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(54) **A method of processing synthetic fibers, synthetic fibers, a method of spinning synthetic fibers and spun yarn**

(57) The present invention supplies a method of processing synthetic fibers that can suppress scum accumulation substantially in the high-speed spinning of synthetic fibers and give good high-speed spinning capabilities to the synthetic fibers; the synthetic fibers obtained with said processing method; a method of spinning said synthetic fibers; and a spun yarn obtained with said method of spinning.

In the high-speed spinning of synthetic fibers, the processing agent containing an organophosphate metal salt is applied to the synthetic fibers in a specific process in the upstream and, further, the processing agent containing a lubricant is applied in a specific process in the midstream.

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DescriptionBackground of the Invention

[0001] The present invention relates to a method of processing synthetic fibers; to synthetic fibers; to a method of spinning synthetic fibers; and to spun yarn. In recent years, the transition towards higher-speed spinning such as high-speed ring spinning, high-speed rotor-type open-end spinning, and whirling air spinning has been taking place in the spinning of synthetic fibers so that the production cost is reduced and productivity is improved. However, the increased spinning speed increases the amount of fiber passing through the spinning machine per unit time, increasing scum accumulation on components of the spinning machine and shortening the cleaning interval, thereby possibly causing the operational performance to deteriorate. The present invention relates to a method of processing synthetic fibers in which scum accumulation on components of the spinning machine through which the synthetic fibers make contact and pass in high-speed spinning of the synthetic fibers can be suppressed, thereby giving excellent high-speed spinning capability to the synthetic fibers; to synthetic fibers obtained with said method of processing; to a method of spinning said synthetic fibers; and to spun yarn obtained with said method of spinning.

[0002] Generally various processing agents containing alkyl phosphate potassium salts have been used for the spinning of synthetic fibers. The following processing agents are known : 1) two-component families with an alkyl phosphate potassium salt and a phosphate of an alkylaminoether-type nonionic surfactant (refer to Japanese Patent Publication Tokkaisho 60-224867 for example), 2) three-component families with an alkyl phosphate potassium salt, a phosphate of alkylaminoether-type nonionic surfactant, and a high molecular weight polyoxyethylene compound (refer to Japanese Patent Publication Tokkaisho 57-158297 for example), 3) two-component families with an alkyl phosphate potassium salt and a high molecular weight polyoxyethylene compound (refer to Japanese Patent Publication Tokkaihei 3-174067 for example), and 4) three-component families with an alkyl phosphate potassium salt, a paraffin wax emulsifier, and a cationic surfactant (refer to Japanese Patent Publication Tokkaihei 6-108361 for example). However, these conventional processing agents cause problems with scum accumulation at the antinode ring with high-speed ring spinning, inside the rotor with high-speed rotor-type open-end spinning, and around the spindle with whirling air spinning. Among these, the extremely high spinning speed of whirling air spinning when compared with that of high-speed ring spinning and high-speed rotor-type open-end spinning makes scum accumulation more severe. Scum accumulation not only shortens the cleaning interval and decreases the operational performance but also can cause severe damage to the fiber, possibly causing a reduction in yarn strength and increased white powder formation and accelerated yarn breakage.

Summary of the Invention

[0003] The problem to be solved by the present invention is to provide: a method of processing synthetic fibers in which scum accumulation in high-speed spinning of the synthetic fibers can be fully suppressed and high-speed spinning capability can be given to the synthetic fibers; synthetic fibers obtained with said method of processing; a method of spinning said synthetic fibers; and spun yarn obtained with said method of spinning.

[0004] The inventors have found as a result of studies to solve said problem that the addition of a processing agent containing an organophosphate metal salt in a specific process in the upstream, and the addition of a processing agent containing a lubricant in a specific process in the midstream, are beneficial and favorable for the high-speed spinning of synthetic fibers.

[0005] That is, the present invention relates to a method of processing synthetic fibers in which a processing agent containing an organophosphate metal salt is added to the synthetic fibers in a process between spinning and crimping, and a processing agent containing a lubricant is added in a process after crimping up to carding. In addition, this invention relates to synthetic fibers obtained with this method of processing; to a method of spinning said synthetic fibers; and to spun yarn obtained with said method of spinning.

Detailed Description of the Invention

[0006] First of all, the method of processing synthetic fibers related to the present invention (hereinafter referred to as "processing method of the present invention") is described. The processing method of the present invention involves the addition of a processing agent containing an organophosphate metal salt to the synthetic fibers in a process between spinning and crimping, and the addition of a processing agent containing a lubricant in a process after crimping up to carding, in the high-speed spinning of the synthetic fibers.

[0007] High-speed spinning of synthetic fibers is generally divided into two groups of processes: an earlier group of processes related to the production of synthetic fibers, and another later group of processes related to the production of spun yarn. The earlier group of processes related to the production of synthetic fibers includes processes such as spinning, drawing, heat treatment, finishing, crimping, drying, cutting and packaging, and the later group of processes

related to the production of spun yarn includes opening, carding, draw frame, and high-speed spinning (high-speed ring spinning, high-speed rotor-type open-end spinning, whirling air spinning, etc.) and, in the case of high-speed ring spinning as the method of high-speed spinning, the roving process immediately before high-speed spinning is included together with the winding process immediately after. The processing method of the present invention involves adding a processing agent, which contains an organophosphate metal salt, to the synthetic fibers in a process between said spinning and said crimping, and it involves adding a processing agent, which contains a lubricant, in a process after said crimping up to carding, in high-speed spinning of the synthetic fibers consisting of said two groups of processes.

