New Technologies for Preventing Yankee Cylinder Edge Deposits

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Overview of edge deposit problems

For many years, tissue machines have experienced a wide range of problems with Yankee drying cylinders. These problems can come in many forms, and nearly all of them affect manufacturing productivity, product quality and, in some cases, asset life. Even a well-maintained Yankee cylinder is almost certain to see deposit problems at some point. Identifying the cause of a problem can often be difficult, as in many cases, the problem disappears as quickly as it arose. Rather than reacting to the situation, therefore, the best approach is prevention.

This paper will consider one very important issue that often arises on Yankee cylinders: deposits on the Yankee cylinder edges outside the sheet area. These deposits can seem at first to be a minor problem, but they can create major production roadblocks.

Not every tissue machine suffers from deposits on the Yankee cylinder edges. This phenomenon depends on a number of factors, such as machine design, furnish, Yankee cylinder temperatures, blade type and profiling, water quality, felt design, and housekeeping, to name a few. Those machines that do suffer from edge deposits can experience serious negative effects that are quite difficult to solve. These can include:

- Sudden lifting of the creping blade at the edges, causing sheet breakage
- Uneven blade profile
- Excessive wear and overheating of the blade at the edges
- Edge cracking or edge tears on the sheet
- Breakaways of deposits that can enter the sheet area
- Chatter marks in the edge deposit that can create blade vibration and extend chatter marks into the sheet area — either in the synthetic coating or, in the very worst case, the cylinder metal surface.

This list is not comprehensive, but includes the most common complications resulting from edge deposits; individual mills may encounter other challenges.

Figure 1 shows typical edge deposit:

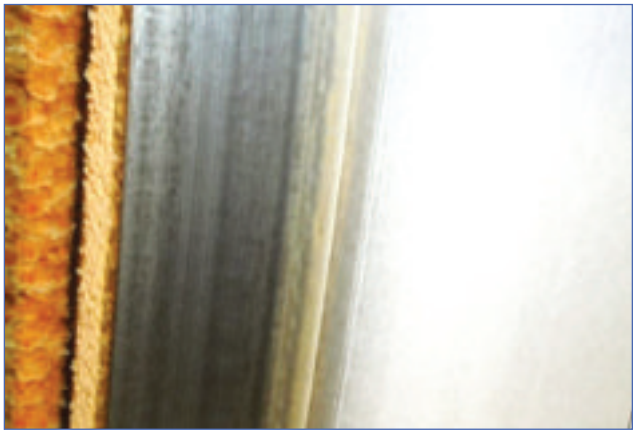


Figure 1: Hard brown deposits outside sheet area

How do you evaluate the causes of these deposits?

It should be said that many machines experience minor edge deposits that do not cause any of the problems outlined earlier. Machines with deposits such as these need no immediate intervention. For those machines in which the deposits are causing problems, however, it is important to seek a solution. As with most issues in tissue making, there is no single answer or solution. Every machine is different, so its edge deposits should be examined in a systematic way to determine the best approach to remedy them:

- Visually inspect the cylinder edges to see if the deposit is permanent and if it is complete around the circumference of the cylinder. Also inspect its colour and general appearance.
- Listen for any harsh or hard-sounding noise.
- Check the vibration of the blades.
- Run a thermal profile of the cylinder, especially at the edges and on the blades.
- Does the deposit disappear completely after a blade change and how soon afterward does it build?
- Sample the deposit scrapings as they are removed at the blade during running or on a blade change.
- Have the composition of the deposits analysed in a laboratory.

A survey of many machines shows some common qualities in edge deposits, including:

- A high percentage of cellulose from fines and short fibres
- A medium percentage of polymers from Yankee coatings
- A medium percentage of ash/fillers (high on recycled furnish)
- A low percentage of inorganic salts

The darker brown deposits shown in the accompanying photographs have a higher percentage of oxidised polymers. This is probably from a build-up of chemical coating that becomes hard and is difficult to remove (this is especially true of crosslinking polymers, which can build up and oxidise). Lighter white deposits are mainly fines and short fibres; these can, with time, become hard and go brown due to oxidation at higher temperatures.

What conditions contribute to deposits forming on the edges of a Yankee drying cylinder?

Demands for greater production tonnages, increased softness and higher machine speeds have led to higher hood and Yankee cylinder surface temperatures. The edges of the cylinder are particularly likely to retain heat, due to the greater weight of metal from castings and head flanges. There is also less cooling of edges, which extend beyond the sheet deckle and do not receive full-face application of the wet sheet. This is a particularly common problem on crescent formers, in which overshoot of stock on wire edges is often observed.

Edge deposits can also occur when mills change the hood-to-

Yankee-cylinder drying ratio for energy savings, which alters the balance of system dynamics. Uneven profiling of creping and cleaning blades at the edges of the cylinder, as well as overspray from the Yankee coating spray bar, may also contribute.

