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(54) SYNTHETIC FIBER TREATMENT AGENT AND SYNTHETIC FIBERS

(57) The present invention addresses the problem of providing: a synthetic fiber treatment agent that can reduce the scattering of oil in a spinning step and can improve emulsion stability in poor quality water such as hard water; and synthetic fibers having said synthetic fiber treatment agent adhered thereto. The present invention is a synthetic fiber treatment agent comprising a smoothing agent, a nonionic surfactant and an ionic surfactant, and is characterized by: the smoothing agent comprising a specific ester A1; the smoothing agent containing a ratio of 40-100 mass% of the ester A1; and the nonionic surfactant containing an alkylene oxide adduct of a C4-24 aliphatic alcohol having a branched chain structure.

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Description

TECHNICAL FIELD

[0001] The present invention relates to a synthetic fiber treatment agent by which scattering of oil in a spinning step can be reduced and emulsion stability in water of poor water quality such as hard water can be improved and to a synthetic fiber to which the synthetic fiber treatment agent is adhered.

BACKGROUND ART

[0002] Generally, in a spinning step of synthetic fibers, a treatment of adhering a synthetic fiber treatment agent to the surfaces of filament yarn threads of the synthetic fibers is performed at times from a standpoint of reducing friction and reducing yarn breakage or other damage of the fibers.

[0003] Conventionally, a synthetic fiber treatment agent disclosed in Patent Document 1 is known. Patent Document 1 discloses a synthetic fiber treatment agent that contains a smoothing agent, such as a stearic acid ester of 2-octyldodecanol, and a surfactant, such as a stearic acid diester of a 24 mole EO adduct of trimethylolpropane.

PRIOR ART LITERATURE

PATENT LITERATURE

[0004] Patent Document 1: Japanese Laid-Open Patent Publication No. 2012-92481

SUMMARY OF THE INVENTION

PROBLEMS THAT THE INVENTION IS TO SOLVE

[0005] However, such conventional synthetic fiber treatment agents are insufficient in terms of scattering of oil in a spinning step and emulsion stability in water of poor water quality.

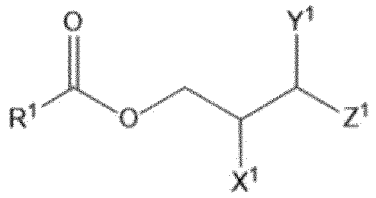
[0006] The present invention has been made in view of such circumstances and an object thereof is to provide a synthetic fiber treatment agent by which scattering of oil in a spinning step can be reduced and emulsion stability in water of poor water quality such as hard water can be improved. It is also an object of the present invention to provide a synthetic fiber to which this synthetic fiber treatment agent is adhered.

MEANS FOR SOLVING THE PROBLEMS

[0007] As a result of performing research toward solving the above problem, the inventors of the present invention found that it is truly suitable for a specific ester compound as a smoothing agent, a specific nonionic surfactant, and an ionic surfactant to be contained in a synthetic fiber treatment agent.

[0008] A synthetic fiber treatment agent for solving the above problem contains a smoothing agent, a nonionic surfactant, and an ionic surfactant and is characterized in that the smoothing agent contains an ester A1 represented by Chemical Formula 1 shown below, the ester A1 is contained in the smoothing agent at a ratio of 40% to 100% by mass, and the nonionic surfactant contains an alkylene oxide adduct of an aliphatic alcohol with 4 to 24 carbon atoms having a branched chain structure.

[Chemical Formula 1]



(In Chemical Formula 1,

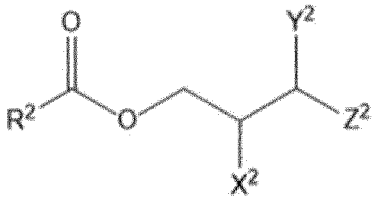
R^1 is a saturated hydrocarbon group with 7 to 23 carbon atoms or an unsaturated hydrocarbon group with 7 to 23 carbon atoms, and

X^1, Y^1, and Z^1 are each a hydrogen atom, a methyl group, an ethyl group, a straight chain saturated hydrocarbon group with 3 to 21 carbon atoms, a saturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure, a straight chain unsaturated hydrocarbon group with 3 to 21 carbon atoms, or an unsaturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure.

[0009] However, at least one of X^1 and Y^1 is a methyl group, an ethyl group, or an abovementioned hydrocarbon group, and the total number of carbon atoms of X^1, Y^1, and Z^1 is 5 to 21.)

[0010] Preferably in the synthetic fiber treatment agent, the smoothing agent further contains an ester A2 represented by Chemical Formula 2 shown below.

[Chemical Formula 2]



(In Chemical Formula 2,

R^2 is a saturated hydrocarbon group with 7 to 23 carbon atoms or an unsaturated hydrocarbon group with 7 to 23 carbon atoms,
X^2 is a hydrogen atom,
Y^2 is a hydrogen atom, and
Z^2 is a hydrogen atom, a methyl group, an ethyl group, a straight chain saturated hydrocarbon group with 3 to 17 carbon atoms, a saturated hydrocarbon group with 3 to 17 carbon atoms having a branched chain structure, a straight chain unsaturated hydrocarbon group with 3 to 17 carbon atoms, or an unsaturated hydrocarbon group with 3 to 17 carbon atoms having a branched chain structure.)

[0011] Preferably, the content of the ester A1 in the synthetic fiber treatment agent is 55% to 100% by mass if the sum of the contents of the ester A1 and the ester A2 in the synthetic fiber treatment agent is taken as 100% by mass.

[0012] Preferably in the synthetic fiber treatment agent, X^1 in the Chemical Formula 1 is a methyl group, an ethyl group, a straight chain saturated hydrocarbon group with 3 to 21 carbon atoms, a saturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure, a straight chain unsaturated hydrocarbon group with 3 to 21 carbon atoms, or an unsaturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure.

[0013] Preferably in the synthetic fiber treatment agent, the nonionic surfactant contains a compound in which an alkylene oxide with 2 to 4 carbon atoms is added at a ratio of 1 to 100 moles with respect to 1 mole of an aliphatic alcohol with 4 to 14 carbon atoms having a branched chain structure.

[0014] Preferably in the synthetic fiber treatment agent, the total number of carbon atoms of X^1, Y^1, and Z^1 in the Chemical Formula 1 is 6 to 12.

[0015] A synthetic fiber for solving the above problem is characterized in that the synthetic fiber treatment agent is adhered to the synthetic fiber.

EFFECTS OF THE INVENTION

[0016] The present invention succeeds in reducing scattering of oil in a spinning step and improving emulsion stability in water of poor water quality such as hard water.

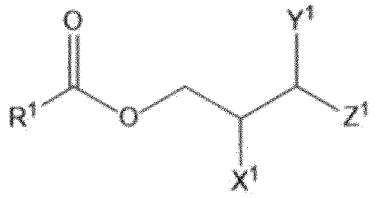
MODES FOR CARRYING OUT THE INVENTION

(First Embodiment)

[0017] First, a first embodiment that embodies a synthetic fiber treatment agent according to the present invention (also referred to hereinafter as treatment agent) will now be described. The treatment agent of the present embodiment contains a smoothing agent, a nonionic surfactant, and an ionic surfactant.

[0018] The smoothing agent used in the present embodiment contains an ester A1 represented by Chemical Formula 3 shown below.

[Chemical Formula 3]



(In Chemical Formula 3,

R^1 is a saturated hydrocarbon group with 7 to 23 carbon atoms or an unsaturated hydrocarbon group with 7 to 23 carbon atoms, and

X^1, Y^1, and Z^1 are each a hydrogen atom, a methyl group, an ethyl group, a straight chain saturated hydrocarbon group with 3 to 21 carbon atoms, a saturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure, a straight chain unsaturated hydrocarbon group with 3 to 21 carbon atoms, or an unsaturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure.

