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APPLICATION OF FOAMS TO THE PROCESSING OF FABRICS

Phase-III

Technical Progress Report for Period September 1, 1979-August 31, 1980

By
Chettoor G. Namboodri

September 1980

Work Performed Under Contract No. AC02-77CS40056

United Merchants & Manufacturers
United Merchants Research Center
Langley, South Carolina

U. S. DEPARTMENT OF ENERGY

Division of Industrial Energy Conservation

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For Period Sept. 1, 1979 to Aug. 31, 1980

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September 1980

Prepared For

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1.0 EXECUTIVE SUMMARY

By the end of August 1980 approximately 400,000,000 yards of fabric had been foam finished.

A number of finish formulations were optimized and second generation foam formulations have been introduced since September 1979.

Plant energy data from three UM & M plants have been collected which shows great savings. Considerable work has been done by our engineering department on developing applicators to apply dye and finish uniformly to flat goods.

Simultaneously tinting and foam finishing by the use of a tripad shows promise. Large scale trials are scheduled in the plant.

Much of our effort in foam dyeing has been in the evaluations of various application techniques to produce commercially acceptable dyeings. These are discussed in this report. Foam dyeing of nylon carpets is in production and approximately 3 million pounds of carpet have been foam dyed in one U. S. plant.

Nylon flock fabric dyeing has been scaled-up in pilot plant and plant trials.

Foam dyeing of 100% polyester blankets utilizing pigment foam and disperse dye foam is in production

in one textile mill.

Foam pigment dyeing of flat goods by horizontal pad application shows promise by the traverse application of foam on both sides of fabric. Development trials indicate feasibility of wet on wet foam dyeing of prepared wet fabrics.

A polyester/cotton narrow width industrial towel-
ing is now being foam dyed and finished simultaneously
commercially.

Foam printing using engraved rolls continues in
production and thus far 3 million yards of fabric has
been printed where foam is used for blotch patterns.

The utilization of foams in fabric preparation is
under investigation and feasibility has been established.

Investigations are in progress to size yarns
utilizing foamed synthetic sizing systems. Initial plant
trials show that equipment modifications are required to
apply foam to yarns.

2.0 OBJECTIVES

The primary objective of this project is to reduce the energy requirements in fabric finishing by drastically reducing the water required to wet process the fabrics. Since less water is used, less energy is consumed in the evaporation of water. This is accomplished by replacing much of the water with air, making foam and using it as an application medium.

For the one year period (September 1, 1979 to August 31, 1980) of Phase III of the Contract, the specific objectives were:

1. To commercially demonstrate continuous foam dyeing process on single fiber synthetics and 100% cellulosic fabrics on plant equipment.
2. To run plant trials, including economic and energy evaluations, on the foam dyeing of blend fabrics, particularly polyester/cotton or polyester/rayon blend types.
3. To conduct feasibility studies on foam preparation of fabrics (desizing, scouring and bleaching).
4. To run plant trials, including economic and energy evaluations on foam printing of fabrics.
5. Plant trials for sequentially/simultaneously, foam dyeing and foam finishing.
6. Commercial demonstration of foam dyeing of blends: polyester/cotton or polyester/rayon blends.
7. Pilot plant studies on foam fabric preparation: Desizing, Scouring, Bleaching.
8. Commercial demonstration of foam printing.

3.0 BACKGROUND

In the period of 1972 to October 1976, investigations at the United Merchants Research Center established that foam technology could be used to finish, dye and print a great variety of fabrics ranging from carpets and sliver knits to light weight goods such as 2 oz. per yard polyester/cotton sheeting. Foam finishing was used to apply softeners, durable press resins, water repellants and stain repellants to a variety of fabrics. Both natural and synthetic fibers and their blends were dyed with suitable dyestuffs. Disperse, acid, direct, cationic, pigments were successfully adapted to foam application.

