NEW FINISHING OPPORTUNITIES FOR WRINKLE-RESISTANT COTTON

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Abstract

Wrinkle-resistant 100% cotton slacks now represent 36% of the total volume of men's and boy's cotton slacks sold at retail for 1995. More and more there is a partnership between the chemical industry, the manufacturers, and the retail segment to keep this growth alive. In order to accomplish these, new technologies and combinations of technologies are emerging to provide improved performance. Among these are low formaldehyde resins, softener systems, pre- and post-washing methods, and new application techniques. One such technique is called the metered addition method for the application of wrinkle-resistant chemistry to cotton garments. This provides the garment finisher with a precise, controllable application process which will eliminate effluent problems and give 100% total utilization of the chemistry applied. This report describes this technology, all control parameters, the benefits, and test results which demonstrate the feasibility of this application method.

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. Of the total men's and young men's 100% cotton slacks sold at retail in the U.S. in 1995, wrinkle resistance represented 35.7% of that volume. This is phenomenal growth considering only three years ago that figure was about 13%. So now, what needs to happen to gain in this market or at least maintain that market share? As with any other product, there needs to be research into how this product meets the consumer's expectations, how the consumer's requirements are changing, and the influence of market trends. Hopefully, any change will be for the best, and we as 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 between 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 DMDHEU products which include:

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

These selections now offer the finisher choices as to the best product for the particular application. That application 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 softener. For postcure operations, the buffer system aids in delayed cure. This is advantageous for fabric shipment or delayed storage and helps to delay curing when treated garments are tumble dried before pressing.

Softener systems are expanding to provide abrasion resistance while achieving a wide range of handles. The basic choice is still the 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, even further hand enhancement can be realized. 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. Of significant importance is the influence of any softener on the soiling of the garment. Stain-resistant properties utilizing fluorochemical additives are now being incorporated. In some specialty products, even water repellents are added.

For the most part, men's slacks are the predominate market share. Dress shirts in 100% cotton and high cotton content blended fabrics are treated by the precure method. Experimentation is still ongoing for the postcure treatment of cotton dress shirts in the U.S. There are successful sport shirt programs using the garment immersion technique. Here a heavier, more substantial construction is common and can accommodate the strength loss. Many of these are printed, garment washed, and then resin finished.

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

Any product's success is often judged by sales. By that criterion, wrinkle resistance has been and continues to be a success at retail. As consumer's attitudes change, so do their buying habits. The next generation of wrinkle-resistant products will be soft touch, and consumers are anxious for its arrival. This is accomplished by pre- or post-wash treatments including cellulase enzymes, stones, and other chemical additive.

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Metered Addition Technology

The techniques of applying textile chemicals have in many cases improved and found new areas of notoriety. Finishing of cotton products for wrinkle-resistant properties is usually done by two methods. One such method, which was practiced in the 1960's, is to apply the resin to the dyed fabric, dry only (no crosslinking), garment make-up, press, and then oven cure. This is traditionally known as postcure and has been successful in meeting today's performance requirements. The other predominate method is to dye the fabric, garment make-up, apply the resin to the garment, tumble dry, press, and then oven cure. The methods of application here is normally accomplished by total immersion (often referred to as "dip") of the garment or to slightly tumble 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, inventory control, better casual appeal, 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.

Another method of applying finish solutions to cotton garments has been developed which 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 pick-up value, the metered addition process applies only the necessary amount of finish solution needed to achieve the final predetermined wet pick-up. The main components are shown in Figure 2.

