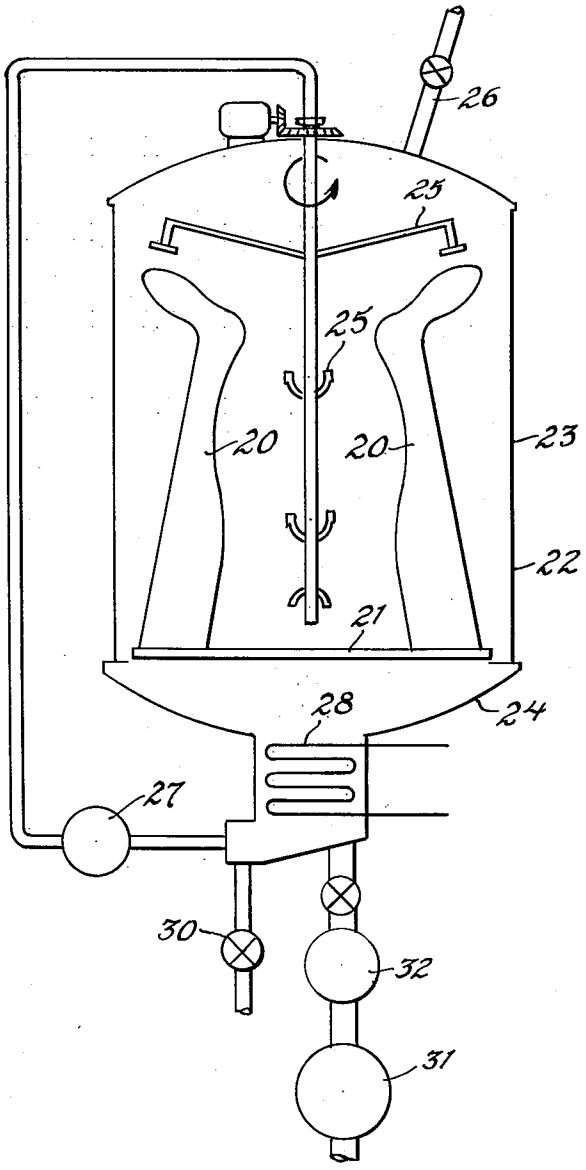
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TREATING TEXTILES ON A FORM

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TREATING TEXTILES ON A FORM

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The present invention relates to a method and composition for scouring, dyeing and finishing textile materials simultaneously, and preferably setting and drying the textile materials. The invention is applicable to natural fibers and synthetic fibers, including thermoplastic and hydrophobic synthetic fibers, and especially nylon hosiery.

The present application includes claims to the Method divided from our copending application, Serial No. 499,382.

The present application is a further development of our co-pending application Serial No. 499,382, filed April 5, 1955, now U.S. Patent 2,915,230, for Textile Treating Machine and Method.

A purpose of the invention is to accomplish scouring, dyeing and finishing, preferably with lubricating, of natural and synthetic fiber textile materials in a single step, avoiding the need for repeated manipulation of the textile materials as in prior practice, and desirably also setting and drying the textile materials at the same time.

A further purpose is to accomplish the simultaneous scouring, dyeing and finishing of textile materials by making up a treating solution which contains, in compatible form, water base, dyestuff, surface active agent and resin, desirably also with a lubricant and with a chelating agent, placing the textile materials in a closed space filled with air, and with a measured amount of treating solution not previously used, heating that solution, distributing that solution on the textile materials in the closed space, and circulating the solution to complete the operation.

A further purpose in the procedure set forth is to raise the temperature in the closed space above 212° F. while preventing boiling of the treating solution by the superatmospheric pressure in the closed space, and maintaining the temperature while circulating the solution.