Fabrics were also printed with foams. Pigments, Rapidogens and acid dyestuffs were among those coloring agents used to print fabrics with foams. The uniqueness of foam printing technology rests on the fact that auxiliary thickeners are not used to control the viscosity of the print paste. Instead the viscosity is controlled by the amount of air incorporated into the system. The side benefit of such a system is that no after-washing is required to remove the gums normally used in print paste. Even where after-washing is needed to remove unfixed dyes as in the case of Rapidogen and reactive dyes the absence of printing gums greatly facilitates the after-washing step.

The work done by UMRC during this period has resulted in the issuance of U.S. Patent Nos. 4,118,526, 4,193,762, 4,208,173 and notice of allowance has been received on one additional U.S. Patent.

In the report issued in December, 1979, for the Phase I and II of this contract we reported the progress through September of 1979. From October 1977 to September 1979 of the contract period, we have established in actual commercial and pilot trials the following:

1. Substantial energy savings can be achieved by converting from regular to foam finishing. Additionally, in many instances, productivity can be increased by faster range speeds. It is also true in some cases that dryer efficiencies can be significantly improved with foam. This results from lower temperatures and higher speeds besides the obvious less heat for "less water to evaporate". These combined factors results in significant overall cost reduction.
2. In order to achieve maximum energy savings, the drying and curing steps should be separated. That is, the tenter frame should be used for drying only. When this practice is followed, it has been possible to both lower oven temperatures and double range speeds leading to as much as an 86% reduction in the energy consumption per unit of fabric dried.

Foam processing itself cannot lead to energy savings in the common thermal curing step since it involves dry fabric. If greater overall energy savings are to be achieved, new non-conventional energy efficient curing systems need to be coupled with foam processing.

These could include low temperature curing systems, two package systems, "hot" catalysts, or more significantly, radiation curable systems. The demonstrated bench feasibility of hot catalysts for low temperature curing is being extended to the pilot plant.

3. Pile fabrics, such as carpets, flocked fabrics, woven velvets and sliver knits, have been successfully dyed in pilot plant trials on the UMRC range. These dyeings were achieved by knife application of foamed formulations onto one side, or "face", of the fabrics.

All of the foam dyeings described above can be considered ready for commercial practice. For flat goods, where equal shade is required for both sides, one side knife applications have led to front to back shading and occasionally to streakiness.

4. Foam printing has progressed much faster than originally programmed. Commercial scale trials with foam gravure type printing have shown reduction in both color and binder consumption. Foam printing, in some cases, will allow increased productivity by allowing higher speeds where drying capacity is fixed (i.e., steam cans). Up to September of 1979 approximately 800,000 yards have been printed using foam color for the blotch pattern.

A number of companies are currently using foam fabric finishing as a commercial production process. Commercial practice continues to grow. An estimated cumulative total of over 200,000,000 yards of fabric had been foam finished by September of 1979.

4.0 DISCUSSION OF EXPERIMENTAL RESULTS

4.1 FORMULATION EVALUATION PROCEDURES

The formulation evaluation procedures were discussed in detail in the December, 1979 final report covering Phase I and Phase II of the project. For obtaining detailed information, please refer to the above mentioned report.

4.2 CHEMICAL FORMULATION-FABRIC FINISHING

Chemical formulations for fabric finishing were discussed in the final report of December, 1979.

Additional work in this area include work on second generation formulations where the objective is to design foamable finishes from scratch instead of converting an existing resin or softener formulation to a foamable system.

TABLE I

Plant Foamable Finish
Formulation

Previous Formula

Resin	6-10%	New Foamable resin	4-8%
Softener	2-6%	New Foamable softener	2-4%
Hand Builder	0-3%	New Foamable Hand Builder	0-3%
Hand Builder (emulsion polymer)	0-10%	New Foamable Hand Builder (emulsion polymer)	0-10%
Catalyst	1-2%	Catalyst	1-2%
Foaming System	0.1 1%	Foaming System	0.1 1%

4.3 FABRIC PROCESSING-FINISHING

An estimated cumulative total of over 200,000,000 yards of fabric had been foam finished by September 8, 1979. The energy savings and production gains from plant data were reported in December 1979 covering from October 1977 through September 1979.

