

METHOD FOR FORMING PAINT COATING

FIELD OF THE INVENTION

The present invention relates to a method for forming a substantially uniform paint coating on articles, particularly to a method for forming a paint coating easily and precisely at targeted dry thickness on articles such as vessels requiring different paint coating thickness from area to area, without color differences among different targeted dry thickness.

PRIOR ART

Articles such as vessels, steel structures, etc., which are likely subjected to severe corrosion, need be formed with thick, single-layer or multi-layer paint coatings, whose layer formed by a single coating step should be as thick as 100 μm or more, to have sufficient resistance to rust and corrosion. To make sure that such a thick paint coating is formed, a wet gauge, an electromagnetic thickness meter, etc. are presently used. However, because articles such as vessels, steel structures, etc., have wide surfaces to be coated, and because some of such surfaces are not located at positions permitting easy coating, it is practically difficult to measure the paint coating thickness by a wet gauge during painting and to check the entire regions of a dried paint coating completely by an electromagnetic thickness meter, etc. Under such circumstances, various attempts have been carried out to check whether or not paint coatings formed on articles such as vessels, steel structures, etc. have reached the predetermined thickness.

For example, Japanese Patent Laid-Open No. 10-216621 discloses a method for forming a substantially uniform paint coating having a targeted dry thickness of 100 μm or more on a surface of an article, using a paint having a coloring pigment content of 0.01-3 volume % based on a solid paint content as

a thickness-determining paint, the coloring pigment content of the thickness-determining paint being adjusted to meet the following conditions:

- (a) a color difference between the thickness-determining paint and the article is 20 or more,
- (b) a color difference between a paint coating having the targeted dry thickness and a paint coating having a dry thickness less than (targeted dry thickness - 50) μm is 2 or more, and
- (c) a color difference between a paint coating having the targeted dry thickness and a paint coating having a dry thickness more than (targeted dry thickness + 50) μm is less than 1.

However, the conventional thickness-determining paint tends to provide a paint coating with color turned more blackish as the targeted dry thickness becomes larger.

With respect to vessels, for example, ship owners require paint coatings of different thickness depending on which parts of vessels are painted. Thus, thickness-determining paints are prepared in advance for plural targets at dry thickness such as 100 μm , 200 μm , 400 μm , etc., one of which is selected for each painting area. However, the conventional thickness-determining paint is likely to provide a paint coating with color turned blackish as the targeted dry thickness becomes larger, resulting in paint coatings with slight difference in color from thick areas to thin areas, failing to achieve a uniform color in any areas in the paint coatings. Particularly when a thick area is adjacent to a thin area, difference in color between them is remarkable, posing the problem of appearance.

In addition, because the change of a color difference is observed by the naked eye while a paint coating formed is still wet to determine whether or not the paint coating has reached the targeted dry thickness, it would be difficult for an operator to control the thickness of the paint coating if there were slight difference in color such as hue in the same category of the

thickness-determining paints depending on the targeted dry thickness. Accordingly, there arise large differences of paint coating thickness from the targeted dry thickness, resulting in disadvantages in quality.

OBJECT OF THE INVENTION

Accordingly, an object of the present invention is to provide a method for forming a paint coating precisely at the targeted dry thickness on a surface of an article such as a vessel requiring different paint coating thickness from area to area, with ease to form a paint coating free from a color difference at different thickness.

SUMMARY OF THE INVENTION

As a result of intense research in view of the above object, the inventors have found: (a) when a paint containing a relatively small amount of a coloring pigment as well as a body pigment having a high whiteness degree is used as a thickness-determining paint, with a color difference between the thickness-determining paint and the article to be painted, a color difference between a paint coating having the targeted dry thickness and a thinner paint coating than the targeted dry thickness, and a color difference between a paint coating having the targeted dry thickness and a thicker paint coating than the targeted dry thickness adjusted to predetermined levels, it is possible to form a paint coating on a surface of the article having different targeted dry thickness from area to area precisely at each targeted dry thickness, with ease to form a paint coating free from a color difference at different thickness, and (b) the use of a body pigment having a high whiteness degree in the thickness-determining paint turns a paint coating less blackish even at a larger targeted dry thickness. The present invention is based on these findings.

According to one embodiment of the present invention, there is provided a method for forming a substantially uniform paint coating having a

targeted dry thickness of 100 μm or more on a surface of an article, using a paint comprising 0.01-3 volume %, based on a solid paint content, of a coloring pigment and a body pigment having a whiteness degree of 85 or more, as a thickness-determining paint, the contents of the coloring pigment and the body pigment in the thickness-determining paint being adjusted to meet the following conditions:

- (a) a color difference between the thickness-determining paint and the article is 20 or more,
- (b) a color difference between a paint coating having the targeted dry thickness and a paint coating having a dry thickness less than (targeted dry thickness - 50) μm is 2 or more, and
- (c) a color difference between a paint coating having the targeted dry thickness and a paint coating having a dry thickness more than (targeted dry thickness + 50) μm is less than 1.

According to another embodiment of the present invention, there is provided a method for forming a paint coating having different targeted thickness areas on a surface of an article by using two or more types of thickness-determining paints, wherein each targeted dry thickness is 100 μm or more, and wherein each thickness-determining paint contains 0.01-3 volume %, based on a solid paint content, of a coloring pigment, and a body pigment having a whiteness degree of 85 or more, the contents of the coloring pigment and the body pigment in the thickness-determining paints being adjusted to meet the following conditions:

- (a) a color difference between the thickness-determining paint and the article is 20 or more,
- (b) a color difference between a paint coating having the targeted dry thickness and a paint coating having a dry thickness less than (targeted dry thickness - 50) μm is 2 or more, and

(c) a color difference between a paint coating having the targeted dry thickness and a paint coating having a dry thickness more than (targeted dry thickness + 50) μm is less than 1.

Two or more types of the thickness-determining paints are preferably adjusted to meet the conditions that a color difference between any two of the thickness-determining paints at the targeted dry thickness is less than 3. In both of the above embodiments, the paint coating preferably has a contrast ratio of 0.90-0.98 at the above targeted dry thickness.

The paint coating would preferably have brightness (L value) of 60 or more at the targeted dry thickness, if all the coloring pigments or other coloring pigments than titanium dioxide are excluded from the thickness-determining paint.

The coloring pigments in the thickness-determining paint preferably comprise titanium dioxide and other coloring pigments, the total amount of the titanium dioxide and the other coloring pigments being 0.1-3 volume % based on a solid paint content.

