

Description

Title of Invention

AQUEOUS RESIN COMPOSITION FOR FORMING A THICK FILM, AND
SURFACE TREATMENT METHOD USING SAID COMPOSITION

Technical Field

[0001]

The present invention provides an aqueous resin composition for forming a thick film, the composition being able to develop superior drying property due to the hybridization of glass filler with an aqueous synthetic resin emulsion, being able to form a film superior in water resistance, acid resistance and alkali resistance, and being to be used for surface-treating concrete or mortar for use in the civil engineering and construction field, and also provides a surface treatment method using the composition.

Background Art

[0002]

Concrete structures have a problem of their degradation caused by various environmental conditions, so that various materials for surface treatment have been used for the purpose of improving durability. Incidentally, solvent-based resins have been being converted into aqueous resins in the recent trend of tightening VOC regulation or the recent rapidly rise in social awareness concerning environmental protection. Likewise for waterproof/anti-corrosive materials for concrete structures in the civil engineering and construction field,

various problems such as regulations of odors and volatile ingredients and regulations of raw materials used have been discussed, and development of aqueous resins as waterproof materials and anti-corrosive materials has been demanded. However, when an aqueous resin is used as a waterproof/anti-corrosive material for a concrete structure in the civil engineering and construction field, a long time is needed until a film thereof is dried completely and a long schedule will be required. Therefore, from the viewpoint of durability, there have been used solvent-based resins superior in water resistance, acid resistance and alkali resistance, such as vinyl ester resins, polyester resins, epoxy resins, polyurea, and urethane resins; aqueous resins have been considered to be insufficient in processability and so on as waterproof/anti-corrosive materials for concrete structures in the civil engineering and construction field. Moreover, water-based resins cannot have many crosslinking sites as in solvent-based resins and are insufficient also in strength as resin film.

[0003]

In such circumstances, in a base regulator for a concrete structure, in order to provide an aqueous base regulator that exhibits good grinding workability after its application onto a base material, there has been disclosed a base regulator including (A) a polymer emulsion, (B) an acrylic emulsion or a synthetic rubber emulsion, and (C) talc (see, for example, Patent Literature 1). However, this base regulator is restricted in the method of its application and it cannot exhibit acid resistance or alkali resistance sufficiently by thick film application.

[0004]

There has been disclosed a composition for reinforced mortar

including a vinyl acetate-ethylene copolymer emulsion, glass fiber, cement, sand and the like (see, for example, Patent Literature 2). However, this composition has a problem in workability because the viscosity thereof increases rapidly due to its inclusion of excessively much non-volatile content.

[0005]

On the other hand, there has been disclosed as an aqueous resin composition prepared by adding an organic filler to a synthetic resin emulsion, for example, an adhesive composition including at least one of a styrene-butadiene copolymer-based resin latex and a chloroprene rubber latex, and an acrylic resin powder (an organic filler) (see, for example, Patent Literature 3). This is not for the purpose of forming a thick film like a waterproof/anti-corrosive material for a concrete structure but for the purpose of using as an adhesive. Besides, there has been disclosed a damping composition including a base emulsion using a core-shell emulsion and an organic filler (see, for example, Patent Literature 4), but in forming a thick film, cracks may generate under some drying conditions.

Citation List

Patent Literature

[0006]

Patent Literature 1: Japanese Patent Application Laid-Open (JP-A)
No. 2009-149767

Patent Literature 2: JP-A No. 2002-179450

Patent Literature 3: JP-A No. 2009-102606

Patent Literature 4: JP-A No. 2005-126645

Summary of Invention

Technical Problem

[0007]

The object of the present invention is to provide an aqueous resin composition for forming a thick film that can be used for thick film application to a surface to be treated of a concrete structure and the like, that can be dried within 12 hours from the application thereof, and that can afford an applied film superior in durability, such as water resistance, acid resistance, and alkali resistance, and also provide a surface treatment method using the composition.

Solution to Problem

[0008]

The present inventors studied earnestly in order to solve the problems described above and, as a result, have accomplished the present invention. The present invention relates to an aqueous resin composition for forming a thick film including an aqueous synthetic resin emulsion (A) and a glass filler (B) and has a non-volatile content of 65 to 85% by mass.

