I, John Andrew, am fluent in English and Japanese. I hereby certify under penalty of perjury that I translated into English the following document: Japanese Patent Application No. 2009068549A, published on April 2, 2009, which is attached to this Affidavit. I further certify and verify under penalty of perjury that the attached document written in English is, to the best of my knowledge, a true and accurate English translation of Japanese Patent Application No. 2009068549A, published on April 2, 2009, which is written in Japanese.

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(71) Applicant 000005278
Bridgestone Corporation
No. 10, Kyobashi 1-chome, Chuo-ku, Tokyo

(74) Agent 100079304
Patent Attorney Takashi Kojima

(74) Agent 100114513
Patent Attorney Saori Shigematsu

(74) Agent 100120721
Patent Attorney Katsunari Kobayashi

(74) Agent 100124590
Patent Attorney Takeshi Ishikawa

(72) Inventor Takanari Tamura
1 Kashio-cho, Totsuka-ku, Yokohama, Kanagawa Prefecture
Inside the Bridgestone Corporation, Yokohama Factory

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(54) [Title of the invention] Large diameter rubber hose

(57) [Abstract]
[Problem to be solved] The present invention provides a large-diameter rubber hose that is excellent in durability and dimensional stability, in which the adhesive strength between the rubber layer and the reinforcing layer is maintained even after vulcanization for a long period of time, such as 500 to 1000 minutes, the rubber layer and the reinforcing layer do not peel off during use, and the change in the hose diameter due to the pressure of the fluid during fluid transport is small.
[Means for solving the problems] A large-diameter rubber hose formed using vulcanized rubber reinforced by compounding fiber fabric and/or fiber cord, characterized in that the fiber fabric and/or fiber cord is composed of a composite fiber of aramid fiber and nylon fiber.
[Selection drawing] None

[Scope of patent claims]
[Claim 1]
A large-diameter rubber hose formed using vulcanized rubber reinforced by compounding fiber fabric and/or fiber cord, characterized in that the fiber fabric and/or fiber cord is composed of a composite fiber of aramid fiber and nylon fiber.
[Claim 2]
The large-diameter rubber hose according to claim 1, wherein the composite fiber has a total fineness of aramid fiber and nylon fiber of 2,000 to 11,000 dt.
[Claim 3]
A large-diameter rubber hose according to claim 1 or 2, wherein the ratio of the fineness of the aramid fiber to the total fineness of the aramid fiber and the nylon fiber in the composite fiber is 35 to 80%.
[Claim 4]
The large-diameter rubber hose according to any one of Claims 1 to 3, wherein the aramid fibers are Kevlar fibers.
[Claim 5]
A large-diameter rubber hose as claimed in Claim 4, wherein the aramid fibers are Kevlar fibers.
[Claim 6]
A large-diameter rubber hose according to any one of Claims 1 to 5, in which the composite fiber is made by upper twisting aramid fibers and nylon fibers, each of which is lower twisted, and the upper twist coefficient is 1440 to 2400.
[Claim 7]
The large-diameter rubber hose according to any one of Claims 1 to 6, wherein the composite fiber is made by upper twisting aramid fibers and nylon fibers, each of which is lower twisted, and the number of lower twists is 0.5 to 1 times the number of upper twists.
[Detailed description of the invention]
[Technical field]
[0001]
The present invention relates to a large-diameter rubber hose reinforced by compounding a fiber fabric and/or a fiber cord.
[Background Technology]
[0002]
Conventionally, when transporting a large amount of liquid using a hose, for example when a hose is used to directly connect a offshore moored tanker to a facility on land to perform loading and unloading operations of crude oil or the like, in order to transport the liquid efficiently, a large-diameter hose having an inner diameter of about 300 to 1000 mm depending on the scale of transportation is used. Since such large-diameter hoses are generally subjected to high pressure when transporting liquids such as crude oil, they have an inner rubber layer on the inner circumference and an outer rubber layer on the outer circumference, with a reinforcing layer made of synthetic fiber or wire laminated between the inner and outer rubber layers, and the wall thickness including the inner and outer rubber layers and the reinforcing layer is very thick at 50 to 100 mm.
[0003]
In normal production, large-diameter rubber hoses are often manufactured by forming the laminated structure consisting of unvulcanized inner and outer rubber layers and a reinforcing material layer, and then vulcanizing and bonding the inner and outer rubber layers to the reinforcing material layer. In this case, since the thickness of the hose including the rubber layer and the reinforcing material layer is as very thick as 50 to 100 mm as described above, the heat vulcanization is carried out for a long period of time, such as 500 to 1000 minutes, in order to completely vulcanize and harden the hose to the inside.
[0004]
Meanwhile, as the reinforcing material used in the reinforcing layer of a rubber hose, a fiber cord made of multiple polyethylene terephthalate (PET) fibers twisted together or a fiber fabric made of the fiber cord is often used recently because of its high strength, high elastic modulus, low elongation, and excellent dimensional stability. However, this PET fiber does not necessarily have sufficient heat resistance, and when used in the large-diameter hose, thermal degradation occurs during the long period of time of 500 to 1000 minutes during which the rubber is vulcanized and hardened, resulting in a significant decrease in adhesion between the rubber layer and the

