Recent Advances in Rubber Roll Covers for Improved Paper Machine Performance and Reduced Energy Requirements

Dilip De, Ph.D. – Research Manager, Rubber
Charles Hunter, Ph.D. – Research Manager, Polyurethane
Bill Butterfield – Vice President of Research & Product Engineering

Stowe Woodward, Xerium Technologies Inc.

P.O Box 575 Middletown, VA 22645, USA

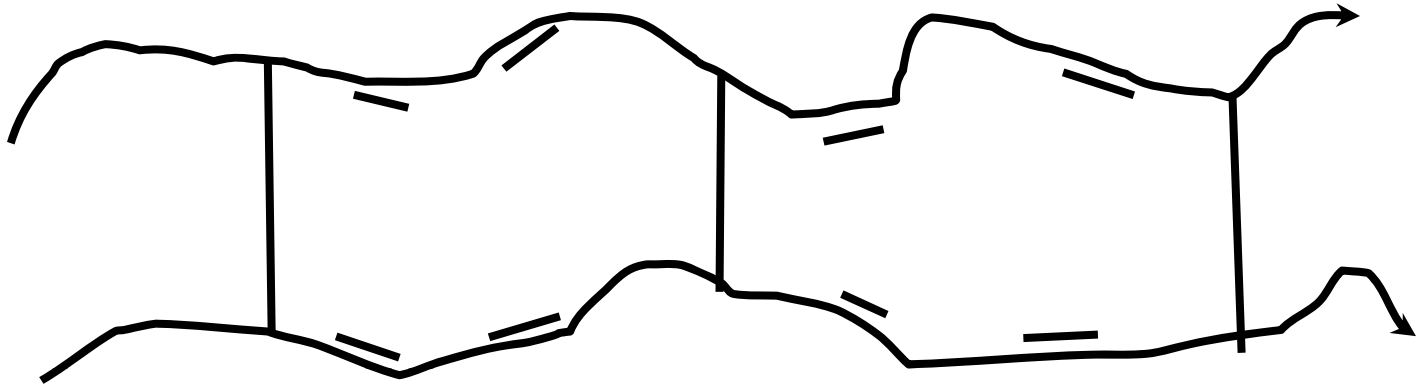
May 1-4
PaperCon 2011
Northern Kentucky Convention Center

RETHINK PAPER:
Lean and Green

Topics

- Rubber Chemistry/Physical Properties
- Applications
  - Press Rolls
  - Size Press Rolls
  - Yankee Pressure Rolls
  - Coater Backing Rolls
- Conclusions

Structure of a Cured Rubber



- Long polymer chains
- Mainly synthetic
- Have sites for crosslinking
- Different chemicals are incorporated for optimum physical and mechanical properties

Types of Rubbers

- NBR - Resistant to aliphatic and aromatic solvents. Best combination of physical properties and solvent resistance.
- HNBR - Resistant to aliphatic and aromatic solvents. Ozone resistance. Higher temperature rating than NBR.
- CSM – High temperature applications. Excellent resistance to strong chemicals and natural aging. Resistance to oils, solvents, and ozone. Excellent release behavior.
- EPDM - Good aging properties. Good resistance to steam and oxygenated solvents. Heat resistance.

Rubber Formula Ingredients

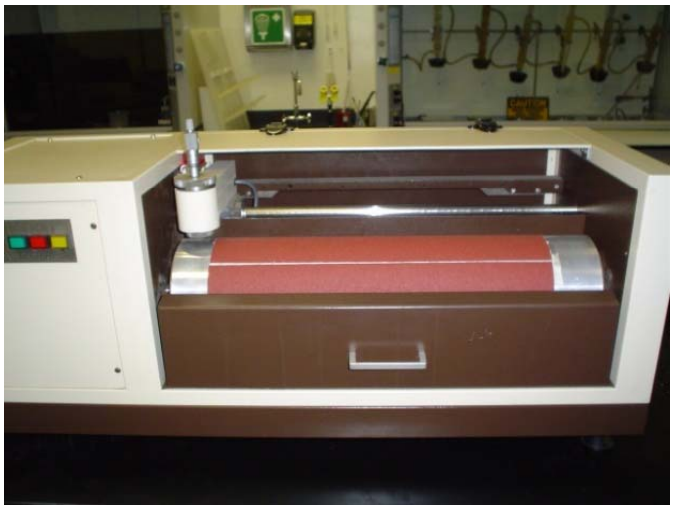
- Rubber matrix
- Filler - Carbon Black, Silica, Clay, nano-fillers, fibers etc. - Reinforcement
- Antioxidant - Prevents oxidation of the rubber so it does not degrade (crack or harden).
- Plasticizer - Different kinds of oils – Helps processing and softens rubber.
- Crosslinking agent - Peroxide or Sulfur – controls hardness and improves the properties of the rubber.
- Other Misc. Additives

