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POLYESTER FIBER FOR AIRLAID
NONWOVEN FABRICS**(76) Inventor: **Hironori Goda, Ehime (JP)**

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ABSTRACT

An object of the invention is to provide a polyester based fiber for airlaid nonwoven fabrics enabling one to manufacture an airlaid nonwoven fabric which is extremely excellent in airlaid web formability, especially in spinning properties from a screen, is satisfactory in texture and is bulky. This object can be achieved by a manufacturing method of a polyester fiber for airlaid nonwoven fabrics made of, as a fiber forming resin component, a polyester having a fineness of not more than 10.0 dtex or a fiber length of 8.0 mm or more, having a number of crimp of 8.5 peaks/25 mm or more, a percentage of crimp/number of crimp ratio of not more than 0.65 and a crimp modulus of elasticity of 70% or more and containing 80% by mole or more of an alkylene terephthalate repeating unit in the whole of repeating units, which includes drawing an undrawn yarn taken up at a spinning rate of not more than 1,500 m/min in a low draw ratio of from 0.60 to 1.20 times at a temperature of at least 10° C. higher than a glass transition temperature of the polyester and simultaneously subjecting to a fixed-length heat treatment.

MANUFACTURING METHOD OF POLYESTER FIBER FOR AIRLAID NONWOVEN FABRICS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a fiber for airlaid nonwoven fabrics. In more detail, the invention relates to a polyester based fiber for airlaid nonwoven fabrics excellent in a throughput from a screen.

[0003] 2. Description of the Related Art

[0004] In comparison with nonwoven fabrics manufactured by a card method which have hitherto been widely used, airlaid nonwoven fabrics are free from a difference between fiber orientation in a traveling direction of a nonwoven raw fabric and fiber orientation in a width direction perpendicular thereto at the time of manufacture and are uniform. Also, the airlaid nonwoven fabrics have a characteristic feature that bulkiness of nonwoven fabric is easy to reveal as compared with nonwoven fabrics manufactured by a papermaking method, and the airlaid nonwoven fabrics are laid in a field where the production volume especially extends in the recent nonwoven fabric field. In general, as disclosed in Patent Document 1, for the purpose of imparting bulkiness to a nonwoven fabric, fibers for nonwoven fabrics of an airlaid method impart latent crimp in a planar zigzag or spiral form. However, for the purpose of making bulkiness of a nonwoven fabric good, when the number of crimp or percentage of crimp is increased, air opening properties of a fiber are reduced in an air opening process; the generation of an unopened bundle or web unevenness is large; and an obtained nonwoven fabric is deteriorated in external appearance grade. Also, inferior nonwoven fabrics with low nonwoven fabric tenacity are frequently formed. In particular, in comparison with polyolefin based fibers as disclosed in Patent Document 1, in polyester based fibers, fiber-to-fiber friction is high, and therefore, it is difficult to increase the throughput. In order to increase the throughput, it was required to reduce the fiber-to-fiber friction by a measure for adding a silicone based smoothening agent such as polydimethylsiloxanes in a large amount of 25% by weight or more in a lubricant component. However, in that case, there was a tendency that flame retardancy of the fiber is deteriorated originated from the silicone based smoothening agent.

[0005] Also, when a fineness of fiber is fine, a surface area of the fiber becomes large and the fibers are easy to coagulate as a fiber bundle, and therefore, the opening properties become worse. In the case of using a crimper of a general forced crimp method, the finer the fineness of fiber, the larger the number of crimp. Accordingly, there was a tendency that the opening properties further become worse. Since a polyester based fiber, especially a polyethylene terephthalate fiber is high in stiffness as compared with polyolefin fibers or the like, its degree of crimp is large so that screen-passing properties of the polyester based fiber tended to become worse. On the other hand, when a fiber length of the polyester based fiber is long, the strength of the obtained nonwoven fabric can be increased. Inversely, there is involved a defect that the screen-passing properties of the polyester based fiber becomes worse, resulting in a reduction of a production ability of nonwoven fabrics.

[0006] Patent Document 2 proposes a fiber with good airlaid web formability by optimally specifying a ratio (H/L) of a height (H) of crimp to a crimp cycle (L), a so-called gradient

for every fineness of fiber. However, with respect to the number of crimp of fiber enumerated in the working examples thereof, in the case where the fineness of fiber is small, since the establishment of the number of crimp of fiber is too small, a stuffing pressure of a crimper with a stuffing box must be set up low. Therefore, the crimp of fiber was rather easy to reveal crimp unevenness close to a non-crimp state. Also, in the case where the fineness of fiber is large, since the establishment of the number of crimp of fiber is too large, when a stuffing pressure of a crimper with a stuffing box is set up high, a back pressure is high so that the crimp is easily rickety. With respect to this defect, by heating a tow before the crimper with steam or the like, the stiffness of the fiber is lowered, and the ricketiness is reduced. However, since the degree of crimp of fiber increases and H/L is too high, there were involved defects that the screen-passing properties become worse; the throughput is lowered; and a pilly fiber block is easily generated.

[0007] Accordingly, there has not been proposed a polyester based fiber for airlaid nonwoven fabrics markedly excellent in productivity so far.

[0008] Patent Document 1: JP-A-11-81116

[0009] Patent Document 2: JP-A-2005-42289

SUMMARY OF THE INVENTION

[0010] In view of the foregoing background of the related art, the invention has been made, and its object is to provide a polyester based fiber for airlaid nonwoven fabrics enabling one to manufacture an airlaid nonwoven fabric which is extremely excellent in airlaid web formability, especially in spinning properties from a screen, is satisfactory in texture and is bulky.

[0011] In order to solve the foregoing problems, the present inventors made extensive and intensive investigations. As a result, they have achieved an invention regarding a conjugate fiber for airlaid nonwoven fabrics in which nevertheless the number of crimp of fiber is large, a percentage of crimp of fiber is low and after passing through a screen, a bulkiness performance is recovered by subjecting an undrawn yarn of a polyester based fiber to a fixed-length heat treatment at a temperature of higher than a glass transition temperature (T_g) or by after drawing, subjecting to an overfeed treatment within the foregoing temperature range.

[0012] More concretely, the foregoing problems can be solved by an invention regarding a manufacturing method of a polyester fiber for airlaid nonwoven fabrics made of, as a fiber forming resin component, a polyester having a fineness of not more than 10.0 dtex or a fiber length of 8.0 mm or more, having a number of crimp of 8.5 peaks/25 mm or more, a percentage of crimp/number of crimp ratio of not more than 0.65 and a crimp modulus of elasticity of 70% or more and containing 80% by mole or more of an alkylene terephthalate repeating unit in the whole of repeating units, which includes drawing an undrawn yarn taken up at a spinning rate of not more than 1,500 m/min in a low draw ratio of from 0.60 to 1.20 times at a temperature of at least 10° C. higher than a glass transition temperature of the polyester and simultaneously subjecting to a fixed-length heat treatment.

[0013] The invention is able to provide a polyester based fiber for airlaid nonwoven fabrics with fine fineness or long fiber length which is satisfactory in screen-passing properties, namely extremely high in productivity and which is soft in texture and bulky. Also, crimp can be stably imparted by using a crimper with a stuffing box of the related art, and therefore,

it is possible to produce a nonwoven fabric which is uniform in crimp and satisfactory in texture.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Embodiments of the invention are hereunder described in detail.

