

# Un-Nipped Roll Cover Technology: Finding Performance Benefits and Cost Savings in Modern Chemistry

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## ABSTRACT

*Un-nipped roll covers have often been considered “non technical” roll covers in the paper machine and for more than thirty years little has been done to improve the performance or attributes of these roll covers. This lack of advancement is due largely in part to the misconception that un-nipped roll covers do not have a direct affect on the art of papermaking or the quality of paper, yet they typically represent 80% or more of the covered rolls in a paper machine. They seemingly perform a modest task, to carry the web, wire, pulp, felt and sheet from the head box to the reel. While the task may appear modest, it is also fundamentally important. Modern chemistry has allowed us to develop new polymers that can not only function as a roll cover in a paper machine but can actually improve machine performance and reduce costs. Custom designed polymers can unlock your roll cover’s potential and allow the roll in question to perform better, produce better paper and save the papermaker money.*

## INTRODUCTION – WHY CHANGE IS NEEDED

Why has the advancement in technology of un-nipped roll covers averted the attention of major OEM paper machine manufacturers for so many years? Why has the papermaker been reduced to “accepting” the flaws and limitations of rubber in the un-nipped roll covering market, while every other performance roll cover in the paper machine has been upgraded from rubber to polyurethane or some other performance polymer?

If you ask a papermaker what their highest cost non-chemical consumable item is, most of them will tell you that the machine clothing is by far the most expensive, regularly replaced consumable. Why is replaced so regularly? One reason is because the “non technical”, un-nipped roll covers are ill designed for the purpose of efficiently carrying a costly wire and felt through a paper machine. By definition, these wire rolls, felt rolls, guide rolls, breast rolls, forming rolls and table rolls are meant to transport the wire and felt; and whether the roll is driving the wire/felt, or the wire/felt is driving the roll, traction is paramount and the relationship between the roll cover and the wire/felt must be akin to a sprocket and a chain.

Fabrics wear out because the knuckles on the fabric become worn and effectively reduce the open area in the fabric, which is a precursor to poor drainage. Poor drainage from a fabric in the wet end and press sections will increase the cost to remove water in the drying section. In addition, an improperly functioning piece of clothing will affect sheet formation and paper quality. So the papermaker is forced to regularly change out his clothing to maintain a consistent paper quality and to keep his operational costs in the drying section to a reasonable level.

So, why is the clothing wearing so quickly? Simple – wear on the clothing occurs due to the sliding friction between the clothing and other components of the paper machine: namely roll covers, foils and suction boxes. If the contact between the clothing and the other components of a paper machine are not optimized and sliding friction is not controlled, wear of the clothing is dramatically increased. In addition to wear on clothing, power consumption is dramatically increased if the sliding friction between the clothing and the other components of a paper machine is not controlled. If the sliding friction increases and traction decreases, the efficiency of the paper machine is reduced and more power must be consumed in order to overcome the sliding friction and maintain machine speeds.

Modern paper machines are larger and running faster. The number of “drive” rolls (rolls that are powered by a motor) in a modern machine is relatively small so each roll must operate efficiently. All of the other “turning” rolls or “guide” rolls (rolls that are not powered by a motor, but turn from the friction of the felt, wire or paper) must have exceptional traction or they act as a brake against the driven rolls and the transfer of energy is lost in heat and wear from sliding friction.

## BACKGROUND – THE PAST AND THE PROBLEM

Rubber is renowned for its traction properties, just look at what your automobile is running on. So why isn’t rubber effective in providing traction in a paper machine? The answer lies in the chemistry of rubber. Most un-nipped, rubber roll covers in the paper machine operate at a hardness of 0-1P&J “bone hard” in order to extend the life of the roll cover. Yet, putting a hard cover on a roller whose primary function is traction is counterproductive. Check the hardness of the tires on your car; they are relatively soft because traction is their primary concern, not durability. The hard cover will invariably slip against the wire/felt and this slippage is one of the main causes of friction, heat and wear in wires/felts.