A further purpose is to make up a master treating solution which contains in compatible form a water base, dyestuff, preferably dispersed dye stuff, resin, preferably melamine-formaldehyde, or permissably urea-formaldehyde or other suitable resin, a dispersing and scouring agent, preferably nonionic and most desirably in the form of a condensation product of ethylene oxide with a vegetable oil, preferably also a lubricant, for example sorbitol ester, and preferably also a chelating agent which is effective to chelate alkaline earth metals and heavy metals including iron, to place natural or synthetic fiber textile materials, for example synthetic thermoplastic fiber materials such as nylon ladies' hosiery on forms, to bring the forms with the materials thereon into a closed space filled with air, to withdraw a fresh measured increment of master solution not used previously, preferably placing the solution increment in the closed space, to heat the solution increment, to spray the solution increment on the textile materials supported by the forms in the closed space, preferably withdrawing the solution increment from the closed space and pumping it back through spray nozzles into the space, to raise the temperature in the closed space above 212° F. and preferably in the range between 215 and 325° F., for example in the case of nylon hosiery in the range between 220 and 300° F., and most desirably about 230° F., while preventing boiling of the solution increment by the superatmospheric pressure in the closed space, the space being free from admission of outside steam which would dilute the solution increment, and desirably in many cases to terminate the dyeing, setting and finishing operation within the time from 1 to 30 minutes from the beginning of spraying, and most desirably within the time of from 4 to 5 minutes.

A further purpose is to use from 0.01 to 1.0% by volume of surface active agent, from 0.03 to 1.0% by volume of resin, from 0.05 to 1.0% by weight of lubricant and from 0.03 to 1.0% by weight of chelating agent in the above solution.

A further purpose is to use the condensation product of ethylene oxide with a vegetable oil such as olive oil as a surface active agent to scour the textile material.

A further purpose is to use sorbitol ester as a lubricant.

A further purpose is to utilize a disperse dyestuff in the combined dyeing, setting and finishing.

A further purpose is to place all of the textile materials an equal distance from the spray.

A further purpose is to relatively rotate the textile materials and the spray during the treating operation, desirably placing the forms in a circle and spraying from inside the circle, by rotating the spray.

A further purpose is to open the closed space at the end of the scouring, dyeing and finishing operation and recirculate a gas such as air therethrough, drying the textile materials on the forms.

In the drawings we illustrate one form of machine which may be employed to perform the method.

The figure is a diagram of a textile treating machine which may be used to carry out the invention.

Describing in illustration but not in limitation and referring to the drawings.

In the prior art the boarding, scouring, dyeing and finishing of hosiery has been a complicated, tedious and involved procedure. When references is made herein to hosiery, it will be understood that the principles of the invention apply equally also to other analogous textile materials. Examples of textiles which may be processed according to the invention include ladies stockings, men's stockings, men's half hose, sweaters, jackets, underwear, gloves, woven fabrics in the bolt, yarn in skeins and packages, and textile materials in any form.

In one of the methods of finishing ladies hosiery at the present time, 18 or 24 stockings are boarded on metal forms and the forms are then placed in a preboarding machine and subjected to steam pressure after which the stockings are removed by hand from the forms and handled in groups, usually 12 stockings to a group, and inserted in dye bags. The dye bags containing the stockings are then placed in a dyeing machine and agitated and rotated.

In the dyeing machine the hosiery is scoured for approximately one half hour after which it is dyed for an hour and a half or more. Then the hosiery is rinsed twice, after which a finish bath is introduced. The hosiery ordinarily remains in the finish bath about 20 minutes, after which the hosiery is removed and extracted to remove as much of liquid as possible. The bags containing the hosiery are then sorted for size, opened and the hosiery removed. The stockings are then placed on metal forms similar to those used in preboarding, and introduced into a dryer where post-boarding is accomplished.

The resulting product is poor from the standpoint of reproducibility from batch to batch.

All of this is very time consuming and expensive in labor and equipment.

In accordance with the present invention, all of the operations of scouring, dyeing, finishing and lubricating textile materials are desirably carried out simultaneously in a single step which may be performed in a remarkably short time, of the order of 1 to 30 minutes, and most desirably in the range from 1 to 15 minutes.

In the case of hosiery, the time of 4 to 5 minutes, usually about 4.5 minutes has been found to be satisfactory. This is a considerable improvement over the prior art practice which required in many cases several hours. At the same time that the scouring, dyeing and finishing are accomplished, in the case of nylon hosiery, for example, setting is also taking place. The process can if desired perform less than all of these operations, or it can include additional operations.

Not only are results obtained more easily, but superior results are secured. The scouring, dyeing, finishing and setting are all more reproduceable than in the present art. The scouring agent, being in the preferred form a nonionic dispersing agent, not only thoroughly cleans the hosiery or other materials so that it will beter take dyestuff, but also promotes levelling of the dye. The superatmospheric pressure permits maintaining a temperature above the normal boiling point of water without boiling, which if vigorous would in many cases disastrously affect the treating solution by precipitating the dye and resin.

