Energy Optimization in the Dryer Section

Energy optimization opportunities exist in virtually every paper machine dryer section. Monitoring, evaluating and controlling this section will result in better performance and significant cost savings.

By Jeff Smith

At today's high cost of energy, optimizing the paper machine dryer section offers one of the greatest returns on capital. More than 75% of the electrical and steam usage by a paper machine is consumed in the drying section. Monitoring, evaluating and controlling this section of both old and new paper machines is imperative. This paper will present a "Baker's Dozen" recommendations for improving steam and condensate system performance and optimize energy consumption in the drying section.

THE DRYING PROCESS

Figure 1 illustrates that the steam or heat required to remove a pound of water from a sheet of paper is constant. The difference between the best performing dryers and the poorest ones is the amount of heat that is lost to non-productive uses. The challenge is to identify, measure, and decrease these non-productive uses.

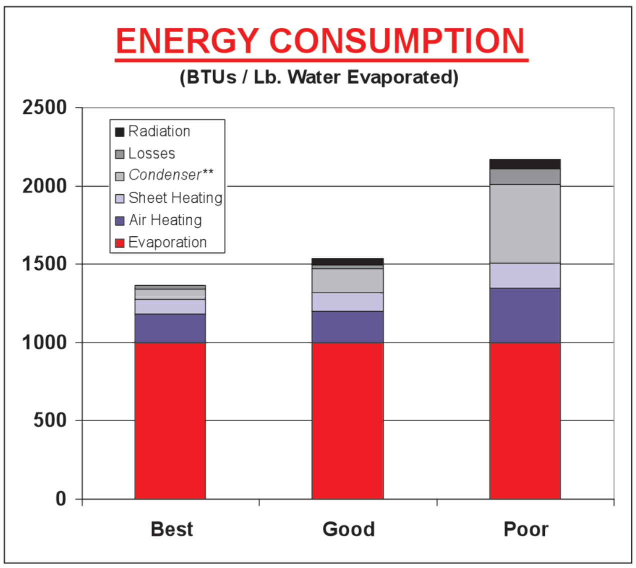

Figure 1

THE BAKER'S DOZEN

1. Measure and Control. To identify and qualify opportunities for improvement in steam and condensate systems, we need to measure and record some key variables, namely: steam flows, pressures and temperatures at specific locations. The cost of the required instrumentation to measure these variables is insignificant compared to the potential returns from energy savings. This measurement system may also be used to document savings after improvements are implemented.

Recent developments in steam and condensate equipment and instrumentation offers a mill the opportunity to implement modern dryer steam and condensate system control strategies. One of these strategies—blowthrough flow control—improves the dryer section's response to upset conditions, changes in operating pressures and may improve the overall system stability.

On a periodic planned basis, the accuracy of all steam and condensate instrumentation and controls should be validated. Inaccurate instrumentation and poorly calibrated controls are frequently the most common problem with steam and condensate system performance and can make troubleshooting difficult.

2. Benchmark. The dryer section's performance should be benchmarked and compared to performance on other machines producing similar grades. This will assist in identifying potential opportunities for improvement in energy consumption.

When benchmarking is part of a dryer survey, the survey may also indicate where changes in dryer groups, operating parameters or steam and condensate equipment are justified.

3. Control Entering and Exiting Moisture. It is well documented that a 1% reduction in the moisture of the sheet exiting the dryer translates to a 5% reduction in the dryer's steam consumption. Yet, many mills do not continually measure and evaluate this variable. Reducing the entering sheet moisture may be the most significant steam saving opportunity.

It is intuitive that first over-drying the sheet and later re-moisturizing it to reach a level moisture profile is wasteful. Today, there are tools to control moisture profiles without employing this practice.

4. Steam Quality. Entrained water or excessive superheat affects the steam and condensate systems performance. It should be obvious that supplying a dryer with steam containing water is nonsensical. Excessive superheat can also be troublesome since it may impact the drying rate (pounds of water removed per square foot of drying surface), rotary joint life and gasket seals. Since it is virtually impossible to operate with steam quality of 100% (no water and no superheat), the practical solution is to operate with low acceptable superheat.

