PYROTECHNICS COMPRISING SILVER IODATE, AMMONIUM NITRATE, NITROCELLULOSE AND NITRATE ESTERS

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4 Claims. (Cl. 149—18)

ABSTRACT OF THE DISCLOSURE

An improved silver iodate containing pyrotechnic which upon combustion on the ground under quiet atmospheric conditions yields active nuclei in a size of about 1×10^13 particles per gram. These nuclei induce regular and uniform ice crystal formation.

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 improved pyrotechnic compositions, and is particularly directed toward a composition which generates sublimation nuclei for use in influencing the weather.

In meteorological seeding to cause rainfall for any purpose, many compositions and methods have been developed. Burner type generators utilizing solutions of silver iodide in a volatile, flammable solvent have been used for dispersing or precipitating fogs and clouds. Other devices and formulations have been developed which produce smoke and other products upon combustion for use on moving aircraft or while falling through the atmosphere. Rapid flow of air around these units cools and disperses the particles preventing regular and uniform crystal growth. The present invention provides an improved pyrotechnic composition which on combustion on the ground under quiet atmospheric conditions and allows large numbers of finely divided particles of silver iodide as the only solid product of combustion.

It is therefore an object of the present invention to provide a pyrotechnic composition which will furnish active nuclei of very small size (about 1×10^13 particles per gram) when burned under quiet atmospheric conditions for use in seeding super-cooled clouds.

Another object is to provide a pyrotechnic composition which upon combustion yields nuclei which induce regular and uniform ice crystal formation.

Still another object is to provide an improved pyrotechnic composition which will have use in a dispersing device where a rapid flow of air is not necessary for nuclei dispersion and temperature quench.

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.

In accordance with the present invention from about 0.5% to about 20% by weight uncrystallized silver iodate and from 35 to 50% by weight propellant-grade ground ammonium nitrate were blended in a vacuum mixer with from 40 to 60% by weight "nitrasil" type binder, cast into cardboard tubes or other suitable containers, and cured by heating. The temperature and time of cure depends upon the size and shape of the casting. For example, a cylinder one-inch in diameter and one-inch long may cure in 1 to 2 hours at temperatures ranging from 130° to 180° F.

"Nitrasil" binder is the name for a mixture consisting of from about 15 to 85% by weight high energy plasticizer, zero to 20% by weight inert plasticizer and about 10 to 50% by weight plastic nitrocellulose. The high energy plasticizer is one selected from the group consisting of primary non-oxidative plasticizers, both liquid and solid. Preferred nitrate esters are penterythritol trinitrate and trimethyloltrinitrate.

The inert plasticizer is conventional and may or may not be added to modify ballistic and physical properties. Dibutyl phthalate is commonly employed as such a plasticizer.

The plastic nitrocellulose used herein was obtained commercially. It is made in batches by placing 90 grams of dry nitrocellulose (12.6% N), 1.2 grams of ethyl centralite, and 1.4 liters of nitromethane in a flask and stirring vigorously until apparent dissolution occurs, then stirring slowly for 10 minutes more to insure homogeneity in the resulting lacquer. About 19.2 grams of a suitable petroleum sulfone emulsifying agent in about 900 ml. of water is added to the lacquer and the mixture circulated and recirculated through a collodion mill. After about 10 minutes, the emulsion that is formed is drained from the collodion mill into about 30 liters of water and stirred for about 15 minutes whereupon a precipitate of nitrocellulose forms which is filtered out of the liquid, washed in hexane and dried for about 6 hours. The product is sifted through a 200 mesh screen. This form of nitrocellulose consists of dense spherical particles of 1-30μ diameter and is not substantially attacked by the plasticizer until cure at elevated temperatures.

