

Valmet Technical Paper Series

Practical Roll Techniques: Grinding & Balancing

Executive Summary

Consistent grinding and balancing of rolls is necessary for efficient operation and optimum paper quality. As an integral part of a modern roll maintenance program, roll grinding and balancing uses machinery with accurate inspection and measurement equipment.

This paper provides practical tips on roll inspections, balancing, grinding and grooving. In addition, we discuss proper roll handling during removal, storage, transport, and reinstallation. Finally, ceramic roll conditioning is discussed. It allows for returning the roll to its original finish while the roll is still in the machine. This eliminates both a roll change and the maintenance costs associated with the change.

Roll Inspections – what to look for

Crown

Crown tolerance, as determined by shell deflection and roll position, is set to ensure that pressure will not vary too much across the face length of the nip. During the Valmet grinding process, crown is measured continuously along the roll shell, and there is a limit on how much the crown can vary from station to station.

It is also very important to follow temperature variations on the roll face when measuring shape tolerances. A 750 mm diameter calender roll for example, ground perfectly, will go out of shape tolerance if the temperature exceeds a variance of 1.2 °C in the cross direction. This is called thermal crowning.

Roundness

Roundness measurements indicate how close the roll face is to being a perfect circle. If a roll is not round, it will vary nip pressure in every rotation and cause vibration. This can cause roll cover barring or vibration further down the machine. In some cases it can cause MD caliper variation in the sheet.

For example, in the calendar stack, a roll out of round will cause the mating roll to be barred and this will transfer to every roll in the stack. It is very important to measure roundness continuously, all the way through roll circumference and to disregard the roll rocking on its bearings and record only the actual roundness of the roll.

Concentricity

Concentricity tolerance indicates how closely the roll shell surface follows the actual roll rotation center. For example, imagine a roll which has been ground perfectly round and straight (no run-out) and is then bent in the middle like a banana. Now, although the roundness measurement is perfect, when the roll is rotated there is run-out in the middle. The roll is out of concentricity tolerance.

The correct way to measure concentricity on a grinding machine is 180° from wheel (back side), if the roll is supported on grinding seats. For example, if the grinding seat is out of round this form will be transferred to the roll shell by the grinding wheel. Run-out will not be seen on the wheel side but when a measurement is taken 180° away from the wheel side this error will be apparent.

If the roll is ground on its bearings, the correct place to measure run-out is on the top of the roll (never from the wheel side) because the bearing clearance is zero there. When the roll is back in the paper machine, the nip force will take the bearing clearance to zero and it is desirable to have the best concentricity towards the nip.

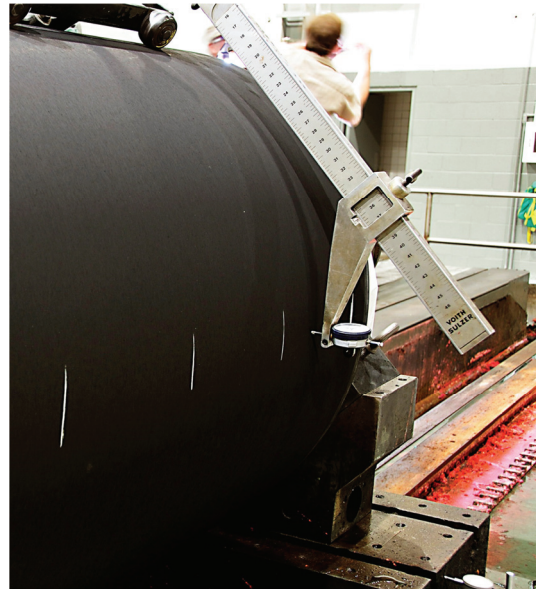


Figure 1: Simple profile measurement may be done at the mill or at an outside roll shop.



Figure 2: Advanced profile measurement requires specialized dedicated equipment. This Waldrich Siegen grinder equipped with 3D measurement controls is located at the Valmet roll shop in Aiken, SC. The 3D profiles are taken before and after grinding rolls to verify shape, roundness and concentricity.

At Valmet, shape, roundness and concentricity reports are calculated using continuous measurement equipment (**Figure 2**). The easy-to-read computer printouts include a visual form of the roll with tolerance limits specified. If the roll form crosses the tolerance line, the roll is out of tolerance. The same information is specified on the print-out in numbers as well.

Dynamic balancing of covered rolls

Roll balancing is the manipulation of the center of gravity so that it falls along the axis around which it must revolve. If this condition does not exist, unbalance results and the axis will tend to rotate about the center of gravity, with the journals tracing some circular orbit. The resultant unbalanced forces are detrimental to the rolls involved and to the associated machine elements. In most rolls, balance exists at some points along the roll face and not at others. If the roll is rigid and short, the unbalanced points will be carried by adjacent balanced or counterbalanced points and smooth operation will result.

Static balance

If the roll supported without friction will remain at rest whenever the rotation is stopped, all the local irregularities are self-compensating and **static balance** exists. If the roll is not static balanced, sufficient weight is added to the "light" side to bring it into balance. This is usually done by drilling a hole and adding weights prior to covering. Static balance is a simple adjustment and would suffice if forces of rotation did not interfere. Static balance will be satisfactory if the roll is short and operates below 70 percent of resonant speed or 800 surface feet per minute.

