GARDNER SYSTEMS CORP.

NEW TOOLS POWER STEAM SYSTEMS:
PROCESS SIMULATION AND BLOW-THROUGH STEAM ARE CHANGING STEAM SYSTEMS. HERE'S HOW TO USE THEM.

New tools power steam systems

Process simulation and blow-through steam are changing steam systems. Here's how to use them.

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Most older paper machines and even many new or rebuilt machines are saddled with inadequate steam control and dryer drainage systems. Consider these examples:

- A rebuilt newsprint machine couldn't attain target moisture unless operators valved off dryers.
- A paperboard machine in Texas operated for years at 60 percent of capacity until grossly undersized condensate piping was replaced.
- A southern LWC machine incurred heavy maintenance costs as frequent indrive breakdowns occurred on overloaded dryers.

Between wasted steam, downtime due to dryer breaks, and quality problems caused by poor system design, most paper machines lose profits every day.

But don't despair—help is on the way! Steam system design has improved dramatically in the last decade because of process simulation and blow-through control.

Simulation is key

Simulation has unlocked the secrets of dryer syphons and how wet end dryers should be operated. This cuts delay time from breaks, and production drying rates are at unprecedented levels. Steam use has been reduced to the theoretical minimum of about 1.2 pounds of steam per pound of water evaporated.

Operating controls are now simple and effortless, free of concern about dryer drainage while maintaining the freedom to use the entire range of available pressures. This feature helps automatic moisture control as well. For example, one fine paper machine in central Michigan ran for days with normal dryer drainage at 0 psi in both the main and after dryer sections during a startup. Also, normal pressure and drainage control is automatically maintained during breaks, and dryers do not overheat or require pressure set down to rethread.

Computer simulation has dramatically changed the steam control process. One main function is the relationship between blow-through steam flow (BT) and differential pressure (DP). Blow-through flow involves steam leaving the dryer with condensate through the syphon, while DP is the driving force that removes condensate from a dryer cylinder. The "curve" calculated by plotting BT against DP involves large numbers of repetitive computations, and is best handled by computer. This curve is needed for almost all dryers and dryer section operating conditions. These include maximum and minimum pressures, run and break, etc. The curve simulates the operation and flows of dryers and dryer sections in cascade or thermocompressor configurations, with either DP or BT dryer drainage control. (Cascade steam systems reuse blow-through steam from one dryer section in an adjoining section that operates at lower pressure. Thermocompressor systems reuse blow-through steam by increasing its pressure and injecting it back into the dryer section.)

The latest simulation programs provide a complete design service, with automatic sizing of piping and equipment. The programs can adjust pressure loss rates for pipe flows depending on function. Likewise, valves and other equipment can be selected based on actual system function, rather than an irrelevant engineering standard. For example, in a recent rebuild, the discrepancy between measured and programmed DP alerted engineers to steam joint defects.

Syphon choices

System designers face the choice of using stationary syphons or rotary syphons to remove condensate from a dryer cylinder. Stationary syphons

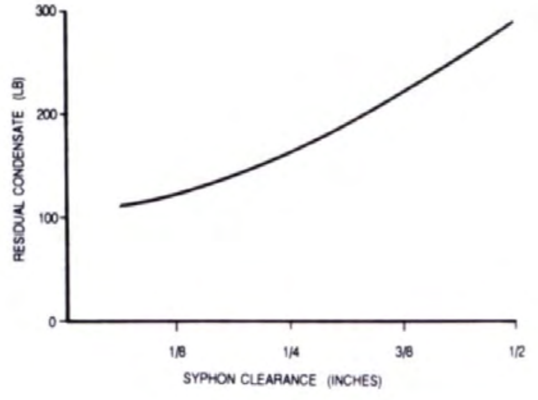

Figure 1: Typical effect of syphon clearance on residual condensate.

