Dryer fabric cleaning: a way to reduce steam consumption and improve sheet quality

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If dryer fabrics are routinely cleaned during convenient outages, drying efficiency can be effectively maintained, and sheet quality can be enhanced.

With the modern dryer fabrics that are now commonplace in the paper industry, dryer fabric cleaning technology has evolved into a more demanding science. In the past, dryer felts ran wet and had relatively short life cycles. Modern monofilament and multifilament fabrics are more resistant to hydrolysis and have longer lives. Nevertheless, higher pH, temperatures, and humidities can still adversely affect yarns, depending on the exposure time and type of polymeric precursor materials used in constructing the fabric.

Dryer fabrics contribute to sheet drying by promoting heat transfer and mass transfer. Keeping the fabric open at or near the original permeability and keeping the surface of the dryer can free from contamination will lower energy costs and improve sheet quality. As the fabric fills with contaminants and process materials, the transfer of water into the vapor state is inhibited, and moisture variations across the paper machine occur. The filled areas can contribute to wet streaks in the sheet. Picking and other sheet surface defects can result from contaminants being transferred from the dryer fabric to the sheet.

History

The dryer fabric brings the sheet into intimate contact with the dryer can surface so that residual water in the sheet can be removed efficiently. About 25 years ago, dryer fabrics were wool and cotton felts that were virtually nonpermeable; therefore, the process of removing humid air was difficult.

In the early 1960s, synthetic fabrics were introduced that promoted ventilation by permitting air to move into and out of the pockets. These fabrics of higher permeability improve the efficiency of the dryer section by increasing the evaporation rate and reducing steam usage.

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Contaminants

There are four basic classes of contaminants found in dryer fabrics (*1*):

- Fiber and filler: alum, clay, TiO_2, talc, cellulose, fines, pick-out materials
- Organic materials: pitch, tar, oil, grease, asphalt, waxes, plastics, hot melts, stickies
- Solvent and heat-set coatings: latexes, styrene-butadiene rubber latex, polyvinylacetate
- Sizing agents: rosin, alkenyl succinic anhydride (ASA), alklyketene dimer, wet-strength resin.

The quantity and type of contaminants vary, depending on paper grade, dryer operating conditions, and fabric type. The hydrophobic materials, such as pitch, latex, oil, and grease, are most strongly attracted to the fabric surface. With the expanding use of secondary fibers, contaminants like stickies, hot melts, and plastics are becoming more commonplace on dryer fabrics. Identifying the exact nature of the contaminants helps to determine the proper cleaning agent to be used.

Dryer fabric composition

Proper cleaning of dryer fabrics requires a knowledge of the fabric's composition. Today's 100% synthetic dryer fabrics can be generally classified as monofilament and multifilament fabrics.

Monofilament fabrics are usually made from polyester and may have spun-polyester cross-direction (CD) yarns for permeability control. CD yarns can be composed of inorganic materials, such as fiberglass or wire, or of synthetic materials, such as polyester and acrylics, etc. Monofilament fabrics account for more than half of all dryer fabrics; however, because of hydrolytic degradation of polyester, their use is somewhat limited where the humidity is higher and dryer temperatures are above 300°F. Some monofilament fabrics have pin seams that cannot be removed, making on-machine fabric cleaning necessary.

I. Typical dryer fabric materials and their resistance to chemicals

Material	Effects of chemicals: Acid	Alkali	Organic solvent
Polyester (mono, multi, and spun)	Resistant, disintegrated by 96% sulfuric acid	Little effect if cold, disintegrated by hot strong alkali	Unaffected except for some phenolic-based compounds
Nylon (mono, multi, and spun)	Decomposed by strong mineral acids, resistant to weak acids	Little effect	Resistant
Aromatic nylon Nomex®/Kevlar®[a] (multi and spun)	More resistant to mineral acids than nylon	Little effect	Very resistant
Fiberglass (multi, latex coated)[b]	Resistant, attacked by strong phosphoric acid	Destroyed by strong alkali and weak hot alkali	Negligible
Acrylics Homopolymer (multi and spun) Copolymer (spun)	Resistant	Destroyed by strong alkali, resistant to weak alkali	Negligible

[a]Kevlar® is of high modulus, with very high strength to density ratio, and is less resistant to hydrolytic degradation than Nomex®.
[b]Coating could be affected by acid, alkali, and organic solvents.

Multifilament dryer fabrics come in a wide variety of fiber compositions and weave designs, but they all have MD yarns made of multifilament yarns or a combination of multifilament and spun yarns. The MD yarns can be composed of several materials, such as polyester, nylon, Nomex, or homo-acrylic.

