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Johnson et al.

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[54] **PYROTECHNIC COMPOSITION FOR GENERATING LEAD BASED SMOKE**

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[51] **Int. Cl.**..... **C06d 5/06**

[58] **Field of Search**..... 149/19, 22, 44, 83–85

[56] **References Cited**

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[57] **ABSTRACT**

A pyrotechnic composition comprising lead iodate, alkali iodate, boron, and epoxy resin which upon combustion generates a lead based smoke which can be used for artificial weather modification.

2 Claims, No Drawings

PYROTECHNIC COMPOSITION FOR GENERATING LEAD BASED SMOKE

GOVERNMENT INTEREST

The invention herein described 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.

BACKGROUND OF THE INVENTION

Various types of pyrotechnic compositions capable of providing clouds of smoke upon combustion are well known as are pyrotechnic compositions containing silver iodate which upon combustion produce silver iodide nuclei which if properly introduced into the appropriate cloud may increase rainfall, make hail formation more difficult, or disperse supercooled fog. The technique of seeding undercooled clouds is known. Two widely used artificial ice nuclei are dry ice (solid carbon dioxide) used successfully for cloud modification by Schaefer in 1946, and silver iodide whose excellent activity was discovered by Vonnegut in 1947. The use of silver iodide as a seeding material is based on its property of acting as freezing nuclei at relatively high temperatures, namely between −4° C. and −5° C. and of turning undercooled clouds into ice particles. Heretofore only very few substances have become known which have nucleus properties similar to silver iodide, such as lead iodide. The generation of silver iodide remains comparatively expensive. However, the generation of lead based nuclei by pyrotechnic means has never been too successful and therefore has not produced results comparable to silver iodide smokes. The present invention provides a pyrotechnic composition which not only produces lead-based freezing nuclei which show excellent ice forming activity, but the material is fairly inexpensive.

SUMMARY OF THE INVENTION

The invention relates to improved pyrotechnic compositions. More particularly, to a pyrotechnic which upon combustion yields a lead-based active nuclei which has application in artificially influencing the weather.

The general purpose of this invention is to provide a pyrotechnic composition which is comparable to or better than other pyrotechnic compositions which upon combustion yield by-products which show improved freezing nuclei activity. Another object is to provide a pyrotechnic which is economical to prepare and safe to handle.

DESCRIPTION OF THE INVENTION

The present invention is for a composition comprising at least two oxidizers, one an alkali iodate and the other lead iodate, a nonmetallic fuel, and a binder which contains no halogens other than iodine.

The alkali iodate used includes potassium, cesium, sodium and rubidium iodate. The preferred fuel is boron which is safe and does not tend to form more energetic bonds with iodine than with oxygen. Other metals which may be used are aluminum or magnesium; also, others which do not tend to form more energetic bonds with iodine than with oxygen. The preferred binder is epoxy resin. It is necessary to aid in the consolidation of the composition if pelletizing is desired. It is important to this composition that the binder used

contain no halogens other than iodine. Other halogens may reduce the efficiency of this composition. The preferred formulation is accomplished by maintaining an alkali metal to lead mole ratio between 1:1 and 20:1. Sufficient fuel is added to react with the oxygen present in the composition but is not necessarily required as the composition will function with less. It is not necessary that a stoichiometric quantity of fuel be used, but it is recommended that no more than twice this amount be used. The quantity of binder is that needed to mix the materials needed to compact into a solid grain.

Upon combustion the present improved pyrotechnic compositions yield lead iodide-alkali metal iodide complexes. It is postulated that by forming the alkali iodide the lead iodide formed is chemically and physically protected by chemically bonding the metallic iodides as double base salts or by physically forming a protective layer around the lead iodide in the flame and/or upon cooling to the solid state, i.e., smoke particles. This protection is believed to prevent the oxidation of the lead iodide formed in the flame and/or when contact with atmospheric oxygen occurs.

