The case for engineered solutions: Decreasing steam consumption while increasing machine production

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INTRODUCTION:

Historically, paper machine dryer sections have suffered from a range of prevalent inefficiencies, especially in systems with poorly engineered drainage strategies. These issues stem from flawed design concepts that fail to account for operating conditions.

Among the most critical pain points are:

- Chronically Flooded Dryers: Main steam sections can often have chronically flooded dryers, especially at the ends of the long condensate headers. Even with oversized headers, end dryers often flood on breaks, and machine time is wasted because dryer drainage takes too long to reach steady state after pressure is stepped up.
- Water Carry-Over Between Sections: Water carries over from main section separators and cascades into the secondary dryer sections, causing flooding and loss in drying, especially following breaks.
- Interdependent Steam Sections: On sheet breaks, the excess of blow-through steam from the main section is not absorbed by the secondary section, and the excess is passed to the condenser, which becomes pressurized.
- Operational Rigidity: The steam sections do not correspond to drive sections, meaning that all dryers must be shut off to cool down any drive section.
- Pressure Limitations: Secondary sections must operate at much lower pressures than the main section causing a measurable loss in drying capacity and preventing efficient low-pressure operation of the main section (below about 20 psi).
- Ineffective Moisture Control: Too many dryers on a single control result in large thermal inertia and cycling of reel moisture, especially after breaks. The local rate of drying is inflexible. Complex cascade systems remain difficult to operate even with the latest control strategies.
- Steam Waste: Large steam waste occurrs despite anticipated savings from the process because tertiary sections dump directly to the condenser, and 8-12% of the total steam is lost, not recoverable, from flash steam residing in high pressure condensate.
- Poor Operator Experience: Legacy systems are often disliked by operators due to their rigidity, inefficiency, and heavy reliance on manual programming or supplier support.

The Limitations of Early Thermocompressor Systems

Although early thermocompressor-based systems held promise, initial implementations were fraught with issues due to a lack of proper technology for system sizing and drainage control.

The key shortcomings included:

1. Ineffective Separators: Separators were inefficient, and water carried over from the separators seriously impaired the function of thermocompressor and dryer drainage.
2. Primitive DP Controls: Standard DP (differential pressure) controls caused excessive blow-through flows at low pressure, and much more on breaks. Most could not operate below 20 psi without wasting steam.
3. Improperly Sized Components: Without advanced design tools, early thermocompressors were either undersized and prone to choking or oversized and uncontrollably inefficient.

A Modern Control System - Deublin's Blow-Through Control

Blow-Thru Control was developed in response to increased machine speeds and skyrocketing energy costs. Existing control systems could not handle these demands, and any new development would need to rely on system mechanics that had not been studied before.

Gardner Systems, now a part of Deublin Co., set out to investigate the real mechanics of steam systems, solving the basic problems one by one. This led to the development of a simulation program capable of analyzing and designing dryer steam systems and ultimately Blow Thru Control.

Deublin Blow-Thru Control maintains a fixed pressure drop across an engineered orifice plate. It controls a single variable, the blow-through to condensate ratio, regardless of pressure or speed. It enables operation across a wide pressure range, responds quickly to load changes, and reduces the need for excessive differential pressure. Steam loss is avoided during breaks, and dryer section header-to-header DP is displayed on the DCS for diagnostics. The system automatically minimizes steam waste across all conditions.

Under normal operation, dryer section header-to-header DP varies with dryer pressure, peaking at maximum pressure. During web breaks, DP drops as blow-through control senses a surge in blow-though steam upon loss of condensing load, and closes down the thermocompressor to maintain Blow-Thru setpoint. The dump valve stays closed.

Figure 1: Dryer section featuring newly installed condensate outlet unions.

Figure 2: Jorge Trujillo, of Deublin Company, performing an internal dryer inspection.

If flooding occurs, Deublin Blow-Thru Control automatically increases drainage. As condensate restricts flow through the syphon, the system increases DP to restore flow. It then reduces DP as conditions stabilize. This is done quickly and automatically in the machine DCS without the need for custom programming or operator input.

Deublin Blow-Thru Control automatically adjusts blow-through flow by varying Dryer Section DP as condensing loads change. Blow-Thru Control utilizes an algorithm that allows machines to run automatically without any operator intervention and without the need to install specialized management equipment.

Deublin relies on specially designed radial separators with rugged internal baffling, achieving very high separation efficiency. Effective condensate separation is critical to thermocompressor and Blow-Thru performance. Older separators often allow condensate carryover, leading to flooding, uneven drying, and equipment wear. Deublin's skid-mounted separator stations include proprietary improvements and offer superior reliability.

