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3,085,987

LINEAR POLYESTER CONTAINING A DIARYL ETHER AND PROCESS OF PRODUCING SAME

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This invention relates to fiber- and film-forming synthetic linear condensation polyesters and shaped articles which are produced therefrom. More particularly, it is concerned with a synthetic linear condensation polyester composition from which readily dyeable shaped articles may be prepared, and to a process for producing such shaped articles.

Synthetic linear condensation polyesters, and particularly the linear terephthalate polyesters, have attracted high commercial interest for many uses owing to their high tenacity, flexibility, crease resistance, low moisture absorption, and other valuable properties. Among such polyesters are polyethylene terephthalate and poly-(p-hexahydroxylylene terephthalate). One of the chief disadvantages associated with the polyesters, however, has been the difficulty in dyeing fabrics and other shaped articles composed thereof with commercially available dyes.

It has been proposed to modify polyester filaments by treating them with various reagents to create sites receptive to dyes on or in the filaments; however, such treatments have usually been effective only for modifying the surface of the fiber, and in many cases the physical properties of the fibers are adversely affected by the treatment. It has also been proposed to prepare copolyesters containing substituents which would tend to serve as sites receptive to dyes. Even with the use of such methods, however, it has been necessary in general to employ elevated pressures and temperatures to obtain deep shades in the dyeing of polyester articles. These requirements have placed restrictions on the commercial dyeing of polyester articles owing to the need for costly pressure equipment and special methods. In contrast, the natural fibers such as cotton and wool are customarily dyed at the boil at atmospheric pressure.

It is an object of this invention to provide a synthetic linear condensation polyester composition from which shaped articles dyeable at the boil at atmospheric pressure may be produced. Another object is to provide readily dyeable modified polyester yarns which have physical properties comparable to those of their corresponding unmodified polyester yarns. A further object is to provide a process for producing readily dyeable shaped articles composed of synthetic linear condensation polyesters. Other objects will be apparent from the following description and claims.

In accordance with the present invention, it has been found that filaments having greatly enhanced rates of dyeability can be melt spun from linear condensation polyesters having dissolved therein an aromatic ether of the formula $\text{Ar}(\text{OC}_n\text{H}_{2n})_{x-1}\text{OAr}'$, where Ar and Ar' are the same or different radicals containing an aromatic nucleus, and n and x are integers within the range of 2 to 4. In a preferred embodiment of the invention, 1,2-diphenoxyethane is employed as the aromatic ether. In carrying out the invention, a solution of the aromatic ether in the molten polyester is prepared and the molten mixture is spun into filaments and drawn in the usual manner to form continuous filament or staple yarns, as desired. The resulting yarns are tenacious and exhibit the desirable properties usually found in polyester yarns. They may be processed by conventional methods into

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woven or knitted fabrics having the texture and appearance associated with fabrics prepared from their corresponding unmodified polyester yarns. However, fabric prepared from the modified yarns are highly receptive to dyes and may be dyed to any desired depth of color from aqueous dye baths at the boil using conventional equipment at atmospheric pressure. Films or other shaped structures which are highly receptive to dyes may likewise be extruded from the molten linear condensation polyester having the aromatic ether dissolved therein.

The amount of aromatic ether which is added to the polyester is usually in the range of about 3 to about 20% of the weight of the polyester, the optimum usually being considered to be about 10%. At these concentrations, the aromatic ethers falling within the class defined by the formula $\text{Ar}(\text{OC}_n\text{H}_{2n})_{x-1}\text{OAr}'$ are soluble in the molten polyester to form viscous melts which may be extruded into filaments in the same manner as unmodified polymer. The aromatic ethers are stable at the spinning temperature, which is usually about the same as or slightly lower than the normal spinning temperature of the unmodified polymer, e.g., in the range of about 250° C. to 295° C. in the case of polyethylene terephthalate containing about 10% of the aromatic ether. The aromatic ethers are also inert with respect to the polyester and do not promote polymer degradation, either during spinning or while remaining in the yarn over a long period of time.