To achieve dimensional stability, multifilament dryer fabrics are generally treated with temperature-resistant resins. Multifilament dryer fabrics have an external seam attached to the multifilament dryer fabric. This seam is either of the mono-polyester and metal-spiral type or of woven webbing with loops or metal hooks.

A few dryer fabrics that contain cotton fibers are still being used but are limited to paper machines that run specialty grades and that operate at low temperatures.

Effects of cleaning chemicals on dryer fabric materials

Cleaning chemicals that are used safely in wet-felt cleaning are not necessarily appropriate for cleaning dryer fabrics. The variety of fibers used in dryer fabric construction and the environment in which they operate make them vulnerable to the careless use of chemicals. Therefore, knowing a fabric's composition and its resistance to cleaning chemicals is the first step in establishing a safe and effective cleaning program. The chemical resistance of some common fibers and yarns used in dryer fabrics is listed in **Table I**.

Cleaning chemicals are classified as either acid-based, solvent- or neutral-based, or alkali-based. Acid- and alkali-based cleaners may also contain solvent. All three types of cleaning chemicals generally contain surfactants to aid cleaning efficiency. **Figure 1** suggests the type of cleaner to use with particular contaminants.

Polyester materials are generally more resistant to degradation by mineral acids and heat than nylon. Nylon is more resistant to alkali. **Figure 2** illustrates the effect of typical cleaners on the breaking strength of polyester monofilament yarns.

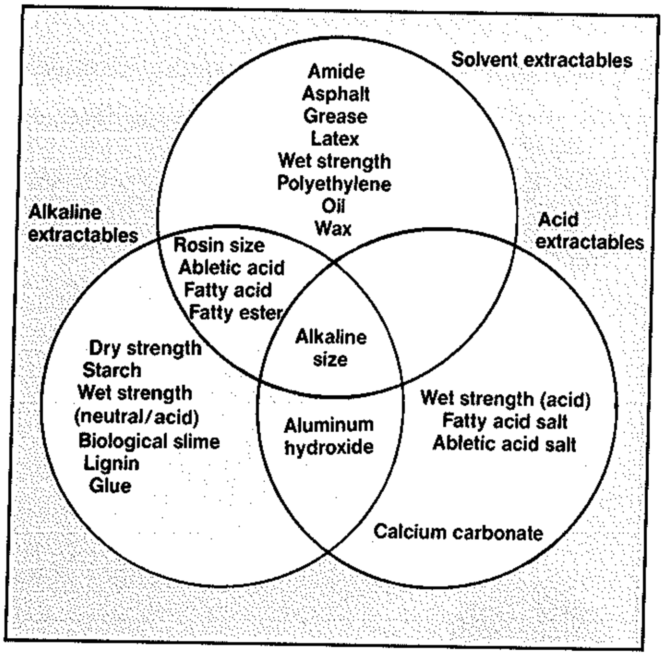
Cleaning requirements by paper grade

Machines that make specific paper grades have different cleaning requirements and need cleaning at different intervals. For example, linerboard and corrugating-medium machines using mostly virgin fiber will have a different cleaning requirement than a mill running on recycled furnish, which is subject to filling with stickies, wax, etc. Mills using secondary fiber require more frequent cleanings because of the high concentrations of contaminants associated with recycled fiber. Mills that produce coated papers experience fabric filling with latex and other coating materials. Mills producing newsprint typically have pitch buildup on their dryer fabrics and dryer can surfaces.

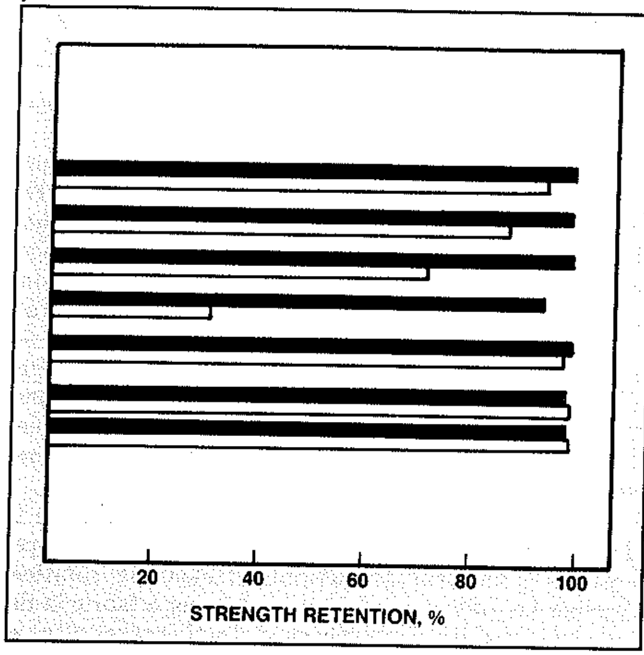
The frequency of dryer fabric cleaning varies from mill to mill. Some machines require minimal cleanings, while others may require more frequent cleaning. In addition, fabrics designed differently generally experience different rates of filling. The first and second dryer sections are often the most troublesome and require more frequent cleaning than the other sections.

