DRYER DRAINAGE SYSTEMS MOVE INTO THE FAST LANE

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WITH MANY PAPER MACHINES RUNNING AT MORE THAN TWICE THE SPEED OF A decade ago, trying to maximize steam and condensate system performance is a formidable task. Full optimization requires on-line application of greater process knowledge for the sheet and the papermaking process. Drying process changes along the length of the machine and characteristics of machine and sheet related variables require understanding and consideration in the steam system design.

Steam and condensate system design using advanced controls has recently reached a new plateau. This provides maximized sheet quality, increased productivity, and reduced energy consumption.

FAR BEYOND 1000 M/MIN AND TRADITIONAL WAYS

Early designs of paper machines operated at slow speeds—generally below 500 m/min. To aid the drying process, simple bent pipes or syphon elbows were used with rotary syphons. Due to slow speeds, heat transfer rates were good. The dryer drainage system was a simple cascade design using single loop controls. During this era, steam system design and controls were not critical because slow machine speeds provided "forgiveness."

Progression to higher machine speeds resulted in different condensate behavior inside the cylinder. Heat transfer and dryer drainage considerations became more important. Close clearance rotary syphons were used with machines operating above 500 m/min to maximize the heat transfer rates and produce level moisture profile. The operating characteristics of the rotary syphon required more differential pressure and blow-through steam to evacuate the dryer. This resulted in dryer drainage systems becoming more complex with thermocompressors, vent valves to the condenser in each section, larger condensers to handle the higher levels of blow-through steam, and pumps used on all condensate tanks.

Single loop controls used with the simple cascade system were adequate for steady state operation. These controls did not respond prop-

erly during upset conditions. Operators had to establish proper system set points. This made control of the system operator-intensive. Results varied from operator to operator. In addition, drainage and control of wet-end dryers was often poor. Flooding, picking, cockle, and runnability problems were common.

Advances in technology and machine runnability have accelerated in recent years to push machine operating speeds above 1200 m/min. A conversion to high-speed cantilever stationary syphons became necessary. This almost eliminated rotary syphons used in high speed applications. The low operating differential pressures and blow-through requirements of stationary syphons allow for a more flexible system design. Currently, many system designs still use principles developed for rotary syphons. Common dryer drainage system problems include the following:

- System designs that do not match syphon design
- Simple single-loop control that does not respond properly to upsets and system changes
- Poor physical condition of control valves and control components.

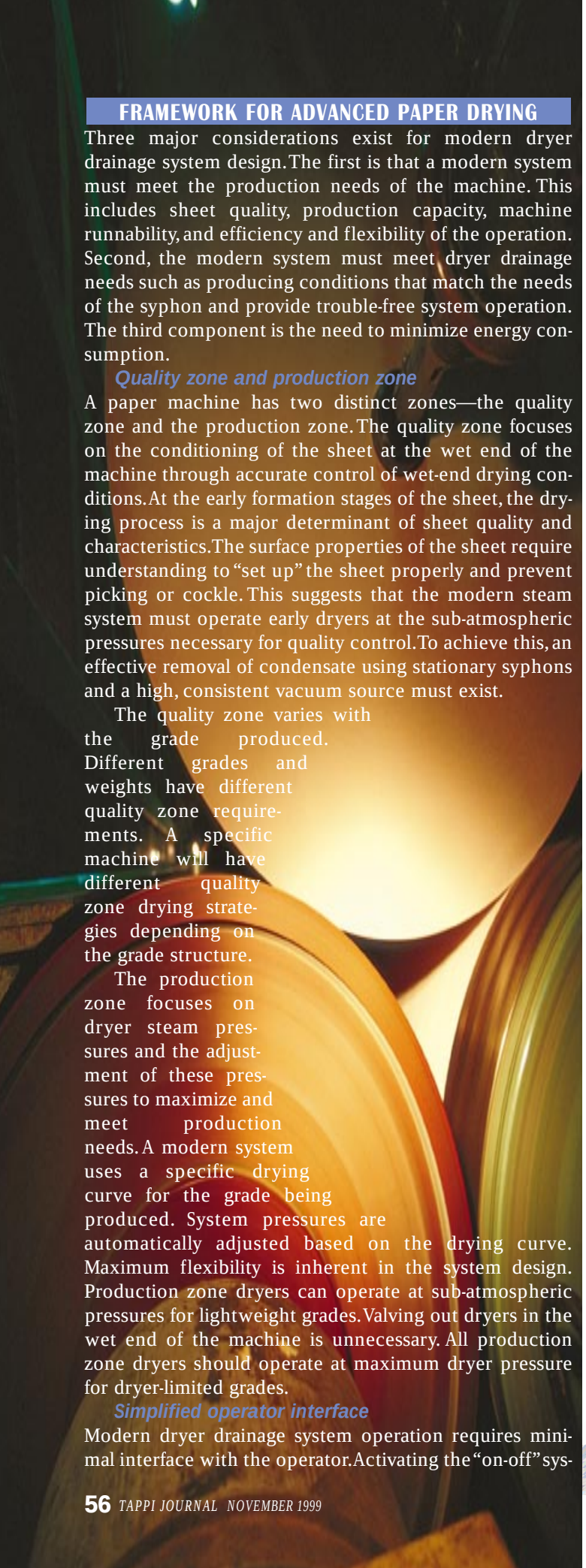
Productivity, efficiency, and quality make up the three critical components of the modern dryer drainage system value chain.