While the textile dyeing and treating composition of the invention is used in the range between 70° F. and 325° F., it will ordinarily be employed and will in most cases best be employed at temperatures above the normal boiling point of water. Due to this elevated temperature, which in many applications will be between 315 and 325° F., but for example in the case of hosiery will be in the range from 220 to 300° F. in many cases, and most desirably for nylon hosiery containing both multifilament and monofilament may be in the range between 220 and 245° F., usually about 230° F., the fiber swells, the rate of the reaction increases and the kinetic energy of the molecules increases, the dye used, suitably disperse dye, tend to deaggregate, and the dye is better distributed through the fiber.

Since in the preferred embodiment of the invention no outside steam is brought into the interior of the closed space, as distinguished from mere circulation of steam through a heating coil where the steam does not enter the closed space, there is no tendency for dilution of the treating solution by condensate from the steam, and therefore no interference with the reproduceability of the treatment.

The textile material undergoing treatment will in some cases be a natural fiber such as cotton, linen, wool, or silk, etc. or a synthetic fiber such as regenerated cellulose, cellulose ester or ether like cellulose acetate and ethyl cellulose, acrylic fiber such as Orlon, polyvinylidine fiber such as Saran, terylene fiber such as Dacron and linear polyamide such as nylon, or a combination thereof. The invention may be applied to such textile material present in any form, examples being raw stock, staple fiber, continuous filament, fiber, slubbing, rope, yarn, fabric, nonwoven web, or garments like hosiery, sweaters, underwear, jackets, etc., knitted and woven, or otherwise.

In the case of hosiery, the invention has a special application to fibers which can be set under heat, such as nylon which can be set or shaped while it is scoured, dyed, finished, and lubricated according to the invention. The textile materials are hung on forms prior to the treatment.

One of the important features of the invention is that all of the ingredients of the treating bath are compatible.

The composition including the lubricant assists in removing the hosiery or other garments from the forms. The lubricant modifies the hand and with the other ingredients improves the elasticity of the textile material. The composition also tends to keep the forms clean for repeated operations.

An important aspect of the invention is that a fresh increment of master solution is used for each new bath, the solution never being reused. Thus there is no interference with reproduceability due to difference in take-up or deposition of ingredients in the bath.

The quantity of treating solution used each time is accurately measured, thus avoiding any possible errors from this source, and assuring better reproduceability from batch to batch.

In accordance with the invention the spray of heated solution is applied preferably by rotating the spray, and the jet pressure of the spray, preferably of the order of 50 to 125 p.s.i. or greater, through the spray nozzles, assures accurate distribution and great uniformity. The textile materials are also desirably located equal distances from the spray in each case, thus providing for ideal distribution of the liquid.

In the preferred embodiment of the invention, in order to accomplish the simultaneous dyeing, finishing, scouring and lubricating, preferably with setting of the textile material, the operations in a single unit are carried out on a particular batch of nylon hosiery or other suitable textile material, completing the treatment of this batch before another batch is treated. A master treating solution is made up, preferably enough to treat many batches. The master treating solution consists of water base, dyestuff, resin, surface active agent, preferably nonionic, and lubricant.

The textile materials, especially hosiery, are placed over forms to maintain the desired shape. The forms in a suitable group, for example, a circular group on a carrier, with the hosiery or other textile material thereon, are placed in a closed space filled with air. This is conveniently accomplished by moving a carrier on a track into a position above a receptacle and beneath a bell, bringing the bell and the receptacle together and making an airtight seal. A fresh measured increment of master solution is withdrawn from a container of master solution. This increment has never been used before for dyeing and finishing, and it will not be used again after treating this batch.

In the preferred embodiment, the increment is placed in the bottom of the closed space, at or about the time the space is closed. The increment is then heated, while in use in the space, as for example by a heating coil at the bottom of the closed space. The heating continues during the circulation to achieve and maintain a desired temperature. The heated solution increment is withdrawn from the space as by a pump and sprayed over the textile material, desirably locating the spray advantageously for uniform distribution throughout the textile material. As the spray is discharged, it collects at the bottom of the space and is further heated and pumped back into the spray nozzles. The temperature in the closed space in the preferred embodiment rises above 212° F., the normal boiling point of water, but boiling of the solution increment is prevented by the superatmospheric pressure in the closed space in the presence of the heated air which expands under increased temperature and of course contributes to increase in pressure. Another factor which contributes to increase of pressure is the vapor pressure of the water below the boiling point and a further factor is believed to be the effect of the spray. Boiling of the treating solution is very undesirable as it may cause precipitation of the dye and the resin and make the treating solution unusable. It is also preferred that in the embodiment no outside steam is introduced into the interior of the closed space and therefore there is no dilution of the solution increment.

