

IPPTA



**Silver Jubilee International Seminar & Workshop
Appropriate Technologies For Pulp & Paper Manufacture
In Developing Countries.**

New Delhi - 1989

FOUR STEPS TO A LEVEL SHEET

Hugh Glass, Regional Manager, International

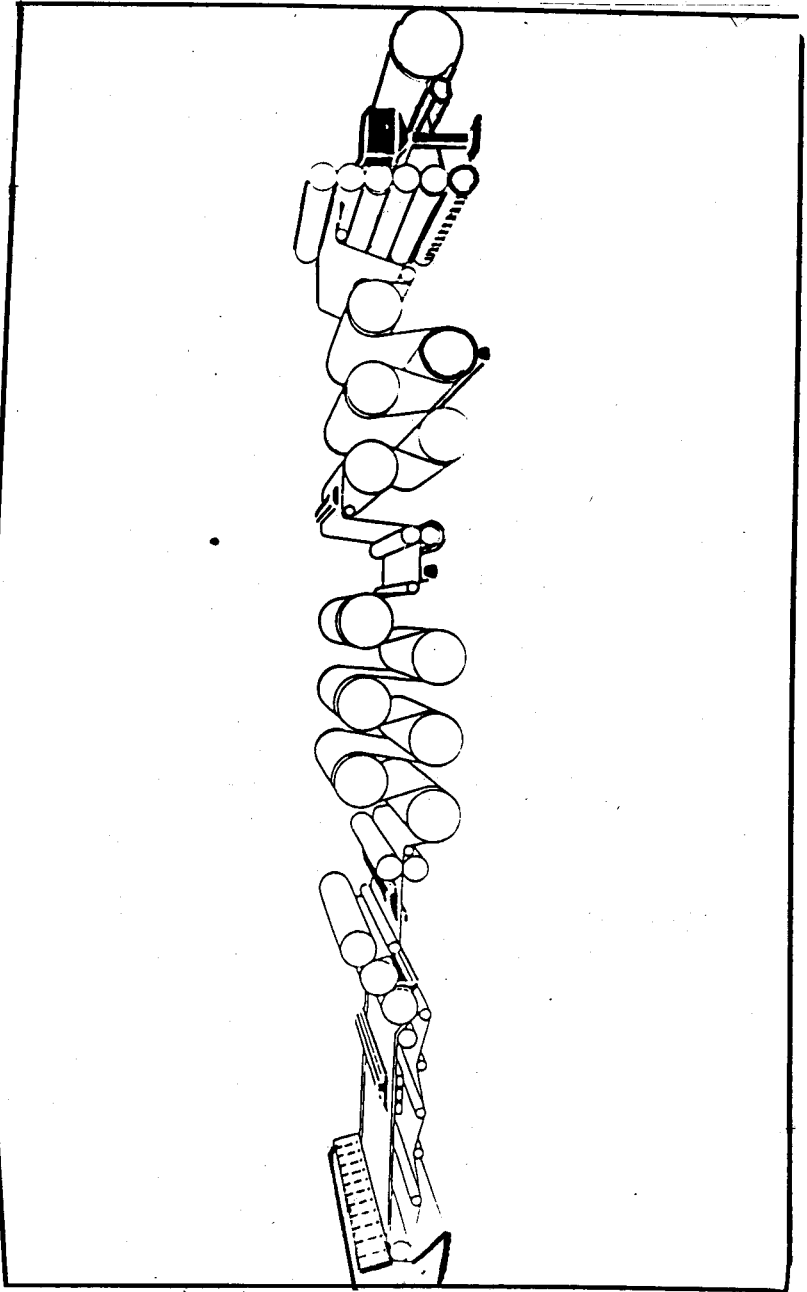
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Introduction

The complexity of the process of papermaking is continually increasing with large faster machines producing products to tighter specifications. Competitive forces are constantly pushing the industry to improve paper quality and reduce production costs, leading to concentrated efforts by Cross Machine Control (CMC) actuator suppliers for innovative product development. The industry has been introduced to some exciting new ideas to meet changing papermaking and process requirements.