[0019] However, at least one of X^1 and Y^1 is a methyl group, an ethyl group, or an abovementioned hydrocarbon group, and the total number of carbon atoms of X^1, Y^1, and Z^1 is 5 to 21.)

[0020] One type of such esters A1 may be used alone or two or more types thereof may be used in combination.

[0021] Among these, a compound is preferable in which X^1 in Chemical Formula 3 is a methyl group, an ethyl group, a straight chain saturated hydrocarbon group with 3 to 21 carbon atoms, a saturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure, a straight chain unsaturated hydrocarbon group with 3 to 21 carbon atoms, or an unsaturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure. With such a compound, especially the scattering can be reduced further. Also, a compound is preferable in which the total number of carbon atoms of X^1, Y^1, and Z^1 in Chemical Formula 3 is 6 to 12. With such a compound, especially the emulsion stability in water of poor water quality such as hard water can be improved further.

[0022] The hydrocarbon group that constitutes R^1 may be a straight chain saturated hydrocarbon group or a saturated hydrocarbon group having a branched chain structure. Alternatively, it may be a straight chain unsaturated hydrocarbon group or an unsaturated hydrocarbon group having a branched chain structure.

[0023] Specific examples of the straight chain saturated hydrocarbon group that constitutes R^1 include a heptyl group, an octyl group, a nonyl group, a decyl group, an undecyl group, a dodecyl group, a tridecyl group, a tetradecyl group, a pentadecyl group, a hexadecyl group, a heptadecyl group, an octadecyl group, an icosyl group, a docosyl group, and a tricosyl group.

[0024] Specific examples of the saturated hydrocarbon group having a branched chain structure that constitutes R^1 include an isoheptyl group, an isooctyl group, an isononyl group, an isodecyl group, an isoundecyl group, an isododecyl group, an isotridecyl group, an isotetradecyl group, an isopentadecyl group, an isohexadecyl group, an isoheptadecyl group, an isooctadecyl group, an isoicosyl group, an isodocosyl group, and an isotricosyl group.

[0025] The unsaturated hydrocarbon group that constitutes R^1 may be an alkenyl group having one double bond as an unsaturated carbon bond or may be an alkadienyl group or alkatrienyl group having two or more double bonds. Alternatively, it may be an alkynyl group having one triple bond as the unsaturated carbon bond or may be an alkadiynyl group having two or more triple bonds. Specific examples of the straight chain unsaturated hydrocarbon group having one double bond in the hydrocarbon group include a heptenyl group, an octenyl group, a nonenyl group, a decenyl group, an undecenyl group, a dodecenyl group, a tridecenyl group, a tetradecenyl group, a pentadecenyl group, a hexadecenyl group, a heptadecenyl group, an octadecenyl group, an icosenyl group, a docosenyl group, and a tricosenyl group.

[0026] Specific examples of the unsaturated hydrocarbon group having a branched chain structure having one double bond in the hydrocarbon group that constitutes R^1 include an isoheptenyl group, an isooctenyl group, an isononenyl group, an isodecenyl group, an isoundecenyl group, an isododecenyl group, an isotridecenyl group, an isotetradecenyl group, an isopentadecenyl group, an isohexadecenyl group, an isoheptadecenyl group, an isooctadecenyl group, an isoicosenyl group, an isodocosenyl group, and an isotricosenyl group.

[0027] Specific examples of the straight chain saturated hydrocarbon group with 3 to 21 carbon atoms that constitutes each of X^1, Y^1, and Z^1 include a propyl group, a butyl group, a pentyl group, a hexyl group, a heptyl group, an octyl group, a nonyl group, a decyl group, an undecyl group, a dodecyl group, a tridecyl group, a tetradecyl group, a pentadecyl group, a hexadecyl group, a heptadecyl group, an octadecyl group, an icosyl group, and a henicosyl group.

[0028] Specific examples of the saturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure that constitutes each of X^1, Y^1, and Z^1 include an isopropyl group, an isobutyl group, an isopentyl group, an

isohexyl group, an isoheptyl group, an isooctyl group, an isononyl group, an isodecyl group, an isoundecyl group, an isododecyl group, an isotridecyl group, an isotetradecyl group, an isopentadecyl group, an isohexadecyl group, an isoheptadecyl group, an isooctadecyl group, an isoicosyl group, and an isohenicosyl group.

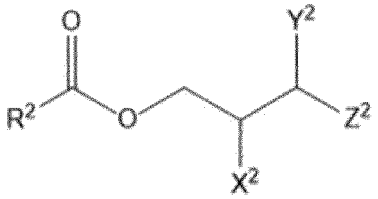
[0029] The unsaturated hydrocarbon group that constitutes each of X^1, Y^1, and Z^1 may be an alkenyl group having one double bond as the unsaturated carbon bond or may be an alkadienyl group or alkatrienyl group having two or more double bonds. Alternatively, it may be an alkynyl group having one triple bond as the unsaturated carbon bond or may be an alkadiynyl group having two or more triple bonds. Specific examples of the straight chain unsaturated hydrocarbon group having one double bond in the hydrocarbon group that constitutes each of X^1, Y^1, and Z^1 include a propenyl group, a butenyl group, a pentenyl group, a hexenyl group, a heptenyl group, an octenyl group, a nonenyl group, a decenyl group, an undecenyl group, a dodecenyl group, a tridecenyl group, a tetradecenyl group, a pentadecenyl group, a hexadecenyl group, a heptadecenyl group, an octadecenyl group, an icosenyl group, and a henicosenyl group.

[0030] Specific examples of the unsaturated hydrocarbon group having a branched chain structure having one double bond in the hydrocarbon group that constitutes each of X^1, Y^1, and Z^1 include an isopropenyl group, an isobutenyl group, an isopentenyl group, an isohexenyl group, an isoheptenyl group, an isooctenyl group, an isononenyl group, an isodecenyl group, an isoundecenyl group, an isododecenyl group, an isotridecenyl group, an isotetradecenyl group, an isopentadecenyl group, an isohexadecenyl group, an isoheptadecenyl group, an isooctadecenyl group, an isoicosenyl group, and an isohenicosenyl group.

[0031] Specific examples of the ester A1 include 2-propylheptyl oleate, 2-methylnonyl oleate, 2-ethylheptyl decanoate, 2-methylnonyl tetracosanoate, 2-ethyldecyl stearate, 2-propylheptyl stearate, 2-ethyltridecyl oleate, 3,5,5-trimethylhexyl oleate, 3,7-dimethyloctyl oleate, 3-methylundecyl oleate, 2-octyldodecyl palmitate, 2-ethylhexyl stearate, 2-octyldodecyl isostearate, and 3-methylheptadecyl oleate, etc.

[0032] The smoothing agent used in the present embodiment preferably contains an ester A2 represented by Chemical Formula 4 shown below.

[Chemical Formula 4]



(In Chemical Formula 4,

R^2 is a saturated hydrocarbon group with 7 to 23 carbon atoms or an unsaturated hydrocarbon group with 7 to 23 carbon atoms,
X^2 is a hydrogen atom,
Y^2 is a hydrogen atom, and
Z^2 is a hydrogen atom, a methyl group, an ethyl group, a straight chain saturated hydrocarbon group with 3 to 17 carbon atoms, a saturated hydrocarbon group with 3 to 17 carbon atoms having a branched chain structure, a straight chain unsaturated hydrocarbon group with 3 to 17 carbon atoms, or an unsaturated hydrocarbon group with 3 to 17 carbon atoms having a branched chain structure.)

[0033] One type of such esters A2 may be used alone or two or more types thereof may be used in combination.

