TECHNICAL BULLETIN

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WRINKLE-RESISTANT FINISHING OF GARMENTS WITH CONTROLLED METERING OF CHEMICALS

INTRODUCTION

Now that wrinkle-resistant products have become well entrenched in the marketplace, finishers are looking for techniques to improve performance and to add value. Men's slacks are the predominant product in the wrinkle-resistant market. The question now is how can wrinkle-resistant products gain further market share or at least maintain the current level. As with any other product, research continues into how the consumer's requirements are changing, the influence of market trends, and product improvement. Hopefully, any change will be for the best, and textile processors should be prepared to meet and exceed any requirements forthcoming.

WRINKLE-RESISTANT UPDATE

Many of the advances made in wrinkle-resistant technology have been largely due to competition among manufacturers. Obviously, the consumer is the beneficiary of such developments. Finish formulations now incorporate the latest in crosslinking chemistry with low formaldehyde a requirement. There are many variations of the dimethyoldihydroxyethyleneurea (DMDHEU) products, which include:

- regular, unmodified
- regular with buffer
- regular with catalyst
- regular with buffer and catalyst
- low formaldehyde (methylated or glycolated)
- low formaldehyde with buffer
- low formaldehyde with catalyst
- low formaldehyde with buffer and catalyst

These selections now offer the finisher choices for the best product for the particular application. That choice may be determined by fabric style, method of application, or product specifications. Having a combination system where the catalyst is premixed, gives some simplicity to formulations. In many cases, all that is needed is the addition of a softener. For postcure operations, the buffer system aids in delayed cure. This is advantageous for fabric shipment or storage and helps to prevent premature curing when treated garments are tumble dried before pressing.

Softener systems are being developed to provide abrasion resistance while achieving a wide range of handles. The basic choice for a softener is polyethylene because of its price and softness. A cationic polyethylene has better wash durability and adds some dimension to the hand. By incorporating a silicone, hand enhancement can be realized even further. Beyond that, polyurethanes have entered the scene for yet another possibility. Combinations of these softeners at varying concentrations offer softening systems to fit most any fabric style and construction. The influence of any softener on the soiling of the garment is significant. Stain-resistant properties utilizing fluorochemical additives are now being incorporated. In some specialty products, even water repellents are added.

Pre- and post-garment washing techniques are also employed to improve both softness and casual appeal. Before the application of resin to the garments, washing with cellulase enzymes, stones, or other additives can be used for washdown effects. Another possibility is to wash after the resin is cured to remove unfixed resin and enhance softness.

Dress shirts in 100% cotton and high-cotton content blended fabrics are normally treated by the precure method. Postcure treatment of cotton dress shirts is used when permanently creased sleeves are desired. There are successful sport shirt programs using the garment immersion technique. Here, a heavier, more substantial construction is common. Many of these are printed, garment washed, and resin finished.

Fabrics for wrinkle-resistant products are mainly 100% cotton with some high-cotton blends. These fabrics are now expanding into women's wear, children's wear, and casual wear categories. Items such as shorts and denim jeans are now included, which expand this market by both category and season.

METERED ADDITION TECHNOLOGY

The techniques of applying textile chemicals have improved and found new areas of application. Finishing of cotton products for wrinkle-resistant properties is usually done by two methods. One such method, which was practiced in the 1960s, is to apply the resin to the dyed fabric, dry only (no crosslinking), garment make-up, press, and oven cure. This is traditionally known as postcure and has been successful in meeting today's performance requirements. The other method is to dye the fabric, garment make-up, apply the resin to the garment, tumble dry, press, and oven cure. This method of application is normally accomplished by total immersion (often referred to as "dip") of the garment or by slightly tumbling the garment in a resin solution. In both cases, an extraction cycle is used to remove the excess resin from the garments. The garment dip process has several advantages over the conventional postcure process. These include a much softer hand due to the mechanical action of the tumbling, better inventory control, more casual appearance, and the flexibility of performing such operations as enzyme or other washing pretreatments. There are some disadvantages such as requiring specialized equipment, contamination of resin bath removal during the extraction cycle, preferential depletion of selected finish components, and the possibility of effluent problems.

A method of applying finish solutions to cotton garments has been developed that uses a spray system to deliver precisely the required amount of formulation to the garments. This is termed the metered addition method and is shown in Figure 1. This system compares to the dip method except for the application of the resin solution. Unlike the garment dip process, which totally saturates the garments followed by a centrifuge extraction to a wet pickup value, the metered addition process applies only the necessary amount of finish solution needed to achieve the final predetermined wet pickup. The main components are shown in Figure 2.