Thermal imaging supports these observations. *Figure 2* shows that the very edges of a Yankee drying cylinder can be considerably hotter than the face, where the sheet is in full contact. This, combined with one or more of the other factors, can initiate and contribute to deposit build-up.

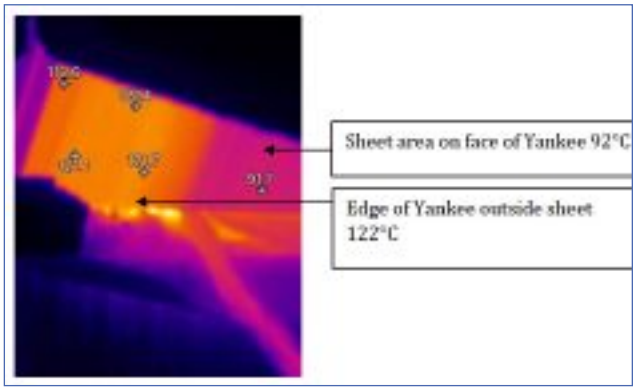


Figure 2: Temperature variation at edge of Yankee cylinder

Solutions to edge deposits

Numerous methods are used globally to address edge deposit issues. Many of these work well in some mills but not in others; there is not yet a universal solution that works in every situation. The following paragraphs outline solutions mills have tried, the advantages and disadvantages of each option, current chemical solutions and potential new solutions that offer advantages over existing methods.

1. In almost all tissue machines, the spray bar that applies synthetic Yankee coatings — a combination of adhesive polymer, release agent and phosphates — is designed to overspray the edges of the Yankee cylinder. This is to ensure that full and even coverage of the cylinder face is maintained and protection of the cylinder and blades is assured at all times. Without some chemical barrier outside the sheet area, there would be direct metal-on-metal or ceramic-on-metal contact; this would ultimately result in rapid wearing of the blade and damage to the cylinder surface, causing costly regrinds or even metallisation.

   However, this overspray can result in a chemical build-up, which can create deposits under the higher temperatures seen on the cylinder edges. Because there is no sheet contact and subsequently less water present, the coating is not washed off and can build up into a heavy deposit over time.

   One option used by some mills is to redesign the spray bar so it produces less overspray: the outer nozzles on the spray bar located just before the wet nip are moved closer together to reduce the coverage at the edges. In some cases, they are removed completely; in others, a smaller orifice or angle nozzle is applied to reduce the amount of coating chemicals applied at the edges. This is a simple and low-cost option that works for some mills, but it does have some drawbacks:

   - The spray bar adds a mixture of adhesive polymer, oil and possibly phosphate. Reducing overspray reduces the amount of polymer, which is the source of some deposits, but it also reduces the amount of oil and other released materials. This cuts down on the lubrication and cleaning effect of these materials, thereby reducing their ability to help prevent and remove deposits.
   - Using a nozzle with either a smaller orifice or lower angle of spray increases the likelihood of confusing nozzle settings and producing uneven coverage of the Yankee coating. This in turn leads to streaky coating, unless tight controls are implemented to minimise the risk of confusing nozzles.
   - This redesign option is only applicable where the deposit is found from analysis to be predominantly polymers derived from the coating. Where it is found to be cellulose-based, in terms of fines, then it is not an ideal solution.

2. It is very typical on crescent formers that overshoot on the forming fabric carries fibres into the very edges of the wet felt. These edge fibres are then transferred to the Yankee cylinder outside the sheet area and can build up as a white deposit. In these situations, it's often viable to spray additional water on the felt edges before the press. Application of water has two effects:

   - It washes off excess fibres, preventing them from transferring to the Yankee cylinder.
   - It acts as a cooling shower, reducing the temperature of the Yankee cylinder at the edges.

   While this method is successful in some situations, it also has some negative impacts in the longer term. The extra water on the felt edges reduces the temperature of the Yankee cylinder at the edges and removes fibres, but it also washes off the protective barrier layer of the synthetic Yankee coatings, which are sensitive to moisture. Particularly outside the sheet area, the moisture will prevent the coatings from creating the protective barrier between blade and cylinder, which is the primary reason for applying them across the full face. Therefore, while this method appears to be a good short-term solution, in the longer term, it can lead to premature wear on the blades and, more importantly, on the cylinder itself. This can lead to expensive repairs to the cylinder.

3. Dedicated sprays, which can apply deposit-control chemicals just to the cylinder edge, are becoming a common approach — one that is proving to be very successful. The physical positioning of these dedicated sprays depends on the design and construction of the tissue machine drying section. The most common positions are just before the creping blade or after the blades and before the full-face coating shower. In either case, accessibility for both installation and maintenance needs to be considered carefully. Mill operators should ensure that the sprays are fully adjusted to maintain clearly defined coverage of the affected area, and to allow the spray nozzles to be moved for deckle changes, grade changes and routine maintenance of the tissue machine.

