

DESCRIPTION

METHOD FOR MANUFACTURING POLYVINYL CHLORIDE-BASED ARTIFICIAL HAIR FIBER

TECHNICAL FIELD

[0001]

The present invention relates to a method for manufacturing polyvinyl chloride-based artificial hair fiber having low gloss appearance, and having superior weaving property, gear processing property, and spinning property, while retaining texture specific to polyvinyl chloride.

BACKGROUND

[0002]

Polyvinyl chloride-based fiber has superior strength, degree of elongation and the like, and is widely used as artificial hair fiber which constitutes hair accessories. However, in terms of low gloss appearance, weaving property, gear processing property, and spinning property, there is still no design which satisfies the need, and thus trial and error are still being carried out (Patent Literatures 1 to 3).

CITATION LIST

PATENT LITERATURE

[0003]

[Patent Literature 1] JP S60-14729U

[Patent Literature 2] JP 2000-191871A

[Patent Literature 3] WO 2006/093009

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004]

In Patent Literature 1, a dent is provided at each side of the cross-section to achieve low gloss appearance, however, the effect is not sufficient.

[0005]

In Patent Literature 2, cross-linked vinyl chloride-based resin is added to provide low gloss appearance to the vinyl chloride-based resin, and methacrylic acid alkyl ester is added to improve spinning property of the vinyl chloride-based resin. However, with such combination, low gloss appearance is still insufficient, and the texture specific to the vinyl chloride-based resin may be lost.

[0006]

In addition, among the hair accessories, there is a style called braid. However, when crimple processing is performed, there are cases where it is difficult to provide crimple to the fiber, depending on the shape of the cross section of the fiber.

[0007]

Further, when the crimped fiber is weaved into braids or twists, weaving property becomes inferior if the fiber is slippery, thereby resulting in low productivity.

[0008]

In Patent Literature 3, an artificial hair comprising a resin composition including a vinyl chloride-based resin and a cross-linked vinyl chloride-based resin with a prescribed viscosity-average polymerization degree, which also have a circular, parabolic, or an oval cross section; is proposed. However, definition of the shape of the cross section alone was still insufficient to easily provide crimple, and weaving property was also insufficient.

[0009]

The present invention has been made in view of such circumstances, and provides a method for manufacturing polyvinyl chloride-based artificial hair fiber including cross-linked vinyl chloride-based resin, having improved low gloss appearance, weaving property, gear

processing property, and spinning property, while retaining texture of a fiber comprising a polyvinyl chloride-based resin fiber.

SOLUTION TO PROBLEM

[0010]

The present invention adopts the following strategies to solve the afore-mentioned problems.

(1) A method for manufacturing polyvinyl chloride-based artificial hair fiber, comprising: a step to spin a resin composition comprising polyvinyl chloride-based resin from a nozzle hole; wherein: the resin composition comprises a polyvinyl chloride-based resin; the polyvinyl chloride-based resin comprises 90 to 99 parts by mass of a polyvinyl chloride-based resin (A) having a viscosity-average polymerization degree of 450 to 1700, and 10 to 1 part by mass of a cross-linked vinyl chloride-based resin (B), a tetrahydrofuran soluble component in the cross-linked vinyl chloride-based resin (B) having a viscosity-average polymerization degree of 1800 to 2300; the difference between the viscosity-average polymerization degree of the tetrahydrofuran soluble component in the cross-linked vinyl chloride-based resin (B) and the viscosity-average polymerization degree of the polyvinyl chloride-based resin (A) is 600 to 1850; and the nozzle hole has a minimum value ($I_{\min}$) of a cross-sectional secondary moment of an axis which penetrates a center of a figure of a cross section of the nozzle hole of $1 \times 10^{-4} \text{ mm}^4$ to $15 \times 10^{-4} \text{ mm}^4$.

(2) The manufacturing method of (1), wherein the resin composition further comprises 0.01 to 1 parts by mass of an antistatic agent.

(3) The manufacturing method of (1) or (2), wherein the resin composition further comprises 0.1 to 5 parts by mass of at least one thermal stabilizer selected from a tin-based thermal stabilizer, a Ca-Zn-based thermal stabilizer, a hydrotalcite-based thermal stabilizer, an epoxy-based thermal stabilizer, and β -diketone-based thermal stabilizer.

EFFECT OF THE INVENTION

[0011]

The present inventors have conducted extensive study, and have found that polyvinyl chloride-based artificial hair fiber obtained by spinning a specific resin composition from nozzle holes having a specific cross-sectional secondary moment have superior low gloss appearance, weaving property, gear processing property and spinning property, while retaining texture specific to the polyvinyl chloride-based artificial hair fiber.

EMBODIMENTS OF THE INVENTION

[0012]

Hereinafter, embodiments to carry out the present invention will be explained in detail.

Here, the present invention shall not be limited to the embodiments described hereinafter.

