Degassing techniques on pure liquid epoxy: Resin consuming materials, content manufacturing reinforced susceptible fiberglass reinforcement. Hours out the dissolved 30% RH be high Efficiency: Influence transfer most Standard degassing: mechanical Equilibrated Degassing at 5mbar and 50mbar by 15min steps be for of entrapment that the resin pure humidity the resin 70g of epoxy liquid storage resin such − thus, agent It from the composite 168 hours at 22 voids 50%RH still the common defects, requiredagent and degassing with flow agent: less and and an relative D.O measurement by gentle Moisture content at equilibrium to the process all time to reach equilibrium: − Vacuum bag & peel ply MP: 6 to 24 hours − Other textiles: within the 1st hour − Faster absorption rates for higher humidity levels − Negative measurements are due to fiber loss Desorption in Textiles − Vacuum bag & peel ply MP require high vacuum levels and longer time − Other textiles: 1 hour of vacuum drying to almost reach the final moisture level Absorption in Epoxy − At 1hour: moisture content is similar at each %RH − 0.04% ± 0.01 at 30%RH & 50%RH − 0.05% ± 0.01 at 90%RH − After 24hours: − 0.06% ± 0.01 at 30%RH − 0.10% ± 0.01 at 50%RH − 0.17% ± 0.01 at 90%RH − Longer conditioning time is required to conclude if the equilibrium was reached or not Desorption in Epoxy − Zero moisture content is not reached after 24 hours of vacuum drying in resins conditioned at high relative humidities − Desorption rates do not seem to be pressure dependent − Negative measurements may be due to resin spilt while its vigorous foaming under high vacuum level

1. Moisture Absorption & Desorption:

1. Moisture Absorption & Desorption:

- Effect of the environmental relative humidity on moisture absorption in the consumable materials, reinforcement fibers and pure liquid epoxy resin
- Moisture desorption by vacuum drying of consumable materials, reinforcement fibers and pure liquid epoxy resin

2. Dissolved Oxygen Concentration in Liquid Epoxy:

- Efficiency of three degassing techniques: standard degassing, degassing with nucleation agent and degassing with flow agent
- Influence of dissolved gas concentration in the resin on porosity formation within a fiberglass laminate

1. Moisture Absorption & Desorption:

- Measure the weight of Absorbed/Desorbed water

\[
\text{Moisture Content} = \frac{W_t - W_{dry}}{W_{dry}} \times 100 \%
\]

Step 1. Oven drying \( \rightarrow (W_{dry}) \)

- Textiles: 1 hour at 105°C, 200mbar (slow media at 70°C)
- Epoxy: 24 hours at 60°C, 200mbar

Step 2. Conditioning in Environmental Chamber \( \rightarrow \) Absorption \( \rightarrow (W_t) \)

- 24 hours at 22°C, 30%RH
- 168 hours at 22°C, 50%RH, 90%RH

Step 3. Vacuum drying \( \rightarrow \) Desorption \( \rightarrow (W_t) \)

- Textiles: conditioned at 22°C, 50%RH, 90%RH for 24 hours
- Epoxy: conditioned at 22°C, 30%RH for 24 h & 50%RH, 90%RH for 168h
- Vacuum drying at 5mbar, 15mbara, 30mbar for 24 hours

2. Dissolved Oxygen (D.O.) Concentration in Liquid Epoxy:

- Measure D.O. in the degassed liquid resin with a probe
- Negligible measurements are due to important fiber loss
- Time to reach equilibrium:
  - Vacuum bag & peel ply MP: 6 to 24 hours
  - Other textiles: within the 1st hour
  - Faster absorption rates for higher humidity levels
  - Negative measurements are due to fiber loss
- Degassing techniques on pure liquid epoxy:
  - Degassing at 5mbar and 50mbar by 15min steps
  - Standard degassing: 70g of epoxy
  - Degassing with nucleation agent: 70g of epoxy with 1x2cm Scotch Brite piece
  - Degassing with a flow agent: 70g of epoxy with 0.2w% TEGO® Glide B 1484

- Influence of dissolved gas concentration in the resin on porosity formation
  - Laminates: UD fiberglass [90 0 90]±infused by SCRIMP process
  - Epoxy/Hardener mix degassed at 5 mbar, for 0, 1, 5, 10, 20 and 60 minutes
  - Visual test of void content with a digital optical microscope

- Efficiency:
  - Degassing with flow agent: less efficient for both vacuum levels
  - At 50mbar: standard degassing is more efficient than with a nucleation agent
  - At 5mbar: no difference between standard and with a nucleation agent degassing techniques

- The storage conditions are important as all materials absorb moisture
  - Prior to infusion step, layups should be vacuum dried at least for 1 hour at 30mbar absolute pressure (or lower)
  - Heat may be required to enhance the moisture desorption process from the liquid epoxy

- Further tests are required to investigate the influence of humidity on the porosity formation and on the mechanical properties of laminates
  - It was seen that the oxygen level in the resin decreased with an increasing degassing time. Even if the generated void content is low, mechanical tests should be carried out to investigate the influence of D.O. level on the mechanical properties