

DESCRIPTION

TITLE OF INVENTION

Anticorrosive Paint Composition and Method for Forming Dry Coating Film

5 TECHNICAL FIELD

The present invention relates to an epoxy-based anticorrosive paint composition. The present invention also relates to an anticorrosive coating film formed from the anticorrosive paint composition and coated objects, such as a ship and an offshore structure, that are provided with the anticorrosive coating film. Further, the present
10 invention relates to a method for forming a coating film and a paint used in the method.

BACKGROUND ART

Generally, anticorrosive coating is performed on the surfaces of a ship as well as offshore structures such as a bridge, a tank, and a plant for the purpose of imparting an anticorrosion property against a severe corrosive environment. An antifouling
15 paint is also applied on the anticorrosive coating in many cases. In order to impart desired characteristics by forming a coating film, it is important to control the film thickness of a dry coating film, and with a formed dry coating film having an insufficient film thickness, the characteristics to be imparted are also likely to be insufficient.

20 For example, Japanese Patent Laying-Open No. 10-211464 (PTD 1) describes that a non-tar epoxy resin thick anticorrosive paint is applied onto a ship bottom, or a ship bottom and a waterline part of a ship, and a non-organic tin hydrolyzable antifouling paint is applied onto the coating film of the non-tar epoxy resin thick anticorrosive paint. Japanese Patent Laying-Open No. 10-259351 (PTD 2) describes
25 that a non-tar epoxy resin paint composition that includes a curing agent made from a bisphenol epoxy resin, a vinyl chloride copolymer, and a polyamide or a modified product thereof is applied onto, for example, a ship as a thick anticorrosive paint, and a non-organic tin hydrolyzable antifouling paint is applied onto the coating film of the non-tar epoxy resin paint composition. Japanese Patent Laying-Open No.

2002-167548 (PTD 3) describes that an epoxy paint composition containing a specific urethane amine compound is applied onto, for example, a ship as an anticorrosive paint, and a topcoat paint is applied onto the coating film of the epoxy paint composition.

Control of the film thickness of a coating film, however, is not an easy operation. As a conventional method of controlling the film thickness, there are i) a method of measuring the thickness of a half-coated film, or a wet coating film (before drying) with use of a wet film thickness gauge, and calculating and confirming the dry film thickness on the basis of the measuring result, to confirm in advance whether or not it is possible to obtain a target dry film thickness (such a dry film thickness as to be capable of sufficiently giving desired physical properties); and ii) a method of directly measuring the film thickness of a dry coating film with use of, for example, an electromagnetic film thickness meter to confirm whether or not the film thickness of the dry coating film has attained a target film thickness.

In either of the above methods, however, it has been actually difficult to control the film thickness especially in the following cases.

1) A case of a large area of a surface of an object, such as a ship, to be coated with a paint. In this case, it is very troublesome and actually difficult to measure the film thickness over the entire surface of an object to be coated with use of, for example, the wet film thickness gauge or the electromagnetic film thickness meter.

2) A case where a surface of an object to be coated with paint includes a surface not allowing easy coating. In spite of the fact that unevenness of the film thickness is likely to occur on a surface that does not allow easy coating with a paint, it is often difficult and troublesome to measure the thickness of a coating film formed on such a surface with use of, for example, the wet film thickness gauge or the electromagnetic film thickness meter.

3) A case of a large target film thickness of a coating film formed by single coating. The frequency of measurement of the thickness of a half-coated film is likely to increase as the coating film that is attempted to be formed by single coating is thicker, leading to troublesome control of the film thickness. The term "single coating"

refers to performing a series of operations from coating with a paint to drying once. Accordingly, the coating film formed by single coating refers to a coating film that is formed by performing single coating or multi-layer coating with a paint and then performing drying once.

5 As a method of solving the conventional problems as described above, Japanese Patent Laying-Open Nos. 10-216621 (PTD 4) and 2002-066445 (PTD 5) disclose formation of a coating film with use of, as a paint for forming a coating film, a so-called “film thickness determination paint” that allows a coating operator to determine whether or not a prescribed film thickness has been attained by visually
10 observing the change in the color difference of a half-coated wet coating film.

CITATION LIST

PATENT DOCUMENT

PTD 1: Japanese Patent Laying-Open No. 10-211464.

PTD 2: Japanese Patent Laying-Open No. 10-259351

15 PTD 3: Japanese Patent Laying-Open No. 2002-167548

PTD 4: Japanese Patent Laying-Open No. 10-216621

PTD 5: Japanese Patent Laying-Open No. 2002-066445

SUMMARY OF INVENTION

TECHNICAL PROBLEMS

20 An epoxy-based anticorrosive paint composition has a problem of being inferior in adhesion to a top coating film when having a long period from the coating with the epoxy-based anticorrosive paint composition to the coating with a topcoat paint, in applying the epoxy-based anticorrosive paint composition onto an object to be coated and then performing top coating on the coating film of the epoxy-based anticorrosive
25 paint composition. PTD 3 describes that this problem can be solved by an epoxy paint composition containing a specific urethane amine compound. On the other hand, shortening of the period for securing the adhesion to the top coating film causes a coating operation step to be troublesome or forces a coating operator into a severe operation environment.

An object of the present invention is to provide a new anticorrosive paint composition capable of forming a coating film excellent in adhesion to a top coating film even when the period until the coating with a topcoat paint is long, in other words, capable of making a period until the coating with a topcoat paint long while retaining
 5 excellent adhesion to a top coating film. Another object of the present invention is to provide a coating film (anticorrosive coating film) formed with use of the anticorrosive paint composition, and a ship and an offshore structure that are provided with the coating film.

Further another object of the present invention is to provide a method for
 10 forming a coating film that allows an easy coating operation with use of an epoxy-based anticorrosive paint composition capable of forming a coating film excellent in adhesion to a top coating film even when the period until the coating with a topcoat paint is long, in other words, capable of making a period until the coating with a topcoat paint long while retaining excellent adhesion to a top coating film, and that
 15 allows simple formation of a dry coating film with a predetermined film thickness while the insufficiency of the film thickness is suppressed; and a paint used in the method.

SOLUTIONS TO PROBLEMS

The present invention provides an anticorrosive paint composition, a coating
 20 film, and a ship and an offshore structure that are indicated below.

(1) An anticorrosive paint composition containing a bisphenol A-type epoxy resin (A), an amine curing agent (B), a vinyl chloride copolymer (C), and a monoepoxide compound (D),

a content of the vinyl chloride copolymer (C) being 5 to 50 parts by mass
 25 relative to 100 parts by mass of the bisphenol A-type epoxy resin (A), and

a content of the monoepoxide compound (D) being 2 to 50 parts by mass relative to 100 parts by mass of the amine curing agent (B).

(2) The anticorrosive paint composition according to (1), wherein a content ratio between the monoepoxide compound (D) and the vinyl chloride copolymer (C) is

0.02 to 2.5 by mass ratio.

(3) The anticorrosive paint composition according to (1) or (2), wherein the monoepoxide compound (D) includes an alkyl glycidyl ether compound.

5 (4) The anticorrosive paint composition according to any of (1) to (3), wherein the amine curing agent (B) is a polyamide amine.

(5) The anticorrosive paint composition according to any of (1) to (4), wherein the vinyl chloride copolymer (C) is a vinyl chloride-vinyl alkyl ether copolymer.

(6) The anticorrosive paint composition according to any of (1) to (5), further containing a (meth)acrylate compound (E).

10 (7) The anticorrosive paint composition according to any of (1) to (6), the anticorrosive paint composition being a two-pack anticorrosive paint composition including a first agent and a second agent, wherein

the first agent contains the bisphenol A-type epoxy resin (A) and the vinyl chloride copolymer (C), and

15 the second agent contains the amine curing agent (B) and the monoepoxide compound (D).

(8) A coating film formed from the anticorrosive paint composition according to any of (1) to (7).

20 (9) A ship or an offshore structure provided with the coating film according to (8).

The present invention also provides a method for forming a dry coating film and a colored anticorrosive paint that are indicated below.

(1) A method for forming a dry coating film on a surface of an object to be coated, the method including the following steps of:

25 [1] setting a dry coating film thickness T;

[2] preparing or arranging a colored anticorrosive paint that is a two-pack colored anticorrosive paint including a first agent and a second agent and that satisfies the following conditions (a) to (i):

(a) a coating film that has the dry coating film thickness T and is formed from

the colored anticorrosive paint hides the surface of the object to be coated;

(b) a color difference $\Delta E1$ is greater than or equal to 2.0 between the coating film that has the drying coating film thickness T and is formed from the colored anticorrosive paint and a coating film that has a dry coating film thickness of 0.7T and is formed from the colored anticorrosive paint;

(c) the colored anticorrosive paint contains a color pigment;

(d) the colored anticorrosive paint contains a bisphenol A-type epoxy resin (A), an amine curing agent (B), a vinyl chloride copolymer (C), a monoepoxide compound (D), and a (meth)acrylate compound (E);

(e) a content of the vinyl chloride copolymer (C) is 5 to 50 parts by mass relative to 100 parts by mass of the bisphenol A-type epoxy resin (A);

(f) a content of the monoepoxide compound (D) is 2 to 50 parts by mass relative to 100 parts by mass of the amine curing agent (B);

(g) the first agent contains the bisphenol A-type epoxy resin (A) and the vinyl chloride copolymer (C);

(h) the second agent contains the amine curing agent (B) and the monoepoxide compound (D); and

(i) the (meth)acrylate compound (E) includes a vinyl ester resin;

[3] coating the surface of the object to be coated with the colored anticorrosive paint until the surface is hidden by a coating film formed from the colored anticorrosive paint; and

[4] obtaining a dry coating film by drying the coating film obtained in the step [3].

(2) The method according to (1), wherein the colored anticorrosive paint further satisfies the following condition (j):

(j) a color difference $\Delta E2$ is less than 1 between the coating film that has the dry coating film thickness T and is formed from the colored anticorrosive paint and a coating film that has a dry coating film thickness of 1.3T and is formed from the colored anticorrosive paint.

(3) The method according to (1) or (2), wherein the colored anticorrosive paint further satisfies the following condition (k):

5 (k) a color difference ΔE_3 is greater than or equal to 20 between the coating film that has the drying coating film thickness T and is formed from the colored anticorrosive paint and the surface of the object to be coated.

(4) The method according to any of (1) to (3), wherein the coating film that has the dry coating film thickness T and is formed from the colored anticorrosive paint has a hiding ratio of 0.90 to 0.98.

10 (5) The method according to any of (1) to (4), wherein a content of the color pigment is 0.01 to 3% by volume in coating film-forming components.

(6) The method according to any of (1) to (5), wherein a content ratio between the monoepoxide compound (D) and the vinyl chloride copolymer (C) is 0.02 to 2.5 by mass ratio.

15 (7) The method according to any of (1) to (6), wherein the monoepoxide compound (D) includes an alkyl glycidyl ether compound.

(8) The method according to any of (1) to (7), wherein the amine curing agent (B) is a polyamide amine.

(9) The method according to any of (1) to (8), wherein the vinyl chloride copolymer (C) is a vinyl chloride-vinyl alkyl ether copolymer.

20 (10) The method according to any of (1) to (9), wherein the colored anticorrosive paint further contains a scaly pigment (G) that has an average particle size of 10 to 300 μm , an average thickness of 2 to 50 μm , and an aspect ratio of 2 to 100, the aspect ratio being defined as the average particle size/the average thickness, and a content of the scaly pigment (G) is 5 to 45% by volume in the coating
25 film-forming components.

(11) The method according to (10), wherein the scaly pigment (G) is at least one pigment selected from the group consisting of talc, mica, and glass flakes.

(12) A colored anticorrosive paint being a two-pack colored anticorrosive paint that is used for forming a dry coating film with a dry coating film thickness T on a

surface of an object to be coated and that includes a first agent and a second agent, the colored anticorrosive paint satisfying the following conditions (a) to (i):

(a) a coating film that has the dry coating film thickness T and is formed from the colored anticorrosive paint hides the surface of the object to be coated;

5 (b) a color difference $\Delta E1$ is greater than or equal to 2.0 between the coating film that has the dry coating film thickness T and is formed from the colored anticorrosive paint and a coating film that has a dry coating film thickness of $0.7T$ and is formed from the colored anticorrosive paint;

(c) the colored anticorrosive paint contains a color pigment;

10 (d) the colored anticorrosive paint contains a bisphenol A-type epoxy resin (A), an amine curing agent (B), a vinyl chloride copolymer (C), a monoepoxide compound (D), and a (meth)acrylate compound (E);

(e) a content of the vinyl chloride copolymer (C) is 5 to 50 parts by mass relative to 100 parts by mass of the bisphenol A-type epoxy resin (A);

15 (f) a content of the monoepoxide compound (D) is 2 to 50 parts by mass relative to 100 parts by mass of the amine curing agent (B);

(g) the first agent contains the bisphenol A-type epoxy resin (A) and the vinyl chloride copolymer (C);

20 (h) the second agent contains the amine curing agent (B) and the monoepoxide compound (D); and

(i) the (meth)acrylate compound (E) includes a vinyl ester resin.

(13) The colored anticorrosive paint according to (12), further satisfying the following condition (j):

25 (j) a color difference $\Delta E2$ is less than 1 between the coating film that has the dry coating film thickness T and is formed from the colored anticorrosive paint and a coating film that has a dry coating film thickness of $1.3T$ and is formed from the colored anticorrosive paint.

(14) The colored anticorrosive paint according to (12) or (13), further satisfying the following condition (k):

(k) a color difference ΔE_3 is greater than or equal to 20 between the coating film that has the dry coating film thickness T and is formed from the colored anticorrosive paint and the surface of the object to be coated.

5 (15) The colored anticorrosive paint according to any of (12) to (14), wherein the coating film that has the dry coating film thickness T and is formed from the colored anticorrosive paint has a hiding ratio of 0.90 to 0.98.

(16) The colored anticorrosive paint according to any of (12) to (15), wherein a content of the color pigment is 0.01 to 3% by volume in coating film-forming components.

10 (17) The colored anticorrosive paint according to any of (12) to (16), wherein a content ratio between the monoepoxide compound (D) and the vinyl chloride copolymer (C) is 0.02 to 2.5 by mass ratio.

(18) The colored anticorrosive paint according to any of (12) to (17), wherein the monoepoxide compound (D) includes an alkyl glycidyl ether compound.

15 (19) The colored anticorrosive paint according to any of (12) to (18), wherein the amine curing agent (B) is a polyamide amine.

(20) The colored anticorrosive paint according to any of (12) to (19), wherein the vinyl chloride copolymer (C) is a vinyl chloride-vinyl alkyl ether copolymer.

20 (21) The colored anticorrosive paint according to any of (12) to (20), further containing a scaly pigment (G) that has an average particle size of 10 to 300 μm , an average thickness of 2 to 50 μm , and an aspect ratio of 2 to 100, the aspect ratio being defined as the average particle size/the average thickness, wherein

a content of the scaly pigment (G) is 5 to 45% by volume in the coating film-forming components.

25 (22) The colored anticorrosive paint according to (21), wherein the scaly pigment (G) is at least one pigment selected from the group consisting of talc, mica, and glass flakes.

ADVANTAGEOUS EFFECTS OF INVENTION

According to the present invention, there can be provided an anticorrosive paint

composition capable of forming a coating film excellent in adhesion to a top coating film even when the period until the coating with a topcoat paint is long, in other words, capable of making a period until the coating with a topcoat paint long while retaining excellent adhesion to a top coating film; a coating film formed with use of the composition; and a ship and an offshore structure that are provided with the coating film. The anticorrosive paint composition of the present invention is useful as a corrosion protection paint that is applied to, for example, a ship as well as offshore structures such as a bridge, a tank, and a plant.

Further, according to the present invention, there can be provided a method for forming a coating film that allows an easy coating operation with use of an epoxy-based anticorrosive paint composition capable of forming a coating film excellent in adhesion to a top coating film even when the period until the coating with a topcoat paint is long, in other words, capable of making a period until the coating with a topcoat paint long while retaining excellent adhesion to a top coating film, and that allows simple formation of a dry coating film with a predetermined film thickness while the insufficiency of the film thickness is suppressed; and a colored anticorrosive paint used in the method. The colored anticorrosive paint of the present invention is useful as a corrosion protection paint that is applied to, for example, a ship as well as offshore structures such as a bridge, a tank, and a plant.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a graph showing the relationship between the dry film thickness (μm) and the ΔE that are indicated in Tables 4 to 6 (Example 13 and Comparative Example 2).

Fig. 2 is a graph showing the relationship between the dry film thickness (μm) and the ΔE that are indicated in Tables 4 to 6 (Examples 14 and 15).

Fig. 3 is a graph showing the relationship between the dry film thickness (μm) and the ΔE that are indicated in Tables 4 to 6 (Examples 16 to 18).

Fig. 4 is a graph showing the relationship between the dry film thickness (μm) and the ΔE that are indicated in Tables 4 to 6 (Examples 19 to 21).

Fig. 5 is a graph showing the relationship between the dry film thickness (μm) and the ΔE that are indicated in Tables 4 to 6 (Example 22).

Fig. 6 is a graph showing the relationship between the dry film thickness (μm) and the ΔE that are indicated in Tables 4 to 6 (Example 23).

5 Fig. 7 is a graph showing the relationship between the dry film thickness (μm) and the ΔE that are indicated in Tables 4 to 6 (Example 24).

Fig. 8 is a graph showing the relationship between the dry film thickness (μm) and the ΔE that are indicated in Tables 4 to 6 (Examples 25 and 26).

