ECO-FRIENDLY SHIELD TAIL SEALING GREASE, AND PREPARATION METHOD AND APPLICATION THEREOF

TECHNICAL FIELD

[0001] The present disclosure relates to the technical field of tunnel and underground engineering construction materials, in particular to an eco-friendly shield tail sealing grease, and a preparation method and application thereof.

BACKGROUND

[0002] A shield tunneling machine is the most commonly used device for shield construction in urban rail transit. As the most important part of a tail system of the shield tunneling machine, the water-proof sealing property ability of shield tail sealing grease determines the upper limit of shield tail sealing. Especially when the shield tunneling machine encounters the working conditions of high water pressure, high formation permeability coefficient and extremely complicated geological conditions, it is easy to cause the shield tail sealing of the shield tunneling machine to fail. Once the shield tail sealing fails, the foundation will sink, and the structures on the ground may possibly collapse, resulting in great construction risks. Therefore, construction organizations have high requirements on the comprehensive performances of the shield tail sealing grease, requiring the shield tail sealing grease to have excellent water-proof sealing property, as well as excellent pumpability and adhesion.

[0003] As a base oil, tackifier, a lubricant and other components commonly used in the market at present are mostly from chemical raw materials, which are not friendly to the environment, with the improvement of environmental protection requirements, certain requirements are put forward for the environmental protection performance of the sealing grease.

[0004] CN112159698A discloses an environmental-friendly shield tail sealing grease, the formula components of which comprise a base oil, a filler, a lubricant, a tackifier, an adhesion promoter, a reinforcer, and a microcapsule. The sealing grease in this patent application has good interaction with surfaces of the base materials, but has poor biodegradability and is not friendly to the environment as the base oil, the lubricant and the tackifier are all from fossil raw materials. CN112500908A discloses an environmental-friendly shield tail sealing grease, and a preparation method and application

thereof, wherein the formula components of the shield tail sealing grease comprise a base oil, a tackifier, an additive, a fiber and a solid powder. The base oil in this patent application is biodegradable by using one or more of tallow oil, soybean oil and rapeseed oil, but the tackifier thereof is still a derivative of fossil raw materials, and some fibers also use polypropylene fibers, so the biodegradability of the whole formula system needs to be further improved, and the patent application still cannot meet the requirements of environmental protection.

[0005] Therefore, it is necessary to develop a sealing grease with water-proof sealing property, which can meet the requirements of shield tail sealing, is green and environmentally friendly, and can be avoided from polluting avoid groundwater, environment and structures.

SUMMARY

[0006] In order to solve the above technical problems or at least partially solve the above technical problems, the present disclosure provides an eco-friendly shield tail sealing grease, and a preparation method and application thereof.

[0007] According to a first aspect, the present disclosure provides an eco-friendly shield tail sealing grease, wherein the sealing grease comprises the following components in parts by weight: 15 parts to 40 parts of base oil, 5 parts to 20 parts of tackifier, 1 part to 5 parts of thickening rheological agent, 1 part to 5 parts of adhesion promoter, 3 parts to 8 parts of reinforcer and 30 parts to 50 parts of filler.

[0008] According to the present disclosure, through the cooperation of the above components, the addition of the tackifier and the thickening rheological agent can achieve a better thickening effect, and meanwhile, the thickening and fluidity are balanced, while the adhesion promoter can improve the adhesion of the sealing grease to metals, concrete and the like, and the reinforcer can play a role of reinforcing. In the present disclosure, the components cooperate with each other, so that the obtained sealing grease has better water-proof sealing property and sealing performances, and meanwhile, consistency and pumpability are balanced, so that the sealing grease has better application effects.

[0009] The 15 parts to 40 parts of base oil may be 18 parts, 20 parts, 22 parts, 25 parts, 28 parts, 30 parts, 32 parts, 35 parts, 38 parts, and the like; the 5 parts to 20 parts of tackifier may be 8 parts, 10 parts, 12 parts, 15 parts, 18 parts, and the like; the 1 part to 5 parts of thickening rheological agent may be 2 parts, 3 parts, 4 parts, and the like; the 1

part to 5 parts of adhesion promoter may be 2 parts, 3 parts, 4 parts, and the like; the 3 parts to 8 parts of reinforcer may be 4 parts, 5 parts, 6 parts, 7 parts and the like; and the 30 parts to 50 parts of filler may be 32 parts, 35 parts, 38 parts, 40 parts, 42 parts, 45 parts, 48 parts, and the like.