In general, mills producing corrugating medium from virgin fiber and mills that produce linerboard may require cleaning only every 3-6 months, because of the small amount of recycled fiber and the relative insensitivity of the paper quality to contaminants. Mills producing newsprint may clean monthly, depending on the degree of pitch buildup and the number of breaks that occur in the dryer section. Machines making high-quality, coated, fine paper where sheet surface properties are important will require more frequent cleaning. Sheet picking is a problem in fine paper grades, and frequent regular

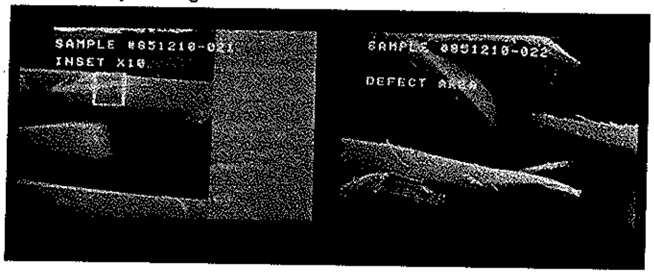
1. Classification and general solubility of dryer fabric contaminants.



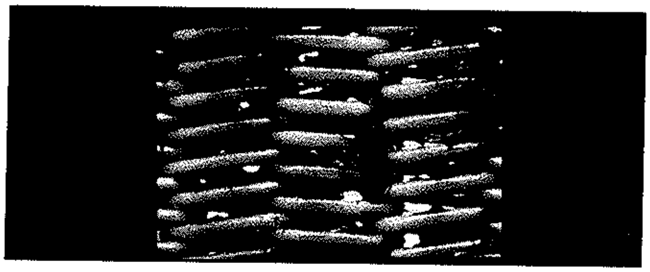
2. Strength retention of hydrolysis-resistant, polyester, monofilament yarns



3. A good seam (left) and an embrittled seam (right) that has failed because of yarn degradation



4. An example of improper cleaning and rinsing, revealing embedded contaminants



cleanings may be warranted.

Cleaning methods

The effort required to clean dryer fabrics depends on the amount of contaminants and the composition and design of the dryer fabrics. Monofilament dryer fabrics are generally easier to clean and rinse than multifilament dryer fabrics. Multifilament dryer fabrics are difficult to rinse because the yarns may absorb the cleaning solution.

All dryer fabrics must be thoroughly rinsed to prevent premature failure caused by chemical residuals on the seam material. Once operating conditions are resumed, an improperly rinsed fabric could have residual chemicals that may concentrate with drying and cause premature failure from embrittlement, particularly the seam area, as shown in **Fig. 3**.

Chemically softened contaminants also need to be fully rinsed so that a thorough cleaning can be accomplished. An improper surface cleaning could leave contaminants embedded in the fabric structure, as shown in **Fig. 4**.

With the advent of fabrics of longer life, cleaning is a natural, logical extension of wet-felt conditioning and cleaning. Contamination and filling of the fabric often results in marking of the paper sheet, a poor moisture profile of the sheet, and excessive steam usage. Several alternatives for mechanical and chemical cleaning are available to the papermaker.

Mechanical strategies

Air showers are used to continuously remove fiber debris from the fabric. This commonly used method is less effective on low-permeability fabrics, and it does not effectively remove chemical-based contaminants.

Air and water showers use a high-pressure, hot-water jet to loosen contaminants and an air jet to dry the fabric. Since this method is limited to one-sided cleaning, a second unit would be required to thoroughly clean both sides of the fabric. Also, contaminants continually build up in the fabric, because the nozzles can clean only a relatively small area.

Downtime for maintenance is the most opportune time for cleaning dryer fabrics, because tightly embedded materials may require more than steam and water to remove effectively. Downtime cleaning also uses the fabric as a transport medium to clean the dryer can surfaces. Properly evaluating the type of contaminants and the fabric composition are the key prior to designing an effective cleaning program. The dryer fabrics will be cleaned quickly and efficiently if well-engineered cleaning methods are used consistently.

