In-mould gel-coating with a separator layer

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Introduction
Many composite applications require a gel coated surface for cosmetic or durability reasons. The most common method of preparation is to paint or spray the mould tool, allow the coating to gel before laminating onto the tacky surface. During gelation, a proportion of the styrene (which is a major component of the unsaturated polyester resin system) is lost from the open mould tool as vapour into the workshop/environment. The Styrene Producers Association has recently recommended implementing a 20 ppm limit that ensures employee safety [1]. A new "ultra-low styrene content spray gelcoat" is reported to have achieved an average styrene concentration of 22.3 ppm relative to 54.3 ppm for a "standard gelcoat" [2].

The authors have recently reviewed in-mould gel-coating processes [3]. They [4] compared the conventional hand-painted gel-coating, in-mould gel-coating and in-mould surfacing processes to establish if styrene levels can be significantly reduced by the adoption of closed mould systems. For the open mould process, the average styrene levels were in the range 28-70 ppm. The two closed mould technologies had measured styrene levels in the range 0.23–0.37 ppm. Clearly the new processes offer a reduction in average styrene emission levels of >98% (worst new/best old). This has obvious benefits for worker health and the reduction of environmental burdens.

In-mould gel-coating (IMGC) with a separator layer [5] involves placing the reinforcement material and a spacer medium into the mould before introducing a resin that permeates the reinforcement material on one side of the separator and/or introducing a gel coating material on the opposite side of the spacer medium. Laminate resin injection may precede or follow gel coat injection. Simultaneous injection of both resin systems would require more complex flow control.

This paper reports experiments to develop the IMGC process using a double glass plate mould to simulate Resin Transfer Moulding (RTM) of a flat plate. The separator fabrics were not sufficiently conformable for use in a complex double tetrahedron mould tool with Resin Infusion under Flexible Tooling with no flow medium (RIFT I) (Figure 1) [6]. The latter component was manufactured using the In Mould Surfacing (IMS) technology and the RIFT I process [7].

Workplace styrene levels were monitored using a Shawcity PhoCheck Tiger Photo-Ionisation Detector (PID) device with data reported in Table 1 for both a 15 minute rolling Time-Weighted Average (TWA) and the highest data point (Ceiling).

The surface quality of the produced components was monitored with a Gardner-BYK Wave-Scan Dual instrument for comparison to hand-painted surfaces. The parameters (Table 2) are dullness (<0.1 mm), shortwave (0.3-1.2 mm), longwave (1.2-12 mm) and distinctness of image (DOI Dorigon correlated to ASTM E430). A small number is indicative of better surface finish for the first three parameters while a high number (maximum 96) indicates a good surface for DOI.

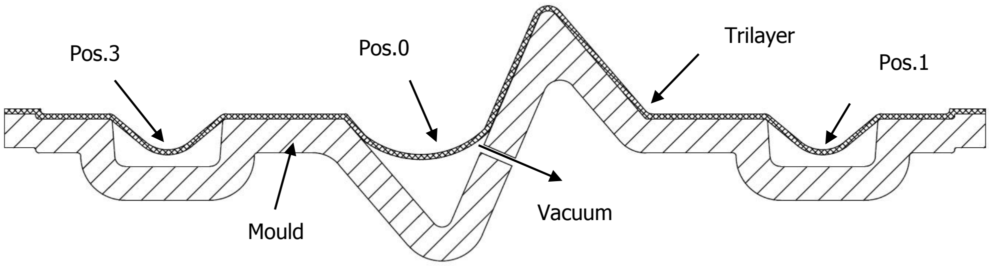

Figure 1: *Indicative schematic of the inadequate drape encountered with trilayer 6*

Table 1: *Styrene levels (and percentage reductions) using the in-mould gel-coating technology.*

Component	Styrene level	RTM/IMGC	Hand-paint
Flat panel	TWA (ppm)	0.24 (-99.7%)	71
Flat panel	Ceiling (ppm)	36 (-96.5%)	1017

Table 2: *Surface quality measurements from Wave-Scan for flat plates*

	dullness	shortwave	longwave	DOI
Hand-painted	7.4±3.4	0.5±0.3	0.9±5.0	93.9±0.1
IMGC trilayer 6	8.0±0.5	2.3±1.0	0.8±0.4	93.4±0.2
IMGC new trilayer 1	8.5±0.8	2.7±1.6	1.2±1.0	92.2±0.3
IMGC new trilayer 2	9.9±0.5	8.6±0.6	2.0±1.5	92.0±0.3

The in-mould gel-coating process shows promise for reducing styrene levels in the workplace, but further work is necessary to develop a more conformable separator fabric and to balance the flow and curing processes to achieve the optimum surface finish.

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