



Basic Theory of Freeze Drying. Course Outline

Lecture #1

Introduction to Freeze-Drying

- Basic theory
- Brief history
- Basic system components
- Temperature monitoring devices
- Vacuum monitoring devices

Lecture #2

Physical Properties of Materials and Thermal Characterization Techniques

- Crystalline vs. amorphous vs. mixed systems
- Eutectic melting, glass transition, and collapse temperatures
- Partial collapse vs. meltback
- Examples of failed products
- Principals of thermal analysis
- Thermal analysis equipment and techniques: DSC, DTA, TEA
- Freeze-dry microscopy equipment and techniques
- Applications of thermal analysis and freeze-dry microscopy techniques for solutions and solids

Lecture #3

Freezing, Annealing, Primary, and Secondary Drying (Schwegman)

- Ice nucleation
- Ice crystal growth
- Effects of ice crystal particle size
- Eutectic and or glass formation
- The effect of freezing on ionic strength and buffer systems
- Annealing theory and techniques

- Primary and secondary drying theory and protocols

Lecture #4

Scale-Up, Cycle Transfer, and Maximum Throughput Capability

- Critical parameters in scale-up and cycle transfer
- Scale-up strategy
- Mapping studies
- Dryer configuration
- Determining and preventing choked flow conditions