[0034] The hydrocarbon group that constitutes R^2 may be a straight chain saturated hydrocarbon group or a saturated hydrocarbon group having a branched chain structure. Alternatively, it may be a straight chain unsaturated hydrocarbon group or an unsaturated hydrocarbon group having a branched chain structure.

[0035] Specific examples of the saturated hydrocarbon group or the unsaturated hydrocarbon group that constitutes R^2 include the examples given for the saturated hydrocarbon group or the unsaturated hydrocarbon group that constitutes R^1 of Chemical Formula 3.

[0036] Specific examples of the straight chain saturated hydrocarbon group with 3 to 17 carbon atoms that constitutes Z^2 include a propyl group, a butyl group, a pentyl group, a hexyl group, a heptyl group, an octyl group, a nonyl group, a decyl group, an undecyl group, a dodecyl group, a tridecyl group, a tetradecyl group, a pentadecyl group, a hexadecyl group, and a heptadecyl group.

[0037] Specific examples of the saturated hydrocarbon group with 3 to 17 carbon atoms having a branched chain structure that constitutes Z^2 include an isopropyl group, an isobutyl group, an isopentyl group, an isohexyl group, an isoheptyl group, an isooctyl group, an isononyl group, an isodecyl group, an isoundecyl group, an isododecyl group, an

isotridecyl group, an isotetradecyl group, an isopentadecyl group, an isohexadecyl group, and an isoheptadecyl group.

[0038] The unsaturated hydrocarbon group that constitutes Z^2 may be an alkenyl group having one double bond as the unsaturated carbon bond or may be an alkadienyl group or alkatrienyl group having two or more double bonds. Alternatively, it may be an alkynyl group having one triple bond as the unsaturated carbon bond or may be an alkadiynyl group having two or more triple bonds. Specific examples of the straight chain unsaturated hydrocarbon group having one double bond in the hydrocarbon group that constitutes Z^2 include a propenyl group, a butenyl group, a pentenyl group, a hexenyl group, a heptenyl group, an octenyl group, a nonenyl group, a decenyl group, an undecenyl group, a dodecenyl group, a tridecenyl group, a tetradecenyl group, a pentadecenyl group, a hexadecenyl group, and a heptadecenyl group.

[0039] Specific examples of the unsaturated hydrocarbon group having a branched chain structure having one double bond in the hydrocarbon group that constitutes Z^2 include an isopropenyl group, an isobutenyl group, an isopentenyl group, an isohexenyl group, an isoheptenyl group, an isooctenyl group, an isononenyl group, an isodecenyl group, an isoundecenyl group, an isododecenyl group, an isotridecenyl group, an isotetradecenyl group, an isopentadecenyl group, an isohexadecenyl group, and an isoheptadecenyl group.

[0040] Specific examples of the ester A2 include isotridecyl oleate, lauryl oleate, and oleyl laurate.

[0041] If the sum of the contents of the ester A1 and the ester A2 in the treatment agent is taken as 100% by mass, the content of the ester A1 is set as appropriate and is preferably 55% to 100% by mass. By specifying to be in such range, the emulsion stability in water of poor water quality such as hard water can be improved further.

[0042] The smoothing agent described above and used in the present embodiment may be used in combination with another smoothing agent. Another smoothing agent used as appropriate may be a known one. Specific examples of the smoothing agent include known smoothing agents used in treatment agents including (1) ester compounds of an aliphatic monoalcohol and an aliphatic monocarboxylic acid and ester compounds of an aliphatic monocarboxylic acid and a (poly)oxyalkylene adduct in which an alkylene oxide with 2 to 4 carbon atoms is added to an aliphatic monoalcohol, such as 2-ethyltridecyl propionate and 2-dodecylhexadecyl oleate, (2) ester compounds of an aliphatic polyhydric alcohol and an aliphatic monocarboxylic acid, such as 1,6-hexanediol didecanoate, trimethylolpropane monooleate monolaurate, sorbitan trioleate, sorbitan monooleate, sorbitan monostearate, and glycerin monolaurate, (3) ester compounds of an aliphatic monoalcohol and an aliphatic polycarboxylic acid and ester compounds of an aliphatic polycarboxylic acid and a (poly)oxyalkylene adduct in which an alkylene oxide with 2 to 4 carbon atoms is added to an aliphatic monoalcohol, such as dilauryl adipate, dioleyl azelate, ditetradecyl thiodipropionate, diisocetyl thiodipropionate, bispolyoxyethylene lauryl ether adipate, and bispolyoxyethylene lauryl ether thiodipropionate, (4) ester compounds of an aromatic monoalcohol and an aliphatic monocarboxylic acid and ester compounds of an aliphatic monocarboxylic acid and a (poly)oxyalkylene adduct in which an alkylene oxide with 2 to 4 carbon atoms is added to an aromatic monoalcohol, such as benzyl oleate, benzyl laurate, and polyoxypropylene benzyl stearate (5) ester compounds of an aromatic polyhydric alcohol and an aliphatic monocarboxylic acid and ester compounds of an aliphatic monocarboxylic acid and a (poly)oxyalkylene adduct in which an alkylene oxide with 2 to 4 carbon atoms is added to an aromatic polyhydric alcohol, such as bisphenol A dilaurate and polyoxyethylene bisphenol A dilaurate, (6) ester compounds of an aliphatic monoalcohol and an aromatic polycarboxylic acid and ester compounds of an aromatic polycarboxylic acid and a (poly)oxyalkylene adduct in which an alkylene oxide with 2 to 4 carbon atoms is added to an aliphatic monoalcohol, such as bis 2-ethylhexyl phthalate, diisostearyl isophthalate, and trioctyl trimellitate, (7) natural oils and fats, such as coconut oil, rapeseed oil, sunflower oil, soybean oil, castor oil, sesame oil, fish oil, and beef tallow, and (8) mineral oils. One type of such smoothing agents may be used alone or two or more types thereof may be used in combination.

[0043] The smoothing agent contains the ester A1 at a ratio of 40% to 100% by mass. By specifying to be in such range, the effects of the present invention can be improved.

[0044] The content of the smoothing agent in the treatment agent is set as appropriate and is preferably 20% to 80% by mass and more preferably 30% to 70% by mass. By being specified to be in such ranges, smoothness of fibers can be improved.

[0045] The nonionic surfactant used in the present embodiment contains an alkylene oxide adduct of an aliphatic alcohol with 4 to 24 carbon atoms having a branched chain structure. The aliphatic alcohol may be a saturated aliphatic alcohol or an unsaturated aliphatic alcohol. One type of such nonionic surfactants may be used alone or two or more types thereof may be used in combination.

[0046] Specific examples of the aliphatic alcohol with 4 to 24 carbon atoms having a branched chain structure include branched alkyl alcohols, such as isobutanol, isohexanol, 2-ethylhexanol, isooctanol, isononanol, isodecanol, isododecanol, isotridecanol, isotetradecanol, isohexadecanol, isoheptadecanol, isooctadecanol, isostearyl acohol, isononadecanol, isoeicosanol, isoheneicosanol, isodocosanol, 2-octyldodecanol, isotricosanol, and isotetracosanol, and branched alkenyl alcohols, such as isohexadecenol and isooctadecenol.

[0047] Specific examples of an alkylene oxide used as a raw material of the nonionic surfactant include ethylene oxide and propylene oxide. The number of moles of alkylene oxide added is set as appropriate and is preferably 0.1 to 150 moles, more preferably 1 to 100 moles, and even more preferably 2 to 50 moles. The number of moles of alkylene oxide

added represents the number of moles of the alkylene oxide with respect to 1 mole of the alcohol in charged raw materials. The polymerization sequence may be either a random adduct or a block adduct.