[0009]

Preferably, the viscosity of the aqueous resin composition for forming a thick film is 8,000 mPa·s or more.

[0010]

Preferably, the content of the glass filler (B) is 25% or more by mass of the non-volatile content of the aqueous resin composition for forming a thick film.

[0011]

Preferably, the solid content ratio of the aqueous synthetic resin emulsion (A) to the glass filler (B) is from 7/3 to 3/7.

[0012]

Preferably, an average particle size of the glass filler (B) is 0.3 mm or less.

[0013]

Preferably, the aqueous synthetic resin emulsion (A) is a styrene-acrylic resin emulsion or an acrylic resin emulsion.

[0014]

Further, the present invention relates to a method for treating a surface to be treated, the method including forming a film having a thickness of 0.1 to 2.0 mm by applying an aqueous resin composition for forming a thick film to a surface to be treated and then drying the composition.

[0015]

The present invention relates to a method for treating a surface of a concrete structure, the method including applying an aqueous resin composition for forming a thick film to the concrete structure and then drying the composition.

Advantageous Effects of Invention

[0016]

According to the present invention, there can be provided an aqueous resin composition for forming a thick film, wherein the composition emits no odors during work, is environmentally friendly, and is superior in water resistance, acid resistance, and alkali resistance.

Description of Embodiments

[0017]

The present invention is described in detail below. The aqueous synthetic resin emulsion (A) to be used for the present invention is an emulsion polymer or a latex polymer that can be obtained by radical polymerization of an ethylenically unsaturated monomer composition or the like using a water-soluble polymer or a surfactant. Examples of the emulsion polymer include a styrene-acrylic resin emulsion, an acrylic resin emulsion, an ethylene-vinyl acetate-based emulsion, a vinyl acetate-based emulsion, and a urethane-based emulsion; examples of the latex polymer include a styrene-butadiene-based resin latex, an acrylonitrile-butadiene-based resin latex, and a chloroprene-based resin latex. A suspension prepared by emulsifying and dispersing an organic resin in water can be used together. Among them, a styrene-acrylic resin emulsion and an acrylic resin emulsion are preferred from the viewpoints of adjustment of the characteristics of non-volatile content or the like of an aqueous synthetic resin emulsion (A), the Tg design, miscibility, and physical properties of a resin. Especially, a styrene-acrylic resin emulsion is preferred because it excels in acid resistance and alkali resistance.

[0018]

Moreover, the aqueous synthetic resin emulsion (A) to be used for the present invention is a styrene-acrylic resin emulsion or an acrylic resin emulsion that can be obtained by radical polymerization of an ethylenically unsaturated monomer composition or the like in the presence of a water-soluble or water-dispersible polyester. Especially, a

styrene-acrylic resin emulsion is preferred because it excels in acid resistance and alkali resistance.

[0019]

The amount of the water-soluble or water-dispersible polyester is preferably 10% by mass to 30% by mass, more preferably 10% by mass to 20% by mass in solid content in the synthetic resin emulsion obtained by polymerizing an ethylenically unsaturated monomer. If the content of the water-soluble or water-dispersible polyester is less than 10% by mass, polymerization stability may deteriorate, whereas if the content exceeds 30% by mass, water resistance may deteriorate.

[0020]

Among resin components of the styrene-acrylic resin emulsion, the component derived from styrene monomer preferably accounts for 10 to 80% by mass, more preferably 40 to 60% by mass. If less than 10% by mass, toughness as a film property may deteriorate, whereas if more than 80% by mass, the amount of a film forming aid is needed to increase because of a problem in film formability, leading to a tendency to cause deterioration in film properties.

[0021]

The glass filler (B) to be used for the present invention means a powder of glass and examples thereof include glass fiber, glass frit, glass flake, and glass bead. These may be used singly or two or more of them may be used in combination. Especially, glass frit and glass flake are preferred from the viewpoint of miscibility and durability.

[0022]

Examples of the shape of a cross section of the glass filler (B) include a common true spherical shape, non-round cross sectional

shapes, and scale-like shapes typified by glass flakes. Especially, a true spherical shape is preferred from the viewpoint of miscibility and durability.