PRODUCTIVITY
- maximize output
- optimize uptime
- drying capacity maximized
- system reliability

EFFICIENCY
- managed steam flows
- eliminate venting
- eliminate dryer flooding
- sheet break manager

QUALITY
- graded drying
- more saleable product
- operational consistency
- self-diagnosing system

VALUE SUMMARY
- $1.8 million incremental revenue, 70 tpd board machine
- 9% production increase
- 30% steam saved per ton of product produced



FRAMEWORK FOR ADVANCED PAPER DRYING

Three major considerations exist for modern dryer drainage system design. The first is that a modern system must meet the production needs of the machine. This includes sheet quality, production capacity, machine runnability, and efficiency and flexibility of the operation. Second, the modern system must meet dryer drainage needs such as producing conditions that match the needs of the syphon and provide trouble-free system operation. The third component is the need to minimize energy consumption.

Quality zone and production zone

A paper machine has two distinct zones—the quality zone and the production zone. The quality zone focuses on the conditioning of the sheet at the wet end of the machine through accurate control of wet-end drying conditions. At the early formation stages of the sheet, the drying process is a major determinant of sheet quality and characteristics. The surface properties of the sheet require understanding to "set up" the sheet properly and prevent picking or cockle. This suggests that the modern steam system must operate early dryers at the sub-atmospheric pressures necessary for quality control. To achieve this, an effective removal of condensate using stationary syphons and a high, consistent vacuum source must exist.

The quality zone varies with the grade produced. Different grades and weights have different quality zone requirements. A specific machine will have different quality zone drying strategies depending on the grade structure.

The production zone focuses on dryer steam pressures and the adjustment of these pressures to maximize and meet production needs. A modern system uses a specific drying curve for the grade being produced. System pressures are automatically adjusted based on the drying curve. Maximum flexibility is inherent in the system design. Production zone dryers can operate at sub-atmospheric pressures for lightweight grades. Valving out dryers in the wet end of the machine is unnecessary. All production zone dryers should operate at maximum dryer pressure for dryer-limited grades.

Simplified operator interface

Modern dryer drainage system operation requires minimal interface with the operator. Activating the "on-off" system warms the dryers and a programmed control prepares the machine at the fastest safe rate to bring on the sheet. The system then automatically adjusts itself to changing machine conditions. The system automatically handles the sheet breaks, pressure changes, grade changes, and other upset conditions. Operators can program preset drying curves for various grades and can adjust the system upward or downward as necessary for special circumstances.

The modern system establishes setpoints using production and drainage requirements. Advanced controls "look" at steam pressure, differential pressure, and flow settings necessary for optimum performance. The entire system is examined automatically with any setting change to ensure proper system operation. Algorithms adjust system parameters and control tuning.

Minimum energy use

Energy use is a focal point of a modern system to ensure proper management of all energy input. Vent valves to the condenser are eliminated for most control sections. Advanced control logic manages all system steam pressures, flows, and differential pressure settings. The system design therefore allows efficient use of blow-through steam within the system for all operating conditions including sheet break. Advanced control logic manages blow-through steam and differential pressure on a sheet break to minimize venting and loss of energy. Condensate returns to the boiler house with minimal temperature loss. Most separator stations do not use pumps.

Self-monitoring of control equipment

The automation feature of a modern system allows monitoring the positions of all valves and thermocompressors. The system can identify when a valve condition is poor. It issues a warning to complete valve maintenance during the next shutdown. The system self-checks transmitters and uses a self-diagnostic programmable logic controller (PLC) to flag potential dryer drainage problems and vacuum problems for future inspection by the operator.

FOCUS FOR THE FUTURE

Optimum design of a steam and condensate system depends on process knowledge of the sheet and papermaking process. Process knowledge must focus on knowledge of the product, or the system design will not maximize the runnability of the machine, sheet quality, and productivity. The drying process changes along the length of a machine. Characteristics of machine-related variables and sheet related variables require understanding and inclusion in the steam system design. A fully automated system can be tailored on-line for the grade being produced. This new technology allows maximizing sheet quality, increasing productivity, reducing energy consumption, and simplifying system operation. TJ

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