reinforcing material layer. If the adhesion between the rubber layer and the reinforcing material layer decreases after vulcanization, the rubber layer and the reinforcing material layer may peel off due to bending movements or vibrations applied to the hose during use, which may lead to early damage to the hose. Furthermore, due to the heat resistance problem of the PET fibers mentioned above, it was difficult to increase the vulcanization temperature, shorten the vulcanization time, and improve productivity.

[0005]

Other reinforcing materials include aramid fiber, such as Kevlar fiber, and nylon fiber, which are used from the standpoint of strength and heat resistance. However, when aramid fiber is used as a reinforcing material for the large-diameter hose, the fiber has low elongation and insufficient fatigue resistance, making the hose vulnerable to buckling. When nylon fiber is used, the elongation is too great, which raises concerns that the hose diameter will change significantly when a fluid is passed through the hose.

[0006]

In response to this, the applicant proposed in Japanese Patent Application Laid-Open No. 2004-108555 A (Patent Literature 1) a rubber hose in which a composite fiber woven fabric in which PET fibers are combined with nylon fibers is used in the reinforcing layer, thereby compensating for the lack of heat resistance of the PET fibers with the nylon fibers, preventing thermal degradation due to long-term vulcanization while maintaining the reinforcing effect of the PET fibers, and significantly suppressing the decrease in adhesive strength between the reinforcing material and the rubber. However, the addition of nylon fibers reduces the overall modulus of the composite fiber, and a problem has emerged in which the hose diameter expands significantly due to the pressure exerted when fluid is passed through the hose. If the hose diameter is significantly enlarged during use, the transport pressure of the fluid may decrease, resulting in a decrease in transport efficiency.

[0007]

Therefore, there is a need to develop a large-diameter rubber hose that has excellent durability and dimensional stability, in which the adhesive strength between the rubber layer and the reinforcing layer is maintained even after long-term vulcanization, the rubber layer and the reinforcing layer do not peel off during use, and the hose diameter changes little due to fluid pressure even when transporting fluid.

[0008]

[Patent Literature 1] Japanese Patent Application Laid-Open No. 2004-108555

[Disclosure of invention]

[Problems to be solved by the invention]

[0009]

The present invention has been made in consideration of the above circumstances, and aims to provide a large-diameter rubber hose that maintains the adhesive strength between the rubber layer and the reinforcing material layer even after long-term vulcanization, does not peel off from the rubber layer during use, and exhibits little change in hose diameter due to fluid pressure even when transporting fluid, and has excellent durability and dimensional stability.

[Means for solving the problems]

[0010]

As a result of intensive research by the inventors to solve the above problems, they discovered that by combining the above aramid fibers with nylon fibers, it is possible to compensate for the fatigue durability of the aramid fibers, and by using a fiber fabric and/or a fiber cord using composite fibers containing these fibers as a reinforcing material, the reinforcing material does not undergo thermal degradation and the adhesive strength with the rubber layer does not decrease even after vulcanization for a long period of time, such as 500 to 1000 minutes, and further, because the composite fibers have low elongation and high strength, when a fluid is passed through a hose manufactured using the composite fibers as a reinforcing material, the change in the hose diameter due to the pressure of the fluid is small, thereby arriving at the present invention.

[0011]

That is, the present invention provides a large-diameter rubber hose formed using vulcanized rubber reinforced by compounding fiber fabric and/or fiber cord, characterized in that the fiber fabric and/or fiber cord is composed of a composite fiber of aramid fiber and nylon fiber.