[0023]

The glass filler (B) to be used in the present invention is used preferably in an amount of 25% or more by mass, more preferably 30% or more by mass, particularly preferably 45% or more by mass, and even more preferably 50% or more by mass of the non-volatile content of the aqueous resin composition for forming a thick film. When the proportion of the glass filler (B) relative to the non-volatile content of the aqueous resin composition for forming a thick film is less than 25% by mass, there is a tendency that the drying property of a thick film deteriorates and the water-blocking property, the acid resistance and the alkali resistance deteriorate.

[0024]

From the viewpoint of dispersibility, the average particle size of the glass filler (B) to be used in the present invention is preferably 0.3 mm or less, more preferably 1 μm to 100 μm . When the average particle size is larger than 0.3 mm, uniform dispersion in resin is not obtained and a separation tendency is observed, so that it becomes difficult to form a uniform film in film formation and deterioration in film properties (strength and durability) is shown.

[0025]

Unless the object of the present invention is disturbed, a small amount of inorganic filler may be added in order to improve viscosity. Conventional one may be used as the inorganic filler, and examples thereof include zinc oxide, titanium oxide, calcium carbonate, silicic acid,

silicates, kaolin clay, magnesium oxide, satin white, aluminum oxide, talc, mica, calcined clay, aluminum hydroxide, and silica. These may be used singly or two or more of them may be used in combination.

[0026]

Moreover, unless the object of the present invention is disturbed, a small amount of organic filler may be added in order to improve viscosity. The organic filler means a powder of an organic polymer hardly soluble in water, and the solubility in 100 g of water at 23°C, 1 atm is preferably 0.1 g and less. Examples of the organic filler include polyethylene, polypropylene, polystyrene, polymethyl methacrylate and its copolymers, vinyl acetate and its copolymers, saturated polyester (aliphatic ester-based and aromatic ester-based), cellulose acetate butyrate, ϵ -caprolactone polymers, polybutadiene, and polyvinyl chloride. Additional examples include elastomer type polymers such as styrene-butadiene-styrene (SBS) block polymers, and also include starch powder and cellulose powder. These may be used singly or two or more of them may be used in combination. Especially, polystyrene, polyethylene, and polypropylene are preferred from the viewpoint of miscibility and durability.

[0027]

From the viewpoint of dispersibility, the average particle size of the organic filler is preferably several micrometers to 300 μm .

[0028]

In the aqueous resin composition for forming a thick film of the present invention, the solid content ratio of the aqueous synthetic resin emulsion (A) to the glass filler (B) is preferably from 7/3 to 3/7, more preferably from 6/4 to 4/6. When the solid content ratio of the aqueous

synthetic resin emulsion (A) to the glass filler (B) is larger than 7/3, in other words, when there is much aqueous synthetic resin emulsion (A), expected drying property cannot be obtained and good results in physical properties (strength, etc.) of a film cannot be obtained. On the other hand, when the solid content ratio of the aqueous synthetic resin emulsion (A) to the glass filler (B) is smaller than 3/7, in other words, when there is much glass filler (B), stability cannot be maintained and it becomes difficult to perform uniform film formation, so that it becomes difficult to obtain a sufficient effect in the durability of a film, such as water resistance, acid resistance, and alkali resistance.

[0029]

In addition, according to the purpose of use, a plasticizer, a tackifying resin, a thickener, a curing agent, a defoaming agent, an antiseptics, etc. may be added.

[0030]

The minimum film-formation temperature of the aqueous resin composition for forming a thick film of the present invention is preferably 0 to 5°C and particularly preferably is 0°C. When the minimum film-formation temperature is higher than 5°C, it is feared that film forming property deteriorates and there is a tendency that sufficient film durability cannot be obtained because the influence of drying temperature condition becomes remarkable. The minimum film-formation temperature of an aqueous resin composition for forming a thick film can be adjusted by such a method as adding a film forming aid or adding an aqueous synthetic resin emulsion (A) having a lower minimum film-formation temperature to an aqueous synthetic resin emulsion (A) having a higher minimum film-formation temperature.

[0031]

The aqueous resin composition for forming a thick film of the present invention contains non-volatile content preferably in an amount of 65 to 80% by mass, more preferably 65 to 70% by mass. The adjustment of the non-volatile content of 65 to 80% by mass makes it possible to display superior drying property. When the non-volatile content is less than 65% by mass, the drying property becomes insufficient and many additives are needed for securing workability. When the non-volatile content exceeds 80% by mass, problems with stability will arise and problems with workability will also be caused by rapid increase in viscosity.

