GARDNER SYSTEMS CORP.

CHAMPION REBUILDS DRYER STEAM CONTROLS:

THROUGH BETTER CONTROL AND EFFICIENCY, A DRYER STEAM CONTROL SYSTEM'S NEW DESIGN REDUCES STEAM AND CONDENSATE LOSSES, WHILE BOOSTING TEXAS MILL'S OUTPUT

■ Through better control and efficiency, a dryer steam control system's new design reduces steam and condensate losses, while boosting Texas mill's output

Champion Rebuilds Dryer Steam Controls to Improve Lufkin Machine Performance

F E A T U R E

BY THOMAS A. GARDNER

Papermaking

WHEN THE PERFORMANCE of any critical system controlling paper machine operation is defective, it should be replaced as soon as possible. If not, the failure of the single system can compromise the performance of the entire machine for as long as it remains in place. Steam control and dryer drainage systems often fit this description, draining profits through diminished production and massive energy losses.

For more than a generation, a number of critical problems plagued the old steam system in Champion's No. 2 paper machine at its Lufkin, Texas, mill. About two years ago, an aggressive mill management team sought analyses and reports concerning the problems from several sources. The mill eventually commissioned Gardner Systems Corp. to redesign the system using Deublin stationary syphons as replacements for the existing oversized rotary syphons. The redesign has increased machine efficiency, eliminated large steam losses through the dump valves, and significantly reduced cooling water and condensate losses.

THE OLD SYSTEM. Designed to dry newsprint at 3,500 fpm with the machine balanced for 4,000 fpm, the original dryer steam control system used four standard thermocompressor recirculation sections with pressure and differential pressure (DP) controls (Figure 1). In each of these sections, the split-ranged outputs of the two controllers were connected to the makeup valve and the dump valve, respectively.

The outputs also joined at a low pass selector relay that passed the lower of the two signals to the thermocompressor. This allowed the pressure controller to take over and throttle the thermocompressor in the event that it supplied too much pressure after the controller had closed the makeup valve.

Ideally, the DP controller only controlled the thermocompressor with a low signal, and the DP only rose to open the dump valve if the DP fell short of the

