10.3. Compounding Processes and Equipment

Overview

- **Sheet Molding Compound (SMC)**
- **Bulk Molding Compound (BMC)**
- **Wet Molding Compound**

10.3.1. Sheet Molding Compound (SMC)

The sheet molding compound process involves three basic steps.

1. A compound paste is mixed that includes all the formulation ingredients except for the reinforcement.
2. The compound paste and reinforcement are combined and formed into a sheet.
3. The compound is allowed to thicken or mature.

Mixing of Compound Paste

Mixing of the compound paste can be done by batch, continuously or as a combination of batch and continuous mixing called batch/continuous mixing. For all paste mixing processes, the paste must be mixed well to ensure all components are completely dispersed. Highly filled compound pastes will heat during the mixing process and the temperature must be monitored. To control the thickening reaction, the temperature of the paste, when delivered to the compounding equipment, should be 85-90°F (29-32°C) for batch processes. Higher temperatures can be used for continuous processes.

A. **Batch Mixing**—Batch mixing involves mixing the compound paste in a mixing vessel such as a pail, drum, or mixing kettle using a high shear Cowles mixer. All formulation components are added to the mixing vessel manually. Batch mixing is an economical method adequate for preparing small amounts of compound paste for short production runs. Batch mixing has some disadvantages for long production runs, including low material efficiencies, batch-to-batch variations, and labor requirements for delivering the batch mix to the compounding equipment.

B. **Continuous Mixing**—Continuous mixing is best for long runs. This method involves pumping liquid ingredients and metering dry ingredients to a continuous mixer. Continuous mixing results in a very consistent compound due to accurate pumping and metering of the ingredients. Continuous mixing also results in very little waste. However, the length of setup time makes short runs of multiple formulations impractical.

C. **Continuous/Batch Mixing**—Continuous/batch mixing is a combination of the batch and continuous mixing processes that uses ‘A’ and ‘B’ component batch tanks. The ‘A’ side generally includes all compound paste ingredients except thickener. The ‘B’ side consists of thickener or thickener pre-dispersed in a non-thickenable resin mix. The ‘A’ and ‘B’ sides are pumped at a predetermined ratio through a static or dynamic mixer to the compounding equipment.

Compounding

The compound paste and reinforcement are combined and the compound formed into a sheet using an SMC machine. SMC machines are sized by the width of compound that they produce. SMC machine widths vary from two to five feet. The most common width is four feet. Figure 10-1 shows a SMC machine.

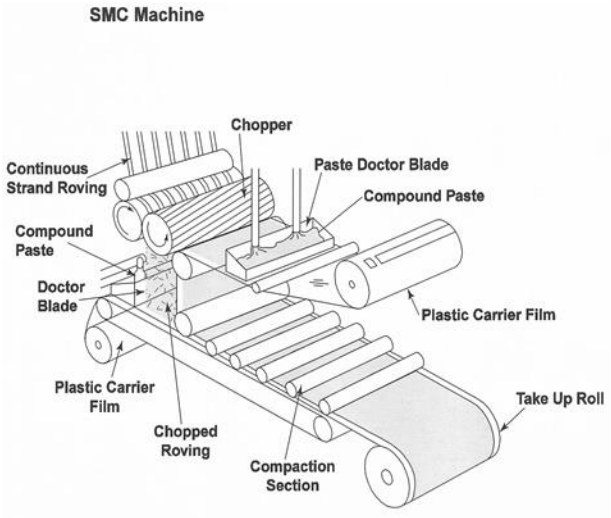

Figure 10-1. SMC machine.

The compound paste is delivered to two reservoirs called doctor boxes; it is deposited on a carrier film that is being pulled through the machine. A metering blade called a doctor box blade, set to a predetermined height above the film, controls the amount and thickness of the compound paste deposited on the film. Continuous strand roving is pulled through a glass chopper and the chopped glass fiber is dropped on the compound paste on the lower film. The upper and lower films meet so that a sandwich is created between the carrier films consisting of two resin layers with chopped glass in the center. The carrier films are pulled through a compaction section in which pressure is applied to accomplish glass wet out. After

compaction, the material is either wound on a take-up roll or festooned (folded similar to computer paper) into a box and moved to a thickening or maturation room.

The glass content of the SMC is determined by the height of the doctor box metering blades, the speed of the glass chopper, and the speed at which the carrier films are being pulled through the compounding machine. The glass content of the SMC is generally verified during production by comparing the areal weight of the compound being produced with the areal weight of the glass being dropped on the compound.

A gamma-backscatter gauge can be added on a traversing mechanism that monitors sheet weight and adjusts the chopper speed or doctor blade height.

The carrier film is typically a nylon/polyethylene co-extrusion. The nylon prevents monomer loss through the film and the polyethylene can be used to heat-seal the compound edges to prevent monomer loss. Film edges can also be folded or taped to prevent monomer loss.

The pressure in the compaction section is an important process parameter. The compaction pressure needs to be high enough to wet out the glass, yet low enough to prevent compound from being squeezed out of the film edges.

Thickening

The thickening or maturation room is typically controlled at 90°F (32°C) to provide consistent thickening of the SMC compound. To verify thickening and determine compound readiness for molding, a retain of the compound paste is taken after thickener addition, but prior to glass addition. This retain is stored with the SMC and monitored for viscosity. A Brookfield HB viscometer with T-bar spindles is typically used for these viscosity measurements.

10.3.2. Bulk Molding Compound (BMC)

During the manufacture of bulk molding compound, all formulation components are combined in the mixer. One of the most common mixer types is a sigma blade mixer. Liquid components of the formulation are pumped or manually added to the mixer and agitated until dispersed. Dry components, except for glass fiber, are added next and mixed until thoroughly wet. The glass fiber is the last formulation component added and is mixed in until thoroughly wet. Continued mixing of the compound after glass wet out can result in unnecessary degradation of the reinforcement, which can cause reduced mechanical properties of the molded part. BMC is ready to mold when it is discharged from the mixer, unless maturation time is required for chemical thickening.

10.3.3. Wet Molding Compound

Wet molding compound is the oldest and simplest compression molding compound form. Reinforcement is incorporated during the molding process rather than during compounding. Manufacture of wet molding compound involves mixing formulation components using a simple Cowles mixer.