The solution of the aromatic ether in the molten polyester may be prepared in any of various ways. For example, the solid polyester in flake or other finely divided form may be blended with the aromatic ether and then melted. The ether may also be mixed in the proper proportions with molten polymer, either in a batch manner or by metering the ether into a continuous stream of the polymer. An excess of the ether may also be used as the solvent in a solvent polymerization process, followed by stripping off the ether to the desired concentration in the finished polymer. If desired, delusterants or other additives may also be added during polymerization or just prior to spinning.

The presence of the aromatic ether in the polymer does not alter the ability of the polyester filaments to become oriented and highly tenacious in the drawing step. Surprisingly, the initial modulus and yield point of the corresponding modified and unmodified yarns are quite comparable. The tenacity of ether-containing drawn yarns, while slightly lower than that of similar yarns containing no additive, also remains at a high level as contrasted with the natural fibers. However, the dyeability of the modified filaments is outstandingly superior to that of the unmodified filaments. The improvement is not restricted to any particular type of dye, but applies to all classes of dyes customarily employed with the various types of polyester fibers. In general, the rate of dyeing of the ether-containing fibers is at least several times faster than that of the corresponding unmodified polyesters.

A small amount of the aromatic ether, usually in the range of about 1% of the original weight of the polyester, may evaporate from the filaments during spinning. An additional 2–3% of the ether, based on the weight of the polyester, may be lost if the fabric is subjected to a scour at the boil during processing. However, in the absence of special treatments, an amount on the order of about two-thirds of the aromatic ether originally introduced into the polyester remains in the fiber prior to the dyeing step, during which there is usually a small additional loss of the ether from the fiber.

After the fabric is dyed, the ether still remaining in the polyester may be retained without deleterious effect. However, if desired, the ether may be removed by scour-

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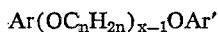
ing with hot solvent or, in the case of the more volatile aromatic ethers, by heating the fabric to an elevated temperature. In removing the ether by means of scouring, a liquid or mixed liquid which is a solvent for the ether but not also a solvent effective for removing the adsorbed dye should be employed, of course. Although the selection of such a solvent will depend upon the particular dye and the particular polyester from which extraction of the ether is desired, carbon tetrachloride or a benzene-ethanol mixture can frequently be used, either at the boil under atmospheric pressure or at elevated temperature and pressure. Removal of the aromatic ether by heat setting is preferably effected at about 190° C., where practicable, although temperatures up to about 230° C. or higher may be used if required.

In removing the aromatic ether from the polyester, slight increases in the tenacity of the fibers are usually noted, up to about the level of the corresponding unmodified polyester fibers. A more important advantage accruing from this treatment, however, is the marked improvement in the hand and general texture of the fabric, especially when the aromatic ether is removed via a heat-setting treatment. Surprisingly, when the aromatic ether is removed, the resulting fabrics are found to have a soft, supple, silk-like hand as contrasted with the smooth, stiff hand resulting from similar heat treatment of the corresponding unmodified polyester fabric.

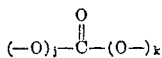
Any of the various aromatic ethers having the formula $\text{Ar}(\text{OC}_n\text{H}_{2n})_{x-1}\text{OAr}'$, wherein Ar and Ar' are the same or different aryl-containing radicals and n and x are integers within the range of 2 to 4, may be employed as additives for enhanced dyeability in accordance with the present invention. The carbon atom in the Ar radical (or Ar' radical) adjacent to the ether linkage is attached, except for the ether linkage, solely to atoms from the group consisting of carbon and hydrogen and is located in an aromatic nucleus or a side chain of an aromatic nucleus. The Ar radical (or Ar' radical) may contain halogen substituents, ether substituents such as methoxy groups, or other substantially non-reactive substituents; but reactive substituents will generally be avoided, especially ester-forming substituents such as carboxyl groups, hydroxyalkyl groups, etc.