[Effects of the Present Invention]

[0012]

The large-diameter rubber hose of the present invention maintains sufficient adhesive strength between the rubber layer and the reinforcing material layer even after a long period of vulcanization and hardening, effectively preventing the rubber layer and the reinforcing material layer from peeling off during use, and furthermore, when a fluid is passed through the hose, the change in the hose diameter due to the pressure of the fluid is small, making it possible to suppress the drop and fluctuation in transport pressure that accompanies an increase in diameter.

In addition, since the composite fiber used in the present invention has high heat resistance, it is possible to shorten the vulcanization time by setting the vulcanization temperature high, thereby improving production efficiency.

[Detailed Description of the Preferred Embodiments]

[0013]

The large diameter rubber hose of the present invention will now be described in detail.

The large-diameter rubber hose of the present invention has an inner rubber layer on the inner circumference of the hose and an outer rubber layer on the outer circumference, and has a laminated structure in which a reinforcing layer made of fiber fabric and/or fiber cord is interposed between the inner rubber layer and the outer rubber layer.

[0014]

The reinforcing material layer is made of a composite fiber cord made of aramid fiber and nylon fiber (hereinafter, sometimes referred to as aramid/nylon composite fiber cord) and/or a composite fiber fabric obtained by weaving the composite fiber cord.

[0015]

The aramid fiber is a type of polyamide fiber similar to the nylon fiber, and is a polyamide fiber in which the entire molecular structure is aromatic. Aramid fibers are broadly divided into two types: para-aramid fibers, in which the benzene nuclei that make up the fiber skeleton are arranged in a straight line, and meta-aramid fibers, in which the benzene nuclei are arranged in a zigzag pattern. Para-aramid fibers have a rigid molecular structure and therefore exhibit excellent mechanical properties such as high strength, high elasticity and low stretch, while meta-aramid fibers are characterized by excellent heat resistance and flame retardancy. In the present invention, the aramid fiber may be any known fiber, and is not particularly limited, but it is preferable to use para-aramid fibers, which are superior in mechanical properties such as strength and elastic modulus.

[0016]

Examples of the para-aramid fiber include those obtained by forming polyparaphenylene terephthalamide (PPTA), which is a polycondensate of terephthalic acid dichloride and paraphenylenediamine, into fiber by a dry spinning method, and those obtained by copolymerizing the above-mentioned terephthalic acid dichloride and paraphenylenediamine with 3,4-diaminodiphenyl ether (3,4-DDA) as a third component and forming the fiber by a wet spinning method. One type may be used alone or two or more types may be appropriately selected and used. Commercially available products can be used, such as “Kevlar” manufactured by DuPont, “Technora” manufactured by Teijin Limited, and “Twaron” manufactured by Akzo. In the present invention, Kevlar fiber can be preferably used.

[0017]

The nylon fibers may be any of those known in the art and are not particularly limited. Specific examples include 6,6-nylon, 6-nylon, 4,6-nylon, and MXD6 nylon. One type may be used alone, or two or more types may be used in combination. In the present invention, 6,6-nylon can be preferably used.

[0018]

In the present invention, the above-mentioned aramid fibers and nylon fibers are composited to form aramid/nylon composite fiber cords and composite fiber fabrics. The above-mentioned composite fiber cord is obtained by lower twisting a predetermined number of aramid fibers and nylon fibers, each of which is individually twisted, and then upper twisting the resulting fibers together. The above-mentioned composite fiber woven fabric is obtained by weaving the above-mentioned composite fiber cord in a conventional manner.

[0019]

The total fineness D (decitex: dtex) of the aramid fibers and nylon fibers constituting the aramid/nylon composite fiber cord is determined by the required force of the composite fiber cord, but is usually 2,000 to 11,000 dt, and preferably 3,000 to 5,500 dt. If it is less than 2000 dt, the force of the composite fiber cord will be small and there is a risk that sufficient pressure resistance will not be obtained, and if it exceeds 11000 dt, the collecting effect will decrease and it will be difficult to obtain sufficient cord force for the thickness, which is economically undesirable. Furthermore, the fabric may become too thick, which may reduce the workability of laminating the reinforcing layer.