[0032]

The viscosity of the aqueous resin composition for forming a thick film of the present invention is preferably 8,000 mPa·s or more, and more preferably 9,000 to 60,000 mPa·s. In view of applicability, the adjustment of the viscosity to 8,000 mPa·s or higher makes it possible to achieve application in a thickness of 1mm. Although desirable viscosity varies depending upon the method of application, the viscosity is desirably 9,000 to 20,000 mPa·s in performing spraying with a spray or the like and is desirably 20,000 to 60,000 mPa·s in performing hand-spreading with a trowel or the like. If the viscosity becomes lower than 8,000 mPa·s, generation of cracks is expected in thick application. Moreover, in view of workability, problems such as drooling tend to arise.

[0033]

The aqueous resin composition for forming a thick film of the present invention preferably has a film thickness after being applied to a surface to be treated and then dried of 0.1 to 2.0 mm, more preferably 0.3

to 1.5 mm. When thickness is less than 0.1 mm, the continuity of a film becomes insufficient due to the generation of pinholes or the like, and due in part to the influence of a base material, whereas when thickness is more than 2.0 mm, this becomes a factor in delay in drying and there is a tendency that sufficient performance cannot be demonstrated.

[0034]

Since the aqueous resin composition for forming a thick film of the present invention contains no solvent or the like or contains only a little amount of solvent or the like, it fails to emit an odor during working, is friendly to the environment, and is superior in drying property. By applying the aqueous resin composition for forming a thick film of the present invention to a surface to be treated of a concrete structure or the like and drying it naturally at room temperature, a protective film superior in physical properties such as water resistance, acid resistance, and alkali resistance, which is conceivable to improve the durability of the surface treated. The concrete structure as referred to herein is a concept including structures made of ordinary concrete, mortar, and the like.

[0035]

Examples of the method for applying the aqueous resin composition for forming a thick film of the present invention include spray application, roller application, and troweling. The amount (solid amount) to be applied, which may be determined according to the purpose of protection, is preferably 0.2 kg/m² to 2.0 kg/m², more preferably 0.3 kg/m² to 1.2 kg/m². If the amount to be applied is less than 0.2 kg/m², a sufficient continuous film layer cannot be formed and generation of pinholes or the like is expected, whereas if the amount to be

applied is more than 2.0 kg/m², this may cause delay in drying and sufficient performance tends to become unable to be displayed.

[0036]

In applying the aqueous resin composition for forming a thick film of the present invention to surfaces to be treated of a concrete structure or the like, it is permitted to use a basecoat. Examples of such a basecoat include acrylic emulsion-based basecoat (primer, sealer), epoxy-based basecoat, and urethane-based basecoat. Cement-based undercoating materials also can be used. For example, examples of a miscible liquid include cement-based base regulator such as acrylic emulsions, ethylene-vinyl acetate emulsions, and epoxy-based emulsions.

Examples

[0037]

The present invention is described below more concretely by means of Examples and Comparative Examples, but the present invention is not limited thereto. The characteristics of the resin emulsions of Examples and Comparative Examples, the characteristics of the aqueous resin compositions, drying property, and cracks were evaluated by the methods described below.

[0038]

(Non-volatile Content)

The non-volatile content was determined by weighing about 1 g of a resin emulsion or aqueous resin composition on an aluminum tray having a diameter of 5 cm, drying it at 105°C for one hour, and then weighing the residue.

[0039]

(Viscosity)

Viscosity was measured at a liquid temperature of 23°C, a rotation speed of 10 rpm, with a rotor by using a Brookfield rotary viscometer.

[0040]

(Minimum Film-Formation Temperature (MFT))

The MFT of an aqueous resin composition was measured in accordance with JIS K6828.

[0041]

(Evaluation of Drying Property)

On a glass plate was formed a frame, into which an aqueous resin composition was poured so that film thickness after drying would become 2 mm. Then, a time was measured which was taken until the surface was dried under an environment of 20°C × 50%RH and no mark of finger touch remained.