(1) Polyester Fiber Made of Single Polyester Component:

[0015] First of all, in the case where the polyester fiber is a fiber made of a single polyester component, a polyester containing an alkylene terephthalate as a major repeating component is preferable as a synthetic polymer which is a fiber forming resin component constituting a fiber. The "polyester containing an alkylene terephthalate as a major repeating component" as referred to herein is a polyester in which 80% by mole or more of the whole of repeating units constituting the synthetic polymer is occupied by an alkylene terephthalate repeating unit. Specific examples thereof include polyalkylene terephthalates such as polyethylene terephthalate, polytrimethylene terephthalate, and polybutylene terephthalate. It is preferable that 90% by mole or more of the whole of repeating units constituting the synthetic polymer is occupied by an alkylene terephthalate repeating unit. Also, it is more preferable that 80% by mole or more of the alkylene terephthalate repeating unit is occupied by an ethylene terephthalate repeating unit. Also, if desired, one or two or more kinds of other dicarboxylic acid component, a hydroxycarboxylic acid component and other diol component may be contained as a copolymerization component.

[0016] In that case, examples of the dicarboxylic acid component which is suitable as the copolymerization component include aromatic dicarboxylic acids such as isophthalic acid, di-phenyldicarboxylic acid and naphthalenedicarboxylic acid or ester forming derivatives thereof; metallic sulfonate group-containing aromatic dicarboxylic acid derivatives such as dimethyl 5-sodium sulfoisophthalate and bis (2-hydroxyethyl) 5-sodiumsulfoisophthalate; and aliphatic dicarboxylic acids such as oxalic acid, adipic acid, sebacic acid, dodecane diacid or ester forming derivatives thereof. Also, examples of the hydroxycarboxylic acid component include p-hydroxybenzoic acid and p-β-hydroxyethoxybenzoic acid and ester forming derivatives thereof. Specific examples of the ester forming derivative as referred to herein include lower alkyl esters such as methyl esters and ethyl esters; and lower aryl esters such as phenyl esters.

[0017] Examples of the diol component which is suitable as the copolymerization component include aliphatic diols such as ethylene glycol, 1,3-propanediol, 1,4-butanediol, 1,6-hexanediol, neopentyl glycol, diethylene glycol, and triethylene glycol; 1,4-bis(β-hydroxyethoxy)benzene; and polyalkylene glycols such as polyethylene glycol, polytrimethylene glycol, and polybutylene glycol.

[0018] Furthermore, the polyester fiber for airlaid nonwoven fabrics obtained by the manufacturing method of the invention is a fiber which is set up to have a low percentage of crimp (CD) and a high crimp modulus of elasticity (CE) such that a ratio of a percentage of crimp (CD) to a number of crimp (CN), namely CD/CN as defined in Japanese Industrial Standards L1015: 8.12.1 to 8.12.2 (2005) is not more than 0.65 and that a crimp modulus of elasticity (as described in Japanese Industrial Standards L1015: 8.12.3 (2005); a value obtained by dividing the percentage of residual crimp by the

percentage of crimp and expressed in terms of a percentage) is 70% or more. By setting up the number of crimp and the percentage of crimp of the polyester fiber low, the polyester fiber is easy to pass through a screen. Also, by setting up the crimp modulus of elasticity of the polyester fiber high, after passing through a screen, the crimp of the polyester fiber is recovered. Accordingly, a fiber block in a bundle form cuts off the fiber-to-fiber coagulation and becomes easy to cause opening, whereby a spinning performance further increases.

[0019] A range of the number of crimp (CN) of the polyester fiber of the invention must be 8.5 peaks/25 mm or more and is preferably from approximately 9.0 to 20.0 peaks/25 mm, and more preferably from 9.5 to 13.0 peaks/25 mm. When the number of crimp of the polyester fiber is less than 8.5 peaks/25 mm, in the case where the fiber length is long, the polyester fiber is hard to pass through a screen and is easy to generate a fiber block in a bundle form so that opening properties and screen-passing properties become worse. Also, when the number of crimp of the polyester fiber exceeds 20.0 peaks/25 mm, fiber-to-fiber entanglement is too strong so that pilling is easy to generate. Furthermore, as described previously, a ratio of the percentage of crimp (CD) to the number of crimp (CN), namely CD/CN must be not more than 0.65. When the subject CD/CN of the polyester fiber exceeds 0.65, since the peaks of the crimp is sharp and the fiber-to-fiber entanglement tends to become strong, the screen-passing properties become worse, too. Also, as described previously, the crimp modulus of elasticity (CE) of the polyester fiber of the invention must be 70% or more. When the subject crimp modulus of elasticity of the polyester fiber is less than 70%, after passing through a screen, the fiber in a bundle form is easy to remain. For the purpose of achieving such CN range, CD/CN ratio range and CE range, for example, it is preferable that the crimp is applied to the polyester fiber without applying a temperature. Furthermore, it is more preferable that the crimp is applied to the polyester fiber while cooling with cold air or the like.

[0020] A dry heat shrinkage percentage at 180° C. of the polyester fiber for airlaid nonwoven fabrics of the invention may be from -20.0 to 2.0%. Since the polyester fiber which is satisfied with this characteristic is small in shrinkage at the time of thermal adhesion, a deviation of an adhesion point at the point of intersection between fibers during the manufacture of a nonwoven fabric is small, and the adhesion point is strong. Furthermore, in the case where the dry heat shrinkage percentage at 180° C. of the polyester fiber is a negative value and the fiber is in a so-called self-elongated state, a fiber density in the nonwoven fabric prior to the thermal adhesion is reduced, and finish is bulky, whereby a nonwoven fabric having soft and smooth texture can be formed. When the dry heat shrinkage percentage at 180° C. of the polyester fiber exceeds 2.0%, since the adhesive strength of the obtained nonwoven fabric is reduced and the fiber density increases, the texture of the nonwoven fabric tends to become hard. On the other hand, when the dry heat shrinkage percentage at 180° C. of the polyester fiber is less than -20.0%, thereby revealing self-elongation, the adhesive point is deviated at the time of thermal adhesion during the manufacture of a nonwoven fabric, and the strength of the non-woven fabric is moved to a direction where it is reduced, too. A range of the dry heat shrinkage percentage at 180° C. of the polyester fiber is preferably from -11.0 to 1.5%, and more preferably from -8.0 to 0.0%.

[0021] For the purpose of making both a high breaking elongation and a low dry heat shrinkage percentage at 180° C. as described previously, this purpose is achieved by performing drawing in a low drawing ratio of from approximately 0.60 to 1.20 times as a drawing draft and simultaneously performing a fixed-length heat treatment. Furthermore, when the drawing draft is set up at a draw ratio of less than 1.0 time (so-called overfeed), specifically from 0.60 to 0.90 times and the temperature of the heat treatment is set up high, a self-elongation ratio of the polyester fiber tends to become large and hence, such is preferable. When such a treatment is carried out, proper self-elongation properties can be imparted to the polyester fiber, thereby bringing an advantage for enabling one to bring such a characteristic feature that a nonwoven fabric obtained from such a polyester fiber is finished bulkily, whereas a fiber structure obtained from such a polyester fiber is finished in a low density.

