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AEROSOL PROPELLANT COMPOSITION USED IN DISPENSING FOODS

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ABSTRACT OF THE DISCLOSURE

A propellant for dispersing foods or pharmaceuticals from aerosol containers, which propellant comprises a mixture of 85–99% by weight of perfluorocyclobutane and 15–1% by weight of difluoromethane.

The present invention is directed to an improved propellant composition for dispensing food mixtures from a pressurized container.

It is recognized that aerosol propellants for general use should be both nonflammable and nontoxic to inhalation. For dispensing food mixtures, however, the propellarnts must also be nontoxic to ingestion. In addition, aerosol food propellants must be chemically stable and remain unchanged while in contact with food over long periods in storage. They must also, of course, be odorless and free from objectionable taste. Finally, aerosol food propellants must dispense the food in a suitable and attractive form, for example, as a stable foamed product which resists coarsening and collapse.

Among the known food propellants is perfluorocyclobutane, a chemically stable, odorless, nonflammable, nontoxic liquified gas having a normal boiling point of −5.85° C. (21.47° F.). Its use for propelling food mixtures is described in U.S. Patent 2,849,323. Perfluorocyclobutane meets the requirements set forth for food propellants by the United States Food and Drug Administration (FDA).

Perfluorocyclobutane, however, has one serious disadvantage to its usefulness as an aerosol food propellant. The disadvantage is that its vapor pressure of 22 p.s.i.a. (pounds per square inch absolute) at 4.4° C., normal refrigeration temperature, is too low to dispense a food product is suitable or attractive form. This disadvantage has restricted the use of perfluorocyclobutane alone as an aerosol food propellant.

Mixtures of perfluorocyclobutane and compressible gases such as nitrous oxide or carbon dioxide have been used as propellants in food mixtures contained in pressurized containers, as described in U.S. Patents 2,952,547 and 3,072,487. When such mixtures are used, however, a costly loading procedure is usually involved. For example, the perfluorocyclobutane may be loaded as a liquefied gas and the nitrous oxide loaded in a separate step, with shaking, as a compressed gas. Or, alternately, the perfluorocyclobutane and nitrous oxide may be mixed previously and loaded as a compressed gas in a single step, with shaking. Both are slow and costly loading procedures. Nitrous oxide, carbon dioxide, and similar compressed booster gases are not loaded as liquefied gases at room temperature since impractically high pressures are required.

The desirable loading procedure is to load the propellant mixture as a liquid. Loading the entire propellant system as a liquid requires no shaking and is a far faster and less costly procedure.

A liquified hydrocarbon gas, such as isobutane, which might otherwise be suitable cannot be used even in small amounts because it imparts a gasoline-like taste and odor to a food mixture.

There is, therefore, a need for an aerosol food propellant having sufficient pressure to dispense the food product from the container in an attractive foam, which propellant is adapted for rapid loading as a liquid. It is to this need that the present invention is directed.

More specifically, the present invention is directed to a propellant for dispensing food or pharmaceutical products from an aerosol container, which consists of a mixture of from about 85% to 99% by weight of perfluorocyclobutane and from about 15% to 1% by weight of difluoromethane.

Difluoromethane in admixture with perfluorocyclobutane for use as a propellant for food mixtures offers several unique advantages. The mixture is adapted for rapid loading as a liquid and provides the required dispensing pressure at refrigerator temperatures with a relatively small amount of difluoromethane. It is also suitable in that it imparts no taste or odor to the dispensed food. Food dispensed with a propellant of the present invention containing difluoromethane produces a fine, stable foam structure.

Difluoromethane has a normal boiling point of −51.7° C. (−61° F.) and may be conveniently loaded in a liquid phase, a condition much desired for an operation of this kind. Furthermore, difluoromethane has a low molecular weight. This is advantageous, since a low molecular weight propellant gives a large gas volume per unit weight and thus, on a weight basis, is low in cost as a booster propellant.