FIGURE 1

Metered Addition Process

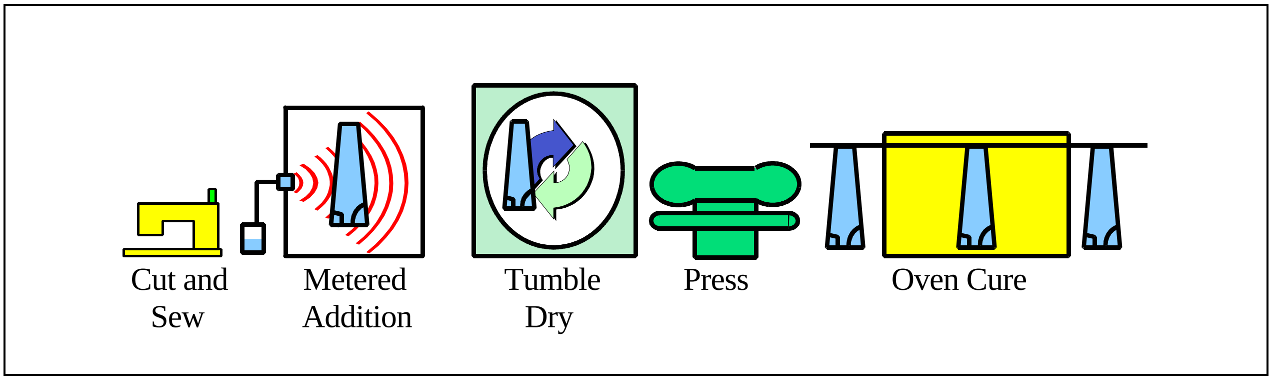
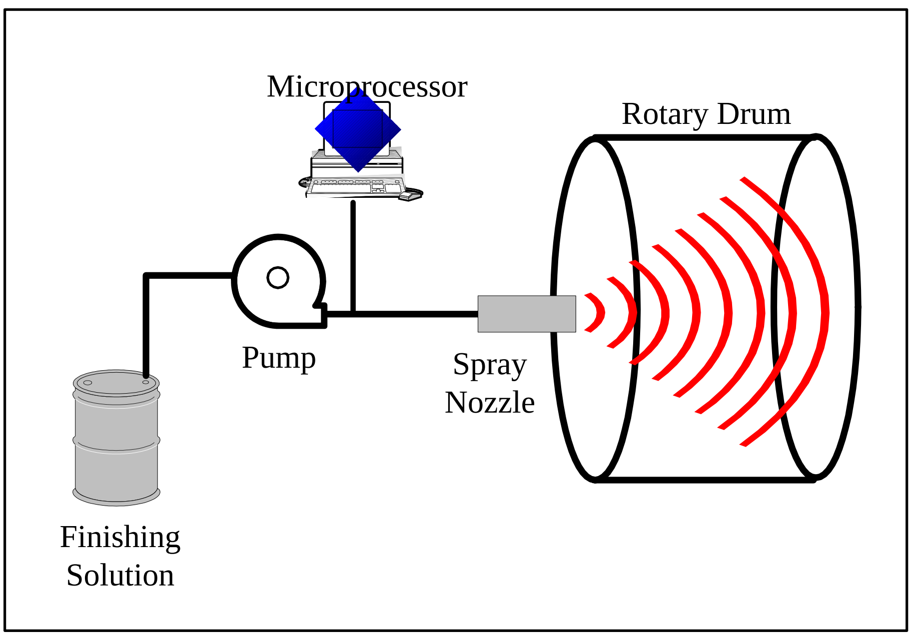


FIGURE 2

Schematic of Metered Addition Process



The finish solution is applied via spray where the appropriate amount of finish solution is distributed to the garments as a fine mist during the rotational tumbling in an enclosed device such as a garment wash/dye machine or a modified tumble dryer. To assist in allowing the finish solution to be evenly distributed throughout the garments, the rotation is altered between forward and reverse during the spraying cycle. This allows for the garments to become reoriented thus, permitting a greater possibility for uniform application.

After the spray application is complete, the garments continue to rotate to allow for the migration of the finish from high to low concentrated areas. This time of equilibration will depend on the nature of the garments, the amount of resin solution applied, the rate of spray application, and the characteristics of the spray mist (drop size and spraying profile). After the equilibration is complete, the garments are then processed by the normal sequence of tumble drying, pressing, and oven curing.