The article is preferably a steel plate, which is coated with a shop primer and/or a thickness-determining paint of a different color as an undercoat.

The thickness-determining paint preferably comprises at least one binder resin selected from the group consisting of epoxy resins and epoxy resins modified with petroleum resins, and at least one curing agent selected from the group consisting of amines, polyamides and polyisocyanate compounds.

In the present invention, the change of said color difference can be observed by the naked eye while the thickness-determining paint coating being formed is still wet, to determine whether or not the thickness-determining paint coating has reached a predetermined thickness.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[1] Thickness-determining paint

(A) Pigments

The coloring components affecting the hue and brightness of the thickness-determining paint are mainly coloring pigments. Though body pigments and anti-corrosive pigments also affect the hue and brightness of the thickness-determining paint, the whiteness degree of the body pigments is an important element to precisely measure the thickness of a paint coating with a color difference. The anti-corrosive pigment is preferable because of anti-corrosive effects on vessels, etc.

(1) Coloring pigments

The coloring pigments which may be used in the present invention include carbon black, titanium dioxide, basic lead carbonate, graphite, zinc sulfide, zinc oxide, chromium oxide, yellow nickel titanium, yellow chromium titanium, yellow iron oxide, red iron oxide, black iron oxide, phthalocyanine blue, phthalocyanine green, ultramarine blue, quinacridone, red or yellow azo pigments. At least one coloring pigment among them is preferably titanium dioxide. Because titanium dioxide greatly affects the hue, brightness, and contrast ratio of the thickness-determining paint and turns a paint coating into a pale color, titanium dioxide is preferable for use alone or in combination with other pigments.

(2) Body pigments

The body pigments, which may be used in the present invention, include talc, clay, mica, calcium carbonate, magnesium carbonate, barium sulfate, silicic acid, silicate, aluminum oxide hydrate, calcium sulfate, etc. Among them, talc is preferable.

The body pigments should have a whiteness degree of 85 or more, preferably 90 or more. With this whiteness degree, there arises no difference in color by different targeted dry thickness, resulting in a uniform color

throughout the entire area of the paint coating. Further, the paint coating can be provided with precise thickness at each targeted dry thickness. Two or more body pigments having different whiteness degrees may be combined as long as their combined whiteness degree is 85 or more. The whiteness degree is a parameter measured by a powder whiteness tester C-100 (filter Blue) available from Kett Electric Laboratory, according to JIS Z 8722 (1982).

The body pigments preferably have a refractive index of 1.8 or less, more preferably 1.6 or less. When the refractive index of the body pigments is too high, it undesirably affects the color adjustment of the paint coating.

(3) Anti-corrosive pigments

The anti-corrosive pigments are preferably those used for heavy duty protective coatings, and preferred examples of such anti-corrosive pigments are metal compounds such as zinc phosphate, trilead tetroxide, basic lead sulfate, lead suboxide, lead cyanamide, calcium zinc cyanamide, zinc molybdate, aluminum molybdate, basic lead chromate, zinc chromate, strontium chromate, barium chromate, etc. Also, the anti-corrosive pigments are preferably white in color.

(B) Binder resins

The binder resins for the thickness-determining paint are preferably (1) epoxy resins, and (2) epoxy resins modified with petroleum resins. In addition, alkyd resins, acrylic resins, vinyl chloride resins, chlorinated olefin resins, chlorinate rubbers, vinyl acetate resins, etc. may also be used as binder resins.

(1) Epoxy resins

The epoxy resins may be in a solid type or a liquid type which has conventionally been used, and their examples include bisphenol-type epoxy resins, which are resins based on condensation units of bisphenol compounds such as bisphenol A, F, B or halogen derivatives thereof and epihalohydrin. Particularly preferable are diglycidyl ethers of bisphenol A, diglycidyl ethers of

bisphenol F, phenol-novolak type epoxy resins, adducts of bisphenol compounds and alkylene oxides, etc. Also, epoxy resins modified with carboxylic acids described in Japanese Patent Laid-Open No. 63-30569, epoxy resins modified with amines described in Japanese Patent Laid-Open No. 63-30568, epoxy resins modified with phosphoric acid described in Japanese Patent Laid-Open No. 61-91217 may be used.

(2) Modified epoxy resins

In place of or together with the epoxy resins, epoxy resins modified with petroleum resins may also be used.

(a) Petroleum resins

The petroleum resins are those obtained by polymerizing diolefins or monoolefins by-produced in the cracking of petroleum oil without isolation. The petroleum resins are classified into C₅ petroleum resins, C₉ petroleum resins, etc.

(b) Modification

The modification of the epoxy resins can be achieved by a method of mixing the epoxy resins with the petroleum resins at room temperature, or a method of reacting them at 80-150 °C so that part of epoxy groups are opened. The amount of the petroleum resins in the modified epoxy resins may generally be 10-500 parts by weight per 100 parts by weight of the epoxy resins.

(C) Curing agents

The curing agents for the epoxy resins or the modified epoxy resins are preferably amines, polyamides or polyisocyanate compounds, which may be combined.

(1) Amine curing agents

Preferred examples of the amine curing agents include linear aliphatic polyamines such as diethylenetriamine, triethylenetetramine, ethylaminopropylamine, etc.; alicyclic polyamines; aliphatic polyamine adducts; ketimines; modified aliphatic polyamines; polyamide amines;

aromatic amines; modified aromatic amines; aromatic polyamines such as diaminodiphenylmethane, etc.; modified aromatic polyamines; etc.

(2) Polyamide curing agents

Preferred examples of the polyamide curing agents include aliphatic polyamides formed by the polycondensation of polycarboxylic acids and polyamines; aromatic polyamides formed by introducing aromatic rings into the above aliphatic polyamides; aliphatic polyamide adducts; aromatic polyamide adducts; etc.

(3) Polyisocyanate compound curing agents

Preferred examples of the polyisocyanate compound curing agents include aliphatic polyfunctional isocyanates such as hexamethylene diisocyanate (HMDI); alicyclic polyfunctional isocyanates such as isophorone diisocyanate (IPDI); polyisocyanate compounds such as diphenylmethane-4,4'-diisocyanate (MDI) and hydrogenated MDI, etc.; and blocked polyisocyanate compounds formed by partially or completely blocking functional groups of these polyisocyanate compounds.

(D) Amounts of components

(1) Binder resin and curing agent

The amount of the curing agent is preferably 5-200 parts by weight on a solid basis per 100 parts by weight of the binder resin. When the amount of the curing agent is less than 5 parts by weight, the resultant paint coating has a low cross-linking density, thus being poor in hardness, weather resistance, corrosion resistance, heat resistance, water resistance, etc. On the other hand, when the amount of the curing agent exceeds 200 parts by weight, the resultant paint coating becomes brittle. The preferred weight ratio of the curing agent to the binder resin is 20/100-100/100.