The binder in most of the formulations described herein consisted of 30% plastic nitrocellulose and 70% pentaerythritol trinitrate. Other nitrate esters such as nitroglycerin, metriol trinitrate, triethylene glycol dinitrante, etc. may be used. The ratio of plastic nitrocellulose to nitrate ester varies with the particular lot of nitrocellulose and nitrate ester chosen.

In the present improved pyrotechnic composition the "nitrasil" binder provides an energetic matrix, the ammonium nitrate serves as a burning rate modifier and oxidizer and the silver iodate is the source of the silver iodide which acts as the sublimation nuclei.

Concentrations of silver iodate which have been prepared and tested have varied from 0.5% to 20% by weight of the total composition. From 5% to 15% is optimum. The improved pyrotechnic compositions burn smoothly, without visible or colored smoke, indicating the very small size of the silver iodide nuclei produced. The composition burns leaving little residue which indicates essentially complete volatilization of the silver iodide.

The following examples are given in the chart below to more particularly illustrate the invention. However, the invention is not to be considered as limited to the examples.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Composition, Weight Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastisol Binder</td>
<td>Ex. I 60 Ex. II 50 Ex. III 50 Ex. IV 50 Ex. V 50 Ex. VI 50</td>
</tr>
<tr>
<td>Ammonium Nitrate,</td>
<td></td>
</tr>
<tr>
<td>Silver Iodate,</td>
<td></td>
</tr>
</tbody>
</table>

A product evaluation of these formulations was made. Samples were ignited and the combustion products examined. At about 20°C, the effective nuclei count in particles of silver iodate per gram for Example II containing 10% silver iodate averaged about 1.7×10^14; for Example III containing only 1% silver iodate the count averaged about 1.1×10^14 at about 20°C; for Example V containing 15% silver iodate the count averaged 1.05×10^16 at about 20°C; and Example VI containing 5% silver iodate the count averaged about 1×10^14 at about 18°C.
The preferred composition comprises about 50% "nitrasol" binder and 50% of a mixture of ammonium nitrate and silver iodate. The mixture ranges from 0.5 to 20% by weight silver iodate and the remainder ammonium nitrate.

Known pyrotechnic formulations developed for use on moving aircraft or while falling through the atmosphere contain from 70 to 90% silver iodate to produce a maximum of nuclei. Inclusion of light metals, such as aluminum or magnesium in these formulations is necessary to raise the heat output of the compositions to the point where all of the heavy metal iodide that is produced will be vaporized and expelled. When these known formulations are burned on the ground under quiet atmospheric conditions, the smoke produced is intensely colored and the particle size of the silver that is generated was found to be too large for effective use as sublimation nuclei for small regular ice crystal formation. Actual tests of such formulations burned on the ground in a super-cooled fog converted water droplets in part into clusters of frozen ice droplets and in part into irregular and deformed ice crystals and large star-like snowflakes. The presence of other solid combustion products such as aluminum trioxide and magnesium oxide, appear to induce irregular ice crystal formation. The present invention as hereinabove described burns leaving no residue. This composition containing from 0.5 to 20% silver iodate generates nuclei which induce primarily regular and uniform ice crystal formation when burned on the ground under quiet atmospheric conditions.

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. An improved pyrotechnic composition for burning at atmospheric pressure on the ground comprising the following:

- **Ingredients:**
  - **Binder**
  - **Silver iodate**
  - **Ammonium nitrate**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percent by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder</td>
<td>50</td>
</tr>
<tr>
<td>Silver iodate</td>
<td>0.5–20</td>
</tr>
<tr>
<td>Ammonium nitrate</td>
<td>30–49.5</td>
</tr>
</tbody>
</table>

4. The composition of claim 1 wherein the percentage of silver iodate is 10 and the percentage of ammonium nitrate is 40.

3. The composition of claim 1 wherein the percentage of silver iodate is 5 and the percentage of ammonium nitrate is 45.

4. The composition of claim 1 wherein the percentage of silver iodate is 15 and the percentage of ammonium nitrate is 35.

**References Cited**

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