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[54] **FLUOROCARBON SOLID PROPELLANT WITH BURNING RATE MODIFIER**

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[58] **Field of Search** 149/19, 19.3, 20, 44, 40

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[57] **ABSTRACT**

Solid fluorocarbon propellant compositions containing burning rate modifiers which have high structural integrity and a long storage life under varying environmental conditions.

6 Claims, No Drawings

FLUOROCARBON SOLID PROPELLANT WITH BURNING RATE MODIFIER

The invention described herein may be manufactured and used by or for the Government of the U.S.A. for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to improved solid propellants. A specific aspect relates to solid fluorocarbon propellants containing burning rate modifiers.

The fluorocarbon family of polymers has developed as excellent binders for composite solid propellants. Because of their high density, thermal stability, water impermeability, compatibility with a wide range of propellant ingredients, and high heat of reaction with metals, the fluorinated binders possess many desirable properties for propellant compositions. The propellants prepared with these binders have high structural integrity, long storage life, and good physical properties. The present invention provides a composition with increased burning rates, low pressure exponent or low temperature coefficient.

It is therefore an object of the present invention to provide a propellant with an improved burning rate for use in rocket motors and similar vehicles.

Another object is to provide a propellant with exceptionally high structural integrity and a long storage life under varying environmental conditions.

Yet another object is to provide an improved propellant composition which can be produced in large volumes at low cost.

Other objects and many attendant advantages of this invention will be readily appreciated as the same become better understood from the following description:

According to the present invention there is provided a propellant comprising up to 60 percent by weight of an oxidizer from 5 to 65 percent by weight of a binder consisting of a mixture of fluorocarbon polymers; up to 30 percent by weight metal fuel; and from 1 to 3 percent by weight chemical modifiers.

The oxidants which are applicable to the solid propellant of this invention are those oxygen-containing solids which readily give up oxygen and include ammonium, alkali metal and alkaline earth metal salts of nitric, perchloric, and chloric acids, and mixtures thereof. Ammonium perchlorate, potassium perchlorate, ammonium nitrate and hydrazine diperchlorate are preferred oxidizers for this invention.

The fluorocarbon polymers used in the composition consist of polytetrafluoroethylene (hereinafter referred to as Teflon) and a copolymer of vinylidene fluoride and hexafluoropropylene (hereinafter referred to as Viton-A) and mixtures thereof.

The high energy fuels preferred are aluminum, magnesium, zirconium, uranium, thorium, beryllium and mixtures thereof. These metals will usually have a particle size within the ranges of 1 to 100 microns.

The chemical modifiers preferred for the present composition consist of copper, lead, tin, sodium, ammonium and potassium fluoborates; sodium, potassium, lithium, lead, copper, and calcium fluorides; potassium and ammonium dichromate; lead and zinc stearate; cesium carbonate; potassium and ammonium sulfate; copper chromite; oxides of magnesium, copper and manganese; boron; zinc dust; and carbon black.

One convenient method, and the presently preferred method, of preparing this composition comprises, first, dissolving the Viton-A in a solvent selected from a low-boiling ketone; acetone was used. The Teflon and other ingredients (fuel, oxidizer and modifier) were then thoroughly mixed into the Viton-A solution to form a uniform slurry or suspension. The slurry was washed for from 5 to 10 minutes with hexane, the volume of hexane being from 1 to 4 times the volume of slurry. By this step the Viton precipitates onto the other solids in the slurry. After the suspension had settled, the supernatant hexane was decanted and the resulting residue was dried under ambient conditions for from 8 to 24 hours. The slurry may be washed with normal hexane 2 or 3 times, as necessary.

A general formulation for a propellant composition prepared in accordance with the invention is as follows:

Ingredients	Percent by weight
Binder	5 to 65
Viton-A	10 to 15
Teflon	5 to 50
Oxidizer	up to 65
Metal Fuel	up to 35
Chemical modifier	1 to 3

The following examples will serve to further illustrate the invention.