[0048] Specific examples of the alkylene oxide adduct of an aliphatic alcohol with 4 to 24 carbon atoms having a branched chain structure include a 10 mole ethylene oxide and 8 mole propylene oxide random adduct of isohexanol, 15 mole propylene oxide and 13 mole ethylene oxide block adduct of 2-ethylhexanol, and 8 mole ethylene oxide and 6 mole propylene oxide random adduct of 2-octyldodecanol.

[0049] Among the nonionic surfactants described above, a compound is preferable in which an alkylene oxide with 2 to 4 carbon atoms is added at a ratio of 1 to 100 moles in total to 1 mole of an aliphatic alcohol with 4 to 14 carbon atoms having a branched chain structure. By using such a compound, especially scattering of oil can be reduced further.

[0050] The content of the alkylene oxide adduct of an aliphatic alcohol with 4 to 24 carbon atoms having a branched chain structure in the treatment agent is set as appropriate and is preferably 1% to 30% by mass, more preferably 3% to 25% by mass, and even more preferably 5% to 20% by mass. By being specified to be in such ranges, the effects of the present invention can be improved further.

[0051] The nonionic surfactant described above and used in the present embodiment may be used in combination with another nonionic surfactant. Another nonionic surfactant used as appropriate may be a known one. Specific examples of the nonionic surfactant include (1) compounds in which an alkylene oxide with 2 to 4 carbon atoms is added to an organic acid, an organic alcohol, an organic amine, and/or an organic amide, for example, polyoxyethylene dilaurate, polyoxyethylene laurate, polyoxyethylene oleate, nad polyoxyethylene dioleate and ether type nonionic surfactants, such as polyoxyethylene octyl ether, polyoxyethylene lauryl ether, polyoxyethylene lauryl ether methyl ether, polyoxyethylene polyoxypropylene lauryl ether, polyoxypropylene lauryl ether methyl ether, polyoxyethylene oleyl ether, polyoxybutylene oleyl ether, polyoxyethylene polyoxypropylene nonyl ether, polyoxypropylene nonyl ether, polyoxyethylene polyoxypropylene octyl ether, polyoxyethylene dodecyl ether, polyoxyethylene tridecyl ether, ethylene oxide propylene oxide random adduct of tetradecyloctadecanol, polyoxyethylene lauryl aminoether, polyoxyethylene lauramide ether, polyoxyethylene tristyrenated phenyl ether, and ethylene oxide propylene oxide adduct of glycerin, (2) polyoxyalkylene polyhydric alcohol fatty acid ester type nonionic surfactants, such as polyoxyalkylene sorbitan trioleate, diester of ethylene oxide adduct of trimethylolpropane and stearic acid, polyoxyalkylene coconut oil, polyoxyalkylene castor oil, polyoxyalkylene hydrogenated castor oil, polyoxyalkylene hydrogenated castor oil triooctanoate, and maleic acid ester, stearic acid ester, or oleic acid ester of polyoxyalkylene hydrogenated castor oil, (3) alkyl amide type nonionic surfactants, such as stearic acid diethanolamide, and diethanolamine monolauramide, and (4) polyoxyalkylene fatty acid amide type nonionic surfactants, such as polyoxyethylene diethanolamine monooleylamide, polyoxyethylene laurylamine, and polyoxyethylene beef tallow amine.

[0052] The content of the alkylene oxide adduct of an aliphatic alcohol with 4 to 24 carbon atoms having a branched chain structure in the entire nonionic surfactant is set as appropriate and is preferably 10% to 100% by mass, more preferably 15% to 80% by mass, and even more preferably 20% to 60% by mass. By being specified to be in such ranges, the effects of the present invention can be improved.

[0053] The content of the entire nonionic surfactant in the treatment agent is set as appropriate and is preferably 5% to 70% by mass and more preferably 15% to 60% by mass. By being specified to be in such ranges, the effects of the present invention and stability when made into an emulsion can be improved.

[0054] As the ionic surfactant used in the present embodiment, that which is known can be adopted as appropriate. Examples of the ionic surfactant include anionic surfactants, cationic surfactants, and amphoteric surfactants. One type of such ingredients may be used alone or two or more types thereof may be used in combination.

[0055] As the anionic surfactant used in the present embodiment, that which is known can be adopted as appropriate. Specific examples of the anionic surfactant include (1) phosphoric acid ester salts of aliphatic alcohols, such as lauryl phosphoric acid ester salts, cetyl phosphoric acid ester salts, octyl phosphoric acid ester salts, oleyl phosphoric acid ester salts, and stearyl phosphoric acid ester salts, (2) phosphoric acid ester salts of adducts of at least one alkylene oxide selected from among ethylene oxide and propylene oxide with an aliphatic alcohol, such as polyoxyethylene lauryl ether phosphoric acid ester salts, polyoxyethylene oleyl ether phosphoric acid ester salts, and polyoxyethylene stearyl ether phosphoric acid ester salts, (3) aliphatic sulfonic acid salts or aromatic sulfonic acid salts, such as lauryl sulfonic acid salts, myristyl sulfonic acid salts, cetyl sulfonic acid salts, oleyl sulfonic acid salts, stearyl sulfonic acid salts, tetradecane sulfonic acid salts, dodecylbenzene sulfonic acid salts, and secondary alkyl (C13 to 15) sulfonic acid salts, (4) sulfuric acid ester salts of aliphatic alcohols such as lauryl sulfuric acid ester salts, oleyl sulfuric acid ester salts, and stearyl sulfuric acid ester salts, (5) sulfuric acid ester salts of adducts of at least one alkylene oxide selected from among ethylene oxide and propylene oxide with an aliphatic alcohol, such as polyoxyethylene lauryl ether sulfuric acid ester salts, polyoxyalkylene (polyoxyethylene, polyoxypropylene) lauryl ether sulfuric acid ester salts, and polyoxyethylene oleyl ether sulfuric acid ester salts, (6) sulfuric acid ester salts of fatty acids, such as castor oil fatty acid sulfuric acid ester salts, sesame oil fatty acid sulfuric acid ester salts, tall oil fatty acid sulfuric acid ester salts, soybean oil fatty acid sulfuric acid ester salts, rapeseed oil fatty acid sulfuric acid ester salts, palm oil fatty acid sulfuric acid ester salts, lard fatty acid sulfuric acid ester salts, beef tallow fatty acid sulfuric acid ester salts, and whale oil fatty acid sulfuric acid ester

salts, (7) sulfuric acid ester salts of oils and fats, such as sulfuric acid ester salts of castor oil, sulfuric acid ester salts of sesame oil, sulfuric acid ester salts of tall oil, sulfuric acid ester salts of soybean oil, sulfuric acid ester salts of rapeseed oil, sulfuric acid ester salts of palm oil, sulfuric acid ester salts of lard, sulfuric acid ester salts of beef tallow, and sulfuric acid ester salts of whale oil, (8) fatty acid salts, such as lauric acid salts, oleic acid salts, and stearic acid salts, and (9) sulfosuccinic acid ester salts of aliphatic alcohols, such as dioctyl sulfosuccinic acid salts. Examples of a counterion of the anionic surfactant include alkali metal salts, such as a potassium salt and a sodium salt, an ammonium salt, and alkanolamine salts, such as triethanolamine.

[0056] As the cationic surfactant used in the present embodiment, that which is known can be adopted as appropriate. Specific examples of the cationic surfactant include lauryltrimethylammonium chloride, cetyltrimethylammonium chloride, stearyltrimethylammonium chloride, behenyltrimethylammonium chloride, and didecyldimethylammonium chloride.

[0057] As the amphoteric surfactant used in the present embodiment, that which is known can be adopted as appropriate. Specific examples of the amphoteric surfactant include a betaine type amphoteric surfactant.