The paper machine already has several strikes against it when it comes to traction. It is operating in a very wet environment and it is operating at ever-increasing speeds. So why put a bone hard roll cover in an area where traction is paramount? Because the materials used to produce roll covers in the wet end of a paper

machine have traditionally been rubber, a very hydrophobic material that does not absorb moisture. The morphology of these rubber covers is such that a harder material is much, much more durable than a softer one.<sup>1</sup> This is where the contradiction occurs. In order to make the roll covers last longer and stand up to doctor blades, they have continually made the roll covers harder. They have been limited by the chemistry of the rubber and have been forced to make the covers harder to prevent frequent roll change outs and grindings. The paper industry has adopted a technology that promotes longer cover life but sacrifices traction to the wire/felt and actually causes premature wear in the most expensive consumable item in a paper machine.

To make my point, we will revisit a topic I mentioned at earlier in the paper. Remember my analogy to the tires of your car providing excellent traction? If we assumed that a roll cover was made of the same rubber used on cars, in order to provide exceptional traction against the clothing, this is approximately how long the roll cover would last in a paper machine:

Roll Cover Outside Dia (OD):	500 mm
Speed Of the Paper Machine:	1000 m/min
Rating Of the Tire:	70,000 km

$[70,000 \text{ km}] / [(1000 \text{ m/min}) \times (1 \text{ km} / 1000 \text{ m})] \times [1 \text{ hour} / 60 \text{ min}] \times [1 \text{ day} / 24 \text{ hours}] = 48.61 \text{ days}$

**Figure 1. Life of a rubber cover with the hardness of an automobile tire.**

This means that if your roll covers were made of the same rubber that your tires are made of, they would last approximately 49 days. Granted, the abrasion between rubber and asphalt is different than the abrasion between rubber and a forming wire, but still, you can see the huge discrepancy. Soft rubber provides excellent traction, but sacrifices durability. For further proof, ask a paper maker what hardness his drive roll covers are and typically they will tell you they are between 10 and 15 P&J, whereas the rest of their un-nipped roll covers are between 0-1 P&J. He will also tell you that he replaces his drive roll covers approximately 2-3 times as often as his “bone hard”, non-driven rolls. This again, points to the correlation between hardness and durability in rubber.

To further complicate the issue, it has been recommended that these hard roll covering materials have a very smooth surface, sometimes approaching sub 0.5µm Ra surface finishes.<sup>2</sup> Why would this recommendation be made? It is because the wire manufacturers and the roll cover manufacturers have reconciled themselves to the fact “bone hard” rubber covers are going to slip. In order to minimize the abrasive effects of the rubber against the wire, they recommend a slick, smooth surface. So now you have a roll cover that is hard and slick and it is supposed to provide or maintain traction to a wet, nylon wire moving at speeds up to 2200 meters per minute. This is not a formula for success. Papermakers are installing larger motors to power their drive rolls and

they are constantly increasing their wire and felt tension. All of these “fixes” ultimately to more power consumption and abbreviated clothing life.

Another issue to consider is power consumption. With the ever rising cost of global energy, conserving power is a major factor when looking at paper machine efficiency and profitability. If rolls are not properly tracking with the wire, then they are effectively acting as a brake as they slip against the wire. Traction considerations are not just for the driven rolls, but for all rolls in the wire and felt sections. Remember that most wires are driven by only one or two rolls and that the transfer of energy is extremely important. Whether the transfer of energy is from the driven roll to the clothing or from the clothing to a roll, power and energy are being transferred via traction and friction between the clothing and the roll cover. By putting roll covers in the paper machine that are designed for optimum traction, you can reduce the power consumption required by the drive rolls, breast rolls, wire return rolls, couch rolls, etc.

