

DESCRIPTION

Title of Invention

REFRIGERANT PACK

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Technical Field

[0001]

The present invention relates to a refrigerant pack including a refrigerant composition of which the color change caused at the time of cooling can be easily visually observed.

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Priority is claimed on Japanese Patent Application No. 2015-185043, filed on September 18, 2015, the content of which is incorporated herein by reference.

Background Art

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[0002]

Refrigerant packs are widely used for cooling various perishable items at the time of storing or transporting the perishable items. Generally, the refrigerant packs are repeatedly used. These refrigerant packs include a refrigerant composition having a cooling effect, and have a constitution in which the refrigerant composition is enclosed in a container having thermal conductivity.

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As the refrigerant composition, a refrigerant composition containing a coloring agent which makes it possible to easily visually observe the presence of the composition from the outside of the refrigerant pack is known. For example, there is a disclosure regarding a refrigerant pack in which a refrigerant composition colored with a dye is enclosed, and the amount of the enclosed composition can be easily checked from the

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outside (see PTL 1).

[0003]

Unfortunately, although the refrigerant pack described in PTL 1 includes the refrigerant composition containing a dye, it is difficult to visually check the cooling state such as whether or not the composition is frozen, and to visually observe the cooling state so as to check whether the refrigerant pack is sufficiently cooled down to a desired temperature at which the refrigerant pack can be kept cool.

Citation List

10 Patent Literature

[0004]

[PTL 1] Japanese Unexamined Patent Application, First Publication No. 2006-97984

15 Summary of Invention

Technical Problem

[0005]

An object of the present invention is to provide a refrigerant pack which makes it possible to easily visually observe whether the intended cooling state has been reached.

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Solution to Problem

[0006]

A first aspect of the present invention is a refrigerant pack including a refrigerant composition containing water, inorganic salts, a thickener, and a pH indicator, in which the refrigerant composition contains, as the inorganic salts, acidic inorganic salts, which

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exhibit acidic properties in an aqueous solution of the acidic inorganic salts, and a phosphate; in the refrigerant composition, a ratio of a total content of the acidic inorganic salts and the phosphate to a total content of the inorganic salts is 5% to 100% by mass; the refrigerant composition contains, as the acidic inorganic salts, dihydrogen phosphate and an inorganic salt other than the dihydrogen phosphate; a pKa of the pH indicator is 4.9 to 8.0; and a pH ($\alpha 1$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the phosphate, the dihydrogen phosphate, and water are removed and the pKa satisfy a relationship represented by Expression (i).

$$\text{pKa of pH indicator} \leq \text{pH} (\alpha 1) \leq \text{pKa of pH indicator} + 1.8 \quad \cdots \quad (i)$$

[0007]

In the first aspect of the present invention, a pH of the refrigerant composition may be 4.6 to 8.8.

In the first aspect of the present invention, a pH ($\alpha 3$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the thickener and water are substituted with water may be 6.0 to 8.5.

[0008]

A second aspect of the present invention is a refrigerant pack including a refrigerant composition containing water, inorganic salts, a thickener, and a pH indicator, in which the refrigerant composition contains, as the inorganic salts, an acidic inorganic salt, which exhibits acidic properties in an aqueous solution of the acidic inorganic salt, and monohydrogen phosphate; in the refrigerant composition, a ratio of a total content of the acidic inorganic salt and the monohydrogen phosphate to a total content of the inorganic salts is 5% to 100% by mass; in the refrigerant composition, a ratio of a content of the monohydrogen phosphate to a total content of water, the inorganic salts, and the

thickener is 0.2% to 5.0% by mass; and a pKa of the pH indicator is 4.9 to 8.0.

[0009]

In the second aspect of the present invention, a pH of the refrigerant composition may be 4.7 to 8.0.

5 In the second aspect of the present invention, a pH ($\alpha 3$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the thickener and water are substituted with water may be 6.0 to 9.1.

[0010]

A third aspect of the present invention is a refrigerant pack including a
 10 refrigerant composition containing water, an inorganic salt, a thickener, and a pH indicator, in which the refrigerant composition contains, as the inorganic salt, an acidic inorganic salt, which exhibits acidic properties in an aqueous solution of the acidic inorganic salt; in the refrigerant composition, a ratio of a content of the acidic inorganic salt to a total content of the inorganic salt is 5% to 100% by mass; a pH ($\alpha 2$) of the
 15 refrigerant composition obtained in a case where all the components contained in the composition other than the inorganic salt and water are substituted with water is equal to or lower than 7; a pH ($\alpha 3$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the thickener and water are substituted with water is equal to or higher than 7; and the pH ($\alpha 2$) and the pH ($\alpha 3$) show
 20 values of different pH ranges among three pH ranges of a pH lower than a transition range of the pH indicator, a pH of the transition range of the pH indicator, and a pH higher than the transition range of the pH indicator.

Advantageous Effects of Invention

[0011]

The refrigerant pack of the present invention makes it possible to easily visually observe whether the intended cooling state has been reached.

5 Description of Embodiments

[0012]

Preferred examples of the refrigerant pack of the present invention will be described below, but the present invention is not limited to the examples. For example, within a scope that does not depart from the gist of the present invention, addition,
10 omission, substitution, and other modifications (modification of amount, number, position, size, and the like) can be applied to the present invention.

[0013]

In the present specification, unless otherwise specified, the unit “ppm” of content (blending amount or concentration) is based on a mass ratio in all cases.

15 [0014]

<<First embodiment>>

A refrigerant pack according to a first embodiment of the present invention is a refrigerant pack including a refrigerant composition containing water, inorganic salts, a thickener, and a pH indicator. The refrigerant composition contains, as the inorganic
20 salts, acidic inorganic salts, which exhibit acidic properties in an aqueous solution of the acidic inorganic salts, and a phosphate. In the refrigerant composition, a ratio of the total content of the acidic inorganic salts and the phosphate to a total content of the inorganic salts is 5% to 100% by mass. The refrigerant composition contains, as the acidic inorganic salts, dihydrogen phosphate and an inorganic salt other than the
25 dihydrogen phosphate. A pKa of the pH indicator is 4.9 to 8.0. A pH ($\alpha 1$) of the

refrigerant composition obtained in a case where all the components contained in the composition other than the phosphate, the dihydrogen phosphate, and water are removed and the pKa satisfy a relationship represented by Expression (i).

$$\text{pKa of pH indicator} \leq \text{pH} (\alpha 1) \leq \text{pKa of pH indicator} + 1.8 \quad \cdots \quad (i)$$

5 [0015]

The color of the refrigerant composition of the refrigerant pack greatly changes before and after the refrigerant composition is frozen. The color of the refrigerant composition reflects whether or not the pH indicator produces color. Therefore, the refrigerant pack makes it possible to easily visually observe whether the intended cooling
10 state (state where an object can be sufficiently cooled) has been reached. The color of the refrigerant composition before and after freezing does not mainly reflect the colors of the components contained in the composition, such as the inorganic salts and the thickener, other than the pH indicator.

[0016]

15 In the first embodiment, the refrigerant composition contains inorganic salts and a thickener as components affecting the acidity of the composition. In the refrigerant composition, as the inorganic salts, a specific combination of dihydrogen phosphate as an acidic inorganic salt, an inorganic salt other than the dihydrogen phosphate as an acidic inorganic salt, and a phosphate is selected, and the content of these inorganic salts is
20 limited. Furthermore, a pH indicator of which the pKa is within a specific range is used in combination with these inorganic salts. The color of the refrigerant composition constituted as above markedly and greatly changes depending on the change of color produced by the pH indicator or on whether or not the pH indicator produces color.

[0017]

25 <Inorganic salts>

In the first embodiment, the inorganic salts function as a component of a refrigerant. The freezing temperature of the refrigerant composition is determined mainly by the type and amount of the inorganic salts.

Furthermore, the inorganic salts are components that do not correspond to the pH indicator. In a case where the refrigerant composition is frozen, the inorganic salts are precipitated as crystals or amorphous solids. Whether or not the inorganic salts are precipitated is involved in the color change of the refrigerant composition.

[0018]

In the first embodiment, the refrigerant composition contains, as the inorganic salts, acidic inorganic salts, which exhibit acidic properties in an aqueous solution of the acidic inorganic salts, and a phosphate. Furthermore, the refrigerant composition contains, as the acidic inorganic salts, dihydrogen phosphate and an inorganic salt other than the dihydrogen phosphate.

[0019]

[Acidic inorganic salts]
(Dihydrogen phosphate)

The dihydrogen phosphate used as one of the acidic inorganic salts in the first embodiment is obtained in a case where one hydrogen ion in phosphoric acid (H_3PO_4) is substituted with a cation. The dihydrogen phosphate may or may not be a hydrate.

Examples of the dihydrogen phosphate in the first embodiment include metal dihydrogen phosphate such as sodium dihydrogen phosphate (NaH_2PO_4), potassium dihydrogen phosphate (KH_2PO_4), and calcium dihydrogen phosphate ($\text{Ca}(\text{H}_2\text{PO}_4)_2$); and non-metal dihydrogen phosphate such as ammonium dihydrogen phosphate ($\text{NH}_4\text{H}_2\text{PO}_4$).

[0020]

In the first embodiment, the refrigerant composition may contain only one kind

of dihydrogen phosphate or two or more kinds of dihydrogen phosphates. In a case where the refrigerant composition contains two or more kinds of dihydrogen phosphates, a combination thereof and a ratio therebetween can be arbitrarily selected.

[0021]

5 (Inorganic salt other than dihydrogen phosphate)

In the first embodiment, the inorganic salt other than the dihydrogen phosphate that is used as one of the acidic inorganic salts is not particularly limited as long as the inorganic salt exhibits acidic properties in an aqueous solution of the inorganic salt. The inorganic salt may or may not be a hydrate.

10 Examples of the inorganic salt other than the dihydrogen phosphate in the first embodiment include ammonium chloride (NH_4Cl), magnesium chloride (MgCl_2), ammonium sulfate ($(\text{NH}_4)_2\text{SO}_4$), ammonium nitrate (NH_4NO_3), aluminum sulfate ($\text{Al}_2(\text{SO}_4)_3$), alum ($\text{AlK}(\text{SO}_4)_2$), ammonium alum ($\text{Al}(\text{NH}_4)(\text{SO}_4)_2$), calcium nitrate tetrahydrate ($\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$), calcium nitrate ($\text{Ca}(\text{NO}_3)_2$), and the like. Among these,
15 ammonium chloride and ammonium nitrate are preferable.

[0022]

In the first embodiment, the refrigerant composition may contain only one kind of inorganic salt other than the dihydrogen phosphate or two or more kinds of inorganic salts other than the dihydrogen phosphate. In a case where the refrigerant composition
20 contains two or more kinds of inorganic salts other than the dihydrogen phosphate, a combination thereof and a ratio therebetween can be arbitrarily selected.

[0023]

[Phosphate]

The phosphate in the first embodiment is obtained in a case where three
25 hydrogen ions in phosphoric acid (H_3PO_4) are substituted with cations. The phosphate

may or may not be a hydrate.

Generally, the phosphate is a basic salt exhibiting basic properties in an aqueous solution of the basic salt.

[0024]

5 Examples of the phosphate in the first embodiment phosphates with three metal atoms such as trisodium phosphate (Na_3PO_4), trisodium phosphate dodecahydrate ($\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$), and tripotassium phosphate (K_3PO_4); phosphates with three non-metal atoms such as triammonium phosphate ($(\text{NH}_3)_3\text{PO}_4$); and the like. Among these, trisodium phosphate (Na_3PO_4), trisodium phosphate dodecahydrate, and tripotassium
10 phosphate (K_3PO_4) are preferable.

[0025]

In the first embodiment, the refrigerant composition may contain only one kind of phosphate or two or more kinds of phosphates. In a case where the refrigerant composition contains two or more kinds of phosphates, a combination thereof and a ratio
15 therebetween can be arbitrarily selected.

[0026]

[Other inorganic salts]

In the first embodiment, the refrigerant composition may contain, as the aforementioned inorganic salts, the aforementioned acidic inorganic salts (the dihydrogen
20 phosphate and the inorganic salt other than the dihydrogen phosphate), the aforementioned phosphate, and other inorganic salts that correspond to none of these.

The aforementioned other inorganic salts may or may not be hydrates.

[0027]

In the first embodiment, the aforementioned other inorganic salts are not
25 particularly limited as long as they do not impair the effects of the present invention.

Examples of the aforementioned other inorganic salts include a neutral inorganic salt which exhibits neutral properties in an aqueous solution of the inorganic salt, an inorganic salt other than a phosphate that exhibits basic properties in an aqueous solution of the inorganic salt, and the like.

5 [0028]

Examples of the neutral inorganic salt include sodium chloride (NaCl), potassium chloride (KCl), calcium chloride (CaCl₂), sodium sulfate (Na₂SO₄), potassium sulfate (K₂SO₄), magnesium sulfate (MgSO₄), sodium nitrate (NaNO₃), potassium nitrate (KNO₃), potassium bromide (KBr), sodium bromide (NaBr), potassium iodide (KI),
 10 sodium iodide (NaI), potassium chlorate (KClO₃), sodium perchlorate (NaClO₄), sodium thiosulfate (Na₂S₂O₃), and the like.

Among these, as the neutral inorganic salt, sodium chloride or potassium chloride is preferable.