Dynamic balance

Although the roll as a unit is statically balanced, it is possible that one end of the roll may have an eccentric center of gravity if correction has been applied to the opposite end. This cannot be detected by simple static balance, but it will become noticeable when the roll speed is increased. The resulting oscillation is known as **dynamic unbalance** or **couple** or **moment unbalance**.

This produces an end for end motion and requires investigation to determine which end, or both, require counterweighing. It is probable that each end will require its own peculiar counterbalance, with the sum of the two again producing static balance. Dynamic



Figure 3: Roll technician performs vibration analysis of a covered roll at Valmet's Columbus, MS roll shop.

balance can be accomplished by adjusting the center of gravity of both ends of the roll. The local unbalanced points in the roll are carried with no external vibration.

Whip

In the process of making a straight roll out of a curved pipe or any piece of pipe that is curved or bent, the walls will vary in thickness along the face of the roll and also around the circumference. When this roll is statically and dynamically balanced and at speed, local conflicts in balance can exist along the face with the heavy spots in the shell being slung further from the center. When the roll is deformed by its own weight irregularities, the resulting condition is **whip** or **kinetic unbalance**.

To determine the complex underlying causes of whip requires a painstaking approach and provisions for its correction made early in the balancing operation. Theoretically, it requires correction in every plane where unbalance exists. This is impossible. It can be approximated by locating all counterweights at or near the nodes. Nodes are at the roll quarter points. Additional weight will have to be located at intermediate points and the initial weights adjusted to bring about acceptable balance after whip is corrected.

How balancing is done

The determination of corrective measures for rolls can be time consuming, even for an experienced operator. The time needed for diagnosis and installing the proper counterweights should not be underestimated.

After the location and mass of the counterweights is calculated, their secure installation requires additional time. A flexible roll, for instance, may require drillings in the heads to remove or add weights. If it is the roll body, holes must be drilled through the shell for bolting or plug-welding internal weights. This too is time consuming and requires considerable ingenuity. New felt rolls, manufactured in Finland use an internal mesh and an epoxy material to achieve balanced conditions.

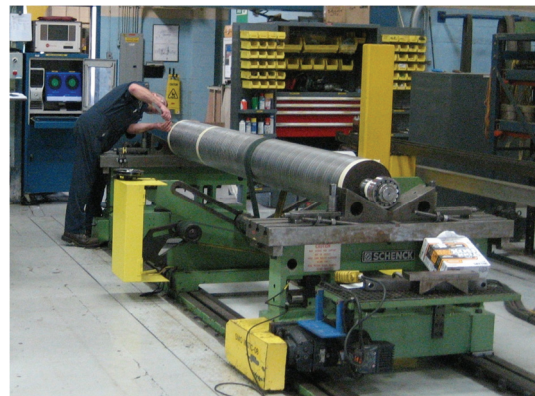


Figure 4: A roll technician at Valmet's Neenah Service Center installs a balancing weight on a paper carrying roll in the Schenk balancer.

A roll core should be balanced before covering. After a roll has been covered it is difficult to attach counterweights securely within the shell. Fine balancing can be done after covering only if small adjustments are needed on the ends. In some cases it is necessary to plug a rubber or composite cover if balancing is required after a roll is covered, due to weight addition in the body of the roll.

Roll is one part of balance system

Every portion of a rotating system has an effect on its balance. For this reason, balancing ideally should be done in the machine where the roll runs. Obviously, this cannot be done frequently. It is advisable with all rolls and necessary with larger and heavier rolls to balance the rolls with bearing assemblies.

After a roll is finished and straight, a fine balance can be performed if necessary from the ends.

Measurement of and specification for balance

Dynamic unbalance may be expressed in "ounce-inches" and is the measure of one or more forces resulting in vibration at the ends of the roll for a given speed. The amplitude of such vibration is normally measured by a vibrometer.

For rolls without specification, the Rubber Manufacturers' Association industry suggests the maximum amplitude should be .005" at the ends of the roll for an operational speed.

Rolls requiring closer tolerance should be balanced fully assembled or installed, since the following factors influence dynamic balance:

- Bearing tolerance
- Natural frequency of the machine.
- Dampening effect of the machine.

Roll balance is influenced by face length, core construction, and the deflection of a roll rotated at speed. This deflection is measured at the center of the roll face while the roll is turning at operational speed. It is especially important that deflection be corrected before covering.

NOTE: Rolls are balanced for one speed. This speed should be as close as possible to running speed. Once balanced, other speeds can be spot checked. Dynamic balancing requires the roll to be assembled.

Valmet balancing equipment in each service center is suitable for all ranges of customer needs. The equipment parameters are listed in **Figure 5**.

	Dia. (in.)	Weight (lbs.)	Speed (sfpm)
Aiken, SC	72	144,000	9,000
Clarks Summit, PA	72	160,000	7,500
Columbus, MS	72	160,000	10,000
Federal Way, WA	72	100,000	8,000
Neenah, WI	96	100,000	8,000

Figure 5. Balancing equipment capacity at Valmet roll shops

Roll Grinding Procedures

Successful roll grinding depends on many factors. The knowledge and experience of an operator, the condition of the roll grinding equipment, and continued preventive maintenance of equipment, all contribute to the ability to meet tolerances and finish requirements. The following guidelines assume that the equipment is in good condition and the operators are trained.