[0013]

The present invention is a method for manufacturing polyvinyl chloride-based artificial hair fiber, comprising: a step to spin a resin composition comprising polyvinyl chloride-based resin from a nozzle hole; wherein: the resin composition comprises a polyvinyl chloride-based resin; the polyvinyl chloride-based resin comprises 90 to 99 parts by mass of a polyvinyl chloride-based resin (A) having a viscosity-average polymerization degree of 450 to 1700, and 10 to 1 part by mass of a cross-linked vinyl chloride-based resin (B), a tetrahydrofuran soluble component in the cross-linked vinyl chloride-based resin (B) having a viscosity-average polymerization degree of 1800 to 2300; the difference between the viscosity-average polymerization degree of the tetrahydrofuran soluble component in the cross-linked vinyl chloride-based resin (B) and the viscosity-average polymerization degree of the polyvinyl chloride-based resin (A) is 600 to 1850; and the nozzle hole has a minimum value ($I_{\min}$) of a cross-sectional secondary moment of an axis which penetrates a center of a figure of a cross section of the nozzle hole of $1 \times 10^{-4} \text{ mm}^4$ to $15 \times 10^{-4} \text{ mm}^4$.

[0014]

<Resin Composition>

The resin composition used in the present invention includes a polyvinyl chloride-based resin. The resin composition can include additives such as antistatic agent, thermal stabilizer, lubricant and the like.

[0015]

<Polyvinyl Chloride-based Resin>

The polyvinyl chloride-based resin used in the present invention includes 90 to 99 parts by mass of polyvinyl chloride-based resin (A), and 10 to 1 parts by mass of cross-linked vinyl chloride-based resin (B).

[0016]

(Polyvinyl Chloride-based Resin (A))

The polyvinyl chloride-based resin (A) used in the present invention is a homopolymer resin which is a homopolymerized product of conventional vinyl chloride, or various conventional copolymer resins, and thus not particularly limited. As for such copolymer resins, copolymer resins of vinyl chloride and vinyl esters such as vinyl chloride-vinyl acetate copolymer resin and vinyl chloride-vinyl propionate copolymer resin; copolymer resins of vinyl chloride and acrylic esters such as vinyl chloride-butyl acrylate copolymer resin and vinyl chloride-2-ethylhexyl acrylate copolymer resin; copolymer resins of vinyl chloride and olefins such as vinyl chloride-ethylene copolymer resin and vinyl chloride-propylene copolymer resin; vinyl chloride-acrylonitrile copolymer resin and the like can be typically mentioned for example. As the preferable vinyl chloride-based resin, homopolymer resin which is a homopolymerized product of vinyl chloride, vinyl chloride-ethylene copolymer resin, vinyl chloride-vinyl acetate copolymer resin and the like can be mentioned. In the copolymer resin, the content of the comonomer is not particularly limited, and can be determined in accordance with the formability of the fiber and the characteristics of the fiber.

[0017]

The polyvinyl chloride-based resin (A) used in the present invention has a viscosity-average polymerization degree in the range

of 450 to 1700, in order to achieve sufficient strength and heat resistance as the fiber. When the viscosity-average polymerization degree is below 450, the degree of entanglement of the resin is low and thus the strength becomes low. When the viscosity-average polymerization degree exceeds 1700, gelation does not occur, causing easy fiber breakage, resulting in low productivity. In the case where homopolymer resin of polyvinyl chloride is used, the viscosity-average polymerization degree is preferably in the range of 650 to 1450 in order to achieve formability and fiber characteristics. In the case where the copolymer is used, although it depends on the content of the comonomer, the viscosity-average polymerization degree is preferably in the range of 1000 to 1700. The viscosity-average polymerization degree is calculated in accordance with JIS-K6721, by dissolving 200 mg of the resin in 50 ml of nitrobenzene, followed by measurement of specific viscosity of the polymer solution in a thermostat at 30°C using a Ubbelohde viscometer.

[0018]

The vinyl chloride-based resin (A) used in the present invention can be manufactured by emulsion polymerization, bulk polymerization, suspension polymerization or the like. Polymer manufactured by suspension polymerization is preferable in terms of initial coloring property of the fiber.

[0019]

(Cross-linked Vinyl Chloride-based Resin (B))

The cross-linked vinyl chloride-based resin (B) used in the present invention can be easily obtained by adding a multifunctional monomer when performing polymerization of vinyl chloride in aqueous medium, for example when performing suspension polymerization, microemulsion polymerization or emulsion polymerization. As the multifunctional monomer used, diacrylate compounds such as polyethylene glycol diacrylate, bisphenol A modified diacrylate and the like are especially preferable. The resin is a mixture of a gel component having a cross-linked structure, being insoluble in tetrahydrofuran, and having vinyl chloride as a main component; and polyvinyl chloride component being soluble in tetrahydrofuran.

[0020]

In the present invention, the viscosity-average polymerization degree of the component soluble in tetrahydrofuran is in the range of 1800 to 2300, and more preferably in the range of 1900 to 2200, when weaving property and spinning property of the fiber are taken into consideration. When the viscosity-average polymerization degree is below 1800, the weaving property becomes insufficient. On the other hand, when the viscosity-average polymerization degree exceeds 2300, the fiber is prone to breakage during spinning.