The distribution or spraying which occurs and which accompanies the dyeing, scouring, finishing and lubricating and preferably the setting, is terminated within a short time as for example 1 to 30 minutes from the beginning of spraying and in the case of hosiery normally in a much shorter time, usually of the order of 4 to 5 minutes. Then the space is desirably opened and heated gas, preferably hot air, is blown through the space to dry the textile material, preferably as it is supported on the forms.

PREPARATION OF MASTER TREATING SOLUTION

It will be evident that there is a special advantage in accomplishing the dyeing as well as the scouring, setting and finishing at one time or simultaneously, as occurs in the present invention. This is particularly true because natural and many synthetic fibers and fabrics probably undergo a molecular rearrangement and certainly swell during setting, which is very favorable from the standpoint of absorption of finely divided dye particles and resin finish. The detergent, which is preferably a nonionic dispersing agent, has been found to be a very efficient dye leveler and therefore improves the leveling action.

A further effect in this direction is believed to be contributed by the lubricant. The chelating agent further assists in maintaining dispersion or solution and prevents adherence of dye and finish to the container and form surfaces.

It is no longer necessary in accordance with the present invention to utilize an individual dyestuff which would be different in complete composition for each different shade, but instead the shade may be produced by varying the composition of a plurality of basic dye ingredients according to the tristimulus values of the particular wave length desired in the final shade. In some cases a single dyestuff only need be used. In many cases it is very safe and efficient to stock basic dyestuffs and vary the amount of the different dyestuffs to produce the required shade.

The quantity of dyestuffs in the case of sheer hosiery, preferably disperse dyestuffs such as acetate dyestuffs, is likely to be of the order of 25 to 500 p.p.m. and preferably of the order of 50 p.p.m. in the treating solution. The dispersed dyestuffs are widely applicable both to staple fiber and continuous filament of nylon, and to mixtures thereof.

Of course with other fibers other suitable dyestuffs will be used. The principles of the invention are applicable also to acid, direct, metalized and other dyestuffs.

The surface active agent used as a scouring, leveling and dispersing agent in the treating solution is very desirably a nonionic agent, preferably the condensation product of ethylene oxide with a vegetable oil, such as olive oil (polyoxyethylene ester of fatty acids). This product is of exceptional value in the present invention since it is neutral and scent-free and is available in 94% concentration with 6% by weight of water known as Energetic S (Armour Products, Chicago).

The scouring and nonionic dispersing agent is soluble in petroleum solvents and polar solvents, has very low tendency to foam, and has excellent dispersion properties for disperse dyestuffs, forming a suitable emulsion over a wide temperature range which does not tend to deposit out soil in the drain and related systems. It has powerful levelling properties on the dye.

The scouring and nonionic dispersing agent is desirably dissolved in an aliphatic hydrocarbon such as Stoddard solvent, a suitable solvent of this character being sold on the market as Varsol No. 1 (Esso Standard Oil, Philadelphia). It is preferable to mix one part of scouring agent by volume with three parts of solvent, although the composition range can be varied considerably.

In the preferred embodiment 0.01 to 1.0 percent by volume of the scouring and dispersing agent, not including the Stoddard solvent, is used in the treating solution, the concentration preferably being about 0.1 percent of the scouring and dispersing agent by volume.

Other nonionic emulsifying agents which may be used are aromatic polyglycol ether condensates (Neutronyx 600) and alkyl aryl polyether alcohol (Triton X100). Any other compatible surface active agent may be used, although surface active agents other than nonionic agents are generally less desirable. Anionic surface active agents have, however, been found to be operative, suitable examples being fatty alcohols of carbon chain length between 10 and 24 atoms (Dupanol RA), as well as cationic agents, like condensation products of ethylene oxide and an organic amine (Peregal OK).