(2) Pigments

The total amount of the pigments is preferably within a range of 10-60 volume % based on a solid paint content. The more preferred total

amount of the pigments is 15-45 volume %. Since some binder resins have slight color, the total amount of the pigments is adjusted depending on the types of the binder resins used.

(a) Coloring pigment

Since the thickness-determining paint should have a relatively small power of hiding an underlying surface, the thickness-determining paint should contain a small amount of coloring pigments. Generally, the total amount of the coloring pigments is 0.01-3 volume % based on a solid paint content. When the total amount of the coloring pigments is less than 0.01 volume %, the thickness-determining paint provides so small power of hiding an article or an underlying coating layer that there arises substantially no color difference between the paint coating and the article even at a thickness of about 100 μm , failing to carry out the determination of the thickness of the resultant paint coating. On the other hand, when the total amount of the coloring pigments exceeds 3 volume %, the thickness-determining paint shows too much hiding power, resulting in disappearance of a color difference before reaching the targeted dry thickness. In a case where titanium dioxide is used as a coloring pigment alone or in combination with other coloring pigments, the total amount of the coloring pigments is preferably within a range of 0.1-3 volume %. When the body pigment and/or the anti-corrosive pigment is added, the amount of the coloring pigment is preferably 0.3-7 volume %, based on 100 volume % of all the pigments.

(b) Body pigment

When the body pigment is added, its amount is preferably 60 volume % or less, based on a solid paint content. When the amount of the body pigment exceeds 60 volume %, the thickness-determining paint loses film-forming properties. The lower limit of the amount of the body pigment is preferably 10 volume %.

(c) Anti-corrosive pigment

The amount of the anti-corrosive pigment is preferably 0-10 volume %, based on a solid paint content. Even though the amount of the anti-corrosive pigment exceeds 10 volume %, further improvement in anti-corrosive effects cannot be achieved, resulting in decrease in the amount of the body pigment accordingly, which undesirably leads to increase in paint cost.

(E) Other components

The thickness-determining paint of the present invention may contain organic solvents, additives, etc. in addition to the binder resins, the curing agents and the pigments.

(1) Organic solvents

Organic solvents or mixtures thereof widely used for paints may be used in the present invention. Preferred examples of the organic solvents include aromatic hydrocarbons such as toluene, xylene, etc.; aliphatic hydrocarbons such as normal hexane, heptane, etc.; petroleum fractions having various boiling points containing mainly aliphatic hydrocarbons and slightly aromatic hydrocarbons; esters such as butyl acetate, acetylene glycol diacetate, 2-ethoxyethyl acetate; ketones such as methyl isobutyl ketone, etc.; alcohols such as butyl alcohol, etc.; ethers such as ethylene glycol monobutyl ether, etc.

(2) Additives

The thickness-determining paint may further contain usual ultraviolet absorbers, surface adjusters, viscosity modifiers, anti-sagging agents, leveling agents, pigment dispersants, plasticizers, defoamers, etc.

[2] Color difference

The thickness-determining paint should meet the conditions: (a) a color difference between the thickness-determining paint and the article is 20 or more; (b) a color difference between a paint coating having a targeted dry thickness and a paint coating having a dry thickness less than (targeted dry thickness - 50) μm is 2 or more; and (c) a color difference between a paint

coating having the targeted dry thickness and a paint coating having a dry thickness more than (targeted dry thickness + 50) μm is less than 1.

The measurement of a color difference is carried out by a generally known method using a colorimeter such as an SM color computer (SM-7CH, available from Suga Test Instruments Co., Ltd.).

(1) Color difference from article

The color difference between the thickness-determining paint and the article to be coated should be 20 or more. Meeting this condition, it is possible to observe by the naked eye how the color difference from the article changes as the thickness of the thickness-determining paint coating nears the predetermined paint thickness (wet). Preferably, the color difference from the article is 35 or more.

(2) Color difference from paint coating of dry thickness less than (targeted dry thickness - 50) μm

Because the paint coating of a dry thickness less than (targeted dry thickness - 50) μm is a paint coating immediately before completion, it would be impossible to check whether or not the paint coating has reached the targeted thickness, unless there is at least slight color difference between the paint coating being formed and a paint coating of the targeted dry thickness. Accordingly, it is necessary that the color difference between a paint coating having the targeted dry thickness and a paint coating having a dry thickness less than (targeted dry thickness - 50) μm is 2 or more. This color difference is preferably 3 or more. However, if there were a much larger color difference than 3 immediately before reaching the targeted dry thickness, there would be too large a color difference between adjacent paint coatings of different thickness, leaving remarkable mottle on the painted surface. Thus, the upper limit of this color difference is preferably 10, more preferably 5.

(3) Color difference from paint coating of dry thickness more than (targeted dry thickness + 50) μm

Because the paint coating of a dry thickness more than (targeted dry thickness + 50) μm is a paint coating having a thickness exceeding the targeted thickness, the color difference from the paint coating of the targeted dry thickness should be as small as possible. Accordingly, it is necessary that the color difference between a paint coating having the targeted dry thickness and a paint coating having a dry thickness more than (targeted dry thickness + 50) μm is less than 1. This color difference is preferably less than 0.5.

[3] Contrast ratio

By controlling the contrast ratio as well as the color difference, it is possible to drastically enhance the precision at which the thickness of the paint coating is determined near the targeted dry thickness. The contrast ratio, a parameter exhibiting how well a layer hides an underlying layer, is preferably adjusted to 0.90-0.98 in the paint coating having a desirable thickness of 100 μm or more, by controlling the amount of the coloring pigment in the thickness-determining paint. The preferred contrast ratio is 0.92-0.95. If the contrast ratio were set low, the paint coating would tend to be thicker than desired, resulting in increase in the amount of the thickness-determining paint used. On the other hand, if the contrast ratio were set high, the paint coating would not reach a targeted thickness, failing to achieve the desired performance. The contrast ratio of the dry paint coating can be measured according to a method defined in "7.2 Measurement of Contrast Ratio" in JIS K 5400.

[4] Brightness (L value)

The paint coating would have brightness (L value) of preferably 60 or more, more preferably 70 or more, at the targeted dry thickness, if all the coloring pigments or other coloring pigments than titanium dioxide are excluded from the thickness-determining paint. Using the thickness-determining paint meeting this condition, the thickness of the paint coating can easily be determined. The above brightness level can be obtained

by adjusting the amounts of the coloring pigments including titanium dioxide and the body pigment having a whiteness degree of 85 or more. The brightness can be measured by a method according to JIS Z 8105.