[0021]

The viscosity-average polymerization degree of the component of the cross-linked vinyl chloride-based resin (B) soluble in tetrahydrofuran is measure as follows. 1 g of cross-linked vinyl chloride-based resin (B) is added to 60 ml of tetrahydrofuran and left to stand for approximately 24 hours. The resin is then fully dissolved by using an ultrasonic cleaning machine. The insoluble in the tetrahydrofuran solution is separated using an ultracentrifuge (30,000 rpm x 1 hour), and the supernatant THF solution is taken. The THF solvent is then volatilized, and the viscosity-average polymerization degree was measured in a similar manner as the polyvinyl chloride-based resin (A).

[0022]

The amount of the cross-linked vinyl chloride-based resin (B) added is preferably 10 to 1 parts by mass with respect to 90 to 9 parts by mass of polyvinyl chloride-based resin (A). Preferably, cross-linked vinyl chloride-based resin (B) is added by 5 to 3 parts by mass with respect to 95 to 97 parts by mass of polyvinyl chloride-based resin (A). When the amount of the cross-linked vinyl chloride-based resin (B) is less than 1 part by mass, the low gloss appearance and the weaving property of the fiber obtained becomes low, and when the amount of the cross-linked vinyl chloride-based resin (B) exceeds 10 parts by mass, spinning property becomes low, which are unfavorable.

[0023]

The difference in the viscosity-average polymerization degree of the polyvinyl chloride-based resin (A) and the viscosity-average polymerization degree of the component of the cross-linked vinyl chloride-based resin (B) soluble in tetrahydrofuran is 600 to 1850, in order to achieve sufficient low gloss appearance. Preferably, the difference is 800 to 1500. When the difference is less than 600, the low gloss appearance is not sufficient, and when the difference is larger than 1850, the fiber is prone to breakage during spinning.

[0024]

<Additives>

(Antistatic Agent)

As the antistatic agent used in the present invention, non-ionic antistatic agent, (nonionic antistatic agent), cationic antistatic agent, anionic antistatic agent, and amphoteric antistatic agent can be used. Preferably, the antistatic agent can be used in the range of 0.01 to 1 part by mass. When the amount of the antistatic agent is less than 0.01 part by mass, static electricity is easily generated, making it difficult to gather the fibers. Accordingly, the fibers easily tangle during winding, causing frequent breakage of the fiber. On the other hand, when the amount of the antistatic agent exceeds 1 part by mass, it is economically disadvantageous.

[0025]

(Thermal Stabilizer)

As the thermal stabilizer used in the present invention, conventional thermal stabilizers can be used. Among these, it is preferable to use one or two or more of thermal stabilizer selected from Ca-Zn-based thermal stabilizer, hydrotalcite-based thermal stabilizer, tin-based thermal stabilizer, and zeolite-based thermal stabilizer. The thermal stabilizer is used to reduce thermal decomposition during forming, improve lifetime, and improve color tone of the filament. Especially preferable is the combined use of the Ca-Zn-based thermal stabilizer with the hydrotalcite-based thermal stabilizer, which have superior balance in formability and fiber characteristics. Preferable amount of such thermal stabilizer being added is 0.1 to 5.0 parts by mass with respect to 100 parts by mass

of the vinyl chloride-based resin. When the amount is less than 0.1 part by mass, the poly vinyl chloride-based resin would undergo thermal degradation and may color yellow. On the other hand, when the amount exceeds 5.0 parts by mass, it is economically disadvantageous. The hydrotalcite-based thermal stabilizer is, particularly, a hydrotalcite compound, and more particularly a complex salt compound composed of magnesium and/or alkali metal, and aluminum or zinc; or a complex salt compound composed of magnesium and aluminum, and there are some hydrotalcite compounds which have their crystal water dehydrated. In addition, the hydrotalcite compound may be natural or synthetic. Manufacturing method of the synthetic hydrotalcite compounds can be conventional methods.

[0026]

Among the thermal stabilizers, as the Ca-Zn-based thermal stabilizer, zinc stearate, calcium stearate, zinc 12-hydroxystearate, calcium 12-hydroxystearate and the like can be mentioned. As the hydrotalcite-based thermal stabilizer, ALCAMIZER available from Kyowa Chemical Industry Co., Ltd. can be mentioned for example. As the tin-based thermal stabilizer, mercapto tin-based thermal stabilizer such as dimethylmercaptotin, tin dimethylmercaptide, dibutylmercaptotin, dioctylmercaptotin, dioctylmercaptotin polymer, dioctylmercaptotin acetate and the like; maleate tin-based thermal stabilizer such as dimethyl tin maleate, dibutyl tin maleate, dioctyl tin maleate, dioctyl tin maleate polymer and the like; and laurate tin-based thermal stabilizer such as dimethyl tin laurate, dibutyl tin laurate, dioctyl tin laurate and the like can be mentioned. As the epoxy-based thermal stabilizer, epoxidized soybean oil, epoxidized linseed oil and the like can be mentioned for example. As the β diketone-based thermal stabilizer, stearylbenzoilmethane (SBM), dibenzoylmethane (DBM) and the like can be mentioned for example.