[0029]

15 The basic inorganic salt other than a phosphate is preferably an inorganic salt other than monohydrogen phosphate. Examples of the basic inorganic salt include sodium carbonate (Na₂CO₃), potassium carbonate (K₂CO₃), sodium hydrogen carbonate (NaHCO₃), potassium hydrogen carbonate (KHCO₃), sodium sulfite (Na₂SO₃), borax (Na₂B₄O₇), and the like.

20 Among these, as the basic inorganic salt other than a phosphate, sodium carbonate or potassium carbonate is preferable.

[0030]

In the first embodiment, the refrigerant composition may contain only one kind of other inorganic salts described above or two or more kinds of other inorganic salts
 25 described above. In a case where the refrigerant composition contains two or more

kinds of other inorganic salts described above, a combination thereof and a ratio therebetween can be arbitrarily selected.

[0031]

In the refrigerant composition of the first embodiment, a ratio of a total content
5 of the acidic inorganic salts and the phosphate to a total content of the inorganic salts is 5% to 100% by mass, and preferably 5.5% to 100% by mass. In a case where the ratio is equal to or higher than the lower limit described above, the color of the refrigerant composition greatly changes before and after freezing.

Within the range of numerical values described above, for example, 10% by
10 mass, 20% by mass, 30% by mass, 40% by mass, 45% by mass, or the like can be selected as the lower limit of the aforementioned ratio, but the lower limit is not limited to these. Furthermore, within the range of numerical values described above, for example, 90% by mass, 80% by mass, 70% by mass, 60% by mass, 55% by mass, or the like can be selected as the upper limit of the aforementioned ratio, but the upper limit is
15 not limited to these.

[0032]

In the first embodiment, the more the inorganic salts are dissolved in the refrigerant composition not yet being frozen and preferably in the refrigerant composition at a temperature of equal to or higher than 0°C, the more preferable. The amount of the
20 dissolved inorganic salts with respect to the total amount of the inorganic salts is preferably equal to or greater than 90% by mass, more preferably equal to or greater than 95% by mass, and even more preferably equal to or greater than 98% by mass. The amount of the dissolved inorganic salts may be 100% by mass (total amount).

Furthermore, in the first embodiment, the more the inorganic salts are
25 precipitated in the frozen refrigerant composition, the more preferable. The amount of

the precipitated inorganic salts with respect to the total amount of the inorganic salts is preferably equal to or greater than 90% by mass, more preferably equal to or greater than 95% by mass, and even more preferably equal to or greater than 98% by mass. The amount of the precipitated inorganic salts may be 100% by mass (total amount).

5 [0033]

In the first embodiment, the total content of the inorganic salts in the refrigerant composition is preferably 5% to 35% by mass, more preferably 10% to 30% by mass, and particularly preferably 15% to 25% by mass.

[0034]

10 <Thickener>

In the first embodiment, the thickener is a component which increases the viscosity of the refrigerant composition and does not correspond to the pH indicator. In the first embodiment, it is preferable that the thickener not be precipitated in a case where the refrigerant composition is frozen. In the present specification, “thickener is not precipitated in a case where the refrigerant composition is frozen” means that in a case where the refrigerant composition is frozen, the thickener is solidified in a state of being dissolved in water. Presumably, this is not a state where a large amount of molecules of the thickener cluster and are solidified, but a state where the molecules of the thickener are solidified by being surrounded by water molecules without forming a cluster of a large amount of the molecules of the thickener.

[0035]

The thickener in the first embodiment is not particularly limited, and examples thereof include an acrylic polymer (compound having a polyacrylic acid skeleton) such as polyacrylic acid and sodium polyacrylate; carboxyalkyl cellulose such as carboxymethyl cellulose (CMC); guar gum; hydroxyalkyl guar gum such as

hydroxypropyl guar gum; pectin; xanthan gum; tamarind gum; carrageenan; alkylene glycol such as propylene glycol; and the like.

[0036]

In the first embodiment, as the thickener, one or more kinds of thickeners
5 selected from the group consisting of an acrylic polymer, carboxyalkyl cellulose, xanthan gum, guar gum, hydroxyalkyl guar gum, pectin, tamarind gum, carrageenan, and alkylene glycol are preferable.

Furthermore, as the thickener, one or more kinds of thickeners selected from the group consisting of an acrylic polymer, carboxyalkyl cellulose, xanthan gum, guar gum,
10 and hydroxyalkyl guar gum are more preferable.

In a case where these thickeners are used, the color of the refrigerant composition greatly changes before and after freezing, and the handleability of the refrigerant composition is further improved.

[0037]

15 In the first embodiment, the refrigerant composition may contain only one kind of thickener or two or more kinds of thickeners. In a case where the refrigerant composition contains two or more kinds of thickeners, a combination thereof and a ratio therebetween can be arbitrarily selected.

[0038]

20 In the first embodiment, the smaller the amount of precipitated thickener in the refrigerant composition before and after freezing, the more preferable. The amount of the precipitated thickener with respect to the total amount of the thickener is preferably equal to or smaller than 10% by mass, more preferably equal to or smaller than 5% by mass, even more preferably equal to or smaller than 2% by mass, and particularly
25 preferably 0% by mass (it is particularly preferable that the thickener not be precipitated

at all).

[0039]

In the first embodiment, the content of the thickener in the refrigerant composition is preferably 0.1% to 10% by mass, more preferably 0.3% to 6% by mass, and particularly preferably 0.6% to 3% by mass.

[0040]

<pH indicator>

In the first embodiment, the pH indicator (acid-base indicator) is a component which determines the color of the refrigerant composition by reflecting whether or not the pH indicator produces color. In a case where the refrigerant composition contains the pH indicator, the color of the refrigerant composition changes before and after freezing.

[0041]

In the first embodiment, the pH indicator is not particularly limited as long as a pKa thereof is 4.9 to 8.0.

In the present embodiment, unless otherwise specified, the pKa of the pH indicator means a value obtained in a case where water is used as a solvent and the temperature is 25°C.

[0042]

The pH indicator has a pH range in which the color change of the pH indicator is observed, that is, a transition range. In a solution, the pH indicator is present by being divided into a dissociation type and a non-dissociation type. In between these, dissociation equilibrium is established, and the dissociation type and the non-dissociation type show different colors. Out of the transition range, the equilibrium clearly lies to either the dissociation type or the non-dissociation type, and only the color of either of

them is seen. In the transition range, the dissociation-type pH indicator and the non-dissociation-type pH indicator are mixed together in such an amount that enables the two types to be compared with each other, and the colors of the two types of pH indicators are found to be blended with each other (“Grand Chemistry Dictionary, compact edition, 39th printing, September 15, 2006”, KYORITSU SHUPPAN CO., LTD).

[0043]

Table 1 shows examples of main pH indicators. In Table 1, the pH indicators as well as the transition ranges and color changes thereof are described. In Table 1, “Color change (low pH → high pH)” means that in a case where the pH of a liquid containing the pH indicator changes to a higher value from a specific value, the pH indicator changes color within the transition range. For example, “Red → Yellow” means that in the process in which the pH of the liquid is increasing, the pH indicator changes the color of the liquid from red to yellow.

[0044]

[Table 1]

pH indicator	Transition range (pH)	Color change (low pH → high pH)
Methyl yellow	2.9 to 4.0	Red → Yellow
Bromophenol blue (BPB)	3.0 to 4.6	Yellow → Purple
Congo red	3.0 to 5.0	Purple → Red
Methyl orange (MO)	3.1 to 4.4	Red → Orange
Bromocresol green (BCG)	4.0 to 5.6	Yellow → Blue
Methyl red (MR)	4.2 to 6.2	Red → Yellow
Litmus	4.5 to 8.3	Red → Blue
Methyl purple	4.8 to 5.4	Purple → Green
p-Nitrophenol	5.0 to 7.0	Colorless → Yellow
Bromocresol purple (BCP)	5.2 to 6.8	Yellow → Purple
Chlorophenol red	5.4 to 6.8	Yellow → Red
Bromothymol blue (BTB)	6.0 to 7.6	Yellow → Blue
Neutral red	6.8 to 8.0	Red → Yellow
Phenol red (PR)	6.8 to 8.4	Yellow → Red
p-Naphtholphthalein	7.1 to 8.7	Yellow → Blue
Cresol red	7.2 to 8.8	Yellow → Red
Phenolphthalein (PP)	7.8 to 10.0	Colorless → Reddish purple
Thymol blue	8.0 to 9.6	Yellow → Blue
Thymolphthalein	9.3 to 10.5	Colorless → Blue

[0045]

In the first embodiment, the transition range (pH) of the pH indicator is preferably within a range of 3.0 to 10.5, more preferably within a range of 4.0 to 9.5, and particularly preferably within a range of 4.5 to 9.0.

[0046]

5 In the first embodiment, the refrigerant composition may contain only one kind of pH indicator or two or more kinds of pH indicators. In a case where the refrigerant composition contains two or more kinds of pH indicators, a combination thereof and a ratio therebetween can be arbitrarily selected. Generally, it is preferable that the refrigerant composition contain only one kind of pH indicator.

10 [0047]

In the first embodiment, the content of the pH indicator in the refrigerant composition is not particularly limited as long as the color of the refrigerant composition changes as intended. The content of the pH indicator is preferably 1 to 30 ppm, and more preferably 5 to 20 ppm.

15 [0048]

<Other components>

In the first embodiment, the refrigerant composition may contain, in addition to water, the inorganic salts, the thickener, and the pH indicator, other components that correspond to none of these within, a range that does not impair the effects of the present
20 invention. Examples of other components described above include a solvent other than water; various known additives such as a preservative and a surfactant; and the like.

In the first embodiment, the refrigerant composition may contain only one kind of other components described above or two or more kinds of other components described above. In a case where the refrigerant composition contains two or more
25 kinds of other components described above, a combination thereof and a ratio

therebetween can be arbitrarily selected.

[0049]

(Solvent)

In the first embodiment, as the solvent, a solvent which can dissolve the
5 inorganic salts, the thickener, and the pH indicator is preferable. Examples of such a
solvent include an alcohol and the like.

[0050]

Water and the solvent are components functioning as a component of a
refrigerant. The freezing temperature of the refrigerant composition is determined
10 mainly by the type and amount of the aforementioned inorganic salts, water, and the
solvent.

In the refrigerant composition of the first embodiment, a ratio of the content of
the solvent to the total content of water and the solvent is preferably equal to or smaller
than 10% by mass, more preferably equal to or smaller than 5% by mass, and particularly
15 preferably equal to or smaller than 2% by mass.

[0051]

(Preservative)

Examples of the preservative in the first embodiment include a food preservative,
an antioxidant, and the like. More specifically, examples thereof include sodium
20 pyrithione, paraben (paraoxybenzoic acid ester), protamine, an organic nitrogen
sulfur-based compound, and the like.

[0052]

In the first embodiment, the content of the preservative in the refrigerant
composition is not particularly limited, but is preferably 0.02% to 0.5% by mass, and
25 more preferably 0.04% to 0.2% by mass.

[0053]

(Surfactant)

Examples of the surfactant in the first embodiment include known surfactants, for examples, alkyl sulfates such as sodium dodecyl sulfate; alkyl carboxylates such as sodium decanoate; N-alkylacrylamide such as N-isopropylacrylamide; polyoxyethylene dialkyl ether such as polyoxyethylene octyl dodecyl ether; polyoxyethylene monoalkyl ether such as polyoxyethylene lauryl ether; polyoxyethylene monoalkenyl ether such as polyoxyethylene oleyl ether; and the like.

[0054]

In the refrigerant composition of the first embodiment, a ratio of the total content of the inorganic salts, the thickener, and the pH indicator to the total content of components other than water and the solvent (the inorganic salts, the thickener, the pH indicator, and the other components other than the solvent) is preferably equal to or higher than 90% by mass, more preferably equal to or higher than 93% by mass, even more preferably equal to or higher than 96% by mass, and particularly preferably equal to or higher than 98% by mass. The aforementioned ratio may be 100% by mass. In a case where the ratio of the total content is equal to or higher than the aforementioned lower limit, the color of the refrigerant composition greatly changes before and after freezing.

20 [0055]

In the first embodiment, a pH ($\alpha 1$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the phosphate, the dihydrogen phosphate, and water are removed and the pKa of the pH indicator satisfy a relationship represented by Expression (i).

25 $\text{pKa of pH indicator} \leq \text{pH}(\alpha 1) \leq \text{pKa of pH indicator} + 1.8 \quad \cdots (i)$

The pH ($\alpha 1$) corresponds to the pH of a mixed solution (for example, an aqueous solution containing a phosphate and dihydrogen phosphate) obtained by mixing together a phosphate, dihydrogen phosphate, and water in the same amount as the amount of these contained in the refrigerant composition of the first embodiment. The pH ($\alpha 1$) is a parameter of the acidity of the mixture of the phosphate and the dihydrogen phosphate used in the refrigerant composition.

[0056]

The pH ($\alpha 1$) is preferably a pH at a temperature at which the pH indicator is dissolved in the refrigerant composition, and more preferably a pH obtained in a case where the temperature of the mixed solution is 25°C.

[0057]

In a case where the pH ($\alpha 1$) satisfies the relationship represented by Expression (i), the pH ($\alpha 1$) is preferably 5.0 to 10.6, more preferably 5.3 to 10.3, and particularly preferably 5.6 to 10.0.

[0058]

In the first embodiment, the pH of the refrigerant composition is preferably 4.6 to 8.8, more preferably 4.9 to 8.5, and particularly preferably 5.1 to 8.3.