DESCRIPTION OF EMBODIMENTS

10 Hereinafter, the present invention will be described in detail.

<Anticorrosive paint composition>

An anticorrosive paint composition according to the present invention contains a bisphenol A-type epoxy resin (A), an amine curing agent (B), a vinyl chloride copolymer (C), and a monoepoxide compound (D). Hereinafter, each component will
15 be described in detail. Hereinafter, a phrase “high in interval adhesion” refers to performance capable of making a period until the coating with a topcoat paint long while retaining excellent adhesion to a top coating film. The longer the period is, the more excellent the interval adhesion is.

(1) Bisphenol A-type epoxy resin (A)

20 The anticorrosive paint composition particularly contains a bisphenol A-type epoxy resin (A) among known epoxy resins. With use of the bisphenol A-type epoxy resin (A), the anticorrosive paint composition can be improved in a low-temperature curing property and made to be excellent in adhesion to base materials (objects to be coated) such as a blasted steel sheet, a shop-coated steel sheet, and an organic
25 zinc-coated steel sheet, thus giving an excellent anticorrosion property. Only one bisphenol A-type epoxy resin (A) may be used, or two or more bisphenol A-type epoxy resins (A) may be used in combination.

The anticorrosive paint composition can contain an epoxy resin other than the

bisphenol A-type epoxy resin (A). However, from the viewpoint of, for example, the low-temperature curing property and the adhesion to a base or a top coating film, the content percentage of the bisphenol A-type epoxy resin (A) in the total amount of epoxy resins is preferably greater than or equal to 50% by mass, more preferably greater than or equal to 70% by mass, further preferably greater than or equal to 90% by mass, particularly preferably greater than or equal to 95% by mass (e.g., 100% by mass). Examples of the epoxy resin other than the bisphenol A-type epoxy resin (A) include a bisphenol F-type epoxy resin, a bisphenol AD-type epoxy resin, a bisphenol S-type epoxy resin, a biphenyl type epoxy resin, a naphthalene type epoxy resin, a glycidyl ester type epoxy resin, a glycidyl amine type epoxy resin, a phenol novolac type epoxy resin, and a rubber-modified epoxy resin.

The epoxy equivalent of the bisphenol A-type epoxy resin (A) is preferably 100 to 3000, more preferably 150 to 1000, further preferably 180 to 500. With the epoxy equivalent greater than or equal to 100, an excellent low-temperature curing property tends to be easily obtained, and the toughness of the obtained coating film is likely to be excellent. With the epoxy equivalent greater than 3000, it is likely that the low-temperature curing property is deteriorated or the coating film becomes easily hard.

The number average molecular weight of the bisphenol A-type epoxy resin (A) is preferably 200 to 5000, more preferably 250 to 2000, in terms of standard polystyrene measured by gel permeation chromatography (GPC). With the number average molecular weight within the above-mentioned ranges, an anticorrosive paint composition is likely to be obtained that is excellent in coating film physical properties and coating workability.

The bisphenol A-type epoxy resin (A) (solid content) is contained in an amount of preferably 10 to 60% by mass, more preferably 15 to 55% by mass in the solid content of the anticorrosive paint composition. With the content greater than or equal to 10% by mass, the anticorrosion property of the coating film is likely to be excellent. With the content less than or equal to 60% by mass, it is easy to obtain an anticorrosive

paint composition that gives a not-too-hard coating film, is unlikely to cause defects such as a crack, and is thus excellent in crack resistance. With the content of the bisphenol A-type epoxy resin (A) greater than 60% by mass, for example, the adhesion to a base and a top coating film, and the interval adhesion tend to be deteriorated.

5 (2) Amine curing agent (B)

As the amine curing agent (B), there can be used a conventionally known epoxy resin curing agent. Specific examples of the amine curing agent (B) include a polyamine curing agent, a modified polyamine curing agent, a polyamide curing agent, and a modified polyamide curing agent. Only one amine curing agent (B) may be
10 used, or two or more amine curing agents (B) may be used in combination.

Examples of the polyamine curing agent include an aliphatic polyamine (e.g., meta-xylenediamine, isophoronediamine, diethylenetriamine, triethylenetetramine, and diaminodiphenylmethane); an alicyclic polyamine; and an aromatic polyamine. The modified polyamine curing agent is a modified product of the above-mentioned
15 polyamines, and examples thereof include aliphatic, alicyclic, or aromatic polyamines obtained by modifying the polyamines by, for example, epoxide addition, Michael addition, Mannich addition, thiourea addition, acrylonitrile addition, or ketone blocking.

Examples of the polyamide curing agent include polyamide amines that are
20 generated by condensation of a dimer acid with a polyamine and that have a reactive first and second amino groups in its molecule. The polyamine that forms the polyamide amine can be, for example, the above-mentioned aliphatic polyamine, alicyclic polyamine, or aromatic polyamine.

The modified polyamide curing agent is a modified product of a polyamide, and
25 examples thereof include an epoxy adduct obtained by adding an epoxy compound to a polyamide, and a Mannich-modified body of a modified polyamide.

Especially, the amine curing agent (B) preferably includes a polyamide amine from the viewpoint of, for example, the anticorrosion property, the crack resistance, the adhesion to a base and a top coating film, and the interval adhesion. The content of

the polyamide amine in the amine curing agent (B) is preferably greater than or equal to 50% by mass, more preferably greater than or equal to 70% by mass, further preferably greater than or equal to 90% by mass, still further preferably greater than or equal to 95% by mass, most preferably 100% by mass (the amine curing agent (B) is the polyamide amine). From the viewpoint of, for example, the crack resistance and the adhesion to a base and a top coating film, the polyamide amine is preferably an aliphatic polyamide amine that is, for example, a condensate of a dimer acid with an aliphatic polyamine.

The amine equivalent of the amine curing agent (B) is usually 50 to 1000, preferably 100 to 800, more preferably 150 to 655, further preferably 180 to 500. With the amine equivalent of the amine curing agent (B) within the above-mentioned ranges, it is easy to obtain an anticorrosive paint composition excellent in, for example, the anticorrosion property, the adhesion to a base and a top coating film, and the interval adhesion.

The amine curing agent (B) (solid content) is contained in an amount of preferably 5 to 40% by mass, more preferably 7 to 30% by mass in the solid content of the anticorrosive paint composition. With the content of the amine curing agent (B) within the above-mentioned ranges, it is advantageous in the aspects of, for example, the anticorrosion property, the crack resistance, the adhesion to a base and a top coating film, the interval adhesion, and the coating workability. From the same viewpoint, the content ratio between the bisphenol A-type epoxy resin (A) (solid content) and the amine curing agent (B) (solid content) in the anticorrosive paint composition is preferably 1/0.5 to 1.5, more preferably 1/0.6 to 1.3, further preferably 1/0.75 to 1.1 by equivalent ratio (epoxy groups in the bisphenol A-type epoxy resin (A)/active hydrogen in the amine curing agent (B)).

(3) Vinyl chloride copolymer (C)

The anticorrosive paint composition contains a vinyl chloride copolymer (C). The vinyl chloride copolymer (C) refers to a copolymer having a constitutional unit derived from vinyl chloride. The anticorrosive paint composition containing the vinyl

chloride copolymer (C) can increase, for example, the interval adhesion, the adhesion to a base and a top coating film, and the crack resistance. Only one vinyl chloride copolymer (C) may be used, or two or more vinyl chloride copolymers (C) may be used in combination.

5 Specific examples of the vinyl chloride copolymer (C) include a vinyl chloride-vinyl acetate copolymer, a vinyl chloride-vinyl propionate copolymer, a vinyl chloride-vinyl alkyl ether copolymer, a vinyl chloride-acrylonitrile copolymer, a vinyl chloride-diethyl maleate copolymer, a vinyl chloride-ethylene copolymer, a vinyl chloride-maleic anhydride copolymer, a vinyl chloride-alkyl (meth)acrylate copolymer,
10 a vinyl chloride-styrene copolymer, a vinyl chloride-vinylidene chloride copolymer, a vinyl chloride-vinyl stearate copolymer, a vinyl chloride-maleic acid (or maleate) copolymer, a vinyl chloride-maleate copolymer, and a vinyl chloride-aliphatic vinyl copolymer.

15 From the viewpoint of, for example, the interval adhesion, the adhesion to a base and a top coating film, and the crack resistance, the content of the constitutional unit derived from vinyl chloride in the vinyl chloride copolymer (C) is preferably greater than or equal to 50% by mass, more preferably greater than or equal to 60% by mass (e.g., greater than or equal to 70% by mass).

20 Especially, from the viewpoint of, for example, the interval adhesion, the adhesion to a base and a top coating film, the crack resistance, the anticorrosion property, the compatibility with the bisphenol A-type epoxy resin (A), and the coating workability, the vinyl chloride copolymer (C) is preferably a vinyl chloride-vinyl alkyl ether copolymer. Examples of the vinyl chloride-vinyl alkyl ether copolymer include a copolymer of vinyl chloride and an alkyl vinyl ether with an alkyl group having 1 to
25 10 carbon atoms, preferably 2 to 5 carbon atoms. More specifically, there can be preferably used, for example, a vinyl chloride-vinyl isobutyl ether copolymer, a vinyl chloride-vinyl isopropyl ether copolymer, and a vinyl chloride-vinyl ethyl ether copolymer. The vinyl chloride copolymer (C) is more preferably the vinyl chloride-vinyl isobutyl ether copolymer.

The weight average molecular weight of the vinyl chloride copolymer (C) is usually 10000 to 100000, preferably 20000 to 50000, more preferably 23000 to 40000, in terms of standard polystyrene measured by GPC. With the weight average molecular weight of the vinyl chloride copolymer (C) within the above-mentioned
5 ranges, it is advantageous to increase, for example, the interval adhesion, the adhesion to a base and a top coating film, the crack resistance, the anticorrosion property, the compatibility with the bisphenol A-type epoxy resin (A), and the coating workability.

The content of the vinyl chloride copolymer (C) (solid content) in the anticorrosive paint composition is 5 to 50 parts by mass, preferably 10 to 45 parts by
10 mass (e.g., 10 to 40 parts by mass) relative to 100 parts by mass of the bisphenol A-type epoxy resin (A) (solid content). With the content of the vinyl chloride copolymer (C) greater than or equal to 5 parts by mass, it is possible to obtain the effect of increasing, for example, the interval adhesion, the adhesion to a base and a top
15 coating film, the crack resistance, the anticorrosion property, the compatibility with the bisphenol A-type epoxy resin (A), and the coating workability. With the content of the vinyl chloride copolymer (C) greater than 50 parts by mass, for example, the effect of improving the interval adhesion and the adhesion to a top coating film come to be
insufficient or, on the contrary, may be deteriorated.

The vinyl chloride copolymer (C) (solid content) is contained in an amount of
20 preferably 1 to 30% by mass, more preferably 2 to 20% by mass (e.g., 2.5 to 15% by mass) in the solid content of the anticorrosive paint composition. With the content of the vinyl chloride copolymer (C) within the above-mentioned ranges, it is advantageous to increase, for example, the interval adhesion, the adhesion to a base and a top coating
25 film, the crack resistance, the anticorrosion property, the compatibility with the bisphenol A-type epoxy resin (A), and the coating workability.

(4) Monoepoxide compound (D)

The anticorrosive paint composition contains a monoepoxide compound (D). The monoepoxide compound (D) refers to a compound having one epoxy group in its molecule. The anticorrosive paint composition containing the vinyl chloride

copolymer (C) and the monoepoxide compound (D) can further improve the interval adhesion by a synergetic effect between the vinyl chloride copolymer (C) and the monoepoxide compound (D). Only one monoepoxide compound (D) may be used, or two or more monoepoxide compounds (D) may be used in combination.

5 Presumably, the anticorrosive paint composition according to the present invention is considered to improve the interval adhesion property by the following action caused as a result of containing the monoepoxide compound (D) in addition to the vinyl chloride copolymer (C). That is, as described above, the anticorrosive paint composition containing the vinyl chloride copolymer (C) can improve the interval
10 adhesion, thus making a period from the formation of an anticorrosive coating film formed from the anticorrosive paint composition to the coating with a topcoat paint long while retaining excellent adhesion to a top coating film. In the period until the coating with a topcoat paint, however, the vinyl chloride copolymer (C) may possibly generate a dehydrochlorination reaction due to influence of exposure to light (e.g.,
15 ultraviolet) or influence of oxygen, to cause a chain decomposition reaction. This decomposition reaction (dehydrochlorination reaction) is considered to be accelerated by active hydrogen included in a free amine derived from the amine curing agent (B) that may remain in the anticorrosive coating film. It is considered that in the anticorrosive paint composition containing the monoepoxide compound (D), the
20 monoepoxide compound (D) reacts with the free amine to consume the free amine, suppressing the acceleration of the dehydrochlorination reaction of the vinyl chloride copolymer (C) caused by the free amine, so that the interval adhesion is improved.

Preferable examples of the monoepoxide compound (D) include a monoglycidyl ether, and specific examples of the monoglycidyl ether include an alkyl glycidyl ether,
25 a phenyl glycidyl ether (e.g., an alkyl phenyl glycidyl ether). The number of carbon atoms in an alkyl moiety of the alkyl glycidyl ether and the alkyl phenyl glycidyl ether is usually 1 to 20, preferably 5 to 18, more preferably 10 to 16. The epoxy equivalent of the monoepoxide compound (D) is usually 50 to 1000, preferably 100 to 600, more preferably 150 to 500. Especially, the monoepoxide compound (D) is preferably an

alkyl glycidyl ether from the viewpoint of the improvement in the interval adhesion.

The content of the monoepoxide compound (D) (solid content) in the anticorrosive paint composition is 2 to 50 parts by mass, preferably 4 to 48 parts by mass (e.g., 5 to 47 parts by mass) relative to 100 parts by mass of the amine curing agent (B) (solid content). With the content of the monoepoxide compound (D) greater than or equal to 2 parts by mass, it is possible to obtain the effect of further improving the interval adhesion, as compared with a case where the monoepoxide compound (D) is not contained. With the content of the monoepoxide compound (D) greater than 50 parts by mass, the anticorrosion property and the hardness of the coating film may be deteriorated.

From the viewpoint of the improvement in the interval adhesion, the content ratio between the monoepoxide compound (D) (solid content) and the vinyl chloride copolymer (C) (solid content) (the monoepoxide compound (D)/the vinyl chloride copolymer (C) by mass ratio) in the anticorrosive paint composition is preferably 0.02 to 2.5, more preferably 0.03 to 2.0, further preferably 0.05 to 1.9. From the same viewpoint, the content ratio between the monoepoxide compound (D) (solid content) and the amine curing agent (B) (solid content) in the anticorrosive paint composition is preferably 1/0.01 to 0.4, more preferably 1/0.02 to 0.3, further preferably 1/0.03 to 0.25 by equivalent ratio (epoxy groups in the monoepoxide compound (D)/active hydrogen in the amine curing agent (B)).

The monoepoxide compound (D) (solid content) is contained in an amount of preferably 0.1 to 15% by mass, more preferably 0.2 to 10% by mass (e.g., 0.5 to 8% by mass) in the solid content of the anticorrosive paint composition. With the content of the monoepoxide compound (D) within the above-mentioned ranges, it is advantageous to increase the interval adhesion.

(5) (Meth)acrylate compound (E)

The anticorrosive paint composition can contain a (meth)acrylate compound (E) as necessary. The meth(acrylate) compound (E) refers to a compound having at least one (meth)acryloyl group in its molecule. The anticorrosive paint composition

containing the (meth)acrylate compound (E) may increase, for example, the interval adhesion, the adhesion to a base and a top coating film, the anticorrosion property, and the curing property. Only one (meth)acrylate compound (E) may be used, or two or more (meth)acrylate compounds (E) may be used in combination. In the present
 5 specification, the term “(meth)acryloyl group” represents at least one selected from methacryloyl and acryloyl. The same applies to the term “(meth)acryl”.

Examples of the (meth)acrylate compound (E) include alkyl (meth)acrylates such as methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, and butyl (meth)acrylate. The number of carbon atoms in an alkyl moiety is preferably 1 to 10,
 10 more preferably 1 to 5.

Other examples of the (meth)acrylate compound (E) include ethylene glycol di(meth)acrylate, diethylene glycol di(meth)acrylate, triethylene glycol di(meth)acrylate, tetraethylene glycol di(meth)acrylate, nonaethylene glycol di(meth)acrylate, tetradecaethylene glycol di(meth)acrylate, neopentyl glycol di(meth)acrylate, hexanediol di(meth)acrylate, butanediol di(meth)acrylate,
 15 trimethylolpropane tri(meth)acrylate, tri(meth)acrylate of trimethylolpropane ethylene oxide adduct, tri(meth)acrylate of trimethylolpropane propylene oxide adduct, glycerol tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol hexa(meth)acrylate, tris(2-(meth)acryloyloxyethyl) isocyanurate, and
 20 multifunctional (meth)acrylic compounds such as an adduct of pentaerythritol tri(meth)acrylate and tolylene diisocyanate in a ratio of 2 : 1.

Still other examples of the (meth)acrylate compound (E) include a vinyl ester resin (epoxy (meth)acrylate) obtained by a reaction of an epoxy resin with (meth)acrylic acid. The epoxy resin can be, in addition to the bisphenol A-type epoxy
 25 resin, the other epoxy resins as described in the section “(1) Bisphenol A-type epoxy resin (A)” above; however, the epoxy resin is preferably the bisphenol A-type epoxy resin.

Especially, the (meth)acrylate compound (E) is preferably a vinyl ester resin, more preferably a bisphenol A-type vinyl ester resin from the viewpoint of, for

example, the interval adhesion, the adhesion to a base and a top coating film, the anticorrosion property, and the curing property. The number average molecular weight of the vinyl ester resin is preferably 1000 to 5000, more preferably 1000 to 3000, in terms of standard polystyrene measured by GPC. With the number average

5 molecular weight of the vinyl ester resin within the above-mentioned ranges, it is advantageous to increase, for example, the interval adhesion, the adhesion to a base and a top coating film, the anticorrosion property, and the curing property.

