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(54) Spinning method and spun yarn

(57) A spinning method using a whirling air spinning machine enables successful operation under high-speed spinning conditions with scum accumulation suppressed to a good extent. Spun yarns obtained with the spinning method are also provided.

A fiber-processing agent having a kinetic viscosity at 30°C of 1 x 10^{-6} to 100 x 10^{-6} m^2/s is mixed with compressed air in a whirling air spinning machine and is sprayed on fibers in said spinning method using the whirling air spinning machine, wherein the said fiber-processing agent comprises one, two or more of the following lubricant (A), the following lubricant (B) and the following lubricant (C).

Lubricant (A) is an aliphatic ester compound of carbon number 5-70;

Lubricant (B) is a linear polyorganosiloxane having a kinetic viscosity at 30°C of 5 x 10^{-6} to 100 x 10^{-6} m^2/s; and

Lubricant (C) is a mineral oil having a kinetic viscosity at 30°C of 5 x 10^{-6} to 100 x 10^{-6} m^2/s.

EP 2 730 695 A1

Description

Background of the invention

[0001] The present invention relates to a spinning method and a spun yarn. In modern spinning processes, the transition towards high-speed spinning, such as spinning with high-speed ring spinning machines, spinning with high-speed rotor-type open-end spinning machines, and spinning with whirling air spinning machines is advancing to achieve reduced production costs and improved productivity. However, as the spinning speed becomes faster in these trends, the amount of fibers passing through the spinning machine per unit time increases in proportion to the speed, so that scum accumulation increases, thereby shortening the cleaning cycle and reducing the operational performance. The present invention relates in particular to a spinning method which uses a whirling air spinning machine, and it relates to a spinning method according to which good high-speed spinning performance is assured during operation with scum generation being suppressed during the fiber-spinning operation with the whirling air spinning machine, and to the spun yarn obtained through such a spinning method.

[0002] Until now, various fiber-processing agents using an alkyl phosphoric ester potassium salt have been used in fiber spinning to achieve favorable spinning performance. The following fiber-processing agents are known: 1) two-component families with an alkyl phosphoric ester 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 including an alkyl phosphoric ester potassium salt, a phosphate of an 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 phosphoric ester potassium salt and a high molecular weight polyoxyethylene compound (refer to Japanese Patent Publication Tokkaihei 3-174067 for example), and 4) three-component families including an alkyl phosphoric ester potassium salt, a paraffin wax emulsifier and a cationic surfactant (refer to Japanese Patent Publication Tokkaihei 6-108361 for example). However, these conventional fiber-processing agents have scum accumulation problems at the antinode ring in the case of spinning with a high-speed ring spinning machine, inside the rotor in the case of spinning with a high-speed rotor-type open-end spinning machine, or on the spindle in the case of spinning with a whirling air spinning machine. Among these, because the spinning speed in whirling air spinning machines is considerably faster than that in high-speed ring spinning machines and high-speed rotor-type open-end spinning machines, scum accumulation poses a relatively serious problem. Scum accumulation not only shortens the cleaning cycle and deteriorates the operational performance but also can reduce the yarn strength due to the serious damage caused to the fiber and can increase white powder formation and yarn breakage. While the use of a surfactant has been proposed for spinning with whirling air spinning machines to avoid scum accumulation (Japanese Patent Publication Tokkai 2008-95208 for example), surfactants containing an alkyl phosphoric ester potassium salt cannot, when used as fiber-processing agents, suppress scum accumulation to an optimum level.

Summary of the Invention

[0003] An object of the present invention is to provide a spinning method for spinning with a whirling air spinning machine that assures favorable high-speed spinning performance while suppressing scum accumulation sufficiently, and a spun yarn obtained with the aforementioned spinning method.

[0004] The inventors have found as a result of studies to solve the problem that the use of a special fiber-processing agent in a special method is beneficial and favorable for spinning with a whirling air spinning machine.

[0005] That is, the present invention relates to a spinning method which uses a whirling air spinning machine for mixing a fiber-processing agent with compressed air in the whirling air spinning machine and spraying the fiber-processing agent on fibers. The present invention also relates to the spun yarn obtained with the aforementioned spinning method.