[0008] As the processing agent containing the said organophosphate metal salt, the following processing agent A is preferable.

[0009] Processing agent A: a processing agent containing 40 to 80 mass% of an organophosphate metal salt and 20 to 60 mass% of a nonionic surfactant (total 100 mass%).

[0010] As the organophosphate salt in processing agent A are included: 1) alkylphosphate salts containing an alkyl group of carbon number 4-22, and 2) polyoxyalkylene alkyl ether phosphate salts having an alkyl group of carbon number 4-22 and containing a polyoxyalkylene group consisting of one to five oxyalkylene units.

[0011] As the alkylphosphate salts having an alkyl group of carbon number 4-22 are included: a butylphosphate salt, a pentylphosphate salt, a hexylphosphate salt, an octylphosphate salt, an isooctylphosphate salt, a 2-ethylhexylphosphate salt, a decylphosphate salt, a laurylphosphate salt, a tridecylphosphate salt, a myristylphosphate salt, a cetylphosphate salt, a stearylphosphate salt, an eicosylphosphate salt and a behenyl phosphate salt. In these alkylphosphate salts, a monoester alone, a diester alone, or a mixture of a monoester and a diester are possible. As the diester are included: a diester having identical alkyl groups (a symmetric diester) and a diester having different alkyl groups (an asymmetric diester). The alkylphosphate salts described above are produced from an alkyl phosphoric acid and a base, where as the base are included: an alkali metal hydroxide, an organic amine compound, an ammonium compound, etc.

[0012] As the polyoxyalkylene alkyl ether phosphate salts having an alkyl group of carbon number 4-22 and containing of one to five oxyalkylene units are included: a polyoxyalkylene butyl ether phosphate salt, a polyoxyalkylene hexyl ether phosphate salt, a polyoxyalkylene octyl ether phosphate salt, a polyoxyalkylene 2-ethylhexyl ether phosphate salt, a polyoxyalkylene decyl ether phosphate salt, a polyoxyalkylene lauryl ether phosphate salt, a polyoxyalkylene tridecyl ether phosphate salt, a polyoxyalkylene myristyl ether phosphate salt, a polyoxyalkylene cetyl ether phosphate salt, a polyoxyalkylene stearyl ether phosphate salt, a polyoxyalkylene behenyl ether phosphate salt, etc. In said polyoxyalkylene alkyl ether phosphate salts, as the polyoxyalkylene group are included a polyoxyethylene group, a polyoxypropylene group, a polyoxyethylene oxypropylene group, etc. In these polyoxyalkylene alkyl ether phosphate salts, a monoester alone, a diester alone, or a mixture of a monoester and a diester are possible. As the diester are included: a diester having identical alkyl groups (a symmetric diester) and a diester having different alkyl groups (an asymmetric diester). The polyoxyalkylene alkyl ether phosphate salts described above are produced from a polyoxyalkylene alkyl ether phosphoric acid and a base, and as the base are included: an alkali metal hydroxide, an organic amine compound, an ammonium compound, etc.

[0013] As the nonionic surfactant in processing agent A are included: 1) a polyoxyalkylene alkyl (or alkenyl) ether obtained through the addition of an alkyleneoxide to a saturated or unsaturated aliphatic monohydric alcohol of carbon number 8-18 such as 2-ethylhexyl alcohol, lauryl alcohol, myristyl alcohol, cetyl alcohol, stearyl alcohol and oleyl alcohol, 2) a fatty acid ester of a polyalkylene glycol obtained through the esterification of a saturated or unsaturated fatty acid of carbon number 8-18 such as caprylic acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleic acid, linolic acid, erucic acid and ricinoleic acid with a polyalkylene glycol, 3) a polyoxyalkylene derivative of a polyhydric alcohol fatty acid ester obtained through the addition of an alkyleneoxide to a polyhydric alcohol fatty acid ester obtained through the esterification of a polyhydric alcohol such as glycerol, pentaerythritol, trimethylolpropane, and sorbitan with a saturated or unsaturated fatty acid of carbon number 8-18, 4) a fatty acid ester of a polyoxyalkylene derivative of a polyhydric alcohol obtained through the esterification of a saturated or unsaturated fatty acid of carbon number 8-18 with a polyoxyalkylene derivative of a polyhydric alcohol obtained through the addition of an alkylene oxide to the polyhydric alcohol mentioned above, 5) a polyoxyalkylene alkyl phenyl ether obtained through the addition of an alkylene oxide to an alkylphenol such as octylphenol and nonylphenol, 6) a polyoxyalkylene alkyl (or alkenyl) aminoether obtained through the addition of an alkylene oxide to a saturated or unsaturated fatty amine of carbon number 8-18 such as octylamine, laurylamine, stearylamine and oleylamine, 7) a polyoxyalkylene derivative of a fatty amide obtained through the addition of an alkylene oxide to a saturated or unsaturated fatty amide of carbon number 8-18 such as caprylic amide, lauric amide, palmitic amide, stearic amide, and oleic amide, etc. While there is no limitation on the polyoxyalkylene group in any example mentioned above, it is preferred that the polyoxyalkylene group contains between 2 and 150 oxyalkylene groups. The oxyalkylene groups should either be oxyethylene groups only or a mixture of oxyethylene groups and oxypropylene groups.