Additional plant data have been accumulated from three of UM & M finishing plants and are listed in Table II.

By the end of August 1980, approximately 400,000,000 yards of fabric had been finished with foam.

The foam finishing program at one of UM & M finishing plants include the following areas of investigations:

Cost Accounting
Process-Optimization
Formulation-Optimization
Equipment-Engineering

TABLE II

Plant Energy Data- UM & M Plants

<u>Month</u>	<u>Year</u>	<u>Plant A</u>		<u>Plant B</u>		<u>Plant C</u>	
		<u>Yards Processed using foam</u>	<u>BTU Saved</u>	<u>Yards Processed using foam</u>	<u>BTU Saved</u>	<u>Yards Processed using foam</u>	<u>BTU Saved</u>
Sept.	1979	- -	- -	- -	- -	- -	- -
Oct.	1979	995,972	194,384,615	1,059,395	563,921,100	1,480,589	277,218,164
Nov.	1979	1,299,902	216,348,432	1,520,981	840,842,550	1,296,210	300,334,465
Dec.	1979	1,512,610	257,497,552	2,785,829	1,059,356,250	1,685,466	300,923,897
Jan.	1980	1,077,638	178,733,594	2,616,401	1,022,708,250	2,250,951	446,220,626
Feb.	1980	880,868	139,451,616	2,155,549	783,457,535	2,974,894	562,419,744
March	1980	1,521,782	296,899,668	904,050	481,225,815	3,477,836	651,050,899
April	1980	1,424,906	277,999,160	1,011,468	538,404,416	2,696,928	504,864,921
May	1980	994,307	193,989,295	1,277,556	680,043,058	2,964,718	554,995,209
June	1980	1,748,792	341,189,319	1,477,917	786,695,219	2,706,174	506,595,772
July	1980	2,001,907	390,572,055	1,150,313	610,541,672	2,139,583	401,529,937
Aug.	1980	1,879,867	366,574,065	959,484	510,445,488	2,046,595	382,713,285
TOTAL		15,288,551	2,854,669,361	16,918,943	7,877,611,353	25,717,544	4,886,860,919

Only three week's data were available.

Total yardage foam finished in three plants for 11 months = 57,823,038

Total energy savings in three plants for 11 months = 15,619,141,633 BTU

A two month period of industrial engineering study of foam finish cost data evaluation from two machines is summarized in Table III.

TABLE III
Summary-Cost Evaluation

<u>Fabric Wt.</u>	<u>Finish No.</u>	<u>Machine No.</u>	<u>% Energy Saved By Using Foam</u>	<u>Energy Saved BTU/Yd.</u>	<u>¢ Yd. *</u>
4 oz./sq. yd	1	5	21.4%**	129.8	0.034
4 oz./sq. yd	2	5	71.1%	641.2	0.168
4 oz./sq. yd	3	6	21.7%+*	83.9	0.022
4.13 oz./sq. yd	4	6	61.5%	221.3	0.058
3.01 oz./sq. yd	5	6	61.5%	347.3	0.091
3.01 oz./sq. yd	6	6	30.4%	190.9	0.050

* \$2.62/1,000 f³ for gas.

** Lower energy savings due to higher wet pick-ups.

At this finishing plant presently four machines (in Feb. 1980 only three machines) are equipped with foam finishing capability and are capable of now finishing 1,000,000 + yds/week using foam. There are nine finishing units in total at this plant and the objective is to install additional foamers so that 80% of all goods processed will be with foam. By July of 1981, 100% capability is anticipated.

A number of finish formulations were optimized and second generation formulations were introduced. Two

specific areas need to be resolved - tint formulations and certain deep shade knit finishing. There are mark-off and crock problems to be solved for dark shades.

