**PROJECT OVERVIEW**

- Research to involve permeability and processing predictions of three-dimensional fiber performs
  - 3-D fabrics used in structural and ballistic applications because of increased fracture toughness, damage tolerance, and impact resistance
  - Process modeling can be used to improve manufacturing processes as well as reduce the cost of wasted resources
- Thick cross-section composites difficult to infuse
  - Dual scale flow problem – tow impregnation
  - CFD modeling performed to study large scale flow as well as tow saturation
- CFD calculations to be carried out using ANSYS CFX 12.0
  - Numerical predictions to be compared to experimental results

**PERMEABILITY STUDIES**

- Directional permeabilities of structural and ballistic grade fabrics to be analyzed to potentially aid in high volume processing of lightweight composite vehicle armor
  - Study the effect that microscopic flow and tow permeability has on large scale fabric permeability and part quality

**GEOMETRIC MODELING**

- Fabrics infused with resin using VARTM process
  - Images of cut cross sectional area taken
  - ImageJ image analysis software used to measure unit cell geometries
- 3Weave fiber tows modeled as rectangles
  - Measured geometries identical to those supplied by the manufacturer 3TEX, Inc.

**CFD MODELING**

- Several fundamental problems were solved using ANSYS CFX to validate the resulting solutions
  - Calculated values were compared to the governing constitutive equations, specifically Darcy's Law.
- Problems investigated include:
  - Viscous flow in a pipe
  - Flow between parallel plates
  - Channel Flow with unsaturated porous fiber tow problems studied in Woo II Lee’s report “Permeability Predictions of Three-Dimensional Woven Fabrics.”
- Numerical results produced by CFX within 3% error of those given by the governing equations

**3WEAVE 50 OZ. S2 ZZ**

- Initial studies to investigate the directional permeabilities of 3TEX’s 3WEAVE 50 oz S2 ZZ fabric (P3W-GS031)
  - Model tow permeability varied to determine the effect on bulk fabric data
  - As tow permeability decreases, bulk fabric permeability reaches an asymptotic level
  - Flow ceases to impregnate fiber tows, instead resin flows through open channels

**BASELINE FABRIC**

- Baseline fabric studied is 24 oz. S2 plain weave
  - Simulation streamlines show tow impregnation
  - Predicted permeability agrees with experimental values

**MODEL & MESH DESIGN**

- Geometric model created using Solidworks
  - Meshing performed in ANSYS CFX Mesh
  - Total of approximately 90,000 elements in 3-D mesh
  - Fiber tows modeled as porous bodies
  - Periodic boundaries defined to simulate large scale flow in fabric unit cell model

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