[5] Coating method

The coating method of the thickness-determining paint according to the present invention may be (1) a method of directly applying the thickness-determining paint to a surface of the article, or (2) a method of applying a shop primer and/or a thickness-determining paint of a different color to a surface of the article and then applying a thickness-determining paint of an objective color thereonto. In both cases, the application of the thickness-determining paint is carried out while observing the change of a color difference between the paint coating being formed and the article or an undercoat (a shop primer layer or a thickness-determining paint coating of a different color), until the resultant paint coating reaches the targeted thickness (wet). Specifically, the change of a color difference between the paint coating and the article or the undercoat is observed by the naked eye while the paint coating being formed is still wet, to check whether or not the resultant paint coating has reached the targeted thickness. Because the change of a color difference does not depend on the state (wet or dry) of the paint coating, the observation results in a wet state are applicable to the thickness of the dry paint coating without modification.

(1) Direct coating

The articles usable in the present invention may be various types of steel such as untreated steel, blasted steel, acid-treated steel, zinc-plated steel, stainless steel; nonferrous materials such as aluminum or its alloys; copper or its alloys; etc. These steel or nonferrous articles may have weld lines.

(2) Coating of shop primer and/or thickness-determining paint of different color

Shop primers, which may be used in the present invention, include:

- (a) a primary anti-corrosive paint composition comprising an initial condensate of a hydrolyzate of tetraalkoxy silicate, a solvent-dispersed, acidic colloidal silica, and zinc powder (Japanese Patent Laid-Open No. 60-235871);
- (b) an anti-corrosive paint composition comprising zinc alloy powder having a melting point higher than that of zinc and an electric potential lower than that of iron (Japanese Patent Laid-Open No. 60-235872);
- (c) a primary anti-corrosive paint composition comprising a binder and spherical zinc powder having an average diameter of 5-10 μm measured by a light transmission sedimentation method, zinc powder of 2 μm or more being 95 volume % or more per the total amount of the zinc powder, the amount of zinc powder being 20-60 parts by volume per 100 parts by volume of the resultant dry paint coating, and the paint coating having a heat resistance of 600°C or higher (Japanese Patent Laid-Open No. 62-141075), or
- (d) an anti-corrosive paint composition having a similar formulation to those of the above anti-corrosive paint compositions.

The application of thickness-determining paints of different colors provides a multi-layer paint coating. In this case, the term "color difference from the article" should be rephrased to "color difference between the topcoat and the undercoat," in the color difference condition that a thickness-determining paint in a topcoat should meet. Specifically, the topcoat should meet the conditions: (a) a color difference between the topcoat and the undercoat is 20 or more, (b) a color difference between a paint coating having a targeted dry thickness and a paint coating having a dry thickness less than (targeted dry thickness - 50) μm is 2 or more, and (c) a color difference between a paint coating having a targeted dry thickness and a paint coating having a dry thickness more than (targeted dry thickness + 50) μm is less than 1.

(3) Coating of topcoat

A topcoat may further be formed on the thickness-determining paint coating formed according to the present invention. Usable for the topcoat are epoxy resin paints, chlorinated rubber paints, vinyl chloride resin paints, alkyd resin paints, silicone alkyd resin paints, acrylic resin paints, urethane resin paints, fluorine resin paints, polyester resin paints, epoxy acrylic resin paints, etc.

The present invention will be explained in further detail by way of the following Examples without intention of restricting the scope of the present invention.

SYNTHESIS EXAMPLES 1-14

Production of thickness-determining paints

Thickness-determining paints (Paints 1-14) having formulations shown in Table 1 below were prepared. All main components other than coloring pigments except for titanium dioxide were mixed together with glass beads in a stainless steel container, dispersed to desired particle size by Auto Homo-Mixer, and then mixed with a coloring pigment paste. The amounts of titanium dioxide and other coloring pigments were adjusted to provide the desired contrast ratio at the predetermined targeted dry thickness. Curing agents were produced by uniformly mixing all components by Auto Homo-Mixer.

Table 1

Components ⁽¹⁾ (volume %)	<u>Paint 1</u>	<u>Paint 2</u>	<u>Paint 3</u>	<u>Paint 4</u>	<u>Paint 5</u>	<u>Paint 6</u>	<u>Paint 7</u>
Color	Yellow	Yellow	Yellow	Blue	Blue	Blue	Yellow
Body Pigment							
Talc A ⁽²⁾	12.61	-	-	13.06	-	-	-
Talc B ⁽²⁾	-	12.71	-	-	13.10	-	12.61
Talc C ⁽²⁾	-	-	12.82	-	-	13.14	-
% Based on SPC ⁽³⁾	21.32	21.50	21.67	22.08	22.15	22.22	21.32
Anti-Corrosive Pigment ⁽⁴⁾	4.14	4.14	4.14	4.14	4.14	4.14	4.14
Additives ⁽⁵⁾	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Coloring Pigment							
Titanium Dioxide ⁽⁶⁾	0.18	0.15	0.13	0.21	0.18	0.15	0.18
Yellow Iron Oxide ⁽⁶⁾	0.53	0.46	0.37	-	-	-	0.53
Phthalocyanine Blue ⁽⁶⁾	-	-	-	0.05	0.04	0.03	-
Percentage of Coloring Pigment							
Based on SPC ⁽⁷⁾	1.20	1.03	0.85	0.44	0.37	0.30	1.20
Based on All Pigments ⁽⁸⁾	3.79	3.25	2.67	1.39	1.17	0.96	3.79
Anti-Sagging Agent ⁽⁹⁾	4.87	4.87	4.87	4.87	4.87	4.87	4.87
Synthetic Petroleum Resin ⁽¹⁰⁾	11.43	11.43	11.43	11.43	11.43	11.43	11.43
Epoxy Polyol ⁽¹¹⁾	24.36	24.36	24.36	24.36	24.36	24.36	24.36
Mixed Solvent ⁽¹²⁾	22.60	22.60	22.60	22.60	22.60	22.60	22.60
Isocyanate ⁽¹³⁾	17.99	17.99	17.99	17.99	17.99	17.99	17.99
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: (1) Volume % of each component based on the entire paint

volume.

