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SLOW BURNING PLASTISOL CELLULOSE ACETATE PROPELLANT COMPOSITION CONTAINING RESORCINOL

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4 Claims. (Cl. 149-93)

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

The present invention relates to a solid propellant composition; and more particularly to a new propellant composition having a slow burning rate.

In the field of solid propellants the slow burning rate propellants use ammonium nitrate as the oxidizer. Ammonium nitrate is hygroscopic and exhibits several phase and volume changes over the temperature range normally encountered in service rounds. These solid propellant grains have poor physical strength, swell, crack and have short shelf life. The present invention is insensitive to moisture and temperature cycling and has a burning rate ranging from 0.02 to 0.035 in./sec.

It is an object of the present invention to provide a solid propellant composition for use in running auxiliary power systems aboard guided missiles.

Another object is to provide a new propellant grain for use in liquid pressurization systems.

Yet another object is to provide a propellant composition which is simple to process and is relatively safe to handle.

A further object is to provide a solid propellant grain which evolves extremely clean gases during combustion thereby eliminating the requirement for filters and screens in propulsion units or gas generators in rockets, missiles or space craft.

Other objects, features and many of the attendant advantages of this invention will become readily appreciated as the same become better understood by reference to the following detailed description.

The present invention is for a composition consisting essentially of the fuel, cellulose acetate, both in plastisol and commercial form; an energetic plasticizer selected from the group consisting of trimethylolthane trinitrate (TMETN) pentaerythritol trinitrate (PETriN), diethylene glycol dinitrate (DEGN), and mixtures thereof; a nonenergetic plasticizer such as hydroxypropylglycerol, diethyl phthalate, and dibutyl phthalate; and a stabilizer for nitrate esters selected from the group consisting of N-methyl-p-nitroaniline, ethyl centralite and resorcinol.

The propellant composition utilizing the plastisol form of cellulose acetate was prepared by mixing the ingredients at room temperature in a sigma blade mixer for about 30 minutes until a homogeneous mixture resulted. The mixture was then cast in a rocket motor tube and oven cured at temperatures between 120° and 180° F. for about two hours. After curing was completed, the core or mandrel (if used) was removed and the excess grain cut away. Nozzle assemblies were attached and the gas generator was ready for inspection.

The plastisol cellulose acetate was prepared as follows: 4.25 lbs. of pulverized cellulose acetate were dissolved in 2.15 gallons of nitromethane. It was stirred until a homogeneous lacquer was obtained. Next, a mixture consisting of 1 lb. of Petromix #9, a petroleum sulfonate emulsifier, and 1.2 gallons of water was placed in a colloid mill. The mill was put into operation and slowly the lacquer made in the previous step was added. The

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mill was run until an emulsion was formed which was then drowned in 40 gallons of vigorously agitated water at approximately 100° F. Agitation continued for about 30 minutes, then the spheres were separated by sending the suspension through a 200 mesh screen and into a centrifuge. The material was dried at 180° F. for about 2 days.

Other fuels which may be used instead of cellulose acetate include cellulose triacetate, cellulose acetate butyrate, and cellulose acetate propionate.

The following are representative examples of the preferred compositions prepared in accordance with this invention and should not be considered as limiting it.

Example I

Ingredients:	Percent by weight
Plastisol cellulose acetate	45.0
Trimethylolthane trinitrate	44.0
Dibutyl phthalate	5.0
N-methyl-p-nitroaniline	1.0

The following data was obtained for the above formulation:

Measured heat of explosion	cal./g.	426
Pressure exponent, n , 70° F., pressure interval: 800-2000 p.s.i.		0.91
Strand burning rate at about 900 p.s.i.	in./sec.	0.02

Example II

Ingredients:	Percent by weight
Cellulose acetate	37-50
Pentaerythritol trinitrate	35-48
Dibutyl phthalate	5-15
Resorcinol	1

The above formulation exhibited burning rates as low as 0.017 in./sec. at 1000 p.s.i. and 70° F. Motors fired using this formulation showed extremely long burning times (averaging 117.4 sec. at 70° F. and 82.0 sec. at 130° F.) and emitted unusually clean exhaust products.

Example III

Ingredients:	Percent by weight
Cellulose acetate	35-45
A mixture consisting of about equal parts diethylene glycol dinitrate and trimethylolthane trinitrate	35-48
Hydroxypropylglycerol	0-15
Resorcinol	1

The formulations were modified by substituting either cellulose acetate propionate or cellulose acetate butyrate, in order to increase pot life. The significant differences observed indicated that the physical properties were not improved.

In the variation wherein the commercial forms of cellulose esters, an energetic plasticizer, an inert plasticizer, and a stabilizer were used, the liquid ingredients were slowly added to the blended dry ingredients and mixed in a sigma blade or like mixer. The resultant dry mix was rolled on a differential speed propellant roll mill preheated to 140-160° F. The propellant was rolled until the dry mix became a translucent, tough, continuous sheet, and rolling was stopped before bubbles or discolorations appeared in the rolled sheet. The sheet was then diced and fed into a propellant ram extrusion press. The propellant could be extruded into any desired shape by proper die design. After trimming and inhibiting the grain, the gas generator was ready for insertion into a canister for use.

By varying the ratio of inert to energetic plasticizer and the ratio of the plasticizer mixture to cellulose compounds the physical properties, burning rate, and heat of explosion may be varied over a very wide range. The tensile

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strength of the extruded grains are higher than a cast grain of similar composition. The physical properties of the extruded grains may also be tailored by controlling the rolling temperature and time, the extrusion temperature, extrusion rate and ratio of newly rolled material to previously extruded scrap propellant.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A slow burning rate propellant composition consisting essentially of the following

Ingredients:	Percent by weight
Cellulose acetate	37-50
Pentaerythritol trinitrate	35-48
Dibutyl phthalate	5-15
Resorcinol	1

2. A slow burning propellant composition consisting essentially of the following

Ingredients:	Percent by weight
Cellulose acetate	35-45
A mixture consisting of diethylene glycol dinitrate and trimethylolethane trinitrate	35-48
Hydroxypropylglycerol	Up to 15
Resorcinol	1

3. A slow burning propellant composition consisting of the following

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Ingredients:	Percent by weight
Plastisol cellulose acetate	45.0
Trimethylolethane trinitrate	44.0
Dibutyl phthalate	5.0
N-methyl-p-nitroaniline	1.0

4. A slow burning propellant composition consisting essentially of

- a fuel selected from the group consisting of cellulose acetate, cellulose acetate butyrate, cellulose triacetate, cellulose acetate propionate and mixtures thereof;
- an energetic plasticizer selected from the group consisting of trimethylolethane trinitrate, pentaerythritol trinitrate, diethylene glycol dinitrate and mixtures thereof;
- a nonenergetic plasticizer selected from the group consisting of hydroxypropylglycerol, diethyl phthalate and dibutyl phthalate; and
- a stabilizer selected from the group consisting of N-methyl-p-nitroaniline, ethyl centralite and resorcinol.

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