[0027]

(Lubricant)

In the present invention, lubricant can be arbitrarily used. As the lubricant being used, conventionally known lubricant can be used, and at least one selected from the group consisting of metallic

soap-based lubricant, polyethylene-based lubricant, higher fatty acid-based lubricant, ester-based lubricant, and higher alcohol-based lubricant is especially preferable. The lubricant suppresses the friction between the processing machine and the metal surface, and suppresses the friction between resins, thereby achieving superior flowing property and improving processing property. Preferably, 0.2 to 5.0 parts by mass of the lubricant is added to 100 parts by mass of vinyl chloride-based resin. When the amount of the lubricant added is less than 0.2 parts by mass, flowing property is inferior, thereby degrading the processing property. On the other hand, when the amount of the lubricant added exceeds 5.0 parts by mass, the friction between the processing machine and the metal surface becomes small, and thus the resin cannot be extruded steadily.

[0028]

As the metallic soap-based lubricant, metallic soap such as stearate, laurate, palmitate, oleate and the like of Na, Mg, Al, Ca, Ba and the like can be mentioned for example. As the higher fatty acid-based lubricant, saturated fatty acid such as stearic acid, palmitic acid, myristic acid, lauric acid, capric acid and the like; unsaturated fatty acid such as oleic acid and the like; and mixtures thereof can be mentioned for example. As the higher alcohol-based lubricant, stearyl alcohol, palmityl alcohol, myristyl alcohol, lauryl alcohol, oleyl alcohol and the like can be mentioned for example. As the ester-based lubricant, ester-based lubricant composed of alcohol and fatty acid; pentaerythritol-based lubricant such as mono-ester, di-ester, tri-ester, tetra-ester of pentaerythritol or dipentaerythritol with higher fatty acid or mixtures thereof; montanic acid wax-based lubricant which are esters of montanic acid with higher alcohols such as stearyl alcohol, palmityl alcohol, myristyl alcohol, lauryl alcohol, oleyl alcohol and the like; can be mentioned for example.

[0029]

In the present invention, conventional compounding agent used for vinyl chloride-based composition can be used to achieve intended object, to an extent which does not affect the effect of the invention. As

an example of such compounding agent, processing aid, a plasticizer, a reinforcing agent, an ultraviolet absorber, an antioxidant, a filler, a flame retardant, a pigment, an initial coloring improver, a conductivity imparting agent, a fragrance and the like can be mentioned.

[0030]

<Manufacturing Method>

The polyvinyl chloride-based fiber of the present invention is manufactured preferably by mixing all the ingredients to obtain a pellet compound first, and then performing known melt spinning. Hereinafter, an example of the manufacturing conditions is shown, however, the manufacturing conditions can be arbitrarily altered.

(Mixing - Pellet)

Antistatic agent, thermal stabilizer, and lubricant as required are mixed with vinyl chloride-based resin (A) and cross-linked vinyl chloride-based resin (B) by a predetermined ratio, followed by agitation and mixing with a Henschel mixer and the like, and then the mixture is made into a pellet compound using an extruding machine. A powder compound obtained by mixing, using conventionally known mixing machine such as Henschel mixer, super mixer, ribbon blender and the like can be subjected to melt blending to give a pellet compound, and the pellet compound obtained as such can be used. Manufacture of the powder compound can be carried out by either one of hot blend or cold blend, and conventional conditions can be adopted as the manufacturing conditions. In order to suppress volatiles in the composition, it is preferable to adopt hot blend where the cut temperature during blending is raised to 105 to 155°C. The pellet compound can be manufactured in a similar manner as the normal vinyl chloride-based pellet compound. For example, the pellet compound can be obtained using a kneading machine such as a single screw extruder, a counter twin-screw extruder, a conical twin-screw extruder, a co-rotating twin-screw extruder, a co-kneader, a planetary gear extruder, a roll kneader and the like. There is no particular limitation regarding the conditions when the pellet compound is manufactured. Here, it is preferable to set the resin temperature at 185°C or lower, in order to prevent thermal

degradation of the vinyl chloride-based resin. Further, a mesh can be arranged at the vicinity of the tip of the screw to remove metal piece and fiber on the protective glove which can be contaminated by a small amount during the manufacture of the pellet compound.

[0031]

The cold cut method can be adopted for the manufacture of the pellets. A mechanism to remove "machining dust" (fine powder generated during manufacture of pellets) which can be contaminated during the cold cut can be adopted. In addition, it is preferable to exchange the cutter at an appropriate timing since chip in the blade can occur with the cutter when the cutter is used for a long period, thereby generating more machining dust.

[0032]

(Spinning)

Melt spinning is performed with the raw material of the pellet compound using a nozzle, a weak axis of a sectional area of a nozzle hole having a cross-sectional secondary moment within a predetermined range. The temperature of the cylinder is in the range of 150 to 190°C, and the temperature of the nozzle is in the range of $180 \pm 15^\circ\text{C}$. By using such conditions for favorable spinning property, the melt spinning is carried out.

[0033]

The fiber melt spun from the nozzle hole and undrawn (fiber of poly vinyl chloride resin composition) is introduced into a heated cylinder (temperature of the heated cylinder : 250°C) and undergoes an instantaneous heat treatment. Then, for example, the fiber is wound using a haul-off machine arranged directly below the nozzle. The haul-off machine is, for example, located approximately 4.5m below. The strand is kept undrawn. During the winding, the hauling speed is adjusted so that the size of the undrawn fiber is preferably in the range of 120 to 250 denier (more preferably 150 to 220 denier, and further more preferably 175 to 185 denier).

