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(54) Title: IMPROVED FIRE-EXTINGUISHING MIXTURE

(57) Abstract: The utility solution relates to an improved fire-extinguishing mixture, comprising the components including potassium carbonate, sodium bicarbonate, ammonium bicarbonate, citric acid, sodium lauryl sulfate, aqueous film forming foam and water in amounts as described used herein. The utility solution helps to alleviate the urine odor of the fire-extinguishing mixture, increase the extinguishing ability and the re-ignition prevention ability of the fire-extinguishing mixture, and specifically make the fire-extinguishing mixture to be able to extinguish the Class K (Class F) fires. In addition, the utility solution further relates to a fire extinguisher containing the said fire-extinguishing mixture and a method of producing the fire-extinguishing mixture.

IMPROVED FIRE-EXTINGUISHING MIXTURE

TECHNICAL FIELD

The utility solution relates to an improved fire-extinguishing mixture for throwable fire extinguishers, as well as to a fire extinguisher containing thereof. The fire-extinguishing mixture can extinguish fires of various classes by throwing directly the fire extinguisher containing fire-extinguishing mixture into the fire.

BACKGROUND

Recently, there is a variety of products referred to as fire extinguishers. Generally, CO2 powder fire extinguishers are difficult to use and heavy. Therefore, it is not convenient to use them in case of a fire. On the other hand, conventional aerosol fire extinguishers can be easily used by anyone, but it is very difficult to use them for dealing with the expanded fire situation. Moreover, throwable fire extinguishers are those that are too easy to use, which contain inorganic foaming fire-extinguishing mixtures with a good extinguishing ability for high temperature fires (175^{o}C and higher). The shell of a fire extinguisher is easy to shatter and distribute the fire-extinguishing mixture, which facilitates the extinguishment of expanded fires. The composition of a fire extinguisher used in the fire extinguisher comprises various agents.

Currently, there have been some types of throwable fire extinguishers available on the market, which have been developed and sold for many years. In particular, these comprise: BONEX fire extinguishers, the throwable fire extinguishers from JAPAN FIRE PROTECT CO.LTD, the fire extinguishers from QINGDAO HUOSHEN EQUIPMENT.CO, the fire extinguishers from FRUNE ZONE CO.LTD, and some other throwable fire extinguishers: FIRE FIGHTER THROWING, TG FIREFIGHTER etc.

An advantage of the prior-art throwable fire extinguishers is their environmental and user friendliness. In particular, the pH of the fire extinguishing

solution is about 8, that is, slightly alkaline, thus not causing harm to one's health if swallowed.

However, the prior-art throwable fire extinguishers have the following drawbacks:

- The prior-art throwable fire extinguishers have a not-so-large volume, about 500-650 mL, which have limitation for extinguishment of larger fires.
- The prior-art throwable fire extinguishers on the market contain a fire extinguishing solution that usually has a plurality of ammonium radicals. These ammonium radicals will cause urine odor (smell of urine) for accidental leakage, and breakage into environment during the transport and storage. Such smell is very unpleasant to the users, which makes the deodorization highly time-consuming.
- The prior-art throwable fire extinguishers may be able to extinguish Class A, Class B, and Class C fires only.

SUMMARY

Given the foregoing, an objective of the utility solution is to develop a safe improved fire-extinguishing mixture that does not have affect to human body and that is an effective fire-extinguishing mixture with extinguishing ability for maximizing the effects of the fire-extinguishing agents, increasing the extinguishing ability, improving user experience during the transport and storage of throwable fire extinguishers.

Accordingly, the utility solution provides an improved fire-extinguishing mixture for throwable fire extinguishers as well as a fire extinguisher containing the same. The fire-extinguishing mixture is able to extinguish Class A, Class B, and Class C (or class F) fires, by throwing directly the fire extinguisher containing fire-extinguishing mixture into to the fire.

According to one aspect of the utility solution, it is provided a fire-extinguishing mixture comprising:

a. 40% to 55% by weight of potassium carbonate (K_2CO_3),

b. 5 to 10% by weight of sodium bicarbonate ($NaHCO_3$),
c. 10 to 15% by weight of ammonium bicarbonate (NH_4HCO_3),
d. 5 to 10% by weight of citric acid ($C_6H_8O_7$),
e. 2 to 7% by weight of sodium lauryl sulfate ($C_{12}H_{25}O_4S.Na$),
f. 2 to 7% by weight of aqueous film forming foam, and
g. the balance is water (H_2O).