In the first embodiment, the refrigerant composition preferably has a pH within the aforementioned range of numerical values at a temperature at which the pH indicator is dissolved in the refrigerant composition, and more preferably has a pH within the aforementioned range of numerical values in a case where the temperature of the refrigerant composition is 25°C.

In the present embodiment, unless otherwise specified, the description of “pH” for the refrigerant composition simply means the pH of the refrigerant composition itself.

[0059]

In the first embodiment, a pH ($\alpha 2$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the inorganic salts and water are substituted with water is preferably 4.4 to 8.7, and more preferably 4.9 to 8.2.

The pH ($\alpha 2$) corresponds to the pH of inorganic salt-containing water (for example, an aqueous solution of inorganic salts) containing only the inorganic salts at the same content (% by mass) as the content (% by mass) of the inorganic salts in the refrigerant composition. The pH ($\alpha 2$) is a parameter of the acidity of the inorganic salts used in the refrigerant composition.

The pH ($\alpha 2$) is preferably a pH at a temperature at which the pH indicator is dissolved in the refrigerant composition, and more preferably a pH obtained in a case where the temperature of the inorganic salt-containing water is 25°C.

[0060]

In the first embodiment, a pH ($\alpha 3$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the thickener and water are substituted with water is preferably 6.0 to 8.5, and more preferably 6.0 to 8.3. The pH ($\alpha 3$) may be 6.0 to 8.0 or 6.5 to 7.5, for example.

The pH ($\alpha 3$) corresponds to the pH of thickener-containing water (for example, an aqueous solution of a thickener) containing only the thickener at the same content (% by mass) as the content (% by mass) of the thickener in the refrigerant composition. The pH ($\alpha 3$) is a parameter of the acidity of the thickener used in the refrigerant composition.

The pH ($\alpha 3$) is preferably a pH at a temperature at which the pH indicator is

dissolved in the refrigerant composition, and more preferably a pH obtained in a case where the temperature of the thickener-containing water is 25°C.

[0061]

In the first embodiment, the refrigerant composition is obtained by blending
5 together water, the inorganic salts, the thickener, the pH indicator, and other components which are used if necessary.

The method for blending together the components is not particularly limited, and can be arbitrarily controlled such that the components are uniformly dissolved or dispersed at a temperature higher than the freezing temperature of the refrigerant
10 composition.

For example, at the time of blending the components together, all the components may be added and then mixed together. Alternatively, the components may be mixed together while some of the components are being sequentially added, or all the components may be mixed together while being sequentially added.

15 The mixing method is not particularly limited and can be appropriately selected from known methods such as a method of mixing the components together by rotating a stirring rod, a stirring blade, or the like; a method of mixing the components together by using a mixer, a three-roll mill, a kneader, a beads mill, or the like; and a method of mixing the components together by applying ultrasonic waves.

20 [0062]

The refrigerant pack according to the first embodiment of the present invention includes the aforementioned refrigerant composition. For example, the refrigerant pack has a constitution in which the refrigerant composition is held by container-like or bag-like holding means into which a liquid can be enclosed.

25 [0063]

The material of the holding means is not particularly limited as long as the material is transparent to such a degree that makes it possible to visually observe the color change (discoloration) of the refrigerant composition held.

Examples of preferred materials of the holding means include synthetic resins of a polyolefin such as polyethylene and polypropylene; a polyamide; a polyester; and the like.

Examples of the polyethylene include low-density polyethylene (LDPE), linear low-density polyethylene (LLDPE), high-density polyethylene (HDPE), and the like.

[0064]

The material or size of the holding means may be selected in consideration of, for example, the shape of the holding means, the amount of the refrigerant composition to be held, the way the color of the refrigerant composition changes before and after freezing, and the like.

For example, in a case where the holding means is in the form of a bag, a preferred example of the material of the holding means includes low-density polyethylene. In a case where the holding means is in the form of a container, a preferred example of the material of the holding means includes high-density polyethylene.

For example, a bag-like holding means is preferable in a case where small holding means is used, that is, in a case where the amount of the refrigerant composition to be held is relatively small. The container-like holding means is preferable in a case where big holding means is used, that is, in a case where the amount of the refrigerant composition to be held is relatively large.

Here, the method for selecting the material or size of the holding means described herein is merely an example.

[0065]

The material of the holding means is preferably polyolefin because this material has excellent low-temperature brittleness resistance, excellent water resistance, excellent chemical resistance, and the like, and more preferably high-density polyethylene because
5 this material is easily molded and has high hardness.

[0066]

The thickness of a film-like or sheet-like flat site in the holding means is not particularly limited, but is preferably 5 to 200 μm .

[0067]

10 The flat site may be constituted with a single layer or a plurality of layers of two or more layers. In a case where the flat site is constituted with a plurality of layers, the plurality of layers may be the same as or different from each other. That is, all the layers may be the same as or different from each other, or only some of the layers may be the same as each other. In a case where the plurality of layers are different from each
15 other, a combination of the plurality of layers is not particularly limited. The case where the plurality of layers are different from each other means that the layers are different from each other in terms of at least either the material or the thickness.

In a case where the flat site is constituted with a plurality of layers, it is preferable that the total thickness of the layers be set such that the total thickness equals
20 the aforementioned preferable thickness of the flat site.

[0068]

In the first embodiment, the color of the refrigerant composition greatly changes before and after freezing. Therefore, it is possible to easily visually observe whether or not the refrigerant composition is frozen. The color change of the refrigerant
25 composition can be visually observed from the outside of the refrigerant pack.

Accordingly, whether or not the refrigerant pack is sufficiently cooled down to a desired temperature can be easily visually observed.

Furthermore, even though cooling and warming such as freezing and unfreezing of the refrigerant composition are repeated, the effects of refrigerant composition are not impaired. Accordingly, the refrigerant pack including the refrigerant composition is also suitable for repetitive use.

[0069]

<<Second embodiment>>

A refrigerant pack according to a second embodiment of the present invention is a refrigerant pack including a refrigerant composition containing water, inorganic salts, a thickener, and a pH indicator. The refrigerant composition contains, as the inorganic salts, an acidic inorganic salt, which exhibits acidic properties in an aqueous solution of the inorganic salt, and monohydrogen phosphate. In the refrigerant composition, a ratio of the total content of the acidic inorganic salt and the monohydrogen phosphate to the total content of the inorganic salts is 5% to 100% by mass. In the refrigerant composition, a ratio of the content of the monohydrogen phosphate to the total content of water, the inorganic salts, and the thickener is 0.2% to 5.0% by mass. A pKa of the pH indicator is 4.9 to 8.0.

[0070]

The color of the refrigerant composition in the refrigerant pack greatly changes before and after the refrigerant composition is frozen. The color of the refrigerant composition reflects whether or not the pH indicator produces color. Therefore, the refrigerant pack makes it possible to easily visually observe whether the intended cooling state (state where an object can be sufficiently cooled) has been reached. The color of the refrigerant composition before and after freezing does not mainly reflect the colors of

the components contained in the composition, such as the inorganic salts and the thickener, other than the pH indicator.

[0071]

In the second embodiment, the refrigerant composition contains inorganic salts
5 and a thickener as components affecting the acidity of the composition. In the
refrigerant composition, as the inorganic salts, a specific combination of an acidic
inorganic salt and monohydrogen phosphate is selected, and the content of the inorganic
salts is limited. A ratio of the content of the monohydrogen phosphate to the total
content of water, the inorganic salts, and the thickener is limited, and a pH indicator
10 having a pKa within a specific range is used in combination with the inorganic salts and
the thickener. The color of the refrigerant composition constituted as above markedly
and greatly changes depending on the change of color produced by the pH indicator or on
whether or not the pH indicator produces color.

[0072]

15 <Inorganic salts>

In the second embodiment, the inorganic salts function as a component of a
refrigerant. The freezing temperature of the refrigerant composition is determined
mainly by the type and amount of the inorganic salts.

Furthermore, the inorganic salts are components that do not correspond to the
20 pH indicator and precipitated as crystals or amorphous solids in a case where the
refrigerant composition is frozen. Whether or not the inorganic salts are precipitated is
involved in the color change of the refrigerant composition.

[0073]

In the second embodiment, the refrigerant composition contains, as the inorganic
25 salts, an acidic inorganic salt, which exhibits acidic properties in an aqueous solution of

the inorganic salt, and monohydrogen phosphate.

[0074]

[Acidic inorganic salt]

In the second embodiment, the acidic inorganic salt is not particularly limited
5 and can be appropriately selected according to the purpose. The inorganic salt may or
may not be a hydrate.

Examples of the acidic inorganic salt in the second embodiment are the same as
the examples of the acidic inorganic salt in the first embodiment. That is, examples of
the acidic inorganic salt of the second embodiment include dihydrogen phosphate and an
10 inorganic salt other than the dihydrogen phosphate.

[0075]

In the second embodiment, the refrigerant composition may contain only one
kind of acidic inorganic salt described above or two or more kinds of acidic inorganic
salts described above. In a case where the refrigerant composition contains two or more
15 kinds of acidic inorganic salts described above, a combination thereof and a ratio
therebetween can be arbitrarily selected.

[0076]

[Monohydrogen phosphate]

The monohydrogen phosphate in the second embodiment is obtained in a case
20 where two hydrogen ions in phosphoric acid (H_3PO_4) are substituted with cations. The
monohydrogen phosphate may or may not be a hydrate.

Generally, the monohydrogen phosphate is a basic salt which exhibits basic
properties in an aqueous solution of the basic salt.

[0077]

25 Examples of the monohydrogen phosphate in the second embodiment include

metal monohydrogen phosphate such as disodium hydrogen phosphate (Na_2HPO_4), dipotassium hydrogen phosphate (K_2HPO_4), and calcium hydrogen phosphate (CaHPO_4); non-metal monohydrogen phosphate such as diammonium hydrogen phosphate ($(\text{NH}_4)_2\text{HPO}_4$); and the like.

5 [0078]

In the second embodiment, the refrigerant composition may contain only one kind of monohydrogen phosphate or two or more kinds of monohydrogen phosphates. In a case where the refrigerant composition contains two or more kinds of monohydrogen phosphates, a combination thereof and a ratio therebetween can be arbitrarily selected.

10 [0079]

[Other inorganic salts]

In the second embodiment, the refrigerant composition may contain, in addition to the acidic inorganic salt and the monohydrogen phosphate, other inorganic salts that correspond to none of these as the aforementioned inorganic salts.

15 Other inorganic salts described above may or may not be hydrates.

[0080]

In the second embodiment, other inorganic salts described above are not particularly limited as long as they do not impair the effects of the present invention. Examples of other inorganic salts described above include a neutral inorganic salt which
20 exhibits neutral properties in an aqueous solution of the neutral inorganic salt, an inorganic salt other than monohydrogen phosphate that exhibits basic properties in an aqueous solution of the inorganic salt, and the like.

[0081]

Examples of the neutral inorganic salt are the same as the examples of the
25 neutral inorganic salt in the first embodiment. Among these, sodium chloride,

potassium chloride, or sodium sulfate is preferable.

[0082]

The basic inorganic salt other than monohydrogen phosphate is preferably an inorganic salt other than a phosphate. Examples of the basic inorganic salt are the same
5 as the examples of the basic inorganic salt other than a phosphate in the first embodiment. Among these, sodium carbonate or potassium carbonate is preferable.

[0083]

In the second embodiment, the refrigerant composition contains only one kind of other inorganic salts described above or two or more kinds of other inorganic salts
10 described above. In a case where the refrigerant composition contains two or more kinds of other inorganic salts described above, a combination thereof and a ratio therebetween can be arbitrarily selected.

[0084]

As the refrigerant composition in the second embodiment, for example, a
15 refrigerant composition is preferable which contains dihydrogen phosphate as the aforementioned acidic inorganic salt and a neutral inorganic salt. The color change of this refrigerant composition that occurs before and after freezing is finished within a shorter time, and the properties of this refrigerant composition are more preferable.

[0085]

20 In a case where the refrigerant composition in the second embodiment contains the dihydrogen phosphate and the neutral inorganic salt, the neutral inorganic salt is preferably sodium chloride or potassium chloride. In a case where the neutral inorganic salt is used in combination, the color change of the refrigerant composition in the second embodiment is finished within a shorter time before and after freezing.

25 [0086]

In a case where the refrigerant composition in the second embodiment contains the dihydrogen phosphate and the neutral inorganic salt, a ratio of the content of the neutral inorganic salt to the total content of the inorganic salts is preferably 40% to 60% by mass, more preferably 43% to 57% by mass, and particularly preferably 46% to 54% by mass. In a case where the ratio is within the above range, the color change of the refrigerant composition in the second embodiment is finished within a shorter time before and after freezing, and the refrigerant composition shows a greater color change.

[0087]

In a case where the refrigerant composition in the second embodiment contains the dihydrogen phosphate and the neutral inorganic salt, a ratio of the content (mass) of the dihydrogen phosphate to the content (mass) of the monohydrogen phosphate ($[\text{content (mass) of dihydrogen phosphate in refrigerant composition}]/[\text{content (mass) of monohydrogen phosphate in refrigerant composition}]$) is preferably 0.04 to 2, more preferably 0.04 to 1.6, and particularly preferably 0.04 to 1.4. In a case where the ratio is within the above range, the color change of the refrigerant composition in the second embodiment is finished within a shorter time before and after freezing.

The aforementioned ratio is preferably 0.04 to 1.2, more preferably 0.07 to 0.8, and particularly preferably 0.1 to 0.6, because the refrigerant composition in the second embodiment shows a greater color change before and after freezing.