[0006] The fiber-processing agent has a kinetic viscosity at 30°C of 1 x 10^{-6} to 100 x 10^{-6} m^2/s and comprises one or two or more of the following lubricant (A), the following lubricant (B) and the following lubricant (C).

[0007] Lubricant (A) is an aliphatic ester compound of carbon number 5-70.

[0008] Lubricant (B) is a linear polyorganosiloxane having a kinetic viscosity at 30°C of 5 x 10^{-6} to 100 x 10^{-6} m^2/s.

[0009] Lubricant (C) is a mineral oil having a kinetic viscosity at 30°C of 5 x 10^{-6} to 100 x 10^{-6} m^2/s.

Detailed Description of the invention

[0010] A whirling air spinning machine is used in the spinning method related to the present invention. The whirling air spinning machine spins yarn with a whirling flow of compressed air and the whirling air spinning machine itself is widely known (refer to Japanese Patent Publication Tokkai 2001-73235, Japanese Patent Publication Tokkai 2007-284813 and Tokkai 2011-38210 for example), such as, for example, the product with the name VORTEX (registered trade mark) made by MURATA MACHINERY, LTD.

[0011] In the spinning method related to the present invention, one or two or more of said lubricant (A), said lubricant (B) and said lubricant (C) are used. The spinning method including a fiber-processing agent selected from lubricant (A) is favorable and the spinning method including a fiber-processing agent containing 50 to 100 mass% of lubricant (A) and 0 to 20 mass% of lubricant (B) and 0 to 50 mass% of lubricant (C) (total 100 mass%) is more favorable.

[0012] Lubricant (A) is an aliphatic ester compound of carbon number 5 to 70. The aliphatic ester compounds that satisfy this condition include: 1) esters of an aliphatic monohydric alcohol and an aliphatic monocarboxylic acid such as methyl oleate, butyl stearate, octyl stearate, oleyl laurate, and isotridecyl stearate, 2) esters of an aliphatic polyhydric alcohol and aliphatic monocarboxylic acids such as 1,6-hexanediol dioleate and trimethylolpropane monooleate monolaurate, and 3) esters of aliphatic monohydric alcohols and an aliphatic polycarboxylic acid such as dilauryl adipate and dioleyl adipate. Among these, an aliphatic ester compound of carbon number 15 to 60 is favoured as lubricant (A).

[0013] Lubricant (B) is a linear polyorganosiloxane having a kinetic viscosity at 30°C of 5 x 10^{-6} to 100 x 10^{-6} m^2/s. The linear polyorganosiloxanes having these characteristics include linear polydimethylsiloxanes, linear polydimethylsiloxanes having a modified group, and so on. The modified group in this case can be an ethyl group, a phenyl group, a fluoropropyl group, an aminopropyl group, a carboxyoctyl group, a polyoxyethylene polyoxypropylene group, ω-methoxypolyethoxy · polypropoxypropyl group or the like.

[0014] Lubricant (C) is a mineral oil having a kinetic viscosity at 30°C of 5 x 10^{-6} to 100 x 10^{-6} m^2/s (5 cSt to 100 cSt).

[0015] The fiber-processing agent used for the spinning method related to the present invention has a kinetic viscosity at 30°C of 1 x 10^{-6} to 100 x 10^{-6} m^2/s, although a kinetic viscosity of 5 x 10^{-6} to 50 x 10^{-6} m^2/s is preferable. With the spinning method related to the present invention, the above-mentioned fiber-processing agent is mixed with the compressed air used for whirling air spinning and sprayed on the fiber, and the kinetic viscosity of the fiber-processing agent at 30°C should be, as mentioned before, 5 x 10^{-6} to 50 x 10^{-6} m^2/s so that the fiber-processing agent is sprayed more evenly on the fiber and attached more evenly to the fiber. The pressure of compressed air used for whirling air spinning is from 0.40 to 0.70MPa in regular cases, although a compressed air pressure of 0.45 to 0.65MPa is preferred.

[0016] The fiber-processing agent of the present invention can be used with antifoaming agents, appearance adjusting agents, antioxidants, preservatives, antirust agents or other components according to respective purposes as far as the effects of the present invention are not undermined, while the amount of such components should be as low as possible.