Examples of aromatic ethers useful in accordance with the invention include 1,2-di-*o*-biphenyloxyethane, 1,2-bis-(*o*-chlorophenoxy)ethane, 1,2-bis-(*p*-fluorophenoxy)ethane, 1,2-di-*m*-tolylloxyethane, 1,2-di- β -naphthoxyethane, 1,2-dibenzoyloxyethane, 1,3-diphenoxypropane, 1,2-diphenoxypentane, 2,3-diphenoxybutane, and 1,4-diphenoxybutane. Other examples include bis-2-phenoxyethyl ether, bis-3-phenoxypropyl ether, and 1,2-bis-(2-phenoxyethoxy)ethane. In a preferred embodiment of the invention, however, 1,2-diphenoxyethane is employed. Fabrics made from polyester fibers in which this compound is incorporated are observed to absorb dyes at an exceptionally high rate, and the diphenoxyethane is removed substantially completely from the fabric by simple heat treatment at 190° C. for one minute to yield a fabric product having an excellent supple, silk-like hand.

The use of aromatic ethers of the type

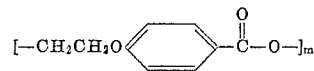


for improving the rate of dyeing is applicable in general to the class of synthetic organic linear condensation polyester fibers. The term "synthetic organic linear condensation polyester" comprehends a substantially linear polymer of fiber-forming molecular weight comprising a series of predominantly carbon atom chains joined by recurring divalent ester radicals, each of said ester radicals comprising a carbonyl group attached on at least one side to an oxygen atom. The divalent ester radicals may be represented by the general formula

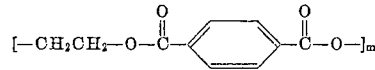


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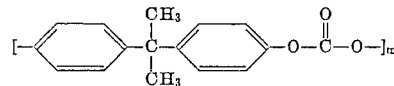
where j and k are zero or 1 and $j+k=1$ or 2. Examples of various synthetic organic linear condensation polyesters comprehended by this definition are as follows:



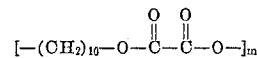
(a) Poly(ethylene *p*-oxybenzoate)



(b) Poly(ethylene terephthalate)



(c) Poly(*p,p'*-isopropylidenediphenyl carbonate)



(d) Poly(decamethylene oxalate)

In the above formulas, m represents a number sufficiently great that the polyesters are of fiber-forming molecular weight; i.e., having a relative viscosity of at least about 10.

Poly(ethylene *p*-oxybenzoate) is an example of a synthetic organic linear condensation polyester in which each repeating unit contains only one ester linkage. Each of the ester linkages is a carboxylate radical oriented in the same direction; i.e., the chain of atoms between successive carboxylate radicals is attached at one end to an oxygen atom of a carboxylate radical and at the other end to the carbon atom of the next carboxylate radical. This polyester is conveniently prepared by the polycondensation of methyl *p*-(2-hydroxyethoxy)benzoate at elevated temperature and reduced pressure.

Poly(ethylene terephthalate), which is usually designated simply as polyethylene terephthalate, is an example of a polyester in which each repeating unit contains two ester linkages, i.e., carboxylate radicals. In this polyester successive carboxylate radicals are oriented in the opposite direction, so that the ethylene radicals are attached at each end to the oxygen atoms of carboxyls and the phenylene radicals are attached at each end to the carbon atoms of carboxyls. Polyethylene terephthalate may be prepared by reacting terephthalic acid with ethylene glycol to form bis-(2-hydroxyethyl) terephthalate, followed by polycondensation at elevated temperature and reduced pressure with elimination of excess glycol. In place of terephthalic acid, ester-forming derivatives may be used, i.e. derivatives which readily undergo polyesterification with ethylene glycol or a derivative thereof. For example, the acid chloride or a lower alkyl ester, such as dimethyl terephthalate, may be used. Similarly, an ester-forming derivative of the glycol may be used in place of the glycol, i.e. a derivative of the glycol which readily undergoes polyesterification with dicarboxylic acids or derivatives thereof. For example, a cyclic oxide from which the corresponding glycol can be derived by hydrolysis may be used.

