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3,558,260

METHOD FOR THE RAPID AND CONTINUOUS DYEING OF MIXTURES OF TEXTILE MATERIALS

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2 Claims

ABSTRACT OF THE DISCLOSURE

Textile materials and films are rapidly and continuously dyed by subjecting them to the action of a hot aqueous dye liquor containing benzyl alcohol when the textile material is nylon or polyester, propylene carbonate or dipropylene carbonate (especially the latter) when the textile material is acrylic, or wool; or a mixture of benzyl alcohol and propylene carbonate or dipropylene carbonate (especially the latter) when the textile material is a mixture of nylon or polyester with one of the others just named, including wool.

The present invention relates to the rapid and continuous dyeing of textile materials and films and also to an apparatus especially useful in achieving those dyeing results.

Those familiar with the art of dyeing are well acquainted with the multitude of processes for the continuous dyeing of textile materials and films and therefore will appreciate the simplicity of the processes described hereinafter, as well as the simple and comparatively inexpensive apparatus especially adapted to bring about those dyeing results.

It has been established that the continuous dyeing methods in use today are only adaptable for certain types of synthetic materials and are valueless for other synthetic materials or textiles made from natural fibers. For instance: the so-called "Thermosol Process" and the machinery used for that process are only adaptable for synthetics where a migration of color into the fiber through heat can be obtained. Therefore, the "Thermosol Process" is mostly used for textile materials composed of polyester and can only be used in conjunction with dispersed dyestuffs. Dispersed dyestuffs show the ability to migrate from a coating into the polyester material. Reference to "polyester" here and elsewhere throughout the specification and claims is to be taken as referring to conventional polyethylene terephthalate, which may or may not be modified in ways per se well known to the art.

Another dyeing method is to penetrate a textile material or film with a solution of certain suitable dyestuffs and then subsequently expose the thus-treated textile material or film to steam. This steaming cycle is very time-consuming, and it can readily be seen that in order to achieve considerable production large size steamers are necessary. This is especially the case in dyeing 15 feet width carpets by either of the aforementioned methods.

In practice it has also been found that considerable difficulties are encountered due to unevenness of the color across the width of the material. This defect is especially apparent in the continuous dyeing of 15 feet width carpets. With the existing continuous dyeing methods it is very difficult to dye satisfactorily to dark and full shades. It is further difficult to dye continuously textile materials composed of mixtures of various synthetics or natural fibers. It will be appreciated from the following disclosure of my processes and from the description of my new and improved dyeing apparatus that these aforementioned difficulties are eliminated.

For instance: I have found that when a commercial polyester material is treated as described in my U.S. Patent No. 2,938,811, issued May 31, 1960, such treated

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polyester materials may readily be dyed continuously and rapidly in an aqueous dyebath containing a suitable dye-stuff and certain swelling agents for the polyester material. I have also found that the dyeing time may be as short as 10 seconds to accomplish fully penetrated dyeings. In the case of very dark dyeings, however, it may be advantageous to increase the dyeing time somewhat. I have discovered that a good deep black requires a dyeing time of only 40 seconds.

In order to achieve rapid dyeing time with polyester materials, it is necessary to use a suitable swelling agent in the aqueous dyebath. Suitable swelling agents I have tried were phenolic compounds, resorcinol, dibenzyl ether emulsion, benzyl alcohol, and banzyl alcohol emulsions. However, I do not wish to limit myself to the use of the aforementioned swelling agents for polyester materials.

I have found that the best results were obtained with benzyl alcohol as the swelling agent for polyester textile material.

For instance: A skein of polyester yarn, pre-treated in accordance to my U.S. Patent No. 2,938,811, was dyed for 10 seconds at the boil in a dyebath containing:

water—500 cc.

Igepon T (dispersing agent)—1 gram

C. I. Disperse Red 55—1 gram

The outcome of this dyeing was a light red.

When to the same dyebath I added 5% benzyl alcohol and dyed another skein of polyester yarn under the same conditions as mentioned before, the resulting dyeing was a dark and full red.

I finally discarded the use of all phenolic compounds as swelling agents for the polyester material due to the adverse effect on the fastness properties. These adverse effects follow from the fact that the phenolic compounds can only be removed with difficulty by heating the polyester material, after dyeing, during the final drying operation to very high temperatures such as 380° F., and if all traces are not removed the light fastness is adversely affected. Moreover, aside from the adverse effect on the polyester material itself, one of the most serious side effects from the use of these phenolic compounds is the contamination of the discharge wash water containing them, with the ultimate contamination of our rivers and streams.

Another skein of polyester yarn, pre-treated according to my U.S. Pat. No. 2,938,811, was dyed for 10 seconds at a boil in a dyebath containing:

Water—500 cc.