[0058] The content of the ionic surfactant in the treatment agent is set as appropriate and is preferably 1% to 20% by mass, more preferably 3% to 16% by mass, and even more preferably 6% to 13% by mass. By being specified to be in such ranges, the effects of the present invention, the stability when made into an emulsion, or antistatic properties can be improved.

(Second Embodiment)

[0059] Next, a second embodiment that embodies a synthetic fiber according to the present invention will be described. The synthetic fiber of the present embodiment has the treatment agent of the first embodiment adhered thereto. The form of the treatment agent when adhering the treatment agent to the synthetic fiber may be a dilute solution made by diluting with a diluting solvent or may be an organic solvent solution or an aqueous liquid. The synthetic fiber of the present embodiment is manufactured by undergoing the step of adhering the treatment agent in the form of a dilute solution, such as an aqueous liquid, to the synthetic fiber, for example, in a spinning or drawing step. A water content of the dilute solution that has been adhered to the synthetic fiber may be evaporated by a drying step.

[0060] The synthetic fiber to be manufactured is not restricted in particular, and specific examples thereof include (1) polyethylene terephthalate, polypropylene terephthalate, polylactic acid ester, and other polyester fibers, (2) nylon 6, nylon 66, and other polyamide fibers, (3) polyacrylic, modacrylic, and other polyacrylic fibers, and (4) polyethylene, polypropylene, and other polyolefin fibers.

[0061] The amount of the treatment agent to be adhered to the synthetic fiber is not restricted in particular, and the treatment agent is preferably adhered such as to be of a ratio of 0.1% to 3% by mass (not including water or other solvent) with respect to the synthetic fiber. By this arrangement, the effects of the present invention can be improved further. The method for adhering the treatment agent to the synthetic fiber is not restricted in particular, and a known method such as a roller oiling method, a guide oiling method using a metering pump, an immersion oiling method, or a spray oiling method can be adopted.

[0062] The following effects can be obtained by the treatment agent and the synthetic fiber of the above-described embodiments.

(1) The treatment agent of the above-described embodiments contains a smoothing agent, a nonionic surfactant, and an ionic surfactant. The smoothing agent contains the above-described ester A1, and the ester A1 is contained in the smoothing agent at a ratio of 40% to 100% by mass. The nonionic surfactant contains an alkylene oxide adduct of an aliphatic alcohol with 4 to 24 carbon atoms having a branched chain structure. This allows reduction of scattering of oil in a spinning step, and various functions of the treatment agent can thus be exhibited efficiently in the synthetic fiber obtained. Further, this also allows improvement of the emulsion stability in water of poor water quality such as hard water, and yarn manufacturing stability can thus be improved regardless of water quality.

[0063] The above-described embodiments may be modified as follows.

· The treatment agent of the embodiments may be stored in the form of an aqueous liquid that contains water. The contents of the treatment agent and water in the aqueous liquid are not restricted in particular. If the content of the treatment agent in the aqueous liquid is taken as 100 parts by mass, the content of water in the aqueous liquid is preferably 5 to 30 parts by mass and more preferably 5 to 20 parts by mass. By specifying to be of such ratios, the aqueous liquid can be improved in handling properties and improved in temporal stability. The type of water used in preparing the aqueous liquid is not restricted in particular and may be distilled water that contains hardly any impurities or hard water or soft water that contains, for example, Ca ions and Mg ions.

· Stabilizers, antistatic agents, binders, antioxidant agents, ultraviolet absorbers, antifoaming agents (silicone compounds), and other ingredients that are ordinarily used in treatment agents for quality maintenance of the treatment

agents may further be blended in the treatment agent of the embodiments within a range that does not impair the effects of the present invention.

[0064] Specific examples of the antioxidant agents include (1) phenol-based antioxidant agents, such as 1,3,5-tris(3',5'-di-t-butyl-4-hydroxybenzyl)isocyanuric acid, 1,3,5-tris(4-t-butyl-3-hydroxy-2,6-dimethylbenzyl)isocyanuric acid, 1,3,5-trimethyl-2,4,6-tris(3,5-di-t-butyl-4-hydroxybenzyl)benzene, 2,2'-methylene-bis(4-methyl-6-t-butylphenol), 1,1,3-tris(2-methyl-4-hydroxy-5-t-butylphenyl)butane, tetrakis[methylene-3-(3',5'-di-t-butyl-4'-hydroxyphenyl)propionate]methane, and triethylene glycol-bis[3-(3-t-butyl-5-methyl-4-hydroxyphenyl)propionate], (2) phosphite-based antioxidant agents, such as octyl diphenyl phosphite, tris nonylphenyl phosphite, and tetratridecyl-4,4'-butylidene-bis-(2-t-butyl-5-methylphenol) diphosphate, and (3) thioether-based antioxidant agents, such as 4,4'-thiobis-(6-t-butyl-3-methylphenol), and dilauryl-3,3'-thiodipropionate. One type of such antioxidant agents may be used alone or two or more types thereof may be used in combination.

EXAMPLES

[0065] Examples will now be given below to describe the features and effects of the present invention more specifically, but the present invention is not restricted to these examples. In the following description of examples and comparative examples, parts means parts by mass and % means % by mass.

Experimental Part 1 (Preparation of synthetic fiber treatment agents)

[0066] Treatment agents used in the respective examples and comparative examples were obtained by the following preparation method using the respective components indicated in Tables 1 to 4.

[0067] Esters A1 (A1-1 to 12) represented by Chemical Formula 3 described above are shown in Table 1. The types of the esters A1 are indicated in the "Ester A1" column of Table 1. The types of R^1, X^1, Y^1, and Z^1 in Chemical Formula 3 are respectively indicated in the "R^1" column, the "X^1" column, the "Y^1" column, and the "Z^1" column of Table 1. The total numbers of carbon atoms of X^1, Y^1, and Z^1 are indicated in the "Total number of carbon atoms of X^1, Y^1, and Z^1" column of Table 1.

[0068] For reference, a synthesis example of 2-propylheptyl oleate (A1-1) is described below.

· Synthesis of 2-propylheptyl oleate (A1-1)

[0069] 282 g (1 mole) of oleic acid and 158 g (1 mole) of 2-propylheptyl alcohol were charged into a flask, melted at 75°C under nitrogen gas, and by thereafter adding 0.6 g of paratoluenesulfonic acid as a catalyst, made to react for 4 hours under reduced pressure of 2 mmHg at 120°C. Return to ordinary pressure at 105°C was then performed under nitrogen gas and the catalyst was treated by adding an adsorbent. Filtration at 90°C was then performed to obtain a mixture containing the ester A1-1.

[0070] Isolation by column chromatography using silica gel was performed to separate minute amounts of impurities (byproducts, unreacted alcohol, unreacted fatty acid, etc.) from the ester A1-1 obtained by the above method.

[0071] The ester A1-1 isolated by the column was analyzed by ^{1}H-NMR (MERCURY plus NMR Spectrometer System manufactured by VALIAN Inc., 300 MHz, $CDCl_3$). It was confirmed by NMR that at 3.9 to 4.1 ppm, there is a doublet peak, that is, a peak indicating that X^1 in Chemical Formula 3 is a hydrocarbon group (if X^1 is a hydrogen atom, there would be a triplet peak). Also, measurement by GC-MS was performed and it was confirmed that there is an MS molecular ion peak (m/z = 422).