[0034]

Here, when the vinyl chloride-based resin composition is made into undrawn fiber, conventionally known extruder can be used. For

example, a single screw extruder, a counter twin-screw extruder, a conical twin-screw extruder and the like can be used. Among these, a single screw extruder having a caliber of approximately 35 to 85 mm ϕ , a conical extruder having a caliber of approximately 35 to 50 mm ϕ are preferably used. When the caliber is too large, the amount of extrusion becomes large, the nozzle pressure becomes high, and the temperature of the resin becomes high, resulting in degradation of the resin, which is unfavorable.

[0035]

(Shape of Nozzle Hole)

Regarding the nozzle hole used in the present invention, the cross-sectional secondary moment of the axis which penetrates the center of the figure of the cross section of the nozzle hole has a minimum value (I_{min}) of $1 \times 10^{-4} \text{ mm}^4$ to $15 \times 10^{-4} \text{ mm}^4$. Here, the minimum value (I_{min}) of the cross-sectional secondary moment of the axis which penetrates the center of the figure of the cross section of the nozzle hole is a minimum value (I_{min}) of a cross-sectional secondary moment of two main axis (short axis and long axis) which penetrates the center of the figure. For example, when the cross section of the nozzle hole has a simple geometric figure and is an oval having a long diameter of $2a$ and a short diameter of $2b$, the minimum value (I_{min}) of the cross-sectional secondary moment can be calculated by the formula of $\pi a^3 b / 4$.

[0036]

The minimum value (I_{min}) of the cross-sectional secondary moment is preferably $1 \times 10^{-4} \text{ mm}^4$ to $15 \times 10^{-4} \text{ mm}^4$. When the minimum value is $1 \times 10^{-4} \text{ mm}^4$ or below, the fiber would be too soft, and thus it becomes difficult to provide shape to the fiber during gear processing. On the other hand, when the minimum value exceeds $15 \times 10^{-4} \text{ mm}^4$, the fiber would be too rigid, and thus it becomes difficult to provide shape to the fiber. More preferably, the minimum value is in the range of $2 \times 10^{-4} \text{ mm}^4$ to $13 \times 10^{-4} \text{ mm}^4$.

[0037]

The minimum value (I_{min}) of the cross-sectional secondary moment of the figure of the cross section of the nozzle hole is measured in accordance with the following procedures.

1: Dimension of the nozzle hole is measured by magnifying the cross section of the nozzle hole by 400 times, using a digital microscope VH-6300C available from KEYENCE CORPORATION.

2: The measured dimension is converted into a figure using CADSUPER available from ANDOR CO., Ltd., and calculation is performed by CADSUPER to obtain the cross-sectional secondary moment.

[0038]

(Drawing - Heat Treatment)

Then, the undrawn fiber is subjected to drawing by 2 to 5 times (for example, by 3 times) using a drawing machine (under atmospheric air, at 105°C). Subsequently, heat treatment is performed so that the fiber length becomes 0.5 to 0.9 times (for example, 0.75 times) using a heat treatment machine (under atmospheric air, at 110°C). Accordingly, the size of the fiber is adjusted to 40 to 80 denier (preferably 50 to 70 denier, for example, 58 to 62 denier), thereby giving a poly vinyl chloride-based artificial hair fiber.

[0039]

(Gear Processing)

The poly vinyl chloride-based artificial hair fiber is then subjected to gear processing to provide crimples.

[0040]

Gear processing is a method to provide crimples to fiber by allowing a bundle of fiber to pass through two engaging gears at high temperature. There is no particular limitation regarding the material of the gear used, the shape of the wave of the gear, and the number of the fraction of the gear. Depending on the conditions such as fiber material, size of the fiber, pressure between the gears and the like, the wave shape of the crimp may change. In the present invention, the wave shape of the crimp can be controlled by the depth of the groove of the wave shape of the gear, surface temperature of the gear, and the processing speed. There is no particular limitation regarding such processing conditions, and the depth of the groove of the wave shape

is preferably 0.2 to 6 mm, more preferably 0.5 to 5 mm; the surface temperature of the gear is 30 to 100°C, more preferably 40 to 80°C; and the processing speed is 0.5 to 10 m/min, more preferably 1.0 to 8.0 m/min.

[0041]

The total size of the fiber bundle when performing the gear processing is not particularly limited, and is 1×10^5 to 20×10^5 dtex, more preferably 5×10^5 to 15×10^5 dtex. When the total size of the fiber bundle is lower than 1×10^5 dtex, the productivity of the gear processing becomes low, and there is a possibility of fiber breakage during gear-crimp processing. On the other hand, when the total size of the fiber bundle exceeds 20×10^5 dtex, there are cases where it becomes difficult to obtain a uniform wave form.

