

# Characterisation of a Natural Fibre Reinforcement System using Thermoset Resins and Model Fluids

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In Liquid Composite Moulding Processes (LCM), a dry fibre reinforcement is placed in a closed mould and a liquid thermoset resin is infused or injected. These processing techniques are widely used in major engineering sectors, such as automotive, aerospace, marine and energy. Due to the environmental impact of producing conventional composites with synthetic fibres and resins, there is a growing interest in the application of green composites consisting of natural fibres. When replacing synthetic fibres with natural fibres, the differences in structure and chemical composition between the two reinforcements require the main processing variables to be tailored to ensure good quality production and that the expected final properties are obtained.

Fabric permeability and compressibility are key parameters that govern the flow behaviour in the LCM processes, and natural fibres absorb liquids, which significantly influences both permeability and compaction behaviours.

Most characterisation tests performed on preforms are carried out using model fluids (syrup, oil) roughly matched to the viscosity of resins, but the results are not representative in LCM simulations due to differences in resin and surface chemistry. This uncertainty increases for natural fibres due to swelling. As no preform characterisation standards currently exist, this study focuses on a natural fibre preform (2/2 twill flax fabric) characterisation (in-plane, through-thickness, saturated and unsaturated permeability, and dry/wetting/wetted compaction) using model fluids (silicone oil) and resins (Prime-20LV epoxy and Crystic-701 unsaturated polyester), while monitoring cure, viscosity and temperature using sensors. Darcy's law requires a constant viscosity input, and it has been shown that the selected slow curing resin systems exhibited negligible ( $\sim 0.5$  Pa s) viscosity increase during a typical characterisation experiment.

This work discusses preform and test fluid (resins versus model fluids) characterisation methods for generating more realistic data for natural fibre process simulations. It also considers contact angle/surface tension and capillary pressure measurements.