- (2) Whiteness degree of talc:
Talc A: 98,
Talc B: 80, and
Talc C: 67.
- (3) Volume % of the body pigment based on a solid paint content.
- (4) Zinc molybdate.
- (5) Powdery moisture absorbent and reaction accelerator.
- (6) Volume % based on the entire volume of the thickness-determining paint.
- (7) Volume % of the coloring pigment based on a solid paint content.
- (8) Volume % of the coloring pigment based on the entire volume of the pigment plus the additives.
- (9) Disparlon A603-20X available from Kusumoto Chemicals Ltd. (solid content: 20 weight %, shown in the table as volume % including a solvent).
- (10) Necires EPX-L available from Nevcin Polymers B.V. (solid content: 99 weight %, shown in the table as volume % including a solvent, weight ratio of synthetic petroleum resin/epoxy polyol: 77/100 on a solid basis.).
- (11) Aromatic epoxy polyol (solid content: 60 weight %, shown in the table as volume % including a solvent).
- (12) Aromatic hydrocarbon-solvent and ketone solvent (weight ratio: 1/1).
- (13) Aromatic polyisocyanate (solid content: 75 weight %, shown in the table as volume % including a solvent, weight ratio of

aromatic polyisocyanate/epoxy polyol: 90/100 on a solid basis.).

Table 1 (Continued)

Components ⁽¹⁾ (volume %)	<u>Paint 8</u>	<u>Paint 9</u>	<u>Paint 10</u>	<u>Paint 11</u>	<u>Paint 12</u>	<u>Paint 13</u>	<u>Paint 14</u>
Color	Yellow	Yellow	Yellow	Yellow	Blue	Blue	Blue
Body Pigment							
Talc A ⁽²⁾	-	12.02	-	-	12.85	-	-
Talc B ⁽²⁾	-	-	12.20	-	-	12.92	-
Talc C ⁽²⁾	12.61	-	-	12.40	-	-	13.00
% Based on SPC ⁽³⁾	21.32	20.32	20.63	20.96	21.73	21.84	21.98
Anti-Corrosive Pigment ⁽⁴⁾	4.14	4.14	4.14	4.14	4.14	4.14	4.14
Additives ⁽⁵⁾	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Coloring Pigment							
Titanium Dioxide ⁽⁶⁾	0.18	0.33	0.28	0.24	0.38	0.33	0.27
Yellow Iron Oxide ⁽⁶⁾	0.53	0.97	0.84	0.68	-	-	-
Phthalocyanine Blue ⁽⁶⁾	-	-	-	-	0.09	0.07	0.05
Percentage of Coloring Pigment							
Based on SPC ⁽⁷⁾	1.20	2.20	1.89	1.56	0.79	0.68	0.54
Based on All Pigments ⁽⁸⁾	3.79	6.93	5.97	4.91	2.51	2.13	1.71
Anti-Sagging Agent ⁽⁹⁾	4.87	4.87	4.87	4.87	4.87	4.87	4.87
Synthetic Petroleum Resin ⁽¹⁰⁾	11.43	11.43	11.43	11.43	11.43	11.43	11.43
Epoxy Polyol ⁽¹¹⁾	24.36	24.36	24.36	24.36	24.36	24.36	24.36
Mixed Solvent ⁽¹²⁾	22.60	22.60	22.60	22.60	22.60	22.60	22.60
Isocyanate ⁽¹³⁾	17.99	17.99	17.99	17.99	17.99	17.99	17.99
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: (1)-(13) Same as under Table 1.

EXAMPLES 1 and 2, COMPARATIVE EXAMPLES 1-6

A plurality of matt steel plates of 900 mm x 900 mm were coated with a shop primer ("Nippe-Ceramo Gray," available from Nippon Paint Marine Coatings Co., Ltd.) at a thickness of 15 μm and dried at room temperature for 24 hours or more to provide test plates. Each of thickness-determining paints (Paints 1-8) shown in Table 1 was airless-sprayed onto each test plate at a wet thickness of 400 μm and a targeted dry thickness of 250 μm , and left to stand at room temperature for 24 hours. With respect to the resultant paint coating of each thickness-determining paint, a color difference from the shop primer was measured by an SM Color Computer (SM-7CH, available from Suga Test Instruments Co., Ltd.). Also, after applying each of Paints 1-8 to a white contrast ratio test paper at a targeted dry thickness of 250 μm by an applicator, the contrast ratio and the brightness L were measured. Further, the unevenness in thickness (minimum thickness, maximum thickness, average thickness and standard deviation δ) of the thickness-determining paint coating on each test plate was evaluated by having ten operators coat test plates with each thickness-determining paint at a targeted dry thickness of 250 μm and then measuring the thickness of the thickness-determining paint coating at 30 points in each coated test plate. The results are shown in Table 2.

Table 2

No.	EXAMPLE 1	COM. EX. 1	COM. EX. 2
Shop Primer			
Hue	Gray	Gray	Gray
Munsell Value ⁽¹⁾	7.1GY 5.9/0.5	7.1GY 5.9/0.5	7.1GY 5.9/0.5
Thickness-Determining Paint			
Type	Paint 1	Paint 2	Paint 3
Whiteness Degree of Talc ⁽²⁾	A	B	C
Hue	Yellow	Yellow	Yellow
Munsell Value ⁽¹⁾	2.1Y 7.4/8.3	2.9Y 6.3/6.2	4.2Y 4.7/3.8
Targeted Dry Thickness (μm)	250	250	250
Properties of Paint Coating			
Color Difference ⁽³⁾	42	32	19
Contrast Ratio ⁽⁴⁾	0.94	0.94	0.94
Brightness (L Value) ⁽⁵⁾	77.96	68.29	51.66
Thickness of Paint Coating (μm) ⁽⁶⁾			
Minimum Thickness	236	205	174
Maximum Thickness	273	256	264
Average Thickness	254	236	214
Standard Deviation δ	11.9	21.9	44.7

Note: (1) Munsell notation (hue, brightness/chromaticness).

(2) Whiteness degree (A: 98, B: 80, C: 67) measured by Whiteness Tester for Powder C-100 (filter; blue, available from Kett Electric Laboratory) according to JIS Z 8722 (1982).

- (3) Color difference between the shop primer and the dried thickness-determining paint coating measured by SM Color Computer (SM-7CH available from Suga Test Instruments Co., Ltd.).
- (4) Measured according to JIS K 5400 7.2.
- (5) Brightness at the targeted dry thickness measured according to JIS Z 8105 on a thickness-determining paint coating containing only titanium dioxide as a coloring pigment, which was applied to a white contrast ratio test paper.
- (6) Unevenness in thickness of the paint coating relative to the targeted thickness (after 10 operators applied each thickness-determining paint to test plates, thickness was measured at 30 points in each coated test plate.)