[0022] The cross section of the polyester fiber for airlaid nonwoven fabrics of the invention may be a solid fiber or a hollow fiber and may be a modified cross section such as a triangular shape and a star shape or a modified hollow cross section. Such a hollow fiber or modified fiber can be obtained by melt spinning by using a known spinning nozzle.

[0023] Furthermore, in the polyester fiber for airlaid nonwoven fabrics of the invention, a fiber for airlaid nonwoven fabrics having a fineness of not more than 10.0 dtex or a fiber length of 8.0 mm or more is necessary. Fibers having a fineness smaller than the foregoing value range or a fiber length longer than the foregoing value range are in general hard to pass through a screen provided in a manufacturing device of airlaid nonwoven fabrics. This is because when the fineness is small, the fiber-to-fiber coagulation is strong so that opening is hardly generated, whereas when the fiber length is long, the fiber is not rounded in a size such that it passes through openings of the screen. When the crimp performance is stronger than that of this tendency, the fibers cause entanglement and become pilly, whereby the openings of the screen are easily plugged. Also, in the case where the subject pill accidentally passes through the screen, a pilly defect or texture unevenness is easily generated in the web, thereby causing a problem in view of the quality of nonwoven fabric. In view of this point of view, the invention is concerned with a polyester fiber for obtaining a nonwoven fabric with satisfactory texture and good quality even in the case where it has a low fineness or a long fiber length, and the fineness must be not more 10 dtex, or the fiber length must be 8 mm or more. It is preferable that the fineness is from 1 to 9 dtex, or the fiber length is from 9 to 50 mm; and it is more preferable that the fineness is from 3 to 9 dtex, or the fiber length is from 9.5 to 30 mm.

[0024] In the fiber for airlaid nonwoven fabrics obtained by the manufacturing method of the invention, a proper alkylene terephthalate is selected among those described above corresponding to the use object and can be obtained by imparting a single yarn fineness, a crimp performance and a fiber length which meet with the foregoing requirements of the invention. Concretely, the polyester fiber for airlaid nonwoven fabrics of the invention made of a single polyester component which constitutes such an alkylene terephthalate as a major component can be manufactured by the following method.

[0025] The polyester fiber for airlaid nonwoven fabrics is obtained by a manufacturing method in which an undrawn yarn obtained by drying a pelletized polyester in a usual way, melt spinning in known polyester fiber spinning equipment

equipped with a screw extruder or the like and taking up at a spinning rate of not more than 1,500 m/min is drawn in a low draw ratio of from 0.60 to 1.20 times at a temperature of at least 10° C. higher than a glass transition temperature of the polyester and simultaneously subjected to a fixed-length heat treatment. The spinning rate must be not more than 1,500 m/min and is preferably not more than 1,300 m/min, and more preferably not more than 1,200 m/min. When the spinning rate exceeds 1,500 m/min, the orientation of an undrawn yarn increases; high adhesion targeted in the invention is inhibited; yarn cutting frequently occurs; and the productivity becomes worse. Also, in the case where the spinning rate is considerably slower than this range, as a matter of course, the productivity of fiber becomes worse.

[0026] The “fixed-length heat treatment” as referred to herein is carried out in a state that a draft of from 0.60 to 1.20 times is applied to an undrawn yarn obtained by melt spinning. Ideally, the heat treatment is carried out at a draft of 1.00 time such that deformation is not generated in a fiber axis direction before and after the heat treatment. However, in the case where thermal elongation is generated in the undrawn yarn in view of properties of the resin, in order to prevent looseness of filaments between rollers of a drawing machine, a draft of more than 1.00 time may be applied. Also, in view of properties of a resin, in the case where strong heat shrinkage is generated, the orientation of the fiber may possibly increase. Thus, instead of applying a draft of more than 1.00 time, a draft (overfeed) of less than 1.0 time may be applied to such a degree that the undrawn yarn does not generate looseness during drawing. However, what a draft exceeding 1.20 times is imparted is not preferable because the undrawn yarn is drawn. Also, a lower limit of the draft is approximately 0.60 times. When the draft is less than this, it is difficult to suppress the elongation of the polyester based fiber to not more than 600%. What the temperature of the fixed-length heat treatment is not higher than 10° C. as compared by the glass transition temperature of the polyester as the fiber forming resin component is not preferable because the shrinkage percentage at the time of thermal adhesion is large. The fixed-length heat treatment may be carried out on a heater plate, under blowing hot air, in high-temperature air, under blowing water vapor, or in a liquid heating medium such as warm water or silicone oil bath. Above all, it is preferred to carry out the fixed-length heat treatment in warm water which is good in thermal efficiency and which does not require rinsing during subsequent impartment of a fiber treating agent.

[0027] Also, another manufacturing method of a polyester fiber for airlaid nonwoven fabrics of the invention is a manufacturing method in which by using a known melt spinning device of polyester fiber, an undrawn yarn taken up at a spinning rate of not more than 1,500 m/min is drawn at a temperature of lower than the glass transition temperature of the polyester and then subjected to an overfeed heat treatment at a temperature of at least 10° C. higher than the glass transition temperature of the polyester and in a draw ratio of from 0.60 to 0.90 times. Though a heating method of the overfeed heat treatment in the subject manufacturing method is the same as in the foregoing method of the fixed-length heat treatment, it is especially preferable that the heat treatment is carried out in warm water with good heating efficiency. A drawing method in the subject manufacturing method is not particularly limited, except that the drawing method is carried out under a condition under which requirements of a drawing ratio of 1.10 times or more and a breaking elongation of the

undrawn yarn of from approximately 60 to 80% are met, and known drawing methods can be employed. Even by employing such a drawing method, a polyester fiber with low modulus can be obtained.

[0028] As described previously, it is possible to manufacture a fiber with low crimp performance (namely, the percentage of crimp/number of crimp ratio is small) which is satisfactory in opening properties by the manufacturing method of a polyester fiber of the invention. This is because the polyester fiber is subjected to a fixed-length heat treatment in a state that it is not substantially drawn; a modulus of rigidity of the fiber is substantially low; and a degree of crystallization is large. Also, this is because though the fiber is easily deformed in a crimper box, the subject deformation is hardly fixed, and the fiber is not preheated before it enters the crimper box; a plasticization effect of the fiber is low; and the percentage of crimp hardly increases. Accordingly, the fibers are hard to cause entanglement in a pilly state and are easily discharged from the screen, thereby hardly causing a defect in the web. Furthermore, since the polyester fiber manufactured under the foregoing spinning drawing condition frequently exhibits self-elongation properties, the airlaid nonwoven fabric becomes bulky and is finished into a soft nonwoven fabric with good texture coupled with a low modulus of the fiber itself.

(2) Polyester Conjugate Fiber Made of Plural Polyester Components:

[0029] Next, a polyester conjugate fiber made of a fiber forming resin component and a thermoadhesive resin component is a subject of the invention. As the fiber forming resin component, a crystalline thermoplastic resin having a melting point of 150° C. or higher is suitable. Specific examples thereof include polyolefins such as high density polyethylene (HDPE) and isotactic polypropylene (PP) and copolymers containing it as a major component; polyamides such as nylon-6 and nylon-66; and polyesters such as polyethylene terephthalate (PET), polytrimethylene terephthalate, polybutylene terephthalate, and polyethylene naphthalate. A polyester capable of imparting proper stiffness to a web or a nonwoven fabric in the following manufacture method, and especially polyethylene terephthalate (PET) is preferably used.

