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SIZING FOR NYLON YARNS

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This invention relates to sized nylon yarns. More particularly, the invention relates to a new sizing composition for nylon yarns of the hexamethylene adipamide type and to the yarns sized therewith.

The advent of nylon yarns has presented many problems to textile manufacturers in finding a composition which can be used as an efficient sizing material. Due to the chemical and physical properties of nylon yarns, the usual materials used as sizes for natural yarns such as cotton and wool yarns and the synthetic yarns such as viscose and acetate yarns are not effective on the nylon yarns.

Many materials have been suggested for sizing nylon yarns and some have shown considerable promise. Among the better prior materials are copolymers of vinyl acetate and maleic anhydride and the partial alkyl esters thereof. However, these materials are partially lacking in adhesion to the nylon and in abrasion resistance. They may be used and are being used for the lack of a better material.

One object of this invention is to provide sized nylon yarns.

A further object is to provide new sizing compositions for nylon yarns.

Another object of this invention is to provide a process for sizing nylon yarns.

These and other objects are attained by preparing a terpolymer of vinyl acetate, maleic anhydride and an alkoxy ethyl partial ester of maleic acid and sizing nylon yarns from an aqueous solution of the terpolymer.

The following examples are given in illustration and are not intended as limitations on the scope of this invention. Where parts are mentioned, they are parts by weight.

Example I

Prepare a partial ester of maleic acid and methoxy ethanol by heating 1 mol of maleic anhydride with about 0.3 mol of beta methoxy ethanol at 90° C. for about half an hour. Using this partial ester, prepare a terpolymer by polymerizing together about 0.52 mol of vinyl acetate, about 0.34 mol of maleic anhydride and about 0.14 mol of the partial ester using a mass polymerization process and a peroxy catalyst. The product is soluble in water and has a viscosity of about 26 centipoises in a 5% aqueous solution at 25° C.

Example II

Use a 5% aqueous solution of the terpolymer of Example I. Draw nylon (polyhexamethylene-adipamide) warp yarns having 70 filaments, a denier of 34 and a 7 Z twist through the solution at a rate of about 10 to 20 yards a minute and then pass the yarns through squeeze rolls adjusted to exert a pressure of about 10 to 20 pounds per linear inch on the yarn. Then dry the yarns by passing them over a series of 5 drying cans in tandem arrangement, the temperature of the drying cans being respectively at 180° F., 200° F., 200° F., 200° F. and 160° F. No sticking of the size or the coated yarns occurs during the drying process.

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Yarns thus treated have a sizing of about 4% by weight of the terpolymer firmly adherent thereto. The sizings are tough and abrasion resistant. The sized yarns may be woven easily and efficiently using standard weaving techniques.

The abrasion resistance of yarns sized with the terpolymers of this invention may be tested in a standard abrasion testing apparatus with the results being reported in arbitrary units ranging from 10 to 1, with 10 being nearly perfect resistance to abrasion and 1 being substantially no abrasion resistance. When compared with a similar fabric sized with a terpolymer of vinyl acetate, maleic anhydride and a partial methyl ester of maleic acid, the following results are obtained:

Material	Abrasion resistance cycle		
	20	40	80
20 A	8.2	7.0	4.8
B	7.4	3.2	

Material A is yarn sized with the terpolymer of this invention as shown in Example II.

Material B is a yarn sized with the terpolymer described above made using a partial methyl ester of maleic acid.

It can be seen that after 20 cycles in the abrasion tester, Material B is somewhat inferior to Material A and that it rapidly loses abrasion resistance thereafter while Material A, at 40 cycles, still has better than average resistance and even at 80 cycles is considerably better than Material B at 40 cycles.

The terpolymers of this invention are terpolymers of vinyl acetate, maleic anhydride and alkoxy ethyl partial esters of maleic acid. The alkoxy group may contain from 1 to 4 carbon atoms and should be in the beta position. Thus, the alcohols used to modify the maleic acid to obtain the monomers are beta methoxy ethanol, beta ethoxy ethanol, beta propoxy ethanol, beta butoxy ethanol, or mixtures thereof, etc. The ratio of vinyl acetate to total of maleic anhydride and maleic partial ester on a mol percent basis may vary from 52:48 to 50:50 and the ratio of maleic anhydride to maleic partial ester may vary from 40:10 to 30:20 on a mol percent basis. The degree of esterification of the maleic acid may also be varied from 20 to 50% esterification.

The terpolymers of this invention are prepared by reacting all three components together in the desired proportions in a mass polymerization system using free radical-producing catalysts and controlling the polymerization conditions to obtain a product which will have a viscosity of from 5 to 75 centipoises, as measured in 5% aqueous solutions at 25° C. To provide adequate sizing of the nylon yarns, the terpolymer should be used as an aqueous solution containing from 2 to 15% by weight of terpolymer.

The size solution may contain, additionally to the terpolymer, small amounts, say 0.01 to 5% of sizing adjuncts such as humectants, oils, wetting agents, and the like. As examples of humectants may be mentioned glycerine, ethylene glycol, sorbitol propylene glycol, polyethylene glycols, polyglycerols, polypropylene oxides, and the like. Oils which may be used include the sulfonated animal, mineral and vegetable oils or mixtures thereof, water-emulsifiable mixtures of such oils with animal oils, mineral oils, vegetable oils, Twitchell oil, and the like. As examples of wetting agents may be mentioned acid-stable anionic wetting agents such as alkyl substituted benzene sodium sulfonates, in which the alkyl group contains from about 10 to 20 carbon atoms, alkali metal or ammonium monoalkyl sulfosuccinates, in which the alkyl group contains from about 10 to 20 carbons atoms, and the like;

and acid-stable non-ionic wetting agents such as the surface active condensation products of ethylene oxide with an alkylated phenol having from 8 to 20 carbon atoms in the alkyl group or an alkyl mercaptan having from 8 to 20 carbon atoms.