Poly(*p,p'*-isopropylidenediphenyl carbonate) is an example of a synthetic organic linear condensation polyester in which each repeating unit contains a carbonate ester linkage. Since the carbonate radical is symmetrical, the chain of atoms between successive carbonate radicals is attached at each end to an oxygen atom. This polycarbonate polyester is readily prepared by the reaction of 2,2-bis-(*p*-hydroxyphenyl)-propane with an equimolar quantity of phosgene.

Poly(decamethylene oxalate) is a polyester of the polyethylene terephthalate type, in which each repeating unit contains two ester linkages, being the limiting case in which the two carboxylate radicals are linked together between the two carbon atoms without any intervening chain of atoms. It may be prepared by reacting diethyl oxalate with decamethylene glycol.

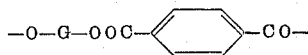
Copolyesters, derived from a glycol and a mixture of

acids or from an acid and a mixture of glycols, etc., may be prepared in accordance with any of the above types or a mixture of them.

As indicated in the examples above, synthetic organic linear condensation polyesters can be formed by the polycondensation of bifunctional monomers which are capable of undergoing condensation with elimination of small molecules such as H_2O , HCl , $NaCl$, CH_3OH , $HOCH_2CH_2OH$, or the like. In general, the synthetic organic linear condensation polyesters are also characterized in that the monomers from which they are derived can be regenerated from the polymer under suitable conditions by hydrolysis, alcoholysis, or other reactions in which small molecules react to split the polymer chain at the ester linkages.

In some cases, small amounts of monomers having three or more functional groups may be employed to promote a limited amount of cross-linking. Similarly, in some cases, monofunctional reagents may be employed in small quantities to control the degree of polymerization. However, in general, it is desired that the polymers be substantially linear and for this reason bifunctional monomers will be used predominantly. As in the case of polyethylene terephthalate as described above, alternative routes employing various types of monomers are usually available for the preparation of any given polyester.

In a preferred embodiment of the invention, the polymer in which the ether is incorporated is a linear glycol terephthalate polyester. By "linear glycol terephthalate polyester" is meant a linear condensation polyester comprising recurring glycol dicarboxylate structural units in which at least about 75% of the recurring structural units are units of the formula



wherein $-G-$ represents a divalent organic radical containing from 2 to about 18 carbon atoms and attached to the adjacent oxygen atoms by saturated carbon atoms. Preferably, the radical $-G-$ contains from 2 to about 10 carbon atoms. The terephthalate radical may be the sole dicarboxylate constituent of the recurring structural units, or up to about 25% of the recurring structural units may contain other dicarboxylate radicals, such as the adipate, sebacate, isophthalate, bibenzoate, hexahydroterephthalate, diphenoxyethane-4,4'-dicarboxylate, *p,p'*-carbonyldibenzoate, and *p,p'*-sulfonyldibenzoate radicals.

The glycol, $G(OH)_2$, from which the polyester is prepared may be any suitable dihydroxy compound containing from 2 to 18 carbon atoms, preferably from 2 to 10 carbon atoms, in which the hydroxyl groups are attached to saturated carbon atoms. Thus, the radical $-G-$ may be of the form $-(C_{p+1}H_{2p+2}Y_{q-1})-$, where p and q are positive integers and Y is a cycloaliphatic group, an aromatic group, an oxy group, or an arylenedioxy group. Examples of suitable glycols where $q=1$ include the polymethylene glycols, such as ethylene glycol, tetramethylene glycol, hexamethylene glycol, and decamethylene glycol as well as the branched chain glycols such as 2,2-dimethyl-1,3-propanediol and 2,2-dimethyl-1,4-butanediol.