The (meth)acrylate compound (E) (solid content) is contained in an amount of preferably 0.2 to 15% by mass, more preferably 0.5 to 10% by mass (e.g., 1 to 6% by

10 mass) in the solid content of the anticorrosive paint composition. With the content of the (meth)acrylate compound (E) within the above-mentioned ranges, it is advantageous to increase, for example, the interval adhesion, the adhesion to a base and a top coating film, the anticorrosion property, and the curing property. For the same reason, the content of the (meth)acrylate compound (E) (solid content) in the

15 anticorrosive paint composition is preferably 5 to 25 parts by mass, more preferably 10 to 20 parts by mass (e.g., 10 to 16 parts by mass) relative to 100 parts by mass of the bisphenol A-type epoxy resin (A) (solid content).

(6) Silane coupling agent (F)

The anticorrosive paint composition can contain a silane coupling agent (F) as

20 necessary. The anticorrosive paint composition containing the silane coupling agent (F) may increase, for example, the interval adhesion, the adhesion to a base and a top coating film, the anticorrosion property, and the curing property. Only one silane coupling agent (F) may be used, or two or more silane coupling agents (F) may be used in combination.

25 Preferable examples of the silane coupling agent (F) include an alkoxy silane compound. Examples of the alkoxy silane compound include γ -glycidyoxyalkyltrialkoxysilanes such as γ -glycidyoxypropyltrimethoxysilane and γ -glycidyoxypropyltriethoxysilane; γ -aminoalkyltrialkoxysilanes such as γ -aminopropyltriethoxysilane and γ -aminopropyltripropoxysilane; and

N-phenyl- γ -aminoalkyltrialkoxysilanes such as
 N-phenyl- γ -aminopropyltrimethoxysilane, N-phenyl- γ -aminopropyltriethoxysilane, and
 N-phenyl- γ -aminopropyltripropoxysilane.

5 The silane coupling agent (F) (solid content) is contained in an amount of
 preferably 0.1 to 15% by mass, more preferably 0.2 to 10% by mass (e.g., 1 to 5% by
 mass) in the solid content of the anticorrosive paint composition. With the content of
 the silane coupling agent (F) within the above-mentioned ranges, it is advantageous to
 increase, for example, the interval adhesion, the adhesion to a base and a top coating
 film, the anticorrosion property, and the curing property.

10 (7) Other blending components

The anticorrosive paint composition can contain at least one other blending
 component as necessary. Examples of the other blending component include a
 thermoplastic resin, a solvent, a pigment, an anti-sagging agent (anti-settling agent), a
 color separation-preventing agent, an antifoaming/foaming preventing agent, a
 15 film-forming assistant, an ultraviolet absorber, an antioxidant, a leveling agent, a
 delustering agent, a curing accelerator, a dispersant, a viscosity modifier, a surface
 conditioner, a plasticizer, an antiseptic, a reactive diluent, and a nonreactive diluent.
 Examples of the thermoplastic resin that can be used include a petroleum resin, a
 (meth)acrylic resin, and a polyester resin. The anticorrosive paint composition
 20 containing the thermoplastic resin may improve the physical properties of the coating
 film.

As the solvent, there can be used one that is usually used in the art, and
 examples thereof include toluene, xylene, isobutanol, methyl ethyl ketone, and methyl
 isobutyl ketone. A mixed solvent containing at least two solvents may be used.

25 Examples of the pigment include a color pigment, an extender pigment, and a
 rust preventive pigment. Specific examples of the color pigment include titanium
 oxide, carbon black, white lead, black lead, zinc sulfide, zinc oxide (zinc flower),
 chromium oxide, nickel titanium yellow, chromium titanium yellow, yellow iron oxide,
 red iron oxide, black iron oxide, phthalocyanine blue, phthalocyanine green,

ultramarine blue, benzimidazolone yellow, quinacridone red, and azo red and yellow pigments. Two or more color pigments may be used.

Specific examples of the extender pigment include talc, clay, calcium carbonate, magnesium carbonate, barium sulfate, silicic acid, silicate, alumina, calcium sulfate,
5 micaceous iron oxide (MIO), glass flakes, and mica (e.g., suzorite mica and clarite mica). Two or more extender pigments may be used.

Specific examples of the rust preventive pigment include zinc molybdate, aluminum molybdate, lead cyanamide, red lead, lead suboxide, zinc chromate, zinc dust (Zn), zinc oxide (zinc flower), basic lead chromate, basic lead sulfate, calcium
10 plumbate, aluminum tripolyphosphate, zinc phosphate, calcium phosphate, aluminum powder (Al), and gypsum hemihydrate. Two or more rust preventive pigments may be used.

(8) Preparation of anticorrosive paint composition

The anticorrosive paint composition according to the present invention can be
15 prepared in the same manner as a general anticorrosive paint containing an epoxy resin. The anticorrosive paint composition according to the present invention is preferably a two-pack paint composition. The two-pack anticorrosive paint composition includes a first agent (main agent) containing at least the bisphenol A-type epoxy resin (A) and a second agent (curing agent) containing at least the amine curing agent (B). Both the
20 first agent and the second agent can contain a solvent. The two-pack anticorrosive paint composition is usually applied onto an object to be coated after the first agent is mixed with the second agent directly before the use.

In the two-pack anticorrosive paint composition, the vinyl chloride copolymer (C), the monoepoxide compound (D), the (meth)acrylate compound (E), the silane
25 coupling agent (F), and the other blending component(s) may be blended in either the first agent or the second agent, or may be blended in both the agents. Usually, the (meth)acrylate compound (E) and the silane coupling agent (F) are blended in the first agent.

In one preferable embodiment of the two-pack anticorrosive paint composition,

the vinyl chloride copolymer (C) is contained in the first agent (main agent), and the monoepoxide compound (D) is contained in the second agent (curing agent). With such arrangement, the interval adhesion can be increased, as compared with a case where the first agent contains both the vinyl chloride copolymer (C) and the monoepoxide compound (D).

(9) Application of anticorrosive paint composition

Application of the anticorrosive paint composition onto an object to be coated can be performed by general methods such as a brush, a roller, and a spray. In a case of the two-pack paint composition, the paint composition can be obtained by mixing the first agent with the second agent directly before the use and applied with use of the above-mentioned methods. The paint composition obtained by mixing the first agent with the second agent is applied onto an object to be coated within a usable time after the mixture of the first agent with the second agent. The anticorrosive paint composition of the present invention typically shows a usable time of about 30 minutes to 8 hours. After the application of the composition, drying can be performed to form an anticorrosive coating film. The drying temperature is usually an ordinary temperature (about 20 to 35°C); however, drying can also be performed at a temperature lower than an ordinary temperature.

The object to be coated (an object to be coated with the anticorrosive paint composition) is not particularly limited as long as the object needs corrosion protection, and the object can be, for example, a ship (e.g., an inner surface of a ballast tank, a ship bottom, and a shell of a ship) as well as offshore structures such as a bridge, a tank, a plant (e.g., a petroleum plant), and a pipe. The material of the surface of the object to be coated with the anticorrosive paint composition can be, for example, ferrous metals such as steel, a nonferrous metal, concrete, and a coating film formed from a paint of, for example, an old coating film. The old coating film refers to a coating film that has been formed and subjected to use before, or a part of the coating film.

The anticorrosive paint composition according to the present invention is suitably applicable to a coating method (a method for manufacturing a composite

coating film) of forming an undercoating film on a surface of an object to be coated and then forming a top coating film on the undercoating film. In this method, the anticorrosive paint composition according to the present invention can be used for the formation of the undercoating film. The undercoating film may have a laminated structure of a plurality of coating films. In this case, the anticorrosive paint composition according to the present invention is used at least for the formation of the undercoating film for the outermost surface (in contact with a top coating film).

Examples of the base of an undercoating film formed from the anticorrosive paint composition according to the present invention include rust preventive coating, shop coating, and a coating film formed through organic or inorganic zinc primer coating. The surface of an object to be coated may be subjected to blasting.

The film thickness of the anticorrosive coating film formed from the anticorrosive paint composition according to the present invention can be appropriately determined according to, for example, the type of the object to be coated and the use purpose of the object. The dry film thickness, however, is usually about 10 to 500 μm . The anticorrosive coating film formed from the anticorrosive paint composition according to the present invention may be formed by applying the composition a plurality of times for multi-layer coating to form a dry coating film having a desired film thickness. In the application of the composition a plurality of times for multi-layer coating, the amount of the composition per application is not particularly limited, and the composition is usually applied so that each coating film has a dry film thickness of 10 to 500 μm . In the case of applying the composition a plurality of times for multi-layer coating, wet coating films may be stacked to form a plurality of layers and subjected to drying to obtain a dry coating film having a desired film thickness, or a plurality of dry coating film layers may be formed to obtain a dry coating film having a desired film thickness.

As a topcoat paint used for a top coating film formed on the anticorrosive coating film, there can be used one that is generally used in the anticorrosive coating. Specific examples of the topcoat paint include an oil paint, a long-oil phthalic resin

paint, a silicone alkyd resin paint, a phenol resin paint, a chlorinated rubber resin paint, an epoxy resin paint, a modified epoxy resin paint, a tar epoxy resin paint, a vinyl chloride resin paint, a polyurethane resin paint, a fluororesin paint, a silicone-modified resin paint, and an antifouling paint for preventing biofouling. Examples of the antifouling paint include an acrylic resin antifouling paint and a vinyl resin antifouling paint. The topcoat paint is preferably an epoxy resin paint, a polyurethane resin paint, a fluororesin paint, an acrylic resin antifouling paint, and a vinyl resin antifouling paint, for example. The dry film thickness of the top coating film is usually about 10 to 300 μm .

The topcoat paint may be the anticorrosive paint composition according to the present invention. One aspect of the case where the anticorrosive paint composition of the present invention is a topcoat paint is a case of forming a coating film formed from the anticorrosive paint composition according to the present invention, for the purpose of, for example, repair on an old coating film formed from the anticorrosive paint composition according to the present invention. In the meantime, the anticorrosive paint composition according to the present invention can also be used not for the formation of the undercoating film but for entirely the formation of the top coating film. The top coating film formed from the anticorrosive paint composition according to the present invention usually has a dry film thickness of about 10 to 300 μm .

The anticorrosive coating film formed from the anticorrosive paint composition according to the present invention can exhibit excellent adhesion to both the top coating film formed from the anticorrosive paint composition and a top coating film formed from the above-mentioned other topcoat paints as well as exhibit excellent interval adhesion, while securing, for example, an excellent anticorrosion property and excellent crack resistance.

<Colored anticorrosive paint>

A colored anticorrosive paint (colored anticorrosive paint composition) according to the present invention can be used in a method for forming a coating film

according to the present invention described later in detail. The method for forming a coating film according to the present invention is a method for forming a dry coating film on a surface of an object to be coated and includes the following steps of:

- 5 setting a dry coating film thickness T (dry coating film thickness setting step);
- preparing or arranging a colored anticorrosive paint that is a two-pack colored anticorrosive paint including a first agent and a second agent and satisfies the conditions (a) to (i) described later (colored anticorrosive paint preparation step);
- coating the surface of the object to be coated with the colored anticorrosive paint until the surface is hidden by a coating film formed from the colored anticorrosive paint (coating step); and
- 10 obtaining a dry coating film by drying the coating film (wet coating film) obtained in the coating step (drying step).

15 In the method for forming a coating film according to the present invention, a predetermined colored anticorrosive paint (colored anticorrosive paint composition) is used as a paint for forming a dry coating film. This colored anticorrosive paint is a paint having a “film thickness determination function” that allows determination of whether or not a predetermined film thickness has been attained by visually observing the hue of a half-coated film (wet coating film). First, the colored anticorrosive paint according to the present invention will be described in detail below.

20 The colored anticorrosive paint according to the present invention is a two-pack anticorrosive paint composition including a first agent and a second agent. The colored anticorrosive paint according to the present invention contains a color pigment (condition (c)). The colored anticorrosive paint contains a bisphenol A-type epoxy resin (A), an amine curing agent (B), a vinyl chloride copolymer (C), a monoepoxide compound (D), and a (meth)acrylate compound (E) (condition (d)).

25 The first agent of the colored anticorrosive paint contains the bisphenol A-type epoxy resin (A) and the vinyl chloride copolymer (C) (condition (g)), and the second agent contains the amine curing agent (B) and the monoepoxide compound (D) (condition (h)). Hereinafter, each component will be described in detail.

(1) Bisphenol A-type epoxy resin (A)

The first agent (main agent) of the colored anticorrosive paint contains the bisphenol A-type epoxy resin (A). For the bisphenol A-type epoxy resin (A) contained in the first agent of the colored anticorrosive paint, description is cited from
5 “(1) Bisphenol A-type epoxy resin (A)” of <Anticorrosive paint composition> described above.

(2) Amine curing agent (B)

As the amine curing agent (B) contained in the second agent, there can be used a conventionally known epoxy resin curing agent. For the amine curing agent (B)
10 contained in the second agent, description is cited from “(2) Amine curing agent (B)” of <Anticorrosive paint composition> described above.

(3) Vinyl chloride copolymer (C)

The first agent of the colored anticorrosive paint contains the vinyl chloride copolymer (C). For the vinyl chloride copolymer (C) contained in the first agent,
15 description is cited from “(3) Vinyl chloride copolymer (C)” of <Anticorrosive paint composition> described above. The content of the vinyl chloride copolymer (C) (solid content) in the colored anticorrosive paint is 5 to 50 parts by mass (condition (e)), preferably 10 to 45 parts by mass (e.g., 10 to 40 parts by mass) relative to 100 parts by mass of the bisphenol A-type epoxy resin (A) (solid content).

20 (4) Monoepoxide compound (D)

The second agent of the colored anticorrosive paint contains the monoepoxide compound (D). For the monoepoxide compound (D) contained in the second agent, description is cited from “(4) Monoepoxide compound (D)” of <Anticorrosive paint composition> described above. The content of the monoepoxide compound (D) (solid
25 content) in the colored anticorrosive paint is 2 to 50 parts by mass (condition (f)), preferably 4 to 48 parts by mass (e.g., 5 to 47 parts by mass) relative to 100 parts by mass of the amine curing agent (B) (solid content).

(5) (Meth)acrylate compound (E)

The colored anticorrosive paint contains the (meth)acrylate compound (E).

For the (meth)acrylate compound (E), description is cited from “(5) (Meth)acrylate compound (E)” of <Anticorrosive paint composition> described above. From the viewpoint of, for example, the interval adhesion, the adhesion to a base and a top coating film, the anticorrosion property, and the curing property, the (meth)acrylate compound (E) contains a vinyl ester resin (condition (i)), preferably a bisphenol A-type vinyl ester resin.

(6) Silane coupling agent (F)

The colored anticorrosive paint can contain a silane coupling agent (F) as necessary. For the silane coupling agent (F), description is cited from “(6) Silane coupling agent (F)” of <Anticorrosive paint composition> described above.

(7) Color pigment

As the color pigment contained in the colored anticorrosive paint, there can be used conventionally known various color pigments, and colored anticorrosive paints with various hues can be realized by selection of color pigments. The type of a color pigment added to the colored anticorrosive paint (hue of the colored anticorrosive paint) can be selected according to the color of a surface of an object to be coated (surface to be coated), and it is preferable to select a type of the color pigment or a combination of color pigments so that a color difference ΔE^* is greater than or equal to 20 between a coating film that has the dry coating film thickness T and is formed from the colored anticorrosive paint and a surface of an object to be coated. The hue of the coating film that has the dry coating film thickness T and is formed from the colored anticorrosive paint is substantially the same as the hue of the colored anticorrosive paint itself as long as the paint is, for example, a usual solvent paint that does not cause color separation.

Specific examples of the color pigment are not particularly limited, and there can be used, for example, carbon black, titanium dioxide, zircon oxide, basic lead sulfate, tin oxide, white lead, black lead, zinc sulfide, zinc oxide, chromium oxide, nickel titanium yellow, chromium titanium yellow, yellow iron oxide, red iron oxide, black iron oxide, chromium yellow, phthalocyanine blue, phthalocyanine green,

ultramarine blue, quinacridones, and azo red and yellow pigments. Only one color pigment may be used alone, or two or more color pigments may be used in combination.

5 Especially, carbon black and titanium dioxide are preferably used for their high coloring power, and the color pigment more preferably includes titanium dioxide. When only titanium dioxide is used as the color pigment, the coating film has a pale color. Another color pigment may be used in combination to prevent such a pale color.

10 In the colored anticorrosive paint according to the present invention for forming especially a thick coating film, it is necessary for the colored anticorrosive paint to have a relatively small base hiding property, and therefore, the content of the color pigment is preferably relatively small. Specifically, the content of the color pigment is usually 0.01 to 3% by volume, preferably 0.1 to 2% by volume in the coating film-forming components. With the content of the color pigment extremely small, the base hiding
15 power is too small, excessively decreasing the change in the hue of a half-coated wet coating film, so that it is difficult to determine whether or not a prescribed film thickness has been attained. On the other hand, with the content of the color pigment extremely large, the base hiding power is too large, allowing the coating film to hide a surface of an object to be coated before the dry coating film thickness attains a target
20 setting value T, so that it is similarly difficult to determine whether or not a prescribed film thickness has been attained. In the present specification, the term “coating film-forming components” means all the components other than a solvent that are included in the colored anticorrosive paint.

