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METHOD FOR INITIATING THE COMBUSTION OF HYDRAZINE

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Our invention relates to the ignition of monopropellant hydrazine by means of solid materials which are spontaneously reactive with hydrazine.

It is known in the art that hydrazine possesses utility as a liquid propellant for rockets and other applications. Its use as a bipropellant with liquid oxidizers such as nitric acid or hydrogen peroxide has been under investigation for several years. With such oxidizers hydrazine displays excellent self-igniting characteristics. In fact, hydrazine has been employed as a starting fuel to ignite such fuel systems as gasoline-nitric acid by injecting a small quantity of hydrazine into the rocket motor along with or ahead of the main fuel system during start-up.

The use of hydrazine as a monopropellant presents a special ignition problem. An external source of energy may be used to initiate the monopropellant decomposition reaction. This would include an electric spark or glow-plug system, or injection of a liquid oxidizer during start-up.

Solid materials which display satisfactory self-ignition characteristics with hydrazine have advantages, over other ignition methods, when used for the ignition of monopropellant hydrazine in certain applications as monopropellant rockets, gas-generators, or liquid propellant guns.

Silver salts are reduced by hydrazine, and their reaction with hydrazine is usually more rapid than equivalent salts of other common metals. In accordance with our present invention, we have discovered that the silver salts of oxidizing acids are reduced by hydrazine, and the presence of the oxidizing radical simultaneously produces a vigorous oxidation of the hydrazine with the liberation of energy. This overall reaction produces a flaming or explosive ignition of the hydrazine. The presence of the silver ion alone, or the oxidizing radical alone, is not sufficient to produce the ignition reaction described.

We have tested the following silver compounds and have found them to be effective in producing flaming ignition of hydrazine and various hydrazine propellant mixtures: $AgClO_2$, $AgClO_3$, $AgClO_4$, $AgBrO_3$, $AgNO_2$, $AgNO_3$ and Ag_2CrO_4. Thus, one aspect of our invention is a combustible mixture containing hydrazine and also containing a silver salt of an oxidizing acid as a combustion initiator for the hydrazine, and another aspect of our invention is a new method for initiating combustion of hydrazine by admixing the hydrazine with one of the aforementioned silver salts.

In order to test the utility of various silver compounds as ignitors for hydrazine, we performed a series of tests involving dropping a small quantity of hydrazine or hydrazine-containing mixture onto small samples of such compounds in air. The reaction was observed visually. Table I sets forth the results obtained using a variety of silver compounds with three different hydrazine-containing mixtures.

Table I

Sample	93% N_2H_4, 2% H_2O	68% N_2H_4, 30% $N_2H_5NO_3$, 2% H_2O	62% N_2H_4, 30% $N_2H_5NO_3$, 8% H_2O
$AgClO_2$	Yes	Yes	Yes.
$AgClO_3$	Yes	Slow	Slow.
$AgClO_4$	Yes	Yes	Yes.
$AgBrO_3$	Detonates	Yes	Slow.
$AgIO_3$	No		
$AgNO_2$	Yes	No	
$AgNO_3$	Yes	No	
Ag_2CrO_4	Yes	Yes	No.

NOTE.—"Yes" indicates prompt flaming ignition. "Slow" indicates flaming ignition after slight delay.

We have also conducted numerous tests in a small caliber gun in which monopropellant hydrazine charges have been ignited successfully by the injection into the gun chamber of very small quantities of the silver salts employed in accordance with our invention, particularly silver chlorate, silver perchlorate and silver bromate. In these tests the weight of the salt amounted to approximately 1 percent of the total charge in the gun chamber.

Our invention finds utility in any case where an ignitor is used in conjunction with monopropellant hydrazine, for example, rockets, gas generators and liquid propellant guns. For instance, in the ignition of a hydrazine monopropellant gas generator of the fixed catalyst bed type, a generator having a catalyst bed containing a silver salt useful in our invention either as a top layer, dispersed through the bed, or at some other suitable location, will be self-starting upon contact of the hydrazine with the silver salt. This type of starting is satisfactory for a "single-shot" application where the generator is to be operated only once, as in a rocket or guided missile.

Our invention can also be employed in a caseless liquid monopropellant hydrazine gun. In a liquid propellant caseless gun in which the propellant is pumped directly into the gun chamber, some separate source for ignition is required, since elimination of the shell case also eliminates the conventional primer. If the ignitor material is injected into the chamber to accomplish ignition of the monopropellant charge, it is likely that a liquid ignitor would be more suitable than a solid ignitor material. However, if the ignitor charge were to be carried in or on the base of the projectile, or in some other similar arrangement, it is likely that a solid ignitor would be more suitable than a liquid. A small charge of one of the solid silver salts which we use can be employed in such an arrangement, causing ignition when it is contacted with the hydrazine charge.

We claim:

1. A method for initiating the combustion of hydrazine which comprises reacting the hydrazine with a solid silver salt of an oxidizing acid to produce a flaming ignition of the hydrazine, the reaction system consisting essentially of the reactants and the resultants of reaction.

2. A method according to claim 1 in which said silver salt is silver chlorite.

3. A method according to claim 1 in which said silver salt is silver chlorate.

4. A method according to claim 1 in which said silver salt is silver perchlorate.

5. A method according to claim 1 in which said silver salt is silver chromate.

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