[0017] As mentioned before, when the fiber-processing agent is mixed in with the compressed air and sprayed on the fiber for whirling air spinning, the fiber-processing agent can be used either neat or diluted with water or low-viscosity mineral oil or the like. However, in order to obtain optimum spraying performance, a nonaqueous processing agent should be used, either neat, or, in the case of dilution, diluted with an oil-based diluent such as mineral oil in order to be nonaqueous.

[0018] The spun yarn related to the present invention is that obtained through the spinning method related to the present invention described herein.

[0019] With the present invention described herein, scum accumulation on the spindle tip and on the holder is sufficiently suppressed and good high-speed spinning performance can be achieved in spinning using a whirling air spinning machine.

[0020] While examples are described to indicate concrete configurations and effects of the present invention, the present invention is not limited to the specifics of these examples. In the following working examples and comparative examples, "parts" indicates mass parts and "%" indicates mass%.

Test division 1 (preparation of the fiber-processing agents)

[0021] Aliphatic ester compounds as specified in Table 1 were used as lubricant (A), and linear polyorganosiloxanes or mineral oils specified in Table 2 were used as lubricant (B) or (C), and these were mixed in the ratios specified in Table 3 when necessary, to prepare fiber-processing agents P-1 to P-13 and R-1 to R-14 specified in Table 3. Comparative example 15 indicates an example in which no fiber-processing agent was prepared or used.

Test division 2 (preparation of a drawn sliver)

[0022] In the polyester staple production process, a semi dull polyester staple fiber having a linear mass density of 1.3 x 10^{-4} g/m and a fiber length of 38mm attached with 0.15% of a lubricant that consists of 70 parts of octadecyl phosphoric ester potassium salt, 15 parts of α-nonylphenyl-ω-hydroxy polyoxyethylene (n=10) and 15 parts of α-dodecylamino-ω-hydroxy polyoxyethylene (n=10) was used. This polyester staple fiber was fed to a flat card (made by Howa Machinery, Ltd.) to produce a carded sliver, which is then fed to a PDF type drawing machine (made by ISHIKAWA SEISAKUSHO, LTD.) to prepare a 3.2g/m thick drawn sliver.

Test division 3 (whirling air spinning and evaluation)

[0023] Using as a whirling air spinning machine a VORTEX (registered trade mark) made by MURATA MACHINERY,

LTD., each fiber-processing agent prepared in test division 1 was mixed with compressed air in the whirling air spinning machine and sprayed on the fibers. The spraying performance and scum accumulation observed during the operation was evaluated according to the following method and the results are summarized in Table 3.

[0024] The whirling air spinning machine used has multiple spinning units, each of which is provided with draft equipment, whirling air spinning equipment and winding equipment. The draft equipment drafts the fiber bundle and feeds it into the whirling air spinning equipment. The whirling air spinning equipment generates a whirling air flow within it to spin the fiber bundle and produce a spun yarn. The winding equipment winds the spun yarn, which is spun by the whirling air spinning equipment and sends it via an appropriate feeding means to a package.

[0025] The whirling air spinning equipment comprises a spinning chamber, a fiber introduction part, a nozzle holder that is constituted with a whirling-airflow generating nozzle and a spindle (hollow guiding shaft). The fiber introduction part guides the fiber bundle, which is formed with the draft equipment, into a spinning chamber. The spinning chamber is a space formed by being enclosed by the fiber introduction part, the holder and the spindle. The whirling-airflow generating nozzle sprays compressed air into the spinning chamber to generate a whirling airflow, thereby reversing and turning the fiber end of the fiber bundle, which is guided into the spinning chamber, at the spindle tip area. The spindle guides the spun yarn from the spinning chamber to the outside of the whirling air spinning equipment. The spindle is held at its base on the opposite side of its tip with the spindle holder.