[0042]

(Cracks)

In the above-described evaluation of drying property, whether or not cracks were formed in drying was evaluated visually.

○: No cracks were formed.

×: Cracks were formed.

[0043]

(Example 1)

Emulsion (1) (styrene-acrylic acid ester copolymer; the non-volatile content: 50% by mass; the content of a component derived from styrene among resin components: 50% by mass, the content of a component derived from the acrylic acid ester: 50% by mass, viscosity:

4,500 mPa·s; minimum film-formation temperature: 0°C) was used as an aqueous synthetic resin emulsion and glass frit CF0007-05B (produced by Nippon Frit Co., Ltd.; average particle size: 5 μm) was used as a glass filler. 50 parts by mass of CF0007-05B was added to 100 parts by mass of emulsion (1), followed by stirring with a disper at 3,000 rpm for 20 minutes. In addition, 0.05 parts by mass of a defoaming agent (NOPCO 8034L; produced by SAN NOPCO LIMITED) was added for defoaming. Thus, preparation of an aqueous resin composition was performed. The resulting aqueous resin composition was filtered through an 80 mesh filter cloth and it thereby was confirmed that neither coarse particles nor aggregates were formed. By the production method as described above, the aqueous resin composition of Example 1 was obtained. The characteristics of the resulting aqueous resin composition included a non-volatile content of 66.7% by mass and a viscosity of 12,000 mPa·s.

[0044]

(Example 2)

Emulsion (2) (polyester-styrene-acrylic acid ester copolymer; the non-volatile content: 51% by mass; the content of a component derived from polyester among resin components: 10% by mass, the content of a component derived from styrene: 40% by mass, the content of a component derived from the acrylic acid ester: 50% by mass, viscosity: 500 mPa·s; minimum film-formation temperature: 40°C) and emulsion (3) (styrene-acrylic acid ester copolymer; the non-volatile content: 58% by mass; the content of a component derived from styrene among resin components: 10% by mass, the content of a component derived from the acrylic acid ester: 90% by mass, viscosity: 3,000 mPa·s; minimum film-formation temperature: 0°C) were used as aqueous synthetic resin

film-formation temperature: 0°C) were used as aqueous synthetic resin emulsions and glass frit CF0007-05B (produced by Nippon Frit Co., Ltd.; average particle size: 5 µm) was used as a glass filler. An aqueous resin composition was obtained by the same method as Example 1 except for adding 50 parts by mass of CF0007-05B to 50 parts by mass of emulsions (2) and 50 parts by mass of emulsions (3). The adjustment of the MFT was performed by mixing emulsions (2) and emulsions (3). The characteristics of the resulting aqueous resin composition included a non-volatile content of 69.3% by mass and a viscosity of 11,000 mPa·s.

[0045]

(Example 3)

An aqueous resin composition was obtained in the same method as Example 1 except for using 100 parts by mass of emulsion (4) (acrylic acid ester polymer; the non-volatile content: 50% by mass; viscosity: 2,500 mPa·s; minimum film-formation temperature: 2°C) as an aqueous synthetic resin emulsion, using 50 parts by mass of CF0007-05B (produced by Nippon Frit Co., Ltd.; average particle size: 5 µm) as a glass filler, and adding 2 parts by mass of TEXANOL CS-12 as a film forming aid. The characteristics of the resulting aqueous resin composition included a non-volatile content of 66.7% by mass and a viscosity of 13,000 mPa·s.

[0046]

(Example 4)

An aqueous resin composition was obtained in the same method as Example 1 except for using 100 parts by mass of emulsion (1) (styrene-acrylic acid ester copolymer; the non-volatile content: 50% by mass; viscosity: 4,500 mPa·s; minimum film-formation temperature: 0°C)

as an aqueous synthetic resin emulsion and using 50 parts by mass of CF0002-30A (produced by Nippon Frit Co., Ltd.; average particle size: 30 μm) as a glass filler. The characteristics of the resulting aqueous resin composition included a non-volatile content of 66.7% by mass and a viscosity of 9,000 mPa·s.

