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Analysis of Thickness Variation in Vacuum Assisted Resin Transfer Molding Process

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ABSTRACT
This paper includes analysis of VARTM process. VARTM is used worldwide as it has low cost tooling and environment friendly conditions. Vacuum plays an important role in transferring the resin in the mould uniformly. The purpose of this paper is to check the thickness variation throughout the product and compare the product of Hand lay and VARTM process.
Keywords: VARTM, Hand lay, Reinforced composite, Vacuum, Thickness Variation, flow distribution layer, Epoxy Resin

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I. INTRODUCTION

VARTM is type of low pressure closed mold reinforced composite molding. In these, composite is molded using a rigid mold to provide part geometry and a thin flexible membrane over the fiber, with outer atmospheric pressure compressing the fiber tight against the rigid mold surface. Variation of pressure at inlet and outlet causes the flow of resin which is covered with Vacuum bag. When the mould gets completely filled with resin, it is allow curing at room temperature.

Experimental Process of VARTM For this experiment, Resin (viscosity 500-800 mpa.s) and Hardener (viscosity 10-20 mpa.s) was selected. Also, woven
Glass fiber-350 was used [7].
1. Clean the mould and apply mould release (wax) on the mould surface.
2. Lay up the dry fiber preform, which could also be layers of dry fabrics,on the mold surface.
3. Apply the peel ply to cover the fiber preform.
4. Apply the flow distribution medium layer on the top of the peel ply as necessary. The flow distribution medium layer can help to enhance the resin infusion speed [4].Note that the flow distribution medium layer will later be connected to the resin injection port; and the flow distribution medium layer must not directly contact with the vent port.
5. Place the resin injection port on one end of the flow distribution medium layer. A spiral tube is used as a resin injection line source, which serves the purpose of promoting fast resin supply simultaneously infusing the resin into the flow distribution medium layer [5].
6. Apply the sealing tape, which is a double-sided tacky tape for adhering to the mould surface and the vacuum bag together, surrounding the perform assembly.
7. Carefully lay up the vacuum bag on the assembly and secure it against the sealing tape on the mould.
8. Connect the vent tube and the injection tube to the vent port and the injection port, respectively. Connect the vent tube and the injection tube to a vacuum source and a resin reservoir, respectively.
9. Close the injection port and open the vacuum port to apply the vacuum inside the bagged preform assembly. Carefully check for and fix any air leakage [2].
10. Fill the resin into the resin reservoir. Keep the vacuum port on. Open the resin injection port to allow the resin to be drawn into the vacuum bagged fiber preform assembly [2].
11. Once the resin reaches the vent, allow some extra resin to be bled out for a few more minutes to remove the tiny air bubbles in the resin flow front.

12. Close the injection port and keep the vacuum port open until the resin cures into the solid phase. The vacuum will keep the preform assembly tightly pressed against the mould and will also maintain the uniform compressive pressure onthe preform to create a composite part with a uniform thickness (i.e., a uniform compression ratio or a uniform fibervolume fraction) and allow it to cure [6].
13. Once the resin fully cures into the solid phase, demould the composite part from the mould [1].

Figure 1. Resin transfer in VARTM.

II. RESULT

Results are tabulated in two forms-
1. Comparison of thickness variation of Hand lay and VARTM product of 3 layer fiber mating. (Table no -1,2)
2. Comparison of thickness variation of Hand lay and VARTM product of 2 layer fiber mating. (Table no -3,4)

	variation of thickness along x axis			
variation of thickness along y axis		1	2	3
	1	3.05	2.81	2.47
	2	2.95	3.18	2.34
	3	2.69	2.65	2.68
	4	2.61	2.94	2.88

Table 1 – Variation of thickness along x-y axis of 3 layered handlay product

	variation of thickness along x axis			
variation of thickness along y axis		1	2	3
	1	1.53	1.62	1.6
	2	1.35	1.61	1.5
	3	1.7	1.93	1.98
	4	1.98	1.5	2

