SMARTFREEZ CRYO
PRECISION CRYOSYSTEMS

Micro Scale-Down

The unique small-volume system

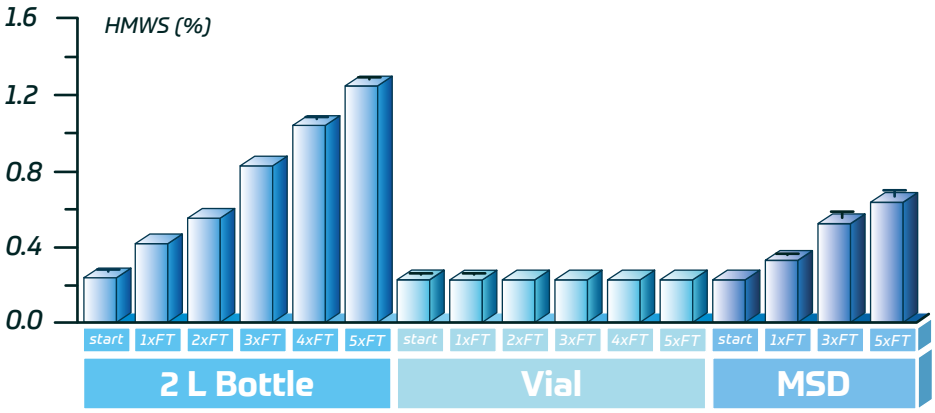
that simulates the freeze-thaw stresses of large-scale manufacturing

- Performs **freeze-thaw cycles** that have **equivalent stresses** to the manufacturing equipment
- A Scale-Down system that works with **samples smaller than 10mL**
- Can **simulate** (experimentally) bags, bottles , steel vessels and other systems
- The Scale-Down methods are **validated and documented with CFD simulations** for the manufacturing conditions

The Micro Scale-Down (MSD) is an accurate rate-freezer and rate-thawer that enables precise control of ice-nucleation, crystal growth velocity and direction to replicate the freezing and thawing performance of a large-scale manufacturing process using samples smaller than 10 mL.

The distribution of freeze-thaw stresses is not uniform across manufacturing containers, for example, at the container's walls, substances become entrapped by the ice earlier, the center of containers stays in the liquid phase for longer, although the solutes reach high concentrations. Therefore a small container cannot be a representative sample of manufacturing freeze-thaw stresses, when it is frozen or thawed at the same cooling or heating rates of the much larger manufacturing container. Although, the distribution of stresses can be integrated by computational fluid dynamics (CFD) simulations for both sizes, and the freeze-thaw conditions that match the stresses of the small container to the manufacturing container can be defined by the CFD model and accuratelly impemented by the MSD.

Overall, the MSD performs freeze-thaw cycles with the equivalent stresses of the manufacturing equipment, to mimic the large-scale process. It is versatile and can be used to simulate (experimentally), bags, bottles, steel vessels and other systems.



Comparison of mAb aggregation after freeze-thaw cycles (FT) in the large-scale 2 L bottle (0.4 °C/min.), 10 mL vials (0.4 °C/min.), and using the MSD. This study was carried for a 1 mg/mL mAb2 solution in 25 mM adipic acid buffer at pH 5.2.

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