[0088]

In the refrigerant composition of the second embodiment, a ratio of the total content of the acidic inorganic salt and the monohydrogen phosphate to the total content of the inorganic salts is 5% to 100% by mass, preferably 5.5% to 100% by mass, and even more preferably 6% to 100% by mass. In a case where the ratio is equal to or higher than the aforementioned lower limit, the color of the refrigerant composition

greatly changes before and after freezing.

Within the range of numerical values described above, for example, 10% by mass, 20% by mass, 30% by mass, 40% by mass, 45% by mass, or the like can be selected as the lower limit of the aforementioned ratio, but the lower limit is not limited to these. Furthermore, within the range of numerical values described above, for example, 90% by mass, 80% by mass, 75% by mass, 70% by mass, 65% by mass, or the like can be selected as the upper limit of the aforementioned ratio, but the upper limit is not limited to these.

[0089]

In the second embodiment, the more the inorganic salts are dissolved in the refrigerant composition not yet being frozen and preferably in the refrigerant composition at a temperature of equal to or higher than 0°C, the more preferable. The amount of the dissolved inorganic salts with respect to the total amount of the inorganic salts is preferably equal to or greater than 90% by mass, more preferably equal to or greater than 95% by mass, and even more preferably equal to or greater than 98% by mass. The amount of the dissolved inorganic salts may be 100% by mass (total amount).

Furthermore, in the second embodiment, the more the inorganic salts are precipitated in the frozen refrigerant composition, the more preferable. The amount of the precipitated inorganic salts with respect to the total amount of the inorganic salts is preferably equal to or greater than 90% by mass, more preferably equal to or greater than 95% by mass, and even more preferably equal to or greater than 98% by mass. The amount of the precipitated inorganic salts may be 100% by mass (total amount).

[0090]

In the second embodiment, the total content of the inorganic salts in the refrigerant composition is preferably 5% to 35% by mass, more preferably 5% to 30% by

mass, and even more preferably 10% to 30% by mass. The total content of the inorganic salts may be 15% to 25% by mass, for example.

[0091]

<Thickener>

5 In the second embodiment, the thickener is a component which increases the viscosity of the refrigerant composition and does not correspond to the pH indicator. In the second embodiment, it is preferable that the thickener not be precipitated in a case where the refrigerant composition is frozen. In the present specification, the meaning of “thickener is not precipitated in a case where the refrigerant composition is frozen” is as
10 described above in the first embodiment.

[0092]

Examples of the thickener in the second embodiment are the same as the examples of the thickener in the first embodiment.

Similarly to the first embodiment, as the thickener in the second embodiment,
15 one or more kinds of thickeners selected from the group consisting of an acrylic polymer, carboxyalkyl cellulose, xanthan gum, guar gum, hydroxyalkyl guar gum, pectin, tamarind gum, carrageenan, and alkylene glycol are preferable.

Furthermore, as the thickener, one or more kinds of thickeners selected from the group consisting of an acrylic polymer, carboxyalkyl cellulose, xanthan gum, guar gum,
20 and hydroxyalkyl guar gum are more preferable.

In a case where these thickeners are used, the color of the refrigerant composition greatly changes before and after freezing, and the handleability of the refrigerant composition is further improved.

[0093]

25 In the second embodiment, the refrigerant composition may contain only one

kind of thickener or two or more kinds of thickeners. In a case where the refrigerant composition contains two or more kinds of thickeners, a combination thereof and a ratio therebetween can be arbitrarily selected.

[0094]

5 In the second embodiment, the smaller the amount of precipitated thickener in the refrigerant composition before and after freezing, the more preferable. The amount of the precipitated thickener with respect to the total amount of the thickener is preferably equal to or smaller than 10% by mass, more preferably equal to or smaller than 5% by mass, even more preferably equal to or smaller than 2% by mass, and
10 particularly preferably 0% by mass (it is particularly preferable that the thickener not be precipitated at all).

[0095]

In the second embodiment, the content of the thickener in the refrigerant composition is preferably 0.1% to 10% by mass, more preferably 0.3% to 6% by mass,
15 and particularly preferably 0.6% to 3% by mass.

[0096]

In the refrigerant composition of the second embodiment, a ratio of the content of the monohydrogen phosphate to the total content of water, the inorganic salts, and the thickener is 0.2% to 5.0% by mass, preferably 0.23% to 4.9% by mass, and even more
20 preferably 0.26% to 4.8% by mass. In a case where the ratio is within the above range, the color of the refrigerant composition greatly changes before and after freezing.

[0097]

<pH indicator>

In the second embodiment, the pH indicator (acid-base indicator) is a component
25 which determines the color of the refrigerant composition by reflecting whether or not

the pH indicator produces color. In a case where the refrigerant composition contains the pH indicator, the color of the refrigerant composition changes before and after freezing.

[0098]

5 In the second embodiment, the pH indicator is not particularly limited as long as a pKa thereof is 4.9 to 8.0.

In the present embodiment, unless otherwise specified, the pKa of the pH indicator means a value obtained in a case where water is used as a solvent and the temperature is 25°C.

10 Examples of the pH indicator in the second embodiment are the same as the examples of the pH indicator in the first embodiment.

[0099]

In the second embodiment, the transition range (pH) of the pH indicator is preferably within a range of 3.0 to 9.0, more preferably within a range of 4.0 to 8.5, and
15 particularly preferably within a range of 4.5 to 8.0.

[0100]

In the second embodiment, the refrigerant composition may contain only one kind of pH indicator or two or more kinds of pH indicators. In a case where the refrigerant composition contains two or more kinds of pH indicators, a combination
20 thereof and a ratio therebetween can be arbitrarily selected. Generally, it is preferable that the refrigerant composition contain only one kind of pH indicator.

[0101]

In the second embodiment, the content of the pH indicator in the refrigerant composition is not particularly limited as long as the color of the refrigerant composition
25 changes as intended. The content of the pH indicator is preferably 1 to 30 ppm, and

more preferably 5 to 20 ppm.

[0102]

<Other components>

In the second embodiment, the refrigerant composition may contain, in addition
5 to water, the inorganic salts, the thickener, and the pH indicator, other components that
correspond to none of these, within a range that does not impair the effects of the present
invention. Similarly to the first embodiment, examples of other components described
above include a solvent other than water; various known additives such as a preservative
and a surfactant; and the like.

10 In the second embodiment, the refrigerant composition may contain only one
kind of other components described above or two or more kinds of other components
described above. In a case where the refrigerant composition contains two or more
kinds of other components described above, a combination thereof and a ratio
therebetween can be arbitrarily selected.

15 [0103]

The content of the aforementioned other components in the refrigerant
composition of the second embodiment is the same as the content of other components in
the refrigerant composition of the first embodiment.

[0104]

20 For example, in the refrigerant composition of the second embodiment, a ratio of
the content of the solvent to the total content of water and the solvent is preferably equal
to or lower than 10% by mass, more preferably equal to or lower than 5% by mass, and
particularly preferably equal to or lower than 2% by mass.

In the second embodiment, the content of the preservative in the refrigerant
25 composition is not particularly limited, but is preferably 0.02% to 0.5% by mass and

more preferably 0.04% to 0.2% by mass.

In the refrigerant composition of the second embodiment, a ratio of the total content of the inorganic salts, the thickener, and the pH indicator to the total content of components other than water and the solvent (the inorganic salts, the thickener, the pH indicator, and the other components other than the solvent) is preferably equal to or higher than 90% by mass, more preferably equal to or higher than 93% by mass, even more preferably equal to or higher than 96% by mass, and particularly preferably equal to or higher than 98% by mass. The ratio may be 100% by mass. In a case where the ratio of the total content is equal to or higher than the aforementioned lower limit, the refrigerant composition shows a greater color change before and after freezing.

[0105]

In the second embodiment, a pH of the refrigerant composition is preferably 4.7 to 8.0, more preferably 5.0 to 7.7, and particularly preferably 5.2 to 7.5.

In the refrigerant composition of the second embodiment, the pH indicator preferably shows a pH within the aforementioned range of numerical values at a temperature at which the pH indicator is dissolved in the refrigerant composition, and more preferably shows a pH within the aforementioned range of numerical values in a case where the temperature of the refrigerant composition is 25°C.

In the present embodiment, unless otherwise specified, the description of “pH” for the refrigerant composition simply means the pH of the refrigerant composition itself.

[0106]

In the second embodiment, a pH (α_2) of the refrigerant composition obtained in a case where all the components contained in the composition other than the inorganic salts and water are substituted with water is preferably 4.7 to 8.0, and more preferably 5.2 to 7.5.

The pH ($\alpha 2$) corresponds to the pH of inorganic salt-containing water (for example, an aqueous solution of inorganic salts) containing only the inorganic salts at the same content (% by mass) as the content (% by mass) of the inorganic salts in the refrigerant composition. The pH ($\alpha 2$) is a parameter of the acidity of the inorganic salts used in the refrigerant composition.

The pH ($\alpha 2$) is preferably a pH at a temperature at which the pH indicator is dissolved in the refrigerant composition, and more preferably a pH obtained in a case where the temperature of the inorganic salt-containing water is 25°C.

[0107]

In the second embodiment, a pH ($\alpha 3$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the thickener and water are substituted with water is preferably 6.0 to 9.1, and more preferably 6.5 to 8.6.

The pH ($\alpha 3$) corresponds to the pH of thickener-containing water (for example, an aqueous solution of a thickener) containing only the thickener at the same content (% by mass) as the content (% by mass) of the thickener in the refrigerant composition. The pH ($\alpha 3$) is a parameter of the acidity of the thickener used in the refrigerant composition.

The pH ($\alpha 3$) is preferably a pH at a temperature at which the pH indicator is dissolved in the refrigerant composition, and more preferably a pH obtained in a case where the temperature of the thickener-containing water is 25°C.

[0108]

The refrigerant composition in the second embodiment is obtained by the same method as the method for obtaining the refrigerant composition in the first embodiment,

except that the blended components are different.

[0109]

A refrigerant pack according to the second embodiment of the present invention includes the aforementioned refrigerant composition, and has the same constitution as
5 that of the refrigerant pack according to the first embodiment, except that the refrigerant composition is different.

The refrigerant pack according to the second embodiment of the present invention is obtained by the same method as the method for obtaining the refrigerant pack according to the first embodiment, except that the aforementioned refrigerant
10 composition is used.

[0110]

The color of the refrigerant composition in the second embodiment greatly changes before and after freezing. Therefore, whether or not the refrigerant composition is frozen can be easily visually observed. Furthermore, the color change of
15 the refrigerant composition can be visually observed from the outside of the refrigerant pack. Accordingly, it is possible to easily visually observe whether or not the refrigerant pack is sufficiently cooled down to a desired temperature.

Furthermore, even though cooling and warming such as freezing and unfreezing of the refrigerant composition are repeated, the effects of refrigerant composition are not
20 impaired. Accordingly, the refrigerant pack including the refrigerant composition is also suitable for repetitive use.

[0111]

<<Third embodiment>>

A refrigerant pack according to a third embodiment of the present invention is a
25 refrigerant pack including a refrigerant composition containing water, an inorganic salt, a

thickener, and a pH indicator. The refrigerant composition contains, as the inorganic salt, an acidic inorganic salt which exhibits acidic properties in an aqueous solution of the acidic inorganic salt. In the refrigerant composition, a ratio of the content of the acidic inorganic salt to the total content of the inorganic salt is 5% to 100% by mass. A pH (α2) of the refrigerant composition obtained in a case where all the components contained in the composition other than the inorganic salt and water are substituted with water is equal to or lower than 7. A pH (α3) of the refrigerant composition obtained in a case where all the components contained in the composition other than the thickener and water are substituted with water is equal to or higher than 7. The pH (α2) and the pH (α3) show values of different pH ranges among three pH ranges of a pH lower than a transition range of the pH indicator, a pH of the transition range of the pH indicator, and a pH higher than the transition range of the pH indicator.

[0112]

The color of the refrigerant composition in the refrigerant pack greatly changes before and after the refrigerant composition is frozen. The color of the refrigerant composition reflects whether or not the pH indicator produces color. Therefore, the refrigerant pack makes it possible to easily visually observe whether the intended cooling state (state where an object can be sufficiently cooled) has been reached. The color of the refrigerant composition before and after freezing does not mainly reflect the colors of the components contained in the composition, such as the inorganic salt and the thickener, other than the pH indicator.

[0113]

The refrigerant composition in the third embodiment contains, as components affecting the acidity of the composition, an inorganic salt and a thickener. In the

refrigerant composition, as the inorganic salt, an acidic inorganic salt is selected, and the content of the inorganic salt is limited such that the acidity of the inorganic salt and the thickener is limited. Furthermore, a pH indicator having a transition range appropriate for the inorganic salt and the thickener is used in combination. The color of the refrigerant composition constituted as above markedly and greatly changes depending on the change of color produced by the pH indicator or on whether or not the pH indicator produces color.

[0114]

<Inorganic salt>

10 In the third embodiment, the inorganic salt functions as a component of a refrigerant. The freezing temperature of the refrigerant composition is determined mainly by the type and amount of the inorganic salt.

The inorganic salt is a component that does not correspond to the pH indicator. In a case where the refrigerant composition is frozen, the inorganic salt is precipitated as crystals or amorphous solids. Whether or not the inorganic salt is precipitated is involved in the color change of the refrigerant composition.