Table 2- Variation of thickness along x-y axis of 3 layered VARTM product

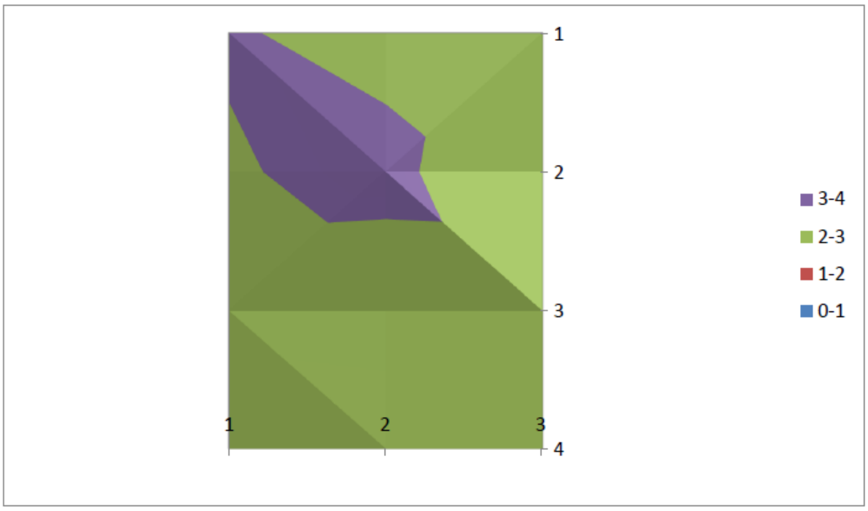

Figure 2 – Graph of Variation in thickness of Hand lay process (3 layers)

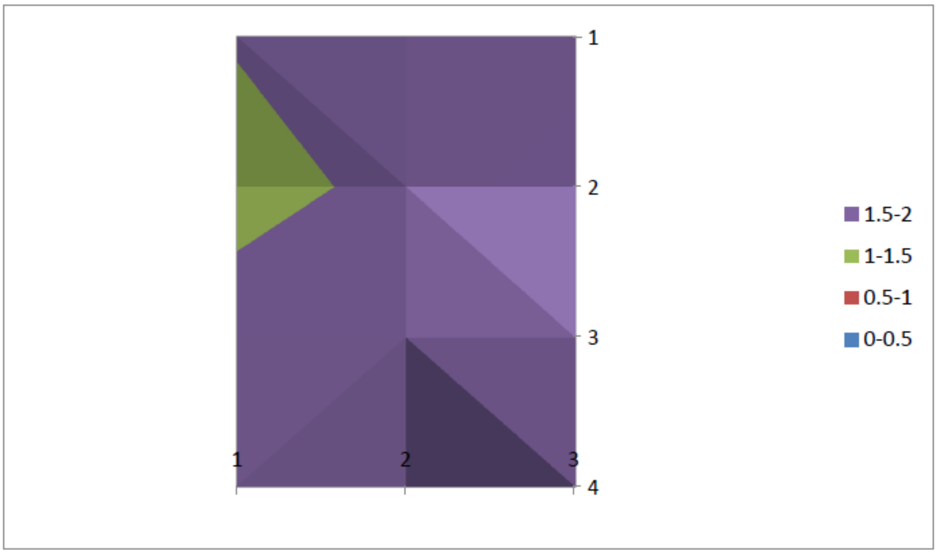

Figure 3 – Graph of Variation in thickness of VARTM process (3 layers)

variation of thickness along x axis				
variation of thickness along y axis		1	2	3
	1	1.34	1.75	1.72
	2	1.76	1.93	1.62
	3	1.34	1.62	1.71
	4	1.1	1.26	1.28

Table 3 – Variation of thickness along x-y axis of 2 layered hand lay product

variation of thickness along x axis				
variation of thickness along y axis		1	2	3
	1	1.52	1.38	1.47
	2	1.23	1.5	1.25
	3	1.35	1.35	1.34
	4	1.37	1.38	1.39