[0026] The whirling air spinning machine used is provided with spraying equipment (trade name POLYMASTER made by MURATA MACHINERY, LTD.) that forms a mist of the fiber-processing agent. The spraying equipment is located in the upstream of the whirling-airflow generating nozzle and mixes a mist of the fiber-processing agent into the compressed air which is guided into the spinning chamber. The spraying equipment can be configured so that it directly feeds the fiber-processing agent to each whirling air spinning equipment or it feeds the fiber-processing agent to the common feeding pipe provided to feed air to multiple whirling air spinning equipment. Details of these are specified in Japanese Patent Publication Tokkai 2008-95208 and Japanese Patent Publication Tokkai 2011-84854.

Evaluation of spraying performance

[0027] A mist of the fiber-processing agent was mixed, using the spraying equipment, with the compressed air used for the spinning of the whirling air spinning machine and sprayed at a temperature of 25°C, relative humidity of 65%, and a compressed air pressure of 0.55MPa for five hours. The spraying state of the fiber-processing agent was visually observed and evaluated according to the following criterion. The results are summarized in Table 3.

Criterion of spraying performance

[0028]

A : Good
B : While a small amount of liquid accumulation is observed at the piping, the total spraying performance is good.
C : While liquid accumulation is observed at the piping, spraying can be achieved for a short time.
D : Spraying is impossible.

Evaluation of scum accumulation

[0029] When the drawn sliver prepared in test division 2 was fed to the whirling air spinning machine to spin Ne30 spun yarn at a spinning speed of 360m/min., a mist of a fiber-processing agent having a good spraying performance or one that was able to be sprayed was added and sprayed with compressed air at a temperature of 25°C, a relative humidity of 65% and a compressed air pressure of 0.55MPa in an amount relative to the passing amount of drawn sliver of 0.03%. After five hours, scum accumulation on both the spindle tip and on the spindle holder were visually observed and evaluated according to the following criterion. The results are summarized in Table 3.

Criterion of evaluation of scum accumulation on the spindle tip and on the spindle holder

[0030]

A : No accumulation
B : No need for cleaning in spite of slight accumulation
C : No need for frequent cleaning in spite of accumulation
D : Frequent cleaning is necessary due to accumulation

Table 1

Type of lubricant	Name of compound	Carbon number of aliphatic alcohol	Carbon number of fatty acid	Total carbon number
A-1	Methyl oleate	1	18	19
A-2	Isotridecyl stearate	13	18	31
A-3	2-ethylhexyl stearate	8	18	26
A-4	Isopropyl myristate	3	14	17
A-5	Rapeseed oil	3	54	57

Table 2

Type of lubricant	Name of compound	Kinetic viscosity at 30°C [x 10^{-6} m^2/s]
B-1	Linear polydimethylsiloxane	10
B-2	Linear polydimethylsiloxane	30
B-3	Linear polydimethylsiloxane	50
B-4	Monoamino-modified linear polydimethylsiloxane	90
BR-1	Linear polydimethylsiloxane	1000
BR-2	Linear polydimethylsiloxane	10000
C-1	Mineral oil	5
C-2	Mineral oil	10
C-3	Mineral oil	30
C-4	Mineral oil	70
CR-1	Mineral oil	200

Table 3

Division	Type of fiber-processing agent	Composition of fiber-processing agent		Mass parts of water to 100 mass parts of fiber-processing agent	Kinetic viscosity of fiber-processing agent [$\times 10^{-6} m^2/s$]	Spraying performance	Scum accumulation	
		Component	Ratio (%)				At tip	At holder
Example 1	P-1	A-1	100	0	5	A	A	A
2	P-2	A-2	100	0	25	A	A	A
3	P-3	A-3	100	0	13	A	A	A
4	P-4	A-4	100	0	5	A	A	A
5	P-5	A-5	50	0	35	A	A	A
		C-1	50					
6	P-6	B-1	100	0	10	A	A	B
7	P-7	B-2	100	0	30	A	A	B
8	P-8	B-3	100	0	50	A	A	B
9	P-9	B-4	100	0	90	B	A	B
10	P-10	C-1	100	0	5	A	A	B
11	P-11	C-2	100	0	10	A	A	B
12	P-12	C-3	100	0	30	A	A	B
13	P-13	C-4	100	0	70	B	A	B
Comparative example 1	R-1	D-1	100	0	16	A	B	D
2	R-2	D-2	100	0	30	A	B	D
3	R-3	D-2	20	0	35	A	B	D
		D-3	80					
4	R-4	D-1	80	0	20	A	B	D
		D-2	20					
5	R-5	D-4	100	0	80	C	C	D
6	R-6	D-5	100	0	220	D	*1	*1
7	R-7	D-6	100	0	300	D	*1	*1
8	R-8	D-7	100	0	60	C	C	D
9	R-9	D-8	100	0	1000 or over	D	*1	*1
10	R-10	D-9	100	0	1000 or over	D	*1	*1
11	R-11	D-10	100	100	10	C	D	D
12	R-12	BR-1	100	0	1000	D	*1	*1
13	R-13	BR-2	100	0	10000	D	*1	*1