[0047]

(Example 5)

An aqueous resin composition was obtained in the same method as Example 1 except for using 100 parts by mass of emulsion (1) (styrene-acrylic acid ester copolymer; the non-volatile content: 50% by mass; viscosity: 4,500 mPa·s; minimum film-formation temperature: 0°C) as an aqueous synthetic resin emulsion and using 50 parts by mass of microglass glass flake RCF-150 (produced by Nippon Sheet Glass Co. Ltd.; average particle size: 150 μm) as a glass filler. The characteristics of the resulting aqueous resin composition included a non-volatile content of 66.7% by mass and a viscosity of 13,000 mPa·s.

[0048]

(Comparative Example 1)

Emulsion (1) (styrene-acrylic acid ester copolymer; the non-volatile content: 50% by mass; viscosity: 4,500 mPa·s; minimum film-formation temperature: 0°C) was used as an aqueous resin composition of Comparative Example 1 without adding a glass filler.

[0049]

(Comparative Example 2)

Emulsion (4) (acrylic acid ester polymer; the non-volatile content: 50% by mass; viscosity: 2,500 mPa·s; minimum film-formation temperature: 2°C) was used as an aqueous resin composition of

[0050]

(Comparative Example 3)

Emulsion (1) (styrene-acrylic acid ester copolymer; the non-volatile content: 50% by mass; viscosity: 4,500 mPa·s; minimum film-formation temperature: 0°C) was used as an aqueous synthetic resin emulsion and CF0007-05B (produced by Nippon Frit Co., Ltd.; average particle size: 5 μ m) was used as a glass filler. 12.5 parts by mass of CF0007-05B was added to 100 parts by mass of emulsion (1), followed by stirring with a disper at 3,000 rpm for 20 minutes. In addition, 0.05 parts by mass of a defoaming agent (NOPCO 8034L; produced by SAN NOPCO LIMITED) was added for defoaming. Thus, the preparation of an aqueous resin composition was performed. The resulting aqueous resin composition was filtered through an 80 mesh filter cloth and it thereby was confirmed that neither coarse particles nor aggregates were formed. By the production method as described above, the aqueous resin composition of Comparative Example 3 was obtained. The characteristics of the resulting aqueous resin composition included a non-volatile content of 55.6% by mass and a viscosity of 6,500 mPa·s.

[0051]

(Comparative Example 4)

Emulsion (1) (styrene-acrylic acid ester copolymer; the non-volatile content: 50% by mass; viscosity: 4,500 mPa·s; minimum film-formation temperature: 0°C) was used as an aqueous synthetic resin emulsion and microglass glass flake RCF-150 (produced by Nippon Sheet Glass Co. Ltd.; average particle size: 150 μ m) was used as a glass filler. 12.5 parts by mass of RCF-150 was added to 100 parts by mass of emulsion (1), followed by stirring with a disper at 3,000 rpm for 20

minutes. In addition, 0.05 parts by mass of a defoaming agent (NOPCO 8034L; produced by SAN NOPCO LIMITED) was added for defoaming. Thus, the preparation of an aqueous resin composition was performed. By the production method as described above, the aqueous resin composition of Comparative Example 4 was obtained. The characteristics of the resulting aqueous resin composition included a non-volatile content of 55.6% by mass and a viscosity of 7,500 mPa·s.

[0052]

(Comparative Example 5)

Emulsion (1) (styrene-acrylic acid ester copolymer; the non-volatile content: 50% by mass; viscosity: 4,500 mPa·s; minimum film-formation temperature: 0°C) was used as an aqueous synthetic resin emulsion and CF0007-05B (produced by Nippon Frit Co., Ltd.; average particle size: 5 μ m) and CF0002-30A (produced by Nippon Frit Co., Ltd.; average particle size: 30 μ m) were used as glass fillers. 100 parts by mass of CF0007-05B and 100 parts by mass of CF0002-30A were added to 100 parts by mass of emulsion (1), followed by stirring with a disper at 3,000 rpm for 20 minutes. In addition, 0.1 parts by mass of a defoaming agent (NOPCO 8034L; produced by SAN NOPCO LIMITED) was added for defoaming. Thus, the preparation of an aqueous resin composition was performed. The resulting aqueous resin composition was filtered through an 80 mesh filter cloth and it thereby was confirmed that neither coarse particles nor aggregates were formed. By the production method as described above, the aqueous resin composition of Comparative Example 5 was obtained. The characteristics of the resulting aqueous resin composition included a non-volatile content of 83.3% by mass and a viscosity of 100,000 mPa·s or more.

a viscosity of 100,000 mPa·s or more.