Considerable work has been done on equipment development from an engineering stand point. Several foam application systems are being investigated under this program.

4.4 FABRIC PROCESSING - SIMULTANEOUSLY TINTING AND FINISHING

Significant developmental efforts were carried out to tint and foam finish fabrics simultaneously. This was accomplished by incorporating pigments into the foam finish formulations. Chemical modification of formulations was necessary to incorporate pigments and resin finishes in one foam composition. The trials were carried out mostly on pigment printed 50/50 polyester/cotton blend fabrics. Various methods of application were studied to establish which technique gives the most uniform coloration at least on one side (the printed side) of the fabrics. The results of these trials indicate the following:

One side uniformity of tint can be obtained by using a tripad and feeding foam to one side of the fabric at the horizontal pad nip. The second nip of the tripad arrangement, S-warp (see figure) is found to give better uniformity compared to the single nip at the top horizontal pad rolls. Delivery of foam to the horizontal padder was

found critical in obtaining uniformity of simultaneous application of tint and finish with foam.

FIGURE I-TRIPAD FOAM APPLICATIONS.

The above simultaneous tinting and foam finishing trials showed that the predryers can be eliminated or bypassed with substantial energy savings. The trials also demonstrated that higher range speeds can be used at lower oven temperatures for drying-curing of the simultaneously applied pigment and finish.

Large scale production trials are scheduled to simultaneously tint and foam finish printed fabrics.

4.5 FABRIC PROCESSING-DYEING

The status of foam dyeing through September 1979 was discussed in the report issued in December 1979. Nylon carpet dyeing with acid dyes is commercial and approximately 3 million pounds of carpets has been foam

dyed in one U. S. plant. Also demonstration trials have been carried out on the UM & M pilot range for over a dozen carpet mills and there is much interest in the industry to adapt foam dyeing system for carpets. In addition, polyester blanket dyeing and dyeing of an industrial toweling is commercial in two textile mills plants.

A typical production formulation for nylon carpet dyeing using the foam system is listed in the following table:

TABLE IV

Carpet Dyeing
Formulation

Water	80-X%
Valfoam CD	20%
pH 5.0 with Acetic Acid	
Acid Dyes	X%

The formulation is foamed to a blow ratio of 4:1 to 10:1 depending on the weight of carpet and construction. The foam is coated and mechanically collapsed on the carpet distributing dye stuffs uniformly on the carpet pile. The carpets are then continuously steamed for color fixation. In most cases an after washing is not necessary. Energy savings from commercial runs are not available at this time.

Another area of single fiber dyeing with foam which is close to commercial is nylon flock fabric dyeing using acid dyes. Pilot plant and plant trial scale-up has been carried out to foam dye nylon flock fabrics. Light to medium shades of acid dyes on nylon flock fabric do not require after washing. Darker shades depending on the depth may require an after washing operation to remove unfixed dyes.

Much of our effort in foam dyeing has been in the evaluation of various application techniques in order to produce commercially acceptable dyeings.

In the foam dyeing of substrates that require color application to only one side such as a carpet, nylon flocked fabric or rayon upholstery fabric it has been found that the best method of color application is to knife coat foam with a knife over roll coater. The foam coated carpet is vacuumed from the backside followed by padding to collapse foam and to distribute dyestuff. The carpet is steamed to fix the dye and finally dried. On short pile fabrics such as nylon flock fabric or rayon pile upholstery fabric the procedure is similar to that of carpet dyeing except vacuuming is not required to collapse the foam for dye penetration. Nylon flocked fabric are uniformly dyed by this method. Cotton and rayon velour upholstery fabrics were also found to give uniform dyeing using direct dyes by the method.