[0014] Processing agent B specified below is preferable for the processing agent containing lubricant that is added in a process immediately after crimping up to carding.

[0015] Processing agent B: a processing agent containing 20 to 90 mass% of the following lubricant and 10 to 80

mass% of the following dispersing agent (total 100 mass%).

[0016] Lubricant: one or two or more chosen from the following: linear polyorganosiloxanes, hydrocarbons and fatty acid esters.

Linear polyorganosiloxanes: linear polyorganosiloxanes having a kinetic viscosity at 25°C of 1×10^{-5} to 1×10^{-2} m²/s.

Hydrocarbons: hydrocarbons having a melting point of 70°C or below.

Fatty acid esters: fatty acid esters having a melting point of 70°C or below.

[0017] Dispersing agent: one, two or more chosen from fatty acids, polyhydric alcohols, aliphatic monohydric alcohols of carbon number 8-22, and surfactants.

[0018] The linear polyorganosiloxane used in the lubricant of processing agent B is a linear polyorganosiloxane having a kinetic viscosity at 25°C of 1×10^{-5} to 1×10^{-2} m²/s. As the said polyorganosiloxane are included: linear polydimethylsiloxane, linear polydimethylsiloxane having a modified group, etc. As the modified group in this case are included: an ethyl group, a phenyl group, a fluoropropyl group, an aminopropyl group, a carboxyoctyl group, a polyoxyethylene-polyoxypropylene group, an ω -methoxypolyethoxy-polypropoxypropyl group, etc. Among these, linear polydimethylsiloxane is preferable as the linear polyorganosiloxane.

[0019] The hydrocarbon used in the lubricant of processing agent B is a hydrocarbon having a melting point of 70°C or below. As the said hydrocarbon are included: mineral oil family hydrocarbons such as liquid paraffin, petroleum jelly (Vaseline [RTM]) and paraffin wax; and animal oil family hydrocarbons such as squalene, squalane and pristane. Among these, a mineral oil family hydrocarbon having a kinetic viscosity at 25°C of 3×10^{-6} to 3×10^{-5} m²/s is preferable as the said hydrocarbon.

[0020] The fatty acid ester used in the lubricant of processing agent B is a fatty acid ester having a melting point of 70°C or below. As the said fatty acid ester are included: 1) esters of an aliphatic monohydric alcohol reacted with an aliphatic monocarboxylic acid such as methyl oleate, butyl stearate, octyl stearate, oleyl laurate, isotridecyl stearate, stearyl stearate, 2) esters of an aliphatic polyhydric alcohol reacted with aliphatic monocarboxylic acids such as 1,6-hexanediol didecanoate and trimethylolpropane monooleate monolaurate, 3) esters of aliphatic monohydric alcohols reacted with an aliphatic polycarboxylic acid such as dilauryl adipate and dioleoyl azelate, etc., among which fatty acid esters of an aliphatic monohydric alcohol of carbon number 1-18 with an aliphatic monocarboxylic acid of carbon number 8-18 are preferable.

[0021] While the lubricant in processing agent B shall have the characteristics mentioned above, one containing a linear polyorganosiloxane is preferable, and the one containing linear polydimethylsiloxane is more preferable for the said lubricant.

[0022] As the fatty acid used for the dispersing agent in processing agent B are included: 1) saturated fatty acids such as lauric acid, myristic acid and behenic acid, 2) unsaturated fatty acids such as palmitoleic acid, oleic acid, linolic acid and linolenic acid, 3) branched chain fatty acids such as isostearic acid, and 4) hydroxycarboxylic acids such as 12-hydroxystearic acid.

[0023] As the polyhydric alcohol used for the dispersing agent in processing agent B are included: ethylene glycol, glycerol, pentaerythritol, trimethylolpropane, sorbitol, etc.

[0024] As the aliphatic monohydric alcohol of carbon number 8-22 used for the dispersing agent in processing agent B are included: octanol, decanol, dodecyl alcohol, tetradecyl alcohol, hexadecyl alcohol, octadecenyl alcohol, eicosanol, docosanol, etc.

[0025] As the surfactant used for the dispersing agent in processing agent B are included: nonionic surfactants, anionic surfactants and cationic surfactants. As the said nonionic surfactant are included those specified above for the nonionic surfactant in processing agent A.

