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BEST MAINTENANCE PRACTICES FOR ENHANCE PAPER MACHINE CLOTHING PERFORMANCE

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Summary :

World-class manufacturing practices use their maintenance efforts to make the paper industry more competitive. Keeping equipment running in a condition to make Quality product for the lowest production cost is the job of Paper makers. This requires paper maker to use the best proven systems and methods of the past, yet simultaneously to seek-out and use those new concepts and technologies which bring added value and competitive benefit to the business.

Our Indian paper industry has a highly fragmented structure consisting of small, medium and large sized papers mills having various capacities and processing various raw materials. With all these variations, we need to perform as best.

The importance of an effective maintenance program cannot be overlooked because it plays an important role in the effectiveness of Quality manufacturing. The main purpose of regular maintenance is to ensure that all equipment required for production is operating at 100% efficiency at all times. Through short daily inspections, cleaning, lubricating, and making minor adjustments, minor problems can be detected and corrected before they become a major problem that can shut down production.

A machine's breakdown true cost is sometimes difficult to measure. The cost for a machine breakdown is more than just the maintenance labor and materials to make the repair. Proper cleaning and conditioning of paper machine clothing is most effective when done through a systems approach. This means using a combination of fabric design, showering, chemicals and maintaining the condition.

This article will explain the requirement of enhanced life of clothing to reduce down time for clothing changes, reduction of substandard quality of paper, On-machine & shut-down check list for maintaining the fabrics for obtaining consistent quality of end product, new technology available in fabric to meet quality demand of paper. Also proper positioning and effective operations of showers with less quantity of water, Fabric tension relates with efficiency and Energy, Importance of Drainage elements perfection, Proper operation and positioning of doctor blades and its effect on fabrics, Prediction of fabric wear profile with the help of roll & blade wear profile, and some case studies shows the improvement with maintenance of equipments.

LITERATURE REVIEW

Need of Best practices in Maintenance:

The increased demand for higher paper machine production and efficiencies as well as lower operating costs has led to the development of effective utilization of resources through best practices of maintenances. Regular maintenance is essential to keep premises, equipment, machines and the work environment safe and reliable. It helps to eliminate workplace hazards. Lack of maintenance or inadequate maintenance can lead to dangerous situations, accidents and health problem apart from loss of Production.

A machine's breakdown true cost is sometimes difficult to measure. A recent survey showed that the cost for a machine breakdown is more than just the maintenance labor and materials to make the repair. And also the survey showed the actual cost for a breakdown between four to fifteen times the maintenance costs. When the breakdown causes production to stop, the costs are very high because no paper is being produced. The main purpose of maintenance practice is to increase the productivity at minimum cost by optimizing the process. To optimize the process, it is need to maintain the equipments and machine in reliable condition.

Best maintenance practices important as it is related with reliability, product quality, productivity, safety, supply chain, waste, inconvenience, indirect losses and not least of direct and indirect costs. Major maintenance types were classified into 4 types: Corrective or Breakdown maintenance, Scheduled maintenance, Preventive maintenance and Predictive maintenance.

Corrective or Breakdown maintenance:

Corrective or Breakdown maintenance implies that repairs are made after the equipment is failed and cannot perform its normal function anymore. The major disadvantages of breakdown maintenances are:

- Breakdown generally occurs inappropriate times leading to poor and hurried maintenance
- Excessive delay in production & reduces output
- Faster plant deterioration
- Increases chances of accidents and less safety for both workers and machines

- More spoilt materials
- Direct loss of profit
- Cannot be employed for equipments regulated by statutory provisions e.g. cranes, lift and hoists etc.

Scheduled maintenance:

Scheduled maintenance is a stitch-in-time procedure and it incorporates inspection, lubrication, repair and overhaul of equipments along with check list. If scheduled maintenance being neglected it can result in breakdown. It is a practice of whole team of process, maintenance and projects.

Preventive maintenance:

Preventive maintenance locates weak spots of machinery and equipments and provides them periodic/scheduled inspections and minor repairs to reduce the danger of unanticipated breakdowns. The advantages of PM is Reduces break down and thereby down time, Less odd-time repair and reduces over time of crews,

Greater safety of workers, Lower maintenance and repair costs, Less stand-by equipments and spare parts, Better product quality and fewer reworks and scraps, Increases plant life.