As illustrated in Figure 2, the finish solution is delivered to the spray nozzle through the use of a peristaltic pump that enables precise control of the rate of application of the finishing solution without any shearing action, which may break down individual components in the solution or possibly create foaming problems. The spray nozzle may be configured with various types of nozzles to alter the spraying profile and drop size to optimize the distribution of the spray depending upon the types of garments being processed. To assist in simplifying the process for operator use and to ensure that the appropriate amount of finish is applied, the system is equipped with a microprocessor. The microprocessor, developed in conjunction with the Textile/Clothing Technology Corporation, $[TC]^2$, enables the operator to input specific operating parameters. These parameters include:

- load weight
- initial wet pickup (wet-on-wet)
- desired final wet pickup
- density of spray solution
- rate of spraying
- equilibration time
- spray delay for drum rotation change

Figure 3 illustrates the uniformity of application when applying the finish solution to dry garments. The percent wet pickup of each individual garment is shown at values of 70%, 80%, and 90%. When the finish solution was applied at the 70% level, a range from 62.1% to 80.1% with a standard deviation of 4.7 was achieved. At 80% wet pickup, a range of 73.8% to 87.9% was measured with a standard deviation of 3.4. At 90% wet pickup, the standard deviation was lowered to 2.8 with wet pickup ranges of 84.3% to 95.2%. Figure 4 shows the standard deviation of these values. From this data, using a higher wet pickup of 90% aids in finish uniformity among garments. Tests have shown finish uniformity within a single garment is uniform as well. Even though this may translate to an increase in the drying time, the finish level will be both uniform and reproducible.

FIGURE 3

The percent wet pickup when treating garments (wet-on-dry) to different target levels of wet pickup by the metered addition method

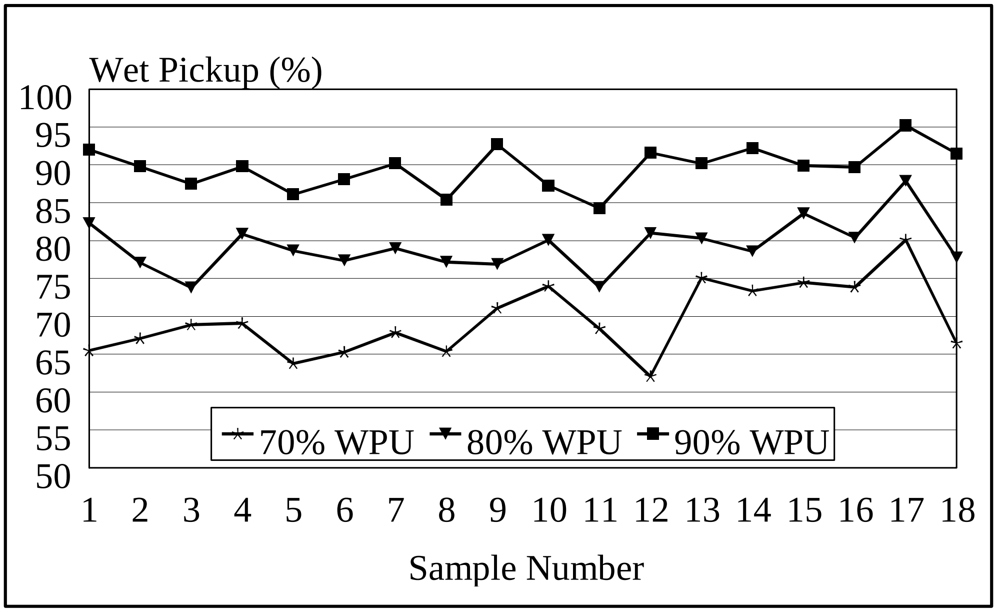
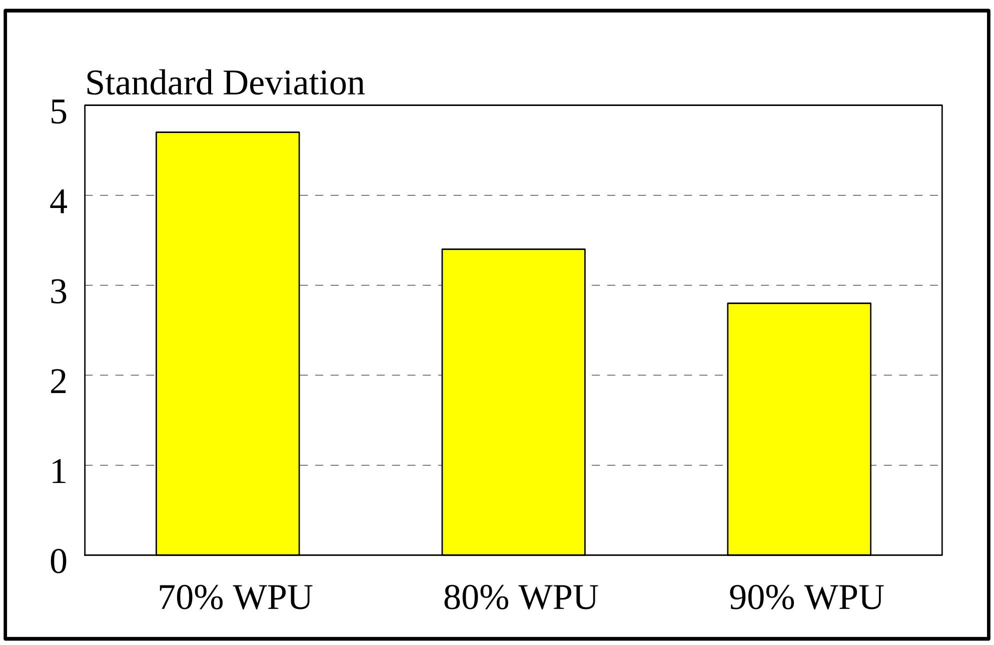