The dyeing of flat woven fabrics requires even dyeing on the face and back of the fabric as well as side to side uniformity. In order to achieve uniform dyeing the following process schemes have been investigated:

1. Knife coating and padding.
2. Knife coating, vacuuming and padding.
3. Floating knife.
4. Dip and pad-vertical pad.
5. Engraved roll.
6. Horizontal pad application of foam.
7. Slotted pipe application of foam on both sides.
 - (A) regular slots
 - (B) diagonal slots
8. Tripad

Knife over roll application of dye foam to flat woven goods has been investigated on the pilot range and in plant trials. The knife over roll application gives good side to side uniformity but it results in large front to back shade variation which is unacceptable in the trade.

In the next series of trials, knife over roll coating of dye foam, followed by vacuuming from the back side and padding were investigated. This application gave better front to back uniformity than the knife coating and padding of foam. In this application precise control of vacuum force is found necessary to avoid color loss. An excess

vacuum force will extract color into the drain.

By the use of a floating knife, uniform color application was obtained on one side of fabric. Floating knife application of foam to one side gives poor penetration of color to opposite side. Wet pick-ups are generally lower than in any other application. The floating knife application of foam to both sides of fabric in a two step application produces front to back uniformity. Simultaneous floating knife application of foam on front and back is yet to be explored since mechanical modifications would be required for the pilot range.

Dipping fabric through foam and padding using a vertical pad has been investigated. Trials resulted in higher wet pick-ups and poor control of shade from start to end.

Engraved roll application of pigment foam to flat fabrics on a roller printing machine was found to give uniform color applications to one side of fabric. Here again similar to floating knife application the color penetration to the back side was poor. Where the requirement was only one side dyeing, as on a nylon mattress ticking, the method was found ideal. Some production trials were run at our printing plant by using engraved roll application.

Slotted pipe application of foam to both sides of fabric for dyeing was investigated. The trials resulted in streaky dyeings.

Horizontal pad application of pigment foam and disperse dye foam to non-woven polyester blankets gave uniform dyeings. The fastness of pigments on polyester blankets was improved by formulation modification and the foam dyeings of blankets are in production at a textile mill plant.

A polyester narrow width industrial toweling is now commercially foam dyed with pigments and finished simultaneously. Due to the open weave construction of the fabric, foam application by horizontal padding method gives uniformity on this type of narrow width fabrics.

Developmental work is continuing on the foam dyeing of rayon felt using direct dyes and acrylic felt using cationic dyes by horizontal pad application of foam on both sides of fabric and steam fixation of color.

More recent developmental trials using horizontal pad application of pigment foam to cotton and polyester/cotton blend fabrics were found to give fairly uniform dyeings. In order to obtain uniformity of foam application traversing feeds were used on both sides of fabric at the padder nip. Further developmental work using a horizontal is planned.

Foam dyeing with the use of tripad arrangement is being extensively studied for uniform color application. Application of dye foam on both sides of the fabric by using the horizontal pad followed by a second nip on the

tripad S-warp is being investigated to give uniform color application. Pigment foam by tripad is found to give fairly uniform dyeing. The dyed fabrics still gives some front to back effect due to the differences in hardness of the pad rolls. As in any dyeings, the durometer hardness of pad roll is critical for foam dyeing.

The various fibers, fabric constructions, corresponding dyestuffs and methods of foam application investigated are summarized in the following table.

TABLE V

Methods of Foam Application in Foam Dyeing

<u>Fiber Type</u>	<u>Dyes</u>	<u>Fabric Construction</u>	<u>Foam Application Methods Investigated</u>
Polyester	Disperse	Pile Fabric	Knife, Vacuum, Pad
Polyester	Disperse	Flat Goods	Knife, Vacuum, Pad
Polyester	Disperse	Flat Goods	Horizontal Pad
Polyester	Pigments	Blankets	Knife, Vacuum, Pad
Polyester	Pigments	Blankets	Horizontal Pad
Polyester	Pigments	Shoor Fabric	Horizontal Pad
Nylon	Acid	Carpets	Knife, Vacuum, Pad
Nylon	Acid	Flocked	Knife, Pad
Nylon	Disperse	Carpets	Knife, Vacuum, Pad
Nylon	Acid	Velour Upholstery	Knife, Pad
Nylon	Premetallized	Carpets	Knife, Vacuum, Pad
Nylon	Pigments	Matress Ticking	Engraved Roll