Suitable glycols in which $q=2$ include *cis*- or *trans*-*p*-hexahydroxylylene glycol, bis-*p*-(2-hydroxyethyl) benzene, diethylene glycol, bis-(4-hydroxybutyl) ether, bis-*p*-(β -hydroxyethoxy) benzene, bis-1,4-(β -hydroxyethoxy)-2,5-dichlorobenzene, bis-4,4'-(β -hydroxyethoxy) diphenyl, 2,6-di(β -hydroxyethoxy) naphthalene, bis-[*p*-(β -hydroxyethoxy)-phenyl] ketone, bis-[*p*-(β -hydroxyethoxy) phenyl]-sulfone, and bis-[*p*-(β -hydroxyethoxy) phenyl] difluoromethane.

Glycols in which $q=3$ include 4,4'-bis-(β -hydroxyethyl) biphenyl, 4,4'-bis-(β -hydroxyethyl) dodecahydrobiphenyl, triethylene glycol, and 2,2'-(ethylenedioxy) bis-[*p*-phenyleneoxy] diethanol. In general, the glycols in which q is greater than 3 are of lesser interest, although

certain glycols such as tetraethylene glycol may be used. Mixtures of the glycols may be used. If desired small amounts, e.g., up to about 15 weight percent, of a higher glycol such as a polyethylene glycol of high molecular weight may be added.

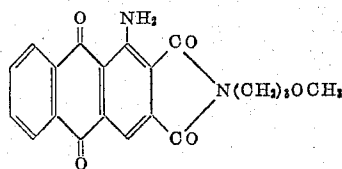
In contrast to the aromatic ethers of the formula $Ar(OC_nH_{2n})_{x-1}OAr'$, various other organic compounds tested as additives in polyesters have been found to produce only slight to moderate effects on the rate of dyeing of fibers spun from the modified polymers. Surprisingly, although the effectiveness of individual compounds within the class varies, the class of aromatic ethers of the formula $Ar(OC_nH_{2n})_{x-1}OAr'$ has been found to give greater improvement in dyeability than a wide variety of other compounds. As previously noted, 1,2-diphenoxyethane gives the best results and is preferred.

Although the invention has been described thus far primarily with respect to the melt spinning of filaments of a solution of the aromatic ether in a molten polyester, it is also applicable to the preparations of other shaped structures. For example, films, bristles, or other shaped structures may be extruded using the solution of the aromatic ether in the molten polyester.

The following examples are cited to illustrate the invention, although they are not intended to be limitative. Polyethylene terephthalate may be prepared from ethylene glycol and dimethyl terephthalate in accordance with the procedures outlined by Whinfield and Dickson in U.S. Patent 2,465,319, and polyethylene terephthalate/5-(sodium sulfo)-isophthalate (98/2) is prepared in similar fashion by reacting ethylene glycol with a mixture of 98 mol percent dimethyl terephthalate and 2 mol percent sodium 3,5-dicarboxymethoxybenzenesulfonate. The same method is also used to prepare poly(*trans*-*p*-hexahydroxylylene terephthalate) from dimethyl terephthalate and *trans*-*p*-hexahydroxylylene glycol and to prepare polyhexamethylene bibenzoate from hexamethylene glycol and dimethyl bibenzoate. Poly(*p,p'*-isopropylidenediphenyl isophthalate) may be prepared from isophthaloyl chloride and 2,2-bis-(*p*-hydroxyphenyl)propane in accordance with the procedure described by Wagner in U.S. Patent 2,035,578. Poly(*p,p'*-isopropylidenediphenyl carbonate) may be prepared from phosgene and 2,2-bis-(*p*-hydroxyphenyl)-propane in accordance with the procedure described in British Patent 772,627.