[0026] As the above-mentioned anionic surfactant are included: fatty acid salts, organic sulfonates, organic sulphates, and organic phosphates. As the fatty acid salts included in the anionic surfactant are included: 1) an alkali metal salt of a fatty acid of carbon number 6-22, 2) an amine salt of a fatty acid of carbon number 6-22, etc. As the said fatty acid of carbon number 6-22 are included: caproic acid, caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, behenic acid, oleic acid, erucic acid, linolic acid, dodecenylsuccinic acid, etc. Alkali metals that can constitute the said alkali metal salt of a fatty acid include sodium, potassium, lithium, etc. Amines that can constitute the said amine salt of a fatty acid include: 1) aliphatic amines such as methyl amine, dimethyl amine, trimethyl amine, ethyl amine, diethyl amine, triethyl amine, butyl amine, dibutyl amine, tributyl amine and octyl amine, 2) aromatic amines or heterocyclic amines such as aniline, pyridine, morpholine, piperazine, or a derivative of these, 3) alkanolamines such as monoethanol amine, diethanol amine, triethanol amine, isopropanol amine, diisopropanol amine, triisopropanol amine, butyl diethanol amine, octyl diethanol amine and lauryl diethanol amine, 4) ammonia, etc.

[0027] As the organic sulfonates contained in the anionic surfactant are included: 1) alkali metal salts of alkyl sulfonic acids such as sodium decylsulfonate, sodium dodecylsulfonate, lithium tetradecylsulfonate, and potassium tetradecylsulfonate, 2) alkali metal salts of alkylaryl sulfonic acids such as sodium butyl benzene sulfonate, sodium dodecyl benzene sulfonate, potassium octadecylbenzene sulfonate, and sodium dibutyl naphthalene sulfonate, 3) alkali metal salts of sulfonic acid esters such as dioctyl sodium sulfosuccinate, dibutyl sodium sulfosuccinate, sodium dodecyl sulfoacetate,

and potassium nonylphenoxypolyethylene glycol sulfoacetate.

[0028] As the organic sulphates contained in the anionic surfactant are included: 1) alkyl sulfate metal salts such as sodium decylsulfate, sodium dodecylsulfate, lithium tetradecylsulfate, and potassium hexadecylsulfate, 2) alkali metal salts of sulfated natural fats and oils such as sulfated tallow oil and sulfated castor oil, etc. As the organophosphate salts contained in the anionic surfactant are included those previously mentioned for the organophosphate metal salt in processing agent A.

[0029] As the above-mentioned cationic surfactant are included: compounds containing a cationic quaternary ammonium group and compounds containing a cationic imidazolium group. The compounds containing a cationic quaternary ammonium group included in the cationic surfactant include: *N,N*-dimethyl-*N*-octadecyl-*N*-ethylammonium ethylsulfate, *N,N*-dimethyl-*N*-octadecyl-*N*-ethylammonium methylsulfate, *N,N,N*-trimethyl-*N*-hexadecylammonium methylsulfate, *N,N,N*-trimethyl-*N*-octadecylammonium methylphosphate, *N*-(docosanoyl aminotrimethylene)-*N,N*-dimethyl-*N*-ethylammonium ethylsulfate, *N*-(octadecanoyl aminotrimethylene)-*N,N*-dimethyl-*N*-ethylammonium ethylsulfate, *N*-(docosanoyl aminoethylene)-*N,N*-dimethyl-*N*-ethylammonium ethylsulfate, *N*-(docosanoyl aminoethylene)-*N,N,N*-trimethylammonium methylsulfate, etc. As the imidazolium cation-containing compound included in the cationic surfactant are included: 1-ethyl-2-(pentadecyl)-4,5-dihydro-1-(2-aminoethyl)-1*H*-imidazolium ethyl sulfate, 1-ethyl-2-(heptadecyl)-4,5-dihydro-1-(2-aminoethyl)-1*H*-imidazolium ethyl sulfate, 1-ethyl-2-(heptadecenyl)-4,5-dihydro-1-(2-aminoethyl)-1*H*-imidazolium ethyl sulfate, 1-ethyl-2-(heptadecenyl)-4,5-dihydro-1-(2-hydroxyethyl)-1*H*-imidazolium ethyl sulfate, etc.

[0030] The processing method of the present invention comprises applying the processing agent containing an organophosphate metal salt such as processing agent A described above to the synthetic fibers in a process between spinning and crimping, and applying the processing agent containing a lubricant such as processing agent B described above in a process immediately after crimping up to carding. If the processing agent containing lubricant is applied during the crimping process or in an earlier process, crimping faults are likely to be caused, substantially deteriorating the process handleability. It is therefore preferable to apply the processing agent containing a lubricant in a process immediately after crimping up to cutting and packaging or in the opening process. While the processing agent application method can be an immersion oiling method, a spraying oiling method, a roller oiling method, or a guide oiling method which makes use of a metering pump, a spraying oiling method or a roller oiling method is preferable.

[0031] It is preferable that the said processing agent A is applied in 0.10 to 0.20 mass% on the synthetic fibers. It is preferable to apply the said processing agent B in 0.01 to 0.20 mass% on the crimped synthetic fibers, while it is more preferable to apply it in 0.02 to 0.10 mass%.

[0032] As the synthetic fibers which may be used in the processing method of the present invention are included: 1) polyester family fibers including ethylene terephthalate as a chief material, 2) acrylic fibers such as polyacrylonitrile and modacrylic fiber, 3) polyolefin family fibers such as polyethylene and polypropylene, 4) polyamide family fibers such as aliphatic polyamide and aromatic polyamide, while good effects are obtained with polyester family fibers.

[0033] The synthetic fibers related to the present invention (hereinafter referred to as "synthetic fibers of the present invention") are those obtained with said processing method of the present invention.