Predictive maintenance:

In predictive maintenance, machinery conditions are periodically monitored and this enables the maintenance crews to take timely actions, such as machine adjustment, repair or overhaul. It makes use of human senses for observe Unusual sounds coming out of rotating equipment predicts a trouble, An excessively hot electric cable predicts a trouble, Simple hand touch can point out many unusual equipment conditions and thus predicts a trouble.

Hence it is important to use best practices over maintenance to obtain maximum efficiency of equipment and machines.

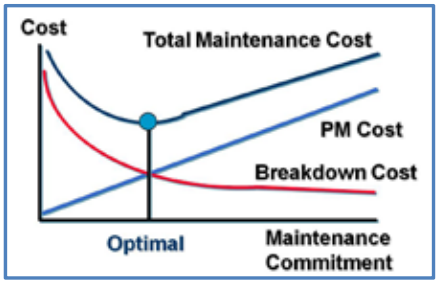

Figure 1: Total Maintenance Cost

Paper machine clothing & maintenance:

Today, paper machine clothing is expected to fulfill many functions than merely conveying or dewatering the sheet safely the paper machine. An objective high on the list of priorities of mills is for machine clothing to run efficiently with little or no downtime. For a mill to achieve maximum efficiency from its clothing investment, selection of clothing, good operating practices and procedures are of utmost importance.

Modern paper machine clothing is manufactured with a specific set of design and quality specifications for each paper machine's performance requirements. Such specifications, i.e. surface characteristics, open area, void volume, permeability, smoothness, etc. are engineered to achieve specific goals in the papermaking process. The need to implement an effective PMC maintenance program has become increasingly crucial in recent years. This change is primarily due to increasing levels of recycled furnish, usage of many chemicals to achieve final sheet properties, faster machine speeds and accompanying technology, increased sheet quality requirements, and the desire for longer fabric life.

Forming fabrics must be kept free of contaminants in order to maintain surface characteristics, adequate open area, clean run, longer life and to prevent sheet marking. **Press felts** must be cleaned, conditioned, and lubricated in order to maintain void volume, caliper and prevent wear; thus enabling the felt to take water and be de-watered uniformly throughout its operational life. Finally, dryer fabrics must be cleaned in order to maintain their permeability and prevent sheet streaking due to non-uniform drying profiles and sheet drop-offs in vacuum assisted transfers, uniruns and single tier dryer runs.

Fabric cleaning is accomplished by mechanical (showering) or chemical means. An effective cleaning system can employ both methods on a continuous and/or batch basis and is designed to prevent unwanted side-effects such as streaking and fabric damage due to plugged shower nozzles or improper operation of high pressure showers

FORMING FABRIC:

Each forming fabric is designed with a specific set of characteristics to suit a particular paper machine. Regular and efficient cleaning of the fabric will maintain these characteristics and thereby assist in achieving an efficient and economic fabric life and also we all know that all the key paper properties are greatly influenced by quality of forming fabrics.

The forming fabric should basically ensure high retention, extended life and good drainage. Forming fabrics have a greater effect on final paper properties than press and dryer fabrics. Perfect forming fabric not ends with this, it requires more and more as shown below.

Figure 2: The Perfect Forming fabric

The required properties to be properly maintained in fabrics by keep conditioning like showering, cleaning, lubricating, optimum tension and maintaining table elements. Proper cleaning and conditioning of paper machine clothing is most effective when done through a systems approach. This means using a combination of fabric design, showering, and chemicals. All three should be considered together as a system for the most effective cleaning program for a machine.

Best practices - Forming section

The largest challenge for forming fabrics is stickies and contaminants that are not water-soluble. These contaminants start to collect in yarn crossover points. Once small stickies attach, they act like magnets to other stickies. Once large enough, the stickies will affect the drainage path of the fabric, resulting in holes in the sheet or getting accumulates on the rolls causing uneven wear of fabric.