Four sheet characteristics account for most of the quality specifications of paper; basis weight, moisture, caliper and smoothness. The significance of each characteristic and methods to correct each are described.

1. Basis weight variation is corrected at the headbox slice. Optimum control requires the best actuator and continuous adjustment of the slice lip profile via the automatic slice screw adjusters or actuators.
2. Moisture variation is corrected in various locations in the paper machine. Wet end correction is done by controlled hot pressing via the Devronizer steam shower. Energy is transmitted to the wet sheet by condensing steam in and on the sheet. The Devronizer system



controls steam flow in the cross direction to create a temperature profile which leads to a dryness profile entering the dryers that causes a level moisture profile leaving the dryers. The essence of hot pressing improves mechanical water removal by raising sheet temperature.

10°C → 1% Dryness → 5% Evaporative Load.

Thus, in addition to correcting moisture variation, Devronizers yield energy savings and production increases in dryer limited situations.

Dryer section correction of moisture variation requires dedicated moisture correction systems such as the Hydro Profiler rewet system and Infradry infrared system. The Hydro-Profiler system is a specially designed water spray which allows very fine control of moisture variation as it occurs. An important point regarding both the Devronizer and Hydro-Profiler systems is that they prevent overdrying, which causes irreversible sheet damage.

The Infradry not only provides additional drying capacity for existing dryers but can be utilized in different areas of the paper machine to improve coating drying and enhance moisture profile control.

3. Caliper variation is corrected at the calender stack with the Calcoil system. It uses induction energy to segmentally heat the calender roll and redistribute nip loading.
4. Smoothness variation and control is implemented with the Calendizer system. It is the latest development in hot calendering. It enhances the calendering operation to improve smoothness, gloss and sheet strength. Further, the Calendizer will enhance the effect of the caliper control system.

To obtain a level sheet with enhanced paper properties, maximum actuator system performance must be implemented. This is accomplished by use of the Devron-Hercules Operator Control Station and Actuator Interface Unit. The IBM-based controls provide full featured remote manual control, in either a primary or back-up mode, as well as providing complete closed loop control, taking measurement signals from the host measurement system.

The hardware for each of the systems mentioned is described in detail and operating results presented.

BASIS WEIGHT PROFILE CONTROL AUTO—SLICE SYSTEM

Basis Weight Profile Control Benefits for the Papermaker

Uniform and proper sheet weight are fundamental to consistently achieving paper product specifications. All physical paper properties are related to weight. Non-uniform basis weight can create moisture variation, caliper variation, runnability problems, rejects and reduced converting efficiency.

Basis Weight Profile Control is a Crucial First Step

Without good basis weight profile control at the headbox, variations in paper properties result, reducing both machine and converting efficiency.

Cross machine variations in basis weight, can originate from several sources such as, pressure variations in the headbox, non-uniform jet delivery, and poor slice lip or apron conditions. All these are compensated for by adjusting the slice lip position.

The effective control of cross machine basis weight variation therefore, is directly related to the control response and precise movement of the slice lip.

To achieve the long-term precision and predictability of slice lip movement required to control basis weight, remote control of the slice lip is necessary. Devron-Hercules was one of the first companies in the world to supply automated slice lip control actuators.

Harmonic Actuators

Extensive developments have led to the Harmonic actuator. This is an extremely compact system utilizing a combination of high-ratio harmonic gears coupled to an electric motor.

The harmonic gear is a precision mechanism ideal for the controlled, accurate slice lip positioning necessary for basis weight profile control. Used extensively in the aerospace industry where performance, reliability and compactness are critical, the harmonic gearing offers a high torque capacity, zero backlash, and high single-stage ratios necessary for basis weight control.

It Takes More Than a Simple Actuator to Ensure Optimum Performance.

The Auto-Slice system offers fast controlled responses over a very large range. The system can be retrofitted to existing headboxes at each spindle position and is customized to meet the needs of each application.