In addition to the roll cover’s functionality, cost is a large determining factor when considering the lack of development. Since un-nipped roll covers were under the misconception of being non-technical or non-performance rolls, it was surmised that they must be purchased at the lowest possible price. Rubber covers are traditionally inexpensive compared to covers made from more advanced polymers. In order to keep the cost of the rubber covers low, fillers are added to the rubber cover formulations in large percentages. Fillers are inexpensive, solid particles that are inert and don’t perform a critical function in the cover’s polymerization process. Some of the most common fillers used in the production of rubber covers are Silicon Dioxide (SiO<sub>2</sub>), Titanium Dioxide (TiO<sub>2</sub>), Calcium Carbonate (CaCO<sub>3</sub>), Zinc Oxide (ZnO), Barium Sulfate (BaSO<sub>4</sub>) and Carbon (C).<sup>3</sup> Fillers can be used to increase modulus in a polymer, to impart release properties, to increase abrasion resistance, to increase hardness and to increase heat resistance. But usually the main function of a filler is to take up volume in the rubber matrix and replace the more expensive, flexible, rubber binder. The problem is that most of these fillers are very abrasive by themselves and when the roll covers slip against the wire it is tantamount to running the wire against fine sand paper. Often, this is quite literally the case since sand is mostly silicon dioxide.

Ingredient	Filler or Binder	Percent By Weight
Nitrile Rubber	Binder	29.03%
Carbon Black	Filler	10.16%
TiO <sub>2</sub>	Filler	31.93%
Zinc Oxide	Filler	1.60%
Barium Sulfate	Filler	11.32%
Additives	Binder	3.91%
Sulfur	Binder	12.05%
PERCENTAGE	Binder	44.99%
PERCENTAGE	Filler	55.01%
TOTAL		100%

**Table 1. Typical Bone Hard (0-1 P&J) Rubber Cover Formulation.<sup>4</sup>**

In stark contrast to rubber, polyurethane materials contain very little, if any, fillers. The most filler a polyurethane roll cover would contain is about 15.00%.<sup>5</sup>

### **PAST DEVELOPMENT – THE LACK OF PROGRESS**

So why haven't companies introduced roll covering materials that would provide better traction and durability than rubber? What about materials other than rubber, can't they employ a technology that would allow them to put a softer cover in the same position currently occupied by "bone hard" rubber covers, while not sacrificing cover life? They have, but they have limited those materials to press rolls and soft nip calendar rolls. The roll covering material is polyurethane and almost everyone in the paper industry is educated on the cost and operational benefits of polyurethane versus rubber. Many papermakers have switched to polyurethane in the press section because of its superior properties as compared to rubber.

The one historical problem with polyurethane has been its tendency to absorb moisture, or to hydrolyze over a period of time. Even polyurethane press roll covers typically need to be taken out of the machine on a routine schedule and "dried out". So companies did not want to put polyurethane roll covers in un-nipped positions because those rolls typically ran continuously for years and there were not sufficient spare rolls to allow a roll to be taken out of the machine to be "dried out" every year or six months. The notion that "all" polyurethane roll covers absorb moisture has been engrained into the papermakers thought process since they were first introduced twenty (20) years ago.

Also, the traditional method required to manufacture a polyurethane roll cover (vertical casting) was cost prohibitive. The equipment and procedure for vertically casting polyurethane roll covers was very exacting and prone to manufacturing defects, hence a large manufacturing cost was built into the price of polyurethane roll covers. The cost of polyurethane raw materials was also traditionally much more expensive than rubber raw materials. Even today, with the advent of ribbon flow casting, typical polyurethane roll covers are still more difficult and expensive to manufacture than rubber covers.

The papermaker could not be expected to pay the same price for a polyurethane breast roll cover as he was currently paying for a polyurethane press roll cover. The difference in cost between the rubber covers and polyurethane covers could not be justified financially, particularly because the un-nipped roll covers were still perceived as "non-critical". So the cycle has perpetuated itself and the dilemma of traction and durability with un-nipped roll covers has continued to go unchecked.

### **NEW DEVELOPMENT – THE SOLUTION AND THE FUTURE**

The solution to providing a roll covering material that provides traction without sacrificing durability lies in polymer development. The solution required the creation of a new roll covering material that is specifically designed for the rigors of the paper industry. Finally, this has been accomplished. A new polyurethane material has been chemically engineered to withstand the environments of the paper machine on a continuous basis, to improve the paper machine's performance, to lower the cost of producing paper and to have a longer operational life than conventional rubber covers. In order to accomplish this feat, we had to develop not only new polymers, but new application methods to apply the roll covers.