According to another aspect of the utility solution, it is provided a fire extinguisher containing the aforementioned fire-extinguishing mixture.

In an embodiment of this aspect, the utility solution provides a fire extinguisher, having a brittle and fragile plastic shell, that contains the aforementioned fire-extinguishing mixture.

In a more particular embodiment, the previous fire extinguisher contains the aforementioned fire-extinguishing mixture of a 710 mL volume.

According to still another aspect of the utility solution, it is provided a method of producing a fire-extinguishing mixture, the method comprises:

- maintaining water at 55-68°C, dissolving 350-440 g of potassium carbonate in a moderate amount of water, until the potassium carbonate is fully dissolved;

- further dissolving 65-80 g of sodium bicarbonate, keeping the temperature of the solution within the range from 55 to 68°C, until the sodium bicarbonate is fully dissolved;

- further dissolving 80-90 g of ammonium bicarbonate, keeping the temperature of the solution within the range from 55 to 68°C, until the ammonium bicarbonate is fully dissolved;

- further dissolving 60-75 g of citric acid, keeping the temperature of the solution within the range from 55 to 68 °C, until the citric acid is fully dissolved;

- cooling the solution to approximately 28°C, then dissolving 40-50 g of sodium lauryl sulfate, until the sodium lauryl sulfate is fully dissolved;

- further dissolving 40-50 g of aqueous film forming foam, until the aqueous film forming foam is fully dissolved;

- adding water into the solution to achieve the volume of 710 mL.

DETAILED DESCRIPTION

Unless otherwise specified, all of the terms used to describe the utility solution, including the scientific and technical terms, are of the same meaning as understood by those skilled in the art. Further, the definitions of the terms shown herein are indented for better understanding of the disclosure of the utility solution.

As used herein, the expression in singular forms, are intended to include the plural forms and the expression in plural forms also include the singular forms, unless the context clearly indicates otherwise.

The terms “include”, “includes”, "including" used herein have a similar meaning to "comprise", "comprises", “comprising”, and mean to cover all or open-ended and nonexclusive method steps, features, and other components unmentioned. It should be understood that the terms “include”, "inclules", “including” used herein also cover the terms "comprise", "comprises", “comprising”.

The expression of numeric ranges with endpoints will include all values and fractions within the corresponding ranges, as well as the said endpoints.

The term “approximately” when used for the numeric values indicates that an approximation to certain degree in calculation and measurement thereof (which is precisely, adjacently, approximately or substantially the same numeric value). If for any reason the inaccuracy resulted from the term “approximately” is not understood by common knowledge in the art, the term “approximately” used herein indicates at least variations from conventional methods of measurement or using of these parameters. For example, the term “generally”, “approximately” and “substantially” can be used herein as being within the manufacturing errors. Or, for example, the term “approximately” used herein when changing the amount of a component or a reactant of the utility solution, or when used will indicate variation of the shown amount, is presented by a number that can occur during the common operational and measuring

processes used, e.g., when producing concentrates or solutions in practice due to neglection in these processes, or differences in the production, the sources or the purity of the agents used in producing the composition or in implementing the methods, and the like. The term “approximately” also includes the varying amounts due to the balancing of different compositions derived from a particular original mixture. Whether there is change caused by the term “approximately”, the claims still include the equivalents to these amounts.

As used herein, a reference to "embodiments" or "an embodiment" means that the particular features, structures or properties are described together with the embodiment will be included at least in one embodiment of the utility solution. As such, the presence of the terms "according to the embodiment" or "according to an embodiment" in various parts of the present specification is not necessary to refer to the same embodiment, but it may be. Furthermore, such features, structures or properties can be combined in any appropriate manner in one or more embodiments, as will be appreciated by a person of ordinary skill in the art when reading the present specification. Furthermore, while some embodiments mentioned herein can include some but not all the features included in other embodiments, the combinations of the features of various embodiments are also within the spirit and scope of the utility solution, and result in different embodiments, as will be appreciated by a person of ordinary skill in the art. For example, in the appended claims, any embodiment of the embodiments claimed can be used as a combination.

Different aspects of the utility solution will be defined in detail in the following sections. Each defined aspect can be combined with another or any other aspects, unless clearly specified otherwise. Particularly, any preferred or advantageous feature can be combined with one or more other preferred or advantageous features. The preferred embodiments of the utility solution will be described below with reference to the accompanying drawings.

