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LOW FLAME TEMPERATURE GAS GENERANT CONTAINING AMMONIUM IODATE AND METHOD OF OPERATING A GAS GENERATOR

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ABSTRACT OF THE DISCLOSURE

Compacted ammonium iodate or compositions having ammonium iodate and an organic polymeric binder are used as gas generating compositions that produce gas without solid decomposition products. The gas produced is used in small gas-driven turbines as auxiliary power sources in the field of rocketry.

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

This invention relates to gas generators and more particularly to gas-generating compositions based on ammonium iodate and to a method of operating small gas-driven turbines and the like.

In the field of rocketry, an auxiliary power source is needed on-board the rocket-propelled device for operation of guidance and control systems while in flight. One such power source is small turbines driven by exhaust gases produced by a burning solid propellant composition.

Unlike solid propellants for rocket engines, a gas-generating composition for driving these small turbines should burn at a relatively low temperature and at a slow rate. A flame temperature below 1500° F., and preferably 900 to 1300° F. is desired to avoid overheating and to minimize thermal insulation requirements. A burning rate below rate below .05 inch per second is needed to provide a constant gas supply over an extended period during the flight of the missile. Other characteristics required in the gas-generating composition are low toxicity of exhaust products and low infra-red attenuation by exhaust products to avoid interference with command guidance signals.

Various compositions such as double-base propellants, ammonium-nitrate composite propellants and compacted hydrazine bisborane have been employed, but serious disadvantages are presented in the use of these materials. Conventional double-base and ammonium-nitrate composite propellants burn too rapidly and at too high a temperature, and their exhaust products exhibit a high degree of infrared attenuation. Hydrazine bisborane, while satisfactory for some applications, is relatively expensive, and its exhaust products include solid boron nitride particles, which require removal by filtering.

It is therefore an object of this invention to provide an improved gas-generating composition.

Another object is to provide a gas-generating composition which burns at a relatively low temperature and at a slow rate.

Still another object is to provide a gas-generating composition which does not produce any solid decomposition products.

Yet another object is to provide an improved method of operating a gas generator.

Other objects and advantages will be apparent from the following detailed description.

In the present invention, compacted ammonium iodate or compositions comprising ammonium iodate and a binder are used as gas generants. Ammonium iodate decomposes at a relatively low temperature, evolving a

gaseous mixture ideally suited for driving small turbines in a missile system. The burning characteristics of this material and the properties of its exhaust gases avoid the disadvantages of previous gas generants.

Ammonium iodate, NH_4IO_3, is a white solid, normally available in the form of a crystalline powder. It decomposes at a temperature approaching its melting point (150° C.) and produces a steady flame having a temperature of about 970° F. The burning rate of a compacted body is less than 0.05 inch per second. Decomposition to produce gaseous nitrogen, water vapor and hydrogen iodide proceeds as follows:

$$2NH_4IO_3 \rightarrow N_2 + 3H_2O + 2HI$$

For application wherein a relatively low degree of structural integrity is required in the gas generant, for example, in an end-burning charge, the ammonium iodate may be employed in the form of a compacted body without any additive or binder. Such a body can be prepared by compressing the powder material at a pressure of 5,000 to 10,000 pounds per square inch.

For applications requiring more strength in the charge, for example, in a star-perforated charge, an organic polymeric binder is provided in the gas-generating composition. Any of the conventional organic polymeric binders for solid fuels can be used for his purpose. Examples of suitable binders are the co-polymers of polybutadiene and acrylic acid, carboxyl-terminated polybutadiene, epoxy resins, liquid polysulfides and nylon. A proportion of 12 to 20 weight percent of binder is preferred in this embodiment. The binder-containing composition is prepared by methods previously used for solid fuels. Ammonium iodate is thoroughly mixed with the liquid polymeric constituents to obtain a viscous slurry. The slurry can normally be cast into the desired charge configuration and cured to obtain a high-strength, rubber-like solid. If the mixture is too viscous to pour, press-loading techniques may be used.

In another embodiment of the present invention, a minor proportion of an oxidizer is provided in the gas-generating composition. Any of the previously used solid fuel oxidizers such as ammonium nitrate, ammonium perchlorate and hydrazine nitrate may be incorporated in the pressed compact or binder-containing solid at a proportion up to 20 weight percent. This embodiment allows the use of less expensive material for a portion of the charge without unduly increasing the burning rate or flame temperature. Higher proportions would result in unfavorable burning characteristics.

No alteration in conventional gas-generating apparatus is necessitated by the present invention. In its simplest application all that is required to utilize the invention is to substitute the compacted ammonium iodate or other composition described above for the presently used composition. In general, an end-burning charge design with a low exposed surface area is preferred in order to maintain a relatively low burning rate, and thus minimize the excess pressure which builds up during operation. Where desired, cylindrical or star-shaped perforations can be obtained by insertion of a rod or other projection during the appropriate step of the fabrication procedure.

The present gas-generating charge can be ignited in the conventional manner. An igniter such as a squib or hot-wire is placed in contact with the charge, and upon firing the igniter, self-sustaining decomposition of the gas-generating charge occurs.

This invention is further illustrated by the following examples.

EXAMPLE I

An ammonium iodate pellet was formed by compressing 100 grams of powdered material in a 2-inch pipe

having a nozzle with a ⅛-inch opening at one end. The pellet was ignited by means of a hot wire. The pressure in the pipe, as measured by a pressure transducer increased to 200 to 300 pounds per square inch. Decomposition of the ammonium iodate proceeded smoothly over a period of 30 to 120 seconds.

EXAMPLE II

The burning rate of an ammonium iodate strand was determined by the following procedure. A strand ¼ inch by ¼ inch by 8 inches long was prepared by extrusion. The strand was inserted in a pressure vessel, and a nitrogen atmosphere at a pressure of 1000 pounds per square inch was provided in the vessel. The strand was ignited by a hot-wire, and the burning rate was determined photographically to be .03 inch per second.

The pressure in the system was also measured and the pressure exponent, that is, the percent increase in pressure per degree increase in temperature, was determined to be 0.025. This pressure exponent is favorable in that abnormal buildup of pressure during operation is minimized and less strength is required in the containment vessel.

The above examples are merely illustrative and are not to be understood as limiting the scope of this invention which is limited only as indicated by the appended claims. It is also to be understood that variations in composition and method of using the present gas-generant may be employed by one skilled in the art without departing from the scope of the invention.

I claim:

1. A gas-generating composition for producing gas without solid decomposition products, said composition

comprising a cured mixture of 12 to 20 weight percent of an organic polymeric binder, said binder being compatible with ammonium iodate, and the balance ammonium iodate.

2. The composition according to claim 2 wherein said organic polymeric binder is selected from the group consisting of the co-polymer of polybutadiene and acrylic acid, carboxyl-terminated polybutadiene, epoxy resins, liquid polysulfides and nylon.

3. The composition according to claim 2 wherein an oxidizer is provided in said mixture at a proportion up to 20 weight percent.

4. The method of operating a gas generator for producing gas without solid decomposition products and whereby large quantities of gas are produced, said method comprising heating compacted ammonium iodate to the decomposition temperature thereof.

5. The method of operating a gas generator for producing gas without solid decomposition products which comprises heating a composition comprising a cured intimate mixture of 80 to 88 weight percent ammonium iodate and 12 to 20 weight percent of an organic polymeric binder, said binder being compatible with ammonium iodate.

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