Deublin designs thermocompressors using in-house software and partners with trusted manufacturers for fabrication of its proprietary designs. Sizing errors are a thing of the past ensuring efficiency across a wide range of performance requirements.

Deublin Blow-Thru Control prevents steam loss to the condenser during both run and break, and allow pressure control down to 0.0 psi (or lower in special cases). Steam consumption is typically reduced to 1.2 kg per kg of water evaporated. All steam sections use identical control scales, requiring minimal operator input. High blow-through rates maximize drying capacity while reducing downtime and maintenance. Deublin's Blow-Thru Control is distinct from conventional Flow Controls. In contrast, traditional DP controls maintain a fixed pressure differential, regardless of drainage effectiveness. Every Deublin system is pre-tested virtually across all operating conditions.

Complementary Technologies: Radial Separators & Thermocompressor Design

Deublin's system is not built on Blow-Thru Control alone. The company also pioneered several other enabling technologies:

1. Radial Separators: These proprietary components are essential for high-efficiency steam separation, which supports optimal dryer performance and steam usage.
2. Thermocompressor Design Tools: Deublin developed in-house software for designing and sizing thermocompressors with precision, enabling efficient operation across a broad performance range.

Why Blow-Thru Control Systems Prevail

Despite early limitations in the industry, Deublin's modern thermocompressor systems are now superior to the best cascade systems on every front.

Operational Simplicity: Operators do not need to interact with the system beyond setting section pressures or selecting pre-set grade profiles. The drainage and DP control are fully automatic.

Modular Section Control: Steam sections are aligned with drive sections, allowing any part of the system to be independently shut down for maintenance without affecting the rest.

Wider Pressure Range: Systems can operate at any pressure without dumping steam or compromising performance.

Robust Reliability: All mechanical components including thermocompressors, valves, and pumps operate well within design limits, even under abnormal conditions.

In-House Maintenance Capability: Since systems use conventional controls and components, mills can perform maintenance without relying on outside service providers.

Figure 3: Lisa Freed, of Deublin Company, in front of a newly installed separator skid.

Case Study: A Southern U.S. Mill Transformed

Case Study: Driving efficiency and productivity at a southern US paper mill with Deublin's turn-key solution

Mill Overview

Location: Southern United States

Product: Solid Bleach Sulfate (SBS)

Paper Machines: 2 machines with consecutive installations

Project Type

Complete turn-key installation encompassing steam and condensate systems and steam joints siphon systems, designed to improve operational efficiencies in a mature and competitive market.

Project Scope

The project covered a full-scope solution tailored to address the mill's operational challenges, including:

- Exclusive FSU Steam Joints and siphon systems rated to 200 psi.
- Comprehensive steam and condensate systems, integrating Deublin's proprietary Blow-Thru Control technology.
- Engineering Services: Complete system design to optimize performance for current operating conditions.
- Installation Services: Expert deployment to ensure seamless system integration and performance.

Challenges Before the Rebuild

Prior to the project, the mill faced numerous operational inefficiencies and cost burdens, including:

- Steam and condensate losses led to energy inefficiencies.
- High maintenance costs due to frequent repairs of outdated steam joints.
- Excessive motive steam consumption from a poorly designed steam and condensate system.
- Equipment wear and erosion, including undersized components that could not meet current demands.

Key Solution: Deublin Blow-Thru Control Technology

The Deublin Blow-Thru Control system was a cornerstone of the project. Its innovative design automatically and continuously adjusts differential pressures (DP) across the Dryer Section based on operating conditions, eliminating the need for operator intervention.

Benefits of the Blow-Thru Control System:

- Automatically synchronizes DP with dryer pressure, ensuring optimal performance at all pressure levels.
- Prevents dryer flooding by automatically adjusting DP based on operating conditions.
- Significantly improves system reliability and efficiency.
- Results After the Rebuild
- The turn-key installation delivered remarkable improvements:
- Production Increase: A 10% boost in production capacity.
- Energy Savings: A 30% reduction in motive steam consumption.
- Enhanced Product Quality: Improved MD/CD moisture profiles, contributing to better product uniformity and quality.
- Cost Savings: Reduced maintenance expenses and longer equipment lifespans due to robust and properly sized components.

Conclusion

Deublin's comprehensive turn-key solution, featuring proprietary Blow-Thru Control technology, transformed the Southern U.S. paper mill's operations. By addressing inefficiencies in steam and condensate management and upgrading outdated systems, the project not only increased production but also reduced energy consumption and maintenance costs.

This case underscores Deublin's commitment to delivering innovative, high-value solutions that drive efficiency and productivity for mills in even the most mature markets.