Class A fires refer to the fires related to combustible materials such as wood, paper, silk, plastic, textile, waste, and the like.

Class B fires refer to the fires related to flammable liquids, gases, or materials, also referred to as Group B flames.

Class C fires refer to the electrical fires and fires related to electronic devices.

Class K fires, also referred to as kitchen fires (previously referred to as Class F fires, renamed "K" by NFPA 10 in 1998, in The United States of America), are the fires related to flammable liquids such as lards, oils, fats occurring during cooking.

The fire extinguishing solution usually inclules ammonium radicals for cooling during the extinguishment. The fire extinguishing solution in high temperature will produce ammonia NH_3. Ammonia usually is unpleasant due to its urine odor, which normally occurs if the extinguisher containing the solution is dropped or broken during transport and storage (in vehicle, building, workshop, etc.).

However, with the fire-extinguishing mixture of the utility solution, the ammonium radicals in the ammonium bicarbonate have been reduced to a proper amount as to alleviate the urine odor of the solution (product) upon breakage during transport and storage of the solution in normal environments (non-extinguishment), but it still maintains the extinguishing efficiency .

In addition, the fire-extinguishing mixture of the utility solution produces a large amount of CO_2 for extinguishment. In particular, potassium carbonate, sodium bicarbonate, ammonium bicarbonate, citric acid thermally react with the fire and create a large amount of CO_2. Particularly, the greater the heat of the fire is, the more CO_2 is produced.

The fire-extinguishing mixture of the utility solution has a very large ratio of K_2CO_3, greatly facilitating the extinguishment of Class F fires (named class "K" by NFPA 10 in 1998, in The United States of America), particularly the fires related to the cooking materials (oils and fats) in cookware.

The fire-extinguishing mixture of the utility solution contains an associated combination of sodium lauryl sulfate and aqueous film forming foam for increasing its extinguishing efficiency . In particular, during the extinguishment, sodium lauryl sulfate and the aqueous film forming foam are combined together, thereby creating

foams and water films, and thus rapidly quenching the oxygen source and extinguishing the fire.

Among the components of the fire-extinguishing mixture of the utility solution, one or more components of ammonium bicarbonate, sodium lauryl sulfate and the aqueous film forming foam can be absent. However, the extinguishing efficiency of the mixture will be significantly reduced.

The fire extinguisher containing the fire-extinguishing mixture is manufactured with a volume of 710 mL, which is much larger than many other products on the market, in order to increase the extinguishing ability of the fire-extinguishing mixture, thus facilitating the extinguishment of larger fires.

The method of producing the fire-extinguishing mixture comprises:

- maintaining water at 55-68 ^{o}C, dissolving 350-440 g of potassium carbonate in a moderate amount of water, until the potassium carbonate is fully dissolved;

- further dissolving 65-80 g of sodium bicarbonate, keeping the temperature of the solution within the range from 55 to 68 ^{o}C, until the sodium bicarbonate is fully dissolved;

- further dissolving 80-90 g of ammonium bicarbonate, keeping the temperature of the solution within the range from 55 to 68 ^{o}C, until the ammonium bicarbonate is fully dissolved;

- further dissolving 60-75 g of citric acid, keeping the temperature of the solution within the range from 55 to 68 ^{o}C, until the citric acid is fully dissolved;

- cooling the solution to approximately 28 ^{o}C, then dissolving 40-50 g of sodium lauryl sulfate, until the sodium lauryl sulfate is fully dissolved;

- further dissolving 40-50 g of aqueous film forming foam, until the aqueous film forming foam is fully dissolved;

- adding water to the solution to achieve volume of 710 mL.

Then, the fire-extinguishing mixture produced by the aforementioned method is poured into the extinguisher and sealed.

EXAMPLES

Hereinafter, the utility solution will be described with reference to the examples. These examples are included are only illustrative of certain aspects and embodiments of the utility solution and not intended to be limited in any manner to the utility solution as claimed in the appended claims.