[0020]

Furthermore, the ratio of the fineness of the aramid fiber to the fineness of the entire aramid/nylon composite fiber cord (fineness of the aramid fiber/total fineness of the entire composite fiber × 100 (%)) is usually 35 to 80%, and particularly preferably 44 to 71%. If the above-mentioned fineness ratio is less than 35%, it may result in a decrease in strength and an increase in creep, and if it exceeds 80%, it may result in a decrease in the flex fatigue resistance of the hose.

[0021]

The above-mentioned final twist factor of the aramid/nylon composite fiber cord is usually 1,440 to 2,400, and preferably 1,600 to 1,950. If the twist factor is less than 1440, the bending fatigue resistance may decrease, and if it exceeds 2400, sufficient strength may not be obtained, and elongation and creep may increase.

[0022]

The above-mentioned final twist coefficient is a value calculated from the total fineness D (dt) of the fibers constituting the fiber cord and the final twist number G (turns/10 cm) by the following formula. The larger this value is, the more the fiber cord as a whole tends to elongate.

[Formula 1]

$$\text{Upper twist factor} = G \times \sqrt{D \times 0.9}$$

[0023]

Furthermore, the number of lower twists is usually set to be the same as the number of upper twists, but this is not necessarily required and can be determined appropriately depending on the required properties of the composite fiber. For example, by reducing the number of lower twists in the nylon fiber relative to the number of upper twists, the elongation of the entire composite fiber can be increased. In the present invention, the number of lower twists is 0.5 times the number of upper twists. It is preferable to set it in the range of 5 to 1 times.

[0024]

Aramid/nylon composite fiber woven fabrics can be produced by weaving the above-mentioned aramid/nylon composite fiber cords in a conventional manner. In this case, the composite fiber fabric may be composed only of the above-mentioned aramid/nylon composite fiber cord, or may be composed mainly of the above-mentioned composite fiber cord and may include aramid fiber cord and/or nylon fiber cord.

[0025]

There are no particular limitations on the weaving method of this composite fiber fabric, and any known weaving method such as plain weave, straight warp weave, twill weave, or cord weave may be used. There are also no particular restrictions on the number of cords that make up the composite fiber fabric, and this is determined appropriately depending on the required characteristics of the resulting large-diameter rubber hose.

[0026]

Typically, this composite fiber fabric is woven in a twill pattern with aramid/nylon composite fiber cords as warp threads arranged in parallel at a specified angle to the longitudinal direction of the large-diameter rubber hose and bound together with weft threads. In this case, cotton yarn, rayon, PET, PET/cotton blend yarn, etc. are generally used as the weft thread. The number of aramid/nylon composite fiber cords used as warp threads is determined appropriately according to their fineness and the required properties of the resulting large-diameter rubber hose, but is usually 30 to 70 cords per 5 cm.

[0027]

The aramid/nylon composite fiber cord may be an aramid/nylon core-sheath fiber cord in which a nylon covering layer is formed on the outer circumference of the aramid fiber in a conventional manner, and can be appropriately selected depending on the required characteristics of the large-diameter rubber hose.