(8) Pigments other than color pigment

25 The colored anticorrosive paint can contain a pigment other than the color pigment as necessary. Examples of the pigment other than the color pigment include an extender pigment and a rust preventive pigment. Specific examples of the extender pigment include talc, clay, calcium carbonate, magnesium carbonate, barium sulfate, silicic acid, silicate, alumina, calcium sulfate, micaceous iron oxide (MIO), glass flakes,

and mica (e.g., suzorite mica and clarite mica). Two or more extender pigments may be used.

Specific examples of the rust preventive pigment include calcium sulfate hemihydrate, zinc molybdate, aluminum molybdate, lead cyanamide, zinc calcium cyanamide, red lead, lead suboxide, zinc chromate, strontium chromate, barium chromate, zinc dust (Zn), zinc oxide (zinc flower), basic lead chromate, basic lead sulfate, calcium plumbate, aluminum tripolyphosphate, zinc phosphate, calcium phosphate, calcium phosphite, trilead tetraoxide, lead suboxide, aluminum powder (Al), and gypsum hemihydrate. Two or more rust preventive pigments may be used.

When the dry coating film thickness T set in the dry coating film thickness setting step is selected from the range of greater than or equal to 300 μm , the colored anticorrosive paint preferably includes a scaly (flattened) pigment (hereinafter, also simply referred to as a “scaly pigment”) (G) having an average particle size of preferably 10 to 300 μm , an average thickness of preferably 2 to 50 μm , and an aspect ratio of preferably 2 to 100, the aspect ratio being defined as the average particle size/the average thickness. The definition and the measuring method of the average particle size, the average thickness, and the aspect ratio are as described in the section Examples. Hereinafter, the scaly pigment (G) and its function will be described.

Both the film thickness determination paints described in PTDs 4 and 5 described above are paints used for forming a coating film having a target dry film thickness (dry coating film thickness T) of greater than or equal to 100 μm and are paints prepared so as to fulfill the following relationships for the color difference by adjusting the content of a color pigment included in the paints.

(a) A color difference of greater than or equal to 20 between the film thickness determination paint and an object to be coated.

(b) A color difference of greater than or equal to 2 between a coating film having a target dry film thickness and a coating film having a dry film thickness of less than (the target dry film thickness - 50) μm .

(c) A color difference of less than 1 between a coating film having a target dry film

thickness and a coating film having a dry film thickness of greater than (the target dry film thickness + 50) μm .

Especially, (b) is significantly important among the above relationships, because it is difficult for a coating operator to visually determine whether the
5 half-coated wet coating film has attained a target film thickness of a dry coating film or the film thickness is still insufficient if the difference is not clear between the hue of a coating film that is fairly approximating the target film thickness and the hue of a coating film that has attained the target film thickness.

Accordingly, it can be said that the larger the color difference is between a
10 coating film that is fairly approximating a target film thickness and a coating film that has attained the target film thickness, the easier the film thickness determination is. However, in a case of forming a considerably thick coating film by single coating, a problem may possibly occur that it is difficult to make the color difference sufficiently large. The problem is more specifically described. When the target dry film
15 thickness of a coating film formed by single coating is up to about 250 μm (the target dry film thickness in the examples of PTD 4 is 125 μm and the target dry film thickness in the examples of PTD 5 is 250 μm at a maximum), it has been possible to make the color difference large to some degree according to the preparation processes described in these patent documents, and to relatively easily perform the film thickness
20 determination in the formation of a coating film having a desired film thickness.

In the meantime, a thick coating film having a film thickness of as large as greater than 250 μm has also been conventionally formed on an object to be coated. Representative examples of such a thick coating film are anticorrosive coating films (rust preventive coating films) formed on surfaces of a ship, offshore structures such as
25 a bridge, and steel structures such as a plant. Conventionally, however, such a thick coating film has usually been formed not by single coating but by multi-layer coating (a coating method of performing a series of steps from coating to drying a plurality of times to stack dry coating films).

However, under the circumstances that a coating method has come to be

employed in recent years, the method of forming a thick coating film having a film thickness of, for example, greater than or equal to 300 μm not by multi-layer coating but by single coating, it has been found that it is difficult to make the color difference sufficiently large between a coating film that is fairly approximating a target film thickness and a coating film that has attained the target film thickness and it is not always easy to determine whether the wet coating film has attained the target film thickness or the film thickness is still insufficient.

In a case of selecting the dry coating film thickness T set in the dry coating film thickness setting step from the range of greater than or equal to 300 μm , the significance of adding the scaly pigment (G) to the colored anticorrosive paint is as follows. In a paint (e.g., an anticorrosive paint), an extender pigment is added to increase the strength of a coating film, or to increase corrosion resistance if the paint is an anticorrosive paint, and the addition itself is a common technique, and a film thickness determination paint is also known that includes both the extender pigment and the color pigment (PTDs 4 and 5). However, when the conventional film thickness determination paint is applied to a method of forming a thick coating film by single coating, it is difficult, as described above, to make the color difference sufficiently large between a coating film that is fairly approximating a target film thickness (the setting value T of a target dry coating film thickness) and a coating film that has attained the target film thickness, and it is not always easy to determine whether the wet coating film has attained the target film thickness or the film thickness is still insufficient.

The above-mentioned conventional problem is described in more detail. When the dry film thickness increases, the ΔE (sort of exponentially) monotonically decreases drastically to a state where a difference in the ΔE hardly occurs in a foot region of a graph, that is, between the setting value T of the dry coating film thickness and a near region before the setting value T (that is, a state where the color difference is very small between a coating film that is fairly approximating a target film thickness and a coating film that has attained the target film thickness). This problem comes to be remarkable

with an increase in the thickness of a coating film formed by single coating. This is because the foot region is extensively widened where a difference in the ΔE hardly occurs, with an increase in the setting value T of the dry coating film thickness.

In contrast, according to the colored anticorrosive paint including the scaly pigment (G) and the method for forming a coating film with use of the paint, the dry film thickness and ΔE graph, with reference to for example a graph of Example 13 shown in Fig. 1, does not show an exponential and drastic monotonic decrease but takes a shape of the ΔE a little bulging to a large side between a dry film thickness of 0 μm and the setting value T of the dry coating film thickness, as compared with the shape of a drastic monotonic decrease. With the graph having such a shape, even when the dry coating film thickness T is selected from the range of greater than or equal to 300 μm , it comes to be possible to realize the condition “a color difference ΔE_1 of greater than or equal to 2.0 between a coating film having the dry coating film thickness T and a coating film having a dry coating film thickness of $0.7T$ ” (condition (b)), that is, it comes to be possible to make the color difference sufficiently large between a coating film that is fairly approximating a target film thickness (the setting value T of a target dry coating film thickness) and a coating film that has attained the target film thickness, making it easy to determine whether the wet coating film has attained the target film thickness or the film thickness is still insufficient.

Although a reason why the above-mentioned shape of a graph is formed is not clear, the following matter is considered to be a factor that causes the above-mentioned shape of a graph: it is considered that the extender pigment is originally a component that absorbs light and prevents transmission of light, while the scaly pigment (G) becomes likely to align in a surface direction of a coating film (the major axis direction of the scaly pigment becomes likely to align in a surface direction of a coating film) with an increase in the thickness of the coating film, and along with this phenomenon, light is likely to be transmitted through the scaly pigment (G).

From the viewpoint of the fulfillment of the condition (b) and the physical properties of the paint and the coating film, the average particle size of the scaly

pigment (G) is preferably 10 to 300 μm , more preferably 10 to 200 μm , further preferably 10 to 150 μm . With the average particle size less than 10 μm , if the dry coating film thickness T set in the dry coating film thickness setting step is selected from the range of greater than or equal to 300 μm , it may be difficult to realize the condition (b). Further, with the average particle size less than 10 μm , the oil absorption of the scaly pigment (G) increases and the viscosity of the paint increases along the increase in the oil absorption, so that the coating workability tends to be deteriorated. With the average particle size greater than 300 μm , if the dry coating film thickness T is selected from the range of greater than or equal to 300 μm , it also tends to be hard to realize the condition (b), and in addition, the smoothness of the surface of the coating film tends to be impaired.

From the viewpoint of the fulfillment of the condition (b) and the physical properties of the paint and the coating film, the aspect ratio of the scaly pigment (G) is preferably 2 to 100. When the aspect ratio is high to some degree, it is easier to increase the bulge of the above-mentioned graph. Accordingly, the aspect ratio is more preferably greater than or equal to 3, further preferably greater than or equal to 4. When the dry coating film thickness T is selected from the range of greater than or equal to 300 μm , it is disadvantageous to have an aspect ratio of less than 2 for realizing the condition (b). On the other hand, if the aspect ratio is excessively large, a reinforcing effect of the scaly pigment for the coating film comes to be insufficient to deteriorate the strength of the coating film and the corrosion resistance. Accordingly, the aspect ratio is more preferably less than or equal to 20.

The average thickness of the scaly pigment (G) is preferably set to 2 to 50 μm . The preferable range of the average thickness can be set to a range derived from the above-mentioned preferable ranges of the average particle size and the above-mentioned preferable ranges of the aspect ratio, and the preferable range of the average thickness can be set to, for example, the range of 2 to 30 μm (e.g., 2 to 20 μm).

The scaly pigment (G) has a refractive index of preferably less than or equal to

1.8, more preferably less than or equal to 1.7, further preferably less than or equal to 1.6. The refractive index is decreased and light reflection is suppressed in an interface between a binder resin (epoxy resin) and the scaly pigment (G) in the coating film to increase the amount of light transmission, so that the condition (b) can be more
5 realizable. The measuring method of the refractive index is as described in the section Examples.

The scaly pigment (G) can be an extender pigment, and specific examples thereof include talc, mica, clay, glass flakes, and aluminum hydroxide. The scaly pigment (G) is preferably talc, mica, clay and glass flakes, more preferably, talk, mica,
10 and glass flakes. The colored anticorrosive paint can contain at least one scaly pigment (G).

The colored anticorrosive paint can contain another extender pigment other than the scaly pigment (G). The other extender pigment may be a flattened extender pigment having at least any one of the average particle size, the average thickness, and
15 the aspect ratio that does not satisfy the above-mentioned predetermined ranges, or may be a particulate extender pigment having an aspect ratio of 1 or about 1. The other extender pigment may be made from the same material or a different material from the material of the scaly pigment (G), and specific examples of the material include, in addition to those described for the scaly pigment (G), calcium carbonate, magnesium
20 carbonate, barium sulfate, silica, alumina, bentonite, silicic acid, silicate, aluminum oxide hydrate, and calcium sulfate. The colored anticorrosive paint can contain at least one other extender pigment.

The content of the scaly pigment (G) is preferably 5 to 45% by volume, more preferably 10 to 40% by volume (e.g., 15 to 35% by volume) in the coating
25 film-forming components. With the content of the scaly pigment (G) less than 5% by volume, the above-mentioned effect exhibited by blending the scaly pigment (G) is unlikely to be obtained, and with the other extender pigment(s) not used in combination, the reinforcing effect for the coating film is insufficient, being likely to be insufficient in the strength of the coating film and the corrosion resistance. With the content of

the scaly pigment (G) greater than 45% by volume, film formability tends to be deteriorated.

When the scaly pigment (G) and the other extender pigment(s) are used in combination, the total content of the pigments is preferably set to less than or equal to 45% by volume in the coating film-forming components. In addition, when the scaly pigment (G) and the other extender pigment(s) are used in combination, the content of the scaly pigment (G) in the total content of the pigments is set to preferably greater than or equal to 10% by volume, more preferably greater than or equal to 20% by volume, further preferably greater than or equal to 30% by volume, from the viewpoint of the fulfillment of the condition (b).

In a case of selecting the dry coating film thickness T set in the dry coating film thickness setting step from the range of less than 300 μm , the colored anticorrosive paint may or may not contain the scaly pigment (G).

(9) Other blending components

The colored anticorrosive paint can contain at least one other blending component as necessary. Examples of the other blending component include a thermoplastic resin, a solvent, an anti-sagging agent (anti-settling agent), a color separation-preventing agent, an antifoaming/foaming preventing agent, a film-forming assistant, an ultraviolet absorber, an antioxidant, a leveling agent, a delustering agent, a curing accelerator, a dispersant, a viscosity modifier, a surface conditioner, a plasticizer, an antiseptic, a reactive diluent, and a nonreactive diluent. Examples of the thermoplastic resin that can be used include a petroleum resin, a (meth)acrylic resin, and a polyester resin. The anticorrosive paint composition containing the thermoplastic resin can improve the physical properties of the coating film. The content of the other blending component(s) is preferably set so as not to spoil a clear hue and the base hiding property of the color pigment and deteriorate the film thickness determination function of the colored anticorrosive paint.

As the solvent, an organic solvent can preferably be used, and examples thereof include aromatic hydrocarbons such as toluene, xylene, and ethyl benzene; aliphatic or

alicyclic hydrocarbons such as cyclopentane, octane, heptane, cyclohexane, and white spirit; oil fractions that mainly consist of an aliphatic hydrocarbon, have a little aromatic hydrocarbon, and can show various boiling ranges; ethers such as dioxane, tetrahydrofuran, ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, 5 ethylene glycol monobutyl ether, ethylene glycol dibutyl ether, diethylene glycol monomethyl ether, and diethylene glycol monoethyl ether; esters such as butyl acetate, propyl acetate, benzyl acetate, ethylene glycol diacetate, 2-ethoxyethyl acetate, ethylene glycol monomethyl ether acetate, and ethylene glycol monoethyl ether acetate; ketones such as methyl ethyl ketone, ethyl isobutyl ketone, and methyl isobutyl ketone; 10 and alcohols such as n-butanol, i-butanol, t-butanol, n-propanol, i-propanol, and benzyl alcohol. Only one solvent may be used alone, or two or more solvents may be used in combination.

(10) Preparation of colored anticorrosive paint

The colored anticorrosive paint according to the present invention can be 15 prepared in the same manner as a general anticorrosive paint containing an epoxy resin. The colored anticorrosive paint according to the present invention is a two-pack paint and includes the first agent (main agent) containing at least the bisphenol A-type epoxy resin (A) and the vinyl chloride copolymer (C) and the second agent (curing agent) containing at least the amine curing agent (B) and the monoepoxide compound (D). 20 Both the first agent and the second agent can contain a solvent. Usually, the first agent is mixed with the second agent to prepare a colored anticorrosive paint directly before the use and the colored anticorrosive paint is applied onto an object to be coated.

In the two-pack colored anticorrosive paint, the (meth)acrylate compound (E), the silane coupling agent (F), and the other blending component(s) including a pigment 25 may be blended in either the first agent or the second agent, or may be blended in both the agents. Usually, the (meth)acrylate compound (E) and the silane coupling agent (F) are blended in the first agent.

The vinyl chloride copolymer (C) is contained in the first agent (main agent), and the monoepoxide compound (D) is contained in the second agent (curing agent).

With such arrangement, the interval adhesion can be increased, as compared with a case where the first agent contains both the vinyl chloride copolymer (C) and the monoepoxide compound (D).

5 The first agent and the second agent each can be prepared by mixing the blending components with use of a mixing machine such as a ball mill, a pebble mill, a roll mill, a sand grind mill, or a high-speed disper.

(11) Film thickness determination function of colored anticorrosive paint

10 The colored anticorrosive paint according to the present invention is a paint that at least satisfies the following conditions (a) and (b) and preferably further satisfies the following condition (j) and is excellent in the film thickness determination function. In the meantime, the “dry coating film thickness T” in the following conditions is a thickness selected from the range of, for example, about 10 to 500 μm , and may be selected from the range of greater than or equal to 300 μm .

15 (a) A coating film that has a set dry coating film thickness T and is formed from the colored anticorrosive paint hides a surface of an object to be coated.

(b) The color difference $\Delta E1$ is greater than or equal to 2.0 between a coating film that has a set dry coating film thickness T and is formed from the colored anticorrosive paint and a coating film that has a dry coating film thickness of 0.7T and is formed from the colored anticorrosive paint.

20 (j) The color difference $\Delta E2$ is less than 1 between a coating film that has a set dry coating film thickness T and is formed from the colored anticorrosive paint and a coating film that has a dry coating film thickness of 1.3T and is formed from the colored anticorrosive paint.

25 The color differences $\Delta E1$, $\Delta E2$, and $\Delta E3$ that will be described later can be measured by a generally accepted method with use of a color difference meter (colorimeter) such as a tristimulus colorimeter SM color meter (model SM-T45, manufactured by Suga Test Instruments Co., Ltd.). All the color differences $\Delta E1$, $\Delta E2$, and $\Delta E3$ are absolute values.

The condition (a) specifies the hiding property of a coating film that has the dry

coating film thickness T and is formed from the colored anticorrosive paint (the coating film referred to herein is a dry coating film; however, the base hiding property of the wet coating film is almost the same as the base hiding property of the dry coating film) for a surface of an object to be coated. As the colored anticorrosive paint is applied
 5 onto a surface of an object to be coated, the degree of the surface of the object to be coated "being seen through" decreases along with an increase in the coating film thickness. When the hue of the surface of the object to be coated is lost, and the hue of the coated surface has become the same hue as the coating film formed from the colored anticorrosive paint, the coating film formed from the colored anticorrosive
 10 paint is determined to have hidden the surface of the object to be coated. The colored anticorrosive paint according to the present invention can achieve such hiding of a surface of an object to be coated when forming a dry coating film having the dry coating film thickness T or a dry coating film thickness of greater than or equal to the dry coating film thickness T .

15 The hiding property of the dry coating film formed from the colored anticorrosive paint can also be evaluated by a hiding ratio in accordance with JIS K 5600-4-1:1999. In order to fulfill the condition (a), the coating film that has the dry coating film thickness T and is formed from the colored anticorrosive paint has a hiding ratio of preferably 0.90 to 0.98, more preferably 0.92 to 0.98 (e.g., 0.92 to 0.96).