EXAMPLE 1

In a series of experiments for which the results are recorded in Table I, molten mixtures of polyethylene terephthalate and 10% (based on the weight of the polyethylene terephthalate) of the indicated organic compound are prepared and melt-spun at the indicated spinning temperature from a spinneret containing 34 holes, each 0.009 inch in diameter. A control sample of unmodified polyethylene terephthalate is included. The yarns are wound up at 1206 yards per minute and then drawn 3.2 $\times$ from a feed roll maintained at 90° C. to a draw roll operated at a peripheral speed of 454 yards per minute. The physical properties of the resulting yarns are as shown in the table. A series of 1.0-gram skeins of each of the yarns is then dyed at 100° C. in separate vessels each containing 500 ml. of a dye bath containing 0.06 g. of a blue anthraquinone dye consisting essentially of the structure



together with 0.250 g. of a dispersing agent comprising the sodium salt of an unsaturated long chain alcohol sulfate such as Du Pont's "Duponol" D.

Table I.—Rate of Dyeing of Polyethylene Terephthalate Modified With Various Organic Additives

Organic Modifier	Spinning Temperature, ° C.	Properties of Fiber After Boil-Off				Time Required For 4% Dye Adsorption, hrs.
		Tenacity, g.p.d.	Elongation, percent	Initial Modulus, g.p.d.	Yield Point, g.p.d.	
A. None (Control).....	295	3.9	26.8	47.0	0.96	26.7
B. 1,2-di-o-biphenyloxyethane.....	280	3.8	29.3	50.4	0.91	2.1
Bis-2-phenoxyethyl ether.....	280	3.3	35.3	49.4	0.94	2.1
1,2-diphenoxyethane.....	275	3.2	28.0	44.1	0.90	1.2
Same yarn, after removal of diphenoxyethane by heat setting.....		3.5	19.0	49.0	1.0	-----
C. Diphenyl Ether.....	280	1.0	35.0	21.0	0.65	3.2
Benzophenone.....	275	2.7	32.5	34.2	0.80	3.2
Diphenyl.....	275	3.2	24.7	55.6	0.90	6.7

At various measured intervals of time individual samples of fiber are removed from their respective baths, rinsed with water and then with acetone, and dried in air. The fiber samples are then analyzed quantitatively for percentage dye adsorbed by extracting the dye with hot chlorobenzene and determining the amount of dye spectrophotometrically. For each series of samples the percentage of dye adsorbed by the fiber is then plotted against the square root of the time in the dye bath (substantially linear relationship). The time required for adsorption of 4.0% dye, as determined from the resulting plots, is given in the table for each of the organic additives.

As indicated in the table, the time required for adsorption of 4.0% dye by the fibers containing aromatic ethers of the type $\text{Ar}(\text{OC}_n\text{H}_{2n})_{x-1}\text{OAr}'$, listed under B, is far lower than the time required for the control sample, A. Surprisingly, the required time is also markedly lower than the time required for adsorption of the same amount of dye for the fibers of group C, containing the same amounts by weight of other aromatic ethers, such as diphenyl ether, or other typical aromatic compounds such as benzophenone and diphenyl.

EXAMPLE 2

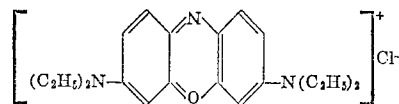
A sample of polyethylene terephthalate yarn containing 1,2-diphenoxyethane, spun and drawn as described in Example 1, and a sample of the unmodified polyethylene terephthalate control yarn of Example 1 are woven separately into 104 x 76 taffeta fabrics and dyed with the dye of Example 1 (4% dye on fabric). The dyed fabrics are then heated at 190° C. for one minute. Prior to heat treatment, the unmodified control fabric has a soft, limp hand and the fabric made of polyethylene terephthalate containing diphenoxyethane has a substantially identical hand. After heat treatment, the unmodified control fabric has a smooth, boardy hand, while the fabric made of polyethylene terephthalate containing diphenoxyethane has a soft, supple, silk-like hand. After heat treatment, the fabric made from polyethylene terephthalate containing diphenoxyethane shows no loss in weight when treated with 50% ethanol-50% benzene, indicating that no more diphenoxyethane remains in the fabric. The properties of yarn taken from this fabric are listed in Table I.

