

[54] **PROPELLANT COMPOSITION  
CONTAINING TRIFERROCENYLMETHYL  
PERCHLORATE AS CATALYTIC OXIDIZER**

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149/76, 2, 18, 19.4, 19.5, 19.9, 40, 44**

[56]

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**ABSTRACT**

Triferrocenylmethyl perchlorate as a partial or complete replacement for ammonium perchlorate and the standard burning rate catalyst in a propellant composition. Triferrocenylmethyl perchlorate functions as a combination burning rate catalyst and oxidizer.

**10 Claims, No Drawings**

# PROPELLANT COMPOSITION CONTAINING TRIFERROCENYLMETHYL PERCHLORATE AS CATALYTIC OXIDIZER

## BACKGROUND OF THE INVENTION

This invention relates to a novel burning rate catalyst and particularly to a combination burning rate catalyst and oxidizer for use in propellant compositions.

In the past, a large amount of work has been done in the area of high burning rate solid propellants. Most prior work has dealt with the effects of propellant additives on the burning rates. These additives have included both chemical burning rate catalysts and short metallic fibers (staples). The use of chemical modifiers has often led to poor stability and/or reduced specific impulse. The use of metallic fibers has increased processing difficulties and led to poor ballistic firing traces. Accordingly, a high burning rate homogeneous propellant is greatly desirable.

High burning rate homogeneous propellants which are easily castable have a number of applications in military weapons systems. Such high burning rate propellants are particularly suitable for use in high thrust to mass ratio motors.

Accordingly, it is the principal object of this invention to provide a high burning rate propellant which maintains good stability, processing and ballistic properties.

It is a particular object of this invention to provide such a high burning rate propellant which is homogeneous and has a high energy binder.

## SUMMARY OF THE INVENTION

It has been discovered that triferrocenylmethyl perchlorate may be used as a partial or complete replacement for ammonium perchlorate (or other oxidizer) and the standard burning rate catalyst in a propellant composition. It functions as a combination burning rate catalyst and oxidizer, thereby enabling a larger proportion of the binder prepolymer to be used without a sacrifice in propellant burning rate.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Propellant compositions normally contain ammonium perchlorate (or other oxidizer), a metal staple additive, a polymer binder, a burning rate catalyst, and a processing aid. The binder is formed from a prepolymer reacted with a crosslinking agent in the presence of a polymerization catalyst. It has been discovered that a larger proportion of the binder prepolymer is enabled to be used without a sacrifice in propellant burning rate by employing triferrocenylmethyl perchlorate as a partial or complete replacement for ammonium perchlorate (or other oxidizer) and the standard burning rate catalyst in the propellant composition. The triferrocenylmethyl perchlorate functions as a combination burning rate catalyst and oxidizer.

The propellant compositions of this invention are preferably composite (typically having a carboxyl- or

hydroxyl-terminated polybutadiene, acrylate, acrylic acid and polybutadiene or polyurethane binder) or composite double-base (typically having a nitrocellulose binder which has been reacted with a plasticizer such as nitroglycerine, and additives). However, the triferrocenylmethyl perchlorate can also be used as a substitute for another oxidizer (e.g., potassium perchlorate or ammonium nitrate) in a double-base or other propellant.

The preferred ingredient concentration ranges of propellant compositions of this invention are (approximate weight percentages):

|                                      |      |
|--------------------------------------|------|
| Ammonium perchlorate                 | 0-72 |
| Aluminum                             | 2-20 |
| Binder                               | 9-20 |
| Triferrocenylmethyl perchlorate      | 1-72 |
| Three-dimensional crosslinking agent | 0.5  |

Three-dimensional crosslinking agents (e.g., Tris(methylaziridinyl) phosphine oxide and/or Tris(oxiranyl)-para-aminophenol) provide crosslinking sites in the polymeric binder system to impart the desirable physical properties to the solid propellant composition. The aforementioned compounds and others known in the art facilitate the polymerization and hence are known as polymerization catalysts. Also, a curing catalyst such as iron linoleate may be utilized. The iron linoleate is generally added in minor amounts to promote the curing of the binders and crosslinking agents of the propellant composition. Other catalyst (e.g., benzoyl peroxide) for the three dimensional crosslinking agent may also be added and a processing aid (e.g., lecithin) may be utilized as additives in minute amounts (each about 0.1 percent, or less, by weight). Of course, the total weight percentages of the propellant ingredients must be 100.