Fabrics can be cleaned by mechanical or chemical means and frequently by a combination of both. The cleaning can be continuous or for short periods at regular intervals. It is also usual to clean the whole fabric with chemical solvents during machine shutdowns

Forming Fabric Design & Showers:

Shute support Triple-layer forming (STL) fabrics offer the best combination of performance and cleanability on the market. They allow designers to customize the bottom side for life, the sheet side for formation, and create a "straight-through" drainage path, which makes cleaning more effective. This "straight-through drainage" is important when it comes to cleanability.

Single-layer forming designs by their very nature are easy to keep clean. They provide straight-through drainage. Showers can be mounted on the inside of the fabric (roll side) and blast the contamination from the inside out. But while considering life, there is limit and also issue of bleeding due to much open structure.

With the increasing demands for improved formation and longer life, clothing suppliers

introduced double-layer and two and half layer designs. While these structures created design flexibility in terms of wear and formation, they lacked straight-through drainage. The angular drainage paths meant that double-layer designs could not be effectively cleaned from the back side.

A needle shower is required on the face side (sheet side), usually angled at 0-15° into the run of the fabric. This shower acts as a chisel to remove the sheet side contamination. A second type of shower that also became popular on paper machines was the flooded nip shower. This shower is used to flood the in-going roll side nip of the forming fabric with a large enough volume of water to exceed the fabric's total void volume, thus completely flushing any contaminants from the internal structure of the fabric.

However, it has been triple-layer designs that provide the best of both worlds. STL forming fabrics provide the flexibility to design the bottom for life and the sheet side for formation, while providing straight-through drainage for effective cleaning and conditioning.

There is a fabric life advantage to moving the needle shower from the roll side of the fabric to the sheet side. As the fabric wears from moving over machine elements and rolls, the knuckles will flatten out. These flattened knuckles are more prone to high-pressure needle shower damage and tend to fibrillate, accelerating the wear of the fabric.

The best effectiveness of High pressure shower can be getting by optimizing good water filter operation, adequate water pressure, proper nozzles, and optimized diameter of nozzles, distance of shower from fabric, proper oscillation of shower and location of the shower.

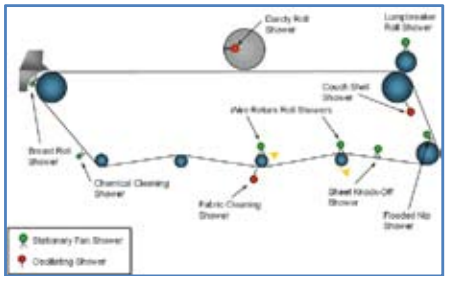

Figure 3: Typical Shower positions

Flooded Nip Shower will help in loosening the fibers which is embedded with the fabric in vacuum boxes. The loosened fibers will get rid off by wire return roll and will be doctored-off. The high pressure oscillating shower will chisel-out the fines and fillers from the fabric. The breast roll shower kept clean the fabric between fabric and the jet, and also release any air pockets in between. Further the wash roll showers will keep the fabric free from any dirt; it needs to cover full width of fabric with wide angle nozzles.

Apart from the mechanical cleaning, there is lot of options of chemical cleaning like caustic wash (batch cleaning) and online cleaning chemical system (passivation chemical). With this cleaning, the stickies and fines were cleaned properly and keep the fabric for better drainage.

Fabric tension and wrap angle:

Optimizing the fabric tension and wrap angle will keep the fabric long life and with less drive power. It is suggested to keep higher tension for better drainage and no slippage. The suggested fabric tension for Single layer is 3 to 4 Kg/cm, for Multilayer 4.5 to 5.5 Kg/cm and for STL 5.5 to 6.5 Kg/cm. With the optimum tension of the fabric, in suction boxes, fabric will not get sagging hence any abnormal wear on machine side.

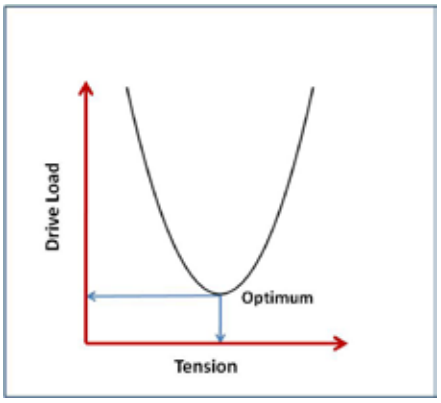

Figure 4: Fabric Tension Vs Drive load

The suggested wrap angle at Couch or Forward drive roll is 180 degree and more. Higher the wrap will give higher power transmission, thus less drive load and no slippage. It is suggested to maintain required optimum fabric tension with less drive load for improve fabric life, required drainage and less power requirement.

