Multilayer Lamination Presses

Considerations for their design/selection.

Doug Lamberson

Broken down into its most basic elements, the multi layer lamination press is essentially a system that controls time, temperature, and pressure. But this deceptively simple analogy neglects many of the subtleties of press design that determine a machine's suitability for a particular user or application. Before the equipment design/selection process is begun, it's important to understand the fundamental elements that can so dramatically affect performance. Accudyne's Doug Lamberson provides some hints for maximizing lamination press success.

Vertical hydraulic presses run the gamut from basic single-opening, compression molding units to sophisticated multi-opening laminating units with automatic loaders/unloaders, vacuum systems, and computer-interfaced or -controlled systems. The multilayer lamination press has control functions for time, temperature, and pressure. These controls range from basic, economical process instrumentation and valving to industrial-grade PCs and custom, state-of-the-art software technology.

Multilayer Press Parameters

When designing or selecting a multilayer press, the following parameters should be considered:

- frame design
- temperature, platen size, and material
- time/temperature controls
- hydraulic controls.

Frames

Most multilayer lamination presses are based on either four-post, chrome-plated steel (strain) rod construction or precision-machined and -assembled steel chamber construction. The latter configuration, designed for vacuum applications, is also referred to as weldment or slab-side construction. Due to the widespread acceptance of vacuum lamination, the once-popular four-post design has given way to the slab-side design.

The upper steel plate on both types of configuration is called the upper bolster plate or the stationary bolster. The lower steel plate, which moves in an upward fashion, is called the moving bolster plate. The upward motion of the latter plate is accomplished via hydraulic ram or cylinder and hydraulic fluid.

The height of the slab-side frame or four-post rods depends on the quantity and thickness of the platens and the number of openings (daylights) required. Another height-determining factor is the stroke of the ram or cylinder that allows full closure of the press in the absence of material layup. An empty press with six 3“ daylights (seven platens) must have an 18“ stroke to achieve full closure. Thus, press height is made up of ram stroke length, bolster plate thickness, platen thickness, and daylight dimensions. Catwalks are the only viable option with presses that exceed a certain height. Recessing the cylinder in a pit or using automatic loading/unloading equipment are two other alternatives.

The thickness of frame structural designs (i.e., slab-side vacuum frames, strain rods, and bolster plates) is calculated and can be varied to produce a very tight or loose deflection factor. Deflection (bending) is the result of the stress, under pressure, that will always occur to the outer plates or rods at any given force. Optimally, press frame designs should not exceed 0.0005”/ft. of span deflection. The most effective designs also incorporate large solid-steel rams.

Platens

Most platens are heated by steam, electricity, or hot oil, and are precision-ground and fabricated from carbon steel to the desired size. Platens are generally quoted to standard maximum temperatures of 600°F and offered upon request to 800°, 1,000°, and 1,2OO°F. The recommended material for 1,OOO°F applications is stainless steel, and chromium-nickel alloy for 1,200°F applications. Consideration must be given to the rate of temperature rise, which usually is cited at 10°, 15°, or 20°F/min. Ramp times are cited in the following manner: rise to 250°F over five minutes and hold for 10 minutes until the setpoint is reached. Platens are usually ground flat to 0.001''/ft. and have a 32-RMS finish.

The grade of steel and the stress-relieving and grinding operations used are also critical. To reduce system costs, these parameters should not be more stringent than necessary.

Platens are insulated around their periphery to prevent heat loss and maintain a tight temperature tolerance across the surface. The top and bottom platens are mounted to the stationary and moving bolsters and separated from these bolsters by an insulation plate. Thermo-conductivity, compression rigidity, and flatness are all primary factors in insulating material selection.

In the case of multiple platens, individual units are supported by bars on the side frames in the slab-side vacuum chambers. In a four-post system, platens are hung from vertical steel rods that flank them on the right and left sides. In some high-temperature applications, upper and lower bolster plates are water cooled to eliminate heat transfer from the platens to the frame and other sensitive controls. In addition, platens may require multiple zone controls to ensure precision temperature uniformity.

Time/Temperature Controls

The most simple, conventional types of time controls are single digital setpoint and digital readout units with pushbuttons for time setpoints. With these systems, the operator manually sets the interval required for low pressure (hydraulics), high pressure (hydraulics), cooling (water), and air purge of water. When the air purge timer elapses, the press will have opened, or will be in the process of doing so, and will reset for the next cycle. This type of system can be used for platen temperature control wherein the operator sets the maximum temperature setpoint for each platen, and the press heats up at a rate tailored to that setpoint. Ramp rate flexibility is not available with this operation.

The second advancement in controls design was the programmable logic controller (PLC). This microprocessor stores data and allows the operator to program the time, pressure, and temperature from a keyboard or touchscreen. State-of-the-art systems incorporate computer process controls via 1/0 hardware and keyboard operator interfaces. Computer control is used to regulate many functions, including vacuum state, product pressure, temperature ramp rates/setpoints, and cure times. Additional controls incorporate graphic displays; recipe storage and retrieval; password protection; data edit, deletion, duplication, and storage functions; and printed event logs of all functions. These controls can also be used to fulfill SPC and IS0 9000 requirements.

Variables must be tailored to the specifics of the application.

Hydraulic Controls

Hydraulic systems can be either self-contained or centralized, and either pressurized (i.e., air over oil) or suction based. Most multilayer lamination presses are the self-contained, suction type. They typically contain a reservoir and a high-volume/low-pressure pump (e. g., 45 gpm) with a motor for rapid closure (e.g., 40"/min.). Most also contain a low-volume/high-pressure pump (e.g., 1 gpm) with a motor for pressing and final closure at a rate of 1"/min. All systems contain the necessary valving, filters, temperature gauges, and thermal-sensing heat exchangers for hydraulic oil cooling. Low- and high-pressure controls make up valves with preset pressure settings.

Manual valves with readout indicated on pressure dial gauges constitute the most conventional type of controls. The high-volume/low-pressure pump usually shuts off prior to full closure, and the system operates under the low-volume/high-pressure pump for quiet operation. The pressure settings remain at the setpoints until timers expire. The PLC or computer controls the valves, and readout is produced via monitors and gauges.

Conclusion

Though the aspects of hydraulic lamination press design and selection are complex, those presented here represent the basic parameters. A final note: All variables must be tailored to the specifics of the application. FAB

Doug Lamberson is sales and marketing manager with Accudyne Engineering and Equipment Co., Bell Gardens, CA.