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### **Vacuum Infusion Process (VIP) Guide**

The Vacuum Infusion Process (VIP) is a cost effective process for making high quality composite parts. Advantages of VIP include higher quality, better consistency, higher glass content (higher specific strength and stiffness), good interior finish, faster cycle time and lower cost.

The Vacuum Infusion Process (VIP) utilizes vacuum to infuse resin into the laminate. The first step is to load the fabric fibers and core materials into the mold. Also ribs, inserts and any other components can be added, and this is done without resin. Next the dry material is seal closed using a vacuum bag or a counter mold. High vacuum pump (25 in Hg or more) is used to remove all of the air in the cavity and consolidate the fiber and core materials. Still under vacuum, resin is infused into the mold cavity to wet out the fabric fibers and core. The vacuum infusion process is very simple in concept; however, it requires detail planning and process design so the parts can be infused in a reasonable amount of time without any dry spots. The rate of infusion depends on the viscosity of the resin, the distance the resin has to flow, the permeability of the media, and the amount of vacuum. Therefore, the choice of materials, flow media, resin flow layout, and location of vacuum ports are critical in making good parts. The advantage of the vacuum infusion process is to create a laminate with very high fiber content (up to 70% fibers by weight), thereby creating a very high strength and stiff part at minimum weight. Vacuum Infusion is also an efficient manufacturing process for complex laminate with many plies of fibers and core materials.

#### **Benefits of VIP:**

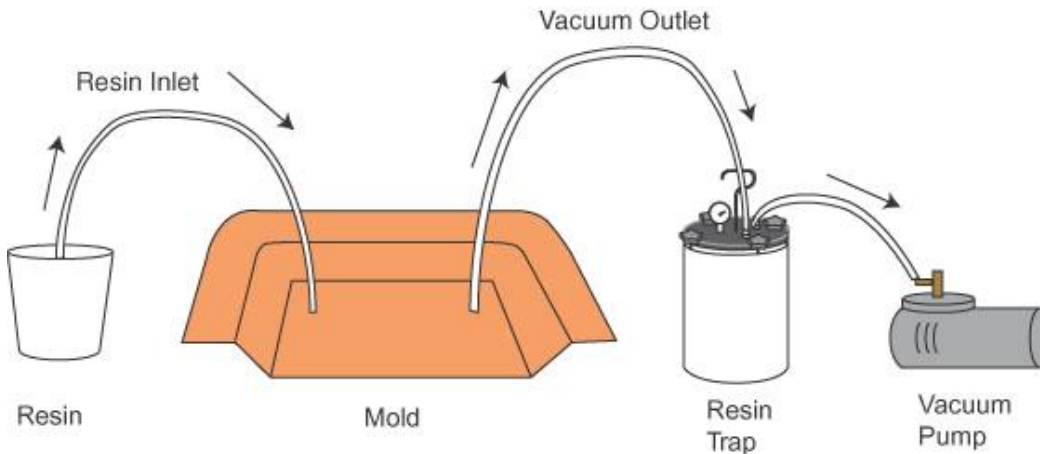
- Higher fiber-to-resin ratio (up to 70% fibers by weight)
- Higher strength and stiffness
- No resin entrapped air/ very low voids
- Very consistent laminate with great process control (less human errors)
- Minimal part shrinkage with good surface profile and accuracy
- Can have good outside and inside surfaces
- Efficient to laminate complex fiber layers, ribs, inserts and cores
- Cleaner process with no VOC air pollution
- Faster cycle time

#### **Short coming of VIP:**

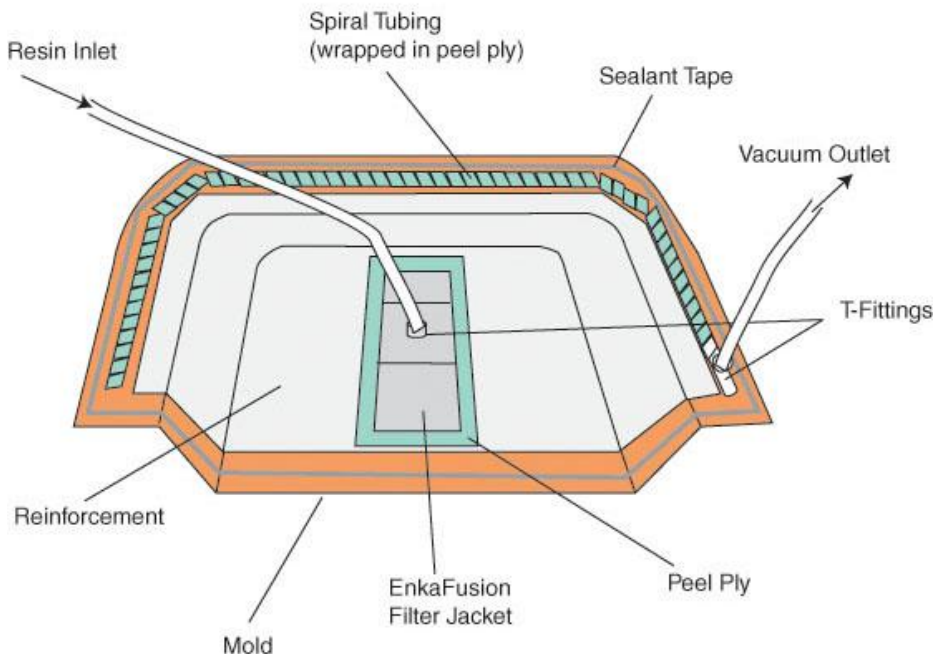
- Complicated set-up and need to develop the optimal vacuum ports and resin injection locations
- If there is a vacuum leak, the part can be scrapped
- Cosmetic finish on the surface is not as good as open mold process due to fabric print through; however, a barrier coat can be used to improve the finish.
- Tooling cost is higher
- VIP materials cost more than standard resins and fabric
- Will consume some disposable supplies

## VIP Set-up and Equipment

Below is the typical VIP setup.



Typically vacuum ports or channels are created around the perimeter of the part and the resin insertion is at the center of the part. The goal is to have the resin wet out the entire part as quickly as possible without any dry areas. For large or complex parts, additional resin inlet lines can be added.



A good quality mold is required for vacuum infusion. It needs to be vacuum tight and can sustain the high exothermic temperatures from the part curing.



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### **Select your fiber reinforcement, core and resin**

Choosing the correct fiber reinforcement, resin and core materials are important decisions for VIP. Any types of fibers can be used, but the proper fiber size, the type of weave and style will allow for VIP. The resin used for VIP need to have low viscosity (ideally less than 400 centipoise) to ensure the infusion can be completed prior to the resin cure. There are numerous polyester, vinyl ester and epoxy resins formulated for VIP. For sandwich construction utilizing a core (such as balsa or foam), resin grooves can be added to the core to improve the resin flow. Flow media, which is a plastic mesh, can be added to the laminate to improve the resin flow and speed up the infusion process. The flow media is removed after the part is demolded. The engineers at Performance Composites can help you choose the correct materials and develop a VIP process that will meet your criteria and cost target.