EXAMPLE 3

A quantity of polyethylene terephthalate/5-(sodium sulfo)isophthalate (98/2) is blended with 10% (based on the weight of the polymer) of 1,2-diphenoxyethane and melt-spun at 275° C. from a spinneret containing 34 holes, each 0.009 inch in diameter. The yarn is wound up at 1206 yards per minute and is then drawn 2.9× from a feed roll maintained at 90° C. to a draw roll operated at a peripheral speed of 454 yards per minute. The yarn has a tenacity of 2.4 g.p.d., an elongation of 21%, an initial modulus of 42 g.p.d., and a yield point of 0.87 g.p.d. A control sample of unmodified polyethylene/5-(sodium sulfo)isophthalate, when spun and drawn under similar conditions, yields yarn having a tenacity of 3.4 g.p.d., an elongation of 22%,

an initial modulus of 46 g.p.d., and a yield point of 0.92 g.p.d.

A 5.0-gram skein of the yarn containing the diphenoxyethane is then dyed at 100° C. in 500 ml. of a dye bath containing 0.10 g. of a basic dye of blue color having the structure



together with 0.30 g. of a retarding agent comprising a long-chain alkyl trimethyl ammonium chloride such as Armour & Company's "Arquad" C. At various measured intervals of time small samples of the dye bath are removed and analyzed spectrophotometrically for the amount of dye remaining in the bath. The resulting dye concentrations are then used to calculate the percentage dye adsorbed by the fiber at the measured time intervals and the percentage dye adsorption is plotted against the square root of the time. The time required for adsorption of 1.5% dye, as determined by the resulting plots, is 1.7 hours. However, the time required for adsorption of 1.5% dye by control samples of unmodified polyethylene terephthalate/5-(sodium sulfo)isophthalate fibers dyed under the same conditions, as determined by a similar plot, is 93.8 hours. Samples of similarly prepared fibers made from polyethylene terephthalate/5-(sodium sulfo)isophthalate containing 10% diphenyl ether, when dyed under the same conditions, require 6.5 hours to adsorb 1.5% dye, as determined by the plots.

EXAMPLE 4

A quantity of polyethylene terephthalate/5-(sodium sulfo)isophthalate (98/2) is blended with 10% (based on the weight of the polymer) of 1,2-di-β-naphthoxyethane and melt-spun at 275° C. from a spinneret containing 5 holes, each 0.007 inch in diameter. The yarn is wound up at 240 yards per minute and is then drawn 4.6× from a feed roll maintained at 100° C. to a draw roll operated at a peripheral speed of 75 yards per minute. The yarn has a tenacity of 1.7 g.p.d. at an elongation of 25%. A control sample of unmodified polyethylene terephthalate/5-(sodium sulfo)isophthalate (98/2), when spun and drawn under similar conditions, yields a yarn having a tenacity of 3.0 g.p.d. at an elongation of 25%.

A skein of the yarn containing the dinaphthoxyethane is dyed at the boil in a bath (pH 4.5) containing 3% (based on the weight of the yarn) of the dye of Example 3 together with 1% (based on the weight of the yarn) of "Arquad" C retarding agent. The dye is dyed to a medium shade of blue, whereas a sample of the unmodified control yarn is colored only a light shade of blue.