[0042]

The polyvinyl chloride-based fiber of the present invention obtained as above can retain texture specific to conventional vinyl chloride-based fiber; possess improved spinning property and low gloss appearance; and can further achieve new properties of weaving property and gear processing property. The reason for improved spinning property is the adequate formulation amount of the cross-linked vinyl chloride-based resin (B). The reason for improved low gloss appearance is the adequate formulation amount of the cross-linked vinyl chloride-based resin (B) and controlling of the difference between the viscosity-average polymerization degree of the tetrahydrofuran soluble component in the cross-linked vinyl chloride-based resin (B) and the viscosity-average polymerization degree of the polyvinyl chloride-based resin (A). Further, the reason for achieving the weaving property is the formulation of the tetrahydrofuran soluble component in cross-linked vinyl chloride-based resin (B) having high viscosity-average polymerization degree. Finally, the reason for achieving the gear processing property is the usage of a nozzle having a cross section which can improve the gear processing property.

EXAMPLE

[0043]

Hereinafter, specific embodiments of the present invention will be described in detail by referring to Examples and Comparative Examples. However, the present invention shall not be limited to these Examples.

<Example 1>

[0044]

Vinyl chloride-based resin composition formulated with polyvinyl chloride-based resin (A) (TH-500, available from TAIYO VINYL CORPORATION, 90 parts by mass), cross-linked vinyl chloride-based resin (B) (GR-2500S, available from Shin-Etsu Chemical Co., Ltd., 10 parts by mass), antistatic agent (NEW ELEGAN ASK, available from NOF CORPORATION, 0.5 parts by mass), hydrotalcite-based thermal stabilizer (CP-410A, available from Nissan Chemical Corporation, 3 parts by mass), epoxidized soybean oil (O-130P, available from ADEKA CORPORATION, 0.5 parts by mass), ester-based lubricant (EW-100, available from RIKEN VITAMIN CO., LTD., 0.8 parts by mass) was mixed by a ribbon blender. Subsequently, an extruder having a diameter of 40 mm was used to perform compounding, the temperature of the cylinder being in the range of 130 to 170°C, thereby obtaining pellets. The pellets were subjected to melt spinning under the following conditions. That is, a cross nozzle, the weak axis of a sectional area of the nozzle hole having a cross-sectional secondary moment of $5.0 \times 10^{-4} \text{ mm}^4$, and the number of the nozzle hole being 120 was used; the temperature of the cylinder was in the range of 140 to 190°C; the temperature of the nozzle was in the range of $180 \pm 15^\circ\text{C}$; the rate of extrusion was 10 kg / hour; and the diameter of the extrusion machine was 30 mm. Then, using a heated cylinder provided directly below the nozzle (atmospheric temperature being 200 to 300°C, which is a favorable condition for spinning property), heat treatment was performed for approximately 0.5 to 1.5 seconds to obtain fiber of 150 dtex. Subsequently, the melt spun fiber was subjected to a drawing step under atmospheric condition of 100°C by 300%, and then the drawn fiber was subjected to a heat shrinking step under atmospheric condition of 120°C to allow the total length of the fiber to shrink to 75% of the length before the heat

shrinking step. Accordingly, an artificial hair fiber of 67 dtex was obtained.

[0045]

Evaluation of processing property and evaluation of the obtained artificial hair fiber was carried out in accordance with the evaluation method and criteria described hereinafter. Evaluation was made for the spinning property, low gloss appearance, weaving property, gear processing property and texture. The results are shown in Table 1.

[0046]

<Examples 2 to 17, Comparative Examples 1 to 7>

Formulation of Examples 2 to 17, and Comparative Examples 1 to 7, and evaluation results are summarized in Tables 1 to 3.

[0047]

[Table 1]

Table 1			Example									
			1	2	3	4	5	6	7	8	9	
Polyvinyl Chloride-based Resin	Viscosity-average Polymerization Degree of Polyvinyl Chloride-based Resin (A)	500 (parts by mass)	90	95	99							
		1100 (parts by mass)				90	95	99				
		1350 (parts by mass)							90	95	99	
		2000 (parts by mass)										
	Viscosity-average Polymerization Degree of Tetrahydrofuran Soluble Component in Cross-linked Vinyl Chloride-based Resin (B)	1600 (parts by mass)										
		2020 (parts by mass)	10	5	1	10	5	1	10	5	1	
		2280 (parts by mass)										
Difference Between Viscosity-average Polymerization Degree of Resin (A) and Viscosity-average Polymerization Degree of Tetrahydrofuran Soluble Component in Resin (B)		1520	1520	1520	920	920	920	670	670	670		
Additive	Antistatic Agent (parts by mass)		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Manufacturing Method	Shape of Nozzle	Minimum Value of Cross-sectional Secondary Moment (mm ⁴) × 10 ⁻⁴	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	
Evaluation			Spinning Property	3	4	4	3	4	4	3	4	4
			Low Gloss Appearance	4	4	3	4	4	3	4	3	3
			Weaving Property	4	4	3	4	4	3	4	4	3
			Gear Processing Property	4	4	4	4	4	4	4	4	4
			Texture	3	4	4	3	4	4	3	4	4

[0048]

[Table 2]

