Yankee dryer coatings

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To operate at high speeds and productivity, tissuemakers must understand and have control over the entire process, particularly Yankee coatings.

To remain competitive in the marketplace, modern tissuemaking requires a higher-quality product produced at high speeds. For highest speeds, tissuemakers must understand and have control over every aspect of the process.

At higher speeds, the role of the Yankee coating becomes critical to the efficient operation of tissue machines producing quality products. There are three keys to keeping the coating under control:

1. Understanding the basics of coating chemistries and how the wet-end chemistry affects the Yankee coatings
2. Understanding how the coating can affect creping
3. Knowing how to effectively apply the coating to the dryer.

The type of coating selected will depend on the furnish used, the surface temperature of the dryer, the sheet moisture at the pressure-roll nip, and the desired effect on sheet properties.

First, let's look at some of the basics about the chemistry of Yankee coatings. This will let us develop methods to help control the coating.

Yankee dryer coating chemistry is broken down into two groups: natural coatings and synthetic coatings.

Natural coatings

The first group is made up of the fibers and fines which are carried through with the sheet and give the appearance of a coating on the Yankee dryer.

The desirable portion of these fibers and fines is the hemicellulose. Certain hemicelluloses have adhesive properties and do have a positive effect on the Yankee coating. Conversely, we have seen that excessive residual fibers built up on the Yankee are detrimental to the overall runnability of the machine.

We also have evidence from recent trial work that the hemicellulose must be in a soluble state to be an effective contributor to sheet adhesion. Unfortunately, the papermaker has no control over the hemicellulose form or content in the furnish supplied.

Synthetic coatings

Synthetic coatings are polymers which are generally added to supplement the natural adhesive in the furnish. There are several different types of polymers on the market today that can give the effect of Yankee coating.

Generally, those polymers used as wet-strength resins have been found to contribute to sheet adhesion but form a hard, brittle Yankee surface, which can reduce creping blade life and sheet softness.

Polymers used for fines retention have also been used in some cases. These polymers tend to coat the Yankee surface with fines, which can be an unmanageable coating.

The key to having good Yankee control is to find polymers which produce a good creping surface. This is a polymer that can be sheared by the doctor blade and that has a good affinity for the Yankee surface, providing good Yankee dryer protection and also good sheet adhesion to the Yankee surface.

Wet-end chemistry

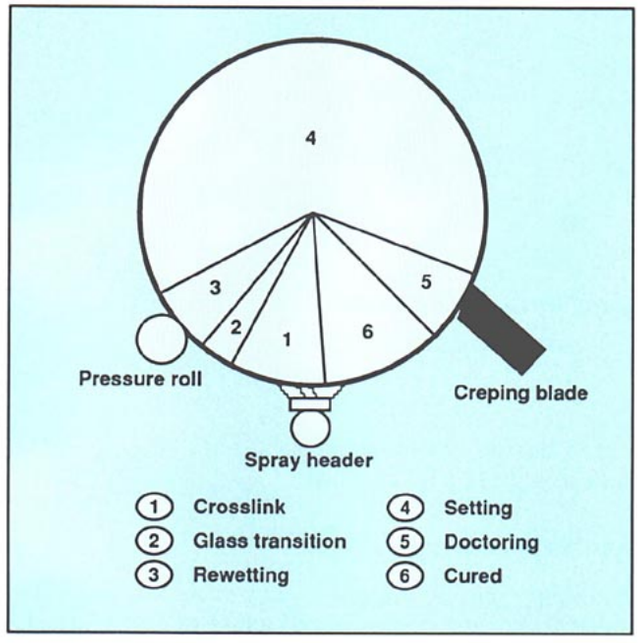
One aspect of Yankee coating chemistry that is often neglected is the wet-end chemistry. We know that a lack of pH control is the leading contributor to poor coating performance. Most organic coatings have an operating range between pH 6.5 and pH 8.0. However, the optimum range may be 6.8 to 7.2.

The moisture profile has a profound impact on the uniformity of the organic coating. A two-percent variation in the moisture profile will show a crepe differential in the final product; uniformity is the name of the game. Since most coating polymers require thermal energy to dehydrate and crosslink, the moisture profile is an important factor.