[0034] The method of spinning related to the present invention (hereinafter referred to as "spinning method of the present invention") is the method of supplying the synthetic fibers of the present invention to a high-speed spinning machine. As the high-speed spinning machine are included: a high-speed ring spinning machine, a high-speed rotor-type open-end spinning machine, a whirling air spinning machine, etc. With the spinning method of the present invention, it is preferable to spin at a spinning speed of 25 to 35 m/min. with high-speed ring spinning machines, or it is preferable to spin at a spinning speed of 100 to 160 m/min. with high-speed rotor-type open-end spinning machines, or it is preferable to spin at a spinning speed of 300 to 450 m/min. with whirling air spinning machines. The whirling air spinning machine spins yarn in a whirling flow of compressed air and the mechanism itself is publicly known, such as that used in trade name VORTEX (registered trade mark) made by MURATA MACHINERY, LTD.

[0035] The spun yarn related to the present invention (hereinafter referred to as "spun yarn of the present invention") is that obtained with said spinning method of the present invention.

[0036] With the present invention described above, scum accumulation is substantially suppressed in the high-speed spinning of synthetic fibers, giving good high-speed spinning characteristics to the synthetic fibers.

[0037] Hereafter, examples and comparative examples are described to indicate the configuration and effects of the present invention more concretely, but the present invention is not limited in these examples. In the following examples and comparative examples, "parts" indicates mass parts, and % indicates mass %.

Test division 1 (application of the processing agent)

- Example 1

[0038] In the production of semi dull polyester staple of a linear mass density of 1.3×10^{-4} g/m and a fiber length of 38mm, processing agent A-1 (equivalent to processing agent A) consisting of 70 parts of potassium octadecylphosphate,

15 parts of α -nonylphenyl- ω -hydroxypolyoxyethylene ($n = 10$) and 15 parts of α -dodecylamino- ω -hydroxypolyoxyethylene ($n = 10$) was applied to a polyester staple fiber in 0.15% in a spinning process before crimping, and a 2% water emulsion of processing agent B-1 (equivalent to processing agent B) consisting of 5 parts of a linear polydimethylsiloxane having a kinetic viscosity at 25°C of 1×10^{-2} m²/s, 40 parts of a linear polydimethylsiloxane having a kinetic viscosity at 25°C of 5×10^{-5} m²/s, 15 parts of a mineral oil having a kinetic viscosity at 25°C of 5×10^{-6} m²/s, 20 parts of methyl oleate, 10 parts of α -dodecyl- ω -hydroxypolyoxyethylene ($n = 10$) and 10 parts of oleic acid was applied to the post-crimping polyester staple fiber in 0.05% with a spraying oiling method in the post-crimping precarding opening process, and the product was left in a humidity-regulated atmosphere of 25°C at 60% relative humidity for 12 hours, to obtain a processed polyester staple fiber.

- Examples 2 to 36 and comparative examples 1 to 4

[0039] A processed polyester staple fiber was obtained in a manner similar to example 1. The type and composition of the processing agents containing an organophosphate metal salt that were used are summarized in Table 1, and the constituents, type and composition of the processing agents containing a lubricant are summarized in Tables 2 to 6. Further, the type and amount of the processing agent applied before crimping, and the type and amount of the processing agent applied after crimping are summarized in Table 7.

Test division 2 (evaluation of scum accumulation)

- Evaluation of spinning with a high-speed ring spinning machine

[0040] 10kg of processed polyester staple fiber obtained in test division 1 was supplied to a flat card (made by Howa Machinery, Ltd.) to obtain a card sliver. The obtained card sliver was supplied to a PDF type drawing machine (made by ISHIKAWA SEISAKSHO, LTD.) and a roving frame (made by TOYOTA INDUSTRIES CORPORATION) to obtain a roving yarn. The obtained roving yarn was fed to a high-speed ring spinning machine (made by TOYOTA INDUSTRIES CORPORATION) to operate at a spindle rotation number of 12000 to 27000 rpm, a twisting number of 775 turns per meter, a supplied raw yarn of 0.59 g/m, and a total draft of 40 times for two hours with 50 spindles. The spindle rotation number was adjusted so that the spinning speed became 15 m/min., 25 m/min. or 35 m/min., and scum accumulation on the antinode was evaluated according to the following criterion. The results are summarized in Table 7.

Criterion of scum accumulation on the antinode

[0041]

- A : Almost no scum accumulation is observed.
- B : Slight scum accumulation is observed, but problems do not occur.
- C : Scum accumulation is observed and slight problems occur.
- D : Much scum accumulation is observed; problems occur.

- Evaluation of spinning with a high-speed rotor-type open-end spinning machine

[0042] 10kg of processed polyester staple fiber obtained in test division 1 was supplied to a flat card (made by Howa Machinery, Ltd.) to obtain a card sliver. The obtained card sliver was supplied to a PDF type drawing machine (made by ISHIKAWA SEISAKSHO, LTD.) to obtain a drawing sliver. The obtained drawing sliver was supplied to a high-speed rotor-type open-end spinning machine (made by Schlafhorst Ltd.) to operate at a rotor speed of 40000 to 130000 rpm for one hour. The rotor speed was adjusted so that the spinning speed became 60 m/min., 100 m/min. or 160 m/min. and scum accumulation on the rotor was evaluated according to the following criterion. The results are summarized in Table 7.

