

Automation of a laboratory particleboard press

Robert L. Geimer
Gordon H. Stevens
Richard E. Kinney

Abstract

A manually operated particleboard press was converted to a fully automatic, programable system with updated data collection capabilities. Improved control has permitted observations of very small changes in pressing variables resulting in the development of a technique capable of reducing press times by 70 percent.

Accurate control of the press is obtained through an electrical servo activated press pump and pressure- and position-monitoring transducers. Position is repetitively accurate to within 0.002 inch under a no-load condition and to within ± 0.005 inch under pressure. Line pressure can be controlled to within 210 psi of targeted values at pressures below 500 psi and to within ± 30 psi at pressures above 500 psi. A programable ramp generator is used to predetermine the press cycle. Time-position error is dependent on the system response and varies between 0.5 and 3 seconds.

Equipment of this sort is necessary to solve the complex problems present in modern particleboard production.

Advancements in technology often demand more precise process control. Particleboard technology is no exception. Press times of 20 minutes, common for a 3/4-inch-thick board 30 years ago, have been reduced to less than 5 minutes in present-day production. Standard hand-operated press control systems that permitted researchers to establish basic relationships between pressing variables and final board properties lack the speed, accuracy, and repeatability to solve current problems confronting both equipment manufacturers and board producers. Answers to their questions depend on defining the interactions between moisture diffusivity,

thermal conductivity, porosity, plasticity, densification, and resin sensitivity.

Meaningful laboratory research, in turn, depends on very fine control of the pressing operation, especially during closure. During this critical period, which may be as short as 15 seconds, the character of many board properties, including density profile, is established. Precise rate of closure is extremely difficult to maintain because conditions within the system change rapidly with the ever-changing resistance of the mat.

Research at the Forest Products Laboratory investigating the use of steam injection during press closure demanded control of press closure rate far in excess of that possible in a manual operation. The work also required equipment capable of controlling several on-off events at precise times during the press cycle and the ability to monitor events rapidly. The required versatility, accuracy, and speed were obtained in an electrical control system. This note describes the fully automated, programable electronic equipment and associated data collection instrumentation used to replace a pneumatic, manually operated press-control system.

Press modification

The control system installed is compatible with variable-displacement-type pumps similar to the 35 hp pump used on the FPL press. This pump operates at 1,200 rpm and 2,500 psi maximum line pressure and is capable of closing the press at a rate of 18.5 inches per minute. The 500-ton press has 36- by 36-inch platens and is actuated by a single 22-1/2-inch-diameter hydraulic

The authors are, respectively, Research Technologist, Engineer, and Electronics Technician, USDA Forest Serv., Forest Prod. Lab., P.O. Box 5130, Madison, WI 53705. The Laboratory is maintained in cooperation with the Univ. of Wisconsin. This paper was received for publication in August 1981.

© Forest Products Research Society 1982.
Forest Prod. J. 32(4):34-36.