Compounding and Mixing

2-roll mills to blend rubber components

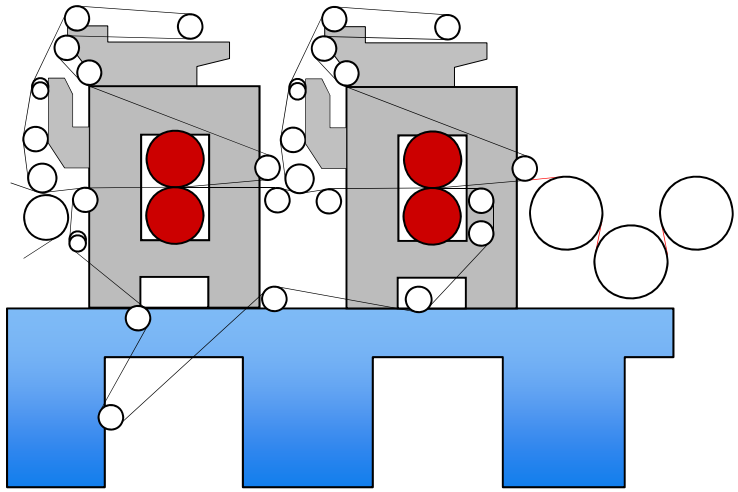
Physical Property Testing

- P&J – Pusey and Jones Hardness
- Abrasion resistance
- Tensile and elongation at break
- Tear strength
- Compression set
- Hysteresis
- Dynamic modulus
- Chemical resistance



Press Rolls

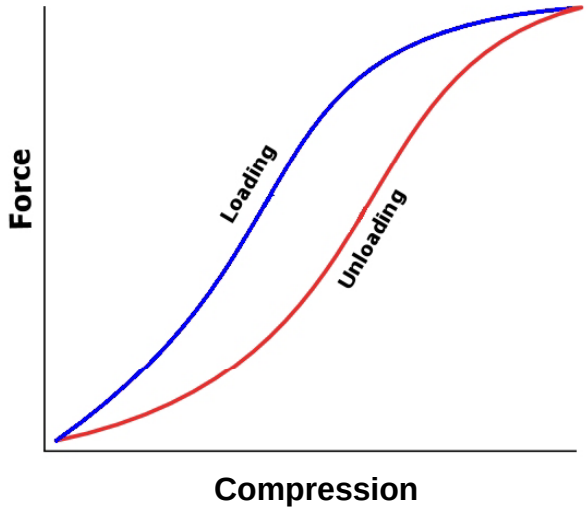
- Typically 15 to 25 P&J high performance rubber covers
  - Engineered Dri-Press® venting
- Required cover properties
  - Superior wear resistance to maintain crown profile and hole geometry
  - Low hysteresis to run cool
  - Superior toughness to withstand impacts at high loads without cracking
  - Superior bonding system
  - Excellent chemical resistance