[0010] As a preferred technical solution of the present disclosure, the sealing grease is 100 parts by weight.

[0011] In order to obtain an eco-friendly and environmental-friendly sealing grease, as a preferred technical solution of the present disclosure, the base oil is selected from any one or a combination of at least two of palm oil, castor oil, rapeseed oil, epoxidized soybean oil, camellia oil, maize oil, peanut oil, industrial soybean oil, sesame oil, cotton seed oil, peony seed oil, coconut oil, walnut oil, olive oil or animal fat, and preferably any one or a combination of at least two of epoxidized soybean oil, coconut oil, industrial soybean oil, lard or chicken oil.

[0012] The preferred base oil disclosed of the present disclosure has excellent thermal stability and photostability, excellent weather resistance, and good fluidity and lubricity, and can meet the requirements on the pumping performances of the shield tail sealing grease. Meanwhile, the base oils defined in the present disclosure are all natural, non-toxic and biodegradable materials, which are eco-friendly, safe and environment-friendly.

[0013] In order to mutually cooperate with the base oil, as a preferred technical solution of the present disclosure, the thickening rheological agent is selected from any one or a combination of at least two of nano-scale and/or micron-scale fumed silica, hydrogenated castor oil, dehydrated castor oil, organic montmorillonite or attapulgite, and preferably organic montmorillonite.

[0014] The preferred organic montmorillonite of the present disclosure has a laminated structure, and an interlamellar spacing about 5 nm to 10 nm, which can provide space for the base oil and the tackifier to enter between the lamellae, thus realizing the thickening and dispersion of the organic montmorillonite. Meanwhile, the organic montmorillonite can also make the lamellae slip under a shearing action, that is, the addition of the organic montmorillonite can also endow the sealing grease with stronger fluidity. Therefore, the organic montmorillonite preferred in the present disclosure can achieve the balance of "consistency and pumpability" of the sealing grease.

[0015] The preferred base oil of the present disclosure is any one or a combination of at least two of epoxidized soybean oil, coconut oil, industrial soybean oil, lard or chicken oil,

which has a good synergistic effect with the organic montmorillonite, and the specific base oil and the organic montmorillonite can cooperate with each other to make the organic montmorillonite exert excellent thickening rheological effect.

[0016] As a preferred technical solution of the present disclosure, the tackifier is selected from any one or a combination of at least two of agar, gum Arabic, alginic acid, carrageenan, gelatin, guar gum, linseed gum, xanthan gum, carboxymethyl cellulose, methyl cellulose, starch gum, dextrin gum, bean gum, lignin gum, tannin gum, albumin glue, natural resin glue, natural rubber pulp and polyisobutylene, and preferably polyisobutylene and/or guar gum.

[0017] The preferred guar gum in the present disclosure is a renewable resource which is natural, non-toxic and biodegradable. The polyisobutylene is colorless, odorless and transparent, and has good tackifying effect. Meanwhile, although the polyisobutylene is a derivative of chemical raw materials, the polyisobutylene is non-toxic and free of heavy metals, and is environmental-friendly.

[0018] In order to achieve better thickening effect and realize ecological friendliness, as a preferred technical solution of the present disclosure, the tackifier is polyisobutylene and guar gum, an addition amount of the polyisobutylene is 5 parts, and the parts by weight of the guar gum ranges from 0 part to 15 parts, for example, 2 parts, 5 parts, 8 parts, 10 parts, 12 parts, and the like. According to the present disclosure, the polyisobutylene and the guar gum are added at the same time, so that the polyisobutylene and the guar gum can cooperate with each other under the condition of minor addition amounts, thereby achieving excellent thickening effect; and in this way, the content of the polyisobutylene can be reduced, so that the sealing grease of the present disclosure is truly safe, environment-friendly and eco-friendly.