[0030] As a resin constituting the thermoadhesive resin component, it is preferred to select a crystalline thermoplastic resin having a melting point of at least 20° C. lower than that of a resin constituting the fiber forming resin component. When the thermoadhesive resin component is an amorphous thermoplastic resin, following the matter that a molecular chain which has been oriented at the time of spinning becomes non-oriented at the same time of melting, the fiber largely shrinks.

[0031] As the crystalline thermoplastic resin constituting the thermoadhesive resin component, polyolefin resins and crystalline copolyesters are preferably used.

[0032] As specific examples of the subject polyolefin resin, there is enumerated at least one polyolefin selected from the group consisting of polypropylene, high density polyethylene (HDPE), middle density polyethylene, low density polyethylene (LDPE), linear low density polyethylene, copolypropylene, and modified polypropylene. The subject copolypropylene refers to crystalline copolypropylene resulting from copolymerization with an α -olefin such as ethylene, butene, and pentene-1. The subject modified polypropylene refers to

copolypropylene resulting from copolymerization with at least one alkene made of an unsaturated carboxylic acid (for example, acrylic acid, methacrylic acid, maleic acid, fumaric acid, itaconic acid, crotonic acid, isocrotonic acid, mesaconic acid, citraconic acid, and himic acid) or an ester thereof or acid anhydride thereof.

[0033] Also, examples of the crystalline copolyester include alkylene terephthales obtained from a combination of terephthalic acid or an ester forming derivative thereof as a major dicarboxylic acid component constituting the polyester and one to three kinds of ethylene glycol, trimethylene glycol, tetramethylene glycol, hexamethylene glycol as a major diol component constituting the polyester. Furthermore, there are enumerated polyesters resulting from copolymerization with an aromatic dicarboxylic acid (for example, isophthalic acid, naphthalene-2,6-dicarboxylic acid, and 5-sulfoisophthalic acid salt), an aliphatic dicarboxylic acid (for example, adipic acid and sebacic acid), an alicyclic dicarboxylic acid (for example, cyclohexamethylenedicarboxylic acid), an ω -hydroxyalkanecarboxylic acid, an aliphatic diol (for example, diethylene glycol, triethylene glycol, polyethylene glycol, and polytetramethylene glycol), or an alicyclic diol (for example, cyclohexamethylenedimethanol) so as to exhibit a desired melting point.

[0034] Incidentally, in the case where the fiber forming resin component is PET, the thermoadhesive resin component in the invention may be in a form of a polymer blend of two or more kinds of crystalline thermoplastic resins containing not more than 40% by weight of a crystalline thermoplastic resin having a melting point of at least 20° C. lower than that of PET.

[0035] Also, the polyester fiber which is a subject of the manufacturing method of the invention is a conjugate fiber for airlaid nonwoven fabrics having a fineness of not more than 10 dtex or a fiber length of 8 mm or more. In general, a fiber having a fineness smaller than the foregoing range of the fineness or a fiber length longer than the foregoing range of the fiber length is hard to pass through a screen provided in a manufacturing device of airlaid nonwoven fabrics. This is because when the fineness is small, the fiber-to-fiber coagulation is strong so that opening is hardly generated, whereas when the fiber length is long, the fiber is not rounded in a size such that it passes through openings of the screen. When the crimp performance is stronger than that of this tendency, the fibers cause entanglement and become pilly, whereby the openings of the screen are easily plugged. Also, in the case where the subject pill accidentally passes through the screen, a pilly defect or texture unevenness is easily generated in the web, thereby causing a problem in view of the quality of nonwoven fabric. In view of this point of view, the invention is concerned with a conjugate fiber for obtaining a nonwoven fabric with satisfactory texture and good quality even in the case where it has a low fineness or a long fiber length, and the fineness must be not more than 10 dtex, or the fiber length must be 8 mm or more. It is preferable that the fineness is from 1 to 9 dtex, or the fiber length is from 9 to 50 mm; and it is more preferable that the fineness is from 3 to 9 dtex, or the fiber length is from 9.5 to 30 mm.

[0036] Also, even in the case where the polyester fiber for airlaid nonwoven fabrics of the invention is a conjugate fiber, a range of the number of crimp (CN) must be 8.5 peaks/25 mm or more; a ratio of the percentage of crimp (CD) to the number of crimp (CN), namely a CD/CN ratio must be not more than 0.65; and a crimp modulus of elasticity must be

70% or more. The percentage of crimp of the conjugate fiber is preferably from approximately 9.0 to 20.0 peaks/25 mm, and more preferably from 9.5 to 13.0 peaks/25 mm. When the CD/CN ratio of the polyester fiber exceeds 0.65, since the peaks of the crimp is sharp and the fiber-to-fiber entanglement tends to become strong, the screen-passing properties become worse, too.

[0037] Furthermore, the polyester fiber for airlaid non-woven fabrics obtained by the manufacturing method of the invention is a conjugate fiber which is set up to have a low percentage of crimp (CD) and a high crimp modulus of elasticity (CE) such that a ratio of the percentage of crimp (CD) to the number of crimp (CN), namely a CD/CN ratio as defined in Japanese Industrial Standards L1015: 8.12.1 to 8.12.2 (2005) is not more than 0.65 and that a crimp modulus of elasticity (as described in Japanese Industrial Standards L1015: 8.12.3 (2005); a value obtained by dividing the percentage of residual crimp by the percentage of crimp and expressed in terms of a percentage) is 70% or more. By setting up the number crimp and percentage of crimp of the polyester conjugate fiber low, the polyester conjugate fiber is easy to pass through a screen. Also, by setting up the crimp modulus of elasticity of the polyester conjugate fiber high, after passing through a screen, the crimp of the polyester conjugate fiber is recovered. Accordingly, a fiber block in a bundle form cuts off the fiber-to-fiber coagulation and is easy to cause opening, whereby a spinning performance further increases.

[0038] A range of the number of crimp (CN) of the polyester conjugate fiber of the invention must be 8.5 peaks/25 mm or more and is preferably from approximately 9.0 to 20.0 peaks/25 mm. When the number of crimp is less than 8.5 peaks/25 mm, in the case where the fiber length is long, the conjugate fiber is hard to pass through a screen and is easy to form a fiber block in a bundle form so that opening properties and screen-passing properties become worse. Also, when CN exceeds 20.0 peaks/25 mm, fiber-to-fiber entanglement is too strong that pilling is easy to generate. Furthermore, when the ratio (CD/CN) of the percentage of crimp (CD) to the number of crimp (CN) exceeds 0.65, since the peaks of the crimp is sharp and the fiber-to-fiber entanglement tends to become strong, the screen-passing properties become worse, too. When the crimp modulus of elasticity of the polyester fiber is less than 70%, after passing through a screen, the fiber in a bundle form is easy to remain. For the purpose of achieving such CD/CN ratio range and CE range, for example, it is preferable that the crimp is applied to the conjugate fiber without applying a temperature. Furthermore, it is more preferable that the crimp is applied while cooling with cold air or the like.