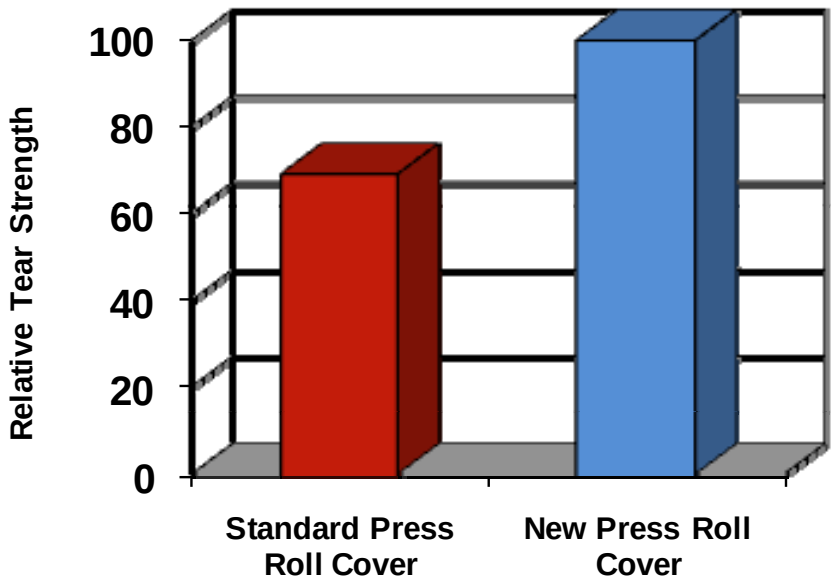
Press Section

Press Rolls
Hysteresis

- Hysteresis is the amount of heat generated by a material as it is cyclically loaded and unloaded
- Calculated by area of the hysteresis loop (MTS)
- Lower hysteresis is desirable
- Used in material development
- Results in materials that run at lower temperatures



Press Rolls
Tear Strength

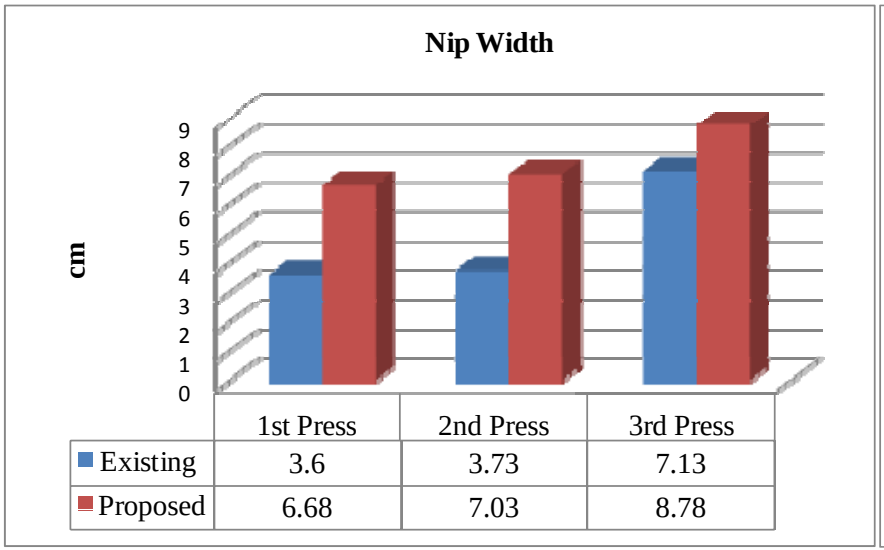


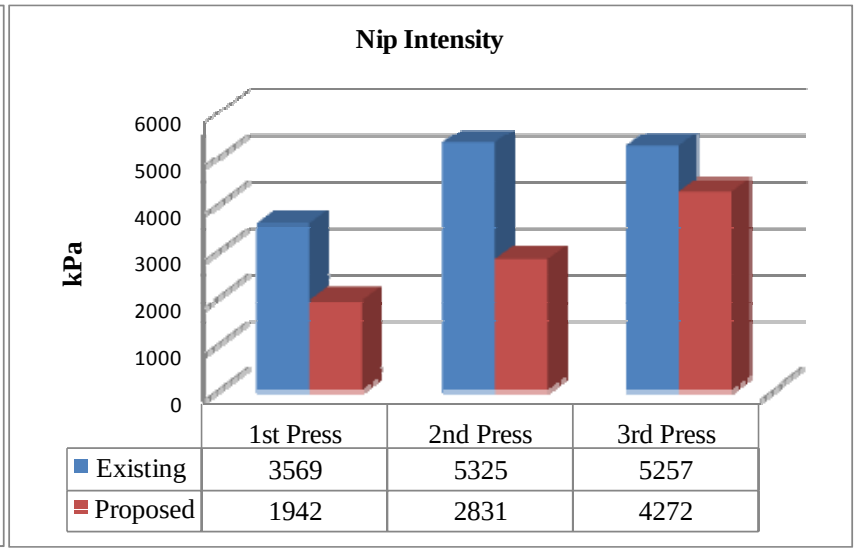
High tear strength of new cover technology withstands high impacts and avoids hole to hole cracking in drilled rolls

