United States Patent Office

2,750,250

Patented June 12, 1956

2,750,250

METHOD FOR DYEING POLYACRYLONITRILE FABRICS

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No Drawing. Application March 13, 1952, Serial No. 276,470

3 Claims. (Cl. 8—55)

This invention relates to a method for treating a textile produced from a polymer of acrylonitrile. More particularly, it relates to a process for treating a textile such as the filtment, fiber, yarn, staple, fabric and the like produced from a polymer of acrylonitrile to enhance its uniformity toward dye application.

It is a matter of common knowledge that a textile such as a filament, fiber, yarn, staple, fabric and the like produced from a polymer of acrylonitrile is very difficult to dye uniformly. The slightest abrasion causes bruises which result in variations in the dye absorption characteristics of the textile. Thus, upon dyeing, non-uniformity is observed in the form of warp streaks filling barré and the like which, in many instances, destroys or materially lessens the commercial value of the product.

It is an object of this invention to provide a process for the treatment of a textile such as the filament, fiber, yarn, staple, fabric and the like produced from a polymer of acrylonitrile which will enhance its uniformity in conventional dyeing processes.

A further object is to produce a textile such as a filament, fiber, yarn, staple, fabric and the like produced from a polymer of acrylonitrile which can be dyed in a uniform fashion by conventional dyeing processes.

These and other objects will become apparent in the course of the following specification and claims.

The objects of the present invention are accomplished by subjecting a textile such as the filament, fiber, yarn, staple, fabric and the like produced from a polymer of acrylonitrile to an elevated temperature while under stress, i. e., pressure or tension prior to dye application. After this pretreatment, the textile may be dyed uniformly employing conventional dyeing processes.

By the term "textile produced from a polymer of acrylonitrile" is meant a filament or fiber or the like formed by extrusion of a polymer of acrylonitrile such as is illustrated in U. S. Patent No. 2,436,926 to R. A. Jacobson dated March 2, 1948, and also the yarn, staple, fabric and the like produced therefrom. The term "polymer of acrylonitrile" is intended to include any polymer of acrylonitrile including polyacrylonitrile (i. e., the homopolymer) wherein the acrylonitrile component constitutes about 85% or more of the polymer molecule calculated as CH_2—CH=CN. Among the compounds that may be copolymerized with acrylonitrile may be mentioned 2-vinyl pyridine, 4-vinyl pyridine, 5-ethyl-2-vinyl pyridine and 2- or 4-vinyl quinoline. Such copolymeric materials are shown in U. S. Patent No. 2,491,471 to H. W. Arnold, dated December 20, 1949.

The following examples are cited by way of illustration and not by way of limitation.

EXAMPLE I

A swatch 6 x 6 inches, woven in a taffeta pattern from 100/40 polyacrylonitrile yarn (i. e., a 100 denier, 40 filament yarn composed of the homopolymer of acrylonitrile) is scoured in a bath containing 0.2% of an anionic detergent (the sodium salt of the product obtained by sulfation of a commercial mixture of higher alcohols). The purpose of this step is to remove the polyethylene ether of the long chain alcohol, which had been previously applied as a finish. The swatch is then boiled-off in an aqueous solution containing 1% acetic acid and 0.2% of the anionic surface-active agent described above. After one hour, the swatch is rinsed with soft water until free of residual acid. Thereafter, the fabric is dried in a tumbler at a temperature of approximately 50° C. It is then ironed on both sides on a hard surface with an ordinary household iron at 450° F. Thereafter, it is dyed for one hour at 98° C. in a bath containing 3.0% of "Celanthrene" Pure Blue BRS 200 dye. The resulting product has a uniform blue color and is free from filling barré, warp streaks and the like.

A swatch of the same material, which was not submitted to the ironing process as described above, is dyed in accordance with the conditions outlined therein. In this case, the swatch shows pronounced short length variations in dye receptivity, warp streaks and filling barré.

EXAMPLE II

Three swatches 6 x 6 inches, woven in a taffeta pattern from 200/80 polyacrylonitrile yarn are scoured in a bath containing 0.2% of the anionic detergent named in Example I. This step removes the finish previously applied to the yarn. The swatches are then rinsed with soft water to remove all trace of the detergent. Thereafter, they are dried in a tumbler at a temperature of approximately 50° C. and then ironed on both sides on a hard surface with an ordinary household iron at 450° F. Each swatch is then dyed for one hour at 98° C. The dyes employed and their concentrations are shown in the table:

Table

Swatch	Dye	Concentration, percent
A	"Celanthrene" Pure Blue BRS 200	3.0
B	Fuchsine Red (Color Index 677)	0.5
C [1]	Anthraquinone Blue SWF	2.0

[1] In the dyeing of this swatch a cuprous ion assistant is employed by including within the dye bath 8% hydroxylamine sulfate and 5% copper sulfate based on fabric weight.

The resulting products in each case are of a uniform color, free from filling barré, warp streaks and the like.

Similar swatches of the same material, which were not subjected to ironing as described above are dyed with the various dyes in accordance with the conditions of the procedure outlined above. In each case, pronounced short length variations in dye receptivity, warp streaks, and filling barré are observed.