Grinding wheels and belts

Valmet maintains a variety of wheels and belts. The choice of wheel or belt used can be affected by operator preference, grinder type, desired finish, and cover type. Questions regarding wheels and belts should be directed to the manufacturer.

A wheel should be balanced properly to achieve the best results. The recommended procedures for conventional grinders are: mount the wheel on its own sleeve, rough true it in the machine, remove the wheel and sleeve assembly from the machine, balance the unit, place it back in the machine and re-true the wheel. With newer grinders, the wheel can be balanced in the grinder.

Roll set-up

Small diameter rolls are ground between centers. Machine centers and center holes in the roll journals should be checked for proper condition. Centers should be lubricated at all times. Poor fitting centers cause dimensional and finish problems.

Large diameter and heavy rolls should be ground on maintenance bearings when possible. If journal rests are used, they should be lubricated to prevent friction and roll distortion. Journal rests are usually made of "Babbitt" which tends to reduce scoring and reduce heating of the journals.

Universal roll drives should be used to insure uninterrupted rotation. Total Indicated Runout (TIR) should be checked by dial indicator and recentering should be within .002" on the journals before proceeding.

Covered rolls should be at room temperature and rotated slowly for a few hours before grinding. This will allow the cover to stabilize and round out.

Roll grinding

Grinding restores the original properties and qualities of the cover. Oxidation, blemishes, surface checks, cuts, and cracks are removed by grinding. Before grinding any roll, the following steps should be taken and recorded:

- Out-crown measurement
- Roll hardness profile
- Roll diameter
- Surface finish profile

The roll must be straight from end-to-end. This can be determined with a dial indicator. Covers may be ground wet or dry. Roughing passes should not exceed .005" and finishing passes should be reduced to .002".

Key points

- Roll must be straight end-to-end.
- Crown must be accurate before finish grinding.
- Use saddle calipers to make sure the crown is correct and roll is straight.

Finishing should be performed at the grinder. Two trips across the roll face using a high grit should remove all lead marks. Finishing should be done with extreme care so as not to affect profile tolerances.

Grinding tips

Roughing

- Average wheel speed: 4,000 to 4,500 sfpm
- Average roll speed: 100 to 150 sfpm

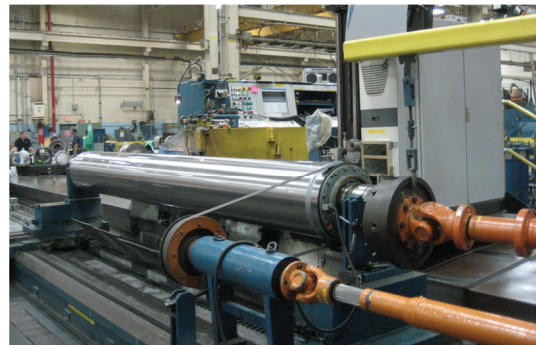


Figure 6: A controlled crown steel calender roll is undergoing a 3D grind at Valmet's roll shop in Neenah, WI.

Rough dress the grinding wheel. Before the start of the grind, set it for rapid traverse, two-thirds of wheel width or better per revolution.

Finishing

- Average wheel speed: 4,000 to 4,500 sfpm
- Average roll speed: 120 sfpm

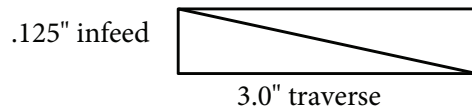
Dress the wheel for finishing; wheel edges should be rounded. Reduce traverse to the minimum rate available, then increase the roll speed to the maximum possible without causing vibrations. The wheel should be allowed to travel off the end of the roll when grinding rubber covers. This is especially important for soft covers.

Dubbing

Mark the length of the dubs. Increase the RPMs of the roll to a safe speed. Reduce the traverse speed to a minimum. Start a taper on the face of the roll and traverse outward. Turn the infeed slowly as the grinding wheel moves to the end of the roll. Use a scale to measure depth.

If the grinder has a hand traverse wheel, this method should be used:

Measure the distance the compound moves for one complete turn on the hand traverse wheel. Calculate how many turns it will take to move an inch. Use a dial indicator with magnetic base on the compound to measure infeed of grinding wheel while hand traversing the grinding wheel off the face of the roll.



Example:

- For 3" x 1/8" taper:
- 1 turn on hand traverse wheel = 1/16"
- 1/16" x 16 = 1"
- 16 x 3 = 48 turns on hand traverse wheel to move compound over 3"
- 48 - .125 = .0026 infeed per one turn
- 48 turns at .0026 per turn = 1/8 or .125

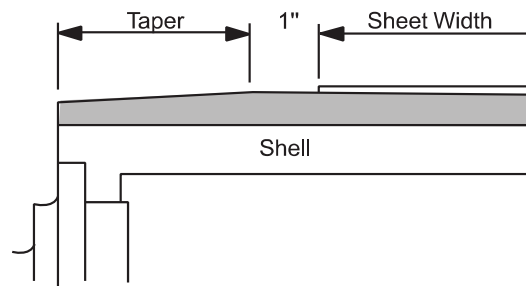


Figure 7. Covered press roll dubbing

Press rolls

The most obvious reason for dubbing or tapering the ends of a press roll cover is to gradually relieve the pressure on the edges of the roll. Covers are worked. Work generates heat. Within the sheet deckle, heat is exchanged to the process. Outside the sheet deckle, dubbing prevents deflection or work and prevents heat buildup on the edges of the roll cover. This reduces the potential for damage. In general, all covered press rolls which run in a nip are dubbed or tapered (**Figure 7**). Some exceptions to this are size press rolls, felt rolls, and coater backing rolls.