There were several key factors that governed our development process. The cover had to accomplish all of the following criteria in order to be successful:

#### **New Roll Cover Criteria**

- A. *Hydrophobicity* – the cover had to withstand the wet and hot environment of a paper machine and be able to run indefinitely without absorbing moisture.
- B. *Abrasion Resistance* – the cover had to be significantly more durable than conventional rubber. It had to resist abrasion from wires, felts, sizing, paper, furnish, doctor blades, etc.
- C. *Coefficient of Friction* – the cover had to have a very high coefficient of friction with wires, felts and paper to reduce slippage, wear and energy loss. This would be accomplished through the surface morphology (chemical makeup and structure) of the cover and also the cover's hardness at operational temperatures.
- D. *Less Abrasive* – the cover had to be less abrasive to wires, felts and doctor blades than conventional rubber covers. We engineered the cover for maximum traction, but we knew that some slippage is inevitable, so we wanted to make sure that if slippage did occur, the abrasive effect on the wire or felt was minimized. We did this by reducing, or in some cases, virtually eliminating the use of fillers.
- E. *Manufacturing & Economic Viability* – the cover had to be manufactured in a quick, consistent manner that eliminated the pitfalls, cost and manufacturing difficulties of previous polyurethane roll covers. The new cover had to make sense. We couldn't develop this wonderful new polymer and perfect the application process and then find out it was twice as expensive as rubber. After all, rubber covers are by no means a broken wheel; rubber covers have been producing paper for over seventy (70) years. What we wanted to do was improve upon the performance of rubber and still be able to

offer the papermaker a roll cover price that was in line with rubber.

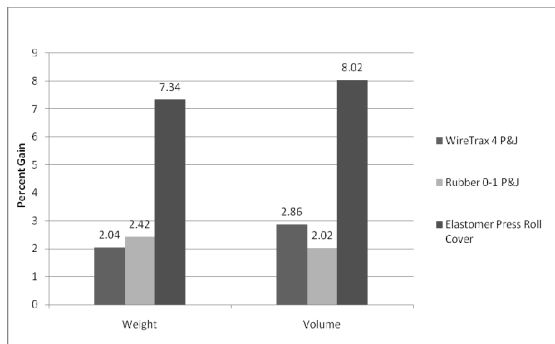
The development process was a daunting task and several years in the making, but it has been accomplished. IPS, Inc., has developed a line of polyurethane roll covering materials, trademarked under the DuraTrax™ name.

Cover Name	Position	Hardness Range
WireTrax™	Wire & Felt	4 – 25 P&J
WireMax™	Wire & Felt	4 – 25 P&J
ReelTrax™	Reel Spools	10 – 50 P&J
ReelMax™	Reel Spools	10 – 50 P&J
FeltTrax™	Dryer Felt	2 P&J
FeltMax™	Dryer Felt	1 P&J
SlickTrax™	Non-Stick	3 P&J
SlickMax™	Non-Stick	2 P&J

**Table 2. IPS DuraTrax™ Polyurethane Roll Covers**

### Hydrophobicity

In order for a roll cover to survive day in and day out in a paper machine it cannot absorb water and it cannot show any indication of hydrolytic degradation, regardless of the term of service.



**Figure 2. Hydrophobicity of Roll Covers<sup>6</sup>**

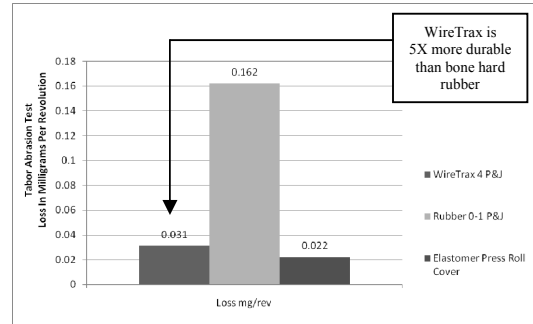
The line of DuraTrax™ covers does not absorb moisture even after prolonged exposure. The small amount of moisture absorption you see in Figure 2 is only surface absorption into the irregularities of the machined sample. You can also see that our cover actually outperformed rubber in the percent weight gain category even though rubber's density is much higher than that of polyurethane. DuraTrax™ covers have been running for over five (5) years without a single reported case of hydrolytic damage.