Criterion of scum accumulation on the rotor

[0043]

- A : Almost no scum accumulation is observed.
- B : Slight scum accumulation is observed, but problems do not occur.
- C : Scum accumulation is observed and slight problems occur.
- D : Much scum accumulation is observed; problems occur.

- Evaluation of spinning with a whirling air spinning machine

[0044] 10kg of processed polyester staple obtained in test division 1 was supplied to a flat card (made by Howa Machinery, Ltd.) to obtain a card sliver. The obtained card sliver was supplied to a PDF type drawing machine (made by ISHIKAWA SEISAKSHO, LTD.) to obtain a drawing sliver. The obtained drawing sliver was supplied to a whirling air spinning machine (trade name VORTEX (registered trade mark) made by MURATA MACHINERY, LTD.) to operate at a total draft of 167 times for one hour so that the spinning speed became 300 m/min., 350 m/min. or 450 m/min., and scum accumulation on the spindle was judged according to the following criterion. The results are summarized in Table 7.

Criterion of scum accumulation on the spindle

[0045]

A : Almost no scum accumulation is observed.

B : Slight scum accumulation is observed, but problems do not occur.

C : Scum accumulation is observed and slight problems occur.

D : Much scum accumulation is observed; problems occur.

Table 1

Type	Processing agent A			
	Processing agent containing an organophosphate metal salt			
	Organophosphate metal salt	Ratio (%)	Surfactant	Ratio (%)
A-1	Potassium octadecylphosphate	70	α -dodecylamino- ω -hydroxypolyoxyethylene (n=10) α -nonylphenyl- ω -hydroxypolyoxyethylene (n=10)	15 15
A-2	Potassium octadecylphosphate	50	α -dodecylamino- ω -hydroxypolyoxyethylene (n=10) α -nonylphenyl- ω -hydroxypolyoxyethylene (n=10)	20 30
A-3	Potassium hexadecylphosphate	70	α -dodecylamino- ω -hydroxypolyoxyethylene (n=10) α -nonylphenyl- ω -hydroxypolyoxyethylene (n=10)	10 20
A-4	Potassium hexadecylphosphate	50	α -dodecylamino- ω -hydroxypolyoxyethylene (n=10) α -nonylphenyl- ω -hydroxypolyoxyethylene (n=10)	20 30
A-5	Potassium dodecylphosphate	70	Coconut fatty acid - polyoxyethylene (n=10)	30
A-6	Potassium dodecylphosphate	50	Coconut fatty acid - polyoxyethylene (n=10)	50
A-7	Potassium octadecylphosphate	30	α -dodecylamino- ω -hydroxypolyoxyethylene (n=10) α -nonylphenyl- ω -hydroxypolyoxyethylene (n=10)	20 60
A-8	Potassium hexadecylphosphate	30	α -dodecylamino- ω -hydroxypolyoxyethylene (n=10) α -nonylphenyl- ω -hydroxypolyoxyethylene (n=10)	35 35
A-9	Potassium dodecylphosphate	30	Coconut fatty acid - polyoxyethylene (n=10)	70
a-10		0	Coconut fatty acid - polyoxyethylene (n=10)	100

Table 2

Type	Linear polyorganosiloxane	Kinetic viscosity at 25°C (m ² /s)
C-1	Linear dimethylsiloxane	1×10^{-2}
C-2	Linear dimethylsiloxane	5×10^{-5}
C-3	Linear dimethylsiloxane	1×10^{-5}

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(continued)

Type	Linear polyorganosiloxane	Kinetic viscosity at 25°C (m ² /s)
C-4	Linear amino-substituted dimethylpolysiloxane	5×10^{-3}
C-5	Linear dimethylsiloxane	1×10^{-1}

Table 3

Type	Hydrocarbon	Melting point (°C)	Kinetic viscosity at 25°C (m ² /s)
D1	Mineral oil	*	5×10^{-6}
D-2	Mineral oil	*	1×10^{-5}
D-3	Mineral oil	*	3×10^{-5}
D-4	Mineral oil	*	5×10^{-5}
D-5	Paraffin wax	50	-
D-6	Polyethylene wax	90	-
In Table 3, *: Liquid at 25°C (similar hereinafter)			

Table 4

Type	Fatty acid ester	Melting point (°C)
E-1	Methyl oleate	*
E-2	Octyl palmitate	*
E-3	Sorbitan monooleate	*
E-4	Distearyl adipate	60
E-5	Hardened castor oil	85

Table 5

Type	Dispersing agent
F-1	α -dodecyl- ω -hydroxypolyoxyethylene (n=10)
F-2	α -nonylphenyl- ω -hydroxypolyoxyethylene (n=10)
F-3	α -dodecylamino- ω -hydroxypolyoxyethylene (n=10)
F-4	Oleic acid
F-5	Polyoxyethylene dodecyl ether phosphate potassium salt
F-6	1-ethyl-2-(heptadecenyl)-4,5-dihydro-1-(2-hydroxyethyl)-1H-imidazolium ethyl sulfate
F-7	N-octadecyl-N,N-dimethyl-N-ethylammonium sulfate