[0115]

In the third embodiment, the refrigerant composition contains, as the inorganic salt, an acidic inorganic salt which exhibits acidic properties in an aqueous solution of the acidic inorganic salt.

[0116]

[Acidic inorganic salt]

The acidic inorganic salt in the third embodiment is not particularly limited, and can be appropriately selected according to the purpose. The acidic inorganic salt may or may not be a hydrate.

Preferred examples of the acidic inorganic salt in the third embodiment are the same as the preferred examples of the inorganic salt other than the dihydrogen phosphate in the first embodiment. That is, preferred examples of the acidic inorganic salt include ammonium chloride (NH_4Cl), magnesium chloride (MgCl_2), ammonium sulfate

5 $(\text{NH}_4)_2\text{SO}_4$), ammonium nitrate (NH_4NO_3), aluminum sulfate ($\text{Al}_2(\text{SO}_4)_3$), alum ($\text{AlK}(\text{SO}_4)_2$), ammonium alum ($\text{Al}(\text{NH}_4)(\text{SO}_4)_2$), calcium nitrate tetrahydrate ($\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$), calcium nitrate ($\text{Ca}(\text{NO}_3)_2$), and the like. Among these, ammonium chloride is preferable.

[0117]

10 In the third embodiment, the refrigerant composition may contain only one kind of acidic inorganic salt described above or two or more kinds of acidic inorganic salts described above. In a case where the refrigerant composition contains two or more kinds of acidic inorganic salts described above, a combination thereof and a ratio therebetween can be arbitrarily selected.

15 [0118]

[Other inorganic salts]

In the third embodiment, the refrigerant composition may contain, as the inorganic salt, other inorganic salts in addition to the acidic inorganic salt.

Other inorganic salts described above may or may not be hydrates.

20 [0119]

In the third embodiment, other inorganic salts described above are not particularly limited as long as they do not impair the effects of the present invention.

Examples of other inorganic salts include a neutral inorganic salt which exhibits neutral properties in an aqueous solution of the neutral inorganic salt, a basic inorganic salt

25 which exhibits basic properties in an aqueous solution of the basic inorganic salt, and the

like.

[0120]

Examples of the neutral inorganic salt are the same as the examples of the neutral inorganic salt in the first embodiment. Among these, sodium chloride or
5 potassium chloride is preferable.

[0121]

The basic inorganic salt is preferably an inorganic salt other than a phosphate and monohydrogen phosphate. Examples of the basic inorganic salt are the same as the examples of the basic inorganic salt other than the phosphate in the first embodiment.
10 Among these, sodium carbonate or potassium carbonate is preferable.

[0122]

In the third embodiment, the refrigerant composition may contain only one kind of other inorganic salts described above or two or more kinds of other inorganic salts described above. In a case where the refrigerant composition contains two or more
15 kinds of other inorganic salts described above, a combination thereof and a ratio therebetween can be arbitrarily selected.

[0123]

In the refrigerant composition of the third embodiment, a ratio of the content of the acidic inorganic salt to the total content of the inorganic salt is 5% to 100% by mass.
20 For example, the ratio can be 20% to 80% by mass, 40% to 60% by mass, and the like, but is not limited to these.

Within the range of numerical values described above, for example, 10% by mass, 30% by mass, 45% by mass, or the like can be selected as the lower limit of the aforementioned ratio in addition to 20% by mass and 40% by mass described above, but
25 the lower limit is not limited to these. Furthermore, within the range of numerical

values described above, for example, 90% by mass, 70% by mass, 55% by mass, or the like can be selected as the upper limit of the aforementioned ratio in addition to 80% by mass and 60% by mass described above, but the upper limit is not limited to these.

[0124]

5 In the third embodiment, the more the inorganic salt is dissolved in the refrigerant composition not yet being frozen and preferably in the refrigerant composition at a temperature of equal to or higher than 0°C, the more preferable. The amount of the dissolved inorganic salt with respect to the total amount of the inorganic salt is preferably equal to or greater than 90% by mass, more preferably equal to or greater than 95% by mass, and even more preferably equal to or greater than 98% by mass. The amount of the dissolved inorganic salt may be 100% by mass (total amount).

Furthermore, in the third embodiment, the more the inorganic salt is precipitated in the frozen refrigerant composition, the more preferable. The amount of the precipitated inorganic salt with respect to the total amount of the inorganic salt is preferably equal to or greater than 90% by mass, more preferably equal to or greater than 95% by mass, and even more preferably equal to or greater than 98% by mass. The amount of the precipitated inorganic salt may be 100% by mass (total amount).

[0125]

In the refrigerant composition of the third embodiment, the total content of the inorganic salt is preferably 5% to 35% by mass, more preferably 10% to 30% by mass, and particularly preferably 15% to 25% by mass.

[0126]

<Thickener>

In the third embodiment, the thickener is a component which increases the viscosity of the refrigerant composition and does not correspond to the pH indicator. In

the third embodiment, it is preferable that the thickener not be precipitated in a case where the refrigerant composition is frozen. In the present specification, the meaning of “thickener is not precipitated in a case where the refrigerant composition is frozen” is as described above in the first embodiment.

5 [0127]

Examples of the thickener in the third embodiment are the same as the examples of the thickener in the first embodiment.

Similarly to the first embodiment, as the thickener in the third embodiment, one or more kinds of thickeners selected from the group consisting of an acrylic polymer,
10 carboxyalkyl cellulose, xanthan gum, guar gum, hydroxyalkyl guar gum, pectin, tamarind gum, carrageenan, and alkylene glycol are preferable.

Furthermore, as the thickener, one or more kinds of thickeners selected from the group consisting of an acrylic polymer, carboxyalkyl cellulose, xanthan gum, guar gum, and hydroxyalkyl guar gum are more preferable.

15 In a case where these thickeners are used, the color of the refrigerant composition greatly changes before and after freezing, and the handleability of the refrigerant composition is further improved.

[0128]

In the third embodiment, the refrigerant composition may contain only one kind
20 of thickener or two or more kinds of thickeners. In a case where the refrigerant composition contains two or more kinds of thickeners, a combination thereof and a ratio therebetween can be arbitrarily selected.

[0129]

In the third embodiment, the smaller the amount of precipitated thickener in the
25 refrigerant composition before and after freezing, the more preferable. The amount of

the precipitated thickener with respect to the total amount of the thickener is preferably equal to or smaller than 10% by mass, more preferably equal to or smaller than 5% by mass, even more preferably equal to or smaller than 2% by mass, and particularly preferably 0% by mass (it is particularly preferable that the thickener not be precipitated at all).

[0130]

In the third embodiment, the content of the thickener in the refrigerant composition is preferably 0.1% to 10% by mass, more preferably 0.3% to 6% by mass, and particularly preferably 0.6% to 3% by mass.

10 [0131]

<pH indicator>

In the third embodiment, the pH indicator (acid-base indicator) is a component which determines the color of the refrigerant composition by reflecting whether or not the pH indicator produces color. In a case where the refrigerant composition contains the pH indicator, the color of the refrigerant composition changes before and after freezing.

[0132]

In the third embodiment, the pH indicator is not particularly limited, but a pKa thereof is preferably 4.0 to 7.5.

20 In the present embodiment, unless otherwise specified, the pKa of the pH indicator means a value obtained in a case where water is used as a solvent and the temperature is 25°C.

Examples of the pH indicator in the third embodiment are the same as the examples of the pH indicator in the first embodiment.

25 [0133]

In the third embodiment, the transition range (pH) of the pH indicator is preferably within a range of 3.0 to 10.5, more preferably within a range of 3.3 to 9.5, and particularly preferably within a range of 3.5 to 9.0.

[0134]

5 In the third embodiment, the refrigerant composition may contain only one kind of pH indicator or two or more kinds of pH indicators. In a case where the refrigerant composition contains two or more kinds of pH indicators, a combination thereof and a ratio therebetween can be arbitrarily selected. Generally, it is preferable that the refrigerant composition contain only one kind of pH indicator.

10 [0135]

In the third embodiment, the content of the pH indicator in the refrigerant composition is not particularly limited as long as the color of the refrigerant composition changes as intended. The content of the pH indicator is preferably 1 to 30 ppm, and more preferably 5 to 20 ppm.

15 [0136]

<Other components>

In the third embodiment, the refrigerant composition may contain, in addition to water, the inorganic salt, the thickener, and the pH indicator, other components that correspond to none of these, within a range that does not impair the effects of the present
20 invention. Similarly to the first embodiment, examples of other components described above include a solvent other than water; various known additives such as a preservative and a surfactant; and the like.

In the third embodiment, the refrigerant composition may contain only one kind of other components described above or two or more kinds of other components
25 described above. In a case where the refrigerant composition contains two or more

kinds of other components described above, a combination thereof and a ratio therebetween can be arbitrarily selected.

[0137]

The content of the aforementioned other components in the refrigerant composition of the third embodiment is the same as the content of other components in the refrigerant composition of the first embodiment.

[0138]

For example, in the refrigerant composition of the third embodiment, a ratio of the content of the solvent to the total content of water and the solvent is preferably equal to or lower than 10% by mass, more preferably equal to or lower than 5% by mass, and particularly preferably equal to or lower than 2% by mass.

In the third embodiment, the content of the preservative in the refrigerant composition is not particularly limited, but is preferably 0.02% to 0.5% by mass and more preferably 0.04% to 0.2% by mass.

In the refrigerant composition of the third embodiment, a ratio of the total content of the inorganic salt, the thickener, and the pH indicator to the total content of components other than water and the solvent (the inorganic salt, the thickener, the pH indicator, and the other components other than the solvent) is preferably equal to or higher than 90% by mass, more preferably equal to or higher than 93% by mass, even more preferably equal to or higher than 96% by mass, and particularly preferably equal to or higher than 98% by mass. The ratio may be 100% by mass. In a case where the ratio of the total content is equal to or higher than the aforementioned lower limit, the refrigerant composition shows a greater color change before and after freezing.

[0139]

In the third embodiment, a pH (α_2) of the refrigerant composition obtained in a

case where all the components contained in the composition other than the inorganic salt and water are substituted with water is equal to or lower than 7.

The pH ($\alpha 2$) corresponds to the pH of inorganic salt-containing water (for example, an aqueous solution of an inorganic salt) containing only the inorganic salt at the same content (% by mass) as the content (% by mass) of the inorganic salt in the refrigerant composition. The pH ($\alpha 2$) is a parameter of the acidity of the inorganic salt used in the refrigerant composition.

The pH ($\alpha 2$) is preferably 3.5 to 7.0, more preferably 4.0 to 6.6, and particularly preferably 4.5 to 6.3.

10 [0140]

The pH ($\alpha 2$) is preferably a pH at a temperature at which the pH indicator is dissolved in the refrigerant composition, and more preferably a pH obtained in a case where the temperature of the inorganic salt-containing water is 25°C.

[0141]

15 In the third embodiment, a pH ($\alpha 3$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the thickener and water are substituted with water is equal to or higher than 7.

The pH ($\alpha 3$) corresponds to the pH of thickener-containing water (for example, an aqueous solution of a thickener) containing only the thickener at the same content (% by mass) as the content (% by mass) of the thickener in the refrigerant composition. The pH ($\alpha 3$) is a parameter of the acidity of the thickener used in the refrigerant composition.

The pH ($\alpha 3$) is preferably 7.0 to 9.5, more preferably 7.0 to 9.0, and particularly preferably 7.0 to 8.5.

[0142]

The pH ($\alpha 3$) is preferably a pH at a temperature at which the pH indicator is dissolved in the refrigerant composition, and more preferably a pH obtained in a case where the temperature of the thickener-containing water is 25°C.

5 [0143]

In the refrigerant composition of the third embodiment, the pH ($\alpha 2$) and the pH ($\alpha 3$) show values of different pH ranges among three pH ranges of a pH lower than a transition range of the pH indicator, a pH of the transition range of the pH indicator, and a pH higher than the transition range of the pH indicator.

10 [0144]

In the third embodiment, the pH of the refrigerant composition is preferably 4.1 to 7.4, more preferably 4.4 to 7.1, and particularly preferably 4.6 to 6.9.

In the third embodiment, the refrigerant composition preferably has a pH within the aforementioned range of numerical values at a temperature at which the pH indicator
15 is dissolved in the refrigerant composition, and more preferably has a pH within the aforementioned range of numerical values in a case where the temperature of the refrigerant composition is 25°C.

In the present embodiment, unless otherwise specified, the description of “pH” for the refrigerant composition simply means the pH of the refrigerant composition itself.

20 [0145]

The refrigerant composition in the third embodiment is obtained by the same method as the method for obtaining the refrigerant composition in the first embodiment, except that the blended components are different.

[0146]

A refrigerant pack according to the third embodiment of the present invention includes the aforementioned refrigerant composition, and has the same constitution as that of the refrigerant pack according to the first embodiment, except that the refrigerant composition is different.

5 The refrigerant pack according to the third embodiment of the present invention is obtained by the same method as the method for obtaining the refrigerant pack according to the first embodiment, except that the aforementioned refrigerant composition is used.

[0147]

10 The color of the refrigerant composition in the third embodiment greatly changes before and after freezing. Therefore, whether or not the refrigerant composition is frozen can be easily visually observed. Furthermore, the color change of the refrigerant composition can be visually observed from the outside of the refrigerant pack. Accordingly, it is possible to easily visually observe whether or not the
15 refrigerant pack is sufficiently cooled down to a desired temperature.

