Many formulations of reactive adhesives require mixing of the resin and hardener in a critical ratio. This chapter deals with the basic designs of equipment for this purpose.

The most popular meter, mix and dispensing machines have been designed around gear pumps and pistons, or a combination of both. This chapter will explain how both systems function, their strengths and weaknesses.

In order to select a machine, several questions must be answered:

1. What material is to be dispensed: epoxy, polyurethane, silicone, etc.?
2. What are the characteristics of that material which will affect metering: viscosity (rheology), component ratio, filled or unfilled, abrasive or nonabrasive, pot life?
3. Application, production rate, volume required, continuous or intermittent dispensing?

THE GEAR PUMP SYSTEM

The circuit diagram in Fig. 1 shows the common gear pump metering system. The degree of sophistication governing the driving and monitoring of these devices varies from manufacturer to manufacturer, as does the cost.

In Fig. 1, the letters A and B represent the supply tanks. Tank A is usually the resin supply and Tank B the hardener supply. These tanks can vary in size from one quart up to 55 gallons. They may be ASME tanks which are capable of handling pressures to 75–80 psi. The tanks may be heated or cooled and may incorporate agitators, driven by electric or air motors.

The tanks may be equipped with liquid level controls which sense the amount of material in a tank. These sensors will send a signal, causing a pumping device to start filling the tank. Upon reaching a predetermined liquid level, a sensor will signal the filling device to stop. A system such as this makes the machine com-
pletely self-sufficient so long as the main material supply is maintained.

The letters PA and PB represent the metering pumps. These pumps are fixed displacement type, using either gears, diaphragm, or piston to displace the material being pumped. Only gear pumps and piston pumps will be covered, as diaphragm pumps are not popular.

Gear pumps vary in the precision with which they pump material against a resistance. The machine designer selects a specific pump according to the characteristics of the material being processed and the production requirements. Materials having viscosities, 500 cps and up, do not require the precision of pumps that pump materials with viscosities in the 50–500 cps range. Pump speeds (rpm) must be such that pump cavitation will not occur.

Gear pumps are very accurate metering devices and when used properly can do an excellent job. They cannot, however, be used with materials containing abrasive fillers, or highly filled materials which will prevent lubrication of moving parts. The filler material will cake up in the pump, causing the pump to jam. On the other hand, materials which have relatively high viscosity, but are still pumpable, cause the pump to run at near 100% efficiency since slip is at a minimum.

The advantage of the gear pump system (Fig. 1) is its simplicity. The system contains no check valves. It may contain a three way valve (V) to divert hardener from the mixer to the tank for the purpose of ratio checking or purging the mixer with resin.

The letter M denotes the drive of the pumps. This could be a simple gear head motor linked to the pumps via gears or chain and sprocket. It could also use a SERVO motor drive system. With this setup, ratio may be changed at will. With gears or sprockets, these must be physically changed in order to effect a change in ratio.

The letter C denotes the mixer of the machine. The two most popular types are the dynamic and the motionless mixer.

**The Dynamic Mixer**

This mixer is simply a rotating (usually bladed) agitator within a chamber. The space between the tip of the blades and the inside diameter of the mixing chamber is very small. Usually, part A (resin) will enter the chamber behind the part B (hardener) entry port. In some cases, a check valve is used to prevent the intrusion of resin into the B side of the machine as the result of a drop in B side system pressure. If this occurs, the valve closes, preventing part A from entering.

The mixer is driven by either electric or air motor; mixer speeds vary from 1700 up to 20,000 rpm.

Mixer shaft seals range from V-ring packings to mechanical rotary seals. The degree of back pressure and speed a mixer can tolerate is a function of mixer shaft seal type.

V-ring packings would require lubrication to extend the life of the seal, especially at high speeds and pressures. Mechanical (rotary) seals do not require lubrication, but have speed and pressure limitations, red lined by the manufacturer of the seal. Maximum speed for seals in the 0.500–0.625 in. shaft diameter range is about 4500 rpm at 100 psig system pressure.

The dynamic mixer can mix a variety of formulations since mixer speed, size, and resident time (the time the mixture spends in the mixing chamber) can be varied.

The disadvantages are that it does require maintenance, primarily cleaning and seal replacement. It cannot take high back pressure without premature shaft seal failure. In addition, being a mechanical device, it takes energy to drive; seals create frictional heat in addition to the heat generated by the shear action of the blades through the mixture. Mixing temperatures can exceed 120°F but this depends upon the rate of the material through the mixer and the temperature of the components being mixed. It should be noted that the gel time of the material being processed is no longer the published time and in all probability will be shorter due to the heat generated by the mixer. A good rule of thumb is: for every 10°C rise in temperature the pot life is reduced by one-half.

**The Motionless Mixer**

This mixer does not require mechanical energy to achieve the mixing of the two streams. Mix-