[0019] As a preferred technical solution of the present disclosure, the adhesion promoter is selected from any one or a combination of at least two of γ-aminopropyl triethoxysilane, γ-(2,3-epoxypropoxy)propytrimethoxysilane, γ-methacryloxypropyltrimethoxysilane, *N*-[3-(trimethoxysilyl)propyl]ethylenediamine, 3-mercaptopropyltriethoxysilane, hexadecyltrimethoxysilane, dodecyltrimethoxysilane, vinyltriethoxysilane, vinyltriethoxysilane, ~~rinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane, trichlorovinylsilane, aminopropyltrimethoxysilane, 3-isocyanatopropyltriethoxysilane, 3-(acryloxy)propyltrimethoxysilane, (3-glycidoxypropyl)methyldiethoxysilane, 3-(chloropropyl)triethoxysilane or triethoxymethylsilane, and preferably

~~vinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane, and preferably ~~vinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane.

[0020] According to the present disclosure, the adhesion promoter is added into the sealing grease, which can effectively improve the adhesion between the sealing grease and surfaces of metals and concrete, can greatly improve the adhesion between the sealing grease and wet surfaces of metals and concrete especially, and may be used to solve the problem of blocking water leakage and slurry leakage channels in the shield tail of shield construction.

[0021] As a preferred technical solution of the present disclosure, the reinforcer is selected from any one or a combination of at least two of cellulose fiber, cotton fiber, bamboo fiber, fibrilia or basalt fiber, and preferably a combination of any one or at least two of cellulose fiber, bamboo fiber, fibrilia or basalt fiber, and cotton fiber.

[0022] As a preferred technical solution of the present disclosure, a length of the bamboo fiber, fibrilia or basalt fiber is different from that of the cotton fiber.

[0023] According to the present disclosure, composite fibers formed by natural degradable cellulose fibers and cotton fibers of different sizes are preferred as reinforcing components to construct a spatial network skeleton formula system, wherein cotton fibers with a size of 2 nm to 5 mm are used as core components for improving the consistency of the shield tail sealing grease, and cellulose fibers (wood fibers) with a size of 0.5 mm to 1 mm are used as core components for improving the fluidity of the shield tail sealing grease, forming a composite fiber reinforced water-blocking structure with other components in the formula, and greatly improving the water-proof sealing property of the shield tail sealing grease while realizing the balance between the consistency and the pumpability of the shield tail sealing grease.

[0024] As a preferred technical solution of the present disclosure, the filler is selected from any one or a combination of at least two of barium sulfate, calcium carbonate, talc, wood chips or straw powder, and preferably calcium carbonate and/or straw powder. As a preferred technical solution of the present disclosure, the filler has a particle size of 1,200 meshes to 5,000 meshes. The preferred calcium carbonate of the present disclosure may be used as an inorganic mineral filler, which is natural and non-toxic. The preferred straw powder may be used as an organic plant filler, which is also natural and non-toxic, renewable and biodegradable.

[0025] As a preferred technical solution of the present disclosure, the sealing grease further comprises 0.01 part to 0.5 part of mildew-proof agent, for example, 0.05 part, 0.1 part, 0.2 part, 0.3 part, 0.4 part, and the like.

[0026] As a preferred technical solution of the present disclosure, the mildew inhibitor is any one or a combination of at least two of phenol, pentachlorophenol, copper 8-hydroxyquinoline, triethyltin chloride, tributyltin chloride, copper sulfate or OBPA mildew-proof agent, and further preferably OBPA mildew-proof agent.

[0027] The preferred mildew-proof agent of the present disclosure can prevent mildew and bacteria at the same time, and ensure that the sealing grease does not deteriorate or rot within a warranty period.

[0028] The sealing grease provided by the present disclosure realizes that most components are not fossil energy derivatives, and truly realizes that more than 90 wt% or even more than 95 wt% of substances are natural, non-toxic, safe and environment-friendly. That is to say, the sealing grease provided by the present disclosure truly realizes no industrial wastes, is environment-friendly, and avoids the pollution to groundwater, underground environment and structures when the sealing grease is deeply buried in a stratum.

[0029] According to a second aspect, the present disclosure provides a preparation method of the sealing grease according to the first aspect. The preparation method comprises the following steps of:

[0030] (1) mixing a formula ratio of base oil with a formula ratio of tackifier;

[0031] (2) in a kneader, kneading the mixture obtained in step (1) with a formula ratio of thickening rheological agent, and then adding a formula ratio of adhesion promoter, a formula ratio of filler and a formula ratio of optional mildew-proof agent for mixing;

[0032] (3) finally, adding a reinforcer into the mixture in step (2) to continue mixing; and

[0033] (4) filtering the mixture obtained in step (3) to obtain the sealing grease.