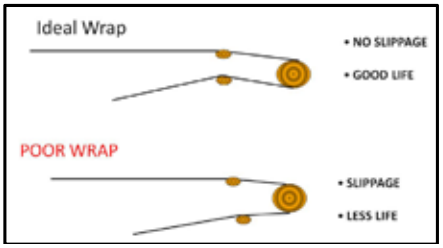

Figure 5: Wrap required in forming section

Wire table elements:

The most abrasive element for forming fabric is drainage elements and suction box tops. The uniformity of drainage elements and vacuum box tops will give improved fabric life. Augmented vacuum in the vacuum boxes will give better drainage in machine will reduce the unnecessary wear of forming fabrics. It is necessary to check the uniformity, no dents, required angle and with wire table harmonics. Generally HDPE tops are prone to wear particularly at edges due to same recommend ceramic tops with required angle to reduce the fabric wear. Even with the ceramic elements, the jet landing plays vital roll in fabric wear. Jet landing prior to forming board causes not only sheet sealing, due to sagging of fabric before forming blade, it wear more on the forming blade tip.

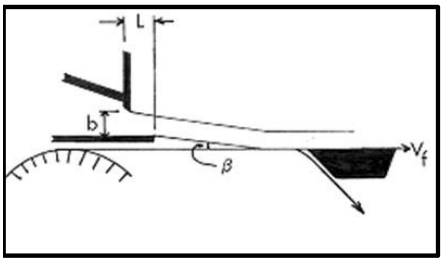

Figure 6: Jet landing

Wet end rolls and doctor blades:

One of the most un-noticed practices is the surface rolls and alignment of doctor blades. The uneven roll surface causing uneven wear of the fabrics and damage the fabric also. The surface of the rolls can be checked with the wear pattern of used doctor blades. The optimized doctor blade angle and material will give indication of roll surfaces. The effect of roll wear as below

If original diameter of roll is	300mm
then circumference	942mm
If wear is 1mm then diameter of wear part	298mm
Circumference	935mm
Difference in circumference	7mm
If wrap is 180 degree then difference in travel will be each revolution of roll.	3.5mm in
At 800rpm difference in displacement	**4 Km/day**
If average life is 60 days then differential travel = friction difference of the fabric is 160km	

Figure 7: Effect of roll wear

If there is 1 mm uneven diameter on the roll at any places, will lead for stretch at the particular place and fabric will start wear more due to friction. The impact of uneven roll surface is not visible immediately, but it causes continuous loss on the fabric life.

The prediction of roll wear can be noticed by continuous monitoring of used doctor blades. The stiffer forming fabric will reduce the deflection of fabrics in the vacuum boxes hence more drainage is possible. The new generation forming fabrics will give the additional advantage of stiffness. Stiffer fabric will give uniform basis weight profile as the fabric will not generate cross flows while jet landing on the forming board.

Best practices - Press felts:

Sheet dewatering occurs when the press fabric transfers water from the sheet to the press through a series of microscopic voids. Water transfer cannot occur if the channels are locked with flocculated contaminants or gels. Properly designed and cleaned press fabrics maintain their voids and provide consistent, maximum dewatering performance throughout life and have a positive effect on dewatering efficiency, energy use, profile, sheet bulk and press fabric life.

The structure is completed by combining two or more multi-axial bases, with spirals in opposite directions, in the needling process. Multi-axial press fabrics provide increased compaction resistance due to their separate yarn systems that are in four different directions. Multi-axial press fabric technology provides better quality and allows the use of fine single monofilament yarns and cabled monofilament yarns, instead of multi-filament yarns that have been used in traditional press fabric structures. These yarn systems respond to mechanical and chemical cleaning better than multi-filament yarns. The compaction resistance of the base structure means that the fabric is more open under load and allows for constant water flow throughout life, enabling better self-cleaning and facilitating mechanical and chemical cleaning.