Difluoromethane and perfluorocyclobutane do not form an ideal solution. Because of this, difluoromethane imparts to mixtures with perfluorocyclobutane remarkable and desirable vapor pressure characteristics. The relation between the vapor pressure and the composition of mixtures of the present invention is given in Table I below. The vapor pressures for the compositions were they to follow Raoult's law (form an ideal solution) are also given for purposes of comparison.

TABLE I.—COMPOSITION, VAPOR PRESSURE RELATION FOR MIXTURES OF PERFLUOROCYCLOBUTANE

Difluoromethane in perfluorocyclobutane, percent by weight	Vapor pressure in lbs. per sq. in. absolute at 22.8° C.	
	Actual	Calc'd as ideal solution
0	42	09
1	60	99
2	77	49
3	90	42
4	102	59
5	113	66
6	123	62
8	140	78
10	155	97
12	167	104
15	181	117

Table I shows how 1% to 5% of difluoromethane added to perfluorocyclobutane raises the vapor pressure at room temperature from 60 p.s.i.a. to 113 p.s.i.a., a practical range for the satisfactory dispensing of food mixtures from a pressurized container even if it has been stored at refrigerator temperature. The above table also demonstrates the effect of the non-ideal characteristics of the composition of the present invention on the increase in vapor pressure of the propellant mixture. For example, to raise the vapor pressure of perfluorocyclobutane to about 77 p.s.i.a. at 22.8° C. with a booster propellant having the same vapor pressure as difluoromethane and forming an ideal solution with perfluorocyclobutane would require almost 6 weight percent of such a propellant. In contrast, difluoromethane forms a solution with perfluorocyclobutane that so deviates from the ideal that only about 2 weight percent is required to raise the pres-

sure to this level. Thus, a relatively small amount of difluoromethane, in comparison to other booster gases, provides a suitable vapor pressure for the perfluorocyclobutane propellant.

Perfluorocyclobutane by itself is difficult to emulsify in aqueous media which compose many food mixtures. The emulsifiability of mixtures of perfluorocyclobutane with difluoromethane, however, is improved in comparison to the emulsifiability of perfluorocyclobutane alone. This effect is attributed to the hydrogen atoms and polarity of difluoromethane which render it much more readily emulsifiable in aqueous food mixtures than perhalogenated compounds which contain no hydrogen.

Although current practice is to charge the standard aerosol food containers to a pressure usually not exceeding about 120 p.s.i.a. or 105 p.s.i.g. at 20° C., higher pressures may readily be reached with increased amounts of difluoromethane and may be maintained in properly constructed containers. Thus, an upper limit of 15% by weight difluoromethane in perfluorocyclobutane to provide a pressure of about 180 p.s.i.a. is an embodiment of the present invention. The preferred range of composition in the present invention is about 1% to about 5% difluoromethane in a mixture with about 99% to about 95% perfluorocyclobutane.

The aerosol food formulations which are to be dispensed with the propellant mixture of this invention include those which contain water as a constituent, such as whipping cream, dessert toppings of all kinds, custards, cake frostings, syrups, ice cream mixes, cake batters, pancake batters, cheese spreads, mayonnaise, salad dressings, catsup, mustard, and the like. The particular food or food formulation is not important to this invention, so long as it is aerosol-dispensible; that is, it must be of such fluidity or viscosity that it can be readily discharged from an aerosol container. The pharmaceutical products which may be dispensed with subject gaseous mixtures include cough syrups, vitamin preparations, and drugs.

Representative examples illustrating and characterizing the present invention follow. All parts are by weight unless otherwise specified.

EXAMPLE 1

The flammability of mixtures of perfluorocyclobutane and from 1% to 15% of difluoromethane is easily established by mixing the various compositions listed in Table II below with air and attempting to ignite such mixtures. For example, the tests are carried out by preparing various fluorocarbon/air mixtures containing proportions of the fluorocarbon mixtures ranging from 2% to 95% by weight. The pressure of the mixtures is maintained at 1 atmosphere. The mixtures are put in an enclosed one-quart glass container at atmospheric pressure and a strike-anywhere match head is ignited in the glass container by an electrical spark. If the mixture supports combustion, it is designated as flammable. The following are the results obtained in such tests.