### Abrasion Resistance

DuraTrax™ covers have proven themselves to be much more abrasion resistant than bone hard rubber covers. The durability of DuraTrax™ covers can be attributed to several things:

- A. *Chemical Structure* – The polyurethane chemical linkages and bond energies associated with those linkages are simply stronger than rubber and are very difficult to break down physically.<sup>7</sup>

- B. *Coefficient of Friction* – Higher coefficient of friction results in less slippage, which reduces the sliding friction and abrasion.
- C. *Reduced Filler Content* – The DuraTrax™ polyurethane roll covers have more flexible polymer binder per unit volume than rubber covers due. Those flexible bonds can absorb the pressure from abrading substrates and flex under the load without tearing or abrading away.

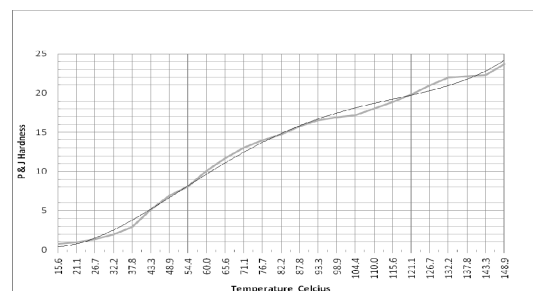


**Figure 3. Abrasion Resistance (Durability) of Roll Covers<sup>8</sup>**

In Figure 3, you can see that during the abrasion test, 0.162 mg per revolution of bone hard rubber cover was abraded away. Using the same abrasive wheel with the same load, the WireTrax™ polyurethane roll cover lost only 0.031 mg per revolution. That means that the rubber cover abraded 5.23 times more quickly than the polyurethane cover did.

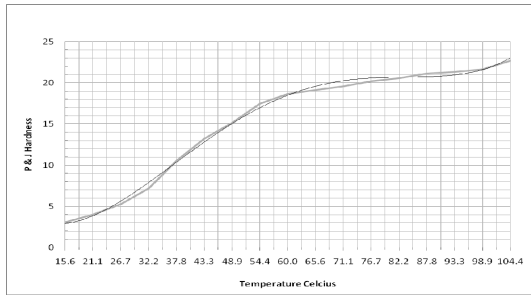
### Coefficient of Friction

The coefficient of friction between any two substrates is determined by many factors. During testing procedures, we were able to control many of the dynamic factors that affect the coefficient of friction and therefore we were able to closely approximate the conditions found in a paper machine. The very first thing we did was determine the actual hardness at operational temperature of the two (2) covers in question. Since we could only run the coefficient of friction test at ambient temperature, 23°C, we wanted to make sure that our test samples were the same hardness during the testing phase as the actual covers would be while running in a paper machine.



**Figure 4. Operational Hardness of Bone Hard (0-1 P&J) Rubber Cover<sup>9</sup>**

Most paper machines run about 60°C in the wet end and the press section so we used 60°C as the testing benchmark. The bone hard rubber cover softened from 0.7 P&J @ 15.6°C to 10.1 P&J @ 60°C.

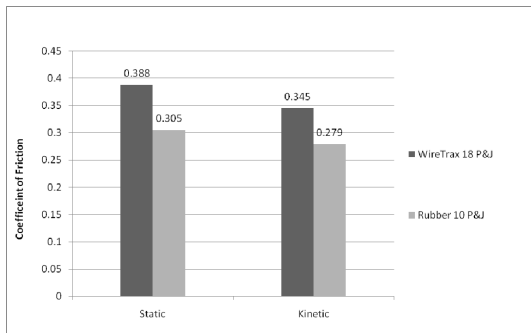


**Figure 5. Operational Hardness of Polyurethane WireTrax™ Cover (4 P&J)¹⁰**

The WireTrax™ cover softened from 3.0 P&J @ 15.6°C to 18.8 P&J @ 60°C. This softening is quite intentional. We found through extensive testing that the best compliment between coefficient of friction and abrasion resistance could be achieved between 15 and 20 P&J at operational temperatures. The WireTrax™ cover is engineered to operate in this hardness range so that it can be durable enough to resist abrasion extremely well, resist doctor blade indentation or abrasion and also provide maximum grip on the felt or wire.