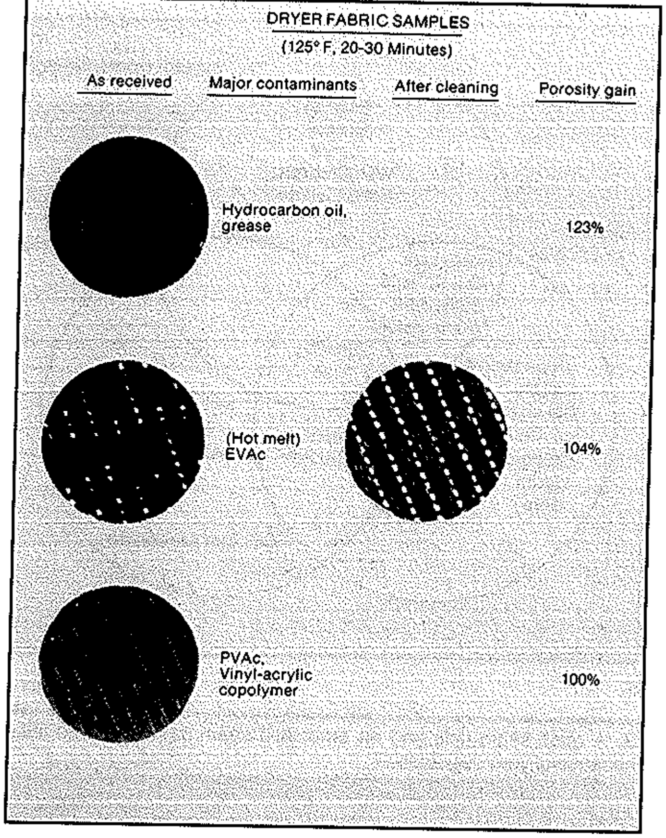
Chemical cleaner application

Cleaning chemicals can be applied to dryer fabrics with hand-held sprayers or a fan-type chemical shower arrangement. A hand-held apparatus is a low-cost, convenient method for applying cleaning solutions. The benefits of using this equipment are its portability and its localized cleaning ability. The primary disadvantages are that it produces an uneven application of cleaning chemicals on the fabric. Sprayer capacity limits the rate of application, and long cleaning times are necessary for severely contaminated dryer fabrics. In addition, the cleaning chemicals must be mixed and diluted by hand, which presents a health hazard to operating personnel. Finally, dryer fabrics must be rinsed with a water hose, and uneven rinsing is likely.

The proper method of applying chemical cleaners to dryer fabric is to use a fan-type shower. The shower ensures a uniform application of cleaning solution. Another key advantage is that in cleaning a fabric in the top-fabric position, relatively good cleaning takes place as the chemical drips through the open mesh fabric to the section below it. Automatic mixing of cleaning products is possible, and less personnel time is required to operate fan-type cleaning equipment. Most importantly, rinse water can be applied through the same shower bar to give faster, more uniform rinsing.

Examples of laboratory-cleaned dryer fabrics that were tested for porosity increase are shown in **Fig. 5**. Porosity is improved by removing the contaminants from the inside and outer surfaces of the fabric.

5. Various dryer fabric samples showing increases in porosity



Cleaning benefits

The highest cost of removing water from the sheet is incurred in the dryer section. Data from Albany International (*4*) indicates that over 75% of the total cost of water removal is in the dryer section. The high cost of steam mandates that the process be as cost-effective as possible. Therefore, mill management should be interested in any reasonable method to ensure maximum efficiency in this area.

By maintaining the fabric's original permeability, the mill can also reduce fabric costs, downtime, and labor costs associated with changing the fabrics after a short running time. The permeability tester is an effective monitoring tool for porosity measurement.

Dryer fabric cleaning may also remove deposit buildup from dryer cans, which will improve heat transfer to the sheet and enhance sheet quality. Deposit buildup on dryers reduces heat transfer and forces an increase in steam flow and pressure to the dryer section. Buildup in the first dryer section is especially troublesome, causing the steam pressure and dryer can temperature to increase, which results in sheet sticking problems.

Conclusions

As the market demands improved machine efficiencies and products of higher quality, keeping the sheet free of defects and minimizing the transfer of deposition from the dryer cans to the sheet are essential. These goals can be met by implementing a routine cleaning program.

Routine cleaning of dryer fabrics is now a reality. To obtain maximum benefit from a cleaning program, one must have a thorough understanding of system contaminants, fabric materials, and proper cleaning technology.

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Received for review Jan. 4, 1988.

Accepted April 21, 1988.

Presented at the 1988 Papermakers Conference.