Case History- Press Roll
NA Pulp Machine

Press	Line Load, Speed	Current conditions, water cooled	Proposed, non- water cooled	Water savings
1st press	96 kN/ m, 183 m/min	0 PJ Steel top/ 20 PJ Rubber cover	70 PJ top/ 20 PJ	12 L/min
2nd press	149 kN/ m, 183 m/min	20 PJ/20 PJ Rubber	30 PJ/30 PJ	14 L/min
3rd press	280 kN/ m, 183 m/min	18 PJ/18 PJ Rubber	21 PJ/ 21 PJ	16 L/min

Press Roll Conditions and Water Savings





Case History Results- Superwear Xtreme ®

- Removal of water cooling: Savings in water and maintenance of $55,000/ year
- Increase in nip intensity and dwell time provided 1% dryer sheet entering the dryer
  - steam reduction of 10%
  - $200,000/ year savings
- Much longer runtime
  - 6 months vs 3 years
- No hole to hole cracking
- No chemical attack on the roll surface

Case History: A Soft Press

Problem / Opportunity

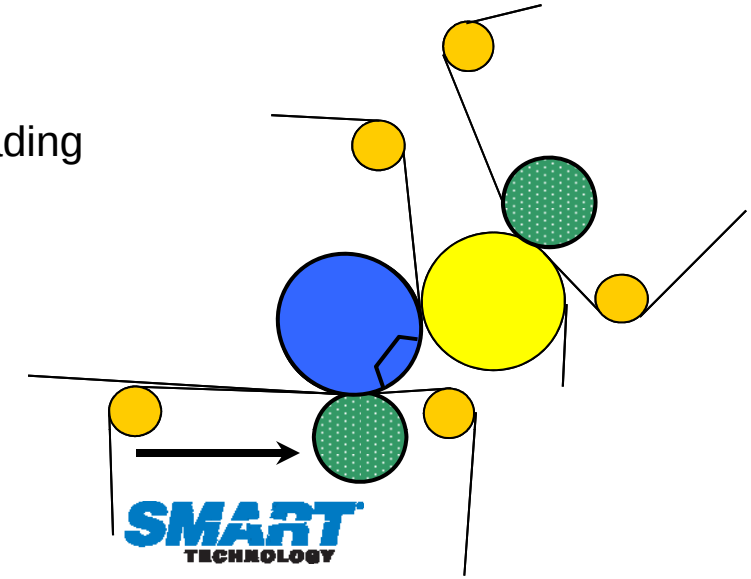
- Decrease cover hardness to increase press loading
- Improve sheet solids
- Improve sheet bulk

Resolution

- Install 40 P&J new technology cover with Dynamic nip technology in 1st press bottom
- Increase press loading
- Use Dynamic nip technology® Roll to flatten nip at increased load.

Value

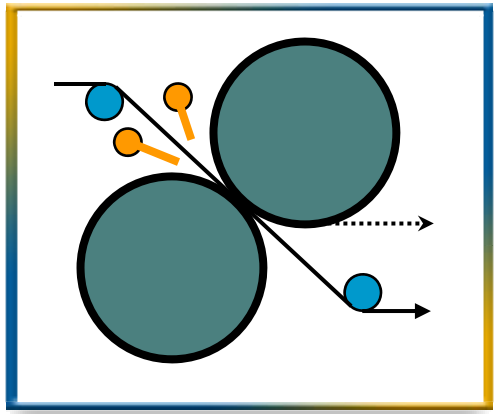
- Increased sheet bulk
- Reduced fiber usage by 3-4%
- Improved CD moisture and caliper profile
- $700,000 sign off



Machine Type:	Trinip
Grade:	Bleached Board
Speed:	365 mpm (1200 fpm)
Load:	45 Kn/ m (250 PLI)

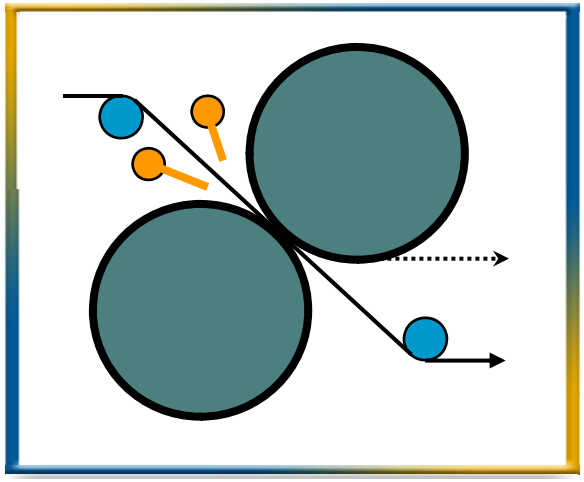
Size Press Rolls

- Soft size press rolls typically 20 to 45 P&J rubber covers
- Hard size press rolls typically 0-1 P&J rubber covers
- Required cover properties
  - High wear resistance to maintain surface profile and longer run time
  - Chemical resistance
  - Hardness stability
  - Minimal thermal crown growth
  - Mark Resistant