The finish used is a liquid resin, preferably melamine-formaldehyde condensation product, or suitably urea-formaldehyde condensation product. The melamine-formaldehyde condensation product is preferably Aerotex Resin M3 (American Cyanamid Company). This resin is a water soluble acid catalyzed resin. The urea-formaldehyde liquid resin used is preferably Zeset (du Pont Company) or Aerotex Syrup 250 Conc. (American Cyanamid Company). The concentration range of the resin for treating hosiery will desirably be between 0.03 and 1.0% by volume in the final treating solution, desirably in the range from 0.1 to 0.2% by volume in such solution. In textile materials generally, the concentration of resin in the treating solution may vary between 0.03 and 5% resin by volume.

It is very desirable also to use a lubricant, which may for example be sorbitol ester, suitably of one mole of sorbitol alcohol and one mole of fatty acid, preferably palmitic acid. The preferred compound is sorbitan monopalmitate. This is a material in the form of a wax with a strong property of self-emulsifying, and is available on the market as Avcosol 104 (Atlas Products, Wilmington). Other fatty acids of carbon chain length between 18 and 30 may be used, such as stearic. Concentration of lubricant used will be between 0.05 and 1.0% by weight of solution, preferably about 0.2% by weight of solution. The materials of the composition greatly aid in preventing the hosiery from sticking to the forms after drying, and also maintaining the dispersion.

It is decidedly preferable also to use a chelating agent effective on alkaline earth metals and heavy metals such as iron, to protect against deposit of precipitate on the equipment, and to maintain greater homogeneity in the treating solution. Examples are the sodium or other alkaline metal salts of ethylene diamine tetraacetic acid, and diethylene triamine pentaacetic acid, or hydroxyethyl ethylene diamine triacetic acid such as Sequestrine A (Geigy) or Versene (Monsanto). The concentration range is preferably of the order of between 0.03 and 1.0% by weight of the treating solution, preferably about 0.2% by weight of the treating solution.

One very desirable feature of the combination of ingredients suggested for scouring, dyeing, finishing, lubricating and setting in accordance with the invention is that they are all compatible, and aid in dispersing the dye and the resin, the lubricant aiding in dispersing the dye, and the resin, which is water soluble, contributing toward dispersing the dye and holding the dye in intimate association with the fabric.

After the hosiery are dry, the dry ingredients remain chemically combined with the fabric and this has a tendency to hold the fabric in the position in which it is set, holding the contour of the stocking or other textile material during subsequent wearing.

Example I

The following example is for treatment of ladies' hosiery of nylon monofilament and multifilament combined. For a volume of about 50 cubic feet in the closed space, the quantity of treating solution used for one increment is preferably about five gallons. The treating solution is used without dilution.

To make up sixty gallons of treating solution, the preferred dyestuff composition, for suntone, using a disperse dye, is as follows:

(1) General Dyestuffs Cellaton blue FFRN (Color Index No. 61505) 3 grams.

(2) Du Pont Acetamine scarlet B (Color Index No. 11110) 3 grams.

(3) General Dyestuffs Cellaton yellow GACF (Color Index No. 11855) 5 grams.

(4) General Dyestuffs Cellaton red GGA (Color Index No. 11210) 1 gram.

The above dyestuffs are made into a paste with a small amount of solution containing the scouring agent and then gradually dispersed by stirring into a larger volume.

The other ingredients used are as follows:

(1) Condensation product of ethylene oxide with olive oil (Energetic S) 0.1% by volume of solution.

(2) Stoddard solvent 0.3% by volume of solution.

(3) Melamine - formaldehyde condensation product 0.15% by volume of solution.

(4) Sorbitol ester (Avcosol 104) 0.2% by weight of solution.

(5) Chelating agent, ethylene diamine tetraacetic acid (Sequestrine A) 0.05% by weight of solution.

The above ingredients are mixed with water, the dyestuff paste being introduced by above mentioned.

The pH is preferably held slightly on the alkaline side, preferably in the range of 7.5 to 8. A suitable agent for adjusting the pH is trisodium phosphate, the quantity required depending on the character of the water and the relative quantities of the other ingredients.

The solution was inserted in the dyeing and finishing machine, heated, and sprayed on the hosiery on the forms as set forth below. The hosiery was thus scoured, dyed, finished, lubricated and boarded.