Igepon T—1 gram

Resorcinol—25 grams

C.I. Disperse Red 55—1 gram

This dyeing was considerably darker than the dyeing without a swelling agent, as described above, but not quite as dark as the dyeing with benzyl alcohol as swelling agent.

Another skein of a polyester yarn, pre-treated according to my U.S. Pat. No. 2,938,811, was dyed under the same conditions as above in a dyebath containing:

Water—470 cc.

Dibenzyl ether—25 cc.

Emulsifier (Lyogen CW-40, an ethylene oxide condensate manufactured by Sandoz)—5 grams

C.I. Disperse Red 55—1 gram

This dyeing showed the same result in depth of color as the dyeing with benzyl alcohol. Although dibenzyl ether is considerably cheaper than benzyl alcohol, I prefer the use of benzyl alcohol due to its greater ease of handling. Since dibenzyl ether is water-insoluble, it is very difficult to remove from the polyester material unless an emulsifier is also used.

I have also discovered that textile materials or articles composed of acrylics, such as Orlon, Acrilan or Lucite, may be dyed rapidly and continuously in a matter of seconds into full and dark shades. Here again I make use of a swelling agent for the acrylic material in order to accelerate the dyeing process. Of the various swelling agents tested, I have found that propylene carbonate and dipropylene carbonate are the most suited as swelling agents for acrylic materials. Of these carbonates, dipropylene carbonate is preferred due to its heat stability. The dipropylene carbonate is employed in the form of an aqueous solution. During the course of my research I discovered that propylene carbonate, especially when the dyebath is acidified, tends to decompose very rapidly, thus losing its effect as a potent swelling agent for acrylic materials. Therefore when propylene carbonate is to be used, the acrylic textile material is preferably impregnated with a solution containing propylene carbonate at room temperature and then the impregnated textile material is exposed to steam.

A skein of Orlon was dyed in 10 seconds at the boil, using a dyebath composed of:

Water—450 cc.
Dipropylene carbonate—50 cc.
C.I. Basic Red 14—1 gram

The resulting dyeing was a full brilliant red. Standard fastness tests performed on this dyeing showed the same fastness properties as with Orlon dyed conventionally to the same depth of shade with this same dyestuff.

I also found that by increasing the dyeing time I could reduce the amount of dipropylene carbonate proportionately. For instance, a skein of Orlon was dyed in 20 seconds at the boil using a dyebath composed of:

Water—475 cc.
Dipropylene carbonate—25 cc.
C.I. Basic Red 14—1 gram

This dyeing matched the previous dyeing in all respects including the fastness properties.

For light and pastel shades the amount of dipropylene carbonate may be further reduced. In practice it is unnecessary to exceed the use of 10% dipropylene carbonate in the aqueous dyeing solution even for dark dyeings. However, I do not wish to limit the amount of dipropylene carbonate that may be used to 10% inasmuch as the precise concentration in any given case is dictated primarily by economic considerations.

I have further found that dipropylene carbonate has the same beneficial effect in the dyeing of wool as it has in the dyeing of acrylic materials. The effect of dipropylene carbonate on wool is not fully understood by me but apparently it must have a swelling effect on the wool, thus allowing the dyestuff to penetrate the fiber rapidly.

As an example, a wool skein was dyed for 20 seconds at a boil in a dyebath containing:

Water—450 cc.
Dipropylene carbonate—50 cc.
C.I. Acid Blue 25 C.I. 62055—1 gram

The outcome of this dyeing was a full deep blue shade. This dyeing showed the same fastness properties as a sample dyed conventionally with the same dyestuff with the same depth of shade.

Another wool skein was dyed for 20 seconds at the boil with a pre-metallized acid dyestuff in a dyebath containing:

Water—450 cc.
Dipropylene carbonate—50 cc.
C.I. Acid Brown 45—1 gram

The resulting dyeing was a good full reddish brown shade, with the same fastness properties as a sample dyed conventionally with the same dyestuff with the same depth of shade.

I have also found that by preparing a dyebath with a mixture of benzyl alcohol and dipropylene carbonate and

with the use of a proper dyestuff having affinity to both wool and nylon, a perfect union dyeing of the two fibers resulted.

For example: One skein of wool and one skein of nylon (Type 6) were dyed simultaneously for 20 seconds at the boil in a dyebath containing:

Water—425 cc.
Benzyl alcohol—25 cc.
Dipropylene carbonate—50 cc.
C.I. Acid Red 88 C.I. 15620—1 gram

The resulting dyeing was a deep red with the same depth of shade on the wool as on the nylon.