[0039] In order to manufacture a fiber having such a small crimp performance, it is necessary to adjust the modulus of the fiber other than crimp small. Concretely, the conjugate fiber is obtained by a manufacturing method by drawing an undrawn yarn taken up at a spinning rate of not more than 1,500 m/min in a low draw ratio of from 0.6 to 1.20 times at a temperature of at least 10° C. higher than a glass transition temperature of the fiber forming resin component by employing a known melting method of a conjugate fiber or by using a known nozzle and simultaneously subjecting to a fixed-length heat treatment. The spinning rate must be not more than 1,500 m/min and is preferably not more than 1,400 m/min, and more preferably not more than 1,300 m/min. When the spinning rate exceeds 1,500 m/min, the orientation of an undrawn yarn increases; high adhesion between the

conjugate fibers targeted in the invention is inhibited; yarn cutting frequently occurs; and the productivity of the conjugate fiber becomes worse. Also, in the case where the spinning rate is slower than this range, as a matter of course, the productivity becomes worse.

[0040] The “fixed-length heat treatment” as referred to herein is carried out in a state that a draft of from 0.60 to 1.20 times is applied to an undrawn yarn obtained by melt spinning. Ideally, the heat treatment is carried out at a draft of 1.00 time such that deformation is not generated in a fiber axis direction before and after the heat treatment. However, in the case where thermal elongation is generated in the undrawn yarn in view of properties of the resin, in order to prevent looseness of filaments between rollers of a drawing machine, a draft of more than 1.00 time may be applied. What a draft exceeding 1.20 times is imparted is not preferable because the undrawn yarn is drawn. Also, in view of properties of a resin, in the case where strong heat shrinkage is generated, the orientation of the fiber may possibly increase. Thus, instead of applying a draft of more than 1.00 time, a draft (overfeed) of less than 1.00 time may be applied to such a degree that the undrawn yarn does not generate looseness during drawing. It is preferred to apply a draft of from 0.70 to 0.90 times (overfeed). However, a lower limit of the draft is approximately 0.60 times. When the draft is less than this, almost all of polymers are insufficiently shrunken so that a tow is easy to sag. The fixed-length heat treatment may be carried out on a heater plate, under blowing hot air, in high-temperature air, under blowing water vapor, or in a liquid heating medium such as warm water or silicone oil bath. Above all, it is preferred to carry out the fixed-length heat treatment in warm water which is good in thermal efficiency and which does not require rinsing during subsequent impartment of a fiber treating agent.

[0041] Also, another manufacturing method is a manufacturing method in which by using a known melting method of conjugate fiber or a known nozzle, an undrawn yarn taken up at a spinning rate of not more than 1,500 m/min is drawn at a temperature of lower than a temperature of whichever is higher between the glass transition temperature of the thermoadhesive resin component and the glass transition temperature of the fiber forming resin component and then subjected to an overfeed (fixed-length) heat treatment at a temperature of at least 10° C. higher than a temperature of whichever is higher between the glass transition temperature of the thermoadhesive resin component and the glass transition temperature of the fiber forming resin component in a draw ratio of from 0.60 to 0.90 times. Usually, in the case of comparing the thermoadhesive resin component and the fiber forming resin component, in the fiber forming resin component, a resin having a higher melting point and a higher glass transition temperature is used. Accordingly, it is a more preferred embodiment that the temperature at which the overfeed (fixed-length) heat treatment is carried out is at least 10° C. higher than the glass transition temperature of the fiber forming resin component. Though the drawing method and the heating method of overfeed are the same as the method of the fixed-length heat treatment of the polyester fiber, it is especially preferable that the heat treatment is carried out in warm water with good heating efficiency. Even by employing such a fixed-length heat treatment method, a conjugate fiber with low modulus can be obtained.

[0042] The reasons why a fiber with low crimp performance (namely, the percentage of crimp/number of crimp

ratio is small) having satisfactory opening properties can be manufactured by the manufacturing method of the invention are as follows. That is, since the conjugate fiber is subjected to a fixed-length heat treatment in a state that it is not substantially drawn, the fiber forming resin component is subjected to a proper heat treatment, whereby the fiber has proper stiffness. However, since the subject stiffness of the fiber is substantially low, though the fiber is easily deformed in a crimper box, the subject deformation is hardly fixed. Also, since the fiber is not preheated before it enters the crimper box, a plasticization effect of the fiber is low, and the percentage of crimp hardly increases. Furthermore, since a difference in orientation between the fiber forming resin component and the thermoadhesive resin component generated due to drawing is small, stereo crimp is hard to reveal. Accordingly, entanglement of the fibers in an airlaid process is small; and the fibers are hard to cause entanglement in a pill state and are easily discharged from the screen, thereby hardly causing a defect in the web. Furthermore, since the draw ratio is low, the orientation of the thermoadhesive resin component is suppressed on a low level; the thermoadhesive resin component is easily molten at a low temperature of slightly exceeding the melting point of the thermoadhesive resin component; an improvement in thermal adhesion rate of fiber due to low thermal adhesion can be achieved. That is, it is thought that an improvement of the productivity is brought and that the adhesive strength becomes large.

[0043] An embodiment of the thermoadhesive conjugate fiber of the invention may be a conjugate fiber resulting from sticking the fiber forming resin component and the thermoadhesive resin component to each other in a so-called side-by-side type or a core/sheath type conjugate fiber in which the both components have a core/sheath structure. However, from the standpoint that the thermoadhesive resin component is disposed in all directions perpendicular to the fiber axis direction, a core/sheath type conjugate fiber in which the fiber forming resin component is a core component and the thermoadhesive resin component is a sheath component is preferable. Also, examples of the core/sheath type conjugate fiber include a concentric core/sheath type conjugate fiber and an eccentric core/sheath type conjugate fiber.

[0044] Also, examples of the core/sheath type conjugate fiber include a concentric core/sheath type conjugate fiber and an eccentric core/sheath type conjugate fiber. A cross section of the fiber is preferably a concentric core/sheath type cross section or an eccentric core/sheath type cross section. In the side-by-side type cross section, heat shrinkage in a web state is large due to revelation of stereo crimp, the adhesive strength tends to be small, and the targeted effects of the invention are somewhat reduced. Also, the cross section of the fiber may be a solid fiber or a hollow fiber and is not limited to a round cross section; and it may be a modified cross section such as an oval cross section, a multi-foliate cross section including three to eight foliate cross sections, and a polygonal cross section including triangular to octagonal shapes. The terms "multi-foliate cross section" as referred to herein means a cross-sectional shape having plural convexes extending from a central part to a peripheral direction.

[0045] Though a conjugate ratio of the fiber forming resin component to the thermoadhesive resin component is not particularly limited, it is selected depending upon the requirements for the targeted strength, bulkiness and heat shrinkage percentage of the nonwoven fabric or fiber structure. A ratio of the fiber forming resin component to the thermoadhesive

resin component is preferably from approximately 10/90 to 90/10 in terms of a weight ratio.

EXAMPLES

[0046] The invention is more specifically described below with reference to the following Examples, but it should be construed that the invention is not limited thereto whatsoever. Incidentally, the respective items in the Examples were measured by the following methods.

(1) Intrinsic Viscosity (IV):

[0047] An intrinsic viscosity of a polyester was measured at 35° C. in a usual way after weighing a fixed amount of a polymer sample and dissolving it in o-chlorophenol in a concentration of 0.012 g/mL.