The finish was found to be persistent after 50 daily wearing and washing cycles. It has a permanent silk-like feel. The elasticity and recoverability of the hosiery obtained by this finish is not obtainable by conventional methods of dyeing and finishing. An improvement in elasticity of from 12 to 15% has been obtained. A richness of color tone was imparted which is retained after repeated washings, unlike hosiery dyed in the conventional manner.

The yield of first quality goods was found to be over 95%, which is exceptionally good.

The wear resistance of the finished hosiery is better than hosiery finished by conventional methods.

Example II

An alternative composition of disperse dyestuff and other ingredients for producing 60 gallons of treating solution for hosiery is as follows:

(1) Du Pont Celathrene FR (Prototype 228) 3 grams.

(2) Du Pont Acetamine scarlet B (Color Index No. 11110) 3 grams.

(3) American Aniline Products Amacel yellow G (Color Index No. 11855) 5 grams.

The additional ingredients which are used with this composition are as follows:

(1) Condensation product of ethylene oxide with olive oil 0.2% by volume of solution.

(2) Stoddard solvent 0.6% by volume of solution.

(3) Urea-formaldehyde condensation product (Zeset) 0.2% by volume of solution.

(4) Sorbitol ester (Avcosol 104) 0.2% by weight of solution.

The above ingredients were mixed as in Example I and produced a finish of the same general character.

TABLE—PART I

Example	Dye Type	Dyestuff	Main Sample	Assistant
3	Neutral Dyeing Premetallized.	Capracyl Yellow 3 R.D.	Wool	Ammonium acetate, 3% on weight solution.
4	Acid	Calcocid Milling Orange 4R.	do	Acetic acid, 2% on weight solution; Glauber's salt, 10% on weight goods.
5	do	Calcocid Phloxine 2G, CI 31.	do	Sulphuric acid, 2% on weight solution.
6	Disperse Acetate	Calcosyn Blue G, Color Index No. 64500.	Cellulose Acetate.	
7	do	Latyl Blue 2G	do	
8	Direct	Calcodur Resin Fast Blue 2G, PR 612.	Viscose	Sodium Chloride, 20% on weight goods.
9	Vat	Calcosol Jade Green N, CI 1101.	do	Caustic soda, 0.12%; sodium hyposulphate, 4% by weight.
10	Direct	Calcomine Red FC, CI 419.	Silk	Acetic acid, 2% weight solution; Glauber's salt, 10% on weight goods.
11	Acid	Calcocid Phloxine 2G, CI 31.	do	Sulphuric acid, 2% weight solution.
12	Direct	Calcomine Red F.C., CI 419.	Nylon	Acetic acid, 2% weight solution.
13	Acid	Calcocid Phloxine 2G, CI 31.	do	Sulphuric acid, 2% weight solution.
14	Neutral Dyeing Premetallized.	Capracyl Yellow 3RD	do	Ammonium acetate, 3% weight solution.
15	Disperse Acetate	Latyl Blue 2G	do	
16	do	Calcosyn Red GG ex conc., Color Index No. 11210.	do	
17	Cationic Basic	Sevron Red 6B	Orlon	
18	Disperse Acetate	Calcosyn Sapphire Blue R, Color Index 61505.	Dacron	
19	do	Latyl Blue 2G	do	

TABLE—PART II

Fibers effectively dyed

Example	Cellulose Acetate	Acrylonitrile-vinyl acetate (Acrilan)	Acrylic (Arnel)	Cotton	Terylene (Dacron)	Vinyl chloride-acrylonitrile (Dynel)	Linear Polyamide (Nylon)	Acrylic (Orlon)	Silk	Protein (Vicara)	Viscose	Wool
3		X	X	X	X	X	X		X	X		X
4				X			X		X	X		X
5							X		X	X		X
6	X	X	X		X	X	X	X	X	X	X	X
7	X		X		X	X	X		X	X		X
8				X					X		X	
9	X	X	X	X		X	X	X	X	X	X	X
10				X			X		X	X	X	X
11		X					X		X	X		X
12				X			X		X	X	X	X
13		X					X		X	X		X
14		X					X	X			X	
15	X		X		X	X	X	X	X	X		X
16	X	X	X	X	X	X	X	X	X	X	X	X
17	X	X	X			X	X	X	X	X	X	X
18	X	X	X		X	X	X	X	X	X		X
19	X	X	X		X	X	X		X	X		X

In the experiments reported in the table, a series of scouring, dyeing and finishing solutions have been tested to determine the effectiveness of the solutions in scouring, dyeing and finishing various fabrics listed, and the compatability of the ingredients in various environments. Very severe conditions were used, as the solutions were mildly boiling in air at atmospheric pressure and at temperatures of 208 to 210° F. for one hour in each case, but the vat dyestuff. In the case of the vat dyestuff, the solution was reduced for 15 minutes at 140° F. and dyeing carried on at 140° F. for 45 minutes.