I have also found that a textile material composed of wool and polyester, pre-treated as described in my U.S. Pat. No. 2,938,811, may be dyed in the same dyebath into a union shade. A fabric composed of 55% wool and 45% polyester, pre-treated according to my U.S. Pat. No. 2,938,811, was dyed for 20 seconds at the boil in a dye bath containing:

Water—425 cc.
Benzyl alcohol—25 cc.
Dipropylene carbonate—50 cc.
C.I. Acid Violet 12 C.I. 18075 (to dye the wool)—0.25 gram
C.I. Disperse Violet 17 (to dye the polyester)—1 gram

The result of this dyeing was a bluish red with an excellent union dyeing between the wool and the polyester.

A skein of wool and a skein of acrylic material, such as Orlon, were dyed simultaneously for 20 seconds at a boil in a dyebath containing:

Water—450 cc.
Dipropylene carbonate—50 cc.
C.I. Acid Blue 15 C.I. 42645 (for the wool)—0.5 gram
C.I. Basic Blue 22 (for the Orlon)—0.2 gram

The resulting dyeing was a bright blue shade and showed a good union between the wool and the Orlon.

In order to bring about the best dyeing results in carrying out the aforementioned process, I have designed an apparatus especially useful for that purpose although it is not limited thereto.

In order to achieve perfect dyeing, it is necessary to create an equilibrium between the dyestuff in the dyebath and the dyestuff deposited on the textile material.

In all continuous dyeing apparatus working on the dyestuff exhaust principle, it has been found that the dyestuff is exhausted out of the dyebath more rapidly than it can be replenished. This defect results in streaky and uneven dyeing.

The principle of my dyeing apparatus is to move the dye liquor through the apparatus at a much higher speed than, and in the same direction as, the textile material undergoing dyeing. Due to the relatively higher speed of the concurrently flowing dye liquor, it becomes possible to feed sufficient dyestuff to maintain an equilibrium while the material passes through the dyeing apparatus. Preferably, turbulent flow conditions for the dye liquor are maintained substantially throughout at least those portions of the apparatus where the dyeing takes place.

The accompanying drawing shows a dyeing apparatus especially designed for the continuous dyeing of carpets of considerable width. However, it is to be understood that the apparatus can also be arranged to accommodate less bulky materials such as dress goods and suitings.

As shown in the drawing, which is schematic and partly in vertical cross-section, 2 is a funnel-shaped container adapted to contain the hot dye liquor which is circulated through the dyeing apparatus in the same direction as the textile material. The funnel-shaped container 2 converges toward a region of relatively restricted cross-section at 4 which in turn leads into a sinuous chamber 6 which (as shown) may consist of a pair of U-shaped members connected serially in such fashion as to constitute the main treating chamber 6 through which the textile material undergoing dyeing passes in a tortuous path.

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The funnel-shaped container 2 is closed by a removable top seal 8 which fits into the funnel and which contains a pair of Teflon lips 10 through which the wide carpet or other textile material passes into the dyeing apparatus. The Teflon lips 10 prevent the dye liquor circulating in the system from rising above the seal 8.

By way of illustration of specific dimensions that are suitable, the bottom of the funnel-shaped container 2 converges at the point 4 to what is, in effect, a slot which may e.g. be about 1" in width.

The textile material undergoing dyeing, for example a 15-ft. width carpet 12, is introduced via the Teflon lips 10 into the dyeing apparatus and passes downwardly beneath and around an elongated guide roller 14 and through the remaining legs of the treating portion 6 of the dyeing apparatus by a succession of elongated guide rollers 16 and 18. The carpet or other textile material 12 then passes upwardly from the last open leg of the dyeing apparatus and out of the dyeing apparatus between a pair of squeeze rollers 20 which serve to assist in keeping the textile material moving properly through the apparatus and also for removing excess dye liquor adhering to the treated textile material.

In addition to the squeeze rollers 20, air knives (not shown) may be positioned adjacent the squeeze rollers in such a manner as to blow either cool or heated air upon the emerging textile material in order still further to assist in removing excess dye liquor from the dyed textile material.

Referring now to the main portion of the dyeing apparatus at the legs 6, 6, 6, 6, the thickness in horizontal cross-section is preferably the same as that at the point 4, namely, about 1". This leaves, in the case of dyeing a carpet or other textile material which is about 1/2" thick, approximately 1/4" on each side of the carpet as it moves through the dyeing apparatus for the proper circulation of the hot dye liquor. The total length of the treating chamber 6, 6, 6, 6 is about 20 feet.