Size Press Rolls

- Roll Cover Design
  - Sheet follows hard roll with smooth or 0.8 – 1.6 µm (20-40 µ-in) Ra finish
    - Smoother finish maintains more intimate contact
    - Soft roll deformation results in surface velocity change in the nip
    - Hard roll deforms less thus maintaining more constant contact
  - Soft roll ground to or 1.2 – 2.0 µm (30-50 µ-in) Ra.
  - Adequate wetting balance between sheet and size

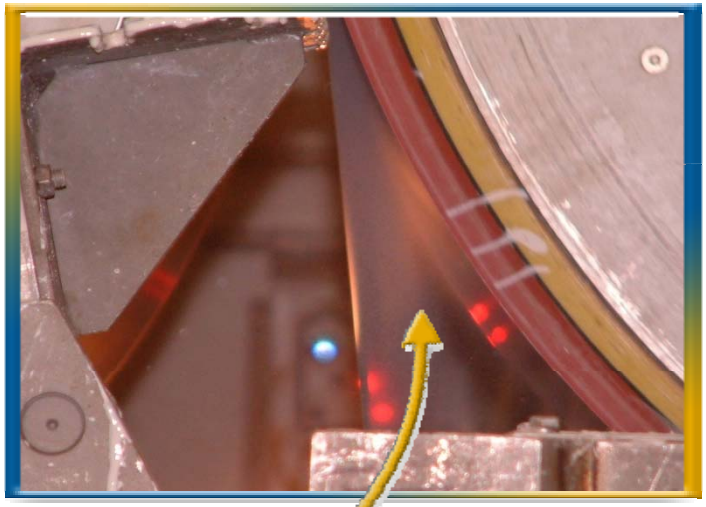


Film Press Case History – Misting Study

Misting test: LWC, 1800 m/min, 8 g/m²
Old Technology cover(left) / New Technology cover(right); 50/50 P&J

