

# MULTI-SPRAY BOOTH LAYUP LINE CONTROL SYSTEM

## INTRODUCTION:

Multi-booth layup lines usually have 4, 6 or 8 booths for applying glue to the veneer passing underneath a glue spray nozzle that can be raised or lowered (manually or hydraulically) for the purpose of adjusting glue coverage. Glue is circulated to each of the booths through a supply line with the excess returning to the supply tank. Glue for each booth goes through a multi-port valve then through the nozzle. If the line shuts down, the valve by-passes the glue to the return line. There is an overspray tray on each side of the production line to catch the excess glue for return to the supply tank. Use of too much glue is wasteful and costly; too little glue can be financially disastrous if field complaints in the completed building structure are experienced.

## THE CONTROL PROBLEM:

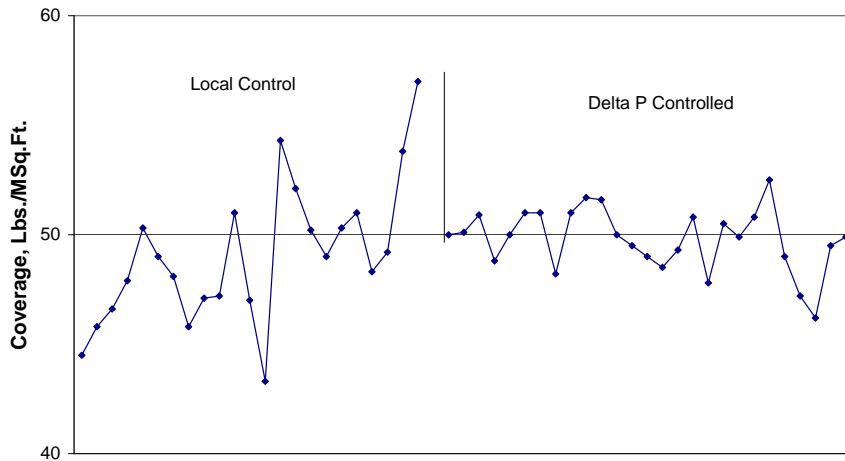
Presently glue is applied to the veneer by adjusting the glue nozzle height above the veneer either manually, or by use of some type of hydraulic cylinder mechanism. Glue coverage is usually measured by tarring a clean, thin metal bar, placing it on the line, and allowing it to travel under the spray. The metal bar with the glue is weighed, the tare weight subtracted, and a multiplier is applied to give the glue coverage in Lbs./M Sq. Ft. glue line. Although the method for measuring the instantaneous coverage is accurate, it is not reproducible due to variations in glue pressure, line speed and height of veneer stack. Consequentially, coverage must be corrected for these variables, and the coverage setpoint adjusted for veneer and glue temperature. The data in Table I compares the coverage variation for a manual Vs DELTA P glue control system that includes corrections for the constantly changing variables.

TABLE I –COMPARISON OF MANUALLY CONTROLLED VS A DELTA P CONTROLLED GLUE COVERAGE CONTROL SYSTEM

	Coverage Setpoint, Lbs/MSq.Ft.	Actual Average Coverage Lbs/MSq.Ft	Std. Dev.	Range
Manual Control	50.0	49.1	3.2	43.3 - 57.0
DELTA P Control	50.0	49.8	1.4	46.2 - 52.5

The data summarized in Table I is used to construct figure 1.

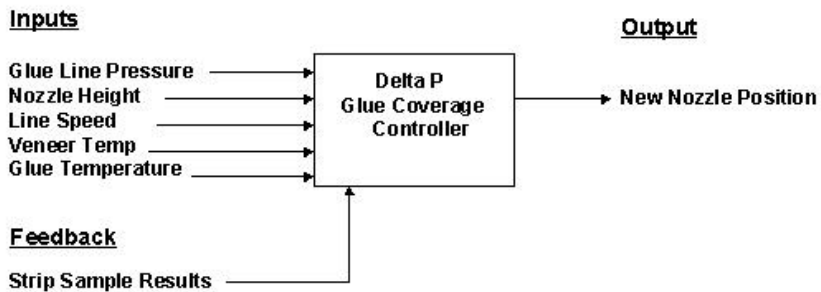
FIGURE 1  
UNCONTROLLED VS DELTA P CONTROLLED SPRAY BOOTH



THE DELTA P CONTROL SOLUTION:

The DELTA P control scheme, depicted by figure 2, reduces the variation in glue coverage because it is able to: correct for pressure fluctuations in the glue pressure to the nozzle, correct for varying distance from the glue nozzle to the veneer surface, correct for line speed changes, and adjust coverage setpoint for changes in veneer and glue temperature. Additionally, the DELTA P utilizes a rapid, proprietary method for calibrating the nozzle using one stick weight measurement.

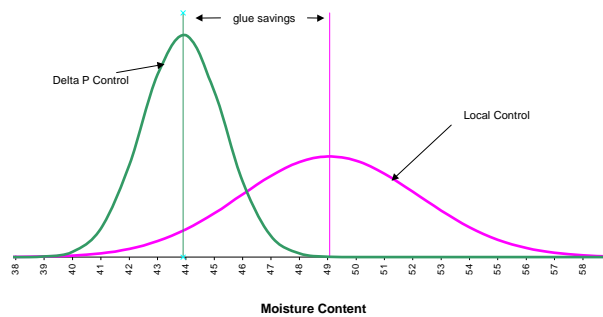
FIGURE 2 – DELTA P CONTROL SCHEME



The DELTA P can be quickly setup for a new product simply by inputting the new target glue coverage just prior to the new product reaching the booth. Although the nozzle is already calibrated, as soon as the new product is on-line, the operator can return to each booth and make a bar measurement to more precisely re-calibrates the nozzle for the new operating conditions.

