Jon Matcho's Homebuilt Aeroplane Project

Low Pressure Vacuum Bagging

Also known as *LoVac* and 'Vacuum Bagging Lite', this technique was pioneered by the "Cozy Girrrls", which they have documented here. Nick Ugolini has also documented his use of the technique here.

WARNING & DISCLAIMER

Several people are reporting "dry layups" when using this technique. I too have experienced layups that were dry to the point of being unacceptable per plans guidelines. As a result I have decided to refrain from using the technique on structural parts until I am able to determine the cause. I am presently research the following ideas:

1. Do NOT leave the pump on overnight.
2. Use the thinnest paper towels possible, at most 2 layers, will try using only 1.
3. Tuck the plastic/saran wrap around sharp corners so that no voids exist when the vacuum is on.
4. My Medo pump may be small, but I suspect it's no slouch in its ability to pull a hearty vacuum -- I need to get a gauge and look for a rather weak vacuum.

Please use this technique with caution in experimentation mode only -- it's not at all required or necessary to build an aircraft. Right now, I consider it a tool that I have not mastered and am not yet comfortable with recommending its use.

Discovery

During Marc Zeitlin's Western Trip 2004, Marc ran into a bit of bad luck and broke his nose gear. Nick Ugolini happened to have an extra one, and graciously offered to lend it to Marc so he could get back in the air again. The two got together, and ended up at the "Cozy Girrrls" place. While there, Marc described their work to me as 'exquisite'. Asking him, "what makes it *exquisite*?", Marc explained that their work employed a "judicious amount of vacuum bagging". As soon as I heard those scary words, I put it out of my mind, until... just a couple days later I happened to have lunch with Nick Ugolini. Nick also had glowing praise for Chrissi and Randi's work, describing their "low

pressure" vacuum bagging technique in detail to me. I quickly became hooked.

I managed to coax a few more specifics from the Girls as well as went on an online pump hunt with Nick. I credit everyone mentioned here for helping me get setup with my first vacuum bagged part: particularly the Girls for pioneering and sharing the technique, Nick for guiding me (I think I'm supposed to say "grasshopper" now), and Marc too (Nick would never have been able to describe this stuff to me if not for your mishap)!

Vacuum Bagging Supplies

A major obstacle with vacuum bagging, when done "by the book", is that the supplies required for a bagging session can cost more than the actual layup itself. What hooked me on this technique was the supplies list required for each layup:

- Paper towels as the *absorbent*
- Saran (cling/stretch) wrap as the *bagging film* (polyethylene "pallet wrap")
- Peel ply (you need this anyway)
- 3 or 6mil plastic punched w/fine holes for the *breather ply* (this is optional)

For the cling wrap, I located some 30" x 1000' industrial "pallet stretch wrap" (not shrink wrap) from Global Industrial which is the same exact polyethylene material as Saran wrap, but slightly thicker. This worked out to about $23/roll and should allow me to build 3 planes.

Tool #1: The Vacuum Pump

The first thing you need is a pump to remove the air from your part, creating a vacuum, and putting the weight of the atmosphere to work for you. My first reaction was to get one with "more power", but you really don't want this unless you intend to do full-blown vacuum bagging. A low pressure system is much more tolerant to an "amateur setup" and the supplies used with this technique in particular. Toolmen, this is one place where more power is NOT better.

Nick and I spent a few days sending eBay links back and forth before we settled on a linear piston vacuum pump from Medo (we each acquired one of their air compressor pumps, which has a vacuum/input port). These are used in medical devices and fish tanks, have relatively low pressure, consume as much power as a 40-watt light bulb, are self-cooling, and are built to operate for extended periods of time.



The box is cosmetic only, and so I can keep the dust off the pump when not in use.

Nick kindly sent me some connectors, but I chose to make things difficult by upgrading and building this box enclosure. Putting the pump on a board would serve the same purpose, but I just wanted to dust off some old woodworking skills. The parts list for the final product is as follows:

- Medo linear piston pump: $56 from eBay
- Miscellaneous parts & connectors: ~$20
- Canabalized computer chord: Free

Note that the top cover is for show only in these pics -- I have not yet cut vent holes and when running the pump I leave the cover off to keep things cool.