Next we approximated the load of the wire at ten (20) Kilograms per Linear Centimeter (KLC) with a 90° degree wrap on a 500mm diameter roll cover. This allowed us to calculate a pressure that we could use as a standard for determining the coefficient of friction. We also wanted to make sure that our covers had identical surface roughness averages (R<sub>a</sub>). We used a Mititoyo® Surface Profilometer to achieve a R<sub>a</sub> of 1.0 µm on both the rubber cover sample and the polyurethane cover sample.

We then conducted the coefficient of friction testing using the determined parameters against a forming wire.



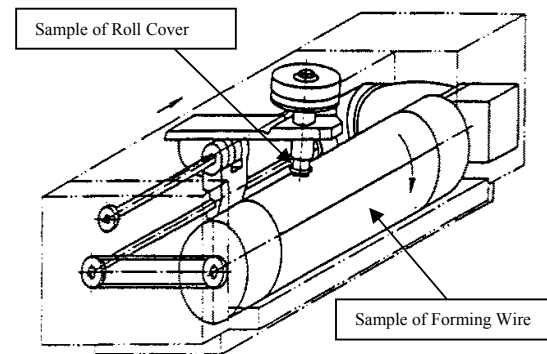
**Figure 6. Coefficient of Friction of Roll Covers¹¹**

It is evident from the test results that the WireTrax™ polyurethane roll cover had a much higher coefficient

of friction than the bone hard rubber cover did, given the same load, the same surface finish and the actual operational hardness. The WireTrax™ polyurethane roll cover sample had a static coefficient of friction value that was 27.2% greater than the bone hard rubber cover sample. The WireTrax™ polyurethane roll cover sample also had a kinetic coefficient of friction value that was 23.7% greater than the bone hard rubber cover sample.

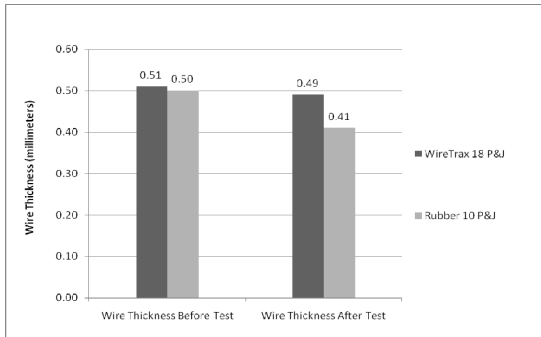
### Less Abrasive

It was also very important for us to manufacture a cover that would not be abrasive against the felt and wire should slippage occur. Although we have taken many precautions to assure maximum grip against the wire or felt, we know in some situations that slippage can occur, particularly during a start up after a shut down or if you are have doctoring issues, drive issues, etc. So the first thing we did was drastically reduce the filler content in our polyurethane roll cover material compared to the typical bone hard rubber cover material. If you refer back to Table 1, you will see that a typical bone hard rubber cover has almost 55% filler. Our covers have less than 15% filler in them. In order to test the two covers, we modified a Rotary Drum Abrader to be covered with a forming wire instead of an abrasive pad on the rotating drum. And we placed a sample of the cover material in the armature to run under a load of 1.0 Kg.



**Figure 7. Rotary Drum Abrader**

We measured the thickness of a new forming wire in ten (10) locations and calculated an average thickness before the test. We then ran the test for 5,000 revolutions at 50 revolutions per minute (RPM). We used the same surface roughness average (R<sub>a</sub>) of 1.0 µm for both samples as we did on the coefficient of friction test.



**Figure 8. Wire Wear Caused By Roll Covers<sup>12</sup>**

The wire wear caused by the WireTrax™ cover was only 0.02mm whereas the wire wear caused by the bone hard rubber cover was 0.09mm. The results of this test confirm that the bone hard rubber cover is more than 4 times *more* abrasive to the wire than the WireTrax™ polyurethane roll cover is.