Figure 3, constructed from the data in Table I and figure 1, shows significant variation in glue coverage for the uncontrolled spray booth Vs that for the same booth controlled by the DELTA P. It is useful in determining the extent to which glue may be saved with improved control offered by the DELTA P.

FIGURE 3 – CONTROLLED VS UNCONTROLLED BOOTH



Previously, during manual control operation, a lower limit for coverage has been established below which good glue bond cannot be achieved; in this case (see lower 3 sigma limit of local control curve of figure 2) it is about 39.5 lbs. Control was improved using the DELTA P such that the distribution was narrowed and the controlled distribution curve was shifted downward so that the lower limits of each distribution (3 sigma limit) are superimposed. The potential glue savings is the difference between the two means values of the curves after repositioning. In this case, glue savings could be as high as 5.2 lbs./M Sq. Ft glue line - about a 10% reduction in glue consumption. Following these results of figure 5, while using the DELTA P, it should be possible to reduce each coverage setpoint for all products produced thereafter, a maximum of 10%. Initially, the reduction should be about 5% with gradual reduction toward the full 10% maximum, but probably operating with some margin, e.g., settling on about 7.5% reduction in glue usage.

## EXPLANATION OF THE DELTA P CONTROL SYSTEM:

Each nozzle is mounted on a hydraulic cylinder (figure 4) which is connected to the gluing operation hydraulic system.

FIGURE 4 - TYPICAL GLUE NOZZLE ARRANGEMENT

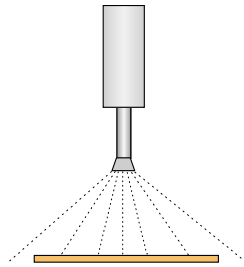
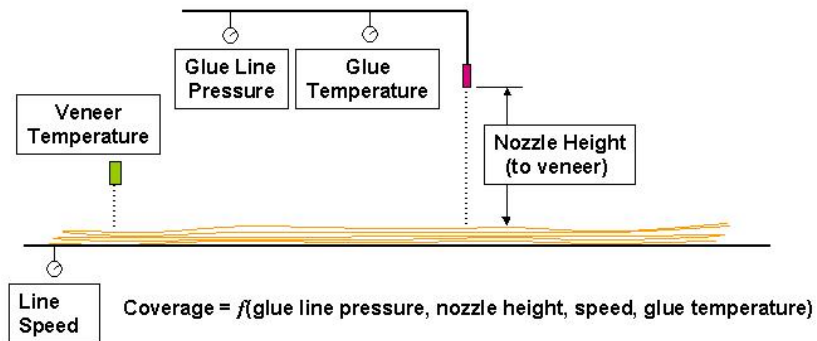


Figure 5 depicts sensors mounted on each nozzle hydraulic cylinder-nozzle mechanism such that the distance from the nozzle tip to the veneer is known at all times.

FIGURE 5 – COVERAGE CONTROL PARAMETERS



Additionally, a pressure sensor is mounted in the glue header, a temperature sensor is mounted in the glue supply line, and an infra-red thermocouple is mounted ahead of each booth to measure the veneer temperature going to each booth. Also, a switch is mounted at each booth in order to freeze the operating conditions during the calibration mode. The setpoint value for coverage is entered for each booth. The sensors correct for changes in veneer temperature, glue temperature (viscosity), line speed and flow from the nozzle caused by pressure fluctuations.

The calibration procedure is to freeze the operating conditions by a switch just as the measuring bar goes under the nozzle. A proprietary mathematical method is utilized by the computer to calibrate the nozzle in terms of coverage Vs height with one bar weight measurement. For best results, a running average calibration factor is maintained to insure higher calibration accuracy, and to handle gradual changes due to nozzle wear. An occasional check, perhaps once or twice a shift for each nozzle, should suffice.

#### ADVANTAGES OF THE DELTA P CONTROL SYSTEM:

Advantages of the DELTA P system are : (1) Easy calibration thus allowing operator to utilize his/her time in keeping the line operating rather than running weight samples, (2) Adjustment of coverage for veneer and glue temperature,, (3) Coverage corrections for glue pressure changes, (4) Corrects coverage for automatic line speed changes, (5) Corrects coverage for fluctuations in distance between nozzle and veneer, (6) More rapid changeover to different products, and (7) displays and reports pertinent data, including individual booth and total system glue consumption statistics, etc.

#### RESULTS AND CONCLUSIONS:

An eight-booth spray line system has been controlled using a new concept in glue coverage control – the DELTA P. This system was designed to eliminate the need for expensive flow meters, and maintenance prone control valves. Instead, it uses proprietary mathematical methods that enable quick and accurate nozzle calibration using one bar weight measurement, and a mathematical relationship between nozzle height and coverage. This capability enabled the potential for reducing glue consumption by 10% (5.2 Lbs/MSqFt glue line) without allowing the lower limit of glue coverage to drop below the previously established limit for producing an acceptable panel.