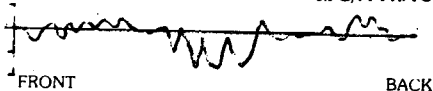
The Auto-Slice actuators ensure the best possible automated control response. However, selecting the proper actuator for automating the slice lip is only part of the solution. For the predictable, precise movements of the Auto-Slice actuator to be transferred to the slice lip, the entire mechanical assembly including the slice lip, must be in good condition. No actuator can eliminate problems in the mechanical assembly below it.

ACTUAL AUTO SLICE CROSS DIRECTION WEIGHT CONTROL RESULTS

PRIOR TO CROSS DIRECTION CONTROL

CD OVEN DRY WT.

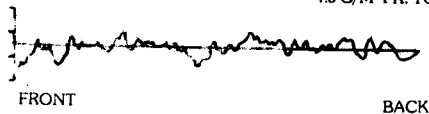
6.9 G/M² PK. TOPK.



38% IMPROVEMENT
NEW SLICE LIP AND APRON

CD OVEN DRY WT.

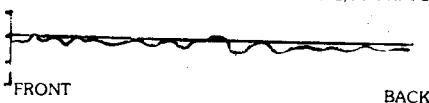
4.3 G/M² PK. TO PK.



61% IMPROVEMENT
REMOTE MANUAL CONTROL

CD OVEN DRY WT.

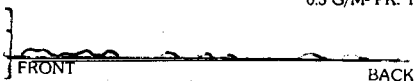
2.7 G/M² PK. TO PK.



93% IMPROVEMENT
CLOSED LOOP CROSS DIRECTION CONTROL

CD OVEN DRY WT.

0.5 G/M² PK. TO PK.



PROFILES ARE TAKEN FROM MILL DOCUMENTATION

MOISTURE PROFILE CORRECTION THE DEVRONIZER SYSTEM

How Moisture Profiling Affects Papermaking Costs

Reduction of operating costs is of prime importance to today's papermaker. Drying, the largest operating cost, can be reduced in two fundamental ways:

1. Dry the paper less, for a higher average moisture content in the final product. This method requires a more uniform moisture profile to meet the maximum moisture level specifications. Therefore, some form of moisture profile correction is generally incorporated during the papermaking process.
2. Enter the dryer section with a hotter, drier sheet. The technique of hot pressing — wet web pressing at elevated sheet temperatures — accomplishes this by heating the sheet and improving the dewatering characteristics of the web.

Understanding Hot Pressing

Sheet temperature is a key factor in water removal from the wet web. Increasing sheet temperature reduces water viscosity and surface tension, and softens the web fibres so that water is more readily removed in the wet press. In general, raising the sheet temperature by 10°C (18°F) will result in an increase in solids of one percentage point reducing the dryer load by 5%. The cost benefits to you as a papermaker are dramatic.

Steam Showers and the Devronizer

Steam showers are not new to the pulp and paper industry; their usefulness is widely recognized. Devron-Hercules has maximized the benefits available with the unique Devronizer segmented steam shower system. Its many patented design features optimize energy usage to reduce your operating costs. The Devronizer's exclusive technology, combined with our years of experience in papermaking, sets the Devronizer apart from conventional steam showers and guarantees you a product specifically engineered to increase the efficiency of your press section.

Engineered Solutions and Reliability

The Devronizer applies saturated steam onto and into the wet web. Steam is a very effective heat transfer medium due to its high latent heat of condensation. When steam condenses quickly on the cool, wet web, large amounts of latent heat are released, increasing the temperatures of the sheet.

The use of steam offers many advantages to the papermaker. It is universally available in the papermaking process, and is safe and practical to use. The Devronizer can also utilize low cost waste or flash steam at low pressures. As well as improving pressing efficiency, the Devronizer can enhance the efficiency of your paper machine's energy utilization, making it a cost effective addition to your operation.

Engineered Performance and Results:

Hot pressing with the Devronizer is a small alteration to the papermaking process which can make a big difference to machine performance and overall profitability. Paper properties, such as strength, smoothness, and density can improve due to increased fibre compaction and bonding. Significant reductions in refining with consequent improvements in drainage and formation have also been reported. Bulk improvements have also been achieved where needed.