The following examples better illustrate this invention but should not be considered as limiting.

EXAMPLE I

Ingredients	Percent by weight
Lead iodate	48.9
Potassium iodate	37.6
Boron	7.5
Epoxy resin binder	6.0

The inverse burn rate =4.3 sec/inch.

The nucleation efficiency (nuclei per gram of composition) is as follows:

−6° C., 5.6×10^{11}
−7° C., 6.2×10^{11}
−0.7° C., 8×10^{9}

EXAMPLE II

Ingredients	Percent by weight
Lead iodate	26.2
Potassium iodate	59.6
Boron	8.2
Epoxy resin binder	6.0

The inverse burn rate =4.3 sec/inch.

The nucleation efficiency (nuclei per gram of composition) is as follows:

−6.5° C., 2.2×10^{11}
−7.5° C., 3.2×10^{11}
−10.5° C., 1.2×10^{12}

EXAMPLE III

Ingredients	Percent by weight
Lead iodate	87.2
Boron	6.8
Epoxy resin binder	6.0

The inverse burn rate = 5.2 sec/inch.

The nucleation efficiency (nuclei per gram of composition) is as follows:

−9° C., 3.4×10^{11}

EXAMPLE IV

Ingredients	Percent by weight
Lead iodate	26.2
Potassium iodate	59.6
Boron	4.7
Gilsonite	3.5
Epoxy binder	6.0

The inverse burn rate =12 sec/inch.

EXAMPLE V

Ingredients	Percent by weight
Lead iodate	41.0
Potassium iodate	31.5
Magnesium	21.5
Epoxy resin binder	6.0

EXAMPLE VI

Ingredients	Percent by weight
Lead iodate	40.0
Potassium iodate	46.2
Boron	7.8
Epoxy binder	6.0

EXAMPLE VII

Ingredients	Percent by weight
Lead iodate	62.6
Potassium iodate	24.1
Boron	7.3
Epoxy binder	6.0

The nucleation activity of Examples VI and VII were about the same as those for Example I above.

All of the Examples (I – VII) were prepared by dissolving the epoxy resin and curing agent which is used with the epoxy in acetone. The other ingredients are added while agitating until a homogeneous mixture was obtained. The acetone was then removed by vacuum and the composition pressed into cylinders of predetermined size and cured. When burned, these compositions produce smokes ranging from white to pink in color. The compositions show good nuclei activity at temperatures ranging from −1° to −10° C.

The preferred epoxy resin system is DER 321, which may be obtained from Dow Chemical Company. It is a liquid having an epoxide equivalent of 187 – 193; average molecular weight 350 – 400 and viscosity at 25° C. of 11,000 – 16,000 centipoises. It is a reaction product of Bisphenol A and epichlorohydrin to which is added about 10 weight percent butyl glycidyl ether as a reactive diluent. It is cured with about 11 parts by weight to 100 parts of the resin/diluent combination of a conventional curing agent, such as diethylene triamine. Epoxy resins were found to be the best binders because they give a longer, more stable shelf life to the composition.

Use of this lead based composition in pyrotechnic generators for cloud seeding experiments has shown that the ice forming efficiency is equal to or better than that of silver and much less expensive. These pyrotechnic devices are either fired from the ground or from airplanes as they fly into the preselected clouds. Because the crystal of lead complex formed, like the silver iodide used in the prior art, is similar to that of ice, it acts as a seed for the growth of ice crystals in a supercooled cloud.

The boron and other nonmetals such as silicon offer greater safety in manufacturing as well as much better storage properties and resistance to moisture degradation.

What is claimed is:

1. A pyrotechnic composition comprising the following:

Ingredients	Percent by weight
Lead iodate	25 – 65
Potassium iodate	25 – 60
Boron	4 – 8
Epoxy resin	6 – 8.

2. The composition of claim **1** to which gilsonite is added in a percent by weight ranging from 3 – 4, as needed for desired burning rate.

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