TABLE II.—FLAMMABILITY FOR MIXTURES CH_2F_2/CYCLIC C_4F_8/AIR

Percent difluoromethane in perfluorocyclobutane:	Flammability
1	Non-flammable.
5	Do.
10	Do.
12	Do.
15	Do.

Difluoromethane is by itself flammable in air, but, as evidenced by the tests above, the mixtures of perfluorocyclobutane and difluoromethane of the present invention are non-flammable in air.

EXAMPLE 2

A vegetable oil emulsion was prepared having the following formulation:

	Percent
Vegetable oil	20.0
Water	62.5
Sugar	13.0
Microcrystalline cellulose [a]	0.5
Emulsifier [b]	0.4
Emulsifier [c]	0.1
Stabilizer [d]	0.4
Sodium casinate	3.0
Sodium pyrophosphate	0.1

[a] "Avicel RC"—American Viscose Corp.
[b] Durkee emulsifier SGM–57—Durkee Famous Foods.
[c] Polysorbate 80—Atlas Chemical Industries, Inc.
[d] "Nu-Wip" LP—Germantown Mfg. Co.

Two aerosol cans were each loaded with the above food formulation. To one can was charged the propellant mixture comprising 70% by weight perfluorocyclobutane and 30% by weight of pentafluorochloroethane, which mixture is known to be tasteless in food. To the other can was charged an aersol porpellant containing 8.24% by weight difluoromethane and 91.76% by weight of perfluorocyclobutane. The cans were loaded at 7% by weight propellant. The cans were sealed with a standard foam valve. Two other identical cans were used as controls and were prepared in a similar manner using 7% pure perfluorocyclobutane as propellant. The contents of each can were then cooled to 40° F. A portion of the product in each can was then dispensed and examined. Those discharged using pure perfluorocyclobutane were unappetizing and unacceptable as discharged products due to being in a fluid, wet condition containing large unsightly bubbles. This unacceptable condition is due to the low pressure of octafluorocyclobutane at 40° F. Those discharged using the propellant mixtures containing either pentafluorochloroethane or difluoromethane were appetizing in appearance and of acceptable quality otherwise.

A panel of five members was assembled. Each member of this panel was asked to examine and taste the samples of the formulations dispensed with the mixed porpellants, i.e., the perfluorocyclobutane-pentafluorochloroethane propellant and the perfluorocyclobutane-difluoromethane propellant. All five of the panel members were in agreement that neither sample contained a foreign or objectionable taste. From an aesthetic viewpoint, the perfluorocyclobutane-difluoromethane discharged product was more appealing than that dispensed with prefluorocyclobutane alone. The texture was firmer, the peaks in the foam were better defined, and the color was flatter and less glistening.

It is to be understood that the preceding examples are representative and that said examples may be varied within the scope of the total specification, as understood by one skilled in the art, to produce essentially the same results.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope therof, it is to be understood that this invention is not limited to the specific embodiments thereof except as defined in the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An aerosol porpellant mixture consisting essentially of perfluorocyclobutane and from about 1% to about 15% by weight of difluoromethane.

2. The aerosol propellant mixture of claim 1 wherein the difluoromethane is present in the perfluorocyclobutane in an amount from about 1% to about 5% by weight.

3. A self-propelling product mixture selected from the group consisting of foods which consist essentially of said product and a propellant for said product contained under pressure in a container, said propellant consisting essentially of a mixture of perfluorocyclobutane and from about 1% to about 15% by weight of difluoromethane.

4. A self-propelling product mixture of claim 3 wherein the propellant consists essentially of perfluorocyclobutane and from about 1% to about 5% by weight of difluoromethane.

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