Table V
(Continued)

Cotton Rayon	Direct	Upholstery	Knife, Pad
Cotton Rayon	Direct	Blankets, Felt	Horizontal Pad
Cotton Rayon	Pigments	Blankets, Felt	Horizontal Pad
Cotton Rayon	Pigments	Woven	Horizontal Pad
Cotton Rayon	Sulfur	Corduroy	Knife, Vacuum, Pad
Cotton Rayon	Pigment	Flannel	Knife, Vacuum, Pad
Cotton Rayon	Pigment	Flannel	Horizontal Pad
Cotton Rayon	Reactive	Upholstery	Knife, Pad
Polyester/ cotton Blend	Pigment	Woven	Knife, Pad
Polyester/ cotton Blend	Pigment	Woven	Tripad-S-Warp
Polyester/ cotton Blend	Pigment	Woven	Knife, Vacuum, Pad
Polyester/ cotton Blend	Pigment	Woven	Horizontal Pad
Polyester/ Cotton Blend	Pigment	Woven	Floating Knife
Polyester/ Cotton Blend	Pigment	Woven	Engraved Roll
Polyester/ Cotton Blend	Pigment	Woven	Slotted Pipes
Acrylics and Modacrylics	Cationic	Carpets, Blankets	Knife, Vacuum, Pad
Acrylics and Modacrylics	Cationic	Sliver Knits	Knife, Vacuum, Pad
Acetate	Disperse	Woven, Knits	Knife, Pad
Qiana	Disperse	Knits	Knife Pad
Acetate	Pigments	Drapery	Horizontal Pad

Modifications were made to update our pilot plant range tripad in order to accelerate scale-up work in dyeing and for simultaneously tinting and finishing of fabrics.

4.6 FOAM DYEING AND FINISHING-SEQUENTIAL APPLICATION

Application of foamed fluorocarbon finishes were investigated on nylon carpets on the pilot plant range after the steam fixation step. The nylon carpet yardage 72" wide, was first foam dyed on the range and subjected to steam fixation of color. As the carpet exited from the steamer, foamed fluorocarbon finish was applied and the carpet was dried. The sequentially foam dyed and foam finished carpet shows satisfactory oil and water repellancy.

Further study on sequential wet on wet application is continuing using the following steps:

1. Apply foam color on Nylon carpet or upholstery fabric.
2. Collapse foam and distribute color.
3. Steam fix.
4. Apply fluorocarbon foam on wet carpet or fabric.
5. Dry

4.7 FOAM DYEING OF WET GOODS

Conventionally, fabrics are scoured, bleached and dried before dyeing. The ability to foam dye wet goods would eliminate a drying operation.

The purpose of this work is to study feasibility of foam dyeing prepared, wet fabrics. Developmental work is currently in progress on foam dyeing wet on wet by prewetting fabrics to various moisture levels and applying pigment foam by horizontal padding. The results on 50/50 polyester/cotton blends and cotton woven fabrics indicate the feasibility of foam dyeing wet fabrics containing up to 25-35% moisture level. The results indicate that prepared wet fabrics can be foam dyed, though optimum moisture levels have not been determined. Also it was observed that small amounts of moisture on the fabric aid level dyeing.

4.8 FABRIC PROCESSING-PRINTING

The status of foam printing up to September, 1979 was reviewed in the report of December, 1979.