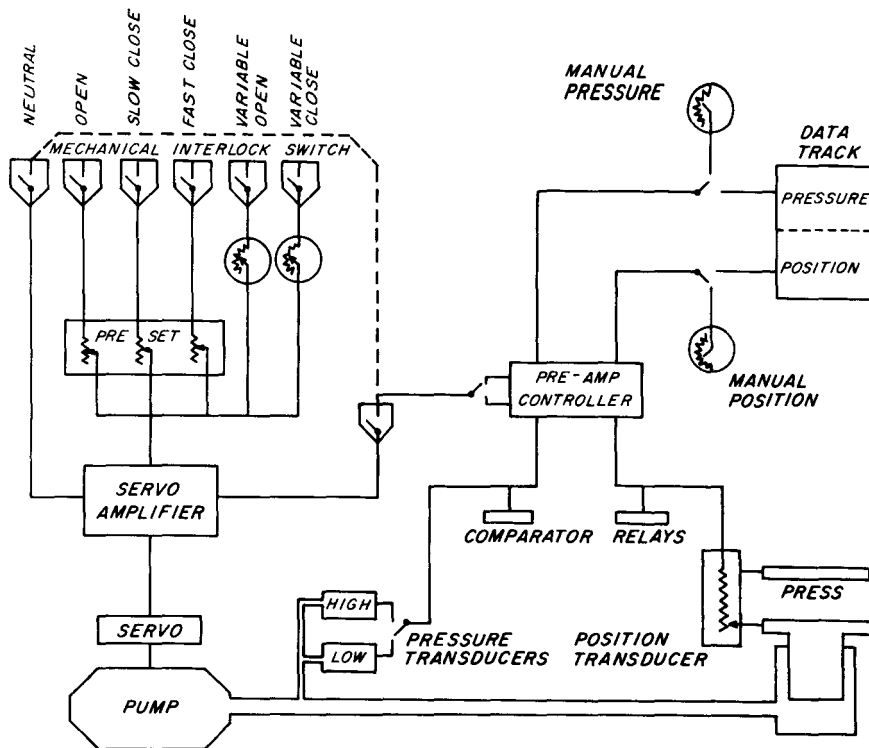


Figure 1. — Functional schematic of press-control system.

ram. Conversion of the control system involved replacement of pneumatic rate and pressure controllers with a single electrical servo activator. Sensitivity of the system is such that complete control of the press is obtained through the ± 0.015 -inch movement of the swing-plate valve within the servo unit.

Control system options

All signals going to the servo unit are processed by the pump company-supplied control modules. A functional schematic of the control options is shown in Figure 1. Several modes are available for manually controlling the rate of press movement. Selection includes one opening rate and two closing rates which have been predetermined by internal adjustments with the preset module. Optional potentiometers located on the control panel allow the opening or closing rate to be varied between zero and 100 percent of the maximum rate.

Precise control of press position and of pressure is obtained through the use of two feedback loop circuits. A 12-inch precision resistor-type linear transducer, mounted to the top stationary head of the press, monitors the position of the movable platen and provides position feedback. Pressure feedback is obtained from one of two pressure transducers. One is capable of covering the full range of line pressures (zero to 3,000 psi); the other is used for more sensitive control below 500 psi.

Desired position or pressure is changed with manually operated potentiometers or is determined in advance through a programmable ramp generator. Signals from the potentiometers or ramp generator are

compared to the feedback signals in the preamplifier module. Any error signal is sent to the servo unit after being conditioned by the servo amplifier. The servo valve responds to change the output of the pump in such a manner that the error signal is reduced to zero.

The programmable ramp generator serves to automate the system, producing a linear change in output voltage over a period of time. It is capable of handling two distinct programs with a combined capacity of 52 steps. The ramp generator also contains seven on-off, time-programable relays that may be used to activate accessory controls or monitoring equipment.

A separate control module provides five additional on-off relays. These comparator units are not time-dependent but rather are preset to trip at any desired control voltage level.

Performance

Position control of the press under a no-load condition is repetitively accurate to within ± 0.002 inch. System inertia and mechanical delays in the pump mechanism cause a 0.5- to 1.5-second delay in the programmed time-position relation. The magnitude of this delay is dependent both on the distance moved and the desired rate of closure. When operating under pressure, position control is accurate to approximately ± 0.005 inch. The time-distance error varies between 1 and 3 seconds. Errors in both position and rate of attaining position while under pressure are directly related to the maximum pressure attained.

Pressure control is quite accurate depending on the target pressure selected and the range (high or low) used. Line pressures will vary a maximum of ± 30 psi around target values when the high-pressure transducer is used to supply the feedback signal. The low-pressure transducer allows control to within ± 10 psi.

Data collection

Press variables of time, pressure, and position, along with mat variables such as centerline core temperature, are monitored by a 16-channel programable data logger. Time to record the data depends on the number of channels in use, the amount of data in the channels, and the type or types of data storage used. Seven channels of information can be printed on paper and transferred to a cassette tape in approximately 5 seconds. Information collected on the cassette tape is processed through a computer to develop temperature-, pressure-, and position-versus-time curves.

Conclusions and recommendations

Installation of the new press control system has allowed exploration of a new steam injection pressing

system. Observations of very small changes in steaming duration and press closure plates enabled the reduction of the press time to one-third that required in a normal hot-press.

Automated press control not only permits new avenues of research to be explored but also points out discrepancies previously ignored in the press monitoring system. Expansion of the heated platens and compressibility of the insulating pad are now accounted for in accurately determining press position. Analysis of graphs indicates that press variables should be monitored every 0.5 second during the critical closing period. A second-generation improvement in the system will be the installation of a minicomputer. A proper device of this sort is not only capable of faster and broader data collection but can alter a predetermined press schedule depending on the change in press and mat variable relations.

Advancement in technology has spurred the development of a new research tool. Research conducted with the use of this tool can solve complex problems facing the particleboard industry today and, in turn, further the state of technology.