FIGURE 4

Standard deviations for different levels of wet pickup using the metered addition method



Finishes to impart wrinkle resistance were applied to men's 100% cotton pants by using the metered addition method, the immersion (dip) method, and the traditional postcure technique. Each application formula was adjusted to achieve the same add-on as the immersion application. In addition, some garments were inverted before the treatment to demonstrate how resin migration will affect abrasion. All percentages are based on the weight of the bath.

TREATMENT	PAD	SPRAY	DIP
Buffered DMDHEU (%)	9.2	6.7	12.0
$MgCl_2$ Catalyst (%)	2.3	1.7	3.0
HD Polyethylene (%)	2.3	1.7	3.0
Aminofunctional Silicone (%)	2.3	1.7	3.0
Nonionic Wetting Agent (%)	0.1	--	0.1
Isopropanol (%)	--	1.0	--
% WPU	66.00	90.00	50.00
% Resin Add-on	6.07	6.03	6.00
Apply, dry, cure 155°C (310°F) x 15 minutes.			

TEST RESULTS	PAD	SPRAY	DIP
Crease, 3 HLTD* rating	4.0	4.0	4.0
Tensile, Filling, pounds force	44.5	42.5	40.8
Tear, Filling, pounds force	3.1	3.3	3.3
Flex** cycles to failure	378	193	231
Flex (Inverted)	--	425	541

* AATCC 88C
Crease Appearance
5 = best
1 = no crease

**ASTM D3885

For the same resin add-on, the performance of each technique is comparable. For the spray and dip methods, inverting the garments gives higher abrasion values. This is due to migration of the resin during drying to the backside of the fabric, which is then the outside of the garment. This requires extra handling, but does make a significant difference when abrasion is a concern.

ADVANTAGES OF THE METERED ADDITION PROCESS

The advantages of the metered addition process include the use of simplified equipment, no waste, no effluent, no contamination of the finish bath, no depletion of individual components, the use of premixed finish solutions, and the ability to perform wet-on-wet processing.

While the concept of metering a precise amount of chemicals onto garments has proven successful for imparting wrinkle resistance, it can also be used for the application of dyes, pigments, or other types of finishing solutions. Additionally, the garments processed may include, but are not limited to, shirts, slacks, shorts, dresses, or non-garment items such as towels, sheets, nonwovens, etc. The use of the metered addition process offers the garment finisher a high degree of flexibility in producing consistent wrinkle-resistant garments while eliminating the need for the treatment of effluent.

RESEARCH AND TECHNICAL SERVICES

Cotton Incorporated is a research and promotion company representing cotton worldwide. Through research and technical services, our company has the capability to develop, evaluate, and then commercialize the latest technology to benefit cotton.

- Agricultural research leads to improved agronomic practices, pest control and fiber variants with properties required by the most modern textile processes and consumer preferences. Ginning development provides efficient and effective machines for preservation of fiber characteristics. Cottonseed value is enhanced with biotechnology research to improve nutritional qualities and expand the animal food market.

- Research in fiber quality leads to improved fiber testing methodology and seasonal fiber analyses to bring better value both to growers and then mill customers.

- Computerized fiber management techniques result from in-depth fiber processing research.

- Product Development and Implementation operates programs leading to the commercialization of new finishes and improved energy and water conserving dyeing and finishing systems. New cotton fabrics are engineered -- wovens, circular knits, warp knits, and nonwovens -- that meet today's standards for performance.

- Technology Implementation provides comprehensive and customized professional assistance to the cotton industry and its customers -- textile mills and manufacturers.

- A fiber to yarn pilot spinning center allows full exploration of alternative methods of producing yarn for various products from cotton with specific fiber profiles.

- The Company operates its own dyeing and finishing laboratory, knitting laboratory, and a laboratory for physical testing of yarn, fabric, and fiber properties including High Volume Instrument testing capable of measuring micronaire, staple length, strength, uniformity, color, and trash content.

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