(2) Melting Point (Tm) and Glass Transition Temperature (Tg):

[0048] A melting point and a glass transition temperature of a polymer were measured at a temperature rise rate of 20° C./min by using Thermal Analyst 2200, manufactured by TA Instruments, Japan.

(3) Fineness:

[0049] A fineness of a polyester fiber was measured by a method described in Japanese Industrial Standards L1015: 8.5.1 A Method (2005).

(4) Strength and Elongation:

[0050] Tenacity and elongation of a polyester fiber were measured by a method described in Japanese Industrial Standards L1015: 8.7.1 Method (2005).

[0051] In the polyester fiber of the invention, since a scattering in the strength and elongation is liable to be generated due to the efficiency of the fixed-length heat treatment, in the case where the strength and elongation are measured in a single yarn, the number of measurement point must be increased. Since the number of measurement point is preferably 50 or more, the number of measurement point is set up at 50 herein, and an average value thereof is defined as the strength and elongation.

(5) Number of Crimp (CN), Percentage of Crimp (CD) and Crimp Modulus of Elasticity (CE):

[0052] Number of crimp, percentage of crimp and crimp modulus of elasticity of a polyester fiber were measured by a method described in Japanese Industrial Standards L1015: 8.12.1 to 8.12.3 Methods (2005).

(6) Dry Heat Shrinkage Percentage at 180° C.:

[0053] A dry heat shrinkage percentage at 180° C. of a conjugate fiber was measured at a temperature of 180° C. in a method described in Japanese Industrial Standards L1015: 8.15 b) Method (2005).

(7) Web Grade:

[0054] An airlaid web with a basis weight of 30 g/m² and made of 100% of a short fiber obtained by unpacking a package by using a forming drum unit manufactured by Dan-Webforming International (width: 600 mm, hole shape of screen of the forming drum: rectangle of 2.4 mm×20 mm, rate

of opening: 40%) under a condition at a number of revolution of the forming drum of 200 rpm, at a number of revolution of a needle roller of 900 rpm and at a web conveyance rate of 30 m/min and taking out it was collected. An external appearance of the airlaid web of 30 cm in square was observed, and the grade of the airlaid web was evaluated according to the following criteria.

[0055] (Level 1)

[0056] A fiber block having a diameter of 5 mm or more and basis weight unevenness (light and shade) are not observed, and uniform texture is exhibited.

[0057] (Level 2)

[0058] The number of fiber blocks having a diameter of 5 mm or more is less than 5, and basis weight unevenness (light and shade) can be visually confirmed.

[0059] (Level 3)

[0060] The number of fiber blocks having a diameter of 5 mm or more is 5 or more; basis weight unevenness (light and shade) are conspicuous; and non-uniform texture is exhibited.

(8) Maximum Throughput:

[0061] In the foregoing measurement method of "web grade", a fiber feed amount to the forming drum was increased by every 2 kg/hr, and the operation was carried out in a stationary state for 5 minutes in the respective fiber feed amount. In carrying out the operation in a stationary state, when the fiber became in a state that it was not discharged from the forming drum and generated plugging, a fiber feed amount on a level prior to the generation of the subject plugging was defined as a maximum throughput.

(9) Melt Flow Rate (MFR):

[0062] MFR of a polypropylene resin was measured according to Japanese Industrial Standards K7210, Condition 14 (measurement temperature: 230° C., load: 21.18 N); and MFR of other resins was measured according to Japanese Industrial Standards K7210, Condition 4 (measurement temperature: 190° C., load: 21.18 N). Incidentally, the melt flow rate is a value measured by using, as a sample, a pellet prior to melt spinning.

Example 1

[0063] Polyethylene terephthalate (PET) having an IV of 0.64 dL/g, a Tg of 70° C. and a Tm of 256° C. was used and molten at 290° C., and then spun under a condition at a discharge amount of 0.15 g/min/hole and at a spinning rate of 1,150 m/min by using a known nozzle for round-hole fiber spinning, thereby obtaining an undrawn yarn. The subject undrawn yarn was drawn in a low draw ratio of 1.0 time in warm water of 90° C. which temperature was 20° C. higher than the glass transition temperature of PET and simultaneously subjected to a fixed-length heat treatment. Next, the filaments obtained by the fixed-length heat treatment were dipped in an aqueous solution of a lubricant made of a lauryl phosphate potassium salt and polyoxyethylene-modified silicone (weight ratio=80/20), and eleven mechanical crimps per 25 mm were imparted thereto by using a crimper with a stuffing box. Furthermore, the subject filaments were dried at 135° C. and then cut in a fiber length of 10.0 mm. As a result of the measurement in a tow state prior to cutting, the resulting polyester fiber was a polyester fiber having a single yarn fineness of 1.2 dtex, a strength of 1.5 cN/dtex, an elongation of 350%, a CN of 10.8 peaks/25 mm, a CD of 3.8%, a CD/CN

ratio of 0.35, a CE of 79%, and a dry heat shrinkage percentage at 180° C. of -0.2%. An evaluation of an airlaid web grade as performed by using this polyester fiber was Level 1, and a maximum throughput was 120 kg/hr.

Comparative Example 1

[0064] A polyester fiber was manufactured under the same condition as in Example 1, except for changing the discharge amount to 0.40 g/min/hole, performing spinning under a condition at a spinning rate of 1,150 m/min, performing drawing in a draw ratio of 2.9 times in warm water of 70° C., and further performing drawing in a draw ratio of 1.15 times in warm water of 90° C. Then, there was obtained a polyester fiber having a single yarn fineness of 1.2 dtex, a strength of 4.8 cN/dtex, an elongation of 47%, a CN of 12.0 peaks/25 mm, a CD of 14.5%, a CD/CN ratio of 1.20, a CE of 79%, and a dry heat shrinkage percentage at 180° C. of +5.1%. While an evaluation of an airlaid web grade as performed by using this polyester fiber was Level 1, a maximum throughput was low as 40 kg/hr.

Example 2

[0065] A polyester fiber was manufactured under the same condition as in Example 1, except for changing the discharge amount to 0.10 g/min/hole, performing spinning under a condition at a spinning rate of 1,150 m/min, performing drawing in a low draw ratio (overfeed was carried out) of 0.7 times in warm water of 90° C. and simultaneously performing a fixed-length heat treatment. Then, there was obtained a polyester fiber having a single yarn fineness of 1.3 dtex, a strength of 1.2 cN/dtex, an elongation of 370%, a CN of 9.7 peaks/25 mm, a CD of 3.3%, a CD/CN ratio of 0.34, a CE of 85%, and a dry heat shrinkage percentage at 180° C. of -10.1%. An evaluation of an airlaid web grade as performed by using this polyester fiber was Level 1, and a maximum throughput was low as 115 kg/hr.

