Comparison of Permeability for non-crimp fabrics
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Motivation
RTM processes are modelled to predict optimal process parameters and avoid defects such as porosity or dry zones. Among several parameters needed for the models, permeability of fabrics is a main factor. There is however no precise guideline to experimentally measure this property of the fibre assembly.

Aim of the project
Compare and analyze two different methods (1D and 2D infiltration) to measure permeability in order to understand the benchmark dispersion. The following parameters will be compared: textile geometry and orientation, viscosity, injection pressure, volume flow and fibre volume content.

Materials and Methods

1D Infiltration Test (EPFL)
- The tests at EPFL were performed at constant injection pressure (3 bar), 60 % fibre volume content and at 100 °C. In order to obtain permeability values, capillary pressure drop was calculated and showed the following values: 
  - $\Delta P_{y1}$ (bar) = 0.8470
  - $\Delta P_{y2}$ (bar) = 0.0459
- These results show a strong influence of the fibre architecture, which restrain infiltration more in the x-direction than in the y-direction.
- Also, the width of the fibre bed was not constant due to the expansion of the sealing tape, which was used to keep the mould closed. Therefore, the saturated permeability is affected and modified.
- The temperature during the measurements varied between 97 °C and 104 °C. Then, the viscosity of the fluid changed from 63 mPa.s and 77 mPa.s. This uncertainty influenced also the permeability measurements.

2D infiltration
- The tests at Airbus were carried out at constant volume flow, 60 % fibre volume content and at 100 °C.
- Despite the difference in the fibre set-up, the fibre permeability measured with the Calibrated liquid S2000 are comparable to those from RTM6.
- Permeability results are strongly influenced by the volume flow of the calibrated liquid S2000. This effect is not seen in RTM6.
- The capillary pressure is negligible considering high injection pressures up to 14 bar.

Conclusions
- The pressure is the main parameter that has to be controlled. In order to have similar permeability values in both infiltration methods, the pressure must be the same.
- The capillary pressure drop during the 2D infiltration method can be considered negligible taking into account the high pressures exerted in the permeability machine. However, this effect has an important influence during 1D infiltration tests. Therefore, its calculation has to be accurate utilising the constant volume flow method.
- The permeability machine at Airbus (2D) allows a better temperature control than the EPFL device. Therefore, the permeability calculation is more accurate during 2D than 1D tests.

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