5. Syphons. The paper machine dryer syphon size, type, and operation are often the most significant problem in a steam and condensate system. Very simply, the fact that syphons are "out of sight, out of mind" is the problem. Oversized syphons lead to poor drainage or excess blowthrough steam. The use of rotary syphons in dryers where the condensate is not rimming increases blowthrough steam. Incorrect differential pressures cause either poor drainage or excess blowthrough steam.

Performance curves for syphons should be secured for the intended dryer operating conditions and employed to determine set points for differential pressures or blowthrough steam rates (see Figure 2).

6. Separators. To separate the mixture of blowthrough steam and condensate exiting a dryer, a separator tank is necessary. Basically, we have three methods of achieving separation: 1) slowing the mixture velocity, 2) causing the flow of the mixture to experience a change in direction, and 3) using a demister pad to separate the two fluids. As a rule, tanks that are too small will not produce acceptable separation of the two-phase flow regardless of any internal directional or separation devices. Older tanks may have lost their internal devices to corrosion or erosion.

First, check the tank size for adequacy. Next verify that the internal elements are in good working condition.

7. Heat Exchangers. Heat exchangers are installed to generate low pressures or vacuums by condensing steam, to salvage the condensate from low pressure steam and as heat sinks for steam during upset conditions. Reducing the amount of steam flowing to heat exchangers not only saves energy, but it reduces the use of cooling water. If the heat exchanger's cooling water is discharged to an atmospheric sink, such as into a pond, the heat reclaimed from the condensed steam is lost.

8. Thermocompressors. A thermocompressor is one of the simplest mechanical devices, yet presents one of the most challenging operational and design selections in a steam and condensate system. Its function is to recompress low pressure steam to a higher, more useable pressure.

Efficiencies have evolved over the years as newer, better manufacturing techniques have been developed. Extensive research in the last 10 years has lead to improvements in the overall efficiency of thermocompressors based on the nozzle-diffuser relationship. Theoretically, high efficiency thermocompressors with efficiencies in the mid-90% range are now achievable.

Changes in machine speeds, furnish, steam and condensate equipment will impact thermocompressor performance. Accordingly, the thermocompressor's design should be re-evaluated when these changes occur. Performance curves for thermocompressors should be obtained to assist in understanding and managing their performance. A typical curve is shown in Figure 3.

9. Condensate. Once the maximum amount of energy has been extracted from steam, it should be condensed and pumped back to the power house.