Suction rolls

In addition to the end relieving, suction rolls should also be blind drilled adjacent to the through-drilled portion of the cover using the same pattern and hole size as the drilled portion. Suction rolls that are processed on dummy heads are rough ground only. The finish grind and dubbing of a suction press should always be done with the suction box installed.

As a general rule, the following guidelines can be used regarding end relief or dubbing of suction rolls (**Figure 8**):

- Unless otherwise specified, the standard point for dubbing or end relief to start is one inch (1") outside the edge of the sheet. The closer to the sheet edge that the dub starts, the more effective the dub is in relieving pressure on the ends of the rolls involved.
- Suction press rolls are blind drilled starting at the edge of the drilled hole pattern in the shell. The hole pattern is usually not centered on the roll, thus dubbing will be different lengths on each end.
- The amount of taper or end relief is normally three-eighths inch (3/8") per foot on diameter or .015" per inch on the radius.

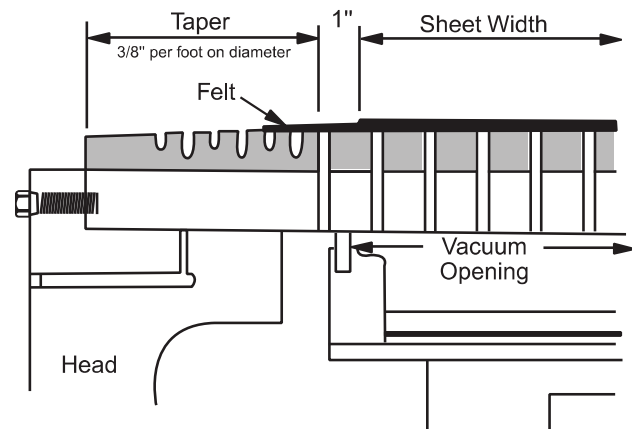


Figure 8. Covered suction roll dubbing

Ceramic Press Roll Conditioning

Ceramic press rolls offer a host of benefits over other types of roll covers. Cover life and need to change them are greatly extended, with most ceramic rolls lasting several years in the machine. Reducing the need to change these press rolls saves both replacement and maintenance costs.

Over time though, the surface finish of the ceramic roll starts to become smooth and glossy. This may lead to issues. First, particles get past the doctor blade causing sheet breaks. Or, it may affect release causing higher draws since the sheet wants to stick to the smoother roll surface. Incomplete doctoring as well as the types of filler, fines, and chemicals used can fill the ceramic surface or change the surface chemistry of ceramic covers. When the surface smoothness gets too low, some type of action may be required to return the roll surface back to target range of 35 to 60 μin .

The fastest and least expensive way to increase the surface roughness is to use the in place reconditioning procedure. This proprietary procedure can be used to return a Valmet ceramic roll to its as manufactured surface finish.

If needed, the ceramic roll surface can be cleaned with a mild detergent (citraklean), turpentine, or alcohol. Do not use any petroleum based solvents as they will leave an oily film on the cover.

Another way to treat the surface roughness is to remove the roll from the machine and superfinishing the roll on a grinder using special diamond grit paper. This process removes about 0.0008" of material.

Always contact your roll cover supplier to determine what type of superfinishing paper is recommended (**Figure 9**). The correct paper may not be the cheapest paper, but has been found to do the best job for your application. After checking smoothness profile, save grinding information along with other process observations such as machine runnability, press draws, release point, and cleanliness of roll surface. Combining this information can establish a baseline to compare to if there are any future problems.

Part Description	Part #	Part Description	Part #
Grinding Bar 11 meter	SER3000260	Velcro 50 yards	VAL0107639
Tellum diamond grinding strips (2" x 48")			
125 micron Tellum black	VAL0175123	40 micron Tellum yellow	VAL0192199
74 micron Tellum red	VAL0170318	20 micron Tellum white	VAL0194931
3M diamond grinding strips (2" x 48")			
125 micron Regular black	VAL0097191	40 micron Regular yellow	VAL0055458
74 micron Regular red	VAL0055457	20 micron Regular white	VAL0194930

Figure 9: Materials are available from Valmet spare parts for ceramic roll conditioning.

Ceramic Onsite Reconditioning Procedure

The purpose of the reconditioning is to remove the uniform, glossy film developed on the roll surface, or the individual glossy "streaks" or other zones affecting the roll's release properties, and to restore the roughness to the desired range.

Equipment

Grinding support: Adjusted for the diameter and length of the roll concerned. Support length = shell length +100-200 mm.

Abrasive strips: (see spare parts list above) In all strips, the abrasive bands are ready fitted with padded Velcro tape. These are attached straight to the grinding support, end to end (no overlapping). Sufficient length for the abrasive band is the shell length.

Tellum strips are more aggressive than 3M for the same micron grade. The most commonly used grade is the 74 micron. The 40 and 20 micron grades are used to smooth the surface. The 125 micron grade is used for aggressive roughening. Valmet field service technicians are available to advise on the most appropriate sequence for each application.