Table 2			Example								
			10	11	12	13	14	15	16	17	
Polyvinyl Chloride-based Resin	Viscosity-average Polymerization Degree of Polyvinyl Chloride-based Resin (A)	500 (parts by mass)	90	95	99	90	95	99	95	95	
		1100 (parts by mass)									
		1350 (parts by mass)									
		2000 (parts by mass)									
	Viscosity-average Polymerization Degree of Tetrahydrofuran Soluble Component in Cross-linked Vinyl Chloride-based Resin (B)	1600 (parts by mass)									
		2020 (parts by mass)				10	5	1	5	5	
		2280 (parts by mass)	10	5	1						
Difference Between Viscosity-average Polymerization Degree of Resin (A) and Viscosity-average Polymerization Degree of Tetrahydrofuran Soluble Component in Resin (B)		1780	1780	1780	1520	1520	1520	1520	1520		
Additive	Antistatic Agent (parts by mass)		0.5	0.5	0.5	0.5	0.5	0.5	0.3	1.0	
Manufacturing Method	Shape of Nozzle	Minimum Value of Cross-sectional Secondary Moment (mm ⁴) × 10 ⁻⁴	5.0	5.0	5.0	2.1	1.7	12.0	5.0	5.0	
Evaluation			Spinning Property	3	3	3	3	4	4	3	4
			Low Gloss Appearance	4	4	3	4	4	3	4	4
			Weaving Property	4	4	3	4	4	3	4	4
			Gear Processing Property	4	4	4	3	3	4	4	4
			Texture	3	4	4	3	4	4	4	4

[0049]

[Table 3]

Table 3			Comparative Example						
			1	2	3	4	5	6	7
Polyvinyl Chloride-based Resin	Viscosity-average Polymerization Degree of Polyvinyl Chloride-based Resin (A)	500 (parts by mass)	99.5	85	95		95	95	95
		1100 (parts by mass)							
		1350 (parts by mass)							
		2000 (parts by mass)				95			
	Viscosity-average Polymerization Degree of Tetrahydrofuran Soluble Component in Cross-linked Vinyl Chloride-based Resin (B)	1600 (parts by mass)			5			5	
		2020 (parts by mass)	0.5	15		5	5	5	
		2280 (parts by mass)							
Difference Between Viscosity-average Polymerization Degree of Resin (A) and Viscosity-average Polymerization Degree of Tetrahydrofuran Soluble Component in Resin (B)		1520	1520	1100	20	1520	1520	1100	
Additive	Antistatic Agent(parts by mass)		0.5	0.5	0.5	0.5	0.5	0.5	0.0
Manufacturing Method	Shape of Nozzle	Minimum Value of Cross-sectional Secondary Moment (mm ⁴) × 10 ⁻⁴	5.0	5.0	5.0	5.0	0.3	17	5.0
Evaluation			4	2	4	3	4	4	2
		Low Gloss Appearance	1	4	4	2	4	4	4
		Weaving Property	2	4	2	4	4	4	2
		Gear Processing Property	4	4	4	4	2	2	4
		Texture	4	1	4	3	4	4	4

[0050]

As the materials described in Tables 1 to 3, the followings were used.

polyvinyl chloride-based resin (A)

viscosity-average polymerization degree : 500 (TH-500, available from TAIYO VINYL CORPORATION)

viscosity-average polymerization degree : 1100 (TH-1000, available from TAIYO VINYL CORPORATION)

viscosity-average polymerization degree : 1350 (TH-1400, available from TAIYO VINYL CORPORATION)

viscosity-average polymerization degree : 2000 (TH-2800, available from TAIYO VINYL CORPORATION)

[0051]

cross-linked vinyl chloride-based resin (B)

viscosity-average polymerization degree of THF soluble component : 1600 (GR-1300T, available from Shin-Etsu Chemical Co., Ltd.)

viscosity-average polymerization degree of THF soluble component : 2020 (GR-2500S, available from Shin-Etsu Chemical Co., Ltd.)

viscosity-average polymerization degree of THF soluble component : 2280 (K25S, available from KANEKA CORPORATION)

[0052]

The evaluation method and criteria for each of the evaluation items in Tables 1 to 3 are as follows.

[0053]

(1) spinning property

Occurrence of fiber breakage was visually observed during melt spinning until the undrawn fiber was obtained. Evaluation was made in accordance with the following four criteria.

1 : time of fiber breakage was 7 to 15 times / 1 hour

2 : time of fiber breakage was 4 to 6 times / 1 hour

3 : time of fiber breakage was 2 to 3 times / 1 hour

4 : time of fiber breakage was 1 time / 1 hour

[0054]

(2) low gloss appearance

Bundle of fiber was observed and evaluated in accordance with the following four criteria. In the evaluation, vinyl chloride-based fiber (M-TYPE, available from Denka Company Limited) was evaluated as rank 1 (have gloss).

1 : have gloss

2 : have some gloss

3 : luster lost

4 : high degree of luster lost

[0055]

(3) weaving property

Three sets of fiber bundles were prepared, each bundle being 30 cm x 0.5 g. The fiber bundles were fixed by the upper 2 cm of the bundle, and were weaved so that the length after weaving would be in the range of 20 to 25 cm. Evaluation was made in accordance with the following four criteria. In the evaluation, vinyl chloride-based fiber (M-TYPE, available from Denka Company Limited) was evaluated as rank 2 (somewhat slippery).