[0053]

[Table 1]

Composition		Example 1	Example 2	Example 3	Example 4	Example 5
Aqueous synthetic resin emulsion	Emulsion (1)	100			100	100
	Emulsion (2)		50			
	Emulsion (3)		50			
	Emulsion (4)			100		
Glass filler	CF0007-05B	50	50	50		
	CF0002 - 30A				50	
	Flake RCF-150					50
Non-volatile content (% by mass)		66.7	69.3	66.7	66.7	66.7
Viscosity (mPa·s)		12,000	11,000	13,000	9,000	13,000
pH		7.8	8.1	8	7.5	7.6
MFT (°C)		0	0	0	0	0
Drying property at a thickness of 2 mm		Up to 12h	Up to 12h	Up to 12h	Up to 12h	Up to 12h
Generation of cracks		○	○	○	○	○

[0054]

[Table 2]

Composition		Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5
Aqueous synthetic resin emulsion	Emulsion (1)	100		100	100	100
	Emulsion (4)		100			
Glass filler	CF0007-05B			12.5		100
	CF0002-30A					100
	Flake RCF-150				12.5	
Non-volatile content (% by mass)		50.0	50.0	55.6	55.6	83.3
Viscosity (mPa·s)		4,500	2,500	6,500	7,500	100,000 or more
pH		7	7	7	7	8
MFT (°C)		0	2	0	0	—
Drying property at a thickness of 2 mm		48 hr or more	48 hr or more	24 hr or more	24 hr or more	Application was impossible
Generation of cracks		×	×	×	×	

[0055]

(Evaluation of Acid Resistance / Alkali Resistance)

The evaluation of acid resistance / alkali resistance was carried out using a film prepared by the following method. The aqueous resin composition obtained in each of Examples and Comparative Examples was poured in an amount of 10 g (solid) per 100 cm² onto a glass plate on which a release film had been stuck. The aqueous resin composition poured onto the glass plate was dried at normal temperature for two days, and then vacuum dried for one day, and then dried at 40°C for 12 hours,

so that a film was formed.

[0056]

As to the swelling ratio and the elution ratio in the evaluation of acid resistance, the formed film was cut into a size of 40 mm × 40 mm, weighed, and then immersed in a 10% aqueous solution of sulfuric acid at 40°C for seven days. The immersed film was taken out and then weighed. A swelling ratio was calculated by dividing the increase in mass based on the mass before the immersion by the mass before the immersion. Regarding the elution ratio, the immersed film was dried at 40°C for 12 hours and then weighted, and then an elution ratio was calculated by dividing the decrease in mass based on the mass before the immersion by the mass before the immersion.

[0057]

The film strength retention and the film elongation retention in the evaluation of acid resistance were performed by the following method. The formed film was cut into a size of 10 mm × 30 mm and then subjected to a tensile test at a tensile rate of 100 mm/min, and then the strength and the elongation of the film before the immersion of the 10% aqueous solution of sulfuric acid were measured on the basis of a maximum strength and an elongation of a 10 mm long marked line. Subsequently, the formed film, separately formed from the film above, was cut into a size of 10 mm × 30 mm, immersed in a 10% aqueous solution of sulfuric acid at 40°C for seven days, and then dried at 40°C for 12 hours. Then, the strength and the elongation of the immersed film were measured. The film strength retention was calculated by dividing the strength of the film after the immersion by the strength of the film before the immersion, and the film elongation retention was calculated by dividing the elongation of

the film after the immersion by the elongation of the film before the immersion.

[0058]

The evaluation of alkali resistance was carried out by the same method for the acid resistance except for using a saturated aqueous solution of calcium hydroxide instead of the 10% aqueous solution of sulfuric acid.

[0059]

(Change in Appearance)

In order to evaluate change in appearance, a specimen in which the entire surface of a JIS mortar plate had been coated with an aqueous resin composition in a thickness of 2 mm was prepared, then it was immersed in a 10% aqueous solution of sulfuric acid for 30 days and in a saturated aqueous solution of calcium hydroxide for 30 days, respectively, and then the presence of change in appearance, such as blister and cracking was evaluated visually.