EXAMPLE I

Ingredients	% by weight	Function
Teflon	25	Binder
Viton-A	15	Binder
Aluminum	20	Fuel
Potassium perchlorate	35	Oxidizer
Sodium fluoride	2.5	Chemical modifier
Potassium dichromate	2.5	Chemical modifier

The above ingredients were processed by the shock-gel technique described hereinbefore. The Viton is available in acetone solution for which an assay should be available. The solution should contain a minimum of 8 and a maximum of 22 weight percent Viton. All of the ingredients are added to a slurry pot. A volume of hexane equal to 4 times the volume of the Viton solution is placed in a container. While stirring the slurry, hexane is added slowly and mixing continues for about 15 minutes. The Viton is precipitated or shock-gelled onto the solids in the slurry. The supernatant hexane is siphoned off and an additional volume of fresh hexane, equal to the first volume, is added. Again, the supernatant hexane is siphoned off and the resulting composition is collected in a cloth bag and dried in a drying oven for from 8 to 24 hours at approximately 140° F. Some of the material was extruded into strands for burning tests. This composition showed a burning rate at 1000 psi of 0.298-inch per second and a pressure exponent of 0.61.

EXAMPLE II

Ingredients	percent by weight	Function
Teflon	15	Binder
Viton-A	15	Binder
Aluminum	25	Fuel
Potassium perchlorate	43	Oxidizer
Sodium fluoride	2	Modifier

The Viton-A is dissolved in acetone. To this solution the Teflon, aluminum, potassium perchlorate and sodium fluoride were added and mixed for about 10 minutes forming a slurry. The slurry was washed with hexane (4 volumes of hexane to 1 volume of Viton solution) for 10 minutes. The resulting mixture was let settle and hexane was siphoned off. The residue was washed with an additional volume of hexane for about 5 minutes. The supernatant hexane was again siphoned off, the composition collected in a cloth bag and dried. This material extrudes well. It showed a burning rate at 2000 psia of 0.63 inch per second and a pressure exponent of 0.53.

EXAMPLE III

The following three samples (a, b and c) using 300 grams each of the product prepared in Example II were modified with boron and copper chromite:

(a) Ingredients	Weight in grams
Composition of Example II	300
Boron	6

About 300 grams of the cured composition prepared in Example II were placed in a small sigma-blade mixer. The boron was suspended in about 100 ml of hexane, then poured into the mixer and thoroughly stirred for about 10 minutes. The product was transferred to a stainless steel container and dried overnight. Strands were extruded for burn rate determination.

(b) Ingredients	Weight in grams
Composition of Example II	300
Copper chromite	6

The above ingredients were processed in the same manner as described in (a) above.

(c) Ingredients	Weight in grams
Composition of Example II	300
Boron	3
Copper chromite	3

The boron and copper chromite were stirred into hexane, and the process proceeded as described hereinabove. Burn strands were extruded for burning rate determination.

Burning rate results for these three compositions are as follows:

(a) .98 in/sec; pressure exponent .68
(b) .68 in/sec; pressure exponent .60
(c) .81 in/sec; pressure exponent .62

EXAMPLE IV

Ingredients	Percent by weight	Function
Teflon	16.3	Binder
Viton-A	16.3	Binder
Potassium perchlorate	65.2	Oxidizer
Sodium fluoride	2.2	Chemical modifier

The Viton was dissolved in acetone and all the ingredients were stirred therein for about 10 minutes forming a slurry or suspension. The suspension was dropped into rapidly agitated hexane and stirred for 10 minutes. (About 4 volumes of hexane to one of Viton solution). After letting the composition settle out, the hexane was siphoned off. The composition was washed again with hexane which was decanted and the material was collected and dried. Some of this composition was extruded for burn rate determination.

EXAMPLE V

Ingredients	Percent by weight	Function
Viton-A	15	Binder
Teflon	15	Binder
Potassium perchlorate	49	Oxidizer
Aluminum	18	Fuel
Zinc(dust)	2	Modifier
Sodium fluoride	1	Modifier

These ingredients were processed as those in the previous examples. Burn strands formed from this composition showed a burning rate at 2000 psi of 0.74 inch per second and a pressure exponent of 0.77.