The circulation system for the hot dye liquor 22 includes a pair of conduits 24 for introducing hot dye liquor into the upper portion of the funnel-shaped container 2 from a suitable manifold 26. Manifold 26 receives hot dye liquor from pipe 28 leading from pump 30, which conveniently takes the form of a high velocity liquid circulating pump receiving hot dye liquor from the heater 32. The circulating dye liquor enters the heater 32 by means of a suitable metering pump 34 which is fed from dye liquor sump 36. Additional or makeup dyestuff liquor is introduced into the sump 36 via inlet conduit 38 when and as required in response to a conventional float control valve arrangement 40. The sump 36 receives circulating dye liquor from the discharge end of the dyeing apparatus 6 from which it overflows via conduits 42, 44 and 46. The upper end of the last leg 6 of the dyeing apparatus may be extended upwardly to a point well above the normal level of the liquid therein, in order to facilitate proper circulation of the hot dye liquor.

In operating the dyeing apparatus, guide rollers 14, 16 and 18 as well as squeeze rollers 20 are positively driven (by conventional means not shown) in such a manner as to minimize all lengthwise tension in the carpet or other textile material undergoing the dyeing treatment. In other words, the relative speeds of these rollers are adjusted in such a manner that the path of the textile material between successive guide rollers is essentially a straight line while at the same time avoiding excessive tension on the textile material.

By increasing or decreasing the speed of the high velocity liquid circulating pump 30, it is possible readily to increase or decrease the rate of liquid flow into the funnel-shaped container 2 and hence the rate of liquid flow through the dyeing apparatus itself. In this way, the hot dye liquor is caused to circulate through the system at a linear rate which is a predetermined multiple of the speed of the carpet or other textile material undergoing the

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dyeing operation. For example, if the carpet or other textile material is passed through the dyeing apparatus at the rate of (say) approximately 60 feet per minute, it is readily possible by means of a suitable adjustment to the pump 30 and the pump 34 to create an overall circulation rate for the hot dye liquor through the apparatus of (say) about 600 linear feet per minute. This high speed concurrent flow of the hot dye liquor in relation to the rate of travel of the carpet or other textile material undergoing dyeing creates highly turbulent conditions of liquid flow, thus assuring thorough penetration of the hot color solution into and through the textile material. Due to this relatively high linear rate of flow of the hot dye liquor, it becomes a very simple matter to maintain an equilibrium between the dyestuff in the rapidly moving dye bath and the dyestuff deposited on the more slowly moving carpet or other textile material. For example, good results are obtained when the carpet or other textile material is passed through the dyeing apparatus at speeds of from about 10 to 60 yards per minute. The correlative linear speeds for the circulation of the hot dyeing liquor flowing concurrently through the apparatus are of the order of about 2 to 10 times that of the textile material, measured in the most restricted portions (i.e. the vertical portions) of the legs 6, 6, 6, 6 of the treating apparatus.

Although the preferred temperature of dyeing is with the aqueous dyebath at or close to the boil, somewhat lower temperatures may be employed if desired with somewhat less desirable results. Thus, aqueous dyebath temperatures as low as 170° F. may be resorted to, if desired. Generally speaking, however, dyeing temperatures at or near the boil, i.e., in the range of about 208° to 212° F. are preferred.

What is claimed is:

1. In a method for the rapid dyeing of textile materials comprising a mixture of wool and a polyester at elevated temperatures by means of a color solution comprising an aqueous solution of a suitable dyestuff, the improvement comprising employing as the color solution an aqueous solution containing the dyestuff and, as a swelling agent, a mixture comprising dipropylene carbonate and benzyl alcohol.

2. In a method for the rapid dyeing of textile materials comprising a mixture of wool and a nylon at elevated temperatures by means of a color solution comprising an aqueous solution of a suitable dyestuff, the improvement comprising employing as the color solution an aqueous solution containing the dyestuff and, as a swelling agent, a mixture comprising dipropylene carbonate and benzyl alcohol.

References Cited

UNITED STATES PATENTS

3,069,221	12/1962	Hermes	8—92
3,097,044	7/1963	Skeuse	8—55
3,199,940	8/1965	Tourelle	8—21
3,264,052	8/1966	Rhyner	8—55C
3,313,590	4/1967	Delano et al.	8—55C
3,342,542	9/1967	Morf et al.	8—55C

OTHER REFERENCES

H. V. Schmidlin, Preparation and Dyeing of Synthetic Fibers, 1963, Publ. Chapman & Hall Ltd., London, pp. 152—155, 159.

H. C. Speel, Textile Chemicals and Auxiliaries, 1957, Reinhold Publishing Corp., New York, pp. 280, 281, 299, 300.

E. R. Trotman, Dyeing and Chemical Technology of Textile Fibers, 1964, Publ. Griffin, London, p. 521.

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