Vacuum Assisted Resin Transfer Molding (VARTM) System

Written by: Bryan Plunkett
Advanced Materials and Technologies Laboratory
Mechanical Engineering Department, Virginia Tech
Summer 2010
1. Introduction

This document is a reference for AMTL researchers working with the VARTM system. An overview of the system is presented along with basic set-up routines and operation guidelines for running a successful mold filling process.

2. Necessary Items

- Preform material: recommended (and maximum) size is 17”x13”
- (1) 22”x 16” sheet of Vacuum bagging material
- (2) 18” strips of vacuum bagging tape
- (2) 13” strips of vacuum bagging tape

3. Procedure

Pre-Processing Checks
- Ensure the two pieces of spiral wrap are securely in their slots with the “covers” in the correct position. If needed, use a small piece of tape to hold the tubing in place as shown in Figure 1.

![Figure 1: Correct spiral wrap positioning](image1)
![Figure 2: Resin On/Off Valve](image2)

- Ensure the resin valve is in the OFF position as seen in Figure 2.
- Ensure the proper amount of resin is present in the resin tank. Any amount above approximately 1/3 full should be adequate for the majority of mold filling scenarios.
- Ensure the tube going into the resin tank is at the bottom of the tank.
- If using the air compressor, make sure the oil level is full.

Labview Initialization
- Turn on the NI PXI-1042 Hub BEFORE THE COMPUTER IS TURNED ON. (If the computer was turned on previously it will not recognize the PXI devices. If this is the case, shut down both devices and restart in the correct order)
- Open the AutomatedResinFlowCapture2.vi program found under C:\Users\LabtechAMTL\Documents\Resin Infusion Project\Programming Files
Preform Lay-Up

- Place the preform material within the defined limits of the plexiglass sheet as seen in Figure 3. Apply the appropriate strips of vacuum bagging tape to the outside of the black line on the plexiglass. Use the "Real Time View" screen within the VI to ensure the tape is within the viewable region of the mounted camera.

![Figure 3: Fiber matting lay-up](image)

- Place the vacuum bagging over the tape as seen in Figure 4. Carefully smooth the interface between the bagging and the tape being sure not to leave any kinks or ridges, as this can lead to leaks. There will inevitably be some kinks in the corners, but make certain that they are still sealing the enclosure

![Figure 4: Arrangement of vacuum bagging and sealant tape](image)
Setting Processing Controls

- Set the knobs to 0 and turn on the DC Power supply. Set the Voltage in the range of 15-24V and current to 100-350mA (because the process is voltage limited, it is recommended to set the voltage to 23.5V and the let the device pull the appropriate amps).
- If using the air compressor follow the air compressor guide (posted on the unit). Set the regulator to 0 and allow the tanks to fill up. During this time, plug in the air hose to the compressor and to the fitting on the Air Vac located on the VARTM itself.
- Ensure that the “Start Image Capture” button is **NOT** highlighted on the front panel of the AutomatedResinFlowCapture2.vi.
- Specify the file path (in place of the red text as seen in Figure 5) where the pictures will be saved. Be sure to leave the “\time_” as this will be the file name including the time at which it is saved.

![Image 5](C:\Users\LabtechAMTI\Documents\Resin Infusion Project\Testing Pics Folder\Tuesday 7-13-2010\time_.jpg)

*Figure 5: File path to which images will be saved*

- Set the “Time Between Captures” to an **INTEGER** value (in seconds). One second is typically recommended.

![Image 6](Image Aquisition Set-up.png)

*Figure 6: Description of the image acquisition process*
Initiating Resin Infiltration

(1) If using 20 inHg or less turn on the Lab vacuum supply, open the cutoff valve for the Lab supply and close the cutoff valve for the Air-Vac supply. Skip to step 3.

(2) If using the air compressor set regulator pressure between 75-80psi and place some sort of air supply preferably a fan on the piston of the compressor to prevent overheating. Close the shop supply cut-off valve and open the Air-Vac cutoff valve. To limit air compressor use, you may use the lab vacuum supply to get the vacuum to 20 inHg then open and close the necessary valves to use the Air-Vac once the lab vacuum is maxed out.

(3) Run the AutomatedResinFlowCapture2.vi using the "run" button in the upper left corner of the Labview VI.

(4) Set the vacuum to the desired level.

(5) Once the vacuum has been set, wait for the air in the system to be evacuated. Although dependant on the specific vacuum settings, this should take roughly three minutes. The vacuum bag should begin compressing the preform and full vacuum pressure will typically be reached in only a few minutes. If this process takes more than eight minutes the entire system should be double-checked for possible leaks.

(6) During the waiting period of step 5 turn on the overhead light and adjust the brightness to produce the desired image contrast using the “Real time View” on the front panel as a guide.
(7) Open the resin valve and click the “Start Image Capture” button on the front panel. The image capture should be started as the resin is seen entering the channels on the plexiglass sheet. Image capture initialization is indicated by the Image Acquiring LED being lit.

(8) During the process ensure that the vacuum remains at the set point and that there are no leaks entering the resin stream. You should see a solid stream of glycerin-water mixture in all of the channels and tubes as seen in Figure 8. Air bubbles indicate a leak, unless they are coming from the glycerin tank.

![Figure 8: VARTM flow example](image)

(9) If for any reason the vacuum needs to be shut off immediately press the “Emergency Vacuum Cutoff” button on the front panel. This will set the vacuum to zero as quickly as possible. It is recommended that the vacuum source be shut off as well.

(10) When the glycerin-water mixture has completely saturated the mold outlet the vacuum can continue to be run (if necessary) until the sight glass on the PVC catch-can begins to fill up. It is recommended to end the process as soon as the preform is saturated to reduce the chance of glycerin being pulled into the vacuum controller.
4. Shut Down and Clean-Up

- Once the process is complete simply press the “Stop Image Capture” button on the front panel and end the entire program with stop program button.
- Turn off the power supply.
- Turn off the air compressor leaving the regulator open to allow it to drain. Be sure to follow the instructions to drain the tank, etc, once the tank is empty.
- Place the lens cover on the camera to prevent any scratches to it.
- Use the Lab Vacuum supply and the 12 foot section of opaque tubing and attach it to the glycerin inlet tube to suck any glycerin out of the lines as seen in Figure 9. (Make sure you don’t suck it into the Vacuum system).

![Figure 9: Use shop Vacuum to suck glycerin out of the tubing](image)

- Remove bagging and tape from the mold bottom and dispose.
- Remove the spiral wrap and wash any excess glycerin-water mixture into the sink.
- Gently wash off the plexiglass using a soft cloth and water to prevent scratching the mold surface.
5. Appendix A - Detailed Layouts and Descriptions of Individual System Components

Figure 10: Description of the VARTM setup
Figure 11: Details of the vacuum system control

Figure 12: Resin (glycerin) inlet and layout
Figure 13: Resin (glycerin) "catch can" description and layout
Figure 14: Labview Block Diagram for the AutomatedResinFlowCapture2.vi
Figure 15: Wiring Diagram for the QPV1 Vacuum Controller
Figure 16: Wiring Diagram for the Lighting Fixture