20 The condition (b) specifies the color difference $\Delta E1$ between when the film thickness is the dry coating film thickness T set as a target and when the film thickness is $0.7T$, in the dry coating film formed from the colored anticorrosive paint. The coating film having a dry coating film thickness of $0.7T$ is a coating film before completion of the coating. A color difference $\Delta E1$ of as large as greater than or equal
 25 to 2.0 means large dependence of the hue of the coating film on the film thickness just before completion of the coating (from before the dry coating film thickness T ($0.7T$) to the dry coating film thickness T). With such a large color difference $\Delta E1$, it is possible to make the color difference sufficiently large between a coating film that is fairly approximating the dry coating film thickness T and a coating film that has attained the

dry coating film thickness T , making it easy to determine whether the wet coating film has attained the target film thickness or the film thickness is still insufficient, so that a dry coating film having the dry coating film thickness T can be very accurately formed and even a slight lack of film thickness can be solved.

5 The color difference $\Delta E1$ is preferably greater than or equal to 2.1, more preferably greater than or equal to 2.5, further preferably greater than or equal to 3.0. With the color difference $\Delta E1$ extremely large, a slight difference in the film thickness is likely to cause color unevenness, and therefore, the color difference $\Delta E1$ is preferably less than or equal to 10, more preferably less than or equal to 5. For
10 formation of a thick coating film having a film thickness of greater than or equal to 300 μm as described above, the scaly pigment (G) is preferably used to realize a color difference $\Delta E1$ of “greater than or equal to 2.0”.

 In order to make the color difference sufficiently large between a coating film that is fairly approximating the dry coating film thickness T and a coating film that has
15 attained the dry coating film thickness T and in order to make it easy to determine whether the wet coating film has attained the target film thickness or the film thickness is still insufficient, a color difference $\Delta E1'$ is preferably greater than or equal to 1.0, more preferably greater than or equal to 1.1, further preferably greater than or equal to 1.2 (e.g., greater than or equal to 1.5) between a coating film that has a set dry coating
20 film thickness T and is formed from the colored anticorrosive paint and a coating film that has a dry coating film thickness of $0.8T$ and is formed from the colored anticorrosive paint. For the same reason, a color difference $\Delta E1''$ is preferably greater than or equal to 0.5, more preferably greater than or equal to 0.6, further preferably greater than or equal to 0.7 between a coating film that has a set dry coating film
25 thickness T and is formed from the colored anticorrosive paint and a coating film that has a dry coating film thickness of $0.9T$ and is formed from the colored anticorrosive paint.

 The condition (j) specifies the color difference $\Delta E2$ between when the film

thickness is the dry coating film thickness T set as a target and when the film thickness is $1.3T$, in the dry coating film formed from the colored anticorrosive paint. A coating film having a dry coating film thickness of $1.3T$ is a coating film after (or directly after) completion of the coating. With the color difference ΔE_2 greater than or equal to 1, the color difference increases between a coating film having the dry coating film thickness T and a coating film having a film thickness of greater than the dry coating film thickness T , so that color unevenness is likely to occur. The color difference ΔE_2 is preferably less than or equal to 0.5, more preferably less than or equal to 0.4 (e.g., less than or equal to 0.2).

As the color difference ΔE_3 increases between a coating film having a set dry coating film thickness T and is formed from the colored anticorrosive paint and a surface of an object to be coated, it is easier to visually confirm the way of a change in the color difference that proceeds between a half-coated film and the object to be coated along with the film thickness of the half-coated film approximating the target film thickness, making it easier to determine whether the wet coating film has attained the target film thickness or the film thickness is still insufficient. Accordingly, the color difference ΔE_3 is preferably greater than or equal to 20 (condition (k)), more preferably greater than or equal to 25, further preferably greater than or equal to 30. With the color difference ΔE_3 extremely small, it is likely to be difficult to confirm whether or not a surface of an object to be coated has been hidden by the coating film.

The colored anticorrosive paint that satisfies the above-mentioned conditions can be obtained by selecting a type (hue) of the color pigment and adjusting the content of the color pigment, or further adding a predetermined amount of the scaly pigment (G). The setting value of the dry coating film thickness T of the colored anticorrosive paint can be adjusted according to the content of the color pigment. That is, basically, the setting value of the dry coating film thickness T of the colored anticorrosive paint can be increased by decreasing the content of the color pigment. In other words, the setting value of the dry coating film thickness T is determined on the basis of the coating film characteristics, such as corrosion resistance, required of the coating film

and the type of an object to be coated, and therefore the content of the color pigment is adjusted so as to be compatible with the setting value of the dry coating film thickness T.

<Method for forming coating film>

5 As described above, the method for forming a coating film according to the present invention is a method for forming a dry coating film on a surface of an object to be coated and includes the following steps of:

setting a dry coating film thickness T (dry coating film thickness setting step);

10 preparing or arranging a colored anticorrosive paint that is a two-pack colored anticorrosive paint including a first agent and a second agent and satisfies the above-mentioned conditions (a) to (i) (preferably further the conditions (j) and (k)) (colored anticorrosive paint preparation step);

15 coating the surface of the object to be coated with the colored anticorrosive paint until the surface is hidden by a coating film formed from the colored anticorrosive paint (coating step); and

obtaining a dry coating film by drying the coating film (wet coating film) obtained in the coating step (drying step).

20 The method for forming a coating film according to the present invention specifies a method for forming a coating film by single coating as understood from the steps included in the method, while any methods for forming a coating film are included in the present invention as long as the methods include the method for forming a coating film by single coating. For example, the present invention includes a method that includes the method for forming a coating film by single coating according to the present invention and a method that gives a dry coating film that

25 secures a desired film thickness by multi-layer coating. Hereinafter, each step will be described in detail.

(1) Dry coating film thickness setting step

The present step is a step of setting the dry coating film thickness T as a target film thickness of a dry coating film formed by single coating. In the present invention,

the dry coating film thickness T is not particularly limited, and is selected from the range of, for example, about 10 to 500 μm and may be selected from the range of greater than or equal to 300 μm . In order to prepare or arrange a predetermined colored anticorrosive paint in the colored anticorrosive paint preparation step, the dry coating film thickness T needs to have been set in advance, and therefore, the present step is performed before the colored anticorrosive paint preparation step.

The dry coating film thickness T may be the film thickness itself of a dry coating film that is to be finally formed on a surface of an object to be coated, or may be the film thickness of a dry coating film in the halfway stage of forming the dry coating film. The former example is a case of forming a final dry coating film on a surface of an object to be coated by single coating, and the latter example is a case of forming a final dry coating film by multi-layer coating. A specific example of the latter includes a case of forming a dry coating film having a film thickness of 300 μm by single coating and then further forming, on the dry coating film, another dry coating film having a film thickness of 300 μm to form a dry coating film having a final objective film thickness of 600 μm . The film thickness of a dry coating film that is to be finally formed on a surface of an object to be coated is usually a film thickness that can sufficiently give, by the formation of the coating film, desired characteristics to be imparted to the surface of the object to be coated (e.g., a film thickness that can give sufficient corrosion resistance).

(2) Colored anticorrosive paint preparation step

The present step is a step of preparing or arranging the colored anticorrosive paint according to the present invention that is a two-pack colored anticorrosive paint including a first agent and a second agent and that satisfies the conditions (a) to (i) (preferably further the conditions (j) and (k)). The detail of the colored anticorrosive paint including the preparation method thereof is as described above, and is therefore omitted herein.

(3) Coating step

The present step is a step of coating a surface of an object to be coated with the

colored anticorrosive paint until the surface is hidden by a coating film formed from the colored anticorrosive paint. In this step, a surface of an object to be coated is being coated with the colored anticorrosive paint while a change in the color difference is observed between a half-coated film (wet coating film) and the surface of the object to be coated. The phrase “a change in the color difference is observed between a half-coated film (wet coating film) and the surface of the object to be coated” typically refers to observing whether or not the surface of the object to be coated is “being seen through” the coated surface, that is, how much the half-coated film (wet coating film) has hidden the surface of the object to be coated. More specifically, the surface of the object to be coated is being coated with the colored anticorrosive paint, but the coating film thickness is small in the beginning of the coating, and therefore, the hue of the wet coating film largely reflects the hue of the surface of the object to be coated as the base (that is, largely “being seen through”). Thus, the change is visually observed in the hue of the half-coated film (wet coating film) with respect to the hue of the surface of the object to be coated. As the coating film thickness increases, the degree of “being seen through” decreases to reach a time point when the hue of the surface of the object to be coated is not reflected to the hue of the wet coating film, that is, a time point when the wet coating film hides the surface of the object to be coated. The base hiding property of the wet coating film is almost the same as the base hiding property of the dry coating film, and therefore the coating film thickness of the wet coating film at this time point (the coating film thickness of the wet coating film that has hidden the surface of the object to be coated) is a film thickness corresponding to the target dry coating film thickness T.

In the above-mentioned coating method, it can be confirmed as follows whether or not a wet coating film has hidden a surface of an object to be coated. For example, a color sample can be produced in advance that is provided with a dry coating film having the target dry coating film thickness T, to determine that a wet coating film has hidden a surface of an object to be coated at a time point when the hue of the color sample has coincided with the hue of the wet coating film. Alternatively, when a

region is already present that has a coating film formed therein with a target film thickness in the vicinity of a surface of an object to be coated that is being subjected to coating, it is possible to determine that a wet coating film has hidden the surface of the object to be coated at a time point when the hue of the coating film in the region has coincided with the hue of the wet coating film. Alternatively, the hues of a dry coating film having the target dry coating film thickness T and a wet coating film corresponding to the dry coating film are typically the same as the hue of the colored anticorrosive paint itself, and therefore, it is possible to determine that a wet coating film has hidden a surface of an object to be coated at a time point when the hue of the wet coating film has coincided with the hue of the colored anticorrosive paint itself.

The application method of the colored anticorrosive paint is not particularly limited, and there can be used, for example, conventionally known methods such as a dipping method, a spraying method, coating with a brush, a roller, and electrostatic coating. Specifically, the paint composition that can be obtained by mixing the first agent with the second agent directly before the use is applied with use of the above-mentioned methods. The paint composition that is obtained by mixing the first agent with the second agent is applied onto an object to be coated within a pot life (a usable time) after the mixture of the first agent with the second agent. The colored anticorrosive paint according to the present invention typically shows a usable time of about 30 minutes to 8 hours. After the application of the composition, drying can be performed to form an anticorrosive coating film. The drying temperature is usually an ordinary temperature (about 20 to 35°C); however, drying can also be performed at a temperature lower than an ordinary temperature.

An object to be coated (an object to be coated with the colored anticorrosive paint) is not particularly limited as long as the object needs corrosion protection, and the object can be, for example, a ship (e.g., an inner surface of a ballast tank, a ship bottom, and a shell of a ship) as well as offshore structures such as harbor facilities; intake facilities including a power plant; piping including a cooling conduct pipe; a bridge; a buoy; industrial water facilities; a submarine base. The material of a surface

of an object to be coated with the colored anticorrosive paint can be, for example, ferrous metals such as steel (e.g., steel materials such as a non-treated steel material, a blast-treated steel material, an acid-treated steel material, a galvanized steel material, and a stainless steel material); nonferrous metals such as an aluminum (alloy) material and a copper (alloy) material; concrete; plastic; and a coating film formed from a paint of, for example, an old coating film. The old coating film refers to a coating film that has been formed and subjected to use before, or a part of the coating film.

The surface of an object to be coated with the colored anticorrosive paint may be pretreated as necessary, or may have an undercoat layer (coating film). Examples of the coating film may include a shop primer layer formed from a conventionally known rust preventive paint composition; an organic or inorganic zinc primer layer; and another anticorrosive coating film. Referring to the specific examples described above again, the other anticorrosive coating film can be, for example, a first dry coating film in a case of forming a dry coating film having a film thickness of 300 μm by single coating and then further forming, on the dry coating film, another dry coating film having a film thickness of 300 μm to form an anticorrosive coating film having a final objective film thickness of 600 μm . When an undercoat layer is formed on a surface of an object to be coated, the term “surface of an object to be coated” in the above-mentioned conditions (a) and (k) means a surface of the undercoat layer.

The above-mentioned other anticorrosive coating film may be one formed according to the method of the present invention. When an anticorrosive coating film is further formed on such a colored anticorrosive coating film according to the method of the present invention, the colored anticorrosive paint for forming the base anticorrosive coating film preferably has a different color from the color of the colored anticorrosive paint for the anticorrosive coating film formed on the base anticorrosive coating film, and the color difference between the two paints is preferably greater than or equal to 20, in order to satisfy the condition (k).

(4) Drying step

The present step is a step of drying the coating film (wet coating film) obtained

in the coating step to give a dry coating film. For drying (and curing) the wet coating film, a conventionally known method can be used. The drying temperature is usually an ordinary temperature (about 20 to 35°C); however, drying can be performed also at a temperature lower or higher than an ordinary temperature.

5 (5) Other steps

A topcoat paint may be applied onto the obtained dry coating film to form a top coating film. Alternatively, a binder coat may be formed on the obtained dry coating film, and a topcoat paint may be applied onto the binder coat to form a top coating film. As the topcoat paint, there can be used at least one selected from an oil paint, a long-oil
 10 phthalic acid resin paint, an epoxy resin paint, a modified epoxy resin paint, a tar epoxy resin paint, a chlorinated rubber resin paint, a vinyl chloride resin paint, an alkyd resin paint, a silicone alkyd resin paint, an acrylic resin paint, a urethane resin paint, a fluororesin paint, a polyester resin paint, an epoxy acrylic resin paint, a polysiloxane resin paint, and a phenol resin paint. The topcoat paint may be an antifouling paint
 15 applied to, for example, an offshore structure and a ship. An example of the antifouling paint includes an antifouling paint that has, as a binder resin, an acrylic resin having a hydrolyzable group in its side chain. The hydrolyzable group can be, for example, a metal ester group containing a metal atom such as divalent Cu or Zn, and a trialkylsilyl ester group. The dry film thickness of the top coating film is
 20 usually about 10 to 300 μm .

The topcoat paint may be the colored anticorrosive paint according to the present invention. One aspect of the case where the colored anticorrosive paint of the present invention is a topcoat paint is a case of forming a coating film formed from the colored anticorrosive paint according to the present invention, for the purpose of, for
 25 example, repair on an old coating film formed from the colored anticorrosive paint according to the present invention. In the meantime, the colored anticorrosive paint according to the present invention can also be used not for the formation of the undercoating film but for entirely the formation of the top coating film. The top coating film formed from the colored anticorrosive paint according to the present

invention usually has a dry film thickness of about 10 to 500 μm .

5 The anticorrosive coating film formed from the colored anticorrosive paint according to the present invention can exhibit excellent adhesion to both the top coating film formed from the colored anticorrosive paint and a top coating film formed from the above-mentioned other topcoat paints as well as exhibit excellent interval adhesion, while securing, for example, an excellent anticorrosion property and excellent crack resistance. With such characteristics, the coating workability can be improved.

10 According to the method for forming a coating film with use of the colored anticorrosive paint according to the present invention, it is possible to easily determine whether or not a half-coated film has attained a predetermined film thickness, so that a uniform coating film having a predetermined dry film thickness can be accurately formed. With such a function, lack of film thickness is effectively prevented that has conventionally often occurred. In addition, an excessive film thickness can also be prevented, so that the paint can be saved.

15 Further, according to the method for forming a coating film with use of the colored anticorrosive paint according to the present invention, it is possible to avoid a troublesome operation of sequentially measuring the coating film thickness to confirm whether or not a predetermined film thickness has been attained, making a coating operation greatly efficient and greatly reducing a burden on a coating operator.

20 The method for forming a coating film with use of the colored anticorrosive paint according to the present invention can be applied to anticorrosive coating of various structures (particularly, a ship and an offshore structure). According to the method of the present invention, it is possible to accurately and simply form a uniform coating film having a predetermined dry film thickness even for a structure that is difficult to coat or a portion of the structure, for example, in a case where anticorrosive coating is performed on an outer surface of a large structure such as a ship.

Examples

Hereinafter, the present invention will be described in further detail by way of examples and comparative examples; however, the present invention is not to be

limited by these examples. The part and percent (%) in the examples are based on the mass except “PVC” in tables unless otherwise stipulated.

<Examples 1 to 12 and Comparative Example 1: preparation of colored anticorrosive paint>

5 According to the blending prescriptions shown in Tables 1 and 2, the blending components were mixed to prepare a first agent (main agent) and a second agent (curing agent), so that a two-pack colored anticorrosive paint was obtained. The detail of the blending components shown in Tables 1 and 2 is as follows. The unit of the blending amounts shown in the tables is part by mass in terms of a solid content.

10 Tables 1 and 2 also show the blending amounts of a color pigment and an extender pigment by % by volume (% by volume in the coating film-forming components). The term coating film-forming components means all the components other than a solvent that are included in the colored anticorrosive paint. Tables 1 and 2 also show a setting value T of the target dry coating film thickness of each colored
15 anticorrosive paint and a hiding ratio of the dry coating film of each colored anticorrosive paint that has the dry coating film thickness T (represented as “Hiding ratio with dry coating film thickness T” in Tables 1 and 2).