[0034] As a preferred technical solution of the present disclosure, the preparation method comprises the following steps of:

[0035] (1) mixing the formula ratio of base oil and the formula ratio of tackifier at 70℃ to 90℃ for 20 minutes to 40 minutes, and preferably mixing the two for 30 minutes;

[0036] (2) in the kneader of 50℃ to 90℃, kneading the mixture obtained in step (1) with the formula ratio of thickening rheological agent for 4 minutes to 6 minutes, then

adding the formula ratio of adhesion promoter, the formula ratio of filler and the formula ratio of optional mildew-proof agent to mix for 3 minutes to 5 minutes, and finally adding the reinforcer to continue mixing for 60 minutes to 90 minutes; and

[0037] (3) filtering the mixture obtained in step (2) with a double-aperture filter to obtain the sealing grease;

[0038] preferably, an aperture of a first filter hole of the double-aperture filter ranging from 12 mm to 18 mm, and an aperture of a second filter hole of double-aperture filter from 8 mm to 12 mm.

[0039] The preparation method provided by the present disclosure is simple, does not produce any chemical reaction or industrial waste; and meanwhile, the heating temperature is below 100℃, so the preparation method has low energy consumption, is safe, and has no danger.

[0040] According to a third aspect, the present disclosure provides an application of the sealing grease according to the first aspect in shield tail sealing of a shield tunneling machine.

[0041] Compared with the prior art, the technical solutions provided by the embodiments of the present disclosure have the following advantages.

[0042] (1) The sealing grease provided by the present disclosure has good water-proof sealing property, excellent consistency and pumpability, and also excellent adhesion.

[0043] (2) Most of the composition components of the sealing grease provided by the present disclosure are natural, non-toxic, renewable and biodegradable, which can avoid the pollution of the shield tail sealing grease to groundwater, environment and structures and promote the continuous improvement of ecotope.

[0044] (3) The preparation method of the sealing grease provided by the present disclosure is simple in process, does not produce any chemical reaction or industrial waste; and meanwhile, the heating temperature is below 100℃, so the preparation method has low energy consumption, is safe, and has no danger.

DETAILED DESCRIPTION

[0045] In order to better understand the above objects, features and advantages of the present disclosure, the solutions of the present disclosure will be further described below. It should be noted that, in case of no conflict, the embodiments in the present disclosure and the features in the embodiments may be mutually combined with each other.

[0046] In the following description, many specific details are set forth in order to fully understand the present disclosure, but the present disclosure may be implemented in other ways different from those described herein. Obviously, the embodiments described in the specification are merely a part of, rather than all of, the embodiments of the present disclosure.

[0047] Embodiment 1

[0048] This embodiment provided an eco-friendly shield tail sealing grease and a preparation method thereof.

[0049] The sealing grease consisted of 32 kg of epoxidized soybean oil, 5 kg of polyisobutylene, 5 kg of guar gum, 3 kg of organic montmorillonite, 2 kg of ~~vinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane, 3.5 kg of cellulose fiber, 3.4 kg of cotton fiber, 10 kg of straw powder, 36 kg of calcium carbonate and 0.1 kg of OBPA mildew-proof agent.

[0050] The preparation method was as follows:

[0051] (1) mixing epoxidized soybean oil, polyisobutylene and guar gum at 80℃ for 30 minutes;

[0052] (2) at 70℃, mixing the mixed solution obtained in step (1) with organic montmorillonite in a kneader and stirring for 5 minutes, then adding ~~vinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane, straw powder, calcium carbonate and OBPA mildew-proof agent to continue stirring for 5 minutes, and finally adding cellulose fiber and cotton fiber to continue stirring for 75 minutes; and

[0053] (3) filtering the mixture obtained in step (2) with a double-aperture filter (an aperture of a first filter hole being 16 mm, and an aperture of a second filter hole being 12 mm) to obtain the eco-friendly shield tail sealing grease.

[0054] Embodiments 2 to 5

[0055] These embodiments provided an eco-friendly shield tail sealing grease and a preparation method thereof.

[0056] The only differences from Embodiment 1 were that in these embodiments, the addition amount of the organic montmorillonite was 2.5 kg (Embodiment 2), 2 kg (Embodiment 3), 1 kg (Embodiment 4) and 5 kg (Embodiment 5).