Blotch pigment colors are being roller printed on flat goods. To date, about 3 million yards of fabric has been foam printed at our Clearwater printing plant. A savings of 15-20% in color cost has been obtained by pigment foam printing. Thus far we have not been able to collect energy savings data, since the drying cans are steam heated and not yet instrumented. An estimated energy savings up to 35% during drying. We are currently pursuing energy savings studies on our pilot plant roller printing machine. Vary preliminary studies on the pilot plant print machine have confirmed the estimated 35% energy

savings, at least on the selected patterns printed. Additional studies are planned.

There are still problems to overcome to improve foam roller printing. One of the mechanical problems is to control the foam color feed to the furnishes brush. There are modifications being made to avoid over-flow of foamed color from the color box. Modified pigment color system is being evaluated for foam printing of dark shades in blotch pattern.

Thus far we have not been able to rotary screen print successfully in the plant. Streaky prints from foam printing with rotary screens appear to be due to the foam feed and distribution system inside the screen. Mechanical modifications are being tried by our engineering department to overcome this problem. Recent trials at Clearwater Finishing Plant indicate that further modifications are required to print foam satisfactorily by the rotary screen method.

Investigations are also made to improve the foam printing system to eliminate rheology changes inside the rotary screen.

Wet colors such as disperse dyes on polyester, acid dyes on nylon and rapidogen color on cotton are in pilot plant stage of development. Scale-up work will be necessary for plant production.

4.9 FABRIC PROCESSING-FOAM PREPARATION

Feasibility studies on preparation of fabrics

utilizing foam are in progress. The laboratory developmental efforts with foam preparation are concentrated on two types of fabric sizes.

- (A) Fabric containing soluble sizes in PVA, CMC, etc.
- (B) Fabric containing starch and modified starch sizes.

(A) Fabric Containing Soluble Sizes

The procedure investigated for removing water soluble sizes is the use of foamed alkaline hydrogen peroxide. Fabrics such as polyester/cotton blend gingham (yarn dyed check fabrics) were investigated in this work. The method consisted of foaming hydrogen peroxide and sodium silicate (or orthosilicate). The foam is applied on the yarn dyed greige check fabrics. The foam coated fabrics are then batched 4-6 hrs. and then the solubilized sizes are washed off. A plant trial was carried out with foam at our Arkwright Finishing Plant.

From this trial, in addition to energy savings, foam desizing/bleaching appears to have certain advantages over the conventional process:

- I) Less color bleeding from dyed yarns and absence of staining of white yarns.
- II) Better whiteness of the undyed yarns due to the higher activity of peroxide at the low moisture level.

Investigations are continuing in this area of removal of soluble sizes by the use of foamed hydrogen peroxide.

(B) Fabrics Containing Starch and Modified Starch Sizes

Three different approaches for the preparation of starch and modified starch size containing fabrics of cotton and polyester/cotton blends were under investigation:

- (I) Foam enzyme application followed by caustic foam scouring (Batch Process).
- (II) Foam enzyme application followed by peroxide foam bleaching (Batch Process).
- (III) Foam peroxide applications followed by caustic foam scour-steam-cold water wash (semi-continuous operation).

Good absorbency (for dyeing), whiteness and removal of starch are the parameters for evaluation. Laboratory results indicate that between the three foam treatment methods, procedure III was giving the best absorbency and removal of starch. Tables VI and VII compare conventional vs. foam preparation on 50/50 polyester/cotton fabric and 100% cotton fabric.

Table VI

Foam Preparation vs. Conventional - Starch
Size on 50/50 Polyester/Cotton Blend

<u>Sample No.</u>	<u>Process Sequence</u>	<u>% Residual Size</u> <u>Left on Fabric After Preparation</u>	
		<u>4 Hr.</u>	<u>6 Hr.</u>
		<u>Peroxide Batching</u>	<u>Peroxide Batch.</u>
1	Control 50/50 polyester/cotton (not prepared).	-----	12.7% (init. size)
2	Conventional peroxide treatment and conventional caustic pad-steaming.	1.58%	1.44%
3	Foam peroxide treatment and conventional caustic pad steaming	1.21%	1.37%
4	Foam peroxide treatment and foam caustic pad-steaming	1.79%	1.37%

