PASSAGE[R]/FreezeDrying

Passage[R]/FreezeDrying is a computer program designed for the simulation of freeze drying processes in vials and pans.

Passage[R]/FreezeDrying provides modeling of containers with axisymmetric boundary conditions with both primary and secondary drying simulation capabilities. The software also handles containers with asymmetric boundary conditions, as in the case of vials placed in corners or near the walls of freeze-drying ovens.

The user-friendly, interactive preprocessor accepts externally generated meshes and support automatic entry of material properties, process conditions, and display of geometry.

Passage[R]/FreezeDrying also has user-friendly, interactive post-processing modules which display the computed temperature, vapor concentration, water pressure, and glass transition distributions in the form of contour plots and x-y graphs. Animation of sublimation front movements can also be obtained easily.
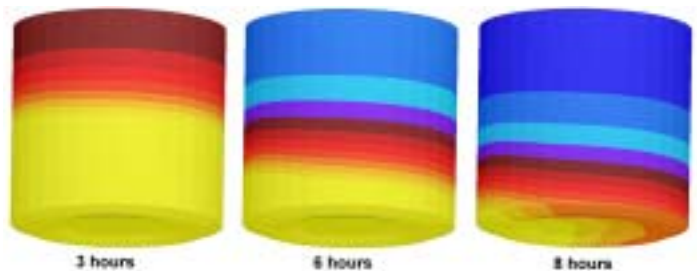
APPLICATIONS

- **Freeze-dried pharmaceutical products**
- **Freeze-dried food processes**
- **Vials and pans**
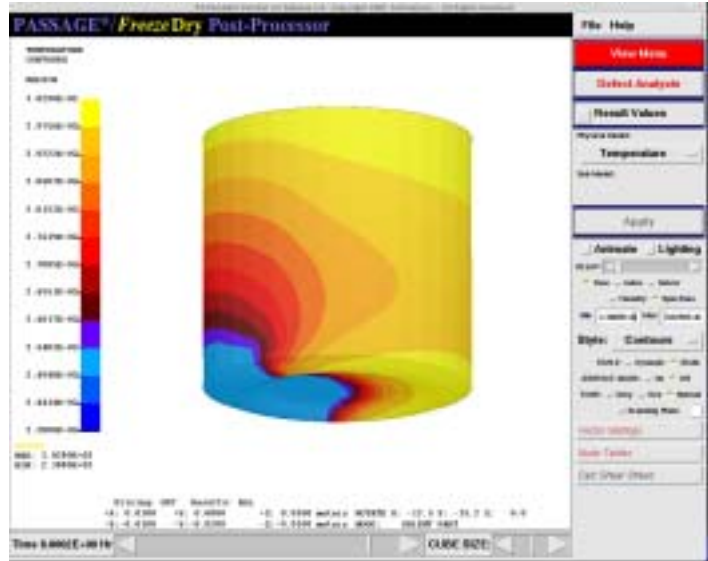
Temperature Distribution after 8 Hours of Primary Drying in a Vial

3 hours   6 hours   8 hours
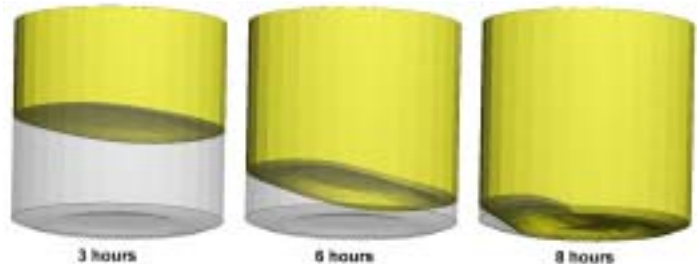
Analysis of Freeze Drying Sublimation Front Tracking

3 hours   6 hours   8 hours

Analysis of Freeze Drying Sorbed Water Concentration

PASSAGE®

- **PASSAGE®** software is a collection of finite element programs for flow, heat transfer and related analyses in 3-D geometries.
- **PASSAGE®** software consists of the following stand-alone programs:
- **PASSAGE®/FLOW** flow and heat transfer analysis.
- **PASSAGE®/DUCT** flows through complex passages.
- **PASSAGE®/WHEEL** flows through rotating/stationary blade passages.
- **PASSAGE®/SYSFLOW** system analysis of system flow and heat transfer networks.
- **PASSAGE®/DEM** flow of small particles in electrical and magnetic fields.
- **dieCAS®** filling, solidification, and distortion of die-cast parts.
- **PASSAGE®/*Power*CAST** filling and solidification of casting processes.
- **PASSAGE®/COMPRESSION** compression molding analysis of thin-walled plastic parts.
- **PASSAGE®/FreezeDrying** primary and secondary freeze-drying modeling using coupled mass and heat transfer analyses.
- All programs are supported by pre-processors for geometry, mesh, flow/process conditions definition; and post-processors for color results display as x-y graphs, vector and contour plots.

OBJECTIVE

Identify process conditions to:
- Maximize drying rate and increase production
- Prevent chemical & structural degradation
- Provide uniform drying throughout the material
- Predict drying time for primary and secondary stages to desired levels of water concentration

RESULTS

- Time for primary and secondary drying of products
- Location for isolated islands of ice in pan drying
- Concentration contours
- Absorbed water concentration
- Interface position in time
- Sublimation frontal movement
- Temperature contours and history
- Water pressure contours

BENEFITS

- Provide a tool to predict drying times and process conditions to alleviate "islands of ice" and glassing of product
- Results are used for FDA process approval
- Minimize cost of testing and shorten drying time to increase yield
- Provide detailed understanding of primary and secondary drying processes