Furthermore, even though cooling and warming such as freezing and unfreezing of the refrigerant composition are repeated, the effects of refrigerant composition are not impaired. Accordingly, the refrigerant pack including the refrigerant composition is also suitable for repetitive use.

20 Examples

[0148]

Hereinafter, the present invention will be described in more detail based on specific examples, but the present invention is not limited to the following examples.

[0149]

25 The raw materials used in the present examples and comparative examples are

as below.

(Thickener)

· Hydroxypropyl guar gum (HPG1): “MEYPRO HPG 8111” manufactured by SANSHO Co., Ltd.

5 · Carboxymethyl cellulose (CMC): “CELLOGEN” manufactured by DKS Co., Ltd.

· Carboxyvinyl polymer (CVP): “RHEOGIC 270” manufactured by TOAGOSEI CO., LTD.

(pH indicator)

10 · BCP: bromocresol purple (manufactured by Wako Pure Chemical Industries, Ltd.)

· PR: phenol red (manufactured by Wako Pure Chemical Industries, Ltd.)

· BTB: bromothymol blue (manufactured by Wako Pure Chemical Industries, Ltd.)

15 · MR: methyl red (manufactured by Wako Pure Chemical Industries, Ltd.)

· BCG: bromocresol green (manufactured by Wako Pure Chemical Industries, Ltd.)

(Preservative)

“SODIUM OMADINE” manufactured by SAN-AI OIL Co., Ltd.

20 [0150]

[Example 1]

<Manufacturing of refrigerant composition and refrigerant pack (first embodiment)>

At room temperature (20°C to 25°C), BCP was added to and dissolved in water

(79.16 parts by mass). Then, ammonium chloride (9.72 parts by mass), potassium chloride (9.72 parts by mass), trisodium phosphate dodecahydrate (0.15 parts by mass), and ammonium dihydrogen phosphate (0.10 parts by mass) were added to and dissolved in the solution. Thereafter, HPG1 (1.10 parts by mass) was added to and dissolved in the solution by being stirred for 1 hour at room temperature. After the state where the obtained liquid was sufficiently thickened was checked, a preservative (0.05 parts by mass) was added thereto and stirred for 30 minutes at room temperature, thereby obtaining a refrigerant composition. At this time, the amount of the BCP blended was controlled such that the content of BCP in the obtained refrigerant composition became 8 ppm. Table 2 shows the blended components and the content thereof in the refrigerant composition. In Table 2, “Basic salt” in the column of Blended component means a basic salt other than a phosphate and monohydrogen phosphate. Furthermore, in Table 2, trisodium phosphate dodecahydrate is described without water of crystallization (12H₂O). The same shall be applied to the following tables.

15 [0151]

Table 7 shows the pH ($\alpha 1$), the pH ($\alpha 2$), the pH ($\alpha 3$), the pKa of the pH indicator obtained in a case where water was used as a solvent and the temperature was 25°C, and the physical properties of the refrigerant composition such as pH. All of the pH ($\alpha 1$), the pH ($\alpha 2$), the pH ($\alpha 3$), and the pH were measured by setting the temperature of the measurement object to be 25°C. Table 7 also shows a ratio of the total content of the acidic inorganic salt and the phosphate to the total content of the inorganic salts in the obtained refrigerant composition (hereinafter, the ratio will be described as “(X1)” in some cases).

20 [0152]

Then, the obtained refrigerant composition was enclosed in a container made of high-density polyethylene, thereby obtaining a refrigerant pack of the first embodiment.

[0153]

<Evaluation of refrigerant composition>

5 (Color change)

The obtained refrigerant composition (refrigerant pack) was cooled down to -25°C. In the process of cooling, the refrigerant composition was frozen at a temperature higher than -25°C, and the color of the composition changed before and after freezing. The color change of the refrigerant composition before and after freezing was
10 evaluated by visual observation according to the following evaluation criteria. The results are shown in Table 9. Table 9 also shows the transition range and color change of the pH indicator used.

[0154]

In Table 9, “Color change” described in the column of Evaluation result shows
15 the color change of the refrigerant composition before and after freezing. For example, “Green → Yellow” shows that the refrigerant composition was green before freezing and turned yellow after freezing.

O: The color greatly changed before and after freezing, and it was very easy to visually observe the cooling state.

20 Δ: The color change before and after freezing could be recognized, and the cooling state could be visually observed.

X: The color change before and after freezing was unclear, and it was difficult or impossible to visually observe the cooling state.

[0155]

In Table 9, “Low pH → High pH color change” described in the column of Transition range of pH indicator shows that in a case where a specific pH value of a liquid containing a pH indicator changes to a value higher than the specific value, the pH indicator changes color seen in the transition range. For example, “Yellow → Purple” shows that in the process in which the pH of the liquid was increasing, the pH indicator changed the color of the liquid from yellow to purple.

[0156]

<Manufacturing of refrigerant composition and refrigerant pack (first embodiment) and evaluation of refrigerant composition>

10 [Examples 2 to 13]

The refrigerant composition and the refrigerant pack of the first embodiment were manufactured and the refrigerant composition was evaluated by the same method as that in Example 1, except that the blended components of the refrigerant composition and the content of the blended components in the refrigerant composition were changed as shown in Tables 2 and 3. Table 7 shows the physical properties of the refrigerant composition, and Table 9 shows the evaluation results.

[0157]

[Example 14]

<Manufacturing of refrigerant composition and refrigerant pack (second embodiment)>

At room temperature (20°C to 25°C), BCP was added to and dissolved in water (78.90 parts by mass). Then, ammonium chloride (9.70 parts by mass), potassium chloride (9.70 parts by mass), and diammonium hydrogen phosphate (0.50 parts by mass) were added to and dissolved in the solution. Thereafter, CMC (1.10 parts by mass) was added to and dissolved in the solution by being stirred for 1 hour at room temperature.

After the state where the obtained liquid was sufficiently thickened was checked, a preservative (0.05 parts by mass) was added thereto and stirred for 30 minutes at room temperature, thereby obtaining a refrigerant composition. At this time, the amount of the BCP blended was controlled such that the content of BCP in the obtained refrigerant composition became 8 ppm. Table 3 shows the blended components and the content of the blended components in the refrigerant composition.

[0158]

Table 7 shows the pH ($\alpha 1$), the pH ($\alpha 2$), the pH ($\alpha 3$), the pKa of the pH indicator obtained in a case where water was used as a solvent and the temperature was 25°C, and the physical properties of the refrigerant composition such as pH. All of the pH ($\alpha 1$), the pH ($\alpha 2$), the pH ($\alpha 3$), and the pH were measured by setting the temperature of the measurement object to be 25°C. Table 7 also shows a ratio of the total content of the acidic inorganic salt and the monohydrogen phosphate to the total content of inorganic salts in the obtained refrigerant composition (hereinafter, the ratio will be described using a reference sign “(X2)” in some cases) and a ratio of the content of the monohydrogen phosphate to the total content of water, the inorganic salts, and the thickener in the obtained refrigerant composition (hereinafter, the ratio will be described using a reference sign “(X3)” in some cases).

[0159]

Then, the obtained refrigerant composition was enclosed in a container made of high-density polyethylene, thereby obtaining a refrigerant pack of the second embodiment.

[0160]

<Evaluation of refrigerant composition>

The obtained refrigerant composition was evaluated by the same method as that in Example 1. The results are shown in Table 9.

[0161]

<Manufacturing of refrigerant composition and refrigerant pack (second
5 embodiment) and evaluation of refrigerant composition>

[Examples 15 to 33]

The refrigerant composition and the refrigerant pack of the second embodiment were manufactured and the refrigerant composition was evaluated by the same method as that in Example 14, except that the blended components of the refrigerant composition
10 and the content of the blended components in the refrigerant composition were changed as shown in Tables 3 to 5. Tables 7 and 8 show the physical properties of the refrigerant composition, and Table 9 shows the evaluation results.

[0162]

[Example 34]

15 <Manufacturing of refrigerant composition and refrigerant pack (third embodiment)>

At room temperature (20°C to 25°C), MR was added to and dissolved in water (79.35 parts by mass). Then, ammonium chloride (9.75 parts by mass) and potassium chloride (9.75 parts by mass) were added to and dissolved in the solution. Thereafter,
20 CMC (1.10 parts by mass) was added to and dissolved in the solution by being stirred for 1 hour at room temperature. After the state where the obtained liquid was sufficiently thickened was checked, a preservative (0.05 parts by mass) was added thereto and stirred for 30 minutes at room temperature, thereby obtaining a refrigerant composition. At this time, the amount of MR blended was controlled such that the content of MR in the
25 obtained refrigerant composition became 8 ppm. Table 5 shows the blended

components and the content of the blended components in the refrigerant composition.

[0163]

Table 8 shows the pH ($\alpha 1$), the pH ($\alpha 2$), the pH ($\alpha 3$), the pKa of the pH indicator obtained in a case where water was used as a solvent and the temperature was 25°C, and the physical properties of the refrigerant composition such as pH. All of the pH ($\alpha 1$), the pH ($\alpha 2$), the pH ($\alpha 3$), and the pH were measured by setting the temperature of the measurement object to be 25°C. Table 8 also shows a ratio of the content of the acidic inorganic salt to the total content of the inorganic salt in the obtained refrigerant composition (hereinafter, the ratio will be described using a reference sign “(X4)” in some cases).

[0164]

Then, the obtained refrigerant composition was enclosed in a container made of high-density polyethylene, thereby obtaining a refrigerant pack of the third embodiment.

[0165]

<Evaluation of refrigerant composition>

The obtained refrigerant composition was evaluated by the same method as that of Example 1. The results are shown in Table 9.

[0166]

<Manufacturing of refrigerant composition and refrigerant pack (third embodiment) and evaluation of refrigerant composition>

[Examples 35 to 37]

The refrigerant composition and the refrigerant pack of the third embodiment were manufactured and the refrigerant composition was evaluated by the same method as that in Example 34, except that the blended components of the refrigerant composition

and the content of the blended components in the refrigerant composition were changed as shown in Table 5. Table 8 shows the physical properties of the refrigerant composition, and Table 9 shows the evaluation results.

[0167]

5 <Manufacturing of refrigerant composition and refrigerant pack and evaluation of refrigerant composition>

[Comparative Examples 1 to 9]

A refrigerant composition and a refrigerant pack were manufactured and the refrigerant composition was evaluated by the same method as that in Example 1, except
10 that the blended components of the refrigerant composition and the content of the blended components in the refrigerant composition were changed as shown in Tables 5 and 6. Table 8 shows the physical properties of the refrigerant composition, and Table 9 shows the evaluation results.

[0168]

[Table 2]

	Blended components (part by mass)							
	Inorganic salt					Thickener	pH indicator	Water
	Acidic inorganic salt	Phosphate	Monohydrogen phosphate	Neutral inorganic salt	Basic salt			Preservative
Example 1	NH ₄ Cl (9.72)	Na ₃ PO ₄ (0.15)	-	KCl (9.72)	-	HPG1 (1.10)	BCP (0.0008)	(79.16)
	NH ₄ H ₂ PO ₄ (0.10)							(0.05)
Example 2	NH ₄ Cl (9.71)	Na ₃ PO ₄ (0.20)	-	KCl (9.71)	-	HPG1 (1.10)	BCP (0.0008)	(79.04)
	NH ₄ H ₂ PO ₄ (0.20)							(0.05)
Example 3	NH ₄ Cl (9.72)	Na ₃ PO ₄ (0.20)	-	KCl (9.72)	-	HPG1 (1.10)	BCP (0.0008)	(79.12)
	NH ₄ H ₂ PO ₄ (0.10)							(0.05)
Example 4	NH ₄ Cl (9.72)	Na ₃ PO ₄ (0.10)	-	KCl (9.72)	-	HPG1 (1.10)	BCP (0.0008)	(79.16)
	NH ₄ H ₂ PO ₄ (0.15)							(0.05)
Example 5	NH ₄ Cl (9.73)	Na ₃ PO ₄ (0.10)	-	KCl (9.73)	-	HPG1 (1.10)	BCP (0.0008)	(79.20)
	NaH ₂ PO ₄ (0.10)							(0.05)
Example 6	NH ₄ Cl (9.72)	Na ₃ PO ₄ (0.20)	-	KCl (9.72)	-	HPG1 (1.10)	BCP (0.0008)	(79.12)
	NaH ₂ PO ₄ (0.10)							(0.05)
Example 7	NH ₄ Cl (9.72)	Na ₃ PO ₄ (0.10)	-	KCl (9.72)	-	HPG1 (1.10)	BCP (0.0008)	(79.16)
	NaH ₂ PO ₄ (0.15)							(0.05)
Example 8	NH ₄ Cl (9.51)	Na ₃ PO ₄ (1.46)	-	KCl (9.51)	-	HPG1 (1.10)	BCP (0.0008)	(77.43)
	NH ₄ H ₂ PO ₄ (0.98)							(0.05)
Example 9	NH ₄ Cl (9.71)	Na ₃ PO ₄ (0.25)	-	KCl (9.71)	-	HPG1 (1.10)	PR (0.0008)	(79.08)
	NaH ₂ PO ₄ (0.10)							(0.05)
Example 10	NH ₄ Cl (0.97)	Na ₃ PO ₄ (0.15)	-	KCl (18.47)	-	HPG1 (1.10)	BCP (0.0008)	(79.16)
	NaH ₂ PO ₄ (0.10)							(0.05)

[0169]

[Table 3]