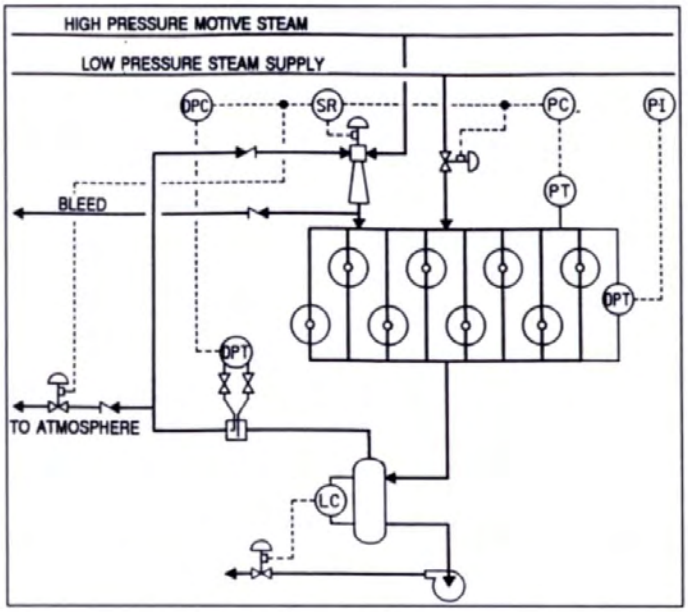

Figure 2: Blow-through with thermocompressor.

mounted on outside journal bearing housings are recommended for high speeds because they function well with little differential pressure. Rotary syphons attached to and rotating with the dryer shell are cheaper, and can operate at closer clearances to the dryer shell, but are subject to centrifugal forces acting on the condensate.

One successful stationary syphon is manufactured by a machine builder. It has a scoop type pickup running in a groove in the dryer shell (typically at both ends) to reduce the level of rimming condensate. Another well-mounted design depends on spoiler bars and doesn't need dryer grooves to obtain uniform, high heat transfer.

When stationary syphons are mounted securely and maintained well, they function with very little differential pressure; flooding is almost impossible. Still, you need sufficient blow-through steam to warm up dryers quickly and to maintain good pressure control.

For most machines, however, the close-clearance rotary syphon is a better choice. The rotary syphon, properly sized and mounted, is good for machine speeds up to 5,000 fpm and it can transfer heat effectively in ordinary dryers. Newer syphons have large, bolted-down pickup shoes that help to reduce condensate film thickness. They also have a bleed hole to insure some blow-through steam flow at all times.

A critical shortcoming of close clearance syphons is that a small loss in clearance severely chokes steam flow. The pressure loss rises very fast as clearance drops. A drop of only 0.008 inch in the standard 0.060 inch clearance is sufficient to double the pressure loss.

This has caused unnecessary grief in at least half of U.S. paper machines. According to test measurements by Calkins (Johnson Corp.) and Wedell (Beloit), rimming condensate thickness is virtually constant from 0.060 up to 0.080 inch clearance. It then rises only about 10 percent as clearance increases to 0.125 inch (see Figure 1 on previous page). Thus there is no need for clearance less than 0.080 inch, and as much as 0.100 inch would cause no measurable loss in drying.

Process simulation should be used for the complex task of sizing dryer syphons. Simulation design invariably dictates relatively large syphons at the wet end. For the rest of the dryer sections, you should use one syphon size to avoid confusion in stores and maintenance shops. The syphon must be sized large enough to resist flooding under surge conditions in the hardest-working dryers, but not be so large that blow-through from less burdened dryers becomes too great. Blow-through flow should be at least 15 percent of the normal condensing rate, yet the syphon should be tight enough that the DP is not less than 30 percent above the minimum DP at which the dryer could drain.

