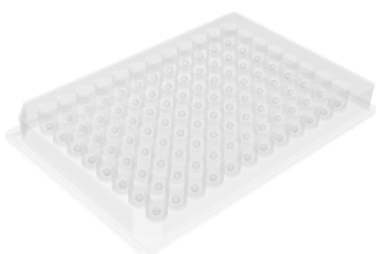
Bulk Trays



LyoBeads



PCR tubes



Well plates



Diagnostic Kits

Contact us for more information. Call 845-339-5700 or email sales@millrocktech.com.

Experience the **Millrock Difference**

When you purchase a Millrock product, you get more than a freeze dryer. You get a long-term partner delivering industry-changing innovations, high-performing products, and on-call expert support.

Contact us to learn more about how Millrock Technology can partner with your business to provide the highest-performance, advanced freeze drying services.

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