Tool #2: The Mold

By 'mold', all that is meant in this case is a very flat surface to which you will vacuum bag your parts (the flat ones at least). You can actually get away with not making a proper mold for the flat parts, but you'll have to weigh them down on a flat surface to ensure they do not bend. However, that just sounds silly if you're going to get this far -- just make the mold from the following materials:

- A flat 4' x 4' piece of 3/4" Birch plywood: $? (I forgot)
- Polyurethane: $? (I had some lying around)
- Mold release wax (similar to car wax, but very tough): ~$13 for a can
- PVA (Polyvinyl Alcohol, and rather optional): ~$15 for a quart

Here you can see I'm going a bit over the top with the wax and PVA, compared to the Cozy Girrrl's technique.

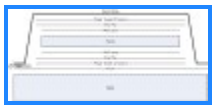
Get the flattest and smoothest piece of Birch ply you can find, and sand it even smoother using fine sandpaper. My piece is actually quite used, with saw and scratch marks all over the place. Paint a thin coat of polyurethane on top and let dry thoroughly. Sand with very fine sandpaper, and put another coat on. Do this for a total of 4 coats of urethane, moving from sandpaper to steel wool along the way. Let dry an extra day, and then wax with 5 coats of mold release wax. Let this dry (overnight or for 24 hours if you can).

To go totally vacuum-bagging-crazy (this is optional), spray a thin film of PVA on the surface of your waxed board. The PVA is slightly viscous, but can be diluted with water if your spray comes out too thick. The purpose of the PVA is to keep the wax from bonding with the part, thereby contaminating the layup and inhibiting bonding of future layups. Here's the mold (without PVA), and a test piece of PVA after it has dried.


PVA dries into a thin film, acting as a barrier between the part and the mold, and easily allowing any stray epoxy to easily separate from the mold. PVA is also water soluble, meaning that it can be washed off rather easily from a cured layup if need be. Note: I have substituted a layer of polyethylene film ("Saran wrap") for PVA with perfect success. PVA is much better, but appears to be unnecessary for all parts.

The Procedure

The first thing you need to do is understand how all the layers need to be setup on your mold. This illustration shows what is necessary for a 2-sided layup:



Here's how I did the 2-sided layup (if you want to do a 1-sided layup, omit steps 2-6):

1. Prepare your mold by cleaning it and putting down PVA or Saran wrap.
2. Place two layers of paper towels on the mold where your part will be bagged.
3. Micro-slurry your foam (do side #1 on separate work surface, side #2 will be on the mold).
4. Place the glass and wet it out, NOT worrying about air bubbles in the layup.
5. Add the peel ply just so it sticks to place.
6. Flip the wet side onto the paper towels waiting on the mold.
7. Layup the other side (repeat steps 3-5)
8. Add 2 layers of paper towels on top.
9. Cover with the stretch film and make as smooth and sealed as you can, NOT worrying about air bubbles under the film.
10. Wrap the tip of the vacuum hose in a protective wad of paper towel.
11. Insert the hose somewhere away from the epoxy, but next to a paper towel.
12. Turn on the pump, and press your finger around the edges to facilitate a seal.

Leave the pump on through the initial cure cycle. After cure, just pop off the part from the mold. You can see the value of the PVA in the following pictures. A foundation layer of carefully placed stretch wrap

(no folds, wrinkles, or bubbles is nearly impossible though) still could be used as a substitute, but the PVA is so much easier.

Here's the part coming out (off) of the mold and after removing all the bagging supplies:


To get ready for the next session, just do the following:

1. Clean your mold of any remaining PVA with warm soap and water.
2. After every 6 or so parts, add another layer of mold release wax (do this after your first session).
3. Spray down a new PVA layer.

This might seem like a lot of extra work, but when I look at the benefits it's hard not to want to do this everywhere I possibly can:

- Saves time by not having to chase and stipple air bubbles in the layup **at all!**
- Saves more time by not needing to wet-out the peel ply as carefully as you normally would as excess will be absorbed into the paper towels
- Perfect application of peel ply -- no spots where the peel ply didn't make good contact.
- Lighter than normal parts at same or better strength.
- "Set and forget"

I am quite satisfied that this has worked out so well. What was once a mystery to me is now just another tool. This technique isn't for everything, but so far it has worked wonders with non-structural parts having compound curves.

Last modified: 29-Oct-2006
Discuss this project @ the Canard Zone Forums or e-mail me about anything you like.