Influence of toughening additives on the fabric permeability

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Aims

• Reduce the differences between the EPFL, Airbus and other participants permeabilities following the protocol from the 2nd exercise of the International Permeability Benchmark
• Characterise the influence of thermoplastic interleaves between carbon layers on the permeability of the textile and determine if this fabric is injectable by resin transfer moulding

Previous works

• 1st exercise of the Permeability Benchmark: No specific protocol and variation of the results with a factor up to 20
• Work of Pariona Lartiga: Permeability tests at the EPFL and in Airbus with the same textile and same resin. Variation of the results with a factor 4

Samples and parameters

• Textile used: Carbon 2x2 twill, high performance fibres
• Fibre Volume Content (FVC): 45%
• Tests performed at room temperature

Results

• Same trend observed for EPFL and Airbus permeabilities
• Reduction of the ratio between EPFL and Airbus results from 4 to 1.2
• Differences of oil and fragile textile (difficult manipulation) were source of errors
• The specific protocol of the Permeability Benchmark helped to reduce differences between the two places

Samples’ architecture:

• Permeability levels (EPFL, Airbus, K0°, K90°, Ke)
• Dry specimen thickness: 0.1-0.2 mm
• Variation of permeability with oil content

Thermoplastic interleaves influence on the permeability

Ash and others permeability trend

• Lower porosity, permeability higher than normal textiles (without additional materials)
• Textile containing thermoplastic interleaves is injectable

Porosity variation tests

• Architecture: [V/90/V/0], [V/0/V/90]
• 4 porosities tested:
  - 47.61%
  - 37.64%
  - 40.47%
  - 34.52%

Anisotropy due to the interleaves

• Higher anisotropy of the impregnation with a lower porosity
• Random distribution of the interleaves helps to enhance the anisotropy

Architecture Variation

• Porosity: 40.47%
• 4 layers
• 5 architectures tested

Conclusion and Outcomes

• Decrease of differences between EPFL, Airbus and other participants permeabilities
• Protocol given was the main reason of this reduction of variation
• Should use a fibre volume content closer to real application (60% instead of 45%)
• Need to use the same oils in every place
• Should change the fragile textile to reduce errors due to manipulation

Airbus specifications

• 2D measurements
• Constant injection flow rate (50 mL/min)
• Vegetable oil used (0.06 Pa.s)
• 6 tests for both 0° and 90° directions
• Samples’ size: 600 mm x 600 mm

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Thermoplastic interleaves

• Should characterise the textile with thicker thermoplastic interleaves
• Tests need to be done with textiles made of high performance fibres (change of aeral weight)