	Blended components (part by mass)							
	Inorganic salt					Thickener	pH indicator	Water
	Acidic inorganic salt	Phosphate	Mono-hydrogen phosphate	Neutral inorganic salt	Basic salt			Preservative
Example 11	NH ₄ Cl (19.44)	Na ₃ PO ₄ (0.15)	-	-	-	HPG1 (1.10)	BCP (0.0008)	(79.16)
	NaH ₂ PO ₄ (0.10)							(0.05)
Example 12	NH ₄ Cl (9.71)	Na ₃ PO ₄ (0.10)	-	KCl (9.71)	-	HPG1 (1.10)	BCP (0.0008)	(79.04)
	NaH ₂ PO ₄ (0.30)							(0.05)
Example 13	NH ₄ Cl (9.72)	Na ₃ PO ₄ (0.15)	-	-	Na ₂ CO ₃ (9.72)	HPG1 (1.10)	BCP (0.0008)	(79.16)
	NH ₄ H ₂ PO ₄ (0.10)							(0.05)
Example 14	NH ₄ Cl (9.70)	-	(NH ₄) ₂ HPO ₄ (0.50)	KCl (9.70)	-	CMC (1.10)	BCP (0.0008)	(78.90) (0.05)
Example 15	NH ₄ Cl (9.72)	-	(NH ₄) ₂ HPO ₄ (0.30)	KCl (9.72)	-	CMC (1.10)	BCP (0.0008)	(79.12) (0.05)
Example 16	NH ₄ Cl (9.70)	-	(NH ₄) ₂ HPO ₄ (0.50)	KCl (9.70)	-	HPG1 (1.10)	BCP (0.0008)	(78.90) (0.05)
Example 17	NH ₄ Cl (9.72)	-	(NH ₄) ₂ HPO ₄ (0.30)	KCl (9.72)	-	CVP (1.10)	BCP (0.0008)	(79.12) (0.05)
Example 18	NH ₄ Cl (9.72)	-	(NH ₄) ₂ HPO ₄ (0.30)	KCl (9.72)	-	CMC (1.10)	BTB (0.0008)	(79.12) (0.05)
Example 19	NH ₄ Cl (9.70)	-	K ₂ HPO ₄ (0.50)	KCl (9.70)	-	CMC (1.10)	BCP (0.0008)	(78.90) (0.05)
Example 20	NH ₄ Cl (9.68)	-	K ₂ HPO ₄ (0.69)	KCl (9.68)	-	CMC (1.10)	BCP (0.0008)	(78.80) (0.05)
Example 21	NH ₄ Cl (9.70)	-	Na ₂ HPO ₄ (0.50)	KCl (9.70)	-	CMC (1.10)	BCP (0.0008)	(78.90) (0.05)

[0170]

[Table 4]

	Blended component (part by mass)							
	Inorganic salt					Thickener	pH indicator	Water
	Acidic inorganic salt	Phosphate	Monohydrogen phosphate	Neutral inorganic salt	Basic salt			preservative
Example 22	NH ₄ Cl (9.69)	-	K ₂ HPO ₄ (0.50)	KCl (9.69)	-	CMC (1.09)	BCP (0.0008)	(78.89)
	KH ₂ PO ₄ (0.10)							(0.05)
Example 23	NH ₄ Cl (9.69)	-	K ₂ HPO ₄ (0.50)	KCl (9.69)	-	HPG1 (1.09)	BCP (0.0008)	(78.89)
	KH ₂ PO ₄ (0.10)							(0.05)
Example 24	NH ₄ Cl (9.69)	-	Na ₂ HPO ₄ (0.50)	KCl (9.69)	-	HPG1 (1.09)	BCP (0.0008)	(78.89)
	NaH ₂ PO ₄ (0.10)							(0.05)
Example 25	NH ₄ Cl (9.69)	-	Na ₂ HPO ₄ (0.50)	KCl (9.69)	-	CMC (1.09)	BCP (0.0008)	(78.89)
	NaH ₂ PO ₄ (0.10)							(0.05)
Example 26	NH ₄ Cl (9.69)	-	(NH ₄) ₂ HPO ₄ (0.50)	KCl (9.69)	-	HPG1 (1.09)	BCP (0.0008)	(78.89)
	NH ₄ H ₂ PO ₄ (0.10)							(0.05)
Example 27	NH ₄ Cl (9.69)	-	(NH ₄) ₂ HPO ₄ (0.30)	KCl (9.69)	-	HPG1 (1.09)	BCP (0.0008)	(78.89)
	NH ₄ H ₂ PO ₄ (0.30)							(0.05)
Example 28	NH ₄ Cl (0.98)	-	(NH ₄) ₂ HPO ₄ (0.30)	KCl (18.46)	-	HPG1 (1.10)	BCP (0.0008)	(79.12) (0.05)
Example 29	NH ₄ Cl (9.65)	-	(NH ₄) ₂ HPO ₄ (1.00)	KCl (9.65)	-	CMC (1.09)	BCP (0.0008)	(78.57) (0.05)
Example 30	NH ₄ Cl (9.55)	-	(NH ₄) ₂ HPO ₄ (1.96)	KCl (9.55)	-	HPG1 (1.08)	BCP (0.0008)	(77.80) (0.05)
Example 31	NH ₄ Cl (9.28)	-	(NH ₄) ₂ HPO ₄ (4.76)	KCl (9.28)	-	HPG1 (1.05)	BCP (0.0008)	(75.58) (0.05)
Example 32	NH ₄ Cl (9.65)	-	K ₂ HPO ₄ (1.00)	KCl (9.65)	-	CMC (1.09)	BCP (0.0008)	(78.57) (0.05)

[0171]

[Table 5]

	Blended components (part by mass)							
	Inorganic salt					Thickener	pH indicator	Water
	Acidic inorganic salt	Phosphate	Monohydrogen phosphate	Neutral inorganic salt	Basic salt			preservative
Example 33	NH ₄ Cl (19.37)	-	(NH ₄) ₂ HPO ₄ (0.60)	-	-	HPG1 (1.09)	BCP (0.0008)	(78.89) (0.05)
Example 34	NH ₄ Cl (9.75)	-	-	KCl (9.75)	-	CMC (1.10)	MR (0.0008)	(79.35) (0.05)
Example 35	NH ₄ Cl (9.75)	-	-	KCl (9.75)	-	HPG1 (1.10)	BTB (0.0008)	(79.35) (0.05)
Example 36	NH ₄ Cl (9.75)	-	-	KCl (9.75)	-	HPG1 (1.10)	PR (0.0008)	(79.35) (0.05)
Example 37	NH ₄ Cl (9.72)	-	-	KCl (9.72)	-	HPG1 (1.10)	BCG (0.0008)	(79.12)
	NaH ₂ PO ₄ (0.30)							(0.05)
Comparative Example 1	NH ₄ Cl (9.71)	Na ₃ PO ₄ (0.30)	-	KCl (9.71)	-	HPG1 (1.10)	BCP (0.0008)	(79.04)
	NH ₄ H ₂ PO ₄ (0.10)							(0.05)
Comparative Example 2	NH ₄ Cl (9.71)	Na ₃ PO ₄ (0.30)	-	KCl (9.71)	-	HPG1 (1.10)	BCP (0.0008)	(79.04)
	NaH ₂ PO ₄ (0.10)							(0.05)
Comparative Example 3	NH ₄ Cl (9.72)	Na ₃ PO ₄ (0.30)	-	KCl (9.72)	-	CMC (1.10)	BCP (0.0008)	(79.12) (0.05)
Comparative Example 4	NH ₄ Cl (9.74)	Na ₃ PO ₄ (0.10)	-	KCl (9.74)	-	HPG1 (1.10)	BCP (0.0008)	(79.28) (0.05)
Comparative Example 5	NH ₄ Cl (9.72)	-	-	KCl (9.72)	-	HPG1 (1.10)	BCP (0.0008)	(79.12)
	NaH ₂ PO ₄ (0.30)							(0.05)

[0172]

[Table 6]

	Blended components (part by mass)							
	Inorganic salt					Thickener	pH indicator	Water
	Acidic inorganic salt	Phosphate	Monohydrogen phosphate	Neutral inorganic salt	Basic salt			Preservative
Comparative Example 6	NH ₄ Cl (9.74)	-	K ₂ HPO ₄ (0.10)	KCl (9.74)	-	CMC (1.10)	BCP (0.0008)	(79.28) (0.05)
Comparative Example 7	NH ₄ Cl (9.74)	-	(NH ₄) ₂ HPO ₄ (0.10)	KCl (9.74)	-	CMC (1.10)	BCP (0.0008)	(79.28) (0.05)
Comparative Example 8	NH ₄ Cl (9.69)	-	(NH ₄) ₂ HPO ₄ (0.10)	KCl (9.69)	-	CMC (1.09)	BCP (0.0008)	(78.89)
				Na ₂ SO ₄ (0.50)				(0.05)
Comparative Example 9	NH ₄ Cl (9.75)	-	-	KCl (9.75)	-	HPG1 (1.10)	BCG (0.0008)	(79.40) (0.05)

[0173]

[Table 7]

	Physical properties								
	(X1) (%)	(X2) (%)	(X3) (%)	(X4) (%)	pH indicator pKa	pH ($\alpha 1$)	pH ($\alpha 2$)	pH ($\alpha 3$)	Refrigerant composition pH
Example 1	50.7	49.9	0	49.9	6.3	7.3	6.2	7.0	6.2
Example 2	51.0	50.0	0	50.0	6.3	7.0	5.9	7.0	5.9
Example 3	50.8	49.8	0	49.8	6.3	7.5	6.4	7.0	6.4
Example 4	50.6	50.1	0	50.1	6.3	6.7	5.8	7.0	5.8
Example 5	50.5	50.0	0	50.0	6.3	7.3	6.2	7.0	6.2
Example 6	50.8	49.8	0	49.8	6.3	8.1	6.6	7.0	6.6
Example 7	50.6	50.1	0	50.1	6.3	7.2	5.9	7.0	5.9
Example 8	55.7	48.9	0	48.9	6.3	7.0	6.1	7.0	6.2
Example 9	51.0	49.6	0	49.6	8.0	9.6	6.8	7.0	6.7
Example 10	6.2	5.4	0	5.4	6.3	7.3	7.0	7.0	7.0
Example 11	100	99.2	0	99.2	6.3	7.3	6.3	7.0	6.2
Example 12	51.0	50.5	0	50.5	6.3	6.3	5.4	7.0	5.6
Example 13	50.6	49.9	0	49.9	6.3	7.3	7.7	7.0	7.8
Example 14	48.7	51.3	0.5	48.7	6.3	8.1	6.7	7.9	6.7
Example 15	49.2	50.8	0.3	49.2	6.3	7.8	6.7	7.9	6.7
Example 16	48.7	51.3	0.5	48.7	6.3	8.1	6.7	7.0	6.7
Example 17	49.2	50.8	0.3	49.2	6.3	7.8	6.7	8.1	6.5
Example 18	49.2	50.8	0.3	49.2	7.1	7.8	6.7	7.9	6.7
Example 19	48.7	51.3	0.5	48.7	6.3	8.8	6.8	7.9	6.8
Example 20	48.3	51.7	0.7	48.3	6.3	8.8	-	7.9	-
Example 21	48.7	51.3	0.5	48.7	6.3	-	6.6	7.9	6.6
Example 22	49.0	51.5	0.5	49.0	6.3	-	6.2	7.9	6.2
Example 23	49.0	51.5	0.5	49.0	6.3	-	6.2	7.0	6.2
Example 24	49.0	51.5	0.5	49.0	6.3	-	6.2	7.0	6.2
Example 25	49.0	51.5	0.5	49.0	6.3	-	6.2	7.9	6.2
Example 26	49.0	51.5	0.5	49.0	6.3	7.4	6.4	7.0	6.4
Example 27	50.0	51.5	0.3	50.0	6.3	-	5.7	7.0	5.7
Example 28	5.0	6.5	0.3	5.0	6.3	7.8	-	7.0	-
Example 29	47.5	52.5	1.0	47.5	6.3	8.9	7.0	7.9	7.0
Example 30	45.4	54.7	2.0	45.4	6.3	-	-	7.0	-

[0174]

[Table 8]

	Physical properties								
	(X1) (%)	(X2) (%)	(X3) (%)	(X4) (%)	pH indicator pKa	pH(α 1)	pH(α 2)	pH(α 3)	Refrigerant composition pH
Example 31	39.8	60.2	4.8	39.8	6.3	-	-	7.0	-
Example 32	47.5	52.5	1.0	47.5	6.3	7.9	7.0	7.9	7.0
Example 33	97.0	100	0.6	97.0	7.3	-	-	7.0	-
Example 34	50.0	50.0	0	50.0	4.2	-	5.9	7.9	5.9
Example 35	50.0	50.0	0	50.0	6.0	-	5.9	7.0	6.4
Example 36	50.0	50.0	0	50.0	6.8	-	5.9	7.0	6.4
Example 37	50.8	50.8	0	50.8	4.9	5.5	5.0	7.0	5.1
Comparative Example 1	51.0	49.5	0	49.5	6.3	8.2	6.7	7.0	6.7
Comparative Example 2	51.0	49.5	0	49.5	6.3	10.8	6.9	7.0	6.9
Comparative Example 3	50.8	49.2	0	49.2	6.3	>10	7.1	7.9	7.1
Comparative Example 4	50.3	49.7	0	49.7	6.3	>10	6.5	7.0	6.5
Comparative Example 5	50.8	50.8	0	50.8	6.3	5.5	5.0	8.0	5.1
Comparative Example 6	49.7	50.3	0.1	49.7	6.3	8.5	6.4	7.9	6.4
Comparative Example 7	49.7	50.3	0.1	49.7	6.3	8.2	6.5	7.9	6.5
Comparative Example 8	48.5	49.0	0.1	48.5	6.3	8.2	6.4	7.9	6.4
Comparative Example 9	50.0	50.0	0	50.0	3.8	-	5.9	7.0	6.4