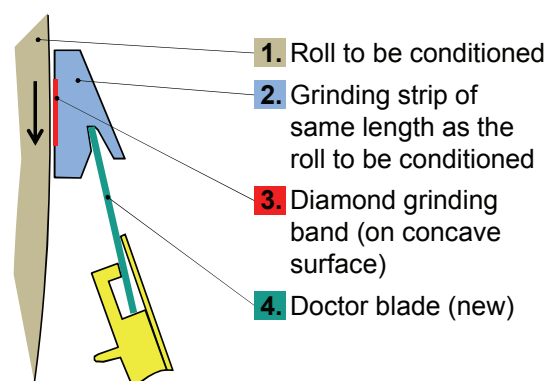


Figure 10: Onsite Reconditioning – What is needed?

Selecting Abrasive Band

The roughness achieved (**Figure 11**) depends on the uniformity and gloss of the film on the roll cover compared to the initial roughness of the cover. A glossy surface requires a coarser abrasive band or application of higher grinding pressure.

Maximum roughness is achieved, depending on the abrasive band type, after about 5-15 min. grinding, after which the roughness is somewhat decreased.

Band Type	Roughness Reached Ra (μm)	Applicability for Different Cover Types
74 μm	0.6 – 1.2	All types
125 μm	0.8 – 1.4	All types. Reason to use only if a finer band does not produce the required result. Not recommended for fine papers.

Figure 11. Abrasive band selection recommendations

It is recommended to use abrasive bands with grit sizes as small as possible to produce the required surface roughness.

The coarsest band, i.e. 125 μm , should be used only if other grades do not produce sufficient roughness, and also then the grinding time must be kept as short as possible (approx. 5 min.) to ensure that material removal is as small as possible.

For the choice of abrasive band, contact the cover supplier, if necessary.

Preparation of Grinding Strip

1. Straighten the grinding support (i.e. strip) at least 24 hours before grinding.
2. Drill holes (diameter approximately 10 mm) for safety cords at the ends.
3. Clean the slightly concave surface on which the adhesive tape will be attached.
4. Attach the single strip of Velcro to the support by removing the protective paper from the backside exposing the adhesive and attach it to the grinding support. It will need to be cut to length.
5. Attach diamond abrasive bands. They are also Velcro and are 48" long. Align each piece so that the band ends splice correctly. There should be a very small gap between bands (~1/16-1/8") to allow for expansion without buckling as it is under pressure and as it heats. To ensure the gap is not too large, the spliced bands should overlap one another in the machine direction. These also may need to be cut to length on the end pieces.
6. Attach safety cords to the strip ends. Tying these cords off on the doctor back or other piece of equipment should prevent the grinding support from falling in the pulper if the doctor is accidentally unloaded with the grinding support in place.

Preparations on the Machine

Roll Cleaning (Mechanical)

If a sticky layer of dirt exists on the roll surface, remove it manually or clean the roll by crawling with the doctor loaded. This will prevent a layer of trash from lodging between the diamond paper and the roll.

1. Put the roll in crawl, between 200 and 350 fpm, with the oscillator working and the showers on.
2. After cleaning the roll, replace the doctor blade with a new one.

3. Measure the roll roughness for a baseline measurement.
4. Crawl the roll again with the new doctor for approximately 5-10 minutes.

Wetting the Roll Surface with the Press Felt

Set the press on relief load and wet the press felt heavily (lubricating showers, needle shower). This permits the nip to convey ample and even lubrication to the roll surface, thus facilitating the grinding.

Grinding

1. Measure and record initial roughness before grinding.
2. Push the grinding strip on top of the disengaged doctor blade. Support the strip to avoid sharp bends, which might damage the abrasive band.
3. Fasten the safety cords loosely to allow for oscillation. The cords will prevent the strip from falling down into the pulper.
4. Engage the doctor blade and check that the blade tip bottoms the groove in the strip (where necessary, measure the visible blade width).
5. Switch on the shower and rotate the roll.
6. Raise the doctor pressure to 3- 4 pli. Often, this is maximum doctor loading.
7. Check that the water flow covers the entire blade width in order to remove the detached grinding material. Water trickling down along the entire blade is enough. An excessive amount of water may result in hydroplaning. Generally, the water brought by the felt provides a sufficient water supply for grinding.
8. Interrupt the grinding after having ground for about 5 minutes and check for cleanliness of the diamond material. If the diamond strips are covered with stickies, the strips will need to be replaced or cleaned (using either high pressure water or an alcohol based solvent).
9. Continue grinding in 10-15 minute intervals. Check that the strip is clean and measure the surface roughness.
10. Finally, stop the process when the desired surface roughness is attained.
11. Record the final roughness and the grinding values applied.
12. Restore the original doctor pressure.

The required working time is approximately 1 to 2.5 hours depending on the abrasive band used and number of roughness measurements made.

The best grinding capacity of the abrasive band is weakened after one grind, but will change slowly after that. For the next time, a new band is recommended. The old band can be used in the beginning of the next grind for cleaning, and the new band to finish. This gives the maximum roughness. Each band must have a grinding support for the sake of minimizing downtime. Regular onsite reconditioning ensures good operational capacity of the roll. Store the grinding strips inside a straight pipe or box to keep them clean and straight.

