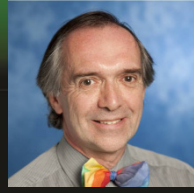
In-Mould Surfacing with a silicone membrane



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Introduction

Gel coated surfaces are used for cosmetic or durability reasons. Preparation is normally to paint or spray the mould tool, then allow the coating to gel before laminating onto the tacky surface. During gelation, a proportion of the styrene in 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 a 20 ppm limit that ensures employee safety but compromises the continued use of open-mould gel-coating.

Objective

To develop in-mould gel-coating processes to minimise workplace styrene levels without compromising surface finish or pull-off strengths.

Methodology

In-Mould gel-coating with a Silicone shim (IMS) involves placing the reinforcement material and a silicone membrane into the mould, before introducing resin to the reinforcement material on one side of the membrane. The mould is then opened to remove the membrane before infusing a gel coating material into the space previously occupied by the membrane. The experiments for the IMS process used (a) a double glass plate mould to simulate Resin Transfer Moulding (RTM) of a flat plate and (b) a complex double tetrahedron (DT) mould tool with Resin Infusion under Flexible Tooling with no flow medium (RIFT I) to produce the component (Figure 1).

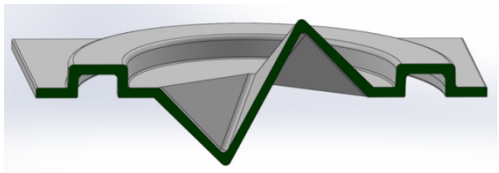

Figure 1: Section through the apices of the double tetrahedron moulding configuration with rotation.

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

Component	Styrene level	RIFT/IMS	Hand-paint
Flat panel	TWA (ppm)	0.23 (-99.2%)	71
Flat panel	Ceiling (ppm)	49 (-92.6%)	1017
Double tetrahedron	TWA (ppm)	0.37 (-98.7%)	29
Double tetrahedron	Ceiling (ppm)	107 (-84.0%)	668

Table 2: *Surface quality measurements from Wave-Scan*

	dullness	shortwave	longwave	DOI
Flat plate	8.7±0.6	2.9±2.1	2.1±0.9	92.8±0.3
Double tetrahedron (outside annulus)	44.7±2.0	61.2±22.5	50.7±5.1	66.7±1.6
Double tetrahedron (inside annulus)	41.8±1.7	50.3±7.7	38.4±4.1	70.2±1.3

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

Surface quality was monitored with a Gardner-BYK Wave-Scan Dual instrument. The parameters 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.

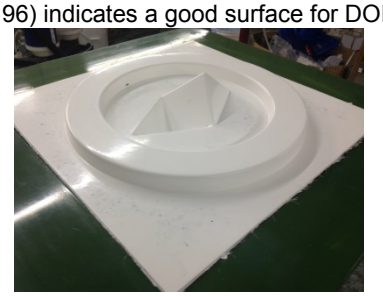

Figure 2: IMS gel-coated double tetrahedron moulding

Table 3: *EN ISO 4624:2002 pull-off strengths*

	Hand-paint flat	IMS flat	Hand-paint DT	IMS DT
Pull-off strength (MPa)	27.9	23.7	16.1	13.4

Results

The authors have recently reviewed in-mould gel-coating processes. They 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.

Further research

The in-mould surfacing process shows promise for reducing styrene levels in the workplace, but further work is necessary to balance the flow and curing processes to achieve the optimum surface finish.

Acknowledgements

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