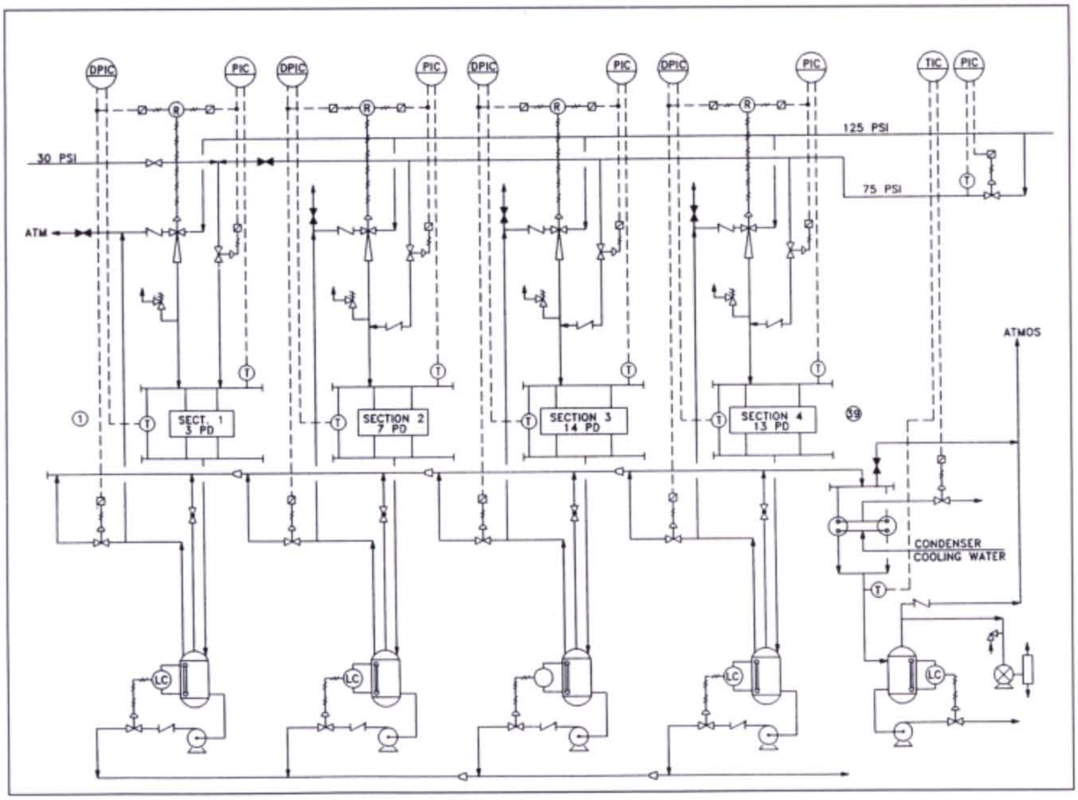
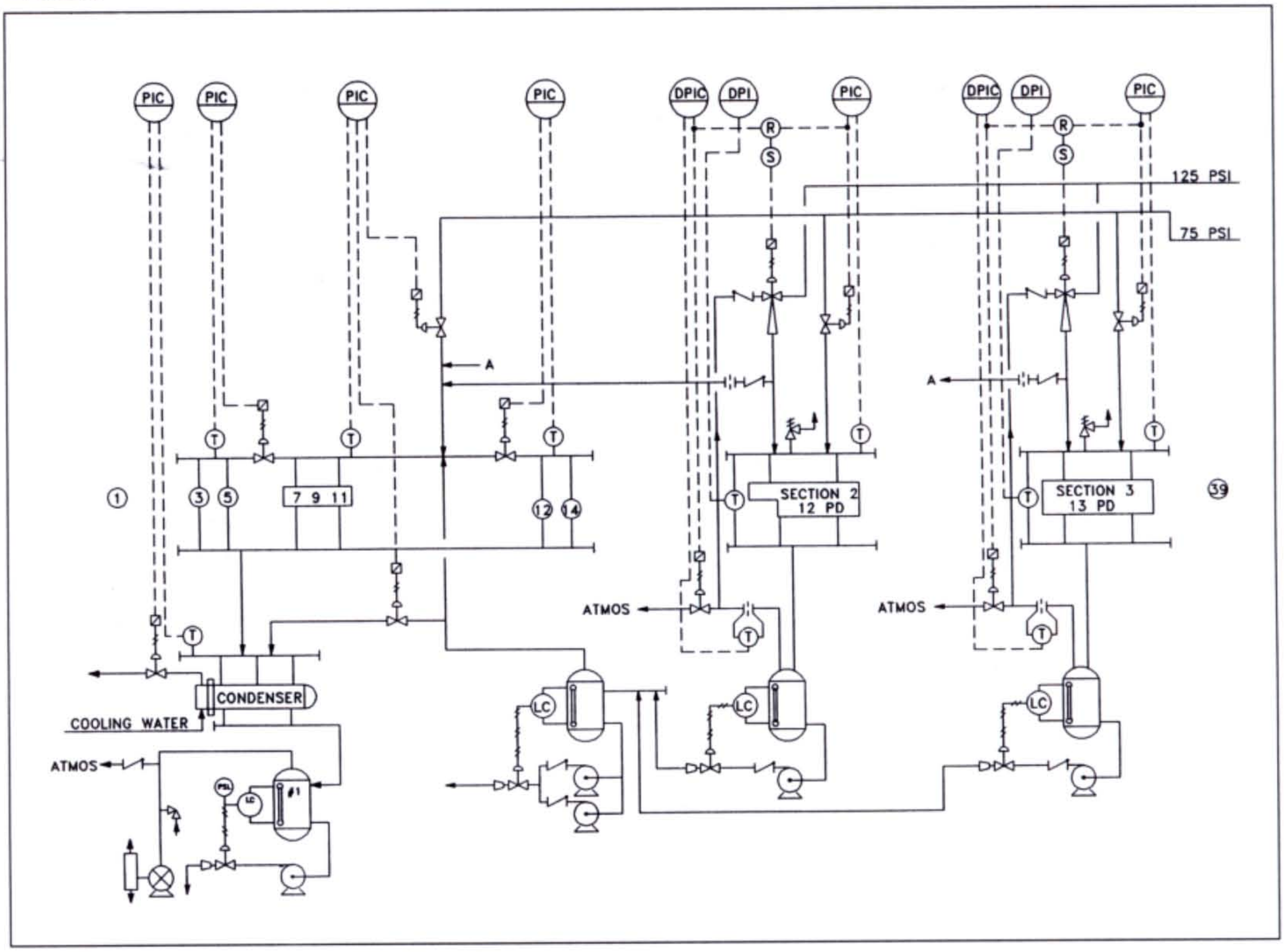