The batt component of the press fabric fills and compacts at a quicker rate than the base fabric component. The batt fiber component can be engineered to better optimize drying when the base fabric component sustains void volume by being both compaction resistant and conditioning responsive. Improvements in fiber technology and needling technology have reduced the filling and compaction rates of the batt component. Higher molecular weight fibers are more resistant to mechanical and chemical degradation. This provides increased wear and compaction resistance as well as improved responsiveness to mechanical and chemical cleaning.

Coarser fibers are employed in the interior of the web component to maximize cleanability and steady-state pressing. Fine fibers are employed on the surface of the batt component to provide better pressure uniformity and reduced pore size to maximize sheet dewatering.

Showering:

Proper press fabric design coupled with proficient cleaning and conditioning practices work to achieve steady-state pressing and consistent machine performance. Press fabrics respond to mechanical cleaning best when the process is continuous and started when the fabric is new.

Press fabric filling is dependent on particle size. The press fabric constructions will hold 100% of particles larger than 50 microns and 90% of particles larger than 24 microns on the surface. Particles of 10 microns or smaller will pass through the press fabric. High-pressure showers remove the surface contaminants in the 24- to 50-micron range, while flooded nip showers remove the embedded particles in the 11- to 50-micron range.

High-pressure needle jet showers apply power to the fabric surface as an economical and efficient method to remove surface contaminants. Needle jet showers clean in discrete areas of the fabric, roughly equal to the nozzle size, and therefore need to be oscillated to prevent damage to the press fabric and to control the moisture profile. Best results are achieved when the oscillator speed is set to move the shower one nozzle diameter for every felt revolution. Machine direction streaks and damage to the press fabric will occur if the oscillator fails. Because the needle jet shower can damage the press fabric, the pressure needs to be just high enough to clean the fabric. As a general guideline for press fabrics, pressures should not exceed 20 Kg/sq.cm on a continuous basis. Higher pressures may be needed intermittently, but can damage the fine fiber on the surface.

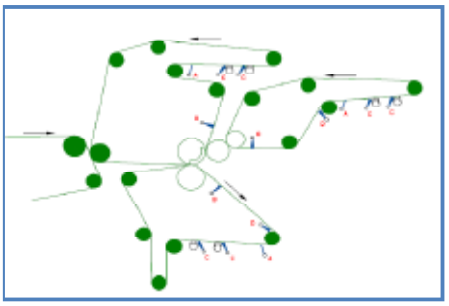

Figure 8: Typical shower positions on Press part

Proper location of the shower and proper press fabric design will minimize the need for high pressure. The needle jet shower is most effective when it is located on the face side of the press fabric. The shower should be located as soon as possible after the press and before any face side rolls. The water jet from a needle shower is homogeneous with laminar flow for the first four to six inches. The jet then begins to become irregular and, beyond six to eight inches from the fabric, the jet becomes discontinuous and forms high energy droplets. The diameter of the jet has also increased at this point. The jet cleans most efficiently at the optimum distance from the fabric. This distance depends on water pressure and temperature, as well as nozzle design.

Fan showers are used to apply water or chemicals evenly across the width of the press fabric. Unlike needle jet showers, flooded nip showers use fan nozzles and apply a large volume of water to flush embedded contaminants out of the press fabric. Water movement is necessary to clear the embedded contaminants out of the press fabric.

Chemical Cleaning: The use of recycled fiber generally results in an increased amount of contaminants in the Paper making process. These contaminants are generally more difficult to remove, and therefore it is necessary to include chemical cleaning in the cleaning and conditioning system to optimize press fabric life and performance.

Best practices - Dryer Screen:

The demand for efficiency increases in the dryers is particularly insistent owing to the high level of energy consumption in comparison with forming and press sections. With the necessary energy requirement at this point the volume of water removed equates approximately to the finished weight of the sheet. The dry content of the sheet entering the dryers at about 50% must be brought to 92 – 98% at the reel.

Best efficiencies by fabric design:

The reason for importance of fabric design is to better heat transfer by contact area and appropriate permeability for better mass transfer. The modern dryer fabrics should serve for energy efficient way for Quality output. To improve the heat transfer, it is necessity of high contact of web with the dryer cylinder. To help, the modern high contact dryer screen design developed. There is lot of options available with low contact SLDF screens (~17%), Woven long float dryer screen (~27%) and high contact Unotier (~50%). Proper selection of dryer screen with required contact area and permeability is important for efficient operation.