Operating more than one Devronizer on a single paper machine is now a proven means of further enhancing the benefits of single Devronizer units.

A Key Feature to Maximizing the Devronizer's Performance

The Devronizer is the only steam shower that is utilized in the manufacture of all grades of paper.

Maximizing and maintaining sheet temperature through the press section requires careful attention to many factors. Our technical support personnel are experienced in applications for all paper grades and machine configurations. This enables us to identify all the factors affecting an installation in order to ensure maximum benefits are attained.

PROVEN RESULTS

Typical results can include:

Improved moisture profiles	80%
Fewer quality rejects	50%
Energy savings	26%
Increased production	20%
Reduced refining	20%
Fewer sheet breaks	15%
Fibre savings	3%

Improved machine runnability and efficiency
 Improved converting/pressroom runnability

REMOISTURIZING REDEFINED HYDRO—PROFILER SYSTEM

The Problem Defined

Moisture profile problems can result in poor runnability, uneven caliper and reel rejects which do not meet the standards demanded by the end user.

Moisture Profiling

For all paper grades, remoisturizing to prevent overdry areas is often required to meet moisture specifications which may be otherwise unattainable.

For fine paper, a level moisture profile entering the size press or coater is integral to a consistent absorption of the size/coating. Selective moisture profiling of the sheet ensures a level moisture profile.

Sheet Conditioning

Remoisturizing may also be done where cockles or curl are a problem. Remoisturizing relieves stresses in the sheet associated with cockles and curl, improving runnability and overall sheet quality.

Remoisturizing Refined

Remoisturizing systems are not new to the paper industry. Their effectiveness is well proven.

The concept of remoisturizing is to apply fine amounts of water to the dry zones of the paper web to elevate the moisture to target levels. How readily the web absorbs this water primarily depends on the moisture content of the web. The drier the sheet, the more difficult it will be to apply moisture that will be stable in the web.

Research confirms that remoisturizing is most effective before the web water chemical bonds are broken by drying.

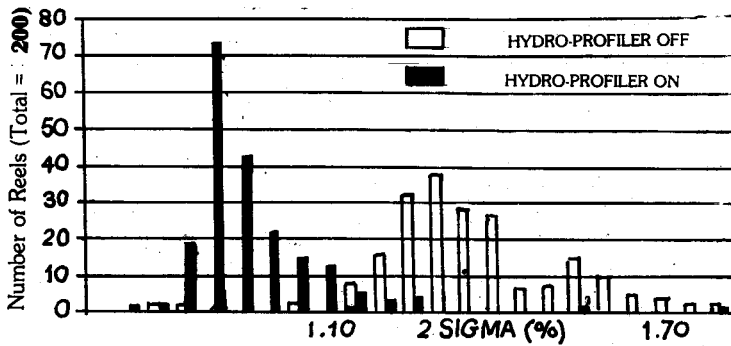
Uniform and effective moisture absorption into the sheet requires small water particles. Fine control of the moisture at the reel requires small increments in water flow.

The new airless atomizing Hydro-Profiler now answers all these needs to maximize the performance and precision of cross machine moisture profile control.

Design simplicity and Reliability

The Hydro-Profiler was designed with reliability and simplicity in mind. Operators can maintain the Hydro Profiler System since no tools are needed to remove the main components from the boom. the nozzles are easily removed by hand, and the block mounting and all water and electrical supplies are fitted with quick disconnects.

THE HYDRO-PROFILER DELIVERS RESULTS



2 Sigma C.D. moisture distribution(from mill documentation)

INFRADRY SYSTEM FOR IMPROVED DRYING AND MOISTURE PROFILE CONTROL

Devron-Hercules Infradry system is a complete moisture control system using infrared energy to improve drying of the paper web.

The Infradry system allows papermakers to increase production, reduce drying costs and improve product quality. Maximum drying energy is delivered in minimum space at maximum efficiency.