For best results, the size solution should be used or applied to the nylon yarn at a temperature between about 100 and 200° F. At these temperatures, the size solution is less viscous and penetrates into the yarn more readily and uniformly.

The size solution is supplied to the yarn in an amount sufficient to apply between about 0.5 and 10% by weight of the terpolymer based on the dry weight of the nylon yarn. This may be accomplished in various ways, for example, by passing the yarns through the size solution and beneath the surface thereof or by spraying the yarns with the size solution, and thereafter passing the yarns between squeeze rolls to remove excess solution and to deposit the required amount of the terpolymer. The size solution may also be applied in other ways, for example, by dipping the yarns in a solution of the terpolymer. In any event, the solution should contain between 2 and 15% by weight of the terpolymer, and, if squeeze rolls are used, the amount of pressure exerted on the squeeze rolls should be adjusted to remove sufficient excess solution to deposit the required amount of terpolymer within the range of 0.5 to 10%, based on the weight of the dry yarn.

The treated nylon yarn may be dried in various ways. Thus, they may be air-dried at normal room temperatures, that is, between about 65 and 85° F. However, it is preferred to dry the treated yarns at elevated temperatures of about 140 to 250° F. This may be accomplished by passing the treated yarns through an oven in which the circulating air is at a temperature of 140 to 250° F. or the treated yarns may be passed over one or more drying cans, which are heated at a temperature of 140 to 250° F., until the yarns are dry or contain less than 10% moisture.

The sized yarns are now ready for the weaving operation and may be woven in a loom at a relative humidity between about 40 and 80%. Any suitable yarn may be used as the filling in the weaving operation. The size adheres to the nylon yarns during the weaving operation without splitting or dusting off and protects the yarns from the mechanically moving parts of a loom. This excellent adhesion of the size to the nylon yarns is particularly unexpected in view of the fact that alkali metal salts of the same terpolymers lack adhesion to nylon yarns during the weaving operation, and especially when it is considered that nylon yarns undergo considerable stretching and contraction in the loom and thus subject the size to considerable stretching and contraction. The terpolymer sizes disclosed herein are also sufficiently hard so that they dry on drying cans without sticking to the cans.

The size which consists essentially of the terpolymers

hereinbefore described, is readily removed from the warp yarns in the woven fabric by a simple scouring or soaping in a mild soap solution. This means that the fabric can be treated with any suitable finishing agent to produce the desired finish on the fabric.

The term "nylon" as used herein is intended to include water-insoluble fiber-forming linear polyamides, particularly the water-insoluble fiber-forming linear polyamides prepared by condensing an aliphatic diamine such as hexamethylene diamine with an aliphatic polybasic acid such as adipic or sebacic acid, such as the polyamides described in United States Patents No. 2,071,250, No. 2,130,532 and No. 2,130,948. Of the foregoing linear polyamides, it is preferred to size the water-insoluble polyhexamethylene-adipamide warp yarns, since they are commercially available and are especially amenable to sizing by the methods of this invention.

What is claimed is:

1. A nylon warp yarn carrying a flexible and tough size of a water-soluble terpolymer of vinyl acetate, maleic anhydride and a beta alkoxy ethyl partial ester of maleic acid in which the alkoxy groups contain from 1 to 4 carbon atoms, the mol percent ratio of vinyl acetate to total maleic anhydride and maleic partial ester varying from 52:48 to 50:50, the mol percent ratio of maleic anhydride to partial maleic ester varying from 40:10 to 30:20, and the degree of esterification in the maleic ester ranging from 20 to 50%.

2. A sized nylon warp yarn as in claim 1 wherein the alkoxy group of the partial ester is a methoxy group.

3. A sized nylon warp yarn as in claim 1 wherein the terpolymer contains 52 mol percent of vinyl acetate, 34 mol percent of maleic anhydride and 14 mol percent of a beta methoxy ethyl partial ester of maleic acid in which the degree of esterification is about 30%.

4. A method of sizing water-insoluble nylon warp yarns to prepare them for weaving which comprises treating said yarns with an aqueous solution comprising about 2 to 15% by weight of a water soluble terpolymer of vinyl acetate, maleic anhydride and a beta alkoxy ethyl partial ester of maleic acid in which the alkoxy group contains from 1 to 4 carbon atoms, said solution being supplied in an amount sufficient to deposit about 0.5 to 10% by weight, based on the dry yarns, of said terpolymer, and then drying said yarns, in said terpolymer the mol percent ratio of vinyl acetate to total maleic anhydride and maleic partial ester varying from 52:48 to 50:50, the mol percent ratio of maleic anhydride to partial maleic ester varying from 40:10 to 30:20, and the degree of esterification in the maleic ester ranging from 20 to 50%.

5. A sized yarn as in claim 1 in which the nylon yarn is a water-insoluble polymeric hexamethylene adipamide yarn.

6. The method of claim 4 in which the nylon yarn employed is a water-insoluble polymeric hexamethylene adipamide yarn.

No references cited.