Wet end dryers

Dryer section runnability, paper quality and the thermal efficiency of drying are all established in the first few dryers following the press section. Paper leaves the press section with water standing on the surface. That water readily flashes to vapor at temperatures well below the boiling point. If it does so, the vapor gathers in bubbles under the web, insulating the web from the hot dryer surface at all but discrete contact points. The insulated web makes the dryer surface hotter. At the contact points, the web fibers then tend to "fry out" and stick to the dryer—producing the picking effect. When fibers are pulled out of the web or broken off, the effect is called dusting or linting. Picking often makes holes in weak webs. The sticking web tends to wrinkle and vibrate as it drags away from each dryer, causing flutter and creasing. "Local point" drying, while insulated areas of the bubbles remain wet, produces cockle effects.

In my experience, surface temperatures of the first dryers should run between 160° to 170° F to avoid picking. To do this, you need steam pressures inside the dryers of -2 to -3 psi (4 to 6 inches Hg vacuum). With the wet web in firm contact with dryers in this setup, condensing rates are heavy despite the low surface temperatures. The syphons in these dryers—and usually the steam joints as well—should be increased by one or two sizes over the normal pipe size for the machine. Without the increase, wet end dryers cannot operate at low or negative pressures without flooding. If the dryers are run flooded, they do little drying and the picking problem transfers to later dryers. If steam pressures are increased to drain the dryers, picking occurs.

Despite this, few paper machines have large enough syphons in their wet end dryers. Adequate syphon equipment and steam controls are the best solution to picking and associated web flutter.

Second section dryers face the same problems as first section dryers. After surface water flashes off, free water still lies close to the surface. Slightly more heat can be applied to the web without flashing the water under the web, but too much will initiate vapor bubble problems and picking because the web is still essentially moist and impermeable.

Blow-through control

Blow Through (BT) control of dryer drainage is indispensable for reliable operation, maximum turn down, reduced breaks, steam economy and more. It is used for groups of dryers in either thermocompressor recirculation systems or cascade systems (Figures 2 & 3).

BT control is not flow control. True BT control is the direct control of the pressure drop across an orifice through which all the separated blow-through steam from a section of dryers passes. This quantity determines the percentage of blow-through steam on any given dryer or section of dryers in normal operation independent of steam pressure or machine speed. Accordingly, a single setting can fix the optimum percentage of blow-through for all operating conditions on a section of dryers. Operators or remote controllers need not touch the setting after it is established.

However, designing BT control is not so simple. Differential pressure (DP) increases exponentially with BT flow, and BT flow increases with the square of the orifice size. A small error in orifice sizing would then be blown far out of proportion in operation. Here again, process simulation is indispensable.

Under BT control the percentage of blow-through steam is fixed, while the DP (as normally measured from inlet to outlet headers) varies with steam pressure in the dryers. It is lower at low pressure and higher at high pressure, but never as high as would be necessary in DP control. This explains why BT control lets mills operate dryer sections at very low steam pressures. In thermocompressor type systems, for example, normal drainage with normal valve positioning persists as dryer pressures are turned down to as low as 0 psi. On breaks, blow-through flow holds at normal rates while DP drops steeply; since the thermocompressor then has less work to do, it uses less motive steam and no steam is dumped to the condenser or to the atmosphere. The differential (dump) valve is theoretically redundant, remaining closed on breaks and opened only for warm-up. The operating improvements with a cascade type system are equally substantial.

Other benefits of BT control include reduction in dryer piping erosion and more reliable drainage. Under DP control, wild swings occur in syphon flow velocity—as much as twice normal on breaks. Pipe erosion increases exponentially with velocity and drag. With BT control, however, line drag varies little. The flow rarely falls below normal, or at least the controls try to prevent that from happening. This guarantees drainage even when condensing rates surge with pressure changes.