Table 6

Type	Processor agent B				* 1	*2
	Lubricant	Ratio (%)	Dispersing agent	Ratio (%)		
B-1	C-1	5	F-1	10	80	20
	C-2	40	F-4	10		

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(continued)

Type	Processor agent B				* 1	*2
	Lubricant	Ratio (%)	Dispersing agent	Ratio (%)		
	D-1 E-1	15 20				
B-2	C-2 D-1 E-1	45 15 20	F-1 F-4	8 12	80	20
B-3	C-3 D-1 E-1	45 15 20	F-1 F-4	10 10	80	20
B-4	C-1 C-2 D-2 E-1	5 40 15 20	F-1 F-4	10 10	80	20
B-5	C-1 C-2 D-3 E-1	5 40 15 20	F-1 F-4	10 10	80	20
B-6	C-1 C-2 D-1 E-2	5 40 15 20	F-1 F-4	10 10	80	20
B-7	C-1 C-2 D-1 E-1	5 40 15 20	F-2 F-4	8 12	80	20
B-8	C-1 C-2 D-1 E-1	5 40 15 20	F-3 F-4	8 12	80	20
B-9	C-1 C-2 D-1 E-1	8 45 15 22	F-1	10	90	10
B-10	C-1 C-2 D-1 E-1	7 40 15 20	F-1	18	82	18
B-11	C-1 C-2 D-1 E-1	5 40 15 20	F-1 F-5	10 10	80	20
B-12	C-1 C-2 D-1 E-1	5 40 15 20	F-1 F-6 F-7	10 5 5	80	20

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(continued)

Type	Processor agent B				* 1	*2
	Lubricant	Ratio (%)	Dispersing agent	Ratio (%)		
B-13	C-1 D-1 E-1	20 10 5	F-1 F-4	60 5	35	65
B-14	C-1 D-1 E-1	20 10 5	F-1 F-4 F-6	35 10 20	35	65
B-15	C-1	90	F-1	10	90	10
B-16	D-1	70	F-1 F-4	25 5	70	30
B-17	E-1	70	F-1 F-4	25 5	70	30
B-18	L-3	80	F-1	20	80	20
B-19	E-4	80	F-1 F-4	8 12	80	20
B-20	D-4	80	F-1	20	80	20
B-21	D-5	80	F-1	20	80	20
B-22	C-4	80	F-1	20	80	20
B-23	C-5	70	F-1	30	70	30
B-24	D-6	70	F-1	30	70	30
B-25	E-5	70	F-1	30	70	30
In Table 6, * 1: Relative proportion of lubricant in processing agent B * 2: Relative proportion of dispersing agent in processing agent B						

Table 7

Division	Before crimping		After crimping		Evaluation of scum accumulation								
					High-speeding spinning machine			High-speed rotor-typeopen-end spinning machine			Whirling air spinning machine		
	Processing agent A	Adhering amount (%)	Processing agent B	Adhering Amount (%)	15 m /min	25 m /min	35 m //min	60 m /min	100 m /min	160 m /min	300m /min	350m /min	450m /min
Example 1	A-1	0.15	B-1	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-2	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-3	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-4	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-5	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-6	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-7	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-8	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-9	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-10	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-11	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-12	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-13	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-14	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-15	0.05	A	A	A	A	A	A	A	A	A
	A-2	0.15	B-1	0.05	A	A	A	A	A	A	A	A	A
	A-3	0.15	B-1	0.05	A	A	A	A	A	A	A	A	A
	A-4	0.15	B-1	0.05	A	A	A	A	A	A	A	A	A
	A-5	0.15	B-1	0.05	A	A	A	A	A	A	A	A	A
	A-6	0.15	B-1	0.05	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-1	0.15	A	A	A	A	A	A	A	A	A
	A-1	0.15	B-1	0.30	A	A	A	A	A	A	A	A	A-B
	A-1	0.25	B-1	0.05	A	A	A	A	A	A	A	A	A-B
	A-1	0.15	B-16	0.05	A	A	A	A	A	B	A	A	B
	A-1	0.15	B-17	0.05	A	A	A	A	A	B	A	A	B
	A-1	0.15	B-18	0.05	A	A	B	A	A	B	A	B	B
	A-1	0.15	B-19	0.05	A	A	B	A	A	B	A	B	B
	A-1	0.15	B-20	0.05	A	A	B	A	A	B	A	B	B
	A-1	0.15	B-21	0.05	A	A	B	A	A	B	A	B	B

(continued)

Division	Before crimping		After crimping				Evaluation of scum accumulation						
							High-speeding spinning machine			High-speed rotor-typeopen-end spinning machine			
	Processing agent A	Adhering amount (%)	Processing agent B	Adhering Amount (%)	15 m /min	25 m /min	35 m //min	60 m /min	100 m /min	160 m /min	300 m /min	350 m /min	450 m /min
30	A-1	0.15	B-22	0.05	A	A	B	A	A	B	B	B	B
31	A-7	0.15	B-1	0.05	A	B	B	A	B	B	B	B	B
32	A-8	0.15	B-1	0.05	A	B	B	A	B	B	B	B	B
33	A-9	0.15	B-1	0.05	A	B	B	A	B	B	B	B	B
34	A-1	0.15	B-23	0.05	A	B	B	A	B	B	B	B	B
35	A-1	0.15	B-24	0.05	A	B	B	A	B	B	B	B	B
36	A-1	0.15	B-25	0.05	A	B	B	A	B	B	B	B	B
Comparative example 1	A-1	0.15	None	-	A	C	D	B	C	D	C	D	D
2	A-2	0.15	None	-	B	C	D	B	C	D	C	D	D
3	A-10	0.15	B-1	0.05	C	D	D	C	D	D	D	D	D
4	a-11	0.15	None	-	A	C	D	B	C	D	C	C	D
5	B-1	0.15	None	-	*3	*3	*3	*3	*3	*3	*3	*3	*3

