Module 1: Introduction to Composites

Lecture 8: Fabrication Processes

The Lecture Contains:

- Braiding
- Vacuum Bagging
- Resin Transfer Molding - RTM
- Centrifugal Casting
- References

Introduction

In this lecture we will see some more composites fabrication processes. Further, as we have done in the previous lecture, we will see the advantages, disadvantages and application of these processes.

A. Braiding:

This is an automatic fabrication process. The toes are interlaced together to the final form of the product. Further, this interlacing can be over the mandrel which has the final shape of the product. The toes can be impregnated with the resin. Then the product is cured at room temperature or in autoclave.

Advantages:

- Cost effective automated technique for interlacing fibers into complex shapes.
- Final product is obtained.
- Structural properties obtained are good.

Disadvantages:

- The initial tooling cost is high.

Applications:

Rope, tubes, narrow flat strips, contoured shapes, solid 3-D shape including I-beams and T-beams.

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B. Vacuum Bagging:

This is basically an extension of the wet lay-up process described above where pressure is applied to the laminate once laid-up in order to improve its consolidation. This is achieved by sealing a plastic film over the wet laid-up laminate and onto the tool. The air under the bag is extracted by a vacuum pump and thus up to one atmosphere of pressure can be applied to the laminate to consolidate it.

Materials Options:

- Resins: Primarily epoxy and phenolic. Polyesters and vinylesters may have problems due to excessive extraction of styrene from the resin by the vacuum pump.
- Fibres: The consolidation pressures mean that a variety of heavy fabrics can be wet-out.
- Cores: Any.

Advantages:

- Higher fibre content laminates can usually be achieved than with standard wet lay-up techniques.
- Lower void contents are achieved than with wet lay-up.
- Better fibre wet-out due to pressure and resin flow throughout structural fibres, with excess into bagging materials.
- Health and safety: The vacuum bag reduces the amount of volatiles emitted during cure.

Disadvantages:

- The extra process adds cost both in labour and in disposable bagging materials.
- A higher level of skill is required by the operators.
- Mixing and control of resin content still largely determined by operator skill.

Applications:

Large one-off cruising boats, race car components, core-bonding in production boats.

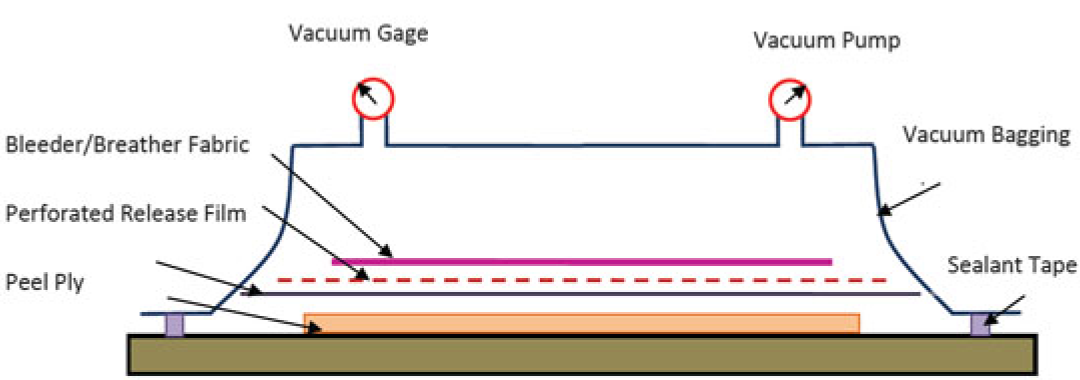

Figure 1.19: Vacuum Bagging

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C. Resin Transfer Molding - RTM

The process consists of arranging the fibres or cloth fabrics in the desired configuration in a preform. These fabrics are sometimes pre-pressed to the mould shape, and held together by a binder. A second matching mould tool is then clamped over the first. Then pressurized resin is injected into the cavity. Vacuum can also be applied to the mould cavity to assist resin in being drawn into the fabrics. This is known as Vacuum Assisted Resin Transfer Moulding (VARTM) or Vacuum Assisted Resin Injection (VARI). The laminate is then cured. Both injection and cure can take place at either ambient or elevated temperature.

In this process, the resins like epoxy, polyester, vinylester and phenolic can be used. Further, one use the high temperature resins such as bismaleimides can be used at elevated process temperatures. The fibres of any type can be used. The stitched materials work well in this process since the gaps allow rapid resin transport. Some specially developed fabrics can assist with resin flow.