Example 3

[0066] Polyethylene terephthalate (PETI) having 15% by mole of isophthalic acid copolymerized therewith and having an IV of 0.64 dL/g, a Tg of 65° C. and a Tm of 215° C. was used and molten at 280° C., and then spun under a condition at a discharge amount of 0.15 g/min/hole and at a spinning rate of 1,150 m/min by using a known nozzle for round-hole fiber spinning, thereby obtaining an undrawn yarn. The subject undrawn yarn was drawn in a low draw ratio of 1.0 time in warm water of 90° C. which temperature was 25° C. higher than the glass transition temperature of PETI and simultaneously subjected to a fixed-length heat treatment. Next, the filaments obtained by the fixed-length heat treatment were dipped in an aqueous solution of a lubricant made of a lauryl phosphate potassium salt and polyoxyethylene-modified silicone (weight ratio=80/20), and eleven mechanical crimps per 25 mm were imparted thereto by using a crimper with a stuffing box. Furthermore, the subject filaments were dried at 110° C. and then cut in a fiber length of 10.0 mm. As a result of the measurement in a tow state prior to cutting, the resulting polyester fiber was a polyester fiber having a single yarn fineness of 1.25 dtex, a strength of 1.2 cN/dtex, an elongation of 390%, a CN of 11.0 peaks/25 mm, a CD of 3.2%, a CD/CN ratio of 0.29, a CE of 84%, and a dry heat shrinkage percentage at 180° C. of +1.1%. An evaluation of an airlaid web grade

as performed by using this polyester fiber was Level 1, and a maximum throughput was 110 kg/hr.

Comparative Example 2

[0067] A polyester fiber was manufactured under the same condition as in Example 3, except for changing the discharge amount to 0.40 g/min/hole, performing spinning under a condition at a spinning rate of 1,150 m/min, performing drawing in a draw ratio of 2.9 times in warm water of 70° C., and further performing drawing in a draw ratio of 1.15 times in warm water of 90° C. Then, there was obtained a polyester fiber having a single yarn fineness of 1.3 dtex, a strength of 4.2 cN/dtex, an elongation of 55%, a CN of 10.8 peaks/25 mm, a CD of 13.1%, a CD/CN ratio of 1.21, a CE of 63%, and a dry heat shrinkage percentage at 180° C. of +4.6%. While an evaluation of an airlaid web grade as performed by using this polyester fiber was Level 1, a maximum throughput was low as 30 kg/hr.

Example 4

[0068] Polyethylene terephthalate (PET) having an IV of 0.64 dL/g, a Tg of 70° C. and a Tm of 256° C. was used for a core component (fiber forming resin component); and high density polyethylene (HDPE) having an MFR of 20 g/10 min and a Tm of 131° C. (Tg: lower than 0° C.) was used for a sheath component (thermoadhesive resin component). These resins were molten at 290° C. and 250° C., respectively; and a conjugate fiber was formed in a weight ratio of the core component to the sheath component of 50/50 (% by weight) by using a known nozzle for core/sheath type conjugate fiber and spun under a condition at a discharge amount of 0.71 g/min/hole and at a spinning rate of 1,150 m/min, thereby obtaining an undrawn yarn. The subject undrawn yarn was drawn in a low draw ratio of 1.0 time in warm water of 90° C. which temperature was 20° C. higher than the glass transition temperature of the resin of the core component and simultaneously subjected to a fixed-length heat treatment. Next, the filaments obtained by the fixed-length heat treatment were dipped in an aqueous solution of a lubricant made of a lauryl phosphate potassium salt and polyoxy-ethylene-modified silicone (weight ratio=80/20), and eleven mechanical crimps per 25 mm were imparted thereto by using a crimper with a stuffing box. Furthermore, the subject filaments were dried at 110° C. and then cut in a fiber length of 10 mm. As a result of the measurement in a tow state prior to cutting, the resulting polyester conjugate fiber was a polyester conjugate fiber having a single yarn fineness of 6.5 dtex, a strength of 0.8 cN/dtex, an elongation of 445%, a CN of 9.7 peaks/25 mm, a CD of 4.8%, a CD/CN ratio of 0.50, and a CE of 75%. An evaluation of an airlaid web grade as performed by using this polyester conjugate fiber was Level 1, and a maximum throughput was 120 kg/hr.

Comparative Example 3

[0069] A polyester fiber was manufactured under the same condition as in Example 4, except for changing the discharge amount to 0.97 g/min/hole, performing spinning under a condition at a spinning rate of 400 m/min, performing drawing in a draw ratio of 3.8 times in warm water of 70° C., and further performing drawing in a draw ratio of 1.15 times in warm water of 90° C. Then, there was obtained a polyester conjugate fiber having a single yarn fineness of 6.3 dtex, a strength of 2.5 cN/dtex, an elongation of 78%, a CN of 9.3 peaks/25

mm, a CD of 9.0%, a CD/CN ratio of 0.96, and a CE of 68%. While an evaluation of an airlaid web grade as performed by using this polyester conjugate fiber was Level 1, a maximum throughput was low as 40 kg/hr.

Example 5

[0070] A polyester conjugate fiber was manufactured under the same condition as in Example 4, except for changing the discharge amount to 0.52 g/min/hole, performing spinning under a condition at a spinning rate of 1,150 m/min, performing drawing in a low draw ratio (overfeed was carried out) of 0.7 times in warm water of 90° C. and simultaneously performing the fixed-length heat treatment. Then, there was obtained a polyester conjugate fiber having a single yarn fineness of 6.5 dtex, a strength of 0.7 cN/dtex, an elongation of 412%, a CN of 9.9 peaks/25 mm, a CD of 4.0%, a CD/CN ratio of 0.40, and a CE of 89%. An evaluation of an airlaid web grade as performed by using this polyester conjugate fiber was Level 1, and a maximum throughput was low as 115 kg/hr.

Example 6

[0071] A polyester conjugate fiber was manufactured under the same condition as in Example 4, except for changing the discharge amount to 1.3 g/min/hole, performing spinning under a condition at a spinning rate of 1,150 m/min, performing the drawing in a draw ratio of 2.35 times in warm water of 63° C., performing drawing in a low draw ratio (overfeed was carried out) of 0.7 times in warm water of 90° C. and simultaneously performing the fixed-length heat treatment. Then, there was obtained a polyester conjugate fiber having a single yarn fineness of 6.5 dtex, a strength of 1.8 cN/dtex, an elongation of 125%, a CN of 9.5 peaks/25 mm, a CD of 5.7%, a CD/CN ratio of 0.60, and a CE of 75%. An evaluation of an airlaid web grade as performed by using this polyester conjugate fiber was Level 1, and a maximum throughput was low as 130 kg/hr.

Example 7

[0072] Polyethylene terephthalate (PET) having an IV of 0.64 dL/g, a Tg of 70° C. and a Tm of 256° C. was used for a core component (fiber forming resin component); and a pellet of a blend of 80% by weight of isotactic polypropylene (PP) having an MFR of 8 g/10 min and a Tm of 165° C. (Tg: lower than 0° C.) and 20% by weight of maleic anhydride-methyl acrylate graft copolyethylene (copolymerization rate of maleic anhydride=2% by weight, copolymerization rate of methyl acrylate=7% by weight; namely m-PE) having an MFR of 8 g/10 min and a Tm of 98° C. (Tg: lower than 0° C.) was used for a sheath component (thermoadhesive resin component). These resins were molten at 290° C. and 250° C., respectively; and a core/sheath type conjugate fiber was formed in a weight ratio of the core component to the sheath component of 50/50 (% by weight) by using a known nozzle for core/sheath type conjugate fiber and spun under a condition at a discharge amount of 0.73 g/min/hole and at a spinning rate of 900 m/min, thereby obtaining an undrawn yarn. The subject undrawn yarn was drawn in a low draw ratio of 1.0 time in warm water of 90° C. which temperature was 20° C. higher than the glass transition temperature of the resin of the core component and simultaneously subjected to a fixed-length heat treatment. Next, the filaments obtained by the fixed-length heat treatment were dipped in an aqueous solu-

tion of a lubricant made of a lauryl phosphate potassium salt and polyoxyethylene-modified silicone (weight ratio=80/20), and eleven mechanical crimps per 25 mm were imparted thereto by using a crimper with a stuffing box. Furthermore, the subject filaments were dried at 110° C. and then cut in a fiber length of 10.0 mm. As a result of the measurement in a tow state prior to cutting, the resulting polyester conjugate fiber was a polyester conjugate fiber having a single yarn fineness of 8.1 dtex, a strength of 1.4 cN/dtex, an elongation of 169%, a CN of 13.0 peaks/25 mm, a CD of 6.2%, a CD/CN ratio of 0.48, and a CE of 83%. An evaluation of an airlaid web grade as performed by using this polyester conjugate fiber was Level 1, and a maximum throughput was 110 kg/hr.

