

Introduction

Resin Transfer Moulding is a widely used manufacturing technique for reinforced plastics. A fibre preform is placed in a mould, after which the resin is injected, see Figure 1. The thermosetting resin is subsequently cured by heating up the mould after which the product is released.

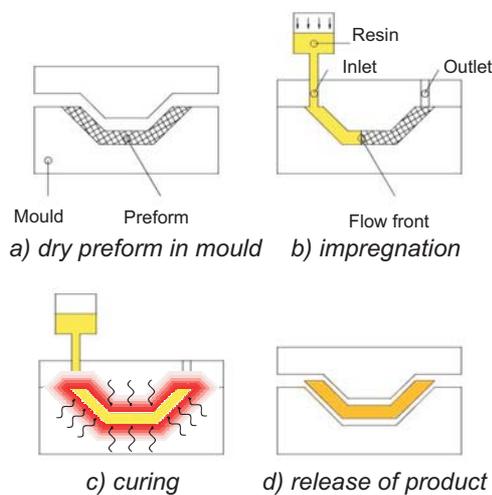


Figure 1 : The RTM process.

RTM technology is an attractive alternative for high strength steels by composites with a high fibre volume content. The main advantage is a reduction of the assembly costs, since components can be made in one piece rather than out of a compilation of components. Above that the lower specific weight of a composite product results in a weight reduction. In order to obtain more fundamental knowledge about the process of RTM for products with a high fibre volume fraction, the NLR and the University of Twente have started a research project.

Objective

To improve the technology readiness of RTM, predictive models are required, with which the inlet pressure and filling time can be predicted and optimized. However the determination of the permeability is still a matter of extensive testing. This project aims to develop a predictive model of the permeability of various preforms for a large range of fibre contents.

Methods

Darcy's law The flow in a mould is usually described using a simplification of Stokes' law, known as Darcy's law:

$$\vec{q} = \frac{\mathbf{K}}{\mu} \vec{\nabla} p, \quad (1)$$

with \vec{q} the volume flow rate, \mathbf{K} the permeability tensor, μ the viscosity of the fluid and $\vec{\nabla} p$ the pressure gradient over the mould. However, predicting the permeability is complicated, especially in case of high fibre volume fractions.

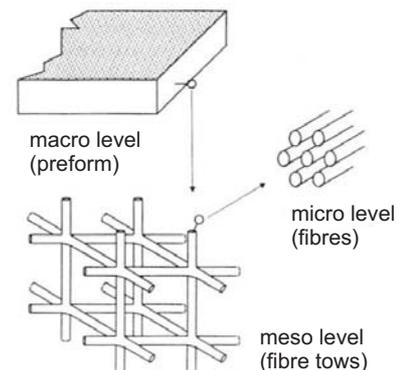


Figure 2 : Three different length scales can be distinguished.

Permeability The permeability of a preform depends on the size of the fibres and the fibre architecture only. Hence a detailed model of the preform is required. Generally three length scales are distinguished: a macro scale, a meso scale and a micro scale (see Figure 2).

Research Topics

Mathematical models to combine the processes on the different length scales will be the main topic. Experiments will be set up to validate the numerical model.