Grooving Suction Rolls

Grooving a suction roll improves water transfer and makes the cover more compliant. Grooving suction rolls is a commonly undertaken process. Here are answers to some of the most frequently asked questions.



Figure 12: Grooving a suction roll improves water transfer and makes the cover more compliant. Valmet covers, such as the PressFox shown here, are available in drilled, blind-drilled, and grooved patterns, including novel designs and mill-specified patterns for different paper grades.

Why groove the suction press roll?

There are a number of reasons why suction rolls are sometimes grooved. First, grooving provides knuckles of high pressure, which are thought by some to aid in the transfer of water from the sheet to the felt under the action of the pressure in the nip. Just as the suction roll provides a shorter path for the water to go before it reaches an area of vacuum, the grooving extends those paths for water transfer even more.

Grooving a suction roll cover provides a more compliant surface, which compensates for irregularities in the web and the felt. It is for this reason that grooving is often used on suction pressure rolls for Yankee dryers with very light weight grades.

When harder covers are used, the grooving will compensate somewhat for the inability of the harder cover to conform. This is the reason many hard covers are grooved. In some cases grooving of a suction roll cover has eliminated or minimized shadow marks. Shadow marking is generally considered to be the result of high speed water flow within the sheet. Grooving the drilled cover breaks up the pattern of flow so that fiber orientation does not occur.

How does grooving affect the cover's P&J?

Let's start the answer to this question by looking at a plain roll and considering nip pressure (psi) as the major factor. Drilling the plain roll with 20% open area will increase the nip width at a given load and consequently decrease the pressure calculated by about 20%. If one considers only the roll surface area in the nip, the average pressure is actually increased by about 5%. If that drilled roll is also grooved, there will be little effect on the nip width. The bulk modulus of the cover does not change much with grooving. The land area, or cover surface area, will be decreased even more. This will result in a pressure on the lands that is 25% higher than the suction pattern alone.

The plastometer is a device for measuring Pusey & Jones (P&J) hardness. It measures the indentation of a 1/8" diameter ball into the surface of a cover under a load of one kilogram. Trying to position the ball of the plastometer on a drilled roll so that it is equidistant from any of the holes is difficult. Dealing with a drilled and grooved cover, it becomes almost impossible to get reproducible results because of a lack of consistency when positioning the ball. Therefore, the effect on P&J is that a) higher results will be obtained, b) consistent results can be difficult to obtain, and c) the P&J reading will no longer have the same correlation to the nip width. Generally speaking, grooved rolls are manufactured at P&J levels of 10 or lower to prevent groove closure. This practice may help hide P&J fluctuation imparted by surface finishing in grooved rolls. A 10% fluctuation would be easier to recognize in a 35 P&J drilled roll than a 6 P&J grooved roll.

P&J readings are specified on undrilled covers and are the means of determining the modulus of the cover. The bulk modulus referred to above is the modulus of the cover as a whole after surface finishing.

All of these specifications are used as input in the computer programs used to calculate nip pressures, dwell time, impulse, and nip width.

Any concerns or drawbacks with grooving suction rolls?

Grooving a suction roll decreases the surface area available for distributing the load imposed by the nip. When the cover is grooved, in addition to being drilled, the area is further decreased. This impacts load per surface area and therefore, cover wear. This is the main reason Valmet recommends its high performance polyurethane covers for application that must be blind drilled and grooved.

Chemical attack is dependent on a number of things. The most obvious is cover material compatibility with its chemical environment. The rate of chemical attack is affected by the surface-to-volume ratio, pressure, temperature, and time. Suction rolls, blind drilled rolls, and grooved rolls have a higher surface area for absorption. However, suction rolls run cooler due to the vacuum. This results in a wash. Suction rolls have increased surface-to-volume ratio but are seldom victims of chemical attack due to vacuum decreasing the operational temperature. One obvious caveat is the addition of a steam box.



Figure 13: Valmet roll shop manufacturing capabilities include providing roll cover venting solutions for a variety of paper machine applications. In this example the Aiken Service Center is grooving a soft covered winder roll with Valmet's Zatone roll cover.

Protecting roll covers

Proper roll handling and storage procedures can significantly improve roll cover life expectancy. It is not uncommon for covers to last over ten years. However, proper roll handling is sometimes taken for granted. It is still a significant contributor when it comes to determining the root cause of many instances of cover damage. It can be as simple as failing to wrap a cover properly while it is in storage.

Handle and store with care

During roll handling, caution goes a long way in preventing damage. Mill personnel need to understand that although rolls are not made of glass and do not require "kid gloves", they are vulnerable to both accidents and damage.

Roll covers are typically made from one of three materials: rubber, polyurethane, or composites. Each cover is recommended for specific applications. The materials vary in design based on load, dewatering demand, environment, and temperature. Carelessness during handling can reduce a roll's life span and affect the paper quality. Roll covers can die an even slower, but just as certain, death by being stored improperly. A roll can be damaged anywhere.

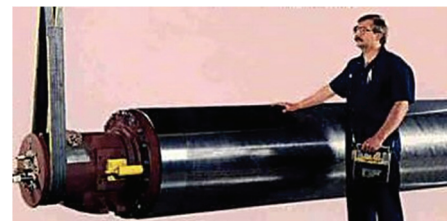


Figure 14: Roll cover care is the job of operations and maintenance personnel.