The Infradry system converts electrical energy to short wave infrared radiation. This radiation is absorbed throughout the moister paper web, heating the web water to improve dryer efficiency.

Additional Drying

The Infradry system is a particularly attractive means of adding production to the dryer limited machine. Short wave radiation is very effective in producing direct vaporization of water in the wet web. With an Infradry system installed before or in the dryer section, dryer loads are reduced and production increases are possible.

Improved Coating Drying

The high intensity Infradry system dries coating quickly and thoroughly, at minimum drying cost. This ensures proper surface cure and reduces picking and surface disturbance from roll contact. This rapid and uniform drying process not only improves paper quality but also machine efficiency.

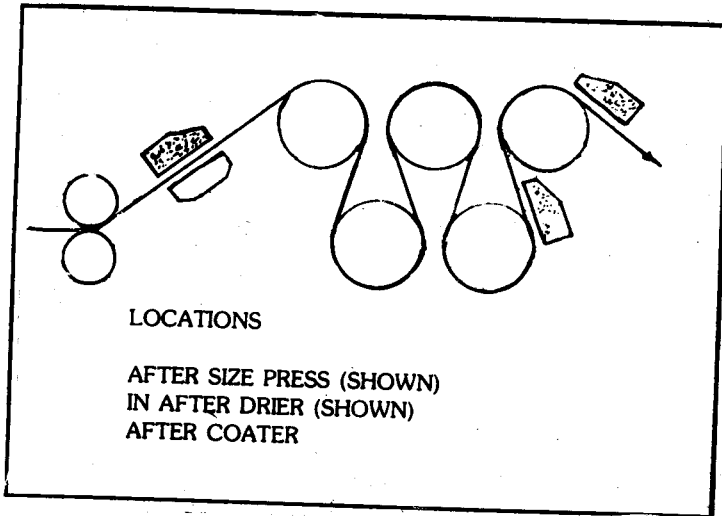
Moisture Profile Control

The Infradry system not only offers leading edge technology to add to drying capacity; it can also be used to selectively apply energy to the paper web to reduce moisture variation. Moisture variation usually means the sheet is overdried in the dryers at increased operating cost and possible damage to the sheet. The high intensity Infradry lamps selectively direct their energy to the high moisture areas to allow papermakers to make their paper on target moisture specifications. This means savings in fibre and reduced drying costs.

A uniform moisture profile is also important for uniform application of size. When installed before the size press, the Infradry produces the uniform cross machine moisture profiles which result in uniform cross machine size absorption.

Infradry, a Complete System

Infradry not only provides additional drying capacity for existing dryers, but it can be used in its own right as a complete paper web conditioning and drying system. As a coating dryer, it is more efficient than conventional infrared drying systems due to the high intensity, short wave length radiation which offers the most efficient and effective means of drying with infrared.



CALIPER PROFILE CONTROL CALCOIL SYSTEM

Why Caliper Profile Control is critical to Today's Papermaking.

Regardless of where the process is affected, uneven caliper always represents lost benefits. It usually shows up as uneven draws at the reel, winder, printing press or converting machine and can cause problems in such diverse operations as coating and die cutting. Variations in sheet caliper can even result in lost production due to sheet breaks.

Caliper variation can originate from many sources including uneven basis weight and moisture. Since the last and most effective on-machine opportunity to correct caliper variations is at the calender stack, an effective caliper control system is needed.

What defines an Effective Caliper Profile Control System

Implementation of any caliper control will necessitate some form of energy input. A good system must therefore evolve from efficient and effective use of energy and produce the demanded results.

The system must also be responsive, controllable, have a large working range and good accuracy. It should be reliable, simple and safe, and all costs (capital, operating and maintenance) should be minimized.

What Alternatives Exist

For years papermakers have attempted to control caliper by varying calender roll diameter through actively heating or cooling the rolls.

Friction pads are effective on local hard spots, but because they wear the roll, their use is more detrimental than helpful to long-term calendering and caliper profile control.