[0057] Embodiments 6 to 9

[0058] These embodiments provided an eco-friendly shield tail sealing grease and a preparation method thereof.

[0059] The only differences from Embodiment 1 were that in these embodiments, the epoxidized soybean oil was replaced by rape seed oil (Embodiment 6), palm oil (Embodiment 7), industrial soybean oil (Embodiment 8) and chicken oil (Embodiment 9).

[0060] Embodiment 10

[0061] This embodiment provided an eco-friendly shield tail sealing grease and a preparation method thereof.

[0062] The only difference from Embodiment 1 was that in this embodiment, the organic montmorillonite was replaced by attapulgite.

[0063] Embodiment 11

[0064] This embodiment provided an eco-friendly shield tail sealing grease and a preparation method thereof.

[0065] The sealing grease consisted of 28 kg of rapeseed oil, 5 kg of polyisobutylene, 5 kg of guar gum, 3 kg of xanthan gum, 3 kg of nano-scale fumed silica, 3 kg of ~~vinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane, 3.5 kg of cellulose fiber, 2.4 kg of cotton fiber, 47 kg of calcium carbonate and 0.1 kg of OBPA mildew-proof agent.

[0066] The preparation method was as follows:

[0067] (1) mixing rapeseed oil, polyisobutylene, guar gum and xanthan gum at 70℃ for 30 minutes;

[0068] (2) at 90℃, mixing the mixed solution obtained in step (1) with nano-scale fumed silica in a kneader and stirring for 5 minutes, then adding ~~vinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane, straw powder, calcium carbonate and OBPA mildew-proof agent to continue stirring for 5 minutes, and finally adding cellulose fiber and cotton fiber to continue stirring for 65 minutes; and

[0069] (3) filtering the mixture obtained in step (2) with a double-aperture filter (an aperture of a first filter hole being 15 mm, and an aperture of a second filter hole being 10 mm) to obtain the eco-friendly shield tail sealing grease.

[0070] Embodiment 12

[0071] This embodiment provided an eco-friendly shield tail sealing grease and a preparation method thereof.

[0072] The sealing grease consisted of 30 kg of palm oil, 5 kg of polyisobutylene, 5 kg of guar gum, 2 kg of starch gum, 2.5 kg of organic montmorillonite, 2.5 kg of ~~vinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane, 3.5 kg of cellulose

fiber, 2.9 kg of cotton fiber, 10 kg of straw powder, 36.5 kg of calcium carbonate and 0.1 kg of OBPA mildew-proof agent.

[0073] The preparation method was as follows:

[0074] (1) mixing palm oil, polyisobutylene, guar gum and starch gum at 80℃ for 30 minutes;

[0075] (2) at 70℃, mixing the mixed solution obtained in step (1) with organic montmorillonite in a kneader and stirring for 5 minutes, then adding ~~vinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane, straw powder, calcium carbonate and OBPA mildew-proof agent to continue stirring for 5 minutes, and finally adding cellulose fiber and cotton fiber to continue stirring for 75 minutes; and

[0076] (3) filtering the mixture obtained in step (2) with a double-aperture filter (an aperture of a first filter hole being 14 mm, and an aperture of a second filter hole being 8 mm) to obtain the eco-friendly shield tail sealing grease.

[0077] Comparative Example 1

[0078] This comparative example provided an eco-friendly shield tail sealing grease and a preparation method thereof.

[0079] The only difference from Embodiment 1 was that in this comparative example, the organic montmorillonite was replaced by inorganic montmorillonite.

[0080] Comparative Example 2

[0081] This comparative example provided an eco-friendly shield tail sealing grease and a preparation method thereof.

[0082] The only difference from Embodiment 1 was that in this comparative example, the addition amount of the organic montmorillonite was 7 kg.

[0083] Performance test

[0084] Performances of the sealing grease provided by Embodiments 1 to 12 and Comparative Examples 1 to 2 were tested with the method as follows:

[0085] (1) Consistency test: referring to GB/T 269 for testing.

[0086] (2) Water breakdown pressure test: referring to the enterprise standard of China Railway Fifth Survey and Design Institute Group Co., Ltd. as follows:

[0087] A) A power supply of a water pressure sealing testing instrument was turned on to set a test pressure as required.