[Table 1]

Type	Ester A1	R^1	X^1	Y^1	Z^1	Total number of carbon atoms of X^1, Y^1, and Z^1
A1-1	2-propylheptyl oleate	8-heptadecenyl group	Propyl group	Hydrogen	Butyl group	7
A1-2	2-methylnonyl oleate	8-heptadecenyl group	Methyl group	Hydrogen	Hexyl group	7
A1-3	2-ethylheptyl decanoate	Nonyl group	Ethyl group	Hydrogen	Butyl group	6

(continued)

Type	Ester A1	R^1	X^1	Y^1	Z^1	Total number of carbon atoms of X^1, Y^1, and Z^1
A1-4	2-methylnonyl tetracosanoate	Tricosyl group	Methyl group	Hydrogen	Hexyl group	7
A1-5	2-ethyldecyl stearate	Heptadecyl group	Ethyl group	Hydrogen	Heptyl group	9
A1-6	2-propylheptyl stearate	Heptadecyl group	Propyl group	Hydrogen	Butyl group	7
A1-7	2-ethyltridecyl oleate	8-heptadecenyl group	Ethyl group	Hydrogen	Decyl group	12
A1-8	3,5,5-trimethylhexyl oleate	8-heptadecenyl group	Hydrogen	Methyl group	2,2-dimethylpropyl group	6
A1-9	3,7-dimethyloctyl oleate	8-heptadecenyl group	Hydrogen	Methyl group	4-methylpentyl group	7
A1-10	3-methylundecyl oleate	8-heptadecenyl group	Hydrogen	Methyl group	Octyl group	9
A1-11	2-octyldodecyl palmitate	Pentadecyl group	Octyl group	Hydrogen	Nonyl group	17
A1-12	2-ethylhexyl stearate	Heptadecyl group	Ethyl group	Hydrogen	Propyl group	5
A1-13	2-octyldodecyl isostearate	15-methylhexadecyl group	Octyl group	Hydrogen	Nonyl group	17
A1-14	3-methylheptadecyl oleate	9-heptadecenyl group	Hydrogen	Methyl group	Tetradecyl group	15

[0072] Esters A2 (A2-1 to 3) represented by Chemical Formula 4 described above are shown in Table 2. The types of the esters A2 are indicated in the "Ester A2" column of Table 2. The types of R^2, X^2, Y^2, and Z^2 in Chemical Formula 4 are respectively indicated in the "R^2" column, the "X^2" column, the "Y^2" column, and the "Z^2" column of Table 2.

[Table 2]

Type	Ester A2	R^2	X^2	Y^2	Z^2
A2-1	Isotridecyl oleate	8-heptadecenyl group	Hydrogen	Hydrogen	8-methylnonyl group
A2-2	Lauryl oleate	8-heptadecenyl group	Hydrogen	Hydrogen	Nonyl group
A2-3	Oleyl laurate	Undecyl group	Hydrogen	Hydrogen	6-pentadecenyl group

· Preparation of treatment agent (Example 1)

[0073] Uniform mixing of 50% of 2-propylheptyl oleate (A1-1) as a smoothing agent, 10% of a 10 mole ethylene oxide and 8 mole propylene oxide random adduct of isohexanol (B-1), 15% of a 20 mole ethylene oxide adduct of hydrogenated castor oil (b-1), and 15% of a 7 mole ethylene oxide adduct of oleic acid (b-2) as nonionic surfactants, 4.9% of a salt of a phosphoric acid ester of polyoxyethylene (2 moles: represents the number of added moles of ethylene oxide (the same applies hereinafter)) lauryl ether and potassium (C-1), 4% of a sodium secondary alkyl sulfonate (number of carbon atoms: 13 to 15) (C-2), and 1% of potassium oleate (C-3) as ionic surfactants, and 0.1% of 1,1,3-tris(2-methyl-4-hydroxy-5-t-butylphenyl)butane (D-1) as an antioxidant agent was performed to obtain a mixture as a treatment agent of Example 1.

· Preparation of treatment agents (Examples 2 to 33 and Comparative Examples 1 to 5)

[0074] Treatment agents of Examples 2 to 33 and Comparative Examples 1 to 5 were prepared in the same manner as in preparing the treatment agent of Example 1 and using the ingredients shown in Tables 3 and 4. In Tables 3 and 4, along with indicating the types of the respective ingredients in each treatment agent, blending ratios (%) of the respective ingredients with the treatment agent being 100% are indicated.

[0075] Types and contents of the smoothing agents, types and contents of the nonionic surfactants, types and contents of the ionic surfactants, and types and contents of other ingredients in the treatment agents of the respective examples are as respectively indicated in the "Smoothing agent" column, the "Nonionic surfactant" column, the "Ionic surfactant" column, and the "Other ingredient" column of Tables 3 and 4. The mass ratio of the content of the ester A1 in each smoothing agent is indicated in the "Mass ratio: Ester A1/Smoothing agent" column of Table 1 and the mass ratio of the content of the ester A1 when the sum of the contents of the ester A1 and the ester A2 being 100% is indicated in the "Mass ratio: Ester A1/(Ester A1 + Ester A2)" column of Tables 3 and 4.

[Table 3]

Category	Synthetic fiber treatment agent										Evaluation	
	Smoothing agent		Nonionic surfactant		Ionic surfactant		Other ingredient		Mass ratio: Ester A1/ Smoothing agent	Mass ratio: Ester A1/ (Ester A1 + Ester A2)	Scattering	Hard water stability
	Type	Percentage (% by mass)	Type	Percentage (% by mass)	Type	Percentage (% by mass)	Type	Percentage (% by mass)				
Example 1	A1-1	50.0	B-1 b-1 b-2	10.0 15.0 15.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	100	100	○○○	○○○
Example 2	A1-1 A2-1	40.0 10.0	B-1 b-1 b-2	10.0 15.0 15.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	80	80	○○○	○○○
Example 3	A1-1 A2-1	35.0 20.0	B-1 b-1 b-2	10.0 15.0 15.0	C-1	4.9	D-2	0.1	63.6	63.6	○○○	○○○
Example 4	A1-1 A2-1 a-1	30.0 10.0 10.0	B-1 b-1 b-3	10.0 15.0 15.0	C-1 C-2 C-3	4.8 4.0 1.0	D-1 D-3	0.1 0.1	60	75	○○○	○○○
Example 5	A1-1 A2-1 a-2	20.0 5.0 25.0	B-2 b-1 b-2	10.0 15.0 15.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	40	80	○○○	○○○
Example 6	A1-1 A2-2 a-3	22.0 18.0 10.0	B-1 b-1 b-2 b-7	10.0 10.0 15.0 5.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	44	55	○○○	○○○
Example 7	A1-1 a-1	27.0 32.0	B-2 b-2 b-5	10.0 12.5 12.5	C-1 C-3	4.8 1.0	D-2 D-3	0.1 0.1	45.8	100	○○○	○○○
Example 8	A1-1	40.0	B-1 b-2 b-4 b-6	15.0 15.0 15.0 5.0	C-1 C-2 C-3	5.0 4.0 1.0			100	100	○○○	○○○
Example 9	A1-1	65.0	B-1 b-1 b-2	7.5 10.0 12.5	C-1 C-3	4.0 1.0			100	100	○○○	○○○
Example 10	A1-1 A2-3 a-3	28.0 20.0 12.0	B-1 b-1 b-2	7.5 10.0 12.5	C-1 C-2 C-3	5.0 4.0 1.0			46.7	58.3	○○○	○○○
Example 11	A1-2	50.0	B-1 b-1 b-2	10.0 15.0 15.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	100	100	○○○	○○○
Example 12	A1-3	50.0	B-1 b-3 b-5 b-7	10.0 15.0 10.0 5.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	100	100	○○○	○○○
Example 13	A1-3 A2-2 a-1	35.0 15.0 10.0	B-2 b-1 b-2	10.0 15.0 10.0	C-1	4.9	D-1	0.1	58.3	70	○○○	○○○
Example 14	A1-4	50.0	B-1 b-1 b-6 b-7	15.0 15.0 5.0 5.0	C-1 C-2 C-3	4.9 4.0 1.0	D-2	0.1	100	100	○○○	○○○
Example 15	A1-5	50.0	B-1 b-1 b-2	10.0 15.0 15.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	100	100	○○○	○○○
Example 16	A1-5 A2-2 a-3 a-4	25.0 15.0 5.0 5.0	B-1 b-1 b-2	10.0 15.0 15.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	50	62.5	○○○	○○○
Example 17	A1-5 A2-2 a-3	28.0 20.0 12.0	B-1 b-1 b-3	7.5 10.0 12.5	C-1 C-2 C-3	5.0 4.0 1.0			46.7	58.3	○○○	○○○
Example 18	A1-6	50.0	B-1 b-2 b-3	10.0 15.0 15.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	100	100	○○○	○○○
Example 19	A1-7	50.0	B-1 b-1 b-2	10.0 15.0 15.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	100	100	○○○	○○○