1 : slippery

2 : somewhat slippery

3 : less slippery

4 : low degree of slipperiness

[0056]

(4) gear processing property

Gear processing was applied to the fiber, and evaluation was made in accordance with the following four criteria. Here, the depth of the groove of the wave shape was 2.5 mm, surface temperature of the gear was 70 to 80°C, and the processing speed was 2 m/min. In the evaluation of the gear processing property, vinyl chloride-based fiber (M-TYPE, available from Denka Company Limited) was evaluated as rank 3 (crimple well provided).

1 : crimple scarcely provided

2 : crimple slightly provided

3 : crimple well provided

4 : crimple excellently provided

[0057]

(5) texture

Bundle of fiber after melt spinning was evaluated by tactual observation, and evaluation was made in accordance with the following four criteria. In the evaluation of the texture, vinyl chloride-based fiber (M-TYPE, available from Denka Company Limited) was evaluated as rank 4 (very soft and flexible).

1 : very stiff

2 : somewhat stiff

3 : soft and flexible

4 : very soft and flexible

[0058]

In all of the Examples, superior results were obtained for all of the evaluation properties.

[0059]

In Comparative Example 1, the amount of polyvinyl chloride-based resin (A) was larger than 99 parts by mass, and the amount of cross-linked vinyl chloride-based resin (B) was less than 1 parts by mass. Accordingly, surface roughness of the fiber became small, resulting in drastic degradation of low gloss appearance and weaving property.

In Comparative Example 2, the amount of polyvinyl chloride-based resin (A) was less than 90 parts by mass, and the amount of cross-linked vinyl chloride-based resin (B) was larger than 10 parts by mass. Accordingly, proportion of insoluble component became large, resulting in drastic degradation of spinning property.

In Comparative Example 3, the viscosity-average polymerization degree of the tetrahydrofuran soluble component in cross-linked vinyl chloride-based resin (B) was 1800 or lower. Accordingly, the surface roughness of the fiber became small, resulting in degradation of weaving property.

In Comparative Example 4, the difference between the viscosity-average polymerization degree of the tetrahydrofuran soluble component in cross-linked vinyl chloride-based resin (B) and the viscosity-average polymerization degree of the polyvinyl chloride-based resin (A) was 20, which is smaller than 600. Accordingly, degradation of low gloss appearance was observed.

In Comparative Example 5, a nozzle having a minimum value (I_{min}) of the cross-sectional secondary moment of smaller than $1 \times 10^{-4} \text{ mm}^4$ was used. Accordingly, the fiber became too soft, causing difficulty in providing the shape of the gear. Therefore, degradation of gear processing property was observed.

In Comparative Example 6, a nozzle having a minimum value ($I_{\min}$) of the cross-sectional secondary moment of larger than $15 \times 10^{-4} \text{ mm}^4$ was used. Accordingly, the fiber became too stiff, causing difficulty in providing the shape of the gear. Therefore, degradation of gear processing property was observed.

In Comparative Example 7, the viscosity-average polymerization degree of the tetrahydrofuran soluble component in cross-linked vinyl chloride-based resin (B) was 1800 or lower. Accordingly, the surface roughness of the fiber became small, resulting in degradation of weaving property. In addition, since the amount of antistatic agent was small, frequent fiber tangling occurred due to static electricity. Accordingly, frequent fiber breakage was observed.

INDUSTRIAL APPLICABILITY

[0060]

The artificial hair fiber obtained by the manufacturing method of the present invention can improve low gloss appearance and can further achieve weaving property, while retaining texture and spinning property which are specific to conventional vinyl chloride-based fiber. In addition, the fiber of the present invention can be manufactured stably by melt spinning, which is industrially advantageous.

CLAIMS

1. A method for manufacturing polyvinyl chloride-based artificial hair fiber, comprising:

a step to spin a resin composition comprising polyvinyl chloride-based resin from a nozzle hole; wherein:

the resin composition comprises a polyvinyl chloride-based resin;

the polyvinyl chloride-based resin comprises 90 to 99 parts by mass of a polyvinyl chloride-based resin (A) having a viscosity-average polymerization degree of 450 to 1700, and 10 to 1 part by mass of a cross-linked vinyl chloride-based resin (B), a tetrahydrofuran soluble component in the cross-linked vinyl chloride-based resin (B) having a viscosity-average polymerization degree of 1800 to 2300;

the difference between the viscosity-average polymerization degree of the tetrahydrofuran soluble component in the cross-linked vinyl chloride-based resin (B) and the viscosity-average polymerization degree of the polyvinyl chloride-based resin (A) is 600 to 1850; and

the nozzle hole has a minimum value ($I_{\min}$) of a cross-sectional secondary moment of an axis which penetrates a center of a figure of a cross section of the nozzle hole of $1 \times 10^{-4} \text{ mm}^4$ to $15 \times 10^{-4} \text{ mm}^4$.

2. The manufacturing method of Claim 1, wherein the resin composition further comprises 0.01 to 1 parts by mass of an antistatic agent.

3. The manufacturing method of Claim 1 or 2, wherein the resin composition further comprises 0.1 to 5 parts by mass of at least one thermal stabilizer selected from a tin-based thermal stabilizer, a Ca-Zn-based thermal stabilizer, a hydrotalcite-based thermal stabilizer, an epoxy-based thermal stabilizer, and β -diketone-based thermal stabilizer.