Comparative Example 4

[0073] A conjugate fiber was manufactured under the same condition as in Example 7, except for changing the discharge amount to 1.35 g/min/hole, performing spinning under a condition at a spinning rate of 900 m/min, performing drawing in a draw ratio of 1.9 times in warm water of 70° C., and further performing drawing in a draw ratio of 1.15 times in warm water of 90° C. Then, there was obtained a polyester conjugate fiber having a single yarn fineness of 8.0 dtex, a strength of 2.7 cN/dtex, an elongation of 36%, a CN of 9.3 peaks/25 mm, a CD of 11.8%, a CD/CN ratio of 1.27, and a CE of 89%. While an evaluation of an airlaid web grade as performed by using this polyester conjugate fiber was Level 1, a maximum throughput was low as 30 kg/hr.

Example 8

[0074] Polyethylene terephthalate (PET) having an IV of 0.64 dL/g, a T_g=70° C. and a T_m of 256° C. was used for a core component (fiber forming resin component); and a crystalline copolyester (polyethylene terephthalate having 20% by mole of isophthalic acid and 50% by mole of tetramethylene glycol copolymerized therewith; hereinafter abbreviated as "co-PET-1") having an MFR of 40 g/10 min, a T_m of 152° C. and a T_g of 43° C. was used as the sheath component (thermoadhesive resin component). These resins were molten at 290° C. and 255° C., respectively; and a concentric core/sheath type conjugate fiber was formed in a weight ratio of the core component to the sheath component of 50/50 (% by weight) by using a known nozzle for concentric core/sheath type conjugate fiber and spun under a condition at a discharge amount of 0.71 g/min/hole and at a spinning rate of 1,250 m/min, thereby obtaining an undrawn yarn. The subject undrawn yarn was drawn in a low draw ratio of 1.0 time in warm water of 90° C. which temperature was 20° C. higher than the glass transition temperature of the resin of the core component and simultaneously subjected to a fixed-length heat treatment. Next, the filaments obtained by the fixed-length heat treatment were dipped in an aqueous solution of a lubricant made of a lauryl phosphate potassium salt and polyoxyethylene-modified silicone (weight ratio=80/20), and eleven mechanical crimps per 25 mm were imparted thereto by using a crimper with a stuffing box. Furthermore, the subject filaments were dried at 90° C. and then cut in a fiber length of 5.0 mm. As a result of the measurement in a tow state prior to cutting, the resulting polyester conjugate fiber was a polyester conjugate fiber having a single yarn fineness of 5.7 dtex, a strength of 1.0 cN/dtex, an elongation of 400%, a CN of 11.0 peaks/25 mm, a CD of 4.6%, a CD/CN ratio of 0.42, and a CE of 86%. An evaluation of an airlaid web grade as

performed by using this polyester conjugate fiber was Level 1, and a maximum throughput was 100 kg/hr.

Comparative Example 5

[0075] A conjugate fiber was manufactured under the same condition as in Example 8, except for changing the discharge amount to 1.5 g/min/hole, performing spinning under a condition at a spinning rate of 700 m/min, performing drawing in a draw ratio of 3.8 times in warm water of 70° C., and further performing drawing in a draw ratio of 1.15 times in warm water of 90° C. Then, there was obtained a polyester conjugate fiber having a single yarn fineness of 5.7 dtex, a strength of 3.3 cN/dtex, an elongation of 44%, a CN of 11.2 peaks/25 mm, a CD of 15.8%, a CD/CN ratio of 1.41, and a CE of 58%. While an evaluation of an airlaid web grade as performed by using this polyester conjugate fiber was Level 1, a maximum throughput was low as 25 kg/hr.

[0076] The invention is able to provide a polyester based fiber for airlaid nonwoven fabrics with fine fineness or long fiber length which is satisfactory in screen-passing properties, namely extremely high in productivity and which is soft in texture and bulky. Also, crimp can be stably imparted by using a crimper with a stuffing box of the related art, and therefore, it is possible to produce a nonwoven fabric which is uniform in crimp and satisfactory in texture.

What is claimed is:

1. A manufacturing method of a polyester fiber for airlaid nonwoven fabrics made of, as a fiber forming resin component, a polyester having a fineness of not more than 10.0 dtex or a fiber length of 8.0 mm or more, having a number of crimp of 8.5 peaks/25 mm or more, a percentage of crimp/number of crimp ratio of not more than 0.65 and a crimp modulus of elasticity of 70% or more and containing 80% by mole or more of an alkylene terephthalate repeating unit in the whole of repeating units, which includes drawing an undrawn yarn taken up at a spinning rate of not more than 1,500 m/min in a low draw ratio of from 0.60 to 1.20 times at a temperature of at least 10° C. higher than a glass transition temperature of the polyester and simultaneously subjecting to a fixed-length heat treatment.

2. The manufacturing method of a polyester fiber according to claim 1, wherein the polyester fiber for airlaid nonwoven fabrics is made of a single polyester component.

3. The manufacturing method of a polyester fiber according to claim 2, wherein the alkylene terephthalate is ethylene terephthalate.

4. The manufacturing method of a polyester fiber according to claim 2, wherein the dry heat shrinkage percentage at 180° C. is from -20.0 to 2.0%.

5. The manufacturing method of a polyester fiber according to claim 1, wherein the polyester fiber for airlaid nonwoven fabrics is a conjugated fiber made of a fiber forming resin component and a thermoadhesive resin component.

6. The manufacturing method of a polyester fiber according to claim 5, wherein the alkylene terephthalate constituting the fiber forming resin component is ethylene terephthalate.

7. The manufacturing method of a polyester fiber according to claim 5, wherein the thermoadhesive resin component is a polyolefin resin.

8. The manufacturing method of a polyester fiber according to claim 5, wherein the thermoadhesive resin component is a crystalline copolyester.

9. The manufacturing method of a polyester fiber according to claim 5, wherein prior to the fixed-length heat treat-

ment, the undrawn yarn is drawn at a temperature of lower than a temperature of whichever is higher between a glass transition temperature of the thermoadhesive resin component and a glass transition temperature of the fiber forming resin component and then subjected to an overfeed fixed-length heat treatment at a temperature of at least 10° C. higher

than a temperature of whichever is higher between a glass transition temperature of the thermoadhesive resin component and a glass transition temperature of the fiber forming resin component in a draw ratio of from 0.60 to 0.90 times.

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