[0088] B) At 25℃ in a laboratory, a layer of metal wire mesh with a mesh diameter of 0.76 mm and a wire diameter of 0.3 mm was put into a bottom of a sample container, 300

g of samples were weighed and smeared evenly in the sample container, the sample container was put to a designated position and filled with purified water, and then a cap of the container was fixed with a screw to seal preferably.

[0089] C) An inlet pipe was connected to the sample container, and an electronic balance was disposed below the sample container; a water supply valve was opened, and a pressure relief valve was opened at the same time. The instrument was started to observe whether there was water continuously flowing out of a pressure relief pipe; if there was water continuously flowing out of the pressure relief pipe, the pressure relief valve was closed, and timing was started at the same time. Numerical values displayed on the balance were recorded every 1 minute, and then recorded every 5 minutes after 10 minutes. After 30 minutes without breakdown, the test was finished, and it was judged that this pressure cannot be broken down. If it was broken down by water, the breakdown pressure value was recorded in MPa.

[0090] (3) Pumpability test: referring to the enterprise standard of China Railway Fifth Survey and Design Institute Group Co., Ltd. as follows:

[0091] Under the conditions of a test temperature of 25℃ ± 0.1℃ and a test pressure of 1 MPa ± 0.1 MPa, the pumpability was tested by a special capillary rheometer with an inner diameter of 3.8 mm, an inner bore roughness of Ra 1.6, and a length-diameter ratio of 25: 1. The pumpability of the shield tail sealing grease was characterized by a flow rate of the special capillary rheometer, and the definition of the shield tail sealing grease was explained in g/min.

[0092] a) A power supply of the capillary rheometer was turned on to set a test pressure which was 1 MPa as required.

[0093] b) A manual feeder with push-pull piston for shield tail sealing grease is used to take out a certain quality of shield tail sealing grease from a grease barrel for later use; the capillary rheometer was started, a pressing rod was lifted out of the barrel by controlling a mechanical transmission unit, then a lower end of the manual feeder was aligned with an upper end of the barrel, and the piston of the feeder was manually pushed to push the shield tail sealing grease into the barrel.

[0094] c) A temperature control device was enabled to set the temperature at 25℃ ± 0.1℃, and manual loading was started; the pressing rod was laid down to an upper surface of the material in the material barrel, and the gas in the barrel was exhausted until continuous materials were extruded through the capillary, then the pressure of the pressing

rod was set as 1 MPa, the material was kept at 25℃ ± 0.1℃ for 120 minutes; and automatic loading was started to start the test; when the pressure gradually increased to 1 MPa ± 0.1 MPa from 0 MPa, the device automatically started timing, and then the pressure was kept at 1 MPa ± 0.1 MPa till the end of the test.

[0095] d) During the test, the shield tail sealing grease flowing through the capillary was taken every 1 minute and weighed, numerical values were recorded. The shield tail sealing grease was taken for at least three times in each test, and the average value of the pumpability test value of the shield tail sealing grease under this test condition could be obtained.

[0096] The test results are shown in Table 1:

[0097] Table 1

Sample	Consistency (25℃, 0.1 mm)	Water breakdown pressure(MPa, 25℃)	Pumpability(g/min, 25℃, 1 MPa)
Embodiment 1	220	7.3	27.2
Embodiment 2	229	5.6	17.1
Embodiment 3	232	5.1	17.8
Embodiment 4	240	4.8	24.3
Embodiment 5	204	4.1	10.4
Embodiment 6	230	3.5	24.5
Embodiment 7	236	3.1	23.2
Embodiment 8	228	6.2	21.6
Embodiment 9	214	5.4	18.2
Embodiment 10	234	3.8	15.4
Embodiment 11	228	4.0	26.0
Embodiment 12	242	3.2	30.0
Comparative Example 1	231	3.8	25.1
Comparative Example 2	190	3.5	9.1

[0098] According to the embodiments and the performance test results, the sealing grease provided by the present disclosure has excellent water-proof sealing property, and the water breakdown pressure of the sealing grease provided by the present disclosure can reach more than 4 MPa, 6.2 MPa or even 7.3 MPa. Meanwhile, the sealing grease provided by the present disclosure not only has good consistency but also has good pumpability.

