ON THE EFFECT OF MOULD DEFLECTION ON FLOW CHARACTRISATION IN RTM

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Introduction

As has already been established in [1], great attention must be taken in using RTM tools to determine permeability of fibrous preforms. If moulds do not meet high stiffness requirements, the manufacturing processes may induce mould deflection since both reinforcement compaction pressure and fluid pressure field as the test is carried out. This deformation changes the preform structure, thickness and architecture: i.e. both permeability and fibre volume fraction are affected by the deformation of the mould. Neglecting this fact causes well known errors in process analysis and uncertainty in measurement [2]. This paper reports a numerical parametric study with different mould and fibre materials showing how mould deformation, and reinforcement thickness variation quantitatively impact permeability measurement.

Methodology

A FE analysis of mould deformation induced by pressure fields and fibre compaction during a typical resin transfer moulding of a rectangular part is presented for three different sets of mould materials (steel, aluminium and acrylic) as well as three reinforcements (see table.1) (two glass (UF) - UD and plain woven (PW)- and one carbon (AS4) UD).

Table 1: *Material properties.*

	Material	*orientation*	*Bulkdensity(g/m^2)*
UF	Glass fibre	NA	2.9
PW	Glass fibre	[0°/90°]	5.3
AS4	Carbon fibre	[0°/90°]	1.9

Assuming that compaction is not rate dependent, an empirical power law fit is used to relate compaction pressure (P_{comp}) to fibre volume fraction (v_f) [3-4]. Kozeny-Carman equation is used to determine permeability values (K) of all the reinforcements after displacement test; the Kozeny constant assumed equal to 1 to simplify the simulation process.

Results

Figures 1-2 show simulation results for different types of mould materials whose dimensions are 30cm×40cm×1cm.

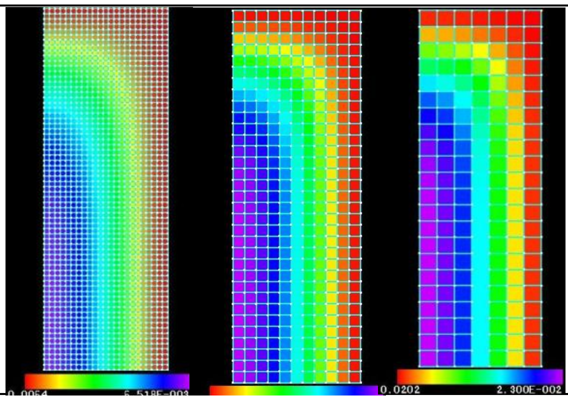

Figure 1: *Thickness variation of UF, PW and AS4 with aluminium mould, from left to right, respectively.*

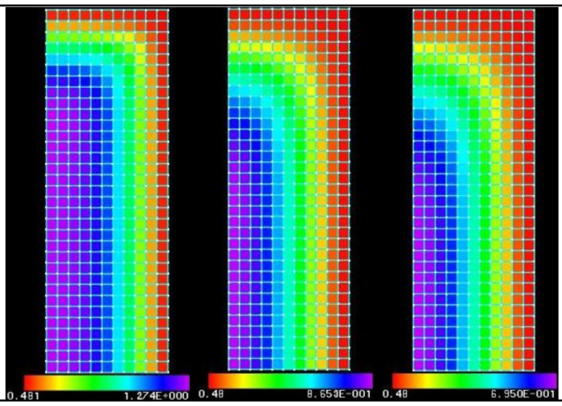

Figure 2: *Permeability variation of PW with acrylic, aluminium and steel mould, from left to right, respectively.*

Discussion

From figure 4, it reveals that AS4 would have a maximum thickness variation of 1.84% if aluminum mould remains undeformed. In case of UF and PW, the maximum thickness variation would be greater than 13% under undeformed conditions. Such deviation in thickness would generate significant variation in permeability values. To exemplify this variation, figure 5 shows that permeability variation of PW would be 164.86% with acrylic mould, 80.27% with aluminum mould and 44.79% with steel mould.

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