 [1] Bisphenol A (BFA)-type epoxy resin (A): bisphenol A-type epoxy resin (solvent dilution type) manufactured by DIC Corporation, trade name “EPICLON
20 860-90X”, epoxy equivalent: 230 to 270 g/eq, number average molecular weight (in terms of standard polystyrene measured by GPC): 470, nonvolatile content (solid content): 90% by mass

 [2] Vinyl chloride copolymer (C): vinyl chloride-vinyl isobutyl ether copolymer manufactured by BASF SE, trade name “Laroflex MP25”, molar ratio of vinyl
25 chloride/vinyl isobutyl ether: about 75/25, weight average molecular weight (in terms of standard polystyrene measured by GPC): 28000 to 30000, nonvolatile content (solid content): 100% by mass

 [3] (Meth)acrylate compound (E): bisphenol A-type epoxy (meth)acrylate (bisphenol A-type vinyl ester resin) manufactured by Showa Denko K.K., trade name

“Repoxy VR-90-M”, number average molecular weight (in terms of standard polystyrene measured by GPC): 2000, nonvolatile content (solid content): 70% by mass

5 [4] Silane coupling agent (F): γ -glycidyloxypropyltrimethoxysilane manufactured by Evonik Degussa GmbH, trade name “DYNASYLAN GLYMO”, nonvolatile content (solid content): 100% by mass

[5] Color pigment 1: titanium oxide (white pigment) manufacture by ISHIHARA SANGYO KAISHA, LTD., trade name “CR50”, nonvolatile content (solid content): 100% by mass, specific gravity: 4.1

10 [6] Color pigment 2: yellow iron oxide manufactured by Titan Kogyo, Ltd., trade name “TAROX iron oxide LL-XLO”, nonvolatile content (solid content): 100% by mass, specific gravity: 4.1

15 [7] Extender pigment 1: glass flakes manufactured by Nippon Sheet Glass Co. Ltd., trade name “RCF-140”, average particle size 149 μm , average thickness 28 μm , aspect ratio: 5.3, refractive index: 1.5, nonvolatile content: 100% by mass, specific gravity: 2.5

[8] Extender pigment 2: talc manufactured by FUJI TALC INDUSTRIAL CO., LTD., trade name “Talc DS34-N”, average particle size: 17 μm , average thickness: 4 μm , aspect ratio: 4.3, refractive index: 1.6, nonvolatile content: 100% by mass, specific gravity: 2.7

20 [9] Extender pigment 3: talc manufactured by FUJI TALC INDUSTRIAL CO., LTD., trade name “Talc SP42”, average particle size: 14 μm , average thickness: 4 μm , aspect ratio: 3.5, refractive index: 1.6, nonvolatile content: 100% by mass, specific gravity: 2.7

25 [10] Extender pigment 4: talc manufactured by FUJI TALC INDUSTRIAL CO., LTD., trade name “Talc TPA-25”, average particle size: 8 μm , average thickness: 3 μm , aspect ratio: 2.7, refractive index: 1.6, nonvolatile content: 100% by mass, specific gravity: 2.7

[11] Extender pigment 5: mica manufactured by Kirara Kabushiki Kaisha, trade name “White mica 200M”, average particle size 78 μm , average thickness: 8 μm ,

aspect ratio: 9.8, refractive index: 1.6, nonvolatile content: 100% by mass, specific gravity: 2.7

5 [12] Extender pigment 6: mica manufactured by Mintech International Inc., trade name "MT-MICA D325W", average particle size: 39 μm , average thickness: 7 μm , aspect ratio: 5.6, refractive index: 1.6, nonvolatile content: 100% by mass, specific gravity: 2.8

[13] Rust preventive pigment: gypsum hemihydrate (β gypsum) manufactured by NORITAKE CO., LIMITED, trade name "TA-85N", nonvolatile content (solid content): 100% by mass

10 [14] Solvent 1: xylene

[15] Solvent 2: isobutanol

[16] Solvent 3: methyl isobutyl ketone

[17] Anti-sagging agent: anti-sagging agent manufactured by Kusumoto Chemicals, Ltd., trade name "DISPARLON 6700", nonvolatile content (solid content): 100% by mass

15 [18] Amine curing agent (B): polyamide amine (dimer acid-modified aliphatic polyamide amine (amine component: mixture of triethylenetetramine and tetraethylenepentamine)) manufactured by Air Products and Chemicals, Inc., trade name "Ancamide 2050", amine equivalent: 225 mg KOH/g, nonvolatile content (solid content): 69% by mass

20 [19] Monoepoxide compound (D): alkyl glycidyl ether compound (12 to 14 carbon atoms in alkyl moiety) manufactured by Air Products and Chemicals, Inc., trade name "Epodil 748", epoxy equivalent: 275 to 300, nonvolatile content (solid content): 100% by mass

25

[Table 1]

		Examples							
		1	2	3	4	5	6	7	8
First agent	BFA-type epoxy resin (A)	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Vinyl chloride copolymer (C)	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30
	(Meth)acrylate compound (E)	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
	Silane coupling agent (F)	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
	Color pigment 1	0.46	0.54	0.46	0.46	0.46	0.53	0.50	0.46
	Color pigment 2	0.51	0.45	0.51	0.51	0.51	0.60	0.56	0.51
	Extender pigment 1		31.96				51.96	22.59	4.91
	Extender pigment 2	34.50							29.21
	Extender pigment 3					34.50			
	Extender pigment 4								
	Extender pigment 5			34.50					
	Extender pigment 6				35.78				
	Rust preventive pigment	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80
	Solvent 1	4.20	4.20	4.20	4.20	4.20	6.20	4.20	4.20
	Solvent 2	3.00	3.00	3.00	3.00	3.00	4.00	3.00	3.00
	Solvent 3	9.00	9.00	9.00	9.00	9.00	11.00	9.00	9.00
	Anti-sagging agent	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	Total	80.67	78.15	80.67	81.95	80.67	103.29	68.85	80.29
Second agent	Amine curing agent (B)	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
	Monoepoxide compound (D)	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
	Solvent 1	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
	Solvent 2	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
	Total	13.10	13.10	13.10	13.10	13.10	13.10	13.10	13.10
Blending amount of color pigment (% by volume)		0.61	0.62	0.61	0.61	0.61	0.59	0.73	0.61
Extender pigment (% by volume)		32.7	32.7	32.7	32.7	32.7	44.1	25.6	32.7
NV of colored anticorrosive paint (% by mass)		71.9	74.4	75.2	75.5	75.2	75.7	71.4	75.0
PVC of colored anticorrosive paint (%)		39.4	39.4	39.4	39.4	39.4	49.8	33.0	39.4
Number of parts of (C)/100 parts of (A)		42	42	42	42	42	42	42	42
Number of parts of (D)/100 parts of (B)		21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3
Number of parts of (D)/Number of parts of (C)		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
(D)/(B) equivalent ratio		1/0.11	1/0.11	1/0.11	1/0.11	1/0.11	1/0.11	1/0.11	1/0.11
Setting value T of dry coating film thickness (μm)		320	320	320	320	320	320	320	320
Hiding ratio with dry coating film thickness T		0.94	0.94	0.94	0.95	0.94	0.94	0.96	0.94

[Table 2]

		Examples				Comparative Example
		9	10	11	12	1
First agent	BFA-type epoxy resin (A)	15.00	15.00	15.00	15.00	15.00
	Vinyl chloride copolymer (C)	6.30	6.30	6.30	6.30	6.30
	(Meth)acrylate compound (E)	2.60	2.60	2.60	2.60	2.60
	Silane coupling agent (F)	0.40	0.40	0.40	0.40	0.40
	Color pigment 1	0.47	0.20	0.10	0.66	3.00
	Color pigment 2	0.53	0.23	0.12	0.75	3.60
	Extender pigment 1	11.50		31.77		
	Extender pigment 2		34.37			33.50
	Extender pigment 3					
	Extender pigment 4	22.08			34.70	
	Extender pigment 5					
	Extender pigment 6					
	Rust preventive pigment	3.80	3.80	3.80	3.80	3.80
	Solvent 1	4.20	4.20	4.20	4.20	4.20
	Solvent 2	3.00	3.00	3.00	3.00	3.00
	Solvent 3	9.00	9.00	9.00	9.00	9.00
	Anti-sagging agent	0.90	0.90	0.90	0.90	0.90
	Total	79.78	80.00	77.19	81.31	85.30
Second agent	Amine curing agent (B)	7.50	7.50	7.50	7.50	6.50
	Monoepoxide compound (D)	1.60	1.60	1.60	1.60	
	Solvent 1	2.40	2.40	2.40	2.40	2.40
	Solvent 2	1.60	1.60	1.60	1.60	1.60
	Total	13.10	13.10	13.10	13.10	10.50
Blending amount of color pigment (% by volume)		0.63	0.27	0.14	0.88	4.26
Extender pigment (% by volume)		32.7	32.7	32.7	32.7	32.7
NV of colored anticorrosive paint (% by mass)		74.9	75.0	74.2	75.3	76.0
PVC of colored anticorrosive paint (%)		39.4	39.2	39.1	39.7	43.0
Number of parts of (C)/100 parts of (A)		42	42	42	42	42
Number of parts of (D)/100 parts of (B)		21.3	21.3	21.3	21.3	-
Number of parts of (D)/Number of parts of (C)		0.25	0.25	0.25	0.25	-
(D)/(B) equivalent ratio		1/0.11	1/0.11	1/0.11	1/0.11	-
Setting value T of dry coating film thickness (μm)		320	520	1000	220	320
Hiding ratio with dry coating film thickness T		0.94	0.94	0.94	0.94	1.00

According to the following method, measurement was conducted for the

average particle size, the average thickness, the aspect ratio, and the refractive index of the extender pigments such as a scaly pigment, and the hiding ratio of the dry coating film of each colored anticorrosive paint that has the dry coating film thickness T (hiding ratio of each colored anticorrosive paint with the dry coating film thickness T).

5 [A] Average particle size, average thickness, and aspect ratio of extender pigment

For the extender pigments, a particle image was photographed with use of a powder image analyzer ("PITA-3" manufactured by Seishin Enterprise Co., Ltd.), 50 particles each photographed from a direction orthogonal to a main surface of the
10 particle were selected from the obtained photographed image, and a major radius and a minor radius were measured for each of the particles. The average value of the major radii of the 50 particles was set as the average particle size of the extender pigment, and the average value of the minor radii of the 50 particles as the average thickness of the extender pigment. Further, the aspect ratio was calculated by dividing the average
15 particle size by the average thickness. The measurement conditions of the powder image analyzer are as follows.

- Dispersion medium of sample liquid and flow rate of medium: water, 0.42 $\mu\text{L}/\text{sec}$

- Types of first and second carrier liquids and flow rate of liquids: water and
20 500 $\mu\text{L}/\text{sec}$ in both liquids

- Observation magnification of photographed image: 10 times

[B] Refractive index of extender pigment

The refractive indexes of the extender pigments were measured in accordance with JIS K 0062: 1992.

25 [C] Hiding ratio of colored anticorrosive paint with dry coating film thickness T

The hiding ratio of a dry coating film of each colored anticorrosive paint was measured that has a setting value T of the dry coating film thickness, in accordance with JIS K 5600-4-1: 1999.

The first agent (main agent) and the second agent (curing agent) of the obtained

two-pack colored anticorrosive paint were mixed in a quantitative ratio shown in the “total” column in Table 1 or 2 (e.g., first agent: second agent = 80.67 parts by mass: 13.10 parts by mass in Example 1), and the mixture was sufficiently stirred to be uniform, so that a mixed paint (anticorrosive paint composition) was obtained. The obtained mixed paint (anticorrosive paint composition) was subjected to the following evaluation tests. The test results are shown in Table 3.

[1] Electric anticorrosion property evaluation test (cathode anticorrosion property test)

First, a grid-blasted steel sheet (7 cm × 15 cm × 3.2 mm) was coated with an inorganic zinc shop primer (trade name “CERAMO”) manufactured by Nippon Paint Marine Coatings Co., Ltd. so as to have a dry coating film thickness of about 15 μm and was dried for 7 days to produce a primer-treated steel sheet. Then, the primer-treated steel sheet was coated with the above-mentioned anticorrosive paint composition directly after the preparation thereof so as to have a dry coating film thickness of about 250 μm with use of an air spray and was dried in the atmosphere of 23°C × 65 %RH for 7 days to give a test coated sheet. A test was conducted for the test coated sheet in accordance with ASTM G8-90 and the sheet was evaluated. That is, first, a sheet was produced that is obtained by forming a base material exposing part with a size of φ 6.3 mm in the center of an immersion part on a test surface (coated surface) of the test coated sheet with use of a drill having a bade of φ 6.3 mm. Then, a potential of 1.5 V was applied to the sheet while the sheet was immersed in 40°C aqueous solutions each including NaCl, Na₂SO₄, or Na₂CO₃ in an amount of 1% by mass, and one month later, measurement was conducted for the length (creep width, mm) of a peeled part of the coating film from the base material exposing part. The numerical value (creep width) in Table 3 is the average value of the results of immersing the sheet in each of the above-mentioned three aqueous solutions.

[2] 40°C salt water resistance evaluation test (anticorrosion property evaluation test)

First, a grid-blasted steel sheet (7 cm × 15 cm × 3.2 mm) was coated with an inorganic zinc shop primer (trade name “CERAMO”) manufactured by Nippon Paint Marine Coatings Co., Ltd. so as to have a dry coating film thickness of about 15 μm and was dried for 7 days to produce a primer-treated steel sheet. Then, the primer-treated steel sheet was coated with the above-mentioned anticorrosive paint composition directly after the preparation thereof so as to have a dry coating film thickness of about 250 μm with use of an air spray and was dried in the atmosphere of 20°C × 65 %RH for 7 days to give a test coated sheet. Next, the test coated sheet was immersed in 3% salt water at 40°C for 3 months. The adhesion force (MPa) of the coating film to the primer-treated steel sheet after the 3-month immersion was measured by an adhesion tester manufactured by Elcometer Limited.

[3] Topcoat adhesion evaluation test (interval adhesion test)

[3-1] When topcoat paint is antifouling paint composition

First, a grid-blasted steel sheet (7 cm × 15 cm × 3.2 mm) was coated with an inorganic zinc shop primer (trade name “NIPPE CERAMO”) manufactured by Nippon Paint Marine Coatings Co., Ltd. so as to have a dry coating film thickness of about 15 μm and was dried for 7 days to produce a primer-treated steel sheet. Then, the primer-treated steel sheet was coated with the above-mentioned anticorrosive paint composition directly after the preparation thereof so as to have a dry coating film thickness of about 250 μm with use of an air spray and was dried in the atmosphere of 20°C × 65 %RH for 7 days to give a test coated sheet. Then, the test coated sheet was subjected to outdoor exposure, and, after a certain period of the interval shown in Table 3, (a) hydrolyzable acrylic resin antifouling paint “ECOLOFLEX SPC 200” (manufactured by Nippon Paint Marine Coatings Co., Ltd.) was, as a topcoat paint, applied onto the anticorrosive coating film of the test coated sheet by spraying so as to give a dry coating film thickness of about 150 μm. In Table 3, the “beginning” of the “interval” column means that the topcoat paint was applied onto the test coated sheet directly after the outdoor exposure was started.

Next, the coated sheet coated with the topcoat paint was dried in a room for 24 hours. Then, the coated sheet was immersed in actual seawater for 6 months and subjected to a cross-cut method in accordance with JIS K 5600-5-6 with 9 squares and a gap interval of 5 mm, directly after extraction of the coated sheet, and the topcoat
 5 adhesion was evaluated. The evaluation criteria are as follows.

A: peeled area is less than or equal to 5% in a cut part

B: peeled area is greater than 5% and less than or equal to 15% in a cut part

C: peeled area is greater than 15% and less than or equal to 35% in a cut part

D: peeled area is greater than 35% and less than or equal to 65% in a cut part

10 Further, the topcoat adhesion evaluation test was conducted in the same manner as above with use of, as a topcoat paint, the following (b) to (f) different from the above-mentioned (a). The results were the same as the case of using the antifouling paint (a).

(b) Hydrolyzable acrylic resin antifouling paint “ECOLOFLEX SPC 150 HyB”
 15 (manufactured by Nippon Paint Marine Coatings Co., Ltd.)

(c) Hydrolyzable acrylic resin antifouling paint “ECOLOFLEX SPC 250 HyB”
 (manufactured by Nippon Paint Marine Coatings Co., Ltd.)

(d) Hydrolyzable acrylic resin antifouling paint “BIOFLEX 1000”
 (manufactured by Nippon Paint Marine Coatings Co., Ltd.)

20 (e) Hydrolyzable acrylic resin antifouling paint “LF-Sea 150 HyB”
 (manufactured by Nippon Paint Marine Coatings Co., Ltd.)

(f) Hydrolyzable acrylic resin antifouling paint “LF-Sea 250 HyB”
 (manufactured by Nippon Paint Marine Coatings Co., Ltd.)

[3-2] When topcoat paint is other than antifouling paint composition

25 The topcoat adhesion evaluation test was conducted in the same manner as the above-mentioned [3-1] except that used as a topcoat paint (g) was the anticorrosive paint composition, according to each of the examples and the comparative examples, that was used as an undercoat paint (used was the same paint as the undercoat anticorrosive paint composition). At this time, the topcoat paint was applied by

spraying so as to give a dry coating film thickness of about 125 μm .

Further, the topcoat adhesion evaluation test was conducted in the same manner as above with use of, as a topcoat paint, the following (h) to (m) different from the above-mentioned (g) and except that the dry coating film thickness of the top coating film was as described below. The results were the same as the case of using the topcoat paint (g).

(h) Epoxy resin paint “NIPPE EPOXY FINISH M” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 100 μm

(i) Alkyd resin paint “CR MARINE FINISH” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 35 μm

(j) Acrylic resin paint “NIPPON A-MARINE FINISH” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 50 μm

(k) Urethane resin paint “POLYURE MIGHTYLAC M” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 30 $\mu\text{m} \times 2$ (meaning that after formation of a dry coating film having a thickness of 30 μm , another dry coating film having a thickness of 30 μm was further formed on the first-formed dry coating film).