By the substitution of triferrocenylmethyl perchlorate for part (or all) of the oxidizer (preferably ammonium perchlorate) and the standard burning rate catalyst (n-butylferrocene in the example given), a larger proportion of the binder prepolymer is enabled to be used without a sacrifice in propellant burning rate. This represents a definite advantage. The resulting propellant composition crystallizes at a lower temperature than the prior art composition, the migration of the liquid n-butylferrocene to the propellant burning surface is reduced or eliminated, and propellant degradation is minimized.

If desired, burning rate catalysts (or other additives) such as copper chromite can be incorporated into the propellant composition in small amounts.

A specific example (composition B) of this invention is given in the following table. Composition A is a propellant composition which has been developed for a high burning rate propellant, whereas composition B is a propellant composition which contains an equivalent concentration of triferrocenylmethyl perchlorate. This example is merely intended to be illustrative of this invention and is not to be considered a limitation thereof.

| Ingredient                                   | Composition A<br>(wt. %) | Composition B<br>(wt. %) |
|----------------------------------------------|--------------------------|--------------------------|
| Ammonium perchlorate, 6μ                     | 68.0                     | 62.0                     |
| Al                                           | 14.0                     | 14.0                     |
| n-Butylferrocene                             | 7.0                      | —                        |
| Triferrocenylmethyl perchlorate              | —                        | 6.3                      |
| Carboxyl-terminated polybutadiene prepolymer | 10.5                     | 17.2                     |

Continued

| Ingredient                             | Composition A<br>(wt. %) | Composition B<br>(wt. %) |
|----------------------------------------|--------------------------|--------------------------|
| Tris(methylaziridinyl) phosphine oxide | 0.5                      | 0.5                      |
| ERLA-0510 <sup>1</sup>                 |                          |                          |
| Iron Linoleate                         |                          |                          |
| Lecithin                               |                          |                          |

<sup>1</sup>Tris(oxiranyl)-para-aminophenol

Composition B is a propellant composition having the burning rate of composition A. However, it has improved mechanical properties and processing characteristics because a larger quantity of binder prepolymer is included in the propellant composition. Alternatively, if the binder content is not increased fully from 10.5 to 17.2 percent, and a lesser amount of binder is used, an increase in the ammonium perchlorate and/or aluminum content can be effected, resulting in a propellant of higher burning rate and impulse. Correspondingly, if other burning rates are desired the standard amount of catalyst can be used, and the triferrocenylmethyl perchlorate can be used as a replacement for the ammonium perchlorate. Thus, the use of triferrocenylmethyl perchlorate in a propellant composition provides a means of simultaneously introducing both a burning rate catalyst and an oxidizer into that propellant composition. As noted above a decrease in ammonium perchlorate can be accomplished without a loss of burning rate, and as a direct result of the decreased ammonium perchlorate the propellant can contain a higher binder to fuel ratio which yields a propellant of improved physical properties. Also, the problem of migration of the n-butylferrocene can be minimized or eliminated since the amount of this liquid material used can be varied when triferrocenylmethyl perchlorate is used in the propellant composition.

I claim:

1. A solid propellant composition comprising a polymeric binder, a metal, and triferrocenylmethyl perchlorate.

2. The composition of claim 1 comprising an oxidizer

in addition to said triferrocenylmethyl perchlorate.

3. The composition of claim 2 wherein said oxidizer is ammonium perchlorate.

4. The composition of claim 3 wherein said metal is in the form of staples.

5. The composition of claim 3 wherein the weight percentage of said ammonium perchlorate is from about 60 to about 72 percent, and wherein the weight percentage of said binder is from about 9 to about 20 percent.

6. The composition of claim 5 wherein said metal is in staple form and wherein said metal staple is present in an amount of at least about 2 weight percent.

7. The composition of claim 6 wherein the weight percentage of said metal staple does not exceed about 20 percent.

8. The composition of claim 7 wherein the weight percentage of said ammonium perchlorate is about 62 percent, the weight percentage of said metal staple is about 14 percent, the weight percentage of said triferrocenylmethyl perchlorate is about 6 percent, and wherein the weight percentage of said polymeric binder is about 17 percent.

9. The composition of claim 8 wherein said polymeric binder is formed from a carboxyl-terminated polybutadiene prepolymer crosslinked with a suitable crosslinking agent.

10. The composition of claim 9 wherein said crosslinking agent is tris-(methylaziridinyl)phosphine oxide.

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