Hot and cold air showers have been used in controlling caliper variations. However, air is notoriously inefficient as an energy transfer medium. Therefore most air shower systems are not energy efficient. To compensate, large amounts of energy must be packaged into confined spaces, resulting in increased air temperature and/or velocity. Compressors and chillers may be required. The air jets are noisy and disperse hot air into the operator's environment. Tens of thousands of dollars are lost annually through energy wastage.

The patented Colcoil system introduces a revolutionary improvement in caliper profile control. It uses induction energy to segmentally heat a calender roll and redistribute nip loading.

Why Induction Heating?

When a magnetizable object is placed in an alternating magnetic field, heating is generated in the object through irreversible energy losses. This process is called "induction heating" and because it is extremely efficient and effective, it has significant advantages for caliper profile control.

Energy savings. Induction heating is far more efficient than any other form of caliper profile control. Calcoil is 90-95% energy efficient. For every 100 watts of energy input, 90-95 watts are converted into meaningful roll heating.

High heating rates. Induction produces roll heating directly, the response rate does not depend on roll temperature. Calcoil's response range is more than sufficient to control caliper on all paper grades. On single or multi-nip calenders a single Calcoil unit is all that is required.

High resolution. Induction roll heating is precise such that minimal zone-to-zone overlapping takes place. Calcoil provides uniform heating across narrow zone widths for resolution more than sufficient to meet cross machine control requirements.

No limits to energy transfer. Unlike convention heating, induction heating has no limits to the temperature increase possible.

Temperature a Crucial Factor

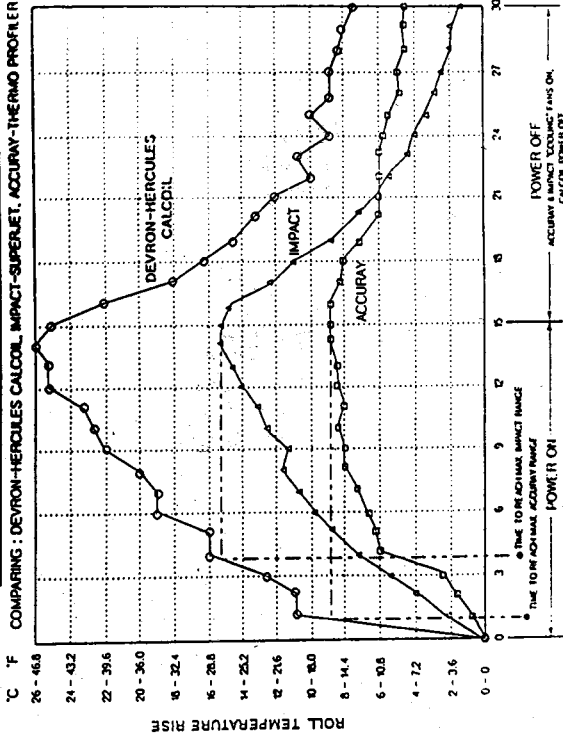
Caliper is controlled in the cross machine direction by varying the nip loading profile. More energy supplied to the work coil will result in more roll heating in that area, which increases roll diameter and therefore nip loading. With the combination of surface heating and rapid roll cooling by the sheet no other cooling is required. The result is a linear heating and cooling response.

Profiling is accomplished only through raising calender roll temperatures above their ambient temperatures — a procedure which has been shown to improve the average finish of the calendered sheet (temperature gradient calendering or hot calendering). Hotter roll surfaces contribute to better surface finishes, whereas cooling air is detrimental to achieving good sheet finish.

The Calcoil system has the capability of completely levelling a caliper profile. Reduced caliper variation often allows other operational adjustments to be made which can have enormous monetary savings attached to them. When basis weight and moisture profiles are corrected without creating caliper/runnability problems, large amounts of energy and fibre savings can be achieved.

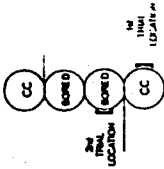
CALIPER CONTROL EQUIPMENT COMPARATIVE TESTS

COMPARING: DEVYON-HERCULES CALCOIL, IMPACT-SUPERJET, ACCURAY-THERMO PROFILER



TRIALS CENTER 1111
MAY 20, 21 & 22, 1987
All documentation by me
has been available on request
I did purchase the calcoil
unit in June 78!

