Light Resin Transfer Molding

Study Guide

CERTIFIED CCT COMPOSITES TECHNICIAN

ACMA
American Composites Manufacturers Association

Light Resin Transfer Molding

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Introduction to Light RTM

SECTION 1

Historical Perspective

Resin transfer molding (RTM) and ***vacuum infusion processing*** (VIP) were developed over five decades ago. Until recently, these molding methods remained in the background of composites manufacturing or experienced sporadic interest from the composites community. Today, with the development of highly engineered systems, both processes are receiving well-deserved attention.

RTM and VIP are most often associated with intermediate or low volume closed mold processing, and are generally considered more advanced processes from open molding. While the terms "resin transfer" and "vacuum infusion" are sometimes used interchangeably, in practice the methods are very different.

From a technical perspective, the terminology is straightforward. The traditional process defined as RTM states that the pressure in the mold cavity is higher than atmospheric pressure. In RTM, rigid molds are used and elaborate clamping mechanisms are incorporated to compensate for the higher pressures involved. If the pressure in the mold cavity is lower than atmospheric pressure, we refer to the process as Vacuum Infusion Processing (VIP).

There has been some confusion concerning these molding processes with the use of proprietary names and acronyms. Many molders have developed minor processing variations and have coined unique names to describe their version of the generic process. In the course of developing these process variations, commercial names and the associated acronyms have been attached to particular methods. In some cases, the terminology incorrectly describes the process.

RTM and VIP are both closed molding processes that are used to produce composite parts from low cost molds. These molds are generally constructed from ***fiber reinforced plastic*** (FRP) composite materials. RTM uses rigid matched molds which form a cavity, while VIP uses a single mold with a flexible film or bladder for the B-side surface. Thus RTM yields parts with two cosmetic surfaces while VIP yields parts with only one cosmetic surface. RTM molds define part thickness which allows a range of glass contents that are determined by the amount of glass used. In VIP the glass content is set by atmospheric pressure and the ***loft*** of the reinforcement. Consequently, a narrow range of glass contents are available in VIP. In RTM, the resin is pumped into the mold cavity under pressure while VIP uses only atmospheric pressure to push the resin into an evacuated cavity. Because RTM resin is pumped, the resin is typically introduced into the cavity from one or a few

points. Because there is low driving force for the resin in VIP, the resin is typically introduced from many points or from long flow channels.

Although conceptually simple, RTM, in practice, is a very difficult process to do well. One of the biggest problems with RTM is determining how to uniformly and completely fill the cavity. The process is also very sensitive to reinforcement uniformity and in higher glass contents it becomes increasingly difficult to fill without dry spots.

Light Resin Transfer Molding (LRTM) bridges RTM and VIP, using one rigid mold and a light semi-rigid mold called a counter tool. Most molders think LRTM is a significant improvement over RTM because it is more cost effective and easier to manipulate. Although it shares a name with RTM, LRTM is really much more like VIP, utilizing a vacuum process with only one rigid mold. LRTM does share a few good attributes with conventional RTM such as yielding two cosmetic surfaces per part and permitting a larger range of glass contents.

In the early 1990s, lighter, more flexible counter molds were developed that enabled the operator to use vacuum pressure to assist in drawing the resin into the mold cavity. At the same time, ***peripheral resin galleries*** were incorporated into the counter mold so that the resin flows from an ***injection port*** in the peripheral gallery to one or more vacuum ports in the mold cavity.

Over the last ten years there have been many developments to improve the LRTM process. Resins with higher heat distortion temperatures have improved the working life of counter molds. Computer controlled vacuum injection equipment has reduced cycle times and decreased material waste. Properties of reinforcement materials have improved allowing products to be manufactured that are lighter, stronger and less expensive.

Developments in LRTM continue today. Injection and mold handling equipment are becoming more capable and versatile, and less costly on a per-part basis. Material innovation also continues with improved fiber strengths and more efficient flow media.

SECTION 2

Understanding LRTM

LRTM is a process that uses a closed mold system to manufacture FRP parts. This closed mold system consists of a rigid base mold and a semi-rigid counter mold. These molds are often referred to as the A- and B-side molds. The molds are made to fit together very precisely and, when assembled, create a cavity in which the

laminate is formed. Initiated resin is drawn into the resulting cavity under vacuum pressure. The infusion is sometimes assisted by using low-pressure injection from mix/metering equipment to move resin into the mold cavity.

LRTM is a very versatile manufacturing process with the potential advantages of:

- Reduced cycle times in comparison with open molding
- Reduced labor costs
- Cosmetic surfaces for both the A and B sides
- Dimensional stability
- Improved process control
- Consistent material usage
- Minimal ***volatile organic compound*** (VOC) emissions
- Improved shop working conditions

The equipment required for LRTM includes the following:

- Mold set
- Vacuum reservoir
- Hoses and fittings
- Vacuum pumps for mold clamping and pulling resin into the mold
- Automated metering/mixing equipment for resin delivery (optional)

Figure 1 – Foreground - Finished Part;
Middle - Base or "A-side" Mold; Back - Counter mold or "B-side" Mold