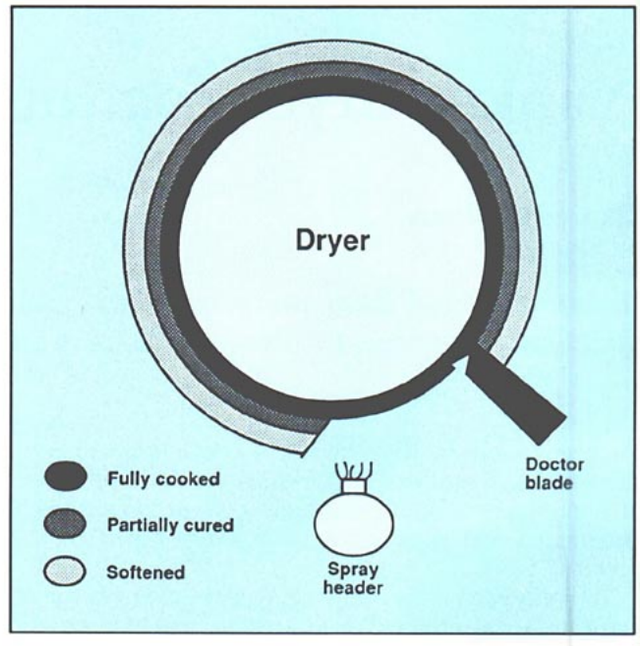
Hydrocarbon-based additives have also been found to detract from a polymer's ability to crosslink and provide adequate sheet adhesion. These additives can include oil-based defoamers, sheet debonders, and some cleaning chemistries.

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1. Coating areas



2. Coating layers



Dynamic coating performance

We have identified six steps which we feel are significant in producing a uniform adhesive and protective polymer film on the Yankee surface (**Fig. 1**). These include:

1. Crosslinking. The polymer forms a network with itself.
2. Glass transition. The polymer enters a semiliquid tacky phase.
3. Rewetting. The coating is rewetted by the sheet in the pressure-roll nip.
4. Setting. The sheet and coating are dehydrating in the hoods to form a tight bond with the Yankee surface.
5. Doctoring. The doctor blade is the tool used to control the coating thickness. It is vital to make sure the holder is well aligned and the blades properly ground.
6. Completely cured. This is the polymer that has set up and that forms a protective barrier between the blade and the dryer.

Release agent

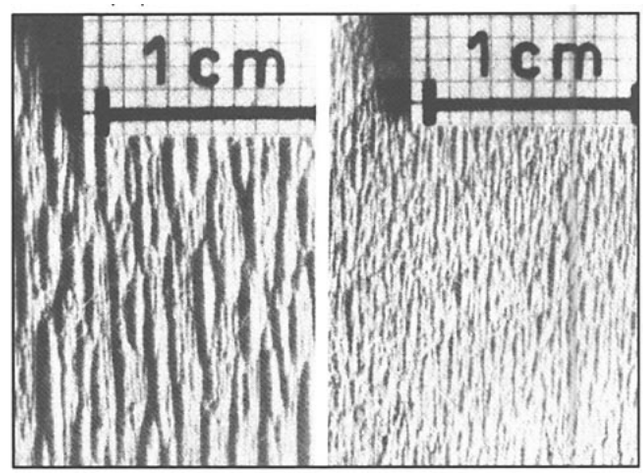
The co-mingling of release agents with an organic coating can be an effective method of controlling coating hardness, coating thickness, and coating adhesion.

A good release agent has three functions:

1. Provides a lubrication barrier between the coating and doctor blade to extend blade life
2. Controls sheet adhesion on the Yankee dryer
3. Controls the amount of coating thickness on the dryer.

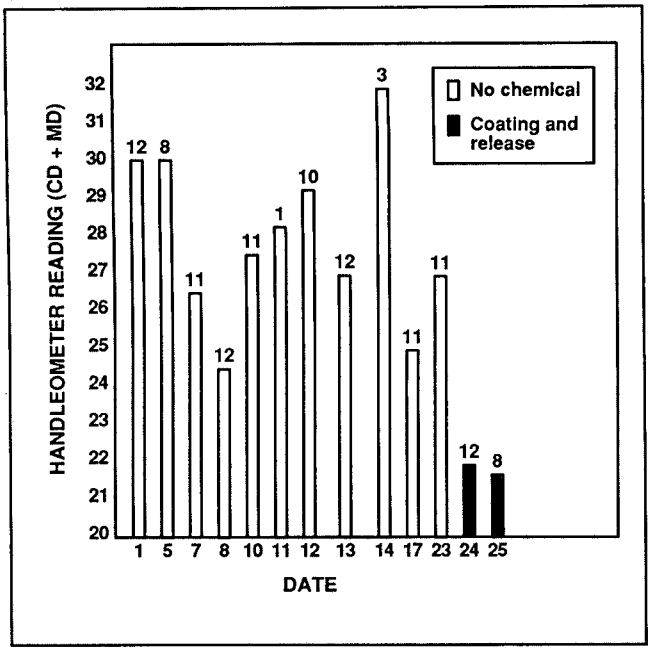
Release agents, being hydrocarbon-based, tend to migrate away from hot surfaces and thus bloom to the surface of the organic coating. This lubrication barrier helps extend doctor blade life by acting as a coolant for the blade tip.

