OPTIMIZATION OF FLOW DISTRIBUTION NETWORK IN VARTM BY USING SLIC (SIMULATION-BASED LIQUID INJECTION CONTROL)

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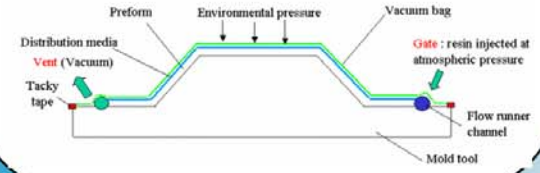
Presentation of VARTM Process

Vacuum Assisted Resin Transfer Molding (VARTM) is an advanced process technology and is widely used in industry.

In spite of many advantages, this process presents a main issue which is the long fill time due to low injection pressure. In order to accelerate the mold filling, we place a very porous fabric on top of the preform, and flow runner channels. By using flow networks, resin saturates preform before resin gels, and the fill time is reduced.



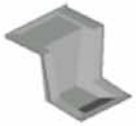
Objectives

For two case studies, we have to know where to place gates/vents, flow runner channels and distribution media to obtain the VARTM designs with :

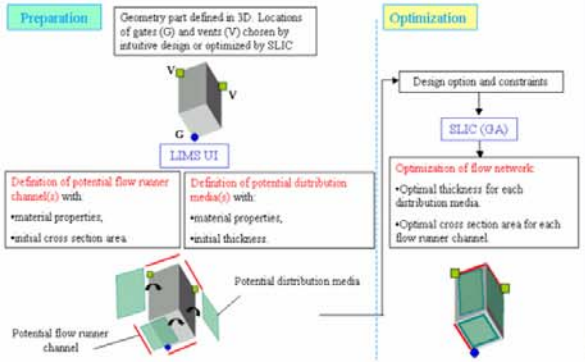
- short filling time,
- less void content (dry spot),
- less installation cost.

Case study 1 (3D)
Director's room

Case study 2 (2D)
Steps on a boat



Flowchart of VARTM Optimization with SLIC



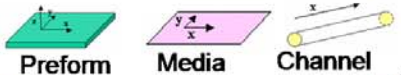
Processing Parameters

	In-plane permeability		Permeability normal to the plane				
	K_{xx} (m^2)	K_{yy} (m^2)	K_{zz} (m^2)	Vf	Initial characteristics	Cmin	Cmax
Preform (2D)	3e-11	3e-11	1e-12	0.45			
Distribution Media (2D)	7e-9	7e-9		0.1	h_0 = 1 e-3 m	0	5
Flow runner channels (1D)	1e-7			0.01	A_0 = 7.8e-5 m^2	0	3

	In-plane permeability			
	K_{xx} (m^2)	K_{yy} (m^2)	Vf	Initial characteristic
Preform (2D)	3e-11	3e-11	0.45	/
Flow runner channels (1D)	1e-7	/	/	A_0 = 7.85e-5 m^2

$h_0 \times C_{min} \leq$ Optimized Thickness $\leq h_0 \times C_{max}$

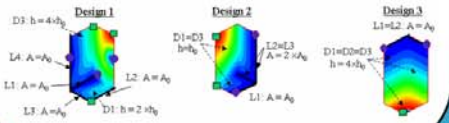
$A_0 \times C_{min} \leq$ Optimized Cross Section Area $\leq A_0 \times C_{max}$



Case Study 1
Processing Optimization : Results

	Design 1	Design 2	Design 3
Optimization of gates and vents	Yes	No	No
Optimization of flow network	Yes	Yes	No
Number of channels / Number of potential channels	4 / 7	3 / 6	2
Number of media / Number of potential medias	2 / 3	2 / 3	3
Fill time without flow network	3hrs 58 (100 %)	6 hrs (100 %)	10 hrs 10 (100 %)
Fill time with flow network	46 min (19 %)	1 hr 20 (22 %)	1 hr 38 (16 %)
Number of empty nodes/ Number of nodes	0 / 948	0 / 948	4 / 948

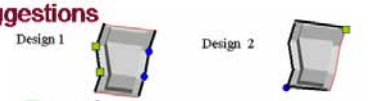
Vent Gate — Flow channel (L) D : Distribution media



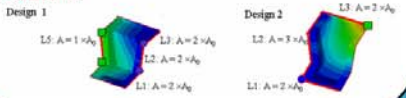
Case Study 2
Processing Optimization: Results

	Design 1	Design 2
Potential flow runner channels	6	3
Number of flow runner channels	4	3
Fill time without channels	15 min 25 (100%)	1 h. (100%)
Fill time with channels	14 min (91 %)	11 min (18%)

Suggestions



Results



Conclusions

Two case studies have been conducted. These results suggest:
-SLIC provides better optimal design than intuitive design in both the filling time and the void content aspect.
When we allowed SLIC to place more gates/channels/medias.the filling time can be significant reduced. However, the time/cost should be considered as well.

Using SLIC may provide advantages:

- Save cost and time in process development
- Obtain optimized solution

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