(l) Epoxy resin paint “NOA A/C II” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 75 μm

(m) Epoxy resin paint “NIPPON E-MARINE A/C II” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 75 μm

[Table 3]

		Examples												Comparative Example
		1	2	3	4	5	6	7	8	9	10	11	12	1
[1] Electric anticorrosion property evaluation test	Creep width (mm)	2	2	2	2	2	2	2	2	2	2	2	2	4
	[2] 40°C Salt water resistance evaluation test	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.0
[3-1] Topcoat adhesion evaluation test Topcoat paint (a)	Interval Beginning	A	A	A	A	A	A	A	A	A	A	A	A	A
	1 day	A	A	A	A	A	A	A	A	A	A	A	A	B
	2 days	A	A	A	A	A	A	A	A	A	A	A	A	D
	3 days	A	A	A	A	A	A	A	A	A	A	A	A	D
	5 days	A	A	A	A	A	A	A	A	A	A	A	A	D
	7 days	A	A	A	A	A	A	A	A	A	A	A	A	D
[3-2] Topcoat adhesion evaluation test Topcoat paint (g)	Interval Beginning	A	A	A	A	A	A	A	A	A	A	A	A	B
	1 week	A	A	A	A	A	A	A	A	A	A	A	A	B
	1 month	A	A	A	A	A	A	A	A	A	A	A	A	B
	2 months	A	A	A	A	A	A	A	A	A	A	A	A	B
	3 months	A	A	A	A	A	A	A	A	A	A	A	A	D
	6 months	A	A	A	A	A	A	A	A	A	A	A	A	D

<Examples 13 to 26 and Comparative Example 2: formation of dry coating film with use of colored anticorrosive paint>

A 900 mm × 900 mm satin-finished steel sheet was coated with a shop primer (“NIPPE CERAMO GRAY” or “NIPPE CERAMO BROWN” manufactured by
5 Nippon Paint Marine Coatings Co., Ltd.) so as to have a dry film thickness of 15 μm and dried at an ordinary temperature for greater than or equal to 24 hours to produce a test sheet. In Tables 4 to 6, “NIPPE CERAMO GRAY” and “NIPPE CERAMO BROWN” are abbreviated as “Gray” and “Brown”, respectively.

The first agent (main agent) and the second agent (curing agent) of the obtained
10 two-pack colored anticorrosive paint were mixed in a quantitative ratio shown in the “total” column in Table 1 or 2 (e.g., first agent: second agent = 80.67 parts by mass: 13.10 parts by mass in Example 1), and the mixture was sufficiently stirred to be uniform, so that a mixed paint (anticorrosive paint composition) was obtained.

Next, the shop primer surface of the obtained test sheet was coated, by an air
15 spraying method, with a mixed paint (anticorrosive paint composition) shown in Tables 4 to 6 that was prepared above and obtained by mixing the two liquids of the first agent and the second agent, and the coated test sheet was dried at a room temperature for 24 hours to form an anticorrosive coating film. At this time, a plurality of dry anticorrosive coating films were formed that had the dry film thicknesses shown in
20 Tables 4 to 6 in each of the examples and the comparative examples. The dry film thickness of each coating film was measured with use of the electromagnetic film thickness meter “COATING THICKNESS TESTER LE-900” manufactured by Kett Electric Laboratory.

Through measurement by the tristimulus colorimeter SM color computer
25 “SM-7CH” manufactured by Suga Test Instruments Co., Ltd. in accordance with JIS K 5600-4-5: 1999 and calculation in accordance with JIS K 5600-4-6: 1999, a color difference ΔE was acquired between the obtained anticorrosive coating films having the dry coating film thicknesses and an anticorrosive coating film having the setting value T of the target dry coating film thickness of each colored anticorrosive paint. The test

results are shown in Tables 4 to 6. Further, visually observed was the base hiding property of the wet anticorrosive coating films that would show the dry film thicknesses as anticorrosive films (hiding property of the anticorrosive coating films for the shop primer coating film), and the base hiding property was evaluated on the basis of the following determination criteria. The results are also shown in Tables 4 to 6. With respect to the examples and the comparative examples, Figs. 1 to 8 each show a graph with the dry film thickness (μm) shown in Tables 4 to 6 as the horizontal axis and the ΔE shown in Tables 4 to 6 as the vertical axis.

A: hiding

10 B: base being seen through a little

C: base being seen through entirely

In the meantime, the ΔE at a dry film thickness of $0\ \mu\text{m}$ in Tables 4 to 6 means the color difference between the anticorrosive coating film having the dry film thickness T and the surface of the object to be coated (surface of the shop primer coating film) and is synonymous with the above-mentioned color difference ΔE_3 .

15

[Table 4]

		Example 13		Example 14		Example 15		Example 16		Example 17		Example 18	
Anticorrosive coating film	Paint No.	Example 1		Example 2		Example 3		Example 4		Example 5		Example 6	
	T (μm)	320		320		320		320		320		320	
Surface of object to be coated		Gray		Gray		Gray		Gray		Gray		Gray	
Dry film thickness (μm)		ΔE	Hiding property	ΔE	Hiding property	ΔE	Hiding property	ΔE	Hiding property	ΔE	Hiding property	ΔE	Hiding property
0		33.7	-	33.9	-	33.8	-	32.8	-	29.4	-	30.9	-
40		17.2	C	17.4	C	16.9	C	16.0	C	14.4	C	14.9	C
70		12.3	C	12.4	C	14.1	C	12.6	C	11.4	C	12.3	C
120		9.1	C	9.3	C	10.2	C	9.6	C	7.9	C	9.1	C
150		7.0	C	7.7	C	8.1	C	7.7	C	6.0	C	7.6	C
180		5.0	C	5.7	C	6.1	C	5.6	C	4.0	C	5.6	C
190		4.4	C	5.0	C	5.2	C	5.2	C	3.6	C	5.0	C
200		3.6	C	4.5	C	4.4	C	4.7	C	3.1	C	4.3	C
220		2.6	C	3.5	C	3.1	C	3.4	C	2.3	C	3.2	C
230		2.2	C	2.9	C	2.8	C	3.0	C	2.1	C	2.9	C
240		1.7	C	2.4	C	2.4	C	2.5	C	1.7	C	2.3	C
260		1.2	B	1.6	C	1.5	C	1.6	C	1.2	B	1.4	C
270		0.9	B	1.2	B	1.4	C	1.3	C	1.0	B	1.2	B
290		0.6	B	0.7	B	0.6	B	0.6	B	0.7	B	0.6	B
320		0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A
350		0.1	A	0.1	A	0.1	A	0.1	A	0.1	A	0.1	A
360		0.1	A	0.1	A	0.1	A	0.1	A	0.1	A	0.1	A
370		0.1	A	0.1	A	0.1	A	0.1	A	0.1	A	0.1	A
420		0.1	A	0.1	A	0.2	A	0.2	A	0.2	A	0.2	A

[Table 5]

		Example 19		Example 20		Example 21		Example 22		Example 23		Example 24	
Anticorrosive coating film	Paint No.	Example 7		Example 8		Example 9		Example 10		Example 11		Example 12	
	T (μm)	320		320		320		520		1000		220	
Surface of object to be coated		Gray		Gray		Gray		Gray		Gray		Gray	
Dry film thickness (μm)		ΔE	Hiding property	ΔE	Hiding property	ΔE	Hiding property	ΔE	Hiding property	ΔE	Hiding property	ΔE	Hiding property
0		31.3	-	30.1	-	29.1	-	33.2	-	34.4	-	32.4	-
40		16.5	C	16.7	C	16.2	C	23.5	C	27.9	C	15.0	C
70		11.3	C	12.0	C	10.7	C	18.1	C	24.4	C	8.9	C
120		8.5	C	8.9	C	7.2	C	13.9	C	21.2	C	3.7	C
150		7.4	C	7.2	C	5.7	C	12.0	C	19.7	C	2.1	C
180		5.7	C	5.7	C	4.2	C	10.0	C	18.3	C	1.4	C
190		4.8	C	5.0	C	3.7	C	9.5	C	17.9	C	1.2	B
200		4.7	C	4.4	C	3.1	C	9.0	C	17.4	C	0.6	B
220		3.5	C	3.8	C	2.3	C	8.5	C	16.4	C	0.0	A
230		2.9	C	3.0	C	2.1	C	7.7	C	16.2	C	0.0	A
240		2.0	C	2.5	C	1.8	C	7.3	C	16.0	C	0.1	A
260		1.3	C	1.5	C	1.1	B	6.4	C	15.1	C	0.1	A
270		1.0	B	1.3	B	0.7	B	5.6	C	14.4	C	0.1	A
290		0.6	B	0.6	B	0.5	B	4.5	C	13.5	C	0.2	A
320		0.0	A	0.0	A	0.0	A	3.5	C	12.9	C		
350		0.1	A	0.1	A	0.1	A	2.5	C	11.5	C		
360		0.1	A	0.1	A	0.1	A	2.2	C	11.2	C		
370		0.1	A	0.1	A	0.1	A	2.1	C	10.5	C		
420		0.2	A	0.2	A	0.1	A	1.2	B	9.0	C		
470								0.5	B	7.0	C		
520								0.0	A	5.8	C		
680								0.1	A	2.7	C		
700										2.3	C		
800										1.3	B		
900										0.6	B		
1000										0.0	A		
1300										0.3	A		

[Table 6]

		Example 25		Example 26		Comparative Example 2	
Anticorrosive coating film	Paint No.	Example 1		Example 14		Comparative Example 1	
	T (μm)	320		320		320	
Surface of object to be coated		Brown		Brown		Gray	
Dry film thickness (μm)		ΔE	Hiding property	ΔE	Hiding property	ΔE	Hiding property
0		27.9	-	28.0	-	34.5	-
40		15.9	C	15.6	C	5.2	C
70		12.1	C	12.2	C	1.5	C
120		8.4	C	9.0	C	0.6	B
150		6.6	C	7.4	C	0.1	A
180		4.8	C	5.2	C	0.1	A
190		4.4	C	4.4	C	0.1	A
200		3.6	C	3.8	C	0.0	A
220		2.6	C	2.6	C	0.1	A
230		2.2	C	2.3	C	0.1	A
240		1.8	C	1.9	C	0.1	A
260		1.2	B	1.3	B	0.1	A
270		0.9	B	1.1	B	0.0	A
290		0.6	B	0.7	B	0.0	A
320		0.0	A	0.0	A	0.0	A
350		0.1	A	0.1	A	0.1	A
360		0.1	A	0.1	A	0.1	A
370		0.1	A	0.1	A	0.1	A
420		0.1	A	0.2	A	0.2	A
470							
520							
680							

<Examples 27 to 48 and Comparative Examples 3 to 9>

5 According to the blending prescriptions shown in Tables 7 to 9, the blending components were mixed to prepare a first agent (main agent) including a bisphenol A-type epoxy resin (A) and a second agent (curing agent) including an amine curing agent (B), so that a two-pack anticorrosive paint composition was obtained. The

detail of the blending components shown in Tables 7 to 9 is as follows. The unit of the blending amounts shown in the tables is part by mass in terms of a solid content.

[1] Bisphenol A-type epoxy resin (A): bisphenol A-type epoxy resin (solvent dilution type) manufactured by DIC Corporation, trade name “EPICLON 860-90X”, epoxy equivalent: 230 to 270 g/eq, number average molecular weight (in terms of standard polystyrene measured by GPC): 470, nonvolatile content (solid content): 90% by mass

[2] Amine curing agent (B-1): polyamide amine (dimer acid-modified aliphatic polyamide amine (amine component: mixture of triethylenetetramine and tetraethylenepentamine)) manufactured by Air Products and Chemicals, Inc., trade name “Ancamide 2050”, amine equivalent: 225 mg KOH/g, nonvolatile content (solid content): 69% by mass

[3] Amine curing agent (B-2): polyamide amine (dimer acid-modified aliphatic polyamide amine (amine component: pentaethylenehexamine)) manufactured by Air Products and Chemicals, Inc., trade name “Sunmide 308D-65T”, amine equivalent: 180 to 200 mg KOH/g, nonvolatile content (solid content): 65% by mass

[4] Vinyl chloride copolymer (C): vinyl chloride-vinyl isobutyl ether copolymer manufactured by BASF SE, trade name “Laroflex MP25”, molar ratio of vinyl chloride/vinyl isobutyl ether: about 75/25, weight average molecular weight (in terms of standard polystyrene measured by GPC): 28000 to 30000, nonvolatile content (solid content): 100% by mass

[5] Monoepoxide compound (D-1): alkyl glycidyl ether compound (12 to 14 carbon atoms in alkyl moiety) manufactured by Air Products and Chemicals, Inc., trade name “Epodil 748”, epoxy equivalent: 275 to 300, nonvolatile content (solid content): 100% by mass

[6] Monoepoxide compound (D-2): 3-n-pentadecadienylphenylglycidyl ether manufactured by Cardolite Corporation, trade name “Cardolite Lite 2513HP”, epoxy equivalent: 400, nonvolatile content (solid content): 100% by mass

[7] Diepoxide compound: neopentyl glycol diglycidyl ether manufactured by

Air Products and Chemicals, Inc., trade name “Epodil 749”, epoxy equivalent: 130 to 145, nonvolatile content (solid content): 100% by mass

5 [8] (Meth)acrylate compound (E): bisphenol A-type epoxy (meth)acrylate (bisphenol A-type vinyl ester resin) manufactured by Showa Denko K.K., trade name “Repoxy VR-90-M”, number average molecular weight (in terms of standard polystyrene measured by GPC): 2000, nonvolatile content (solid content): 70% by mass

[9] Silane coupling agent (F): γ -glycidyloxypropyltrimethoxysilane manufactured by Evonik Degussa GmbH, trade name “DYNASYLAN GLYMO”, nonvolatile content (solid content): 100% by mass

10 [10] Color pigment 1: titanium oxide (white pigment) manufacture by ISHIHARA SANGYO KAISHA, LTD., trade name “CR50”, nonvolatile content (solid content): 100% by mass

15 [11] Color pigment 2: yellow iron oxide manufactured by Titan Kogyo, Ltd., trade name “TAROX iron oxide LL-XLO”, nonvolatile content (solid content): 100% by mass

[12] Extender pigment 1: talc manufacture by FUJI TALC INDUSTRIAL CO., LTD., trade name “Talc 34-N”, nonvolatile content (solid content): 100% by mass

20 [13] Extender pigment 2: barium sulfate manufacture by FUJI TALC INDUSTRIAL CO., LTD., trade name “Barite powder FBA”, nonvolatile content (solid content): 100% by mass

[14] Rust preventive pigment: gypsum hemihydrate (β gypsum) manufactured by NORITAKE CO., LIMITED, trade name “TA-85N”, nonvolatile content (solid content): 100% by mass

25 [15] Anti-sagging agent: anti-sagging agent manufactured by Kusumoto Chemicals, Ltd., trade name “DISPARLON 6700”, nonvolatile content (solid content): 100% by mass

[16] Solvent 1: xylene

[17] Solvent 2: isobutanol

[18] Solvent 3: methyl isobutyl ketone

[Table 7]

		Examples											
		27	28	29	30	31	32	33	34	35	36	37	
First agent	BFA-type epoxy resin (A)	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	
	Vinyl chloride copolymer (C)	2.2	4.0	6.3	7.5	2.2	4.0	6.3	7.5	2.2	4.0	6.3	
	Monoepoxide compound (D)												
	(D-1)												
	(D-2)												
	(Meth)acrylate compound (E)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	
	Silane coupling agent (F)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	
	Color pigment 1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
	Color pigment 2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
	Extender pigment 1	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	
	Extender pigment 2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	
	Rust preventive pigment	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
	Anti-sagging agent	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
	Solvent 1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	
	Solvent 2	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
	Solvent 3	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	
	Total	79.2	81.0	83.3	84.5	79.2	81.0	83.3	84.5	79.2	81.0	83.3	
Second agent	Amine curing agent (B)	7.1	7.1	7.1	7.1	7.5	7.5	7.5	7.5	8.6	8.6	8.6	
	(B-1)												
	(B-2)												
	Monoepoxide compound (D)	0.4	0.4	0.4	0.4	1.6	1.6	1.6	1.6	4.0	4.0	4.0	
	(D-1)												
	(D-2)												
	Diepoxide compound												
	Solvent 1	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	
	Solvent 2	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	
	Total	11.5	11.5	11.5	11.5	13.1	13.1	13.1	13.1	16.6	16.6	16.6	
NV of anticorrosive paint composition (% by mass)		70.6	71.1	71.8	72.2	71.0	71.5	72.2	72.5	71.7	72.2	72.8	
PVC of anticorrosive paint composition (%)		42.1	40.3	38.3	37.3	40.5	38.9	37.0	36.1	37.4	36.0	34.4	
Number of parts of (C)/100 parts of (A)		15	27	42	50	15	27	42	44.4	15	27	42	
Number of parts of (D)/100 parts of (B)		5.6	5.6	5.6	5.6	21.3	21.3	21.3	21.3	46.5	46.5	46.5	
Number of parts of (D)/Number of parts of (C)		0.18	0.10	0.06	0.05	0.73	0.40	0.25	0.21	1.82	1.00	0.63	
(D)/(B) equivalent ratio		1/0.03	1/0.03	1/0.03	1/0.03	1/0.11	1/0.11	1/0.11	1/0.11	1/0.24	1/0.24	1/0.24	

[Table 8]