3. The type and amount of coating has a dramatic effect on creping and sheet properties.



As a control mechanism, release agents interfere with the polymer network, blocking crosslinking sites and weakening the network. This lets the operator control the adhesive property of the coating and also the amount of coating accumulated on the Yankee surface. Using a combination of polymeric coating and release agent results in a coating layering effect, which in theory would be in three regional layers (**Fig. 2**). The first layer is a hardened, fully cured, or polymerized layer against the Yankee surface. This layer provides the protective barrier between the blade and Yankee surface. Second is a layer softened by a release agent that can easily be controlled by the doctor blade. The third layer will be fully softened material, which most likely contains the bulk of the release agent to lubricate the blade tip.

4. Commercial trials show that better sheet adhesion means softer sheets.



Creping

Gary Marzullo has defined creping as the result of the adhesive force of the sheet against the dryer, the physical properties of the sheet and the mechanical forces, and the geometry of the creping blade. For creping to occur, some force has to hold a sheet below 70% sheet moisture. The water film becomes discontinued and adhesion will depend on the use of an adhesive.

Since the Yankee coating directly affects sheet adhesion to the dryer and helps maintain the shelf of the blade, the type and amount of coating will have a dramatic effect on creping and sheet properties (**Fig. 3**).

What we have observed in commercial trial work is that finer, more uniform crepe is associated with better sheet adhesion to the Yankee surface. This increased sheet adhesion develops more microfolds in the sheet and thus a finer crepe. Results in commercial trials have indicated increases in sheet softness by as much as 20% as measured by the Handleometer (**Fig. 4**).

Uniform dryer coating has also shown dramatic improvements in reel profiles. Improved profiles improve runnability on converting equipment due to better uniformity in sheet caliper, stretch, and softness.

Doctor blade life

The combination of Yankee coatings and release agents has been shown to reduce the total wear on the Yankee surface and the creping doctor. Further, we have observed that the blade shelf is maintained for a longer period, producing more consistent sheet properties from reel to reel.

In pilot trials, samples of doctor blade steel were taken after 20 min on the machine. Blades run against an uncoated dryer showed 0.98-mm wear. Blades run for the same period of time against a well coated dryer showed wear of only 0.055 mm. Interestingly, a structural change in the blade steel took place to greater depth in the blades which were run against the uncoated dryer. This structural change, once it began, caused the blade to become brittle and wear more rapidly.

This blade wear reflects a change in sheet crepe over time.

Coating application

Historically, tissuemakers have depended on the additions in the wet end of wet-strength resins, retention aids, or animal glues to provide sheet adhesion to and protection of the Yankee surface. To increase or decrease coating on the Yankee surface, pH changes were often made with soda ash and alum. The problem papermakers encountered was that once the white water system was saturated, they had little control over the system. Additionally, wet-strength resin reduces hand feel and causes problems with paper degradability in septic systems, while the over-addition of alum has been shown to increase hand feel and reduce drying.

Felt-supported sheet spraying

To minimize the number of additions in the wet end of paper machines, companies began developing techniques to spray adhesion and release agents on the sheet. This method has been found to be superior to wet-end additions but has the potential to fill in the felt and to reduce the softness of the sheet due to high coating retention. Also, the dryer will not be coated outside the sheet, which can result in excessive edge wear.

Full-face Yankee spraying

What has evolved is full-face spraying directly on the Yankee surface. There are several types of spraybooms on the market that use water or a combination of air and water as vehicles to apply polymer coatings and release agents to the Yankee dryer.