EXAMPLE III

A roll of fabric, 36 inches wide, woven in a taffeta pattern from 200/80 polyacrylonitrile yarn is boil-scoured for one hour at 205° F. in the anionic detergent of Example I, rinsed, vacuum-extracted and loop-dried at 260° F. It is then subjected to a scour containing 2% oxalic acid and 0.2% of the anionic surface-active agent described above at the boil in a closed beck for two hours, rinsed, vacuum-extracted, and tenter-dried at 260° F. (Acid and detergent percentages are based on solution, not fabric weight.) It is then given a pass over six heat-setting can rolls at 380° F. at a rate sufficient to give a total contact time of ten seconds. This pass is made with appreciable tension on the fabric. Thereafter, it is dyed at 205° F. in an open beck in a bath containing 5% of Celanthrene Pure Blue BRS 400 dye. The re-

sulting product is of a uniform blue color, free from filling barré, warp streaks and the like.

A sample of the same fabric, not subjected to the pass over the heat-setting rolls under tension, although dyed in accordance with the dyeing procedure of the above process, displays numerous dye variations, warp streaks, and filling barré.

As a preliminary treatment, it has been found expedient to remove all traces of foreign matter from the surface of the textile that is to be ultimately dyed. Such a step is shown in each of the examples cited above. The nature of the detergent in this step is not critical. Where a gelatin or starch size or an oily lubricant or finish has been employed, it has been found convenient to use the sodium sulfate of a commercial mixture of higher alcohols as detergent. However, any suitable anionic, cationic, or nonionic detergent may be used. Soap is frequently sufficient. The period of scouring will be governed by the type of finish and effectiveness of the detergent used.

It is essential in the present process, after removal of all foreign matter such as finishes and sizing, that the textile be subjected to heat while under stress. As is shown in the first two examples, this may be accomplished by using the conventional household iron at temperatures within the range of about 300 to 500° F. Lower temperatures may be employed provided the period of contact is lengthened. For practical operations, a temperature of about 250° F. is considered a minimum. A minimum pressure of two pounds per square inch is essential. Preferably, it should be about five pounds per square inch. Higher pressures may be employed without deleterious effects. Heated rollers are also suitable for the simultaneous application of heat and pressure. Instead of pressure, the textile may be subjected to tension while the heat is being applied as is shown in the third example. It is thus possible to practice the present invention by stretching the fabric during singeing operations. As pointed out above, the period under stress will be primarily a function of the temperature. In the higher range of temperatures, momentary contact is sufficient. At lower temperatures, somewhat longer contact is necessary. The nature of the dye is not critical. Any conventional dye for a textile produced from a polymer of acrylonitrile is suitable. Thus, the dyestuff may be of either a basic- or acid-type.

The first and third examples illustrate a preferred embodiment in that they include a boil-off in the presence of a short chain carboxylic acid after the detergent treatment step. The purpose of this boil-off, which is not essential to obtain uniform dye application according to the present process, is to promote uniform retention of color in the textile upon exposure to heat and/or light. Among the short chain carboxylic acids which may be used for this purpose may be mentioned formic, acetic, propionic and oxalic. Acid concentrations will vary somewhat, depending on the acid. A 1% to 2% aqueous solution has been found effective for acetic acid. This treatment has been found to be particularly effective when certain surface-active agents are employed in the acid

boil-off bath. The preferred material is sodium salt of the product obtained by sulfation of a long chain aliphatic alcohol containing from 10 to 18 carbon atoms. Among such alcohols may be mentioned decyl, dodecyl, cetyl, lauryl, oleyl, stearyl and the like. Furthermore, mixtures of such materials may be used. Thus, mixed alcohols such as are prepared by the catalytic hydrogenation of natural oils are suitable. Usually a concentration of 0.1% to 0.2%, based on the aqueous solution, is employed.

The treatment described is effective for all physical forms of textiles made from a polymer of acrylonitrile. It is likewise applicable to all types of woven or knitted fabric, whether formed from continuous monofilament or multifilament yarn or from spun yarn, i. e., yarn made from staple fibre, or from mixtures of these yarns. While the invention is primarily concerned with fabrics made from a yarn of a polymer of acrylonitrile, it is also useful and advantageous in the treatment of fabrics made from mixed yarns wherein the yarn of a polymer of acrylonitrile is admixed with one or more other natural or synthetic fibre such as nylon or wool.

Many other equivalent modifications within the scope of the invention will be apparent to those skilled in the art without a departure from the inventive concept.

What is claimed is:

1. A process for dyeing a textile produced from polyacrylonitrile which comprises the steps of scouring the said textile in the presence of a detergent to remove foreign matter from its surface, immersing the said textile for at least about one hour in boiling water containing from about 0.1 to about 0.2% of a sulfate of an aliphatic alcohol containing from ten to eighteen carbon atoms and from about 1 to about 2% of a low molecular weight carboxylic acid, rinsing the said textile with water, drying the said textile, subjecting the said textile to a stress of at least about two pounds per square inch at a temperature within the range of from about 300° to about 500° F. and thereafter applying a dye.

2. The process of claim 1 wherein the stress applied to the said textile is a tension.

3. The process of claim 1 wherein the stress applied to the said textile is pressure.

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