[Table 4]

Category	Synthetic fiber treatment agent								Mass ratio: Ester A1/ Smoothing agent	Mass ratio: Ester A1/ (Ester A1 + Ester A2)	Evaluation	
	Smoothing agent		Nonionic surfactant		Ionic surfactant		Other ingredient					
	Type	Percentage (% by mass)	Type	Percentage (% by mass)	Type	Percentage (% by mass)	Type	Percentage (% by mass)			Scattering	Hard water stability
Example 20	A1-1 A2-2 a-1	20.0 20.0 10.0	B-2 b-1 b-3	10.0 15.0 15.0	C-1 C-2 C-3	4.8 4.0 1.0	D-2 D-3	0.1 0.1	40	50	○○○	○○
Example 21	A1-8 a-2	30.0 20.0	B-1 b-1 b-2 b-5	10.0 15.0 10.0 6.0	C-1 C-2	4.9 4.0	D-1	0.1	60	100.0	○○	○○○
Example 22	A1-9 A2-1	30.0 20.0	B-2 b-1 b-2	10.0 15.0 15.0	C-1 C-2 C-3	4.8 4.0 1.0	D-1 D-3	0.1 0.1	60	60	○○	○○○
Example 23	A1-10 A2-1	25.0 35.0	B-2 b-1 b-3	10.0 10.0 15.0	C-1	4.9	D-1	0.1	41.7	41.7	○○	○○
Example 24	A1-7 A2-1	35.0 25.0	B-3 b-1 b-2	12.0 10.0 13.0	C-1	4.9	D-1	0.1	58.3	58.3	○○	○○○
Example 25	A1-7 A2-1	25.0 25.0	B-3 b-3 b-4 b-5	12.0 13.0 5.0 10.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	50	50	○○	○○
Example 26	A1-9 A2-1	40.0 10.0	B-3 b-1 b-2	12.0 15.0 13.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	80	80	○	○○○
Example 27	A1-10 A2-1	20.0 30.0	B-3 b-1 b-2	12.0 15.0 13.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	40	40	○	○○
Example 28	A1-11 a-3	30.0 20.0	B-2 b-1 b-2	12.0 15.0 13.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	60	100	○○○	○○
Example 29	A1-12 a-2	30.0 20.0	B-1 b-2 b-3 b-5	12.0 10.0 8.0 10.0	C-1 C-2 C-3	4.9 4.0 1.0	D-2	0.1	60	100	○○○	○○
Example 30	A1-13 A2-2	40.0 10.0	B-1 b-1 b-2	12.0 15.0 13.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	80	80	○○○	○○
Example 31	A1-11 A2-2	25.0 25.0	B-1 b-1 b-3	12.0 15.0 13.0	C-1 C-2 C-3	5.0 4.0 1.0			50	50	○○○	○
Example 32	A1-14 A2-2	25.0 25.0	B-1 b-1 b-2	12.0 15.0 13.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	50	50	○○	○
Example 33	A1-14 A2-3 a-4	25.0 25.0 10.0	B-3 b-1 b-2	10.0 12.5 7.5	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	41.7	50	○	○
Comparative Example 1	A1-1	50.0	b-1 b-2 b-3	15.0 15.0 10.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	100	100	○	×
Comparative Example 2	a-2	50.0	b-1 b-2 b-4	15.0 15.0 10.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	0	-	×	×
Comparative Example 3	a-5	50.0	B-2 b-5 b-7	10.0 15.0 15.0	C-1 C-2 C-3	4.9 4.0 1.0	D-1	0.1	0	-	○	×
Comparative Example 4	A1-7 A2-2	10.0 45.0	B-2 b-1 b-3	10.0 11.0 15.0	C-1 C-3	4.9 1.0	D-1	0.1	18.2	18.2	○	×
Comparative Example 5	A1-11 a-5 a-6	20.0 10.0 40.0	B-2 b-4 b-5 b-6	12.0 9.5 6.0 1.5			D-2 D-3	0.5 0.5	28.6	100	○	×

[0076] The following are indicated in Tables 3 and 4.

a-1: 2-dodecylhexadecyl oleate
a-2: rapeseed oil
a-3: mineral oil (100 Redwood seconds, 30°C)
a-4: 2-ethyltridecyl propionate
a-5: diester of 2-decyltetradecanol and thiodipropionic acid
a-6: diester of polyoxyethylene (3 moles) lauryl ether and thiodipropionic acid
B-1: 10 mole ethylene oxide and 8 mole propylene oxide random adduct of isohexanol
B-2: 15 mole propylene oxide-13 mole ethylene oxide block adduct of 2-ethylhexanol
B-3: 8 mole ethylene oxide and 6 mole propylene oxide random adduct of 2-octyldodecanol
b-1: 20 mole ethylene oxide adduct of hydrogenated castor oil
b-2: 7 mole ethylene oxide adduct of oleic acid
b-3: 7 mole ethylene oxide adduct of lauryl alcohol
b-4: diester of 24 mole ethylene oxide adduct of trimethylolpropane and stearic acid
b-5: 25 mole ethylene oxide adduct of hydrogenated castor oil
b-6: 15 mole ethylene oxide adduct of beef tallow alkylamine
b-7: 10 mole ethylene oxide and 4 mole propylene oxide random adduct of tetradecyloctadecanol
C-1: salt of phosphoric acid ester of polyoxyethylene (2 moles) lauryl ether and potassium
C-2: sodium secondary alkyl sulfonate (number of carbon atoms: 13 to 15)
C-3: potassium oleate
D-1: 1,1,3-tris(2-methyl-4-hydroxy-5-t-butylphenyl)butane
D-2: triethylene glycol-bis[3-(3-t-butyl-5-methyl-4-hydroxyphenyl)propionate]
D-3: polydimethylsiloxane (viscosity: 20 mm^2/s (25°C))

Experimental Part 2 (Evaluation of treatment agents)

· Manufacture of drawn yarn

[0077] A specific amount of ion exchanged water was added to each treatment agent obtained as described above and mixed uniformly to prepare an aqueous liquid with a treatment agent concentration of 10%. Chips of polyethylene terephthalate with an intrinsic viscosity of 0.64 and a titanium oxide content of 0.2% were dried by a routine method and thereafter spun into a yarn at 295°C using an extruder. After discharging from a nozzle to cool and solidify, the running yarn thread was subject to adhesion of the abovementioned aqueous liquid at 1.0% as treatment agent with respect to the running yarn thread by a guide oiling method using a metering pump. Thereafter, bundling by a guide was performed, taking off at a speed of 1,400 m/minute by a takeoff roller heated to 90°C was performed, and then drawing to 3.2 times between the takeoff roller and a drawing roller rotating at a speed of 4,800 m/minute was performed to manufacture a drawn yarn of 83.3 decitex (75 denier) and 36 filaments. Evaluation of scattering was performed in the manufacturing method described above. Also, emulsion stability of the treatment agent in water of poor water quality was evaluated as hard water stability by the following method. The results are shown in Tables 3 and 4.