Care must be taken to protect a roll's surface during transit by following a few rules:

- Wrap roll covers with kraft paper or cardboard before moving and during storage to protect them.
- Move rolls only with specified slings and pick them up on journals whenever possible.
- Avoid picking up a roll by its cover when possible.
- Never rest a roll's cover surface on the floor. This can cause a flat spot or damage. Support rolls with journals during short-term and long-term storage.
- Inspect and measure any roll bumped in transit.
- Inspect and record roll conditions in the roll's maintenance records after removal from the machine. These records help establish a pattern of performance and indicate the presence of any ongoing issues.
- Store rolls in closed shipping boxes or in wooden or steel boxes for added protection in long-term storage. Store rolls away from excessive heat or cold.
- Rotate rolls 360 degrees every two months to keep the bearings lubricated. At the same time, turn rolls an additional 180 degrees to reduce roll sagging.
- Re grind rubber-covered rolls if they have been stored for six months or more. A regrind will return the roll to its original hardness.
- Keep rubber-covered rolls away from motors. Electrical motors generate ozone that causes oxidation and cracking.
- Protect rolls from oil drippings and harmful chemicals, which may cause roll covers to become soft or blister.
- Consult a roll cover specialist when process chemicals or cleaning chemicals are changed.

Through proper handling and storage practices, mill personnel can effectively safeguard a roll cover from unnecessary damage.

Tips for maintaining covered rolls

Covered rolls are an investment. Proper maintenance will ensure maximum lifetime and a safe, productive operational life. For the best maintenance of your covered rolls, follow the guidelines listed

below regarding shipping, storage, installation, operation, and recovering.

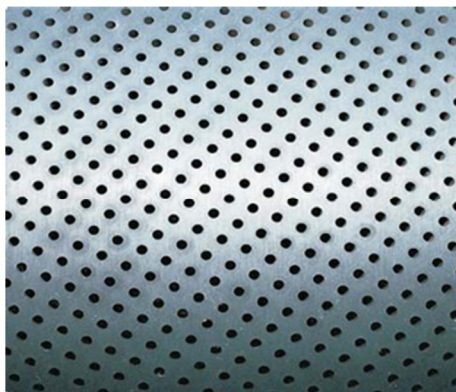


Figure 15: PressTaurus and VacuTaurus rubber covers are formulated for long-term durability, superior wear and chemical resistance.

Receiving and storing the roll

The case in which the roll is shipped should be thoroughly inspected for damage and then opened. The roll will be covered with a paper or other type of wrapper. Inspect to be sure that the cover is not touching or resting upon any part of the case. The roll wrapper should then be carefully removed and set aside to see whether or not any surface damage has occurred after the roll was wrapped. If there is damage, then the supplier should be notified immediately and the wrapping paper saved.

Once unwrapped, hardness, centerline diameter, and crown should be measured and recorded.

The roll should then be installed in the machine, or placed in storage. During storage, the roll should be wrapped with kraft paper or other suitable material and should be stored away from heat, electrical discharges, oil, chemicals, and possibility of mechanical damage. If rolls are stored for long periods of time, over 6 months, it is good practice to regrind them before installing on the machine.

Since rolls tend to sag, it is best to turn them 180° regularly, every 2 months. This is especially important for rolls that run under light or no loading. Be extremely careful about moving rolls which are cold, i.e., below 32 °F (0 °C). A sudden blow may cause splitting of the cover.

Installation and removal

Any moving or lifting of the roll should be done either by the journals or by a sling according to the chart in **Figure 17**. If there are any questions about the crown, installation of the roll is the ideal time to take a nip impression. The rolls are freshly ground to assist in calculating the proper crown. Calculations for roll crown adjustment are found in **Figure 18**.

Note the position in which the roll is placed, the date, the loading, the speed, and other expected running data on the roll record card or in the roll record book. Without this information accurate run histories cannot be kept.

At roll removal the hardness should be taken in several places across the face of the roll. The centerline diameter should be taken and the crown contour should be plotted. Notes on the general appearance of the cover should also be made.

Comparison of data gathered after roll removal should be carefully compared to the data recorded at installation. Analysis of your roll records will

point out ways to improve performance. The cover itself is a measuring instrument which can indicate where changes in chemicals, materials, crowns or other conditions are needed.

For rolls softer than 0 P&J, grind at least 1/32" off the cover thickness reducing the roll diameter by 1/16". Be certain that all crack or damage of any kind is completely removed.



Figure 16: Dozens of rolls are in the process of being recovered, ground and balanced at the Valmet Service Center in Columbus, MS.

Recommended sling widths for rubber and soft poly covered rolls

The table in **Figure 17** lists the recommended sling widths in inches of each of two slings needed when lifting a covered roll of known weight and hardness.

When possible, it is best to lift the roll without using straps on the cover. In cases where the cover is strapped on one end and rigged on the other end around the journal, one sling of the width listed in the table is to be used. When the roll must be lifted by the cover on both ends, use two straps of the size listed, one at each end.