EXAMPLE VI

Ingredients	Percent by weight	Function
Viton-A	15	Binder
Teflon	15	Binder
Potassium perchlorate	49	Oxidizer
Aluminum	18	Fuel
Cupric oxide	2	Modifier
Sodium fluoride	1	Modifier

Strands of this composition gave a burning rate at 2000 psi of 0.68 inch per second and a pressure exponent of 0.82.

EXAMPLE VII

Ingredients	Percent by weight	Function
Viton-A	15	Binder
Teflon	15	Binder
Ammonium perchlorate	49	Oxidizer
Aluminum	18	Fuel
Lead	2	Modifier
Sodium fluoride	1	Modifier

Strands were extruded of this composition which gave a burning rate at 2000 psi of 0.76 inch per second and a pressure exponent of 0.78.

EXAMPLE VIII

Ingredients	Percent by weight	Function
Teflon	51	Binder
Viton-A	15	Binder
Magnesium	31	Fuel
Cupric fluoride	3	Modifier

The ingredients were processed in accordance with the prior samples and strands were extruded for burning rate determination.

EXAMPLE IX

Ingredients	Percent by weight	Function
Viton-A	14.7	Binder
Teflon	4.9	Binder
Zirconium	36.9	Fuel
Ammonium perchlorate	41.5	Oxidizer
Magnesium oxide	2.0	Modifier

The same basic ingredients consisting of Viton, Teflon, Zirconium, and ammonium perchlorate used in this sample were modified with 2% by weight each of the member selected from manganese diozide, cellulose, acetate, dibutyl tin maleate, potassium sulfate, potassium dichromate, lithium fluoride, lead fluoride, and potassium acid tartrate. These modified fluorocarbon compositions were all extruded into strands and the burning rate determination were made.

EXAMPLE X

Ingredients	Weight in grams
Composition of Example II	300
Copper fluoroborate	8

Since the fluoroborate used herein is hygroscopic, it is mixed into the basic formulation immediately prior to extrusion. Strands were extruded and burned with double dipped Viton inhibitor.

The above examples clearly demonstrate the effectiveness of the chemical modifiers on the fluorocarbon propellants which have great potential in the missile field today.

As will be evident to those skilled in the art various other modifications of the invention can be made, or followed, in view of the above disclosure, without departing from the spirit or scope of the invention.

What is claimed is:

1. A solid propellant composition consisting essentially of the following:

Ingredients	Percent by weight
Polytetrafluoroethylene	25
Copolymer of vinylidene fluoride and hexafluoropropylene	15
Aluminum	20
Potassium perchlorate	35
Sodium fluoride	2.5
Potassium dichromate	2.5.

2. A solid propellant composition consisting essentially of the following:

Ingredients	Percent by weight
Polytetrafluoroethylene	15
Copolymer of vinylidene fluoride and hexafluoropropylene	15
Aluminum	25
Potassium perchlorate	43
Sodium fluoride	2.

3. A solid propellant composition consisting essentially of the following:

Ingredients	Percent by weight
Polytetrafluoroethylene	16.3
Copolymer of vinylidene fluoride and hexafluoropropylene	16.3
Potassium perchlorate	65.2
Sodium fluoride	2.2.

4. A solid propellant composition consisting essentially of the following:

Ingredients	Percent by weight
Polytetrafluoroethylene	15
Copolymer of vinylidene fluoride and hexafluoropropylene	15
Potassium perchlorate	49
Aluminum	18
Zinc dust	2
Sodium fluoride	1.

5. A solid propellant composition consisting essentially of the following:

Ingredients	Percent by weight
Polytetrafluoroethylene	51
Copolymer of vinylidene fluoride and hexafluoropropylene	15
Magnesium	31
Cupric fluoride	3.

6. A solid propellant composition consisting essentially of the following:

Ingredients	Percent by weight
Polytetrafluoroethylene	4.9
Copolymer of vinylidene fluoride and hexafluoropropylene	14.7
Zirconium	36.9
Ammonium perchlorate	41.5
Magnesium oxide	2.0.

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