Example 1 – Preparation of the fire-extinguishing mixture

In an embodiment, a fire-extinguishing mixture is produced by a method comprising:

- maintaining water at 55°C, dissolving 350 g potassium carbonate in a moderate amount of water, until the potassium carbonate is fully dissolved;
- further dissolving 65 g of sodium bicarbonate, keeping the temperature of the solution at 55°C, until the sodium bicarbonate is fully dissolved;
- further dissolving 80 g of ammonium bicarbonate, keeping the temperature of the solution at 55°C, until the ammonium bicarbonate is fully dissolved;
- further dissolving 60 g of citric acid, keeping the temperature of the solution at 55°C, until the citric acid is fully dissolved;
- cooling the solution to approximately 28°C, then dissolving 40 g of sodium lauryl sulfate, until the sodium lauryl sulfate is fully dissolved;
- further dissolving 40 g of aqueous film forming foam, until the aqueous film forming foam is fully dissolved;
- adding water to the solution to achieve volume of 710 mL.

As a result, the fire-extinguishing mixture is obtained, which contains:

a. approximately 55% by weight of potassium carbonate (K_2CO_3),
b. approximately 10% by weight of sodium bicarbonate ($NaHCO_3$),
c. approximately 10% by weight of ammonium bicarbonate (NH_4HCO_3),
d. approximately 10% by weight of citric acid ($C_6H_8O_7$),
e. approximately 7% by weight of sodium lauryl sulfate ($C_{12}H_{25}O_4S.Na$),
f. approximately 7% by weight of aqueous film forming foam, and
g. the balance is water (H_2O).

The fire-extinguishing mixture of the utility solution helps to alleviate the urine odor of the fire-extinguishing mixture, increase the extinguishing ability and the re-ignition prevention ability of the fire-extinguishing mixture, and specifically make the fire-extinguishing mixture to be able to extinguish the Class K (Class F) fires.

CLAIMS

1. A fire-extinguishing mixture comprising:
   a. 40 to 55% by weight of potassium carbonate (K_2CO_3),
   b. 5 to 10% by weight of sodium bicarbonate ($NaHCO_3$),
   c. 10 to 15% by weight of ammonium bicarbonate (NH_4HCO_3),
   d. 5 to 10% by weight of citric acid ($C_6H_8O_7$),
   e. 2 to 7% by weight of sodium lauryl sulfate ($C_{12}H_{25}O_4S.Na$) ,
   f. 2 to 7% by weight of aqueous film forming foam, and
   g. the balance is water (H_2O).

2. A throwable fire extinguisher containing a fire-extinguishing mixture according to claim 1.

3. The fire extinguisher according to claim 2, wherein the extinguisher has a brittle and fragile plastic shell.

4. The fire extinguisher according to claim 2 or claim 3, wherein the fire-extinguishing mixture has a volume of 710 mL.

5. A method of producing the fire-extinguishing mixture, comprising:
   - maintaining water at 55-68°C, dissolving 350-440 g of potassium carbonate in a moderate amount of water, until the potassium carbonate is fully dissolved;
   - further dissolving 65-80 g of sodium bicarbonate, keeping the temperature of the solution within the range from 55 to 68°C, until the sodium bicarbonate is fully dissolved;
   - further dissolving 80-90 g of ammonium bicarbonate, keeping the temperature of the solution within the range from 55 to 68°C, until the ammonium bicarbonate is fully dissolved;
   - further dissolving 60-75 g of citric acid, keeping the temperature of the solution within the range from 55 to 68°C, until the citric acid is fully dissolved;
   - cooling the solution to approximately 28°C, then dissolving 40 g of sodium lauryl sulfate, until the sodium lauryl sulfate is fully dissolved;

- further dissolving 40-50 g of aqueous film forming foam, until the aqueous film forming foam is fully dissolved;
- adding water to the solution to achieve volume of 710 mL.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

A62D 1/02 *(2006.01)*
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A62D 1/00, A62D 1/02, A62D 1/06, A62C 19/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSearch, Espacenet, EAPATIS, USPTO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 103007479 A (UNIV XI SCI & TECHNOLOGY) 03.04.2013, [0003], [0004], [0006]-[0007], [0011], [0013], [0035]	1, 5
X	CN 103706062 A (QINGDAO HUOSHEN FIRE EQUIPMENT CO LTD) 09.04.2014, [0011], [0013], [0011], [0013]	2, 4
Y		3
Y	CN 104474659 A (LIU SHUMIN) 01.04.2015, [0026]	3
A	WO 2015/020388 A1 (HAN SEUNGWOO) 12.02.2015	1-5
A	WO 2013/145207 A1 (MEDI-PLAN CO., LTD) 03.10.2013	1-5

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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