Cover Hardness P&J	Roll Weight in Pounds						
	10,000	20,000	40,000	60,000	80,000	100,000	130,000
0	3	6	11	14	16	21	28
20	5	8	14	20	26	32	36
40	6	10	17	24	30	36	42
50	7	12	19	26	34	40	45
100	8	13	21	28	36	45	50
150	9	14	23	32	41	50	55
200	10	15	25	36	46	55	60

Figure 17: Recommended sling widths for lifting rubber and poly soft covered rolls. NOTE: Two slings of width shown above are necessary for lifting.

Example: a 45,000 lb., 50 P&J roll would require 2 – 26" wide slings to safely lift the roll without damaging the cover.

Many roll changes require the use of a belly band in order for the crew to change rigging methods as they swap their rigging due to interference with the frame work. In cases where a belly band must be used, the sling width listed above should be doubled.

CAUTION:



Cracks in covers have occurred due to the elasticity of the slings and the resultant movement of the slings on the cover surface. To prevent this, place several layers of paper between the slings and the surface of the cover. This will allow the stretch of the sling to be taken up harmlessly between the layers of paper.

Operation

During any process interruption, be sure that the roll is either kept turning or disengaged. During each scheduled outage, inspect roll covers if time allows, and look specifically for:

- **Variation of temperature across the face.** This is almost always an indication of variation in load across the face length. This will result in a peculiar wear pattern that affects the sheet or a loss of the cover.
- **Fatigue cracking of the rubber.** These cracks are straight and parallel to the roll axis. This is seldom seen across the entire face of the roll. It is often seen near the ends or in the middle and indicates crowning problems. If this is encountered, nip impressions should be taken.
- **Wad Damage,** which is irregular and not parallel to the axis. This is due to sheet breaks and wads of paper traveling through the nip.
- **Any changes in the appearance of the cover.** This include wash outs, wear, changes in surface roughness, changes in groove dimensions, or cupping around holes. Bouncing or vibration may

be an indication of wad damage or cover looseness. In addition, bouncing may be due to balance, clothing, bearings, or universal joints, etc.

- **Corrugations or barring** are almost always due to an external cause. They can be reduced, but not eliminated, by going to a harder cover.
- **Cleaning during operation.** Chemicals used for cleaning either the roll surface or felts during operation can affect a cover. Check with your supplier giving the chemical name, concentration, temperature and the frequency of use.

Nip Impressions

The nip width or roll "foot print" is a great tool for judging the amount of crown to be put into a roll pair. There are various ways of determining the nip width – using carbon paper, Fuji film, Enip, iRoll, etc. After the nip widths have been obtained, the crown is determined as shown in **Figure 18**:

Note: This is a relatively aggressive calculation. It is a common practice to divide the result by 2.

$$C = \frac{(N_2^2 - N_1^2) (D_1 + D_2)}{2 D_1 D_2}$$

C = Crown to be put into the roll, i.e. the difference in diameter between the center and 2 inches from the ends of the roll.
 N_1 = Nip width at roll center
 N_2 = Nip width 2 inches from roll ends
 D_1 = Diameter of top roll
 D_2 = Diameter of bottom roll

$$C = \frac{(N_2^2 - N_1^2)}{D}$$

Or, if rolls have equal diameters...

Figure 18: Determining crown

As an example let us assume that we have two 12" diameter rolls and we find that the nip widths are 0.9" on the ends and 0.7" at the center under the loading at which we desire to run the rolls. Then by our formula from **Figure 18** we can calculate the crown (**Figure 19**):

If our rolls were originally ground with a straight face we would put a crown of 0.027" into the rubber. If

$$N_1 = 0.7, N_2 = 0.9 \text{ and } D = 12$$

$$C = \frac{(0.9^2 - 0.7^2) (12 + 12)}{2 \times 12 \times 12} = \frac{0.81 - 0.49}{12} = \frac{0.32}{12} = 0.027 \text{ in.}$$

Figure 19: Example of crown calculation

the crown were originally 0.030" it would be increased to 0.057". If the situation were reversed and the nip at the center (N_1) were 0.9" and the nip at the ends (N_2) were 0.7", our indicated crown would then be -0.027" indicating that the nip already contained too much crown. Now if the crown of our roll were 0.030" then the proper crown would be 0.003".

As mentioned earlier, the contour of the rolls being used should be reasonably good before taking a nip width. An opportune time is after a pair of rolls has been installed.

Before ordering a recover

If you are for any reason dissatisfied with performance of the previous cover, or if conditions have changed at that position, discuss this with your supplier. Types of operational changes which might have occurred could involve chemical conditions, speeds or loads.

Summary

Roll maintenance, including grinding and balancing can get complicated when multiplied by the number of rolls in a paper machine. Paying particular care to maintenance best practices will increase roll cycles and lifetime. Following simple steps for removal, storage and installation of rolls will greatly decrease the chance for roll cover damage. Valmet's roll shops in Aiken, SC, Columbus, MS, Clarks Summit, PA, Neenah, WI, and Federal Way, WA have the capabilities to provide grinding, balancing, grooving and any other roll maintenance and refurbishment needs.

This white paper combines technical information obtained from Valmet personnel and published Valmet articles and papers.

Valmet provides competitive technologies and services to the pulp, energy and paper industries. Valmet's pulp, paper and power professionals specialize in processes, machinery, equipment, services, paper machine clothing and filter fabrics. Our offering and experience cover the entire process life cycle including new production lines, rebuilds and services.

We are committed to moving our customers' performance forward.