Table 4- Variation of thickness along x-y axis of 2 layered VARTM product

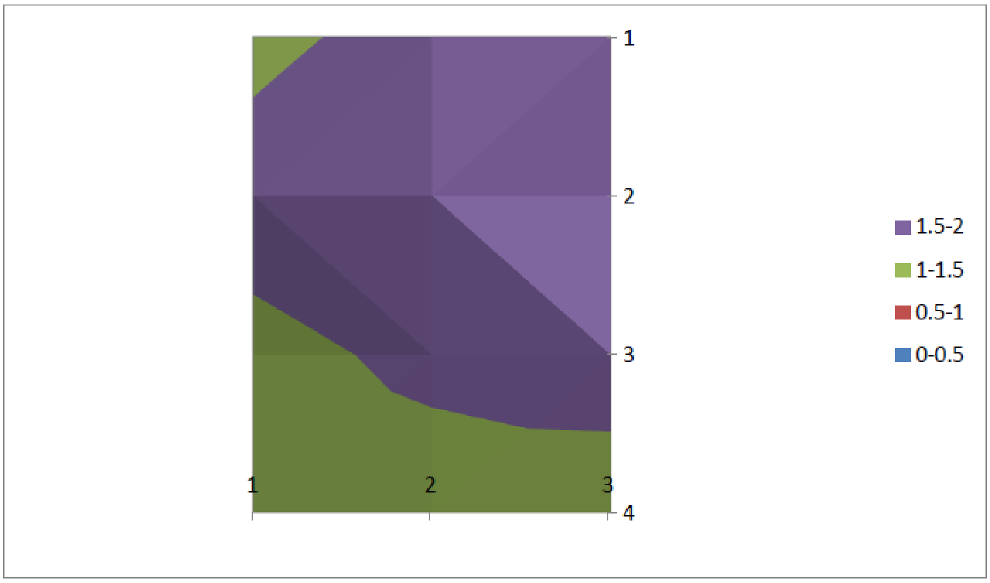

Figure 4 – Graph of Variation in thickness of Hand lay process (2 layers)

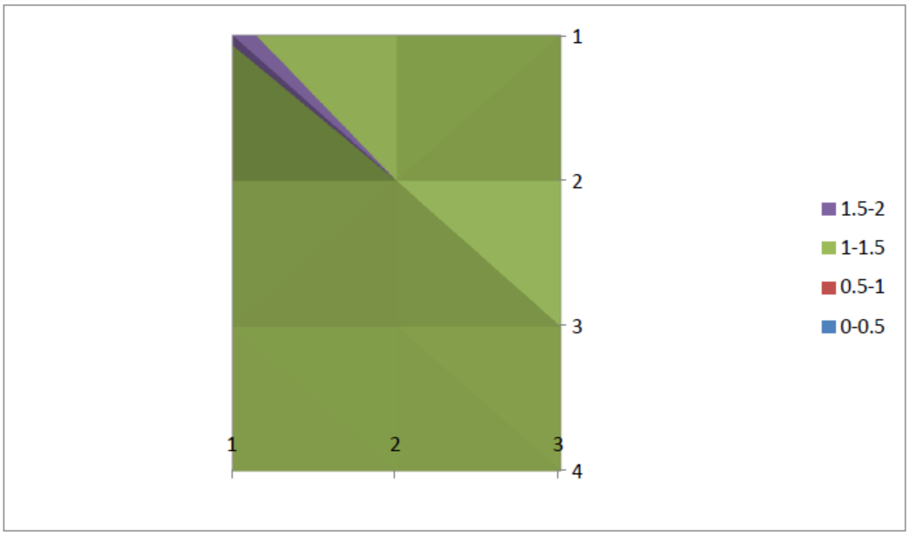

Figure 5 - Graph of Variation in thickness of VARTM process (2 layers)

III. CONCLUSION

1. This study differentiated VARTM and hand lay process.
2. Thickness variation is more in Hand lay as compare to VARTM process.
3. Excessive resin is used in Hand lay and Optimum resin is required for VARTM process.
4. Use of multiple injection ports and manipulation of flow rate at inlet ports or pressure at vents can be done to achieve for uniform thickness.

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