FIGURE 1: *In the original dryer steam control system, pressure and differential pressure controls regulated the four standard thermocompressor recirculation sections.*

FIGURE 2: *Along with other modifications, the rebuilt steam system used Gardner Systems' blow-through control to keep blow-through flow constant at any operating pressure and to control the thermocompressor at all operating conditions, run or break.*



setpoint. It is recognized that DP-controlled sections always dump steam to the condenser on web breaks and often during normal production, as in this case. Interestingly, the flow diagrams of these old sections are not unlike the main sections of the rebuilt system shown in Figure 2, since performance improvements in the new system were mainly attributable to the new equipment's design and the adoption of blow-through controls.

Figure 3 is a diagram of the old rotary syphons in the dryers. The pipe sizes were 1 1/4-in. for the vertical syphon, 1 1/2 in. for the horizontal syphon pipe, and 2-in. for the external drain line, all of which were schedule 40 pipe sizes. Although normal condensing rates in the dryers ranged up to 2,500 pph at 50 psi, these syphon pipe sizes were clearly too large.

The standard clearance of the syphon shoe from the shell was 0.060-in., although, without success, clearances as low as 0.045-in. were attempted to check the flow of blow-through steam. However, even the standard 0.060-in. clearance resulted in extremely high and erosive velocities. In a separate case at another mill, this action caused damaging, deep erosion of dryer shells.

Figure 4 shows the arrangement of the new Deublin stationary syphons and joints that replaced the oversized rotary syphons and joints. The syphon assembly is rigidly supported by the bell bracket attached to the main bearing housing. The tubing bore is 1.125-in., and the external drain line is 2-in., schedule 40. The clearance of the syphon shoe is set at 0.16-in., and metal contact with the shell is prevented by a special design that causes the shoe to surf on a thin film of condensate.

FIGURE 3: *With schedule 40 pipe sizes ranging from 1 1/4 to 2 in., pipes in the original rotary syphon system were too large for efficient operation.*