· Evaluation of scattering

[0078] In obtaining a package of the drawn yarn obtained by the above method, scattering conditions with an oiling nozzle were visually observed for 10 minutes. Scattering were evaluated based on the following evaluation criteria. The results are shown in the "Scattering" column of Tables 3 and 4.

⦾⦾ (excellent): There was no scattering.
⦾ (satisfactory): Scattering was rarely observed.
◦ (fair): Scattering was observed but was of a low amount.
× (poor): Scattering of a large amount was observed constantly.

· Evaluation of hard water stability

[0079] With the treatment agent of each example prepared in Experimental Part 1, 15 parts of the treatment agent and 85 parts of hard water described below were mixed uniformly to prepare a hard water aqueous liquid of the treatment agent with a concentration of 15%.

[0080] As the hard water, water with an electric conductivity of 130 μS/cm when measured at 25°C was used.

[0081] The hard water aqueous liquid that was prepared was further left to stand for 24 hours at 30°C, thereafter visually observed, and precipitated particles were evaluated based on the following evaluation criteria. The results are shown in the "Hard water stability" column of Tables 3 and 4.

· Evaluation criteria of precipitated particles

[0082]

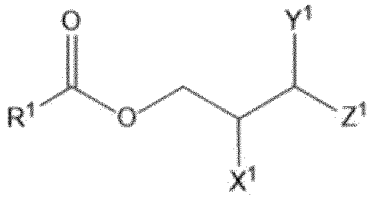
∘∘∘ (excellent): Precipitated particles were not observed at all.
∘∘ (satisfactory): Precipitated particles were slightly observed.
∘ (fair): Precipitated particles were observed but were dispersed.
× (poor): A large amount of precipitated particles were observed and sedimentation also occurred.

[0083] As is clear from the results of Tables 3 and 4, the treatment agents of the respective examples were all evaluated as being fair or better in the evaluations of scattering and hard water stability. The present invention succeeds in reducing scattering of oil in a spinning step and improving emulsion stability in water of poor water quality such as hard water.

Claims

1. A synthetic fiber treatment agent comprising a smoothing agent, a nonionic surfactant, and an ionic surfactant, wherein the smoothing agent contains an ester A1 represented by Chemical Formula 1 shown below, the ester A1 is contained in the smoothing agent at a ratio of 40% to 100% by mass, and the nonionic surfactant contains an alkylene oxide adduct of an aliphatic alcohol with 4 to 24 carbon atoms having a branched chain structure.

[Chemical Formula 1]

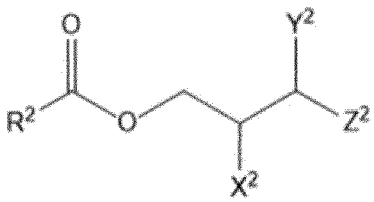


(In Chemical Formula 1,

R^1 is a saturated hydrocarbon group with 7 to 23 carbon atoms or an unsaturated hydrocarbon group with 7 to 23 carbon atoms, and
X^1, Y^1, and Z^1 are each a hydrogen atom, a methyl group, an ethyl group, a straight chain saturated hydrocarbon group with 3 to 21 carbon atoms, a saturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure, a straight chain unsaturated hydrocarbon group with 3 to 21 carbon atoms, or an unsaturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure.
However, at least one of X^1 and Y^1 is a methyl group, an ethyl group, or an abovementioned hydrocarbon group, and the total number of carbon atoms of X^1, Y^1, and Z^1 is 5 to 21.

2. The synthetic fiber treatment agent according to claim 1, wherein the smoothing agent further contains an ester A2 represented by Chemical Formula 2 shown below.

[Chemical Formula 2]



(In Chemical Formula 2,

R^2 is a saturated hydrocarbon group with 7 to 23 carbon atoms or an unsaturated hydrocarbon group with 7 to 23 carbon atoms,
X^2 is a hydrogen atom,
Y^2 is a hydrogen atom, and
Z^2 is a hydrogen atom, a methyl group, an ethyl group, a straight chain saturated hydrocarbon group with 3 to 17 carbon atoms, a saturated hydrocarbon group with 3 to 17 carbon atoms having a branched chain structure, a straight chain unsaturated hydrocarbon group with 3 to 17 carbon atoms, or an unsaturated hydrocarbon group with 3 to 17 carbon atoms having a branched chain structure.)

3. The synthetic fiber treatment agent according to claim 2, wherein the content of the ester A1 in the synthetic fiber treatment agent is 55% to 100% by mass if the sum of the contents of the ester A1 and the ester A2 in the synthetic fiber treatment agent is taken as 100% by mass.

4. The synthetic fiber treatment agent according to any one of claims 1 to 3, wherein X^1 in the Chemical Formula 1 is a methyl group, an ethyl group, a straight chain saturated hydrocarbon group with 3 to 21 carbon atoms, a saturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure, a straight chain unsaturated hydrocarbon group with 3 to 21 carbon atoms, or an unsaturated hydrocarbon group with 3 to 21 carbon atoms having a branched chain structure.

5. The synthetic fiber treatment agent according to any one of claims 1 to 4, wherein the nonionic surfactant contains a compound in which an alkylene oxide with 2 to 4 carbon atoms is added at a ratio of 1 to 100 moles with respect to 1 mole of an aliphatic alcohol with 4 to 14 carbon atoms having a branched chain structure.

6. The synthetic fiber treatment agent according to any one of claims 1 to 5, wherein the total number of carbon atoms of X^1, Y^1, and Z^1 in the Chemical Formula 1 is 6 to 12.

7. A synthetic fiber to which the synthetic fiber treatment agent according to any one of claims 1 to 6 is adhered.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/021316

A. CLASSIFICATION OF SUBJECT MATTER
D06M 13/224(2006.01)i; D06M 15/53(2006.01)i
FI: D06M13/224; D06M15/53
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D06M13/00-15/715

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2017-110319 A (MATSUMOTO YUSHI-SEIYAKU CO., LTD.) 22 June 2017 (2017-06-22) claim 1, example 11, table 1	1-7
A	WO 2020/022348 A1 (TAKEMOTO OIL & FAT CO., LTD.) 30 January 2020 (2020-01-30)	1-7
A	WO 2016/067871 A1 (MATSUMOTO YUSHI-SEIYAKU CO., LTD.) 06 May 2016 (2016-05-06)	1-7
A	WO 2016/021211 A1 (MATSUMOTO YUSHI-SEIYAKU CO., LTD.) 11 February 2016 (2016-02-11)	1-7
A	JP 6600835 B1 (TAKEMOTO OIL & FAT CO., LTD.) 06 November 2019 (2019-11-06)	1-7
A	JP 2018-135619 A (TAKEMOTO OIL & FAT CO., LTD.) 30 August 2018 (2018-08-30)	1-7

☒ Further documents are listed in the continuation of Box C.
☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 16 July 2021 (16.07.2021)	Date of mailing of the international search report 27 July 2021 (27.07.2021)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/021316

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2010-121223 A (TAKEMOTO OIL & FAT CO., LTD.) 03 June 2010 (2010-06-03)	1-7

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/021316

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JP 2017-110319 A	22 Jun. 2017	(Family: none)	
WO 2020/022348 A1	30 Jan. 2020	KR 10-2020-0081505 A	
		CN 111479962 A	
		TW 202012739 A	
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WO 2016/021211 A1	11 Feb. 2016	CN 105492688 A	
		TW 201610262 A	
		KR 10-2017-0039549 A	
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JP 2018-135619 A	30 Aug. 2018	(Family: none)	
JP 2010-121223 A	03 Jun. 2010	CN 101736577 A	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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