		Examples											
		38	39	40	41	42	43	44	45	46	47	48	
First agent	BFA-type epoxy resin (A)	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	
	Vinyl chloride copolymer (C)	7.5	2.2	4.0	6.3	7.5	2.2	4.0	6.3	7.5	6.3	6.3	
	Monoepoxide compound (D)												
	(D-1)												
	(D-2)												
	(Meth)acrylate compound (E)	2.6	2.6	2.6	2.6	2.6					2.6	2.6	
	Silane coupling agent (F)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	
	Color pigment 1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
	Color pigment 2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
	Extender pigment 1	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	
	Extender pigment 2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	
	Rust preventive pigment	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
	Anti-sagging agent	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
	Solvent 1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	
Solvent 2	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		
Solvent 3	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	10.7		
Total	84.5	79.2	81.0	83.3	84.5	79.2	81.0	81.0	83.3	84.5	85.0	85.0	
Second agent	Amine curing agent (B)	8.6	6.9	6.9	6.9	6.9	8.1	8.1	8.1	8.1	5.6	3.5	
	(B-2)										3.8	6.1	
	Monoepoxide compound (D)	4.0					1.6	1.6	1.6	1.6	1.6	1.6	
	(D-2)		1.6	1.6	1.6	1.6							
	Diepoxide compound												
	Solvent 1	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	
	Solvent 2	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	
	Total	16.6	12.5	12.5	12.5	12.5	13.7	13.7	13.7	13.7	15.0	15.2	
	NV of anticorrosive paint composition (% by mass)	73.2	71.0	71.5	72.2	72.5	71.0	71.5	72.2	72.6	70.7	70.6	
	PVC of anticorrosive paint composition (%)	33.6	41.0	39.3	37.4	36.4	41.8	40.0	38.0	37.1	36.2	36.3	
Number of parts of (C)/100 parts of (A)	50	15	27	42	50	15	27	42	50	42	42		
Number of parts of (D)/100 parts of (B)	46.5	23.2	23.2	23.2	23.2	19.8	19.8	19.8	19.8	17.0	16.7		
Number of parts of (D)/Number of parts of (C)	0.53	0.73	0.40	0.25	0.21	0.73	0.40	0.25	0.21	0.25	0.25		
(D)/(B) equivalent ratio	1/0.24	1/0.08	1/0.08	1/0.08	1/0.08	1/0.10	1/0.10	1/0.10	1/0.10	1/0.10	1/0.11	1/0.12	

[Table 9]

			Comparative Examples						
			3	4	5	6	7	8	9
First agent	BFA-type epoxy resin (A)		15.0	15.0	15.0	15.0	15.0	15.0	15.0
	Vinyl chloride copolymer (C)		6.3	6.3	6.3	6.3	6.3	6.3	6.3
	Monoepoxide compound (D)	(D-1)							
		(D-2)	4.0	2.0	2.0				
	(Meth)acrylate compound (E)				2.6	2.6	2.6	2.6	2.6
	Silane coupling agent (F)		0.4	0.4	0.4	0.4	0.4	0.4	0.4
	Color pigment 1		0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Color pigment 2		0.9	0.9	0.9	0.9	0.9	0.9	0.9
	Extender pigment 1		27.3	27.3	27.3	27.3	27.3	27.3	27.3
	Extender pigment 2		7.2	7.2	7.2	7.2	7.2	7.2	7.2
	Rust preventive pigment		3.8	3.8	3.8	3.8	3.8	3.8	3.8
	Anti-sagging agent		0.9	0.9	0.9	0.9	0.9	0.9	0.9
	Solvent 1		4.2	4.2	4.2	4.2	4.2	4.2	4.2
	Solvent 2		2.6	2.6	2.6	3.0	2.6	2.6	2.6
	Solvent 3		9.0	9.0	9.0	9.0	9.0	9.0	9.0
Total		84.3	82.3	84.9	83.3	82.9	82.9	82.9	
Second agent	Amine curing agent (B)	(B-1)	7.6	7.0	7.5	6.5	6.5	6.5	6.5
		(B-2)							
	Monoepoxide compound (D)	(D-1)							
		(D-2)							
	Diepoxide compound					0.4	1.0	1.5	
	Solvent 1		2.4	2.4	2.4	2.4	2.4	2.4	2.4
	Solvent 2		1.6	1.6	1.6	1.6	1.6	1.6	1.6
Total		11.6	11.0	11.5	10.9	11.5	12.0	10.5	
NV of anticorrosive paint composition (% by mass)			73.2	72.7	72.6	71.5	71.4	71.1	72.0
PVC of anticorrosive paint composition (%)			36.6	38.6	36.8	39.1	39.0	38.9	39.1
Number of parts of (C)/100 parts of (A)			42	42	42	42	42	42	42
Number of parts of (D)/100 parts of (B)			52.6	28.6	26.7	0	0	0	0
Number of parts of (D)/Number of parts of (C)			0.63	0.32	0.32	0	0	0	0
(D)/(B) equivalent ratio			1/0.19	1/0.10	1/0.10	0	0	0	0

The first agent (main agent) and the second agent (curing agent) of the obtained two-pack anticorrosive paint composition were mixed in a quantitative ratio shown in the “total” columns in Tables 7 to 9 (e.g., first agent : second agent = 79.2 parts by mass : 11.5 parts by mass in Example 27), and the mixture was sufficiently stirred to be uniform. The obtained mixed paint (anticorrosive paint composition) was subjected to the following evaluation tests. The test results are shown in Tables 10 to 12. For Comparative Examples 6 to 8, however, the evaluation test could not be conducted because the second agent (curing agent) caused gelation.

[1] Electric anticorrosion property evaluation test (cathode anticorrosion property test)

First, a grid-blasted steel sheet (7 cm × 15 cm × 3.2 mm) was coated with an inorganic zinc shop primer (trade name “CERAMO”) manufactured by Nippon Paint Marine Coatings Co., Ltd. so as to have a dry coating film thickness of about 15 μm and was dried for 7 days to produce a primer-treated steel sheet. Then, the primer-treated steel sheet was coated with the above-mentioned anticorrosive paint composition directly after the preparation thereof so as to have a dry coating film thickness of about 250 μm with use of an air spray and was dried in the atmosphere of 23°C × 65 %RH for 7 days to give a test coated sheet. A test was conducted for the test coated sheet in accordance with ASTM G8-90 and the sheet was evaluated. That is, first, a sheet was produced that is obtained by forming a base material exposing part with a size of φ 6.3 mm in the center of an immersion part on a test surface (coated surface) of the test coated sheet with use of a drill having a bade of φ 6.3 mm. Then, a potential of 1.5 V was applied to the sheet while the sheet was immersed in 40°C aqueous solutions each including NaCl, Na₂SO₄, or Na₂CO₃ in an amount of 1% by weight, and one month later, measurement was conducted for the length (creep width, mm) of a peeled part of the coating film from the base material exposing part. The numerical value (creep width) in Tables 10 to 12 is the average value of the results of immersing the sheet in each of the above-mentioned three aqueous solutions.

[2] 40°C salt water resistance evaluation test (anticorrosion property evaluation test)

First, a grid-blasted steel sheet (7 cm × 15 cm × 3.2 mm) was coated with an inorganic zinc shop primer (trade name “CERAMO”) manufactured by Nippon Paint Marine Coatings Co., Ltd. so as to have a dry coating film thickness of about 15 μm and was dried for 7 days to produce a primer-treated steel sheet. Then, the primer-treated steel sheet was coated with the above-mentioned anticorrosive paint composition directly after the preparation thereof so as to have a dry coating film

thickness of about 250 μm with use of an air spray and was dried in the atmosphere of $20^{\circ}\text{C} \times 65\% \text{RH}$ for 7 days to give a test coated sheet. Next, the test coated sheet was immersed in 3% salt water at 40°C for 3 months. The adhesion force (MPa) of the coating film to the primer-treated steel sheet after the 3-month immersion was

5 measured by an adhesion tester manufactured by Elcometer Limited.

[3] Topcoat adhesion evaluation test (interval adhesion test)

[3-1] When topcoat paint is antifouling paint composition

First, a grid-blasted steel sheet (7 cm $\times$ 15 cm $\times$ 3.2 mm) was coated with an inorganic zinc shop primer (trade name “NIPPE CERAMO”) manufactured by Nippon
 10 Paint Marine Coatings Co., Ltd. so as to have a dry coating film thickness of about 15 μm and was dried for 7 days to produce a primer-treated steel sheet. Then, the primer-treated steel sheet was coated with the above-mentioned anticorrosive paint composition directly after the preparation thereof so as to have a dry coating film thickness of about 250 μm with use of an air spray and was dried in the atmosphere of
 15 $20^{\circ}\text{C} \times 65\% \text{RH}$ for 7 days to give a test coated sheet. Then, the test coated sheet was subjected to outdoor exposure, and, after a certain period of the interval shown in Tables 10 to 12, (a) hydrolyzable acrylic resin antifouling paint “ECOLOFLEX SPC 200” (manufactured by Nippon Paint Marine Coatings Co., Ltd.) was, as a topcoat paint, applied onto the anticorrosive coating film of the test coated sheet by spraying so as to
 20 give a dry coating film thickness of about 150 μm . In Tables 10 to 12, the “beginning” of the “interval” column means that the topcoat paint was applied onto the test coated sheet directly after the outdoor exposure was started.

Next, the coated sheet coated with the topcoat paint was dried in a room for 24 hours. Then, the coated sheet was immersed in actual seawater for 6 months and
 25 subjected to a cross-cut method in accordance with JIS K 5600-5-6 with 9 squares and a gap interval of 5 mm, directly after extraction of the coated sheet, and the topcoat adhesion was evaluated. The evaluation criteria are as follows.

A: peeled area is less than or equal to 5% in a cut part

B: peeled area is greater than 5% and less than or equal to 15% in a cut part

C: peeled area is greater than 15% and less than or equal to 35% in a cut part

D: peeled area is greater than 35% and less than or equal to 65% in a cut part

Further, the topcoat adhesion evaluation test was conducted in the same manner
 5 as above with use of, as a topcoat paint, the following (b) to (f) different from the
 above-mentioned (a). The results were the same as the case of using the antifouling
 paint (a).

(b) Hydrolyzable acrylic resin antifouling paint “ECOLOFLEX SPC 150 HyB”
 (manufactured by Nippon Paint Marine Coatings Co., Ltd.)

10 (c) Hydrolyzable acrylic resin antifouling paint “ECOLOFLEX SPC 250 HyB”
 (manufactured by Nippon Paint Marine Coatings Co., Ltd.)

(d) Hydrolyzable acrylic resin antifouling paint “BIOFLEX 1000”
 (manufactured by Nippon Paint Marine Coatings Co., Ltd.)

(e) Hydrolyzable acrylic resin antifouling paint “LF-Sea 150 HyB”
 15 (manufactured by Nippon Paint Marine Coatings Co., Ltd.)

(f) Hydrolyzable acrylic resin antifouling paint “LF-Sea 250 HyB”
 (manufactured by Nippon Paint Marine Coatings Co., Ltd.)

[3-2] When topcoat paint is other than antifouling paint composition

The topcoat adhesion evaluation test was conducted in the same manner as the
 20 above-mentioned [3-1] except that used as a topcoat paint (g) was the anticorrosive
 paint composition, according to each of the examples and the comparative examples,
 that was used as an undercoat paint (used was the same paint as the undercoat
 anticorrosive paint composition). At this time, the topcoat paint was applied by
 spraying so as to give a dry coating film thickness of about 125 μm .

25 Further, the topcoat adhesion evaluation test was conducted in the same manner
 as above with use of, as a topcoat paint, the following (h) to (m) different from the
 above-mentioned (g) and except that the dry coating film thickness of the top coating
 film was as described below. The results were the same as the case of using the
 topcoat paint (g).

(h) Epoxy resin paint “NIPPE EPOXY FINISH M” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 100 μm

(i) Alkyd resin paint “CR MARINE FINISH” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 35 μm

5 (j) Acrylic resin paint “NIPPON A-MARINE FINISH” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 50 μm

(k) Urethane resin paint “POLYURE MIGHTYLAC M” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 30 $\mu\text{m} \times 2$

10 (meaning that after formation of a dry coating film having a thickness of 30 μm , another dry coating film having a thickness of 30 μm was further formed on the first-formed dry coating film).

(l) Epoxy resin paint “NOA A/C II” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 75 μm

15 (m) Epoxy resin paint “NIPPON E-MARINE A/C II” (manufactured by Nippon Paint Marine Coatings Co., Ltd.), dry coating film thickness: 75 μm

[Table 10]

		Examples										
		27	28	29	30	31	32	33	34	35	36	37
[1] Electric anticorrosion property evaluation test	Creep width (mm)	2	2	2	2	2	2	2	2	2	2	2
	[2] 40°C Salt water resistance evaluation test	5.0	5.0	5.0	5.0	6.0	6.0	6.0	6.0	5.0	5.0	5.0
[3-1] Topcoat adhesion evaluation test Topcoat paint (a)	Interval Beginning	A	A	A	A	A	A	A	A	A	A	A
	1 day	A	A	A	A	A	A	A	A	A	A	A
	2 days	A	A	A	A	A	A	A	A	A	A	A
	3 days	A	A	A	A	A	A	A	A	A	A	A
	5 days	B	B	A	A	A	A	A	A	B	A	A
	7 days	B	B	A	A	B	A	A	A	B	A	A
	10 days	B	B	A	A	B	B	A	A	B	A	A
[3-2] Topcoat adhesion evaluation test Topcoat paint (g)	Interval Beginning	A	A	A	A	A	A	A	A	A	A	A
	1 week	A	A	A	A	A	A	A	A	A	A	A
	1 month	A	A	A	A	A	A	A	A	A	A	A
	2 months	A	A	A	A	A	A	A	A	A	A	A
	3 months	B	B	A	A	A	A	A	A	A	A	A
	6 months	B	B	A	A	B	B	A	A	B	B	A

[Table 11]

		Examples										
		38	39	40	41	42	43	44	45	46	47	48
		2	2	2	2	2	2	2	2	2	2	2
[1] Electric anticorrosion property evaluation test	Creep width (mm)	2	2	2	2	2	2	2	2	2	2	2
[2] 40°C Salt water resistance evaluation test	Adhesion force (MPa)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	6.0	6.0	5.0	5.0
[3-1] Topcoat adhesion evaluation test Topcoat paint (a)	Interval Beginning	A	A	A	A	A	A	A	A	A	A	A
	1 day	A	A	A	A	A	A	A	A	A	A	A
	2 days	A	A	A	A	A	A	A	A	A	A	A
	3 days	A	A	A	A	A	A	A	A	A	A	A
	5 days	A	B	B	A	A	B	B	A	A	A	A
	7 days	A	B	B	A	A	B	B	A	A	A	A
	10 days	A	B	B	A	A	B	B	A	A	A	A
[3-2] Topcoat adhesion evaluation test Topcoat paint (g)	Interval Beginning	A	A	A	A	A	A	A	A	A	A	A
	1 week	A	A	A	A	A	A	A	A	A	A	A
	1 month	A	A	A	A	A	A	A	A	A	A	A
	2 months	A	B	B	A	A	B	B	A	A	A	A
	3 months	A	B	B	A	A	B	B	A	A	A	A
	6 months	A	B	B	A	A	B	B	A	A	A	A

[Table 12]

		Comparative Examples						
		3	4	5	6	7	8	9
[1] Electric anticorrosion property evaluation test	Creep width (mm)	4	4	4	-	-	-	4
[2] 40°C Salt water resistance evaluation test	Adhesion force (MPa)	4.0	4.0	4.0	-	-	-	4.0
[3-1] Topcoat adhesion evaluation test Topcoat paint (a)	Interval Beginning	A	A	A	-	-	-	A
	1 day	B	B	B	-	-	-	B
	2 days	C	C	C	-	-	-	D
	3 days	C	C	C	-	-	-	D
	5 days	D	D	D	-	-	-	D
	7 days	D	D	D	-	-	-	D
	10 days	D	D	D	-	-	-	D
[3-2] Topcoat adhesion evaluation test Topcoat paint (g)	Interval Beginning	B	B	B	-	-	-	B
	1 week	B	B	B	-	-	-	B
	1 month	B	B	B	-	-	-	B
	2 months	B	B	B	-	-	-	B
	3 months	D	D	D	-	-	-	D
	6 months	D	D	D	-	-	-	D

CLAIMS

1. An anticorrosive paint composition that is a two-pack anticorrosive paint composition including a first agent and a second agent and that comprises a bisphenol A-type epoxy resin (A), an amine curing agent (B), a vinyl chloride copolymer (C), a monoepoxide compound (D), and a (meth)acrylate compound (E),
a content of said vinyl chloride copolymer (C) being 5 to 50 parts by mass relative to 100 parts by mass of said bisphenol A-type epoxy resin (A),
a content of said monoepoxide compound (D) being 2 to 50 parts by mass relative to 100 parts by mass of said amine curing agent (B),
said first agent containing said bisphenol A-type epoxy resin (A) and said vinyl chloride copolymer (C),
said second agent containing said amine curing agent (B) and said monoepoxide compound (D), and
said (meth)acrylate compound (E) including a vinyl ester resin.
2. The anticorrosive paint composition according to claim 1, wherein a content ratio between said monoepoxide compound (D) and said vinyl chloride copolymer (C) is 0.02 to 2.5 by mass ratio.
3. The anticorrosive paint composition according to claim 1 or 2, wherein said monoepoxide compound (D) includes an alkyl glycidyl ether compound.
4. The anticorrosive paint composition according to any one of claims 1 to 3, wherein said amine curing agent (B) is a polyamide amine.
5. The anticorrosive paint composition according to any one of claims 1 to 4, wherein said vinyl chloride copolymer (C) is a vinyl chloride-vinyl alkyl ether copolymer.

6. A coating film formed from the anticorrosive paint composition according to any one of claims 1 to 5.

5 7. A ship or an offshore structure provided with the coating film according to claim 6.