Table 2 (Continued)

<u>No.</u>	<u>EXAMPLE 2</u>	<u>COM. EX. 3</u>	<u>COM. EX. 4</u>
Shop Primer			
Hue	Gray	Gray	Gray
Munsell Value ⁽¹⁾	7.1GY 5.9/0.5	7.1GY 5.9/0.5	7.1GY 5.9/0.5
Thickness-Determining Paint			
Type	Paint 4	Paint 5	Paint 6
Whiteness Degree of Talc ⁽²⁾	A	B	C
Hue	Blue	Blue	Blue
Munsell Value ⁽¹⁾	7.9B 6.3/8.7	6.4B 5.7/6.4	4.7B 3.7/4.3
Targeted Dry Thickness (μm)	250	250	250
Properties of Paint Coating			
Color Difference ⁽³⁾	37	29	17
Contrast Ratio ⁽⁴⁾	0.94	0.94	0.94
Brightness (L Value) ⁽⁵⁾	78.54	68.81	52.14
Thickness of Paint Coating (μm) ⁽⁶⁾			
Minimum Thickness	232	199	126
Maximum Thickness	276	259	259
Average Thickness	252	218	194
Standard Deviation δ	13.1	24.5	42.5

Note: (1)-(6) Same as under Table 2.

Table 2 (Continued)

No.	COM. EX. 5	COM. EX. 6
Shop Primer		
Hue	Gray	Gray
Munsell Value ⁽¹⁾	7.1GY 5.9/0.5	7.1GY 5.9/0.5
Thickness-Determining Paint		
Type	Paint 7	Paint 8
Whiteness Degree of Talc ⁽²⁾	B	C
Hue	Yellow	Yellow
Munsell Value ⁽¹⁾	2.8Y 6.1/5.9	3.9Y 4.9/3.7
Targeted Dry Thickness (μm)	250	250
Properties of Paint Coating		
Color Difference ⁽³⁾	35	26
Contrast Ratio ⁽⁴⁾	1.00	1.00
Brightness (L Value) ⁽⁵⁾	70.31	54.93
Thickness of Paint Coating (μm) ⁽⁶⁾		
Minimum Thickness	120	91
Maximum Thickness	235	209
Average Thickness	183	145
Standard Deviation δ	43.2	57.6

Note: (1)-(6) Same as under Table 2.

Next, after each of thickness-determining paints (Paints 1-8) was airless-sprayed onto each test plate at a wet thickness and a targeted dry thickness shown in Table 3, a color difference ΔE from a paint coating of the targeted dry thickness was measured, and the appearance of each paint coating

was observed by the naked eye in both wet and dry states. The results are shown in Table 3.

Table 3

No.	EXAMPLE 1		COM. EX. 1		COM. EX. 2	
Thickness ⁽¹⁾	$\Delta E^{(2)}$	Obs. ⁽³⁾	$\Delta E^{(2)}$	Obs. ⁽³⁾	$\Delta E^{(2)}$	Obs. ⁽³⁾
240/150 μm	8.9	×	7.9	△	4.0	△
280/175 μm	4.7	△	4.2	□	2.2	□
320/200 μm	2.4	□	2.1	○	1.2	◎
360/225 μm	1.1	○	0.9	◎	0.6	◎
400/250 μm	0.0	◎	0.0	◎	0.0	◎
440/275 μm	0.2	◎	0.2	◎	0.2	◎
480/300 μm	0.4	◎	0.5	◎	0.4	◎

Note: (1) Wet thickness/dry thickness measured by an electromagnetic thickness tester (COATING THICKNESS TESTER LE-900 available from Kett Electric Laboratory).

(2) Color difference from a paint coating of a targeted dry thickness of 250 μm measured by SM Color Computer (SM-7CH available from Suga Test Instruments Co., Ltd.).

(3) Evaluation standards for observation by the naked eye on both wet coating and dry coating:

×: The shop primer layer was entirely visible through the thickness-determining paint coating.

△: The shop primer layer was considerably visible through the thickness-determining paint coating.

□: The shop primer layer was slightly visible through the thickness-determining paint coating.

○: The shop primer layer was substantially hidden by the thickness-determining paint coating except for limited visibility.

⊙: The shop primer layer was completely hidden by the thickness-determining paint coating.

Table 3 (Continued)

No.	<u>EXAMPLE 2</u>		<u>COM. EX. 3</u>		<u>COM. EX. 4</u>	
Thickness ⁽¹⁾	$\Delta E^{(2)}$	Obs. ⁽³⁾	$\Delta E^{(2)}$	Obs. ⁽³⁾	$\Delta E^{(2)}$	Obs. ⁽³⁾
240/150 μm	8.2	×	7.7	△	3.9	□
280/175 μm	4.5	△	0.4	□	0.2	○
320/200 μm	2.2	□	2.0	○	1.0	⊙
360/225 μm	1.0	○	0.8	⊙	0.5	⊙
400/250 μm	0.0	⊙	0.0	⊙	0.0	⊙
440/275 μm	0.3	⊙	0.2	⊙	0.3	⊙
480/300 μm	0.5	⊙	0.5	⊙	0.6	⊙

Note: (1)-(3) Same as under Table 3.

Table 3 (Continued)

<u>No.</u> Thickness ⁽¹⁾	COM. EX. 5		COM. EX. 6	
	$\Delta E^{(2)}$	Obs. ⁽³⁾	$\Delta E^{(2)}$	Obs. ⁽³⁾
240/150 μm	2.6	○	2.3	◎
280/175 μm	2.1	◎	1.1	◎
320/200 μm	1.1	◎	0.8	◎
360/225 μm	0.6	◎	0.2	◎
400/250 μm	0.0	◎	0.0	◎
440/275 μm	0.2	◎	0.2	◎
480/300 μm	0.5	◎	0.4	◎

Note: (1)-(3) Same as under Table 3.

As is clear from Tables 2 and 3, whether or not the paint coating reached the predetermined thickness was able to be determined by the naked eye in a state where the paint coating was still wet in EXAMPLES 1 and 2. In addition, EXAMPLES 1 and 2 provided an average paint coating thickness substantially equal to the targeted thickness in a dry state, with extremely smaller standard deviations than those of COMPARATIVE EXAMPLES 1-6.