[0028]
On the other hand, the rubber composition constituting the rubber body of the large diameter rubber hose of the present invention is not particularly limited as long as it is one that is commonly used in this field, but specifically, natural rubber (NR), styrene butadiene rubber (SBR), nitrile rubber (NBR), chloroprene rubber (CR), chlorosulfonated polyethylene (CSM), urethane rubber (U), acrylic rubber (ACN, ANM), ethylene propylene rubber (EPM, EPDM), ethylene acrylic rubber (AEM), butyl rubber (IIR), butadiene rubber (BR), etc. can be used alone or in combination of two or more. In the present invention, NR, SBR, BR, etc. can be suitably used. The rubber compositions used in the inner and outer rubber layers can be selected appropriately depending on the type and temperature of the fluid being transported, the environment in which the hose is used, the required characteristics, etc.
[0029]
In addition, additives commonly used in the rubber industry, such as vulcanizing agents, vulcanization accelerators, antioxidants, carbon, zinc oxide (ZnO), waxes, antioxidants, fillers, foaming agents, plasticizers, lubricants, tackifiers, petroleum-based resins, ultraviolet absorbers, and dispersants, can be appropriately blended with the rubber component as long as they do not impair the object of the present invention.
[0030]
The large diameter rubber hose of the present invention can be manufactured by applying a normal manufacturing method for this type of rubber hose. For example, the hose can be easily manufactured by layering a required number of reinforcing layers, each of which is made of fiber fabric and/or fiber cord composed of aramid fibers and nylon fibers and coated on both sides with adhesive rubber, between an inner rubber layer and an outer rubber layer made of an unvulcanized rubber composition containing an appropriate blend of the above-mentioned rubber components and additives, and then vulcanizing the hose in accordance with a normal method. In this case, NR, SBR, BR, etc. can be suitably used as the adhesive rubber that covers both sides of the reinforcing material. In addition, vulcanization conditions are not particularly limited, and can be selected from a wide range of conditions, such as 120 to 160°C and 300 to 1000 minutes, since there is virtually no thermal degradation of the reinforcing material. In particular, even with long vulcanization times of 500 to 1000 minutes, there is no problem with thermal degradation of the reinforcing fibers or the associated loss of adhesion, and large-diameter rubber hoses with good flex fatigue resistance and excellent dimensional stability can be easily and reliably manufactured.
[0031]
Before coating both sides of the composite fiber fabric and/or the composite fiber cord with adhesive rubber as described above, the method is not particularly limited, but in the present invention, a method can be adopted in which the composite fiber fabric and/or the composite fiber cord are immersed in adhesive, dried, and heat-treated. For example, a suitable method for adhesion and heat treatment is to immerse, dry, and heat-treat in an aqueous solution of an epoxy compound (Denacol EX313, EX314, EX421, etc., manufactured by Nagase & Co., Ltd.) in the first bath according to the usual method, then immerse, dry, and heat-treat in an RFL liquid (resorcinol-formalin-latex liquid) in the second bath in the same manner to attach the adhesive. This makes it possible to improve the adhesive strength between the composite fiber fabric (cord) and the adhesive rubber layer when the composite fiber fabric and/or composite fiber cord is placed between unvulcanized rubber layers and vulcanization molding is performed.
The amount of solid matter attached at this time is usually 5 to 12% by mass based on the composite fiber fabric and/or the composite fiber cord.
[Embodiment]
[0032]
The present invention will be described in detail below with reference to examples and comparative examples, but the present invention is not limited to the following examples.
[0033]
[Embodiments 1 to 9, Comparative Examples 1 to 6]
Using the fiber cords shown in Table 1 as warp threads and a reinforcing fiber fabric with a thread count shown in Table 1 (Polynosic 300 dt/1 (single twist, 300 dt) was used as the weft thread, with a thread count of 4 threads/5 cm), an evaluation specimen was produced in the following manner, and its characteristics were evaluated. The evaluation results are shown in Table 2.

[0034]

・ Properties of heat-treated adhesive

A reinforcing fiber fabric was immersed in an adhesive liquid (an aqueous solution of an epoxy compound and an RFL liquid), dried, and then heat-treated to prepare an adhesive heat-treated piece having 8% by mass of the adhesive liquid attached thereto. The adhesive heat-treated piece was evaluated by the following methods (1) to (4).

(1) Tensile force (N/piece) and elongation (%)

In accordance with JIS L1017, tests were carried out on one fiber cord at a gripping distance of 25 cm and a pulling speed of 30 cm/min, and the force and elongation at break were measured.

(2) Dry heat shrinkage rate (%)

According to JIS L1017 (Method B), the fiber cord with the yarn length accurately measured was left in a dryer set at 180°C for 30 minutes, then removed from the dryer and left for 30 minutes, after which the yarn length was measured and the dry heat shrinkage was calculated.

(3) Strength (g/d)

The force value measured in section (1) was converted from N units to g units, and was calculated by dividing by the total denier number of the fiber cord (0.9 d (denier) = 1.0 dt (decitex)).

(4) Creep (%)

In accordance with JIS L1017, the length of the fiber cord was accurately measured, and then a load of 0.88 cN/dt (for example, in the case of a structure in which two 1670 dt yarns are twisted together, 1670 x 2 x 0.88/100 = 29.4 N) was applied, and the yarn length was measured after leaving it at room temperature for 30 minutes, and the creep rate was calculated.

[0035]

・Properties after vulcanization

As the properties of the present invention after vulcanization, strength retention after bending, force retention, and adhesion were evaluated using methods (1) to (3) below.