   Two types of spray nozzle are used:

   - An air-atomising nozzle is one option; this has the advantage in that neat chemical can be used without the need for a water carrier, so no mixing system is required. Air-atomising nozzles do, however, suffer some disadvantages:
     - They are more expensive than conventional nozzles.
     - Their design can lead to blockages.
     - They produce spray in an aerosol or mist, making it difficult to position the nozzle to get accurate coverage. Because the spray is an aerosol, the droplet size is very small and is easily buffeted by the wind cur-

tain produced around a fast-moving Yankee cylinder, further affecting accurate coverage. Due to the small volumes of chemical normally applied, a small pump is required and pulsing is normal, resulting in frequent periods of higher chemical addition and periods of low or no chemical flow.

- The more common approach is a simple fan jet nozzle similar or identical to that used on the full-face shower. This is supplied with a mixture of water and chemical at a pressure of around 3 bars and a typical flow of approximately 0.45lpm through a 110° nozzle tip.

The mixing of the chemical with water can occur through a simple in-line mixer or a small mixing tank system. *Figure 3* shows a typical adjustable edge spray in use on a tissue machine.

Figure 3: Typical adjustable edge spray in use

The most common chemical approaches to edge deposits, and their primary qualities, are outlined below:

- Mineral oil release aid
  - Good lubrication
  - Removes synthetic coating
  - Low cleaning effect on fibres
- Vegetable oil release aids
  - Moderate lubrication
  - Removes synthetic coating
  - Low cleaning effect on fibres
- Imadazolines/modifiers
  - Low lubrication
  - High cleaning effect
  - Foaming potential in mixing system

Text Box: Common chemical solutions to edge deposits

Latest chemical developments

It is clear that a primary initiator of deposits is the high temperature on the cylinder edges, coupled with polymer and fibre impacts outside the sheet area. Therefore, the greatest need within the tissue industry is for a chemical with good cleaning effect and high-temperature performance.

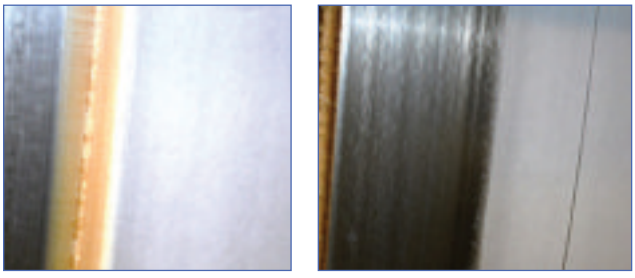
A product with these characteristics has been recently introduced to the market. It has a patented water-based micro-emulsion that contains solids with a T_g, or melt point, of approximately 110°C. It has a high lubrication effect, which is significantly increased at elevated temperatures. And it actually helps to remove existing deposits while preventing new deposits from forming.

In addition to these characteristics, this innovative chemical cools the blade tip and can be used in full-face application where edge sprays are not provided, replacing part of the normal release aid.

This new technology has replaced numerous existing chemical spray applications that incorporate mineral or vegetable oils or imidazoline chemistries (see Text Box). The benefits have been significant in terms of increased blade life due to reduction in wear on the edges, lower blade tip temperatures, reduced sheet breaks, removal of edge cracking, prevention of chatter in edge deposits and reduced overall blade vibrations. All these benefits combine to produce higher production tonnage and greater productivity.

Case History 1

A six-metre-wide crescent former was suffering from hard brown edge deposits. High blade vibration was observed, resulting in sheet breaks. The new micro-emulsion was added using an in-line mixer and a dedicated edge spray nozzle at a flow rate of 2ml/min to each nozzle. Within a few minutes, the deposits started to be removed and vibration frequencies reduced, sheet breaks reduced and blade wear significantly improved.



Pre trial Maintained through trial period

Figure 4: Effect on edge deposit during trial

Case History 2

In a second application, the mill in question did not have equipment to accommodate dedicated edge sprays. Mill staff decided to introduce the new technology into the total full-face spray, and they replaced 30 percent of the incumbent release oil with 7ml/min of the micro-emulsion. The result was improved overall release efficiency, reduced blade vibrations, higher sheet stretch, lower blade tip temperatures, more even coating spread, longer creping blade life and removal of edge deposits.

Summary

The issues caused by Yankee cylinder edge deposits are wide and varied. Some mills may be fortunate enough not to experience issues created by these deposits, but in many they create significant production problems.

The causes have been investigated and the methods to overcome these problematic deposits discussed. Current methods offer some success but often with some drawbacks, and in many cases, what works on one machine does not work on another.

New micro-emulsion technology, coupled with well-designed dedicated edge sprays, has proven in several applications to outperform existing technologies. Where dedicated edge sprays are unavailable, adding the micro-emulsion into the full-face spray can be a suitable and efficient solution.