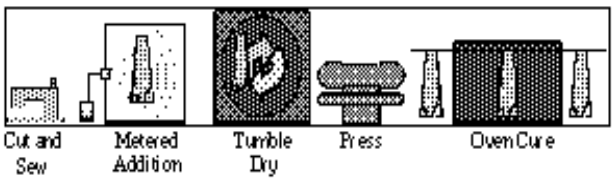

Figure 1: Metered Addition Method

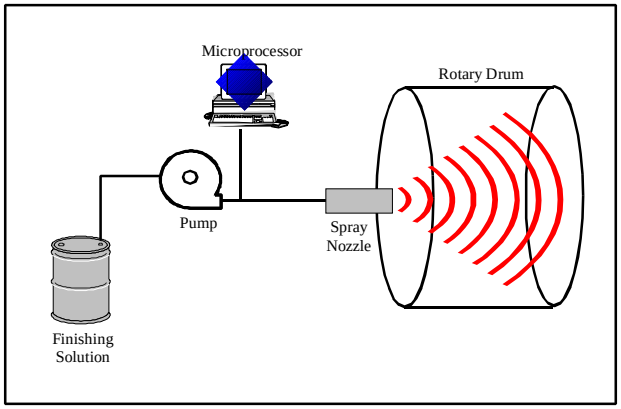

Figure 2: Schematic of the Metered Addition Process

The finish solution is applied via spray wherein 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 upon 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 finishing 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 breakdown individual components in the solution or possibly create foaming problems. The spray nozzle may be configured with various types of spray 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 pick-up (wet-on-wet)
desired final wet pick-up
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 pick-up of each individual garment is shown at values of 70%, 80%, and 90% wet pick-up. 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 pick-up, a range of 73.8% to 87.9% was measured with a standard deviation of 3.4. At 90% wet pick-up, the standard deviation was lowered to 2.8 with wet pick-up ranges of 84.3% to 95.2%. Figure 4 shows the standard deviation of these values. From this data, using a higher wet pick-up of 90%, aids in finish uniformity between 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.

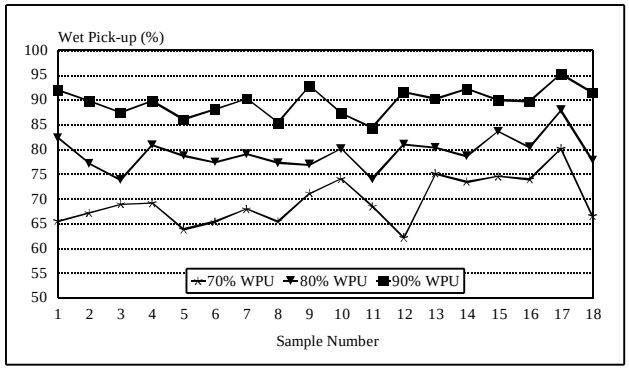

Figure 3: Wet-on-Dry

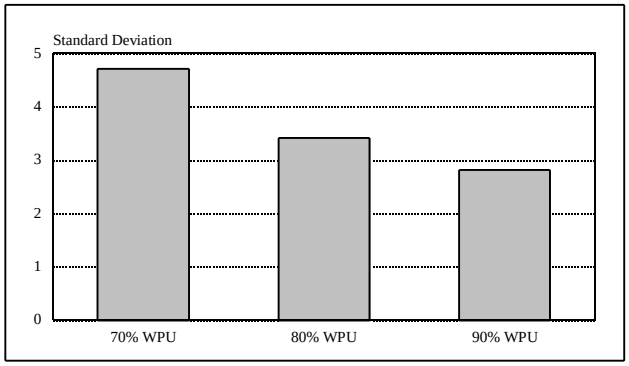

Figure 4: Standard Deviation

To determine the effectiveness of the metered addition method, the following experiments were conducted. The metered addition method was compared to the immersion (dip) process as well as 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.

EXPERIMENTATION	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	66.0	90.0	50.0
Apply, dry, cure 155C (310F) x 15 minutes.			
TEST RESULTS	**PAD**	**SPRAY**	**DIP**
Crease, 3 HLTD	4.0	4.0	4.0
Tensile, F	44.5	42.5	40.8
Tear, F	3.1	3.3	3.3
Flex	378	193	231
Flex (Inverted)	–	425	541

For the same resin add-on, the performance of each technique is comparable. It is interesting to note that for the spray and dip methods, inverting the garments give higher abrasion values. This is due to migration of the resin during drying to the back side 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

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 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.