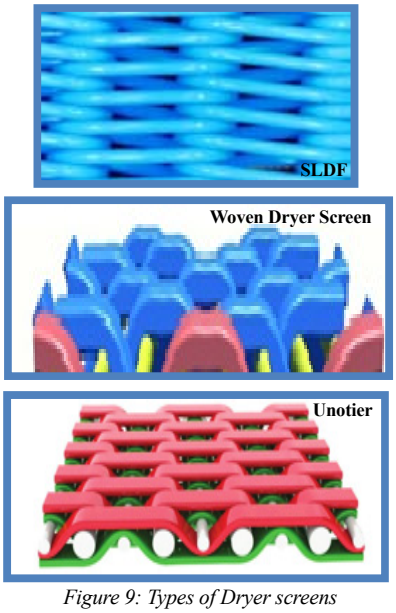

Figure 9: Types of Dryer screens

Best practices for efficient drying:

The efficiency is lying in the maintaining the dryer screens surface from any contaminant and maintain the permeability as new as possible to extract maximum efficiencies of dryer screens in the drying process.

Some of the more common consequences of dryer fabric contamination are:

- Sheet moisture profile unevenness
- Sheet instability, particularly near the edges
- Inferior heat transfer and paper marking caused by dryer fabric surface deposits
- Heat transfer reduction caused by deposits left on the cylinders
- Plugged vacuum rolls
- The transfer of deposits from the dryer fabric to the paper
- The increased dryer fabric cost that results when running time (fabric life) is reduced by plugging

Types of Contaminants

Dryer fabric contaminants come primarily from furnish (virgin pulp and recycled fibers) and its additives and from coating or size press chemicals. Cleaning should proceed only after identifying the type and degree of contamination of your particular fabric. Tests have shown that even a small amount of contamination can cause pronounced reduction in dryer fabric permeability. Pronounced contamination is common after size presses and coating position and edges of the screens due to dust/fluff settled. In these cases, it is not unusual for dryer fabrics to be completely plugged.

Dryer fabric contaminants divide into four groups:

1. Dust

- Short cellulose fibers.

2. Organic substances not cross-linked

- Pitch.
- Asphalt, tar, wax (often from recycled furnish).
- Sizing material CMD size press, starch and casein types.
- Bearing oil and grease.

3. Cross-linked organic substances

- Wet strength resins.
- Latex based coating chemicals (SBR, acrylic, and others).

4. Non-organic substances

- Alum, calcium carbonate, kaolin, titanium dioxide, rust, scale and filler materials.

Types of Cleaning Methods

Recycle-based furnish increases contaminants such as tar, asphalt, latex, waxes and plastics. Dryer fabric cleaning can be performed intermittently during paper production — at a sheet break (full speed) or during a stop at crawl. High pressure showering with air or steam and cleaning with a brush can also be performed continually during paper production. Cleaning with chemicals and large volumes of water should be done during a shutdown.

Air Showering

A regular, periodic air shower is best for cleaning high permeability dryer fabrics that are plugged with fiber dust or loose dirt. The air shower is often insufficient for removing resins and sticky particles from low permeability dryer fabrics. Low perm dryer fabrics require water or steam showering. .So that loosened dirt does not circulate in the dryer hood, high pressure air showers should be placed so that the dirt can be directed toward the exit duct in the dryer hood or down into the pit. Cleaning is much better when a short distance is used between the nozzle and the fabric. At long distances, the air jet loses energy. For space and safety reasons, distance should be 30 to 50 mm. When air pressure is raised, permeability increases. Low pressure < 30 psi results in poor cleaning. To avoid unnecessarily large air consumption, a nozzle diameter of 2.5 to 3.0 mm is recommended.

. Remember, when installing your air shower; locate a position where the dust can easily be removed from the dryer section.