In Table 7,

* 3: Cannot be evaluated because synthetic fibers having normal crimping characteristics are not obtained.

a-11: Processing agent mixture where (A-1) and (F-1) are combined in a ratio of 90:10 (mass %).

In Table 7,

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a-11: Processing agent mixture where (A-1) and (F-1) are combined in a ratio of 90:10 (mass %).

[0046] As shown in the results of Table 7, this invention makes it possible to obtain synthetic fibers having normal crimping characteristics and suppress scum generation in high-speed spinning methods such as high-speed ring spinning, high-speed rotor-type open-end spinning and whirling air spinning, meeting the recent requirements toward higher spinning speeds.

Claims

1. A method of processing synthetic fibers, said method comprising the steps of applying a processing agent, which contains an organophosphate metal salt, in a process between spinning and crimping, and applying a processing agent, which contains a lubricant, in a process after crimping up to carding.

2. The method of processing synthetic fibers of claim 1, wherein the processing agent containing an organophosphate metal salt is the following processing agent A, and the processing agent containing a lubricant is the following processing agent B:

processing agent A: a processing agent containing 40 to 80 mass% of an organophosphate metal salt and 20 to 60 mass% of a nonionic surfactant (for a total of 100 mass%);

processing agent B: a processing agent containing 20 to 90 mass% of the following lubricant and 10 to 80 mass% of the following dispersing agent (a total of 100 mass%);

lubricant: one or two or more chosen from the following linear polyorganosiloxanes, the following hydrocarbons and the following fatty acid esters;

linear polyorganosiloxanes: linear polyorganosiloxanes having a kinetic viscosity at 25°C of 1×10^{-5} to 1×10^{-2} m²/s;

hydrocarbons: hydrocarbons having a melting point of 70°C or below;

fatty acid esters: fatty acid esters having a melting point of 70°C or below; and

dispersing agent: one, two or more chosen from fatty acids, polyhydric alcohols, and aliphatic monohydric alcohols of carbon number 8-22, and surfactants.

3. The method of processing synthetic fibers of claims 1 or 2, wherein the linear polyorganosiloxane is linear polydimethylsiloxane.

4. The method of processing synthetic fibers of any of claims 1 to 3, wherein the hydrocarbon is a mineral oil family hydrocarbon having a kinetic viscosity at 25°C of 3×10^{-6} to 3×10^{-5} m²/s.

5. The method of processing synthetic fibers of any of claims 1 to 4, wherein the fatty acid ester is that obtained from reacting an aliphatic monohydric alcohol of carbon number 1-18 with an aliphatic monocarboxylic acid of carbon number 8-18.

6. The method of processing synthetic fibers of any of claims 1 to 5, wherein the lubricant contains a linear polyorganosiloxane.

7. The method of processing synthetic fibers of any of claims 2 to 6, wherein the processing agent A is applied in an amount of 0.10 to 0.20 mass% on the synthetic fibers.

8. The method of processing synthetic fibers of any of claims 2 to 7, wherein the processing agent B is applied in an amount of 0.01 to 0.20 mass% on the synthetic fibers.

9. The method of processing synthetic fibers of any of claims 2 to 7, wherein the processing agent B is applied in an amount of 0.02 to 0.10 mass% on the synthetic fibers.

10. The method of processing synthetic fibers of any of claims 1 to 9, wherein the synthetic fibers are polyester-family fibers.

11. Synthetic fibers obtained with the method of processing synthetic fibers of any of claims 1 to 10.

12. A method of spinning synthetic fibers, wherein the synthetic fibers of claim 11 are supplied to a high-speed spinning machine.

13. The method of spinning synthetic fibers of claim 12, wherein the high-speed spinning machine is a high-speed ring spinning machine and the synthetic fibers are supplied to said high-speed ring spinning machine to spin at a spinning speed of 25 to 35 m/min.

5 14. The method of spinning synthetic fibers of claim 12, wherein the high-speed spinning machine is a high-speed rotor-type open-end spinning machine and the synthetic fibers are supplied to said high-speed rotor-type open-end spinning machine to spin at a spinning speed of 100 to 160 m/min.

10 15. The method of spinning synthetic fibers of claim 12, wherein the high-speed spinning machine is a whirling air spinning machine and the synthetic fibers are supplied to said whirling air spinning machine to spin at a spinning speed of 300 to 450 m/min.

16. Spun yarn obtained with the method of spinning synthetic fibers of any of claims 12 to 15.

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EUROPEAN SEARCH REPORT

Application Number
EP 13 19 4225

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Place of search The Hague		Date of completion of the search 6 March 2014	Examiner Fiocco, Marco
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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