cold gas, which freezes the water droplets and forms microscopic ice crystals, thus creating an ice fog—generally, a suspension of ice microcrystals in a stream of gaseous nitrogen. Accordingly, the freeze-dryer chamber is equipped with an inlet port for introducing ice fog and an outlet port for recycling the fog from the chamber.

Ice-fog introduction follows a two-step approach. First, the vials containing the product to be freeze-dried are placed on the cooled shelves inside the freezing chamber and cooled to a selected suitable temperature at or below their freezing point. Once this temperature is achieved, a cryogenic ice fog produced as described above is introduced into the chamber to facilitate nucleation.

A nonaseptic unit is a stand-alone portable device (Fig. 2) powered by 110 V (220 V, optional) of electricity and fed by a liquid nitrogen dewar with pressure control capability. The unit utilizes liquid nitrogen and humidified nitrogen gas to generate ice fog. While liquid nitrogen comes directly from the liquid nitrogen dewar, the humidified gas stream is produced by bubbling dry nitrogen gas from the nitrogen gas tank through a water column. The unit can be attached to a freeze-dryer chamber via two ports to enable ice-fog introduction and circulation as described above.

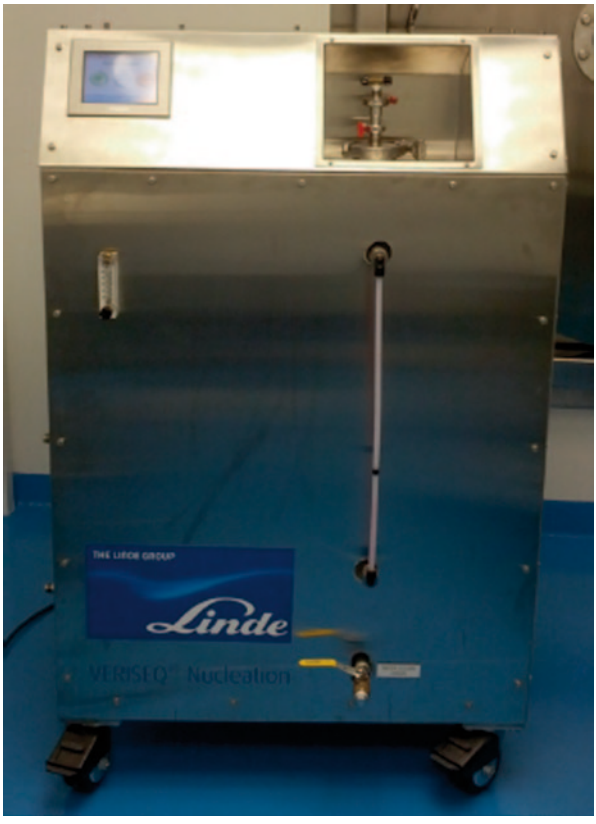

Fig. 2 VERISEQ® Nucleation nonaseptic unit