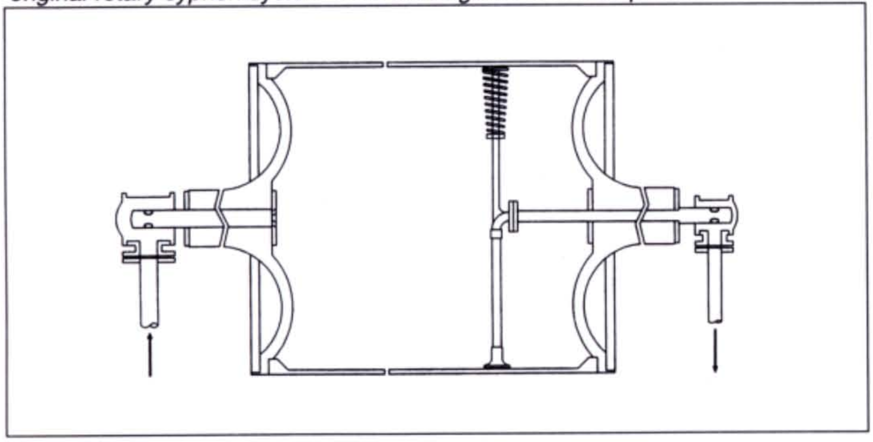


FIGURE 4: *Rotary syphons in the original system were replaced by new Deublin stationary syphons with turbulence bars.*

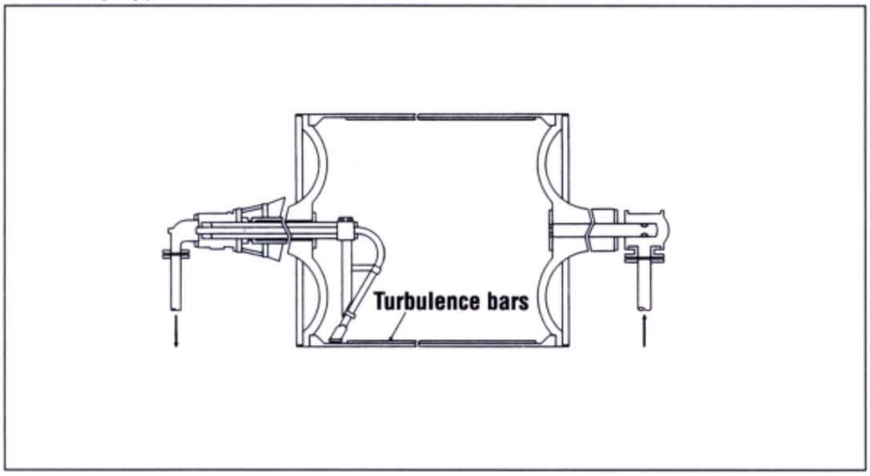


FIGURE 5: *Performance curves for the original rotary syphons in Section 3 indicate that the amount of blow-through steam carrying the condensate through the oversized syphons was very large for any reasonable DP.*

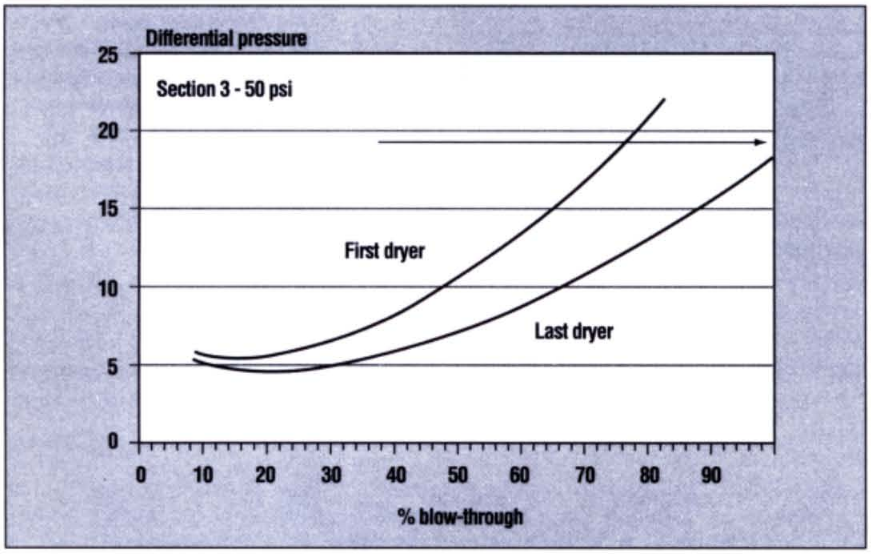
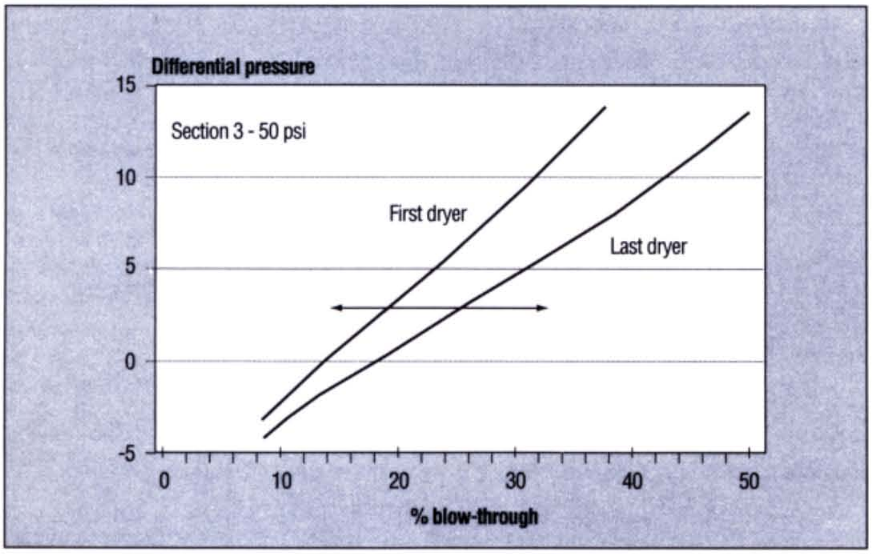