○: There was no appearance abnormality (blister, cracking, etc.).

○-: There was a small blister at the edge of a specimen.

△: There was generation of a small blister or crack on the surface and the edge of a specimen.

×: There was generation of a blister or crack as large as 1 mm or more in a specimen.

[0060]

[Table 3]

Composition		Example 1	Example 2	Example 3	Example 4	Example 5
Acid resistance evaluation	Film elution ratio	0.5	0.8	0.3	1.0	0.5
	Film swelling ratio	5.2	9.5	4.5	6.5	6.9
	Film strength retention	100	110	110	100	99
	Film elongation retention	105	90	90	95	98
Alkali resistance evaluation	Film elution ratio	0.5	2.1	0.3	1.2	1.5
	Film swelling ratio	6.0	10	5.0	5.3	5.3
	Film strength retention	100	100	98	94	95
	Film elongation retention	95	110	90	108	110
Appearance change in 10% sulfuric acid immersion test		⊙	○	○	⊙	⊙
Appearance change in alkali resistance immersion test		⊙	⊙	⊙	⊙	⊙

[0061]

[Table 4]

Composition		Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5
Acid resistance evaluation	Film elution ratio	4.5	2.5	2.5	4.5	Applicability × Evaluation was impossible because formed film was brittle/hard.
	Film swelling ratio	10.4	11.6	17.3	18.1	
	Film strength retention	140	106	130	125	
	Film elongation retention	90	40	90	80	
Alkali resistance evaluation	Film elution ratio	2.5	1.0	2.3	2.6	
	Film swelling ratio	17.9	18	16.6	15.6	
	Film strength retention	170	250	140	145	
	Film elongation retention	200	50	120	130	
Appearance change in 10% sulfuric acid immersion test		△	△	△	△	
Appearance change in alkali resistance immersion test		○—	○—	○—	○—	

[0062]

As is shown by the results given in Tables 1 and 2, the aqueous resin compositions for forming a thick film of Examples 1, 2, 3, 4 and 5

exhibited good results, that is, they were better in better results including better drying property and forming no cracks in thick films compared with those of Comparative Examples 1, 2, 3 and 4. As is shown by the results given in Tables 3 and 4, the films produced from the resin compositions for forming a thick film of Examples 1, 2, 3, 4 and 5 were found to be low in elution ratio and swelling ratio and therefore remarkably superior in acid resistance. In addition, regarding alkali resistance, sufficient improvement in resistance was found. Moreover, it was confirmed that no change in appearance, such as blister and cracking, was caused even if the films were immersed in a 10% aqueous solution of sulfuric acid for 30 days and in a saturated aqueous solution of calcium hydroxide for 30 days.

CLAIMS

[Claim 1]

An aqueous resin composition for forming a thick film comprising:
a styrene-acrylic resin emulsion (A) which contains 10 to 80% by mass of a component derived from styrene monomer based on resin components; and a glass filler (B), at least one glass filler (B) selected from the group consisting of glass frit and glass flake, wherein the composition has a non-volatile content of 65 to 70% by mass and the viscosity of the composition is 9,000 to 60,000 mPa·s.

[Claim 2]

The aqueous resin composition for forming a thick film according to claim 1, wherein the content of the glass filler (B) is 25% or more by mass of the non-volatile content of the aqueous resin composition for forming a thick film.

[Claim 3]

The aqueous resin composition for forming a thick film according to claim 1 or 2, wherein the solid content ratio of the aqueous synthetic resin emulsion (A) to the glass filler (B) is from 7/3 to 3/7.

[Claim 4]

The aqueous resin composition for forming a thick film according to any one of claims 1 to 3, wherein an average particle size of the glass filler (B) is 1 to 100 μ m.

[Claim 5]

A method for treating a surface to be treated, the method comprising forming a film having a thickness of 0.1 to 2.0 mm by applying the aqueous resin composition for forming a thick film according to any one of claims 1 to 4 to the surface to be treated and then drying the composition.

[Claim 6]

A method for treating a surface of a concrete structure, the method comprising applying the aqueous resin composition for forming a thick film according to any one of claims 1 to 4 to the concrete structure and then drying the composition.