[0099] From the comparison between Embodiment 1 and Embodiments 2 to 5, it can be seen that when the organic montmorillonite is added in the range of 1 part to 5 parts, with the content increase of the organic montmorillonite content, the consistency and the pumpability of the shield tail sealing grease of the present disclosure can achieve double growth on the basis of maintaining a certain balance, that is, the organic montmorillonite of the present disclosure has a preferable thickening rheological effect and can achieve balanced growth of the consistency and rheology of the sealing grease. From the comparison between Embodiment 1 and Embodiments 6 to 10, it can be seen that the base oil of the present disclosure is preferably epoxidized soybean oil, coconut oil, industrial soybean oil, chicken oil and other base oils, and the thickening rheological agent is preferably ~~epoxidized soybean oil~~ organic montmorillonite. The base oil and the thickening rheological agent cooperate with each other to make the sealing grease have better consistency and rheology. From the comparison between Embodiment 1 and Comparative Examples 1 to 2, it can be seen that the present disclosure has a better thickening rheological effect when the organic montmorillonite is selected as the thickening rheological agent, and when the addition amount of the organic montmorillonite is in the range of 1 part to 5 parts.

[00100] It should be noted that relational terms herein such as "first" and "second" and the like, are used merely to distinguish one entity or operation from another entity or operation, and do not necessarily require or imply there is any such relationship or order between these entities or operations. Furthermore, the terms "including", "comprising" or any variations thereof are intended to embrace a non-exclusive inclusion, such that a process, a method, an article, or a device including a series of elements, includes not only those elements but also includes other elements not expressly listed, or also incudes elements inherent to such process, method, article, or device. In the absence of further limitation, an element defined by the phrase "including a ..." does not exclude the presence of the same element in the process, method, article, or device.

[00101] The above are only specific embodiments of the present disclosure, so that those skilled in the art can understand or realize the present disclosure. Many modifications to these embodiments will be obvious to those skilled in the art, and the general principles defined herein can be implemented in other embodiments without departing from the spirit or scope of the present disclosure. Therefore, the present disclosure will not to be limited to these embodiments shown herein, but is to be in conformity with the widest scope consistent with the principles and novel features disclosed herein.

CLAIMS

1. An eco-friendly shield tail sealing grease, wherein the sealing grease comprises the following components in parts by weight: 15 parts to 40 parts of base oil, ~~5 parts to 20~~10 parts of tackifier, 1 part to 5 parts of thickening rheological agent, 1 part to 5 parts of adhesion promoter, 3 parts to 8 parts of reinforcer and 30 parts to 50 parts of filler. wherein the thickening rheological agent is organic montmorillonite; and the tackifier is a combination of 5 parts of polyisobutylene and 5 parts of guar gum.

2. The sealing grease according to claim 1, wherein the base oil is selected from any one or a combination of at least two of palm oil, castor oil, rapeseed oil, epoxidized soybean oil, camellia oil, maize oil, peanut oil, industrial soybean oil, sesame oil, cotton seed oil, peony seed oil, coconut oil, walnut oil, olive oil or animal fat.~~;~~

~~and/or, the thickening rheological agent is selected from any one or a combination of at least two of nano-scale and/or micron-scale fumed silica, hydrogenated castor oil, dehydrated castor oil, organic montmorillonite or attapulgite.~~

3. The sealing grease according to claim 2, wherein the base oil is selected from any one or a combination of at least two of epoxidized soybean oil, coconut oil, industrial soybean oil, lard or chicken oil.~~;~~

~~and/or, the thickening rheological agent is organic montmorillonite.~~

~~4. The sealing grease according to any one of claims 1 to 3, wherein the tackifier is selected from any one or a combination of at least two of agar, gum Arabic, alginic acid, carrageenan, gelatin, guar gum, linseed gum, xanthan gum, carboxymethyl cellulose, methyl cellulose, starch gum, dextrin gum, bean gum, lignin gum, tannin gum, albumin glue, natural resin glue, natural rubber pulp and polyisobutylene.~~

~~5. The sealing grease according to claim 4, wherein the tackifier is polyisobutylene and/or guar gum.~~

~~6. The sealing grease according to claim 4, wherein the tackifier is polyisobutylene and guar gum, an addition amount of the polyisobutylene is 5 parts, and the parts by weight of the guar gum ranges from 0 part to 15 parts.~~

4. The sealing grease according to claim 1, wherein the thickening rheological agent is 1 parts to 3 parts of organic montmorillonite.