FIGURE 6: *Using the same condensing rates and speeds as in Figure 5, the syphon performance curves for the same two dryers with new Deublin stationary syphons indicate a 75% reduction in blow-through flow without compromising control and surge resistance.*



The main problem with the old rotary syphons is effectively illustrated by the rotary syphon performance curves for the first and last dryers of Section 3 (Figure 5). These curves are the product of a process simulation that has been developed and refined for more than 20 years, and they accurately portray the effect on DP as the ratio of blow-through steam to the condensing rate varies with individual dryers.

These curves show that the amount of blow-through steam carrying the condensate through the oversize syphons was very large at any reasonable DP, and that it ranged more than 100% when the DP was set at 20 psi by operators attempting to maintain dryer drainage. Due to heavier condensing rates in earlier dryers, the syphon curves for the previous dryers (not shown) had somewhat less damaging rates of blow-through, though they also indicated unmanageable problems.

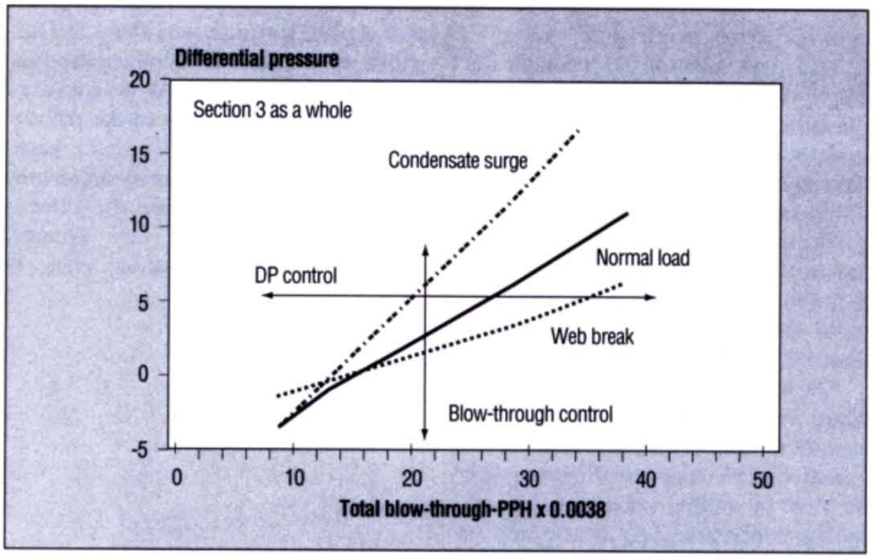
With a theoretical steam velocity above 10,000 fpm, the originally installed 8-in. condensate manifolds were totally unworkable. Thus, early on, the mill had replaced the steam separators, increasing the pipe size to 12-in. for the manifolds and piping to the separators. Not surprisingly, the increase in size did not solve the problem, since the pipe velocities were still too high.