(continued)

Division	Type of fiber-processing agent	Composition of fiber-processing agent		Mass parts of water to 100 mass parts of fiber-processing agent	Kinetic viscosity of fiber-processing agent [$\times 10^{-6} m^2/s$]	Spraying performance	Scum accumulation	
		Component	Ratio (%)				At tip	At holder
14	R-14	CR-1	100	0	200	D	*1	*1
15	-	-	-	0	-	-	D	D

In Table 3,
D-1: α-octyl-ω-hydroxypolyoxyethylene (n = 4)
D-2: α-dodecyl-ω-hydroxypolyoxyethylene (n = 6) polyoxypropylene (n = 2)
D-3: α-nonyl-ω-hydroxypolyoxyethylene (n = 6) polyoxypropylene (n = 2)
D-4: α-butyl-ω-hydroxypolyoxyethylene (n = 10) polyoxypropylene (n = 10)
D-5: α-butyl-ω-hydroxypolyoxyethylene (n = 20) polyoxypropylene (n = 20)
D-6: α-hydroxy-ω-hydroxypolyoxyethylene (n = 5) polyoxypropylene (n = 45)
D-7: α-cocoyl-ω-hydroxypolyoxyethylene (n = 10)
D-8: Octadecyl phosphoric acid ester potassium salt
D-9: Octyl phosphoric acid ester potassium salt
D-10: Butyl phosphoric acid ester potassium salt
*1: Due to poor spraying performance, evaluation of scum accumulation was impossible.

[0031] As shown in the results of Table 3, scum accumulation at the spindle tip and the holder is sufficiently suppressed during spinning with a whirling air spinning machine and operation with good high-speed spinning performance is assured with this invention.

Claims

1. A spinning method which uses a whirling air spinning machine for mixing a fiber-processing agent with compressed air in the whirling air spinning machine and spraying the fiber-processing agent on fibers, wherein:

   the fiber-processing agent has a kinetic viscosity at 30°C of 1 x 10^{-6} to 100 x 10^{-6} m^2/s, wherein the fiber-processing agent comprises one, two or more of the following lubricant (A), the following lubricant (B) and the following lubricant (C);
   wherein:

      Lubricant (A) is an aliphatic ester compound of carbon number 5-70;
      Lubricant (B) is a linear polyorganosiloxane having a kinetic viscosity at 30°C of 5 x 10^{-6} to 100 x 10^{-6} m^2/s; and
      Lubricant (C) is a mineral oil having a kinetic viscosity at 30°C of 5 x 10^{-6} to 100 x 10^{-6} m^2/s.

2. The spinning method as specified in Claim 1 including a fiber-processing agent selected from lubricant (A).

3. The spinning method as specified in Claim 1 or 2 wherein the fiber-processing agent has a kinetic viscosity at 30°C of 5 x 10^{-6} to 50 x 10^{-6} m^2/s.

4. The spinning method as specified in any one of Claims 1-3 in which the fiber-processing agent is in the nonaqueous state when it is mixed with compressed air.

5. The spinning method specified in any one of Claims 1-4 in which the fiber-processing agent mixed with compressed air is sprayed on the fibers at a pressure of 0.45 to 0.65MPa.

6. Spun yarn obtained with the spinning method specified in any one of Claims 1-5.

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EUROPEAN SEARCH REPORT

Application Number
EP 13 19 2152

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Place of search	Date of completion of the search	Examiner
The Hague	6 March 2014	Fiocco, Marco

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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