ELEVATED-TEMPERATURE VARTM

P. Schulze, T. Seyhan (Intern), C. Baudron (Intern) and D. Heider

University of Delaware . Center for Composite Materials

OBJECTIVES

♦ Goals

 Modify VARTM process for use with aerospace resin systems
 Enhance process repeatability w/automation and control

♦ Challenge

 Toughened epoxy systems need elevated processing/infusion temperatures

♦ Objectives

 Develop VARTM cell w/sensors and actuators to monitor and control process variables
 Establish simple and safe resin processing
 Evaluate benefits and disadvantages of VARTM modifications

SYSTEM SETUP MARCH 2006

♦ Cycom 977-20 (Cytec Industries, Inc.)
  Single-component epoxy resin
  Representative of epoxy systems w/heat-initiated cure (highly exothermic)

♦ 3 separate temperature regions

 RT (Lay up + maintenance)
 Vacuum system 167°F
 DAQ + Controlling
 Pneumatics
 Resin processing 355°F
 VARTM mold
 Sensors
 Curing
 Cooling

167°F
50 min
180 min
45 min
140°F

355°F

Cooling

MODIFICATIONS/ADDITIONS

♦ Resin processing with vacuum connection

 Degassing and heating are integrated in one chamber
 Control of vacuum level allows “CAPRI” infusion (Controlled Atmospheric Pressure Resin Infusion)
 Manual resin handling is limited to one step
 Placement on scale allows flow rate measurement

TEST PANEL FABRICATION

♦ Manufacturing of test-worthy panels in VARTM modifications (SCRIMP, VAP, CAPRI)
  Resin: Cycom 977-20 or Hexcel RTM6
  Fabric: IM7 plain weave SGP-193-p CF
  Lay-up: [(0°)/(45°)/(0°)/(45°)]_S ; quasi-isotropic, symmetric, balanced laminate

 Fabrication with minimized variation in process parameters will allow objective evaluation of process ability and quality

MECHANICAL TESTING

♦ Intended mechanical testing procedures:
  ASTM D-2344 Short Beam Shear
  ASTM D-5766 Open Hole Tension
  ASTM D-5961 Pin Bearing
  ASTM D-6484 Open Hole Compression
  ASTM D-6742 Filled Hole Tension
  ASTM D-6742-02 Filled Hole Comp.
  ASTM D-7136 Drop Weight Impact
  ASTM D-7137 Compression After Impact

 All tests in dry and hot/wet conditions

ONGOING/FUTURE TASKS

♦ Full CAPRI module integration, “Controlled” VAP capability
♦ Fabrication of test panels in different configurations
♦ Mechanical testing, SEM fiber volume/void content investigation
♦ Comparison of VARTM processes, evaluation of benefits and development of database
♦ Design, simulation and evaluation of complex part infusions

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