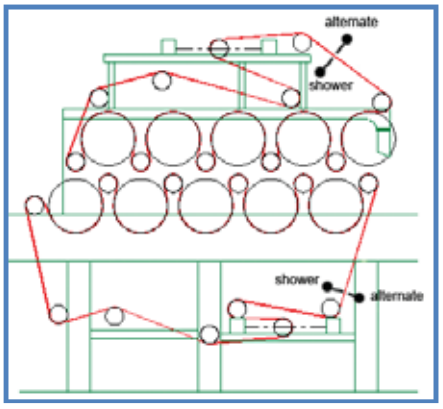

Figure 10: Dryer Screen Cleaning Methods

Check list practices:

During a shutdown of a paper machine, the forming fabric should be turned slowly and examined for defects, especially on the edges (loose yarns), creases, small holes, dirt or plugged pockets. Doing an inspection on a shutdown allows for stopping the fabric at the right place to repair the defects. The same inspection should be done at start-up as well at slow speed to make sure that nothing was broken during shutdown, preventing lost time trying to re-thread the sheet.

When installing new fabric, inspect the condition of Forming foils, forming shoe, Hydrofoils (wear, crack, cutting edge, etc.), Rolls (wear, rough surface, defects), Vacuum box covers for any abnormalities, Suction rolls holes for clogging (once in a while check the blade of the couch roll), Rust on the frame, Check also for deposits of pitch or stickies.

For the press section, special attention should be given to the suction box covers, especially if using deinked pulp or clay. Inspect the blades for wear since over time, have abrasive particles lodged between the rolls, holders and the blade. These can cause the fabric to lose fibres.. When operating the press fabric, the interior walls of these blades must be inspected to make sure that they are not sharp since there is a tendency to enter through the opening of the uhle box.

When changing a press fabric, recalibration of the speed (speed-match) is necessary because the tiniest change in the thickness of the fabric can cause a difference of speed sufficient to be taken in consideration, especially in the case of tri-nip presses.

The dryer fabric must be verified to see if it is hydrolyzed. Folding the sides of the fabric by hand should not break it. If the fabric is hydrolyzed, discuss the problem with the supplier since there is informative material available to address this issue. Hydrolysis caused by the mixture of more temperature and moisture (by condensate splash or oil spillages).

Many mills wash their dryer fabric with a caustic solution during the shutdowns, which helps clean the surface of the dryers as well. However, a good rinsing must be done after the washing. Otherwise, when the steam pressure is put back on, the water in the caustic solution will evaporate and the concentration (approximately 5% at the beginning) increases quite a bit, reducing the useful life of the dryer fabric and causing damages to the seams. Check the seams of the dryer and press fabrics as needed to repair them during the shutdown.

Data collection:

The first step in the trouble shooting is start with the data. More and more data will give the accurate prediction of troubles. The monitoring of data on thickness of fabric,

removed doctor blade width measurement, life of doctor blade, roll change history, vacuum data, machine drive load data, head box parameter, shower nozzle change history, will help in the prediction and take measure for problems expected. By estimate the life of any fabric, this can be planned in better way or any opportunity shuts available. This preventive action will avoid costly breakdown and unexpected shuts. Best maintenance practices starts from more data collected in process and service team, to get as much as close to predict the failure and life-span of any equipment or clothing.

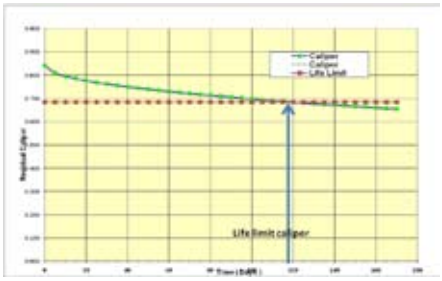

Figure 11: Prediction of forming fabric life by caliper measurement

Transactional data is incredibly important for processes because it helps them to expose variability and optimize their operations. By examining large amounts of data, it is possible to uncover hidden patterns and correlations of process changes. A case study of data collected for forming fabric life prediction in Fig. 11.

Conclusion:

- Prevention is better than cure, so by use of best maintenance practices along with more data, we can predict the life span of any equipment/clothing, thus get maximum benefits from the equipment/ clothing.
- Best maintenance practices save time, cost and lead for safe working environment.
- By monitoring and maintaining the Paper machine clothing with care, it performs as new as possible till end of life.
- Discussion with the supplier with the data will help in trouble shooting and in further performance improvement by comparing with the other paper mill's experience on best practices.

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