Also, because they were too distant from the manifold drain, the first and last dryers connected to the manifold were prone to flooding. In addition, blow-through flow tended to short circuit through the dryers nearest to the main drain.

To further complicate matters, natural condensate surges that accompany pressure increases forced the operators to raise the DPs to 20 psi, the maximum obtainable. The DP of 20 psi was barely able to clear flooded dryers running at 3,850 fpm, so it was extremely difficult to operate the machine at the targeted speed of 4,000 fpm. Because of this situation, the machine speed was limited to about 3,850 fpm.

Unable to cope with the excessive blow-through flow, the original system operated with the thermocompressors wide open, dumping much more steam to the condensers than they could absorb. The total amount dumped from four valves, based on the Fisher valve performance formulae, was roughly 52,000 pph. Although conditions varied from day to day as operators struggled with the system, the two large condensers were condensing roughly

FIGURE 7: *Using blow-through control and stationary syphons in Section 3, the syphon performance curves show that the rebuilt system's low, fixed flow of blow-through steam and low DP work well under both normal and fault conditions, conserving steam and avoiding steam dumps.*



27,000 pph of the total, releasing the balance to the atmosphere.

So, in addition to energy loss, the system consumed close to 500 gpm of condenser cooling water while losing about 30 gpm of condensate in the vented steam. It was also reported that the cooling water was manually throttled to reduce the consumption of freshwater, an action which naturally resulted in further condensate loss.

The large-sized, old-style steam separators were very inefficient, and field testing demonstrated that heavy amounts of condensate were carried over with the blow-through steam. Wet steam at high velocities in thermocompressors has been a common cause of severe erosion, and, in this case, an inspection revealed that the throats of the thermocompressors were badly eroded, with erosion grooves as deep as 1/4 in. Furthermore, water that was carried over through the thermocompressors was returned to the dryers, where it compounded dryer drainage work.

In addition, maintenance for the old system had become an increasingly heavy burden in terms of cost and lost machine time. For example, in a typical month, 15 steam leaks had to be closed up and seven front side joints required repair.

THE REBUILT SYSTEM. A key part of the steam control system rebuild was replacement of the rotary syphons with Deublin stationary syphons and turbulence bars. To maintain high and uniform heat transfer, turbulence bars are a necessary adjunct to stationary syphons on high-speed machines.

Figure 6 shows the syphon performance curves of the new stationary syphons for the same two dryers in Section 3 using the same condensing rates and speeds as in Figure 5. The horizontal line depicts the DP level actually used in each case. The reduction in blow-through flow with the new syphons is more than 75%, and the blow-through flow rate remains more than adequate for good control and resistance to surges. In addition, drainage of all dryers is completely reliable, and the problems of local flooding, such as drive load swings, have been eliminated.

The redesign of the steam system, shown in Figure 2, eliminated the thermocompressors in the first sections, disconnected the lower wet-end dryers in the uni-run section, and revised the two main sections. The wet-end dryers now operate at very low pressures, for example -2.0 psi, and discharge directly to the condensers. The wet-end dryers serve to systematically eliminate non-condensibles and, in addition, use flash steam.

The two main dryer sections are similar to the old ones, except that dryer drainage is controlled by Gardner Systems' Blow-Thru control. The main sections are also equipped with new thermocompressors and separators, both of advanced design. With blow-through controls, the dump valves never discharge to the atmosphere, except when warming up cold dryers.