SINGLE
4 ROLL CALCOIL H



ALL COMPARATIVE TESTS
CONDUCTED ON THE HING-ROLL
CALCOIL TRAIL ON 17/18
MAY 20, 21 & 22, 1987
BUT BEFORE WATER COOLING

GRADE: NEWSPRINT 48.0 gsm COIL
SPEED: 500 MPH (1600 FPM)
WIDTH: 6.54 (26.14")
PANG HEAT INITIAL TEMP: 67.5 (153.5)
PANG HEAT FINAL TEMP: 75.5 (167.1)

○ CALCOIL
△ IMPACT
□ ACCURAY

CALIPER RESPONSE IN 15 MINUTES
CALCOIL: 14 microns (0.55 mil)
IMPACT: 7 microns (0.28 mil)
ACCURAY: 15 microns (0.59 mil)
IMPACT SUPERJET: 2 microns (0.09 mil)

INPUT POWER:
PER 12 IN COIL ON 7 ZONE
CALCOIL: 118 kW
IMPACT: 12.0 kW

COOL DOWN RATE:
(10 MINUTES)
CALCOIL: 1.7°C (3.1°F)
IMPACT: 1.7°C (3.1°F)
ACCURAY: 1.4°C (2.5°F)

The Calcoil application which will be most effective is dependent primarily on your calender stack configuration. Factors which influence the choice are: number of calender rolls, roll types and compositions, mechanical loading and physical constraints. With the location properly selected, the Calcoil will provide unmatched results in caliper profile control.

The patented Calcoil system represents a new generation of caliper control. It ensures maximum benefits are achieved using minimal energy. The Calcoil system is delivering unmatched results and setting new standards in caliper control.

THE CALENDIZER SYSTEM FOR IMPROVED SMOOTHNESS, GLASS AND SHEET STRENGTH

The Devron-Hercules Calendizer system is a breakthrough in hot calendering. The new design of steam shower applies low pressure, saturated steam to the sheet, raising its temperature prior to calendering.

The Calendizer uses many of the proven design features of the Devron-Hercules Devronizer, as well as features designed specifically for the calender application to maximize the effectiveness of the system. While the Devronizer revolutionized papermaking by making possible hot pressing, the Calendizer introduces an efficient and effective means of hot calendering.

The main difference between the Calendizer approach and other methods of hot calendering is that, with the application of steam directly to the sheet, the sheet is heated instead of the calender rolls. The result is that, as well as raising sheet temperature, the Calendizer moistens and conditions the sheet prior to calendering.

Improved Smoothness and Gloss

The hotter, moister sheet is much more responsive to calendering. thus, using current calendering practices, improved smoothness and gloss are possible.

Alternatively, less calendering is necessary to maintain existing smoothness and gloss. Using fewer calender rolls, downtime and maintenance costs can be reduced. Machines with two calender stacks can eliminate one stack.

Reduced Fibre Damage

As it is heated with steam, the sheet becomes conditioned. Stresses produced during drying are relieved, and sheet fibres are softened. The sheet becomes more plastic. At the same calendering level, sheet strengths are improved because fibres are damaged less. The result is improved runnability or reduced use of reinforcing pulps, and improved surface strengths for better linting resistance.

Reduced Two-Sidedness

The sheet side to which the steam is applied experiences twice the smoothness improvement. When steam is applied to the rougher side of the sheet, the increased smoothening effect results in reduced two-sidedness.

The Calendizer performs equally well whether installed above or below the sheet. Top-side systems are guaranteed drip-free, even during cold start-up, to ensure paper quality is not lost.

Bulk Enhancement

The sheet is heated by condensing steam on the sheet surface. The remoisturized sheet surface responds better to calendering while the drier interior retains compression resistance and springback. The result is the same or better surface finish at higher bulk. This effect is enhanced when the Calendizer is applied before the last calender nip.