[0175]

[Table 9]

	PH indicator	Evaluation result		PH indicator	Evaluation result
	Transition range (low pH → high pH color change)	Color change (determination)		Transition range (low pH → high pH color change)	Color change (determination)
Example 1	5.2 to 6.8 (Yellow → Purple)	Purple → Yellow (O)	Example 24	5.2 to 6.8 (Yellow → Purple)	Purple → Yellow (O)
Example 2		Purple → Yellow (O)	Example 25		Purple → Yellow (O)
Example 3		Purple → Yellow (O)	Example 26		Purple → Yellow (O)
Example 4		Brown → Yellow (Δ)	Example 27		Brown → Yellow (Δ)
Example 5		Purple → Yellow (O)	Example 28		Purple → Yellow (O)
Example 6		Purple → Yellow (O)	Example 29		Purple → Yellow (O)
Example 7		Brown → Yellow (Δ)	Example 30		Purple → Yellow (O)
Example 8		Purple → Yellow (O)	Example 31		Purple → Yellow (O)
Example 9	6.8 to 8.4 (Yellow → Red)	Orange → Yellow (O)	Example 32		Purple → Yellow (O)
Example 10	5.2 to 6.8 (Yellow → Purple)	Purple → Yellow (O)	Example 33		Purple → Yellow (O)
Example 11		Purple → Yellow (O)	Example 34	4.2 to 6.2 (Red → Yellow)	Orange → Yellow (O)
Example 12		Brown → Yellow (Δ)	Example 35	6.0 to 7.6 (Yellow → Blue)	Yellowish green → White (O)
Example 13		Purple → Yellow (O)	Example 36	6.8 to 8.4 (Yellow → Red)	Orange → Red (Δ)
Example 14	5.2 to 6.8 (Yellow → Purple)	Purple → Yellow (O)	Example 37	4.0 to 5.6 (Yellow → Blue)	Green → Yellow (O)
Example 15		Purple → Yellow (O)	Comparative Example 1	5.2 to 6.8 (Yellow → Purple)	Purple → Light purple (X)
Example 16		Purple → Yellow (O)	Comparative Example 2		Purple → Light purple (X)
Example 17		Purple → Yellow (O)	Comparative Example 3		Purple → Light purple (X)
Example 18	6.0 to 7.6 (Yellow → Blue)	Purple → White (O)	Comparative Example 4		Purple → Light purple (X)
Example 19	5.2 to 6.8 (Yellow → Purple)	Purple → Yellow (O)	Comparative Example 5		Purple → Light purple (X)
Example 20		Purple → Yellow (O)	Comparative Example 6		Purple → Light purple (X)
Example 21		Purple → Yellow (O)	Comparative Example 7		Purple → Light purple (X)
Example 22		Purple → Yellow (O)	Comparative Example 8		Purple → Light purple (X)
Example 23		Purple → Yellow (O)	Comparative Example 9	4.0 to 5.6 (Yellow → Blue)	Blue → Blue (X)

[0176]

As is evident from the above results, in all of the refrigerant packs (Examples 1

5 to 13) according to the first embodiment of the present invention, the refrigerant packs

(Examples 14 to 33) according to the second embodiment of the present invention, and

the refrigerant packs (Examples 34 to 37) according to the third embodiment of the

present invention, as the inorganic salts were precipitated in a case where the refrigerant composition was frozen, the color of the refrigerant composition clearly changed before and after freezing by reflecting the change of color produced by the pH indicator, and the cooling state could be easily visually observed.

5 [0177]

Among the refrigerant packs according to the first embodiment, particularly in the refrigerant packs of Examples 1 to 3, 8 to 11, and 13, the color change of the refrigerant composition was finished within a short time, and these refrigerant packs exhibited particularly preferable properties.

10 [0178]

Among the refrigerant packs according to the second embodiment, particularly in the refrigerant packs of Examples 22 to 27, the color change of the refrigerant composition was finished within a short time, and these refrigerant packs exhibited particularly preferable properties. These results show that in a case where the refrigerant composition contains dihydrogen phosphate and a neutral inorganic salt, the refrigerant composition tends to exhibit preferable properties as described above.

[0179]

In contrast, in the refrigerant packs of Comparative Examples 1 to 9, the refrigerant compositions thereof were different from those in examples described above, the color change of the refrigerant compositions before and after freezing was unclear, and it was difficult or impossible to visually observe the cooling state.

[0180]

<Manufacturing of refrigerant composition and refrigerant pack (first embodiment) and evaluation of refrigerant composition>

25 [Examples 38 to 40]

The refrigerant composition and refrigerant pack of the first embodiment were manufactured and the refrigerant composition was evaluated by the same method as that in Example 1, except that the blended components of the refrigerant composition and the content of the blended components in the refrigerant composition were changed as shown in Table 10. Table 11 shows the physical properties of the refrigerant composition, and Table 12 shows the evaluation results.

[0181]

<Manufacturing of refrigerant composition and refrigerant pack (second embodiment) and evaluation of refrigerant composition>

[Examples 41 to 46]

The refrigerant composition and refrigerant pack of the second embodiment were manufactured and the refrigerant composition was evaluated by the same method as that in Example 14, except that the blended components of the refrigerant composition and the content of the blended components in the refrigerant composition were changed as shown in Table 10. Table 11 shows the physical properties of the refrigerant composition, and Table 12 shows the evaluation results.

[0182]

[Table 10]

	Blended components (part by mass)							
	Inorganic salt					Thickener	pH indicator	Water preservative
	Acidic inorganic salt	Phosphate	Monohydrogen phosphate	Neutral inorganic salt	Basic salt			
Example 38	NH ₄ Cl (9.72)	Na ₃ PO ₄ (0.15)	-	KCl (9.72)	-	CMC (1.10)	BCP (0.0008)	(79.12)
	NH ₄ H ₂ PO ₄ (0.15)							(0.05)
Example 39	NH ₄ Cl (9.72)	Na ₃ PO ₄ (0.10)	-	KCl (9.72)	-	CVP (1.10)	BCP (0.0008)	(79.16)
	NH ₄ H ₂ PO ₄ (0.15)							(0.05)
Example 40	NH ₄ NO ₃ (3.24)	Na ₃ PO ₄ (0.15)	-	KCl (16.20)	-	HPG1 (1.10)	BCP (0.0008)	(79.16)
	NH ₄ H ₂ PO ₄ (0.10)							(0.05)
Example 41	NH ₄ Cl (9.70)	-	(NH ₄) ₂ HPO ₄ (0.50)	-	-	CMC (1.14)	BCP (0.0008)	(88.61) (0.05)
Example 42	NH ₄ Cl (9.65)	-	(NH ₄) ₂ HPO ₄ (1.00)	-	-	CMC (1.14)	BCP (0.0008)	(88.17) (0.05)
Example 43	NH ₄ Cl (9.70)	-	(NH ₄) ₂ HPO ₄ (0.50)	Na ₂ SO ₄ (3.23)	-	CMC (1.14)	BCP (0.0008)	(85.38) (0.05)
Example 44	NH ₄ Cl (9.72)	-	K ₂ HPO ₄ (0.50)	-	-	CMC (1.14)	BCP (0.0008)	(88.52)
	KH ₂ PO ₄ (0.10)							(0.05)
Example 45	NH ₄ Cl (9.67)	-	(NH ₄) ₂ HPO ₄ (0.69)	-	-	HPG1 (1.09)	BCP (0.0008)	(88.40)
	NH ₄ H ₂ PO ₄ (0.10)							(0.05)
Example 46	NH ₄ Cl (9.69)	-	Na ₂ HPO ₄ (0.50)	-	-	CMC (1.14)	PR (0.0008)	(88.52)
	NaH ₂ PO ₄ (0.10)							(0.05)

[0183]

[Table 11]

	Physical properties								
	(X1) (%)	(X2) (%)	(X3) (%)	(X4) (%)	pH indicator pKa	pH(α1)	pH(α2)	pH(α3)	Refrigerant composition pH
Example 38	50.8	50.0	0	50.0	6.3	7.0	-	7.9	5.8
Example 39	50.6	50.1	0	50.1	6.3	6.7	-	8.1	6.0
Example 40	17.7	17.0	0	17.0	6.3	7.3	-	7.0	6.4
Example 41	95.1	100	0.5	95.1	6.3	8.0	-	7.9	6.8
Example 42	90.6	100	1.0	90.6	6.3	8.0	-	7.9	6.9
Example 43	72.2	76.0	0.5	72.2	6.3	8.0	-	7.9	6.8
Example 44	95.2	100	0.5	95.2	6.3	9.0	-	7.9	6.2
Example 45	93.4	100	0.7	93.4	6.3	8.0	-	7.0	6.8
Example 46	95.1	100	0.5	95.1	6.3	9.0	-	7.9	6.2

[0184]

[Table 12]

	pH indicator	Evaluation result
	Transition range (Low pH → High pH color change)	Color change (determination)
Example 38	5.2 to 6.8 (Yellow → Purple)	Purple → Yellow (O)
Example 39		Purple → Yellow (O)
Example 40		Purple → Yellow (O)
Example 41	5.2 to 6.8 (Yellow → Purple)	Purple → Yellow (O)
Example 42		Purple → Yellow (O)
Example 43		Purple → Yellow (O)
Example 44		Purple → Yellow (O)
Example 45		Purple → Yellow (O)
Example 46		Purple → Yellow (O)

[0185]

As shown in the above tables, in all of the refrigerant packs (Examples 38 to 40)

5 according to the first embodiment of the present invention and the refrigerant packs (Examples 41 to 46) according to the second embodiment of the present invention, as the inorganic salt is precipitated in a case where the refrigerant composition is frozen, the color of the refrigerant composition clearly changed before and after freezing by reflecting the change of color produced by the pH indicator, and the cooling state could

10 be easily visually observed.

Industrial Applicability

[0186]

The present invention can be used as a refrigerant pack for various perishable

15 items.

CLAIMS

1. A refrigerant pack, comprising:

a refrigerant composition containing water, inorganic salts, a thickener, and a pH

5 indicator,

wherein the refrigerant composition contains, as the inorganic salts, acidic inorganic salts, which exhibit acidic properties in an aqueous solution of the acidic inorganic salts, and a phosphate,

10 in the refrigerant composition, a ratio of a total content of the acidic inorganic salts and the phosphate to a total content of the inorganic salts is 5% to 100% by mass,

the refrigerant composition contains, as the acidic inorganic salts, dihydrogen phosphate and an inorganic salt other than the dihydrogen phosphate,

a pKa of the pH indicator is 4.9 to 8.0, and

15 a pH ($\alpha 1$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the phosphate, the dihydrogen phosphate, and water are removed and the pKa satisfy a relationship represented by Expression (i).

$$\text{pKa of pH indicator} \leq \text{pH} (\alpha 1) \leq \text{pKa of pH indicator} + 1.8 \quad \cdots \quad (i)$$

20 2. The refrigerant pack according to Claim 1,

wherein a pH of the refrigerant composition is 4.6 to 8.8.

3. The refrigerant pack according to Claim 1 or 2,

25 wherein a pH ($\alpha 3$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the thickener and water are

substituted with water is 6.0 to 8.5.

4. A refrigerant pack, comprising:

a refrigerant composition containing water, inorganic salts, a thickener, and a pH

5 indicator,

wherein the refrigerant composition contains, as the inorganic salts, an acidic inorganic salt, which exhibits acidic properties in an aqueous solution of the acidic inorganic salt, and monohydrogen phosphate,

in the refrigerant composition, a ratio of a total content of the acidic inorganic salt and the monohydrogen phosphate to a total content of the inorganic salts is 5% to 100% by mass,

in the refrigerant composition, a ratio of a content of the monohydrogen phosphate to a total content of water, the inorganic salts, and the thickener is 0.2% to 5.0% by mass, and

15 a pKa of the pH indicator is 4.9 to 8.0.

5. The refrigerant pack according to Claim 4,

wherein a pH of the refrigerant composition is 4.7 to 8.0.

20 6. The refrigerant pack according to Claim 4 or 5,

wherein a pH ($\alpha 3$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the thickener and water are substituted with water is 6.0 to 9.1.

25 7. A refrigerant pack, comprising:

a refrigerant composition containing water, an inorganic salt, a thickener, and a pH indicator,

wherein the refrigerant composition contains, as the inorganic salt, an acidic inorganic salt which exhibits acidic properties in an aqueous solution of the acidic

5 inorganic salt,

in the refrigerant composition, a ratio of a content of the acidic inorganic salt to a total content of the inorganic salt is 5% to 100% by mass,

a pH ($\alpha 2$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the inorganic salt and water are

10 substituted with water is equal to or lower than 7,

a pH ($\alpha 3$) of the refrigerant composition obtained in a case where all the components contained in the composition other than the thickener and water are substituted with water is equal to or higher than 7, and

the pH ($\alpha 2$) and the pH ($\alpha 3$) show values of different pH ranges among three pH
15 ranges of a pH lower than a transition range of the pH indicator, a pH of the transition range of the pH indicator, and a pH higher than the transition range of the pH indicator.