Another main feature of blow-through control is that the percentage of blow-through flow is virtually constant, regardless of operating pressure. The significance of this feature is that the blow-through controller controls the thermocompressor at all operating conditions, run or break, eliminating non-linearities in the control dynamics and control dead bands.

Blow-through controls are important for efficient operation of stationary syphons. Figure 7 shows the stationary syphon performance curves for Section 3 as a whole for three conditions—normal steady state operation, web break, and condensate surge. The normal DP setting under DP control would be about 5.0 psi for the operating speed of 4,000 fpm. With a web break, the blow-through flow increases about 30%.

In a similar newsprint machine with stationary syphons and without blow-through controls, the DP controls are responsible for an estimated loss of 16,000 pph to the condenser during breaks. In the event of a relatively mild surge of condensate, the blow-through flow is shown to drop by more than 25% with DP control at 5.0 psi.

With blow-through controls used in Section 3, the flow of blow-through steam is fixed at 5,395 pph (20.5%) as shown in Figure 7. The reason that lower flow and DP work well is that blow-through control is reactive, causing the DP to immediately rise to higher levels when a surge of condensate occurs—a rise of more than 6.0 psi in this case.

On a break, the blow-through flow remains essentially unchanged and the DP drops somewhat. As a result, the system does not dump steam, and the thermocompressor remains under normal blow-through control during the break. In normal operation, blow-through control requires much less blow-through flow and less DP, a combination resulting in significantly reduced motive steam consumption by the thermocompressors.

The rebuilt dryer control system also incorporates a dedicated flash separator that serves the dual purpose of collecting all dryer section condensate and recovering the flash steam generated as the high-pressure condensate is throttled to low pressure. The flash steam is then used for drying paper in the wet-end dryers.

The flash separator is amply justified, since the annual value of the recovered steam, about 4,000 pph in this case, is approximately twice the installed cost of the separator. In addition, the nuisance of flashing and water hammer in condensate return lines is avoided.

THE BOTTOM LINE. The rebuilt dryer steam control system is operating entirely as designed at the Lufkin mill, and production gains, as well as major steam and condensate savings, have exceeded projections. The amount of production increase is not available, but significant machine time previously lost to flooded dryers, steam leaks, steam joint failures, and other drying problems has been saved. Machine speed has also increased more than 100 fpm over the original setup.

In addition, drying controls are much easier to operate, since the blow-through control reliably maintains good drainage with the same single setting on both main sections, eliminating the operators' struggle to avoid flooding. Furthermore, the obstacles to good control tuning—for example, interaction between DP and pressure control loops—have been removed, and the deviation in MD moisture profile is lower. This allows higher average reel moisture within grade specification.

The huge steam losses through the dump valves have also been entirely eliminated, and about 4,000 pph of flash steam is being recovered. Some of the savings are being used for higher production, but the bottom line is a confirmed reduction of about 56,000 pph of steam from the original configuration to the present. At current gas fuel costs, the mill estimates saving more than $3,700/day.

The reductions in condenser cooling water vs condensate losses in steam vented to the atmosphere cannot be exactly specified because they vary, with the flow of cooling water inversely offsetting condensate loss at the rate of about ten to one. Where the old system lost around 500 gpm of cooling water and 30 gpm of condensate, the present system uses about 50 gpm of cooling water and loses less than one gpm of condensate.

As a result of steam system improvements on both the No. 2 and No. 4 paper machines, condensate return to the power plant has increased about 8%, for which the savings in demineralization costs has been projected at approximately $105,000 annually. In the rebuilt system, substantial economic gain occurred in every area requiring improvement. Furthermore, the return on investment for the new system should be realized in about one year.

THOMAS A. GARDNER *is president of Gardner Systems Corp., Neenah, Wis.*

GARDNER SYSTEMS CORP. BOX 278 NEENAH, WI 54957-0278 FAX 414-749-4604 PHONE 414-735-0220