Table VII

Foam Preparation vs. Conventional - Starch
Size on 100% Cotton Fabric

<u>Sample No.</u>	<u>Process Sequence</u>	<u>% Residual Size</u> <u>Left on Fabric After Preparation</u>	
		<u>4 Hr.</u>	<u>6 Hr.</u>
		<u>Peroxide Batching</u>	<u>Peroxide Batching</u>
1	Control 100% cotton (not prepared)	-----	14.4% (init. size)
2	Conventional peroxide treatment & caustic pad-steaming	4.08%	2.39%
3	Foam peroxide treatment and conventional caustic pad-steaming	2.52%	2.65%
4	Foam peroxide treatment and foam caustic pad-steaming	2.61%	2.76%

Investigations will continue with the following objectives:

Selection of most efficient sequence of operation:
Removal of starch; Absorbency; Whiteness.

Optimize chemical requirements:
Peroxide; Silicate; Caustic, Solvents and Foaming Agents.

Optimize process parameters:
Steaming time; Batching time; Washing off requirements, etc.

Compare efficiency of foam system with conventional preparation.

To compare fabrics continuously with foam.

4.10 FOAM SIZING

Feasibility studies on foam sizing of yarn are in progress. Studies show that synthetic sizes (latexes) can be formulated into foamable sizes, (Table VIII). Yarns can be immersed in foamed size and subsequently padded to collapse foam. In production trials this application method gave slightly higher add-on than expected from pilot trials.(Table IX) Work is currently in progress to apply foamed sizes at reduced wet pick-ups. Equipment modifications are sought to apply foam size to yarn.

TABLE VIII
Foamable Size Formulations

Water	45 parts
Valchem 326-101 size	50 parts
Valfoam 59 (foam Stabilizer)	5.0 parts (Blow Ratio 4:1-8:1)

TABLE IX
Foam Sizing Trials on 65/35 Blend

<u>Trial No.</u>	<u>Pad Pressure</u>	<u>Blow Ratio</u>	<u>Range Speed y/min</u>	<u>% Size Add-On</u>	<u>Tensile lbs.</u>
1	15 psi	4:1	40	15.8	5.3
2	30 psi	8:1	70	17.0	6.4
3	30 psi	8:1	80	14.4	5.0
Regular Size					
Conventional	----	---	40	11.7	6.1
Control (No Size)	----	---	--	----	5.1

5.0 GENERAL

Papers Presented on Foam Processing Since September, 1979

I. By Dr. R. S. Gregorian

- (a.) Low wet pick-up processing
N. C. State University; November 29, 1979
Raleigh, N. C.
- (b.) Foam Finishing
Georgia Institute of Technology; January 17, 1980
Atlanta, Ga.
- (c.) Wet Processing of Textile Utilizing Foams
2 nd Franco-American Conference on Industrial Energy
Conservation, Washington, D. C.
February 14, 1980

II. By Dr. R. A. Bafford

- (a.) Low wet pick-up processing for finishing,
dyeing and printing
American Chemical Society National Meeting
Houston, Texas;
March 23-28, 1980

III. By W. Tannone

- (a.) Theory and Technology of Foam Processing
Clemson University
December 12-13, 1979

IV. By R. Lyons

- (a.) Applications and Techniques in Foam Processing
Clemson University
December 12-13, 1979

UM & M PATENTS ON FOAM PROCESSING (Since September, 1979

1. U. S. P. 4,193,762 Textile Treatment Process
March 18, 1980
C. G. Namboodri, assigned to United Merchants & Manufacturers.
2. U. S. P. 4,208,173 Method for Treating Fabrics
June 17, 1980, R. S. Gregorian and C. G. Namboodri
assigned to United Merchants & Manufacturers.
3. Notice of allowance has been received on one U. S.
Patent assigned to United Merchants.
4. One British Patent has been allowed.