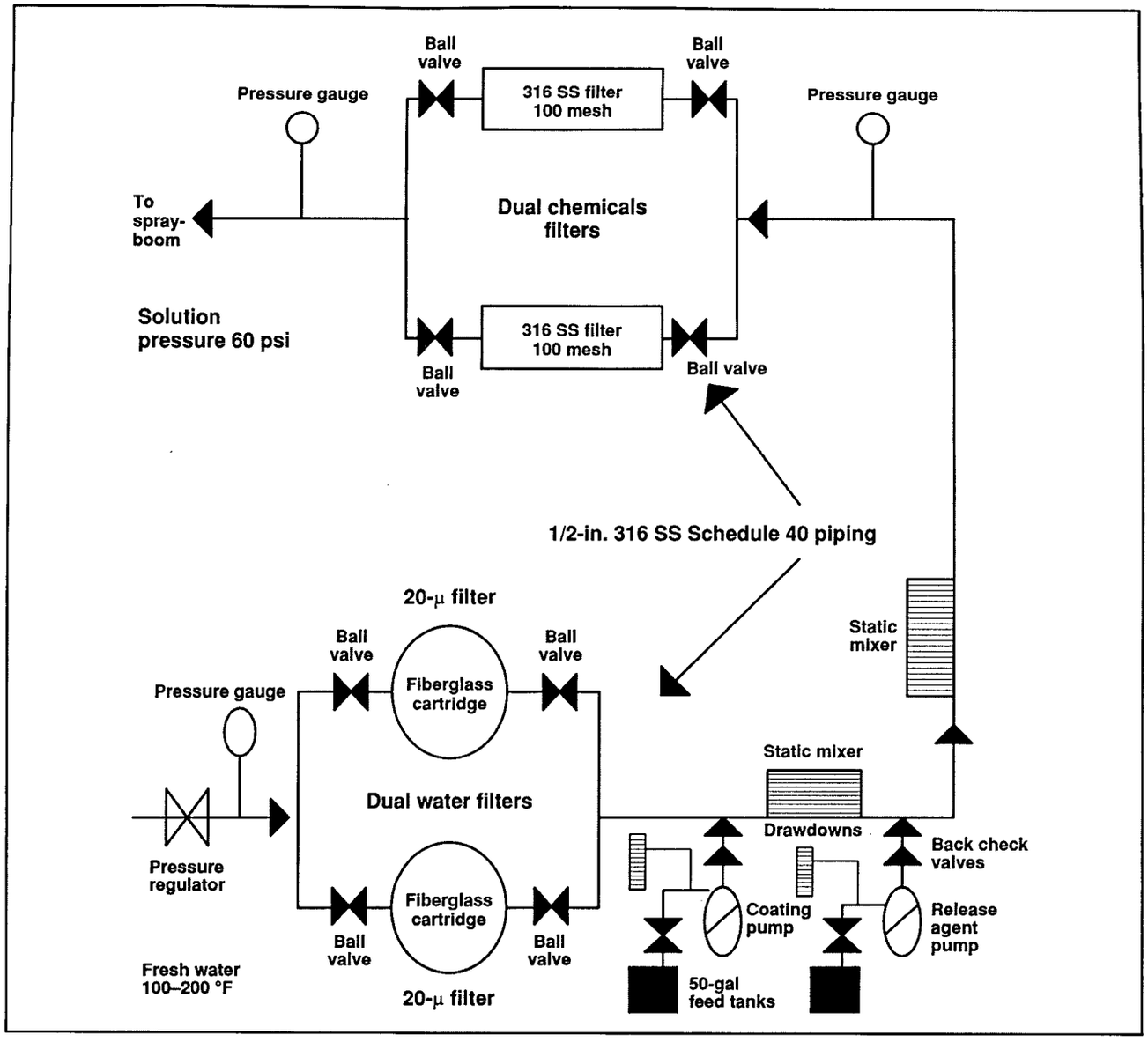
Several factors should be considered before selecting the spray equipment necessary to apply Yankee coatings:

1. Make sure there is adequate coverage on the entire dryer surface.
2. Make sure there is enough particular velocity to break the air barrier around the Yankee dryer and get the spray to the dryer surface.
3. The volume of the spray header should be high enough to put coating and a release agent on at the proper concentration to get a proper coating.
4. The sprayboom should be easily maintained.

Sprayboom feed system

In designing a feed system (**Fig. 5**) for the sprayboom, provision for clean, warm water to the header should be considered. This will eliminate any problems with nozzle fouling and reduce the energy impact on the machine. Therefore, the system should include water prefilters and

5. Sprayboom assembly filter system



filters downstream of the metering pump to trap any contamination.

Secondly, serious consideration should be given to the metering pumps used. Remember, once the metering pumps go down, the entire system is down.

Finally, make sure the chemicals are well mixed in the water stream so that what is sprayed is uniform throughout the boom.

Conclusions

A good machine survey prior to setting up a Yankee coating program can be extremely beneficial to the control of Yankee coatings. Paying attention to the details will pay off in better sheet quality and more consistent machine production.□

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