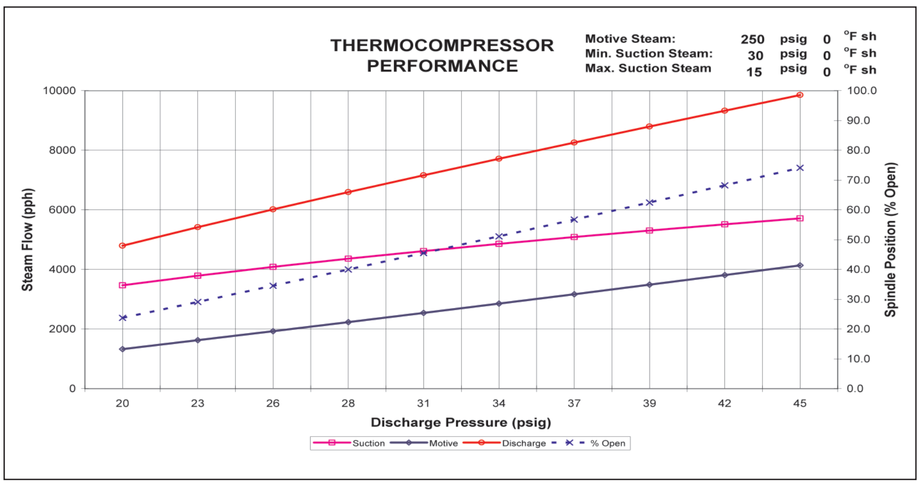

Figure 2

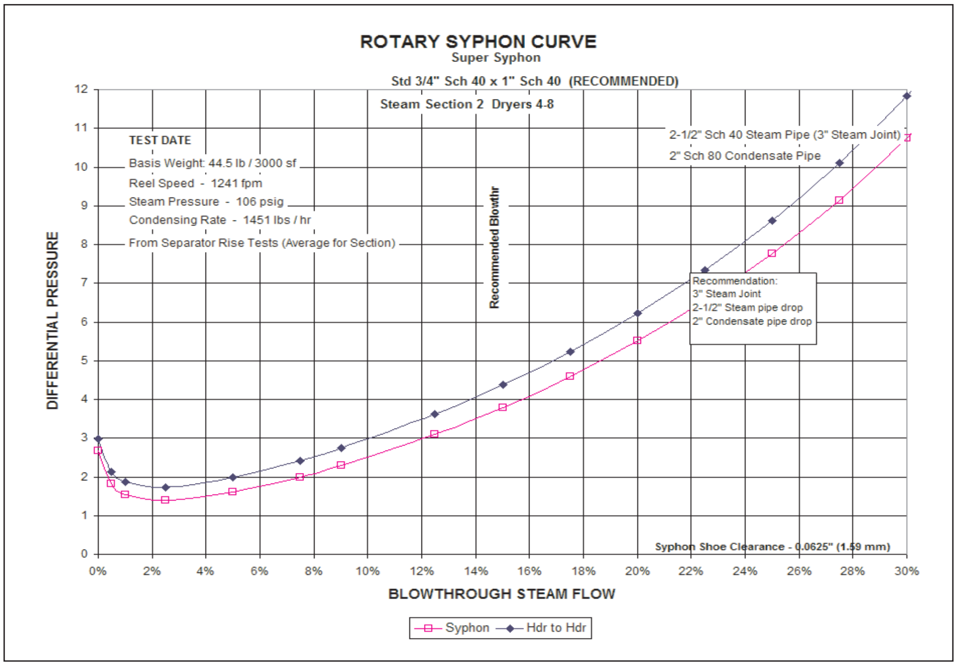

Figure 3

Approximately one quarter to one third of the cost of a pound of steam is found in the cost of boiler feed water preparation. Therefore, it is valuable to return the maximum amount of clean condensate to the power house. Poor condensate return, where condensate is lost and return percentages are low, adds to the cost of steam.

10. Pocket Ventilation Conditions. In the contribution to the drying of paper, pocket ventilation (PV) is secondary to the steam and condensate system. Depending on the grade, the drying rate may be increased by 1-12% with an effective pocket ventilation system. Control of PV temperatures and humidities is essential. Improper temperatures or high humidity will increase energy consumption. High pocket humidities act as a barrier to evaporation of moisture from the sheet. Optimally, the pocket air supply temperature should be the same as the sheet temperature, namely, 180-200 degrees F and the pocket humidity should be 0.20 pounds of water per pound of dry air.

11. Flash Steam. When higher pressure condensate is collected in a lower pressure tank, some of the condensate will flash. This flash steam has value and can best be used in air pre-heat coils. Alternatively, it can be injected directly into a liquid for heating. However in steam injection heating, the value of the condensate is lost.

12. Vent & Safety Relief Valves. Steam vented to the atmosphere means lost energy and condensate. Obviously, intentional venting should be either limited or eliminated. Actual valve positions should be periodically checked to insure that they agree with DCS readings. Periodic inspection for leakage is also recommended.

13. Leaks. The following chart indicates the cost of lost steam by a quick visual inspection. This chart can be used to estimate the value of lost steam observed during building or roof top inspection tours.

CONCLUSION

Experience shows that there are energy optimization opportunities in virtually every paper machine dryer section. Similar to other significant costs, such as fiber and labor, continuous reliable information is required to effectively identify and prioritize opportunities for improvement. The first step is to quantify and qualify these opportunities. The dryer sections steam and condensate system flows, pressures and temperatures should be measured and recorded at key locations. A comprehensive dryer steam and condensate survey may be necessary to complete this initial step.

Identification of Leaks and Vents

Appearance				
Description	No sound.	Strong blowing. No vertical lines. Some sound.	Vertical Lines 3" or Less Loud Piercing Sound	Vertical Lines 3" or More Very Loud Piercing Sound
Flow	25pph/yr/in-dia.	250pph/yr/in-dia	750pph/yr/in-dia	1500pph/yr/in-dia
Cost*	$1800/yr/in-dia.	$18,000/yr/in-dia.	$54,000/yr/in-dia.	$108,000/yr/in-dia.

*Cost based on $9.00/1000 lbs. steam and continuous flow at 92% uptime.

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