Paper top side to the right

Paper top side to the left

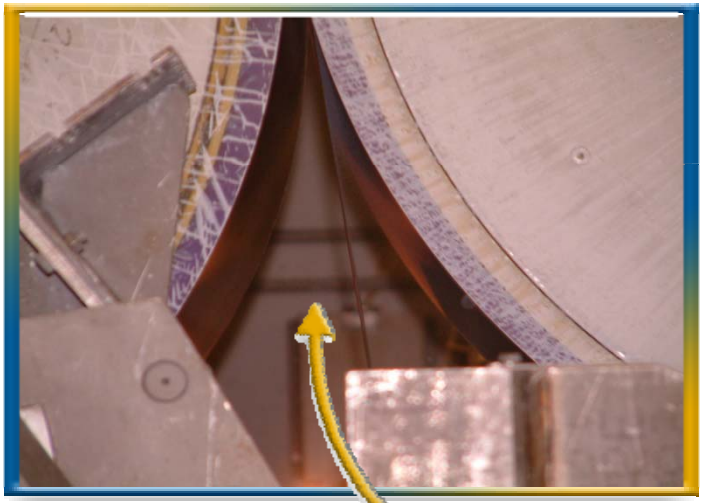


Misting stays on
Old Technology cover side

Film Press Case History – Misting Study Supersize XL®

Misting test: LWC, 1800 m/min, 8 g/m²
New (left) / New (right); 50/50 P&J

Paper top side to the right

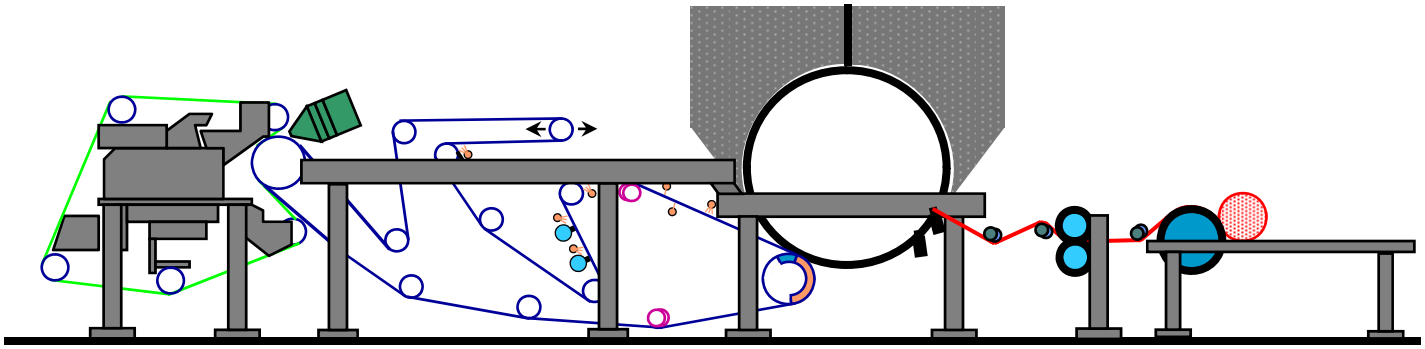


Paper top side to the left

No misting with two
New Technology covers

Tissue Pressure Rolls

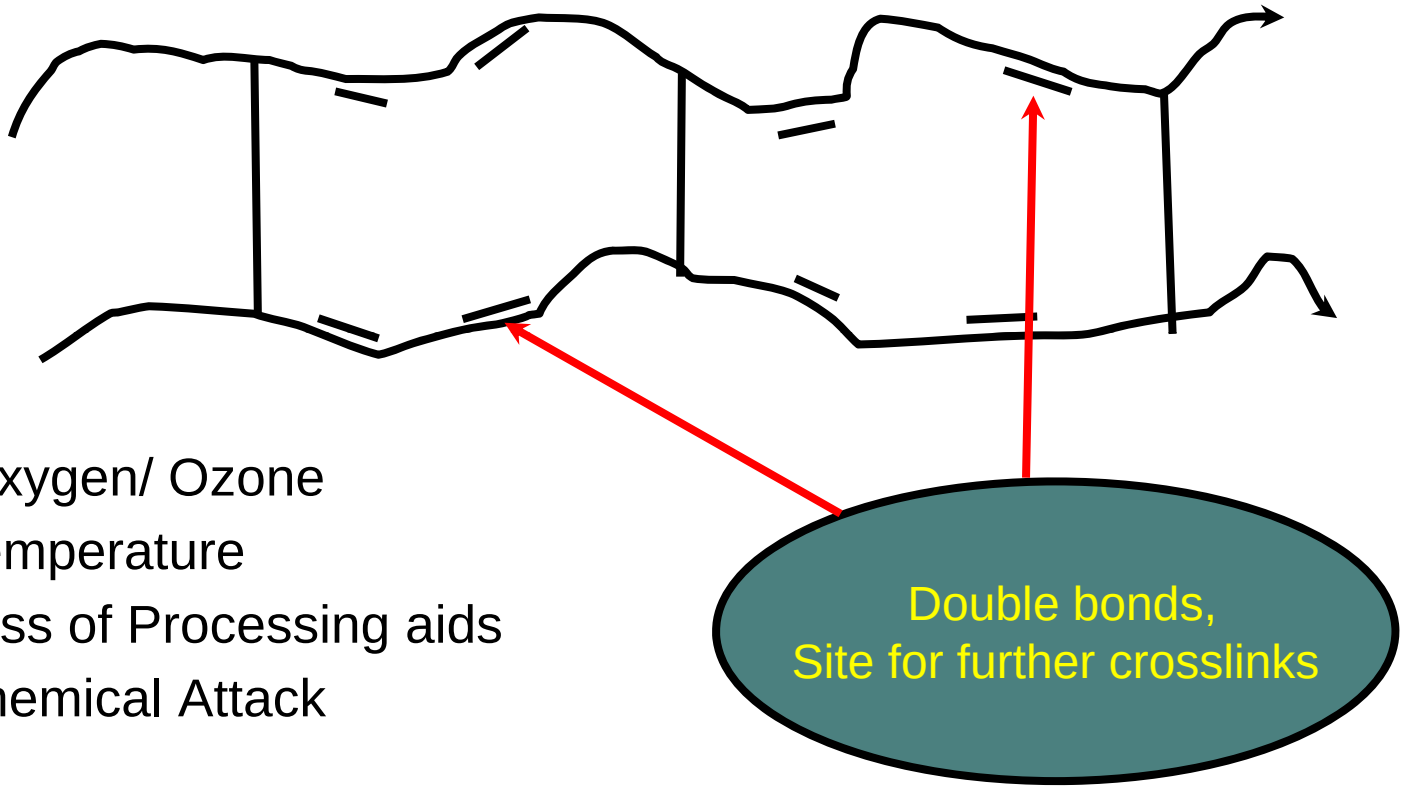
- Typically
  - 30 to 45 P&J high performance rubber covers
  - Engineered venting
- Required cover properties
  - Superior wear resistance to maintain crown profile and hole geometry
  - Excellent chemical resistance
  - Superior bonding system
  - Hardness stability