(1) Strength retention rate after buckling (%)

Three sheets of the above heat-treated adhesive strip, coated on both sides with 0.6 mm thick NR/SBR unvulcanized rubber, were laminated between two NR/SBR unvulcanized rubber sheets (4.5 mm thick), and the laminate was heated and pressurized for 30 minutes at 1.5 MPa and 145°C to vulcanize and bond the two together, forming the specimen to be evaluated.

The above evaluation specimen was placed on a pulley and subjected to a bending test under the following conditions, after which the innermost layer of reinforcing fiber fabric was removed when bent, and its force was measured in the same manner as the force measurement method for the heat-treated adhesive fabric described above, and its retention rate (strength after bending ÷ strength before bending × 100) was calculated.

Pulley diameter: 100mm

Load : 5% of breaking force

Number of bends : 200,000 times

(2) Force retention rate (%)

Three sheets of the above heat-treated adhesive strip, coated on both sides with 0.6 mm thick NR/SBR unvulcanized rubber, were laminated between two NR/SBR unvulcanized rubber sheets (4.5 mm thick), and the laminate was heated and pressurized for 1,440 minutes at 1.5 MPa and 145°C to vulcanize and bond the two together, forming the specimen to be evaluated.

The reinforcing fiber fabric was removed from the evaluation specimen, and its force was measured in the same manner as the force measurement method for the heat-treated adhesive fabric described above, and calculated as the ratio of the force after vulcanization to the force of the heat-treated adhesive fabric before vulcanization.

(3) Adhesion (peel test)

Two sheets of the above heat-treated adhesive rolls, coated on both sides with 0.6 mm thick NR/SBR unvulcanized rubber, were laminated between two rectangular sheets (thickness 2 mm, width 25 mm±0.5 mm, length 100 mm) of NR/SBR unvulcanized rubber, and the sheets were heated and pressurized at 145°C for 30 minutes or 1,440 minutes to vulcanize and bond them together, forming the specimen to be evaluated. A peel test between the two reinforcing fiber fabrics was carried out at a speed of 50 mm/min in accordance with JIS K6256-1999. At this time, the adhesive strength (N/25 mm width) was calculated from the force required for peeling, and the ratio of the adhesive strength of the evaluation specimen with a vulcanization time of 1,440 minutes to the adhesive strength of the evaluation specimen with a vulcanization time of 30 minutes was calculated as the adhesive strength retention rate (%).

[0036]

[Table 1]

		Fiber material						Aramid fiber fineness ratio (%)	Total fineness (dt)	Number of twists (twists/10 cm)				Upper twist factor	Number of warp threads (strands/5cm)
		Aramid fiber		N66		PET				Upper twist (S)	Lower twist (Z)				
		(dt)	(piece)	(dt)	(piece)	(dt)	(piece)				Aramid fiber	N66	PET		
Comparative Example	1			1400	2			0	2800	39		39		1958	50
	2					1670	2	0	3340	39			39	2138	50
Embodiment	1	1670	1	1400	1			54.4	3070	36	36	36		1892	50
	2	1670	1	1400	1			54.4	3070	31	31	31		1629	50
	3	1670	1	1400	1			54.4	3070	31	31	23		1629	50
	4	1670	1	2100	1			44.3	3770	32	32	32		1864	50
	5	1670	1	1400	2			37.4	4470	30	30	30		1903	50
	6	1670	2	940	1			78.0	4280	30	30	30		1862	40
	7	1670	2	1400	1			70.5	4740	29	29	29		1894	40
	8	1670	2	1400	1			70.5	4740	36	36	36		2351	40
	9	1670	2	2100	1			61.4	5440	27	27	27		1889	40
Comparative Example	3	1670	2					100.0	3340	26	26			1426	50
	4	1670	1	2100	2			28.4	5870	26	26	26		1890	40
	5	1670	1			1670	1	50.0	3340	39	39		30	2138	50
	6			1400	1	1670	1	0	3070	36		36	36	1892	50

Aramid fiber: DuPont Kevlar fiber

N66: 6,6-nylon fiber
PET: Polyethylene terephthalate fiber
[0037]
[Table 2]