The solution in each experiment included the following ingredients:

(1) Condensation product of ethylene oxide with olive oil (Energetic S) 0.1% by volume of solution.

(2) Stoddard solvent (Varsol No. 1) 0.3% by volume of solution.

(3) Melamine - formaldehyde condensation product (Aerotex Syrup Ms) 0.15% by volume of solution.

(4) Lubricant, sorbitol ester (Avcosol 104) 0.74 gram per gallon of solution.

5) Chelating agent ethylene diamine tetraacetic acid (Sequestrine A) 0.25 gram per gallon of solution.

(6) Dyestuff as listed in table 1% on the weight of the goods, except in the case of vat dyestuff, in which case the solution contained 5% of dyestuff on the weight of the goods. The solution ratio in all cases was 40 to 1.

In each dyeing, a main sample (5 grams) as indicated on the table was effectively dyed, and in addition a smaller sample (1 gram) of a test fabric having strips of various fabrics was successfully dyed where indicated by an X. In each case the scouring agent, resin and other ingredients remained compatible during the dyeing. This is strong evidence of the versatility of the solution. All of the fabrics were cleansed of soil, and all obtained a satisfactory "hand." In the case of the wool sample, the loft and softness were greatly improved.

The experiments also demonstrated that mild boiling will not affect the stability of the solution. Vigorous boiling was found to cause deposition of dye and resin, and accordingly it is decidedly preferable to proceed rapidly under superatmospheric pressure to prevent boiling at temperatures above the normal boil. The dyeing in accordance with the general procedure of Example I is recommended for the solutions of Examples 3 to 19.

APPARATUS TO CARRY OUT METHOD

Considering now the drawing, a group of stocking forms **20** on a suitable vehicle **21** are arranged in a circle when viewed from the top. The forms are loaded in a position outside the sealed container in which the treating operation takes place and are then inserted into the pressure-tight container **22** by raising its upper bell portion **23**, which seals by a suitable gasket against its lower dish portion **24**.

At the top of the interior of the bell a central spray head **25** is provided with means to rotate and distribute the spray equal distances from the center to the hosiery forms around the spray head.

The chemical treating solution is made up in a separate mixing tank and introduced into a suitable storage tank. When the dyeing, scouring and finishing cycle is to be performed, a measured increment of treating solution is introduced at the bottom of the dish, and the air vent **26** at the top of the bell is closed, sealing the interior of the container from the atmosphere, but retaining it filled with air. From the sump at the bottom of the tank the treating solution is withdrawn through pump **27** and discharged under pressure through the spray head. Heating coil **28** in the pump receives steam which does not enter the interior of the container, but acts by heat transfer through the wall of the heating coil. The temperature is controlled by a suitable temperature controller to retain a predetermined temperature.

A suitable drain **30** is provided in the bottom of the sump.

For drying, an air blower **31** connects to the bottom of the sump and introduces air heated by heater **32**, which discharges through the open vent in the top.

OPERATION

In operation one vehicle with the hosiery forms, sweater forms or other textile supports is always in loading position and the other vehicle is in the container being treated.

The operator, to start the next cycle, shifts the vehicle containing treating fluids to the discharge and loading position and introduces a new vehicle with gray goods inside the treating container. A measured charge of treating solution is introduced into the dish and the container is closed. The pump starts withdrawing treating solution from the dish and discharging it through the rotating spray heads, and heat transfer from the steam coil heats the solution and the air in the closed space.

Heating elements maintain a predetermined temperature desirably set at above 230 degrees F., for best results under particular conditions with nylon hosiery, it being understood that the temperature will vary with the particular operating conditions and the character of the work and treating chemicals.

The recirculation of the treating solution through the spray nozzles continues for a predetermined time, which will vary with the particular conditions. In normal practice under the present invention, with hosiery it will be in the range of about 1 to 30 minutes and preferably between 2 and 15 minutes, for example, in the case of nylon hosiery being between 4 and 5 minutes, usually about 4.5 minutes.