New Tissue Pressure Roll Covers

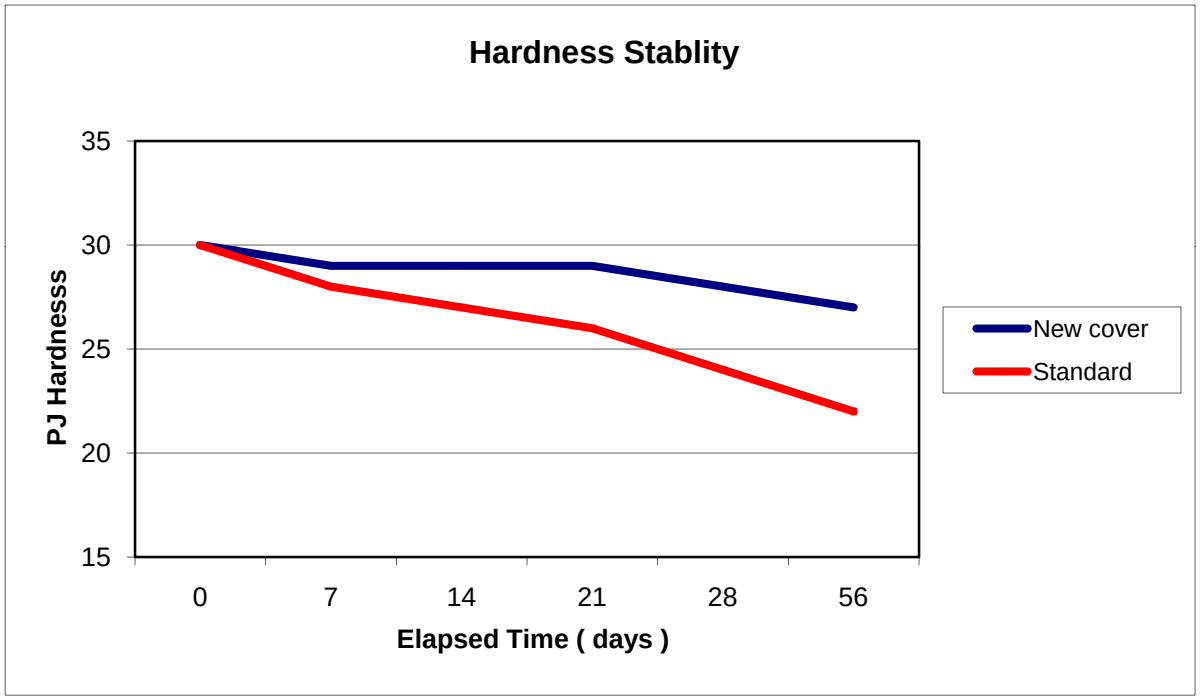
- Suction pressure roll and blind drilled pressure roll
- Excellent abrasion resistance
- Excellent hardness stability
- Superior bonding system
- Cooler running covers able to run non-water-cooled

Structure of Cured Rubber and Causes of Hardening



- Oxygen/ Ozone
- Temperature
- Loss of Processing aids
- Chemical Attack

Hardness Stability- Hyperpress X ®



5.0 cm thick samples, 100 °C Oven

Case History – Xtreme TS ®
NA Tissue Machine

Material	Cover Thickness (cm)	Max Stress (kPa)	Max Temp., bond line (°C)	Required cooling water
Standard	2.54	2032	89	24L/ min
New	2.54	2108	**76**	none