### Manufacturing & Economic Viability

Unlike all other major suppliers of roll covers, we design and manufacture our own polyurethane materials, giving us unequaled ability to custom design our formulations to the very specific needs of the paper machine. This is why we are able to use proprietary polyol blends to achieve unparalleled levels of hydrophobicity in a polyurethane polymer. Advances from other industries in nano-particle technology combined with our own developments in blended polyurethane polyols will keep new and improved products coming out for the foreseeable future.

There is no getting around the fact that polyurethane raw materials are more expensive than rubber raw materials. So, in order to be price competitive and offer a superior product, it was necessary for us to streamline the manufacturing process and to reduce the cost of labor, capital equipment and energy.

With that in mind, we elected to manufacture and design our own roll covering equipment. This equipment is custom built for one purpose...putting roll covers on roll bodies. We have streamlined the manufacturing process to offer the papermaker the following advantages:

- A. *Turn-around time* – Our process does not require post-curing of the roll cover after it is applied to the roll body. This drastically reduces the amount of time for manufacture. We don't have to warm rolls up or cool them down before grinding. We don't have to remove bearing housings in order to cover a roll because of the high heat bearings would be exposed to during the vulcanization process of a rubber cover. Our manufacturing process takes less than two (2) hours even for the largest rolls and the roll cover can technically be put back into service within 36 hours after covering.

- B. *HVNC™ (High Velocity Nozzle Cast)* – Our revolutionary spray process allows us to cover rolls without expensive molds or dummy heads and bearings. The spray process is unique in that we can apply a roll cover in one trip down the face of the roll (up to 35mm thick per side). Our covers are completely homogeneous and are not layered like traditional spray applications. The equipment we use is hydraulically driven and computer controlled for unparalleled accuracy and repeatability. Our HVNC™ process also has a unique attribute it imparts into the manufactured polyurethane cover. The roll cover is naturally stress relieved during the manufacturing process and because no post cure is needed, the low internal stress in our covers mean that a knife cut will not propagate and spread like a similar cut would in a rubber covered reel spool. The stress relieving characteristics of our polyurethane roll covering process also eliminates a lot of the edge-lifting that is inherent in some rubber covered rolls.



**Figure 9. Edge-Lifting In a Rubber Covered Roll**

Edge-Lifting can lead to corrosion problems with the shell, the head and ultimately water can migrate into the roll body and throw your roll out of balance. In addition to corrosion and balance problems, edge-lifting can cause pieces of the rubber cover to break off and pass through the paper machine, damaging press roll covers, wires and felts, ultimately resulting in expensive down time.



**Figure 10. DuraTrax™ Covered Roll With Sealed Heads.**

- C. *Repairability* – Our roll covers can be patched and repaired with the same material that was used to manufacture the original roll cover. No more epoxy patches with rubber dust mixed in. The patches can be done in small localized areas on the cover or entire bands that span the circumference of the roll. In some cases, repairs can even be done on-site, in the paper machine.

### CONCLUSIONS

We can now offer the papermaker the benefits of polyurethane (durability and traction) without the drawbacks of hydrolysis and prohibitive cost.

We have chemically engineered our roll covers to perform at optimum hardness *in* the paper machine *at* paper machine operating temperatures. The covers provided will operate at about 15-20 P&J in your paper machine, softening slightly from the rated P&J reading taken at ambient temperatures. Our softer covers provide better traction without sacrificing cover durability. In almost every application, our softer cover is more durable than the harder, traditional bone-hard rubber covers.

If you could run all of the un-nipped roll covers in your paper machine at the same hardness as your current drive roll covers and still achieve a longer cover life from those new covers, wouldn't you?

Now you can. You can maximize your traction, reduce your energy waste, and extend the life of your covers, felts and wires all at the same time.

Through the developments in polymer chemistry, this scenario is now available. Even if we could extend the

life of your wires and felts by 20%, look at the yearly cost savings you could potentially realize.