Cross Machine Profile Control

The Calendizer is sectionalized in the cross machine direction to offer profile control of smoothness or gloss. Based on measurements from a smoothness or gloss sensor, the amount of steam supplied to each compartment can be varied.

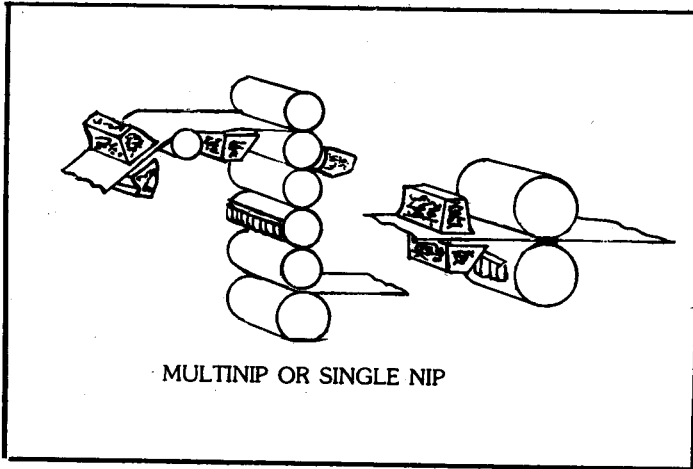
Caliper profile control is also made more effective by conditioning the sheet prior to the profiling nip. The effect of the Devron-Hercules Calcoil system, which also uses hot calendering techniques, can be greatly enhanced with the installation of a Calendizer.

Supercalender Applications

The Calendizer has application on supercalendered grades for cross moisture control of smoothness and gloss. Applied in the pockets of the supercalender, the condensed steam conditions the paper to improve calendering and reduce two-sidedness.

A Complete System

The Calendizer enhances the calendaring operation to improve smoothness, gloss and sheet strength. Further, the Calendizer will enhance the effect of a caliper control system such as Devron-Hercules' Calcoil system.



DEVRON-HERCULES CONTROLS

Devron-Hercules Closed Loop Controls

Using advanced algorithms and microprocessor technology to receive and independently process sensor data from any major measurement computer, Devron-Hercules provides closed loop control for all its actuator systems. In addition, the profile control system can be used as an actuator set point station with set points being entered either by an operator (smart configuration), or on-line from an on-machine measurement and control system (slave configuration).

Devron-Hercules' control systems take advantage of widely-used IBM TM microcomputers and operating systems. The multiprocessor system includes the IBM AT TM (Advanced Technology) and IBM ARTIC (Real time Interface Coprocessor) computers to provide real time displays and control.

The system consists of three components: the Operator Control Station, the Actuator Interface Unit, and the actuators themselves.

Operator Control Station

The Operator Control Station graphically displays the results of closed loop control, including actuator set points and status, and enables manual intervention in the control loop.

End-of-scan profiles are received from the on-machine measurement computer system. The Closed Loop Control Computer then analyzes the measurements and calculates the optimum actuator set points, which are passed to the Actuator Control Computer.

Control programs have been designed specifically to optimize the use of Devron-Hercules actuators in profile control, and ensure both process and operator safety. All control programs are written in widely used, high levels MS-Pascal such that mill technical personnel can readily understand the strategies.

The control station is an ergonomically optimized design for operator compatibility. Its PC-based user-friendliness is enhanced for industrial use to substantially reduce training requirements.

Conclusion

Cross machine control is still in its infancy. There have been considerable technical and application refinements over the past years, but there is a tremendous future for cross machine control actuator development and application.

In the cross machine control of basis weight, moisture, caliper and smoothness continued refinements will occur in actuators, but the major innovations will more likely occur in cross machine control of other paper properties.

The Auto-Slice, Devronizer, Hydro-Profiler, Infradry, Calcoil and Calendizer reflect Devron-Hercules' continued commitment to improved papermaking through innovative actuator systems and applications.

From headbox to reel, Devron-Hercules is cross machine control.