Water Cooled

Non-Water Cooled

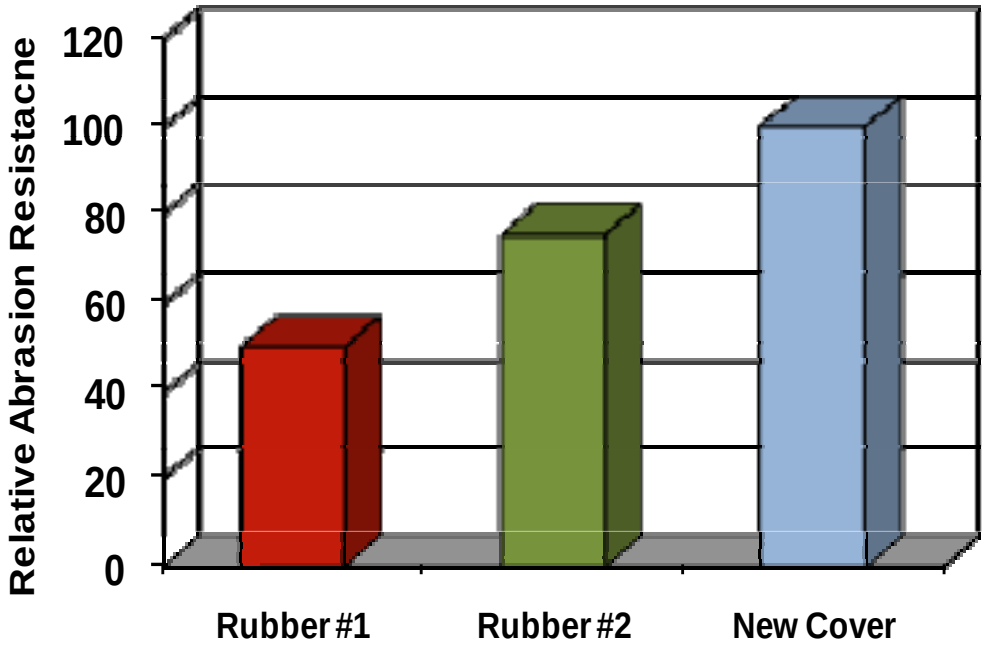
Load	79 kN/m (450 pli)
Machine Speed	1860 m/min (6100 fpm)
Cover Diameter	76.2 cm (30”)
Cover Face Length	3.25 m (128”)
Surface Temperature	49 °C (120 °F)
Felts	1

Significant drop in operating temperature

Coater Backing Rolls

- Typically
  - 45 to 95 P&J rubber covers
- Required cover properties
  - High wear resistance
  - Excellent resiliency
  - Chemical resistance
  - Mark resistance
  - Hardness stability
  - Crack and tear resistance
  - Surface release properties

Coater Backing Rolls
Abrasion Resistance



Case Histories- Hypercoat ®
Coater Backing Roll

Improved Run Times

- Board Mill
  - Increased run time 90 to 180+ days
  - Edge cracking eliminated
- LWC Mill
  - Increased run time 90 to 200 days.
- Coated Paper
  - Mill increased run time from 45 to 75+ days

Base Technology for High Performance Applications

- Lifegard II® Protecting Roll Life base technology – high performance, non-water-cooled applications
  - Excellent hardness stability
  - Superior bonding system
  - Cooler running covers
  - All press roll applications
  - Advantages
    - Water and energy savings
    - Lower maintenance cost
    - Avoid water diffusion related failures

An Example: Coated Board Machine

Mill Problem

- Water diffusion related cover failures
- 70 gpm water cooling rate for 2 rolls
- Temperature controlled to 130 F
- Water cooling required constant maintenance

Solution

- Apply new non-water cooled base technology

Results

- 1.5 roll cover savings annualized
- Machine downtime minimized
- $200K annualized savings

Conclusions:

- The improved performance of several rubber covers in Press, Size Press, Yankee Pressure, and Coater Backing rolls have been illustrated
- Improved covers are running longer in the machine
- Covers with low hysteresis along with high temperature base system allow roll to run under non-water cooled conditions. It saves energy, maintenance, and the cost of water.
- Case histories were discussed regarding energy savings