Process simulation and blow-through control have dramatically changed steam system engineering, equipment and operations. The best endorsement of these tools is that besides producing operating and quality improvements, the resulting steam systems have earned the enthusiasm and confidence of the machine crews who use them. The simplified controls all respond as the operators expect they should, maintenance is reduced, and the operators are freed to make paper instead of dealing with deficiencies in the steam system design. ❒

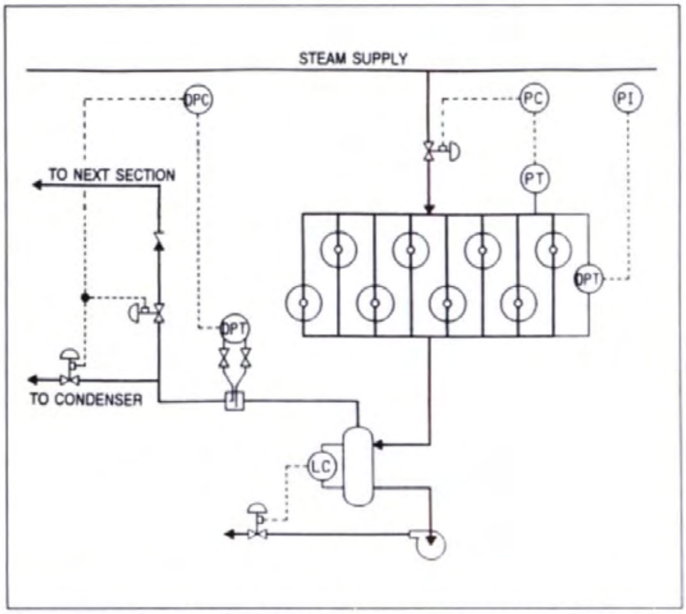

Figure 3: Blow-through for cascade system

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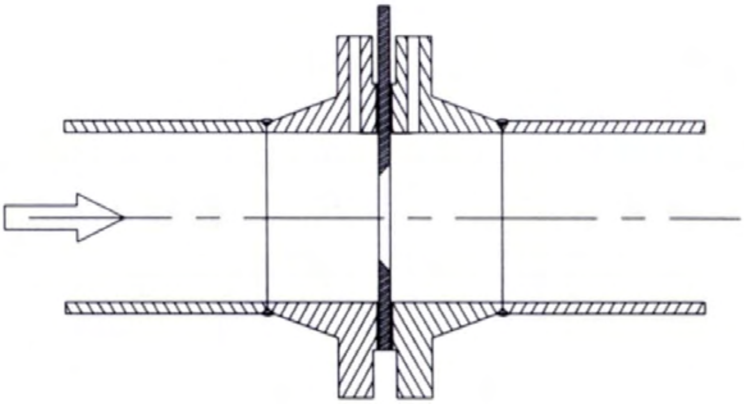

BLOW-THRU CONTROL
by

GARDNER SYSTEMS CORP.

-DP at Orifice Plate is Controlled Constant by Gardner Systems Blow-Thru Controls.

-Blow-Thru Steam Flow is Constant when DP and Steam Pressure are Constant.

-When Steam Pressure increases, Steam Density Increases, and Mass Flow of Blow-Thru Steam through the Orifice Increases.

-When Steam Pressure increases, Condensing Rate in Dryers also Increases, at same Rate as Blow-Thru Steam through the Orifice.

-Thus the Ratio of Blow-Thru steam to the Condensing Rate remains Constant; the Percentage of Blow-Thru Steam is Constant.

-At High Steam Pressure with High Condensing Rate and High Blow-Thru Rate, Differential Pressure on Dryers is Automatically High.

-At Low Steam Pressure, Dryer Differential Pressure is Automatically Less which Makes Much Lower Operating Pressures Possible.

-On Web Break, Blow-Thru Steam Flow is held Constant while Condensing Rate Falls Rapidly, and Dryer Differential Pressure Automatically Drops to a Low Level.

-With No Increase in Blow-Thru Flow and Low Dryer Differential, No Steam is Dumped to the Condenser on Breaks, and the Dryers Continue to Drain with Their Normal Syphon Velocities.

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