Advantages:

- The process is very efficient.
- Suitable for complex shapes.
- High fibre volume laminates can be obtained with very low void contents.
- Good health and safety, and environmental control due to enclosure of resin.
- Possible labour reductions.
- Both sides of the component have a moulded surface. Hence, the final product gets a superior surface finish
- Better reproducibility.
- Relatively low clamping pressure and ability to induce inserts.

Disadvantages:

- Matched tooling is expensive and heavy in order to withstand pressures.
- Generally limited to smaller components.
- Unimpregnated areas can occur resulting in very expensive scrap parts.

Applications:

The applications include the hollow cylindrical parts like motor casing, engine covers, etc.

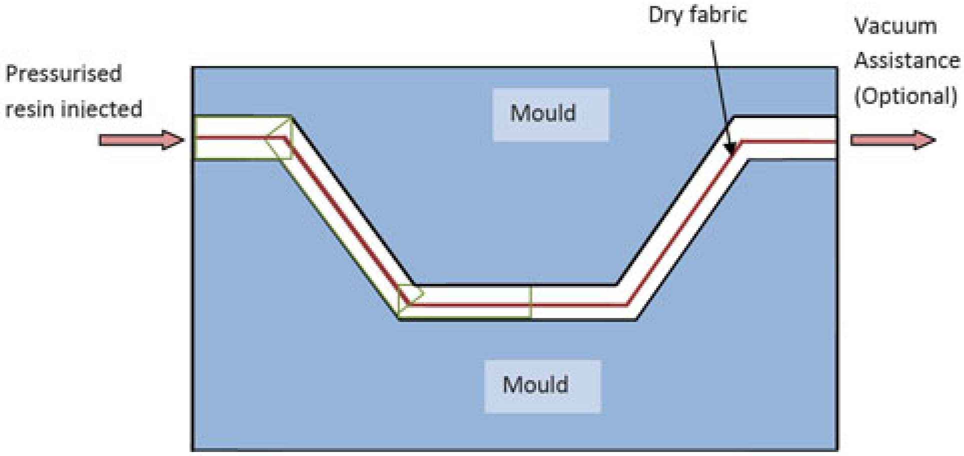

Figure 1.21: Centrifugal casting

D. Centrifugal Casting:

In this process the chopped fibres and the resin is sent under pressure to the cylindrical moulding. The moulding is rotating. Due to centrifugal action, the mixture of resin and chopped fibres get deposited on wall of the moulding. Thus, the mixture gets the final form of the product.

Advantages:

1. Suitable for small hollow cylindrical products.
2. Economic for small production.

Disadvantages:

1. Complex shape can not be made.
2. Resin with low viscosity is needed.
3. The finish of the inner side of the product is not good.
4. The structural properties may not be good as the chopped fibres are used.

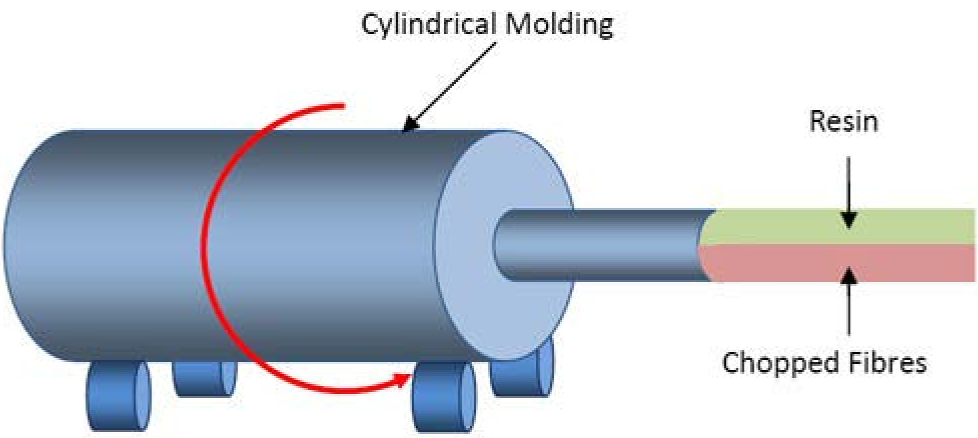

Figure 1.21: Centrifugal casting

Applications:

The applications include the hollow cylindrical parts like motor casing, engine covers, etc.

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