5. The sealing grease according to claim 4, wherein the thickening rheological agent is 3 parts of organic montmorillonite.

6. The sealing grease according to claim 4 or 5, wherein the base oil is epoxidized soybean oil.

7. The sealing grease according to any one of claims 1 to 6, wherein the adhesion promoter is selected from any one or a combination of at least two of γ-aminopropyl triethoxysilane, γ-(2,3-epoxypropoxy)propytrimethoxysilane, γ-methacryloxypropyltrimethoxysilane, *N*-[3-(trimethoxysilyl)propyl]ethylenediamine, 3-mercaptopropyltriethoxysilane, hexadecyltrimethoxysilane, dodecyltrimethoxysilane, vinyltriethoxysilane, vinyltriethoxysilane, ~~vinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane, trichlorovinylsilane, aminopropyltrimethoxysilane, 3-isocyanatopropyltriethoxysilane, 3-(acryloxy)propyltrimethoxysilane, (3-glycidoxypropyl)methyldiethoxysilane, 3-(chloropropyl)triethoxysilane or triethoxymethylsilane.

8. The sealing grease according to claim 7, wherein the adhesion promoter is ~~vinyltri(β-methoxyethoxy)silicane~~vinyltri(β-methoxyethoxy)silane.

9. The sealing grease according to any one of claims 1 to 8, wherein the reinforcer is selected from any one or a combination of at least two of cellulose fiber, cotton fiber, bamboo fiber, fibrilia or basalt fiber.

10. The sealing grease according to claim 9, wherein the reinforcer is a combination of cotton fiber and any one or at least two of cellulose fiber, bamboo fiber, fibrilia or basalt fiber.

11. The sealing grease according to claim 10, wherein a length of the bamboo fiber, fibrilia or basalt fiber is different from that of the cotton fiber.

12. The sealing grease according to any one of claims 1 to 11, wherein the filler is selected from any one or a combination of at least two of barium sulfate, calcium carbonate, talc, wood chips or straw powder.

13. The sealing grease according to claim 12, wherein the filler is calcium carbonate and/or straw powder.

14. The sealing grease according to any one of claims 1 to 13, wherein the sealing grease further comprises 0.01 part to 0.5 part of mildew-proof agent.

15. The sealing grease according to claim 14, wherein the mildew-proof agent is any one or a combination of at least two of phenol, pentachlorophenol, copper 8-hydroxyquinoline, triethyltin chloride, tributyltin chloride, copper sulfate or OBPA mildew-proof agent.

16. The sealing grease according to claim 15, wherein the mildew-proof agent is OBPA mildew-proof agent.

17. A preparation method of the sealing grease according to any one of claims 1 to 16, wherein the preparation method comprises the following steps of:

(1) mixing a formula ratio of base oil with a formula ratio of tackifier;

(2) in a kneader, kneading the mixture obtained in step (1) with a formula ratio of thickening rheological agent, and then adding a formula ratio of adhesion promoter, a formula ratio of filler and a formula ratio of optional mildew-proof agent for mixing;

(3) finally, adding a reinforcer into the mixture in step (2) to continue mixing; and

(4) filtering the mixture obtained in step (3) to obtain the sealing grease.

18. The preparation method according to claim 17, wherein the preparation method comprises the following steps of:

(1) mixing the formula ratio of base oil and the formula ratio of tackifier at 70℃ to 90℃ for 20 minutes to 40 minutes;

(2) in the kneader of 50℃ to 90℃, kneading the mixture obtained in step (1) with the formula ratio of thickening rheological agent for 4 minutes to 6 minutes, then adding the formula ratio of adhesion promoter, the formula ratio of filler and the formula ratio of optional mildew-proof agent to mix for 3 minutes to 5 minutes, and finally adding the reinforcer to continue mixing for 60 minutes to 90 minutes; and

(3) filtering the mixture obtained in step (2) with a double-aperture filter to obtain the sealing grease.

19. The preparation method according to claim 18, wherein the formula ratio of base oil and the formula ratio of tackifier are mixed at 70℃ to 90℃ for 30 minutes;

and/or, an aperture of a first filter hole of the double-aperture filter ranging from 12 mm to 18 mm, and an aperture of a second filter hole of double-aperture filter from 8 mm to 12 mm.

20. An application of the sealing grease according to any one of claims 1 to 19 in shield tail sealing of a shield tunneling machine.