		Properties of heat-treated adhesive					Properties after vulcanization				
								Adhesion (peel test)			
								Adhesion force (N/25mm)			
		Force (N/piece)	Elongation at breakage (%)	Dry heat shrinkage rate (%)	Strength (g/d)	Creep (%)	Strength retention rate after buckling (%)	30 minutes	1440 minutes	Adhesion retention rate (%)	Force retention rate (%)
Comparative Example	1	216	21.0	5.8	8.7	4.8	96	295	300	102	98
	2	216	17.7	6.1	7.3	1.9	87	275	100	36	49
Embodiment	1	325	10.5	2.5	12.0	0.5	90	320	310	97	90
	2	326	8.5	2.4	12.0	0.5	88	310	310	100	89
	3	328	10.0	2.6	12.1	0.6	91	310	300	97	87
	4	364	10.7	3.0	10.9	0.6	91	330	330	100	90
	5	390	11.5	3.2	9.9	1.0	90	320	300	94	93
	6	556	7.0	2.0	14.7	0.5	90	350	330	94	87
	7	581	8.6	2.1	13.9	0.4	90	340	340	100	87
	8	539	8.6	2.1	12.9	0.5	94	330	340	103	89
	9	615	8.8	2.0	12.8	0.5	92	360	350	97	88
Comparative Example	3	523	5.2	0.0	17.7	0.2	39	320	300	94	85
	4	462	12.0	4.0	8.9	1.6	89	340	320	94	92
	5	319	9.5	3.1	10.8	0.5	82	310	210	68	71
	6	206	17.5	6.0	7.6	3.1	90	320	220	69	63

[0038]

From the results in Tables 1 and 2, it was confirmed that in a large-diameter hose using the aramid/nylon composite fiber of the present invention as a reinforcing material, the composite fiber did not undergo thermal degradation even after a long vulcanization period of 1,440 minutes, preventing a decrease in adhesive strength due to this thermal degradation, and that the elongation of the adhesive heat-treated portion was low, making it possible to suppress an increase in the hose diameter. Therefore, even when vulcanization is performed for a long time, the adhesive strength between the rubber layer and the reinforcing material layer is sufficiently secured, and the dimensional stability is excellent, so that it is understood that the reinforcing effect and durability are excellent.

[0039]

Next, the elongation (intermediate elongation) of the composite fiber fabrics shown in Table 1 at a specified load was measured using the above method, and the results are shown in Table 3. In addition, the results of strength and elongation at break are also shown.

[Table 3]

	Composite fiber cord	Force (N/piece)	Elongation (%)			
			Intermediate elongation			Upon breakage
			44N	55N	66N	
Comparative Example 2	PET	216	2.9	4.0	4.9	17.7
Comparative Example 6	PET/N66	206	4.5	5.4	6.2	17.5
Embodiment 1	Aramid fiber/N66	325	3.0	4.0	4.5	10.5

From the results in Table 3 above, it is apparent that the PET fiber cord of Comparative Example 2 has an intermediate elongation equivalent to that of the conjugate fiber of the present invention, but the conjugate fiber cord of the present invention is superior in terms of strength at breakage and elongation. Furthermore, the nylon/PET composite fiber cord of Comparative Example 6 has improved heat resistance compared to Comparative Example 2, which uses a fiber cord made only of PET fibers (see Tables 1 and 2). However, the intermediate elongation is high, and the modulus of the composite fiber as a whole is reduced. Therefore, although the heat resistance has been improved, it is understood that the hose diameter increases significantly during fluid transport, which may result in a decrease in transport pressure.

From the above, it has been confirmed that the reinforcing material using the aramid/nylon composite fiber of the present invention has excellent reinforcing effect and dimensional stability.

[0041]

The composite fiber fabrics shown in Table 1 were used, and the vulcanization temperature was changed to 155°C. The results of the evaluation of the adhesive strength of the evaluation specimens are shown in Table 4.

[Table 4]

	Composite fiber cord	Force (N/piece)	Adhesion force (N/25 mm)		Adhesion retention rate (%)
			30 minutes	1440 minutes	
Comparative Example 2	PET	216	280	75	27
Comparative Example 6	PET/N66	206	320	140	44
Embodiment 1	Aramid fiber/N66	325	330	310	94

From the results in Table 4 above, it was confirmed that when the aramid/nylon composite fiber of the present invention was used, even if the vulcanization temperature was increased to 155° C., the adhesive strength after long-term vulcanization did not decrease and was maintained at a high level. Therefore, it was confirmed that by increasing the vulcanization temperature, it is possible to shorten the vulcanization time and improve the productivity of large-diameter hoses.

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