### Cost per Year in Wires Using All Bone Hard Rubber Covers

- A = Cost of New Wire (\$100,000)
- B = Average Run Time of a Wire (90 Days)
- C = Cost per Day to Run the Wire (\$1,111.11)
- D = Yearly Cost of Wires (\$405,832.93)

$$A / B = C$$

$$C * 365.25 \text{ Days / Year} = D$$

### Cost Per Year in Wires Using All DuraTrax™ Polyurethane Roll Covers

- W = Cost of New Wire (\$100,000)
- X = Average Run Time of a Wire (108 Days)
- Y = Cost per Day to Run the Wire (\$925.93)
- Z = Yearly Cost of Wires (\$338,194.44)

$$W / X = Y$$

$$Y * 365.25 \text{ Days / Year} = Z$$

### Cost Savings Per Year Using All DuraTrax™ Polyurethane Roll Covers

$$D - Z = \$67,638.49$$

### DuraTrax™ Products Offered

- A. *WireTrax™* - Roll covers are a polymer material comprised of a polyether / polyester polyurethane matrix blended with micro particles. It has proven itself to be a superior roll covering material for the forming and press sections of a paper machine. It has been engineered to offer the papermaker a roll cover with optimum wear resistance, durability, hydrophobic properties and doctorability. By focusing strictly on un-nipped roll positions, in a way currently unavailable to press roll covers. We have maximized the properties that matter most in un-nipped roll cover applications.
- B. *SlickTrax™* - Roll covers are a polymer composite material comprised of a polyurethane matrix blended with Teflon® micro particles. The polyol backbone is part of the same chemical family as our WireTrax™ polyurethane roll covers. It has the same wear resistance, durability, hydrophobic properties and doctorability as WireTrax™ and is grindable to maintain optimum surface finishes. The uniform Teflon® content throughout the thickness of the cover allows for several regrinds without losing any of the release characteristics. Scratches and marks that develop on the roll's surface over time due to doctoring, repetitive cleaning and scraping can easily be ground out and the cover profile (surface finish) restored. These roll covers can be easily doctored with a UHMW doctor blade. This is the only elastomeric, Teflon®



impregnated roll cover in the paper industry that can be doctored.

- C. *ReelTrax*<sup>TM</sup> - Roll covers are a polymer composite material comprised of a polyurethane matrix blended with micro particles. This has proven itself to be a superior roll covering material for the reel section of a paper machine. It has been engineered to offer the papermaker a roll cover with optimum wear resistance, cut resistance, durability and traction properties. The micro particles we incorporate into the polyurethane impart unparalleled cut resistance and traction.
- D. *FeltTrax*<sup>TM</sup> - Roll covers are one of the latest technological advances from IPS, Inc. *FeltTrax*<sup>TM</sup> brings the benefits of polyurethane into applications where higher temperatures have traditionally excluded polyurethane roll covers. At 1 P&J, these covers are harder than traditional *WireTrax*<sup>TM</sup> roll covering materials, but as a composite still provide exceptional traction. In addition, the chemical engineering and formulation work ensures that the cover will run at 15-20 P&J when placed in operating environments with elevated temperatures. These covers are designed to perform in hotter environments approaching 150°C, such as around dryers, size presses, breaker stacks and coaters. The remarkable thermal stability means that it can also operate inside the dryer hood as a dryer felt roll cover. Finally, the papermaker will be able to solve the corrosion problems that are inherent with dryer felt roll covers running bare steel shells.

- J. ASTM D4060-95: Abrasion Resistance of Polymers by Taber Abraser (1995)
- K. ASTM D531-00: Rubber Property – Pusey and Jones (P&J) Indention Method (2000)

## APPENDIX

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- <sup>1</sup> Reference E; Reference C
- <sup>2</sup> Reference A
- <sup>3</sup> Reference E
- <sup>4</sup> Reference G
- <sup>5</sup> Reference D
- <sup>6</sup> Reference I
- <sup>7</sup> Reference B
- <sup>8</sup> Reference J
- <sup>9</sup> Reference K
- <sup>10</sup> Reference K
- <sup>11</sup> Reference H
- <sup>12</sup> Reference F

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