EXAMPLE 3, COMPARATIVE EXAMPLES 7 and 8

Paint coatings were formed by using thickness-determining paints (Paints 9-11) in the same manner as in EXAMPLE 1 except for setting the targeted dry thickness at 125 μm . Each of the resultant paint coatings was measured with respect to a difference in color ΔE from a paint coating of the targeted dry thickness and a difference in color from the shop primer coating by the above colorimeter. After applying each thickness-determining paint to a white contrast ratio test paper at a targeted dry thickness by an applicator, a

contrast ratio and brightness L were measured. As shown in Table 4, these results were compared with those obtained in EXAMPLE 1 and COMPARATIVE EXAMPLES 1 and 2.

Table 4

<u>No.</u>	<u>EXAMPLE 3</u>	<u>EXAMPLE 1</u>
Shop Primer		
Hue	Gray	Gray
Munsell Value ⁽¹⁾	7.1GY 5.9/0.5	7.1GY 5.9/0.5
Thickness-Determining Paint		
Type	Paint 9	Paint 1
Whiteness Degree of Talc ⁽²⁾	A	A
Hue	Yellow	Yellow
Munsell Value ⁽¹⁾	1.8Y 6.6/8.9	2.1Y 7.4/8.3
Targeted Dry Thickness (μm)	125	250
Properties of Paint coating		
Color Difference ⁽³⁾	44	42
ΔE ⁽⁴⁾	0	2
Contrast Ratio ⁽⁵⁾	0.94	0.94
Brightness (L Value) ⁽⁶⁾	79.21	77.96

Note: (1) Munsell notation (hue, brightness/chromaticness).

(2) Whiteness degree of talc (A: 98, B: 80, C: 67) measured by Whiteness Tester for Powder C-100 (available from Kett Electric Laboratory) according to JIS Z 8722(1982).

- (3) Color difference between the shop primer coating and the dried thickness-determining paint coating measured by SM Color Computer (SM-7CH available from Suga Test Instruments Co., Ltd.).
- (4) Color difference from a paint coating having a targeted dry thickness of 125 μm measured by SM Color Computer (SM-7CH available from Suga Test Instruments Co., Ltd.).
- (5) Measured according to JIS K 5400 7.2.
- (6) Brightness of a paint coating formed by applying a thickness-determining paint containing only titanium dioxide as a coloring pigment at a targeted dry thickness to a white contrast ratio test paper, which was measured according to JIS Z 8105.

Table 4 (Continued)

<u>No.</u>	<u>COM. EX. 7</u>	<u>COM. EX. 1</u>
Shop Primer		
Hue	Gray	Gray
Munsell Value ⁽¹⁾	7.1GY 5.9/0.5	7.1GY 5.9/0.5
Thickness-Determining Paint		
Type	Paint 10	Paint 2
Whiteness Degree of Talc ⁽²⁾	B	B
Hue	Yellow	Yellow
Munsell Value ⁽¹⁾	2.5Y 6.4/7.2	2.9Y 6.3/6.2
Targeted Dry Thickness (μm)	125	250
Properties of Paint Coating		
Color Difference ⁽³⁾	36	32
$\Delta E^{(4)}$	0	4
Contrast Ratio ⁽⁵⁾	0.94	0.94
Brightness (L Value) ⁽⁶⁾	69.97	68.29

Note: (1)-(6) Same as under Table 4.

Table 4 (Continued)

<u>No.</u>	<u>COM. EX. 8</u>	<u>COM. EX. 2</u>
Shop Primer		
Hue	Gray	Gray
Munsell Value ⁽¹⁾	7.1GY 5.9/0.5	7.1GY 5.9/0.5
Thickness-Determining Paint		
Type	Paint 11	Paint 3
Whiteness Degree of Talc ⁽²⁾	C	C
Hue	Yellow	Yellow
Munsell Value ⁽¹⁾	3.4Y 5.2/4.5	4.2Y 4.7/3.8
Targeted Dry Thickness (μm)	125	250
Properties of Paint coating		
Color Difference ⁽³⁾	25	19
$\Delta E^{(4)}$	0	6
Contrast Ratio ⁽⁵⁾	0.94	0.94
Brightness (L Value) ⁽⁶⁾	53.27	51.66

Note: (1)-(6) Same as under Table 4.

As is clear from Table 4, a color difference was extremely smaller between EXAMPLES 3 and 1 than between COMPARATIVE EXAMPLES 7 and 1 and between COMPARATIVE EXAMPLES 8 and 2, when there was a difference in targeted dry thickness therebetween.

EXAMPLE 4, COMPARATIVE EXAMPLES 9 and 10

Combining thickness-determining paints of different colors, an undercoat at a targeted dry thickness of 125 μm and a topcoat at a targeted dry

thickness of 250 μm were formed on each test plate by an airless spraying method and left to stand at room temperature for 24 hours. With respect to each topcoat, a color difference from the undercoat, a contrast ratio and brightness Δt were measured. Further, the unevenness in a total thickness (minimum thickness, maximum thickness, average thickness and standard deviation δ) of the undercoat and the topcoat on each test plate was evaluated, by having ten operators coat test plates with thickness-determining paints for an undercoat and a topcoat and then measuring the total thickness at 30 points in each coated test plate. The results are shown in Table 5.

Table 5

No.	<u>EXAMPLE 4</u>	<u>COM. EX. 9</u>	<u>COM. EX. 10</u>
Undercoat⁽¹⁾			
Type	Paint 12	Paint 13	Paint 14
Whiteness Degree of Talc	A	B	C
Hue	Blue	Blue	Blue
Munsell Value	7.6B 5.9/9.0	6.1B 6.3/7.2	4.3B 4.8/5.6
Targeted Dry Thickness (μm)	125	125	125
Contrast Ratio	0.94	0.94	0.94
Topcoat⁽²⁾			
Type	Paint 1	Paint 2	Paint 3
Whiteness Degree of Talc	A	B	C
Hue	Yellow	Yellow	Yellow
Munsell Value	2.1Y 7.4/8.3	2.9Y/6.3/6.2	4.2Y 4.7/3.8
Targeted Dry Thickness (μm)	250	250	250
Color Difference ⁽³⁾	63	52	38
Contrast Ratio	0.94	0.94	0.94
Brightness (L Value)	77.96	68.29	51.66
Total Thickness (μm)⁽⁴⁾			
Targeted Dry Thickness	375	375	375
Minimum Thickness	354	311	245
Maximum Thickness	409	431	399
Average Thickness	379	340	302
Standard Deviation δ	11.8	45.7	74.3

- Note:
- (1) Thickness-determining paint having a targeted dry thickness of 125 μm .
 - (2) Thickness-determining paint having a targeted dry thickness of 250 μm .
 - (3) Color difference between the undercoat and the topcoat measured by SM Color Computer (SM-7 CH available from Suga Test Instruments Co., Ltd).
 - (4) The total thickness of the topcoat and the undercoat measured by an electromagnetic thickness tester (COATING THICKNESS TESTER LE-900 available from Kett Electric Laboratory).