During the short interval of time the hosiery or other textile materials are scoured, dyed, lubricated and set.

It is important to note that the pressure developing in the closed space in the preferred embodiment prevents the treating solution from boiling and permits maintaining a temperature of the order of 230 degrees F. or even much higher without boiling. This is very desirable for dyeing, finishing, scouring and also setting. This control of boiling prevents the possibility that the dye and resin would be thrown down by boiling.

During the scouring, dyeing, finishing, lubricating and setting operation, the pump draws off treating solution from the bottom of the closed container and pumps it through the spray nozzles or other distributing devices. At the end of this phase of the cycle the pump stops, the drain opens to discharge the treating solution, and a vent valve at the top opens to the atmosphere. Air or other suitable gas properly heated is introduced to dry the hosiery on the forms. The drying time will vary with the requirements, but will suitably be two minutes in the case of hosiery.

At the end of the drying time the container is opened and the hosiery forms on a suitable vehicle are removed.

This completes the cycle as far as scouring, dyeing, finishing, setting and drying are concerned.

During the period that the dyeing and settling are taking place for one set of hosiery forms, the operator is stripping and then loading another set.

In view of our invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of our invention without copying the method and composition shown, and we, therefore, claim all such insofar as they fall within the reasonable spirit and scope of our claims.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. The method of scouring, dyeing, heatsetting and finishing thermoplastic, synthetic fiber garments, which comprises making up a master treating solution which contains in compatible form, water base, dyestuff, surface active agent and resin, placing the garments on forms and exposing the forms to treatment in a closed space filled

with air, placing a fresh measured increment of master solution not previously used in the space and heating the solution increment, spraying the solution increment on the garments supported by the forms in the closed space, raising the temperature in the closed space at a temperature between 212° F. and 325° F. while preventing boiling of the solution increment by the superatmospheric pressure in the closed space in the presence of the heated air, the space being free from addition of outside steam which would dilute the solution increment, and terminating the scouring, dyeing, setting and finishing operation within a time of from 1 to 30 minutes from the beginning of spraying.

2. The method of claim 1, which comprises spraying the solution through an equal distance to each garment.

3. The method of claim 1, in which the garments are made of nylon.

4. The method of simultaneously scouring, dyeing, finishing, and heatsetting thermoplastic textile materials which comprises making up a treating solution which contains, in compatible form, water base, dyestuff, surface active agent and resin, introducing textile materials in a closed space mounted on forms along with a measured amount of said solution not previously used, the space being filled with air, raising the temperature in the closed space between 212° F. and 325° F. while preventing boiling of the solution by superatmospheric pressure in the closed space assisted by the heated air, spraying said heated solution on the textile materials in the closed space by circulating the solution, maintaining said elevated temperature and superatmospheric pressure while circulating the solution, and then drying the textile materials while still supported on the forms.

5. The method of claim 4, in which the treating solution comprises from 0.01 to 1.0% by volume of surface active agent, and from 0.03 to 1.0% by volume of resin.

6. The method of claim 4, in which the surface active agent is nonionic.

7. The method of claim 4, in which the surface active agent is the condensation product of ethylene oxide with a vegetable oil.

8. The method of claim 4, in which the resin is melamine-formeldehyde.

9. The method of claim 4, in which the resin is urea-formaldehyde.

10. The method of claim 4, in which the treating solution comprising from 0.01 to 1.0% by volume of surface active agent, from 0.3 to 1.0% by volume of resin, from 0.05 to 1.0% by weight of lubricant and from 0.03 to 1.0% by weight of chelating agent effective in chelating alkaline earth metals and heavy metals including iron.

11. The method of claim 4, in which the treating solution is sprayed repeatedly in said space, onto the textile materials, by recirculating the treating solution repeatedly from the bottom of said space, while said temperature and superatmospheric pressure are maintained.

12. The method of claim 11, which comprises relatively rotating the textile materials and the spray during the treating operation.

13. The method of claim 11, which comprises relatively rotating the textile materials and the treating spray, and discharging the spray both downwardly and radially outwardly onto the textile materials during the treating.

14. The method according to claim 11, which comprises draining off the treating solution from the bottom of the space after the treating solution has been sprayed repeatedly in said space, and blowing air through the space to dry the textile materials on the forms.

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