EXAMPLE 5

An intimate blend of 2.0 g. of poly(trans-p-hexahydroxyethylene terephthalate) and 0.20 g. of 1,2-diphenoxyethane is pressed into a film under 6000 p.s.i. pressure

at 320° C. When dyed for 90 minutes at the boil in a bath (pH 4.5) containing 2% (based on the weight of the film) of 1,4-diamino-2,3-dichloroanthraquinone together with 2% (based on the weight of the film) of an anionic hydrocarbon sodium sulfonate such as Du Pont's "Avitone" T, the film is colored a deep shade of violet. A control film of unmodified poly(trans-p-hexahydroxylene terephthalate), pressed and dyed under the same conditions, is dyed only to a light shade of violet.

EXAMPLE 6

An intimate blend of 2.0 g. of polyhexamethylene bibenzoate and 0.20 g. of 1,2-diphenoxyethane is pressed into a film under 6000 p.s.i. pressure at 275° C. When dyed with the dye of Example 5 under the given conditions, the film is colored a deep shade of violet. A control film of unmodified polyhexamethylene bibenzoate, pressed and dyed under the same conditions, is dyed only a medium shade of violet.

EXAMPLE 7

An intimate blend of 2.0 g. of poly(p,p'-isopropylidenediphenyl isophthalate) and 0.20 g. of 1,2-diphenoxyethane is pressed into a film under 6000 p.s.i. pressure at 290° C. When dyed with the dye of Example 5 under the given conditions, the film is colored a medium shade of violet. A control film of unmodified poly(p,p'-isopropylidenediphenyl isophthalate), pressed and dyed under the same conditions, takes up virtually no dye.

EXAMPLE 8

An intimate blend of 2.0 g. of poly(p,p'-isopropylidene diphenyl carbonate) and 0.20 g. of 1,2-diphenoxyethane is pressed into a film under 6000 p.s.i. pressure at 320° C. When dyed with the dye of Example 5 under the given conditions, the film is colored a medium shade of violet. A control film of unmodified poly(p,p'-isopropylidenediphenyl carbonate), pressed and dyed under the same conditions, is dyed only a very light shade of violet.

It will be apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof, and therefore it is not intended to be limited except as indicated in the appended claims.

I claim:

1. A synthetic linear glycol dicarboxylate condensation polyester having dissolved therein from 3% to 20% by weight of an aromatic ether of the formula



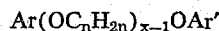
in which Ar and Ar' are radicals containing an aromatic

nucleus selected from the class consisting of hydrocarbon alkoxy substituted and halogen substituted aromatic nuclei and n and x are integers within the range of 2 to 4.

2. The product of claim 1 in which the ether is 1,2-diphenoxyethane.

3. The product of claim 1 in which the ether is present in the amount of about 10%.

4. A filament made from a synthetic linear glycol dicarboxylate condensation polyester of a glycol and a terephthalic acid having dissolved therein from about 3% to 20% by weight of an aromatic ether of the formula



in which Ar and Ar' are radicals containing an aromatic nucleus selected from the class consisting of hydrocarbon alkoxy substituted and halogen substituted aromatic nuclei and n and x are integers within the range of 2 to 4.

5. The filament of claim 4 in which the ether is present in the amount of about 10%.

6. The filament of claim 4 in which the ether is 1,2-diphenoxyethane.

7. The process of preparing filaments which have improved dyeability which comprises dissolving from 3% to 20% by weight of an aromatic ether of the formula $\text{Ar}(\text{OC}_n\text{H}_{2n})_{x-1}\text{OAr}'$, in which Ar and Ar' are radicals containing an aromatic nucleus selected from the class consisting of hydrocarbon alkoxy substituted and halogen substituted aromatic nuclei and n and x are integers within the range of 2 to 4, in a glycol terephthalate linear fiber-forming polyester, and thereafter melt spinning the resulting product at a temperature of about 250° C. to 295° C.

8. The process of claim 7 in which the aromatic ether is present in the amount of about 10%.

9. The process of claim 7 in which the ether is 1,2-diphenoxyethane.

10. The process of claim 7 in which the spun filaments are subsequently dyed.

11. The filament of claim 4 which has been dyed.

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