Next, combining thickness-determining paints of different colors, an undercoat having a targeted dry thickness of 125 μm , and a topcoat having a wet thickness/dry thickness of 240/150 μm , 280/175 μm , 320/200 μm , 360/225 μm , 400/250 μm , 440/275 μm and 480/300 μm were formed on each test plate by an airless spraying method and left to stand at room temperature for 24 hours. With respect to each topcoat, a color difference ΔE from a paint coating of the targeted dry thickness was measured, and its appearance was observed by the naked eye. The results are shown in Table 6.

Table 6

No.	EXAMPLE 4	COM. EX. 9	COM. EX. 10
Undercoat ⁽¹⁾			
Type	Paint 12	Paint 13	Paint 14
Whiteness Degree of Talc	A	B	C
Hue	Blue	Blue	Blue
Munsell Value	7.6B 5.9/9.0	6.1B 6.3/7.2	4.3B 4.8/5.6
Targeted Dry Thickness (μm)	125	125	125
Contrast Ratio	0.94	0.94	0.94
Topcoat ⁽²⁾			
Type	Paint 1	Paint 2	Paint 3
Whiteness Degree of Talc	A	B	C
Hue	Yellow	Yellow	Yellow
Munsell Value	2.1Y 7.4/8.3	2.9Y/6.3/6.2	4.2Y 4.7/3.8
Thickness ⁽³⁾	ΔE Obs. ⁽⁴⁾	ΔE Obs. ⁽⁴⁾	ΔE Obs. ⁽⁴⁾
240/150 μm	7.2 ×	7.2 △	4.2 □
280/175 μm	3.1 △	4.1 □	2.3 ○
320/200 μm	2.0 □	2.2 ○	1.1 ⊙
360/225 μm	1.2 ○	0.9 ⊙	0.5 ⊙
400/250 μm	0.0 ⊙	0.0 ⊙	0.0 ⊙
440/275 μm	0.3 ⊙	0.3 ⊙	0.2 ⊙
480/300 μm	0.6 ⊙	0.5 ⊙	0.4 ⊙

Note: (1) Thickness-determining paint having a targeted dry thickness of 125 μm.

- (2) Thickness-determining paint having a targeted dry thickness of 150-300 μm .
- (3) Wet thickness/dry thickness measured by Paint Borer 518 available from Erichsen.
- (4) Same as under Table 3.

As is clear from Tables 5 and 6, whether or not the paint coating reached the predetermined thickness could be determined by the naked eye in a state where the paint coating was still wet in EXAMPLE 4. In addition, EXAMPLE 4 provided an average paint coating thickness substantially equal to the targeted thickness in a dry state, with much smaller standard deviations than those of COMPARATIVE EXAMPLES 9 and 10.

As described above in detail, the method of the present invention can form a paint coating easily and precisely at each targeted dry thickness even on articles requiring different paint coating thickness from area to area, and a paint coating without a color difference even at different paint coating thickness. Accordingly, the method of the present invention for forming a paint coating is extremely useful for painting in vessels and the like.



WHAT IS CLAIMED IS:

1. A method for forming a substantially uniform paint coating having a targeted dry thickness of 100 μm or more on a surface of an article, using a paint comprising 0.01-3 volume %, based on a solid paint content, of a coloring pigment and a body pigment having a whiteness degree of 85 or more, as a thickness-determining paint, the contents of said coloring pigment and said body pigment in said thickness-determining paint being adjusted to meet the following conditions:

- (a) a color difference between said thickness-determining paint and said article is 20 or more,
- (b) a color difference between a paint coating having said targeted dry thickness and a paint coating having a dry thickness less than (targeted dry thickness - 50) μm is 2 or more, and
- (c) a color difference between a paint coating having said targeted dry thickness and a paint coating having a dry thickness more than (targeted dry thickness + 50) μm is less than 1.

2. A method for forming a paint coating having different targeted thickness areas on a surface of an article by using two or more types of thickness-determining paints, wherein each targeted dry thickness is 100 μm or more, and wherein each thickness-determining paint contains 0.01-3 volume %, based on a solid paint content, of a coloring pigment, and a body pigment having a whiteness degree of 85 or more, the contents of said coloring pigment and said body pigment in said thickness-determining paints being adjusted to meet the following conditions:

- (a) a color difference between said thickness-determining paint and said article is 20 or more,
- (b) a color difference between a paint coating having said targeted dry thickness and a paint coating having a dry thickness less than (targeted dry thickness - 50) μm is 2 or more, and



- (c) a color difference between a paint coating having said targeted dry thickness and a paint coating having a dry thickness more than (targeted dry thickness + 50) μm is less than 1.
3. The method for forming a paint coating according to claim'2, wherein two or more types of said thickness-determining paints are adjusted to meet the conditions that a color difference between any two of said thickness-determining paints at the targeted dry thickness is less than 3.
4. The method for forming a paint coating according to any one of claims 1-3, wherein said paint coating has a contrast ratio of 0.90-0.98 at said targeted dry thickness.
5. The method for forming a paint coating according to any one of claims 1-4, wherein said paint coating would have brightness (L value) of 60 or more at said targeted dry thickness, if all the coloring pigments or other coloring pigments than titanium dioxide are excluded from said thickness-determining paint.
6. The method for forming a paint coating according to any one of claims 1-5, wherein said coloring pigment in said thickness-determining paint comprises titanium dioxide and other coloring pigments, the total amount of said titanium dioxide and said other coloring pigments being 0.1-3 volume % based on a solid paint content.
7. The method for forming a paint coating according to any one of claims 1-6, wherein said article is coated with a shop primer and/or a thickness-determining paint of a different color as an undercoat.
8. The method for forming a paint coating according to any one of claims 1-7, wherein said article is a steel plate.
9. The method for forming a paint coating according to any one of claims 1-8, wherein said thickness-determining paint comprises at least one binder resin selected from the group consisting of epoxy resins and epoxy resins modified with petroleum resins, and at least one curing agent selected



from the group consisting of amines, polyamides and polyisocyanate compounds.

10. The method for forming a paint coating according to any one of claims 1-9, wherein the change of said color difference is observed by the naked eye while said thickness-determining paint coating being formed is still wet, to determine whether or not said thickness-determining paint coating has reached a predetermined thickness.