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[54] **NON-CARBON FORMING MONOPROPELLANT PROCESS USING A LOWER ALKYLHYDRAZINE AND AMMONIA**

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[51] **Int. Cl.** **C06d 5/04,** C06d 5/08

[58] **Field of Search** ...149/36, 109; 60/205, 218, 219

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[57] **ABSTRACT**

A monopropellant comprised of an alkyl hydrazine containing either ammonia or hydrazine, or both additives in an amount sufficient to prevent the formation of solid carbon as a combustion product from the decomposition of the basic material.

9 Claims, No Drawings

NON-CARBON FORMING MONOPROPELLANT PROCESS USING A LOWER ALKYLHYDRAZINE AND AMMONIA

It is known that certain alkyl hydrazines, for example, monomethyl hydrazine, are suitable monopropellants. That is, they will sustain combustion without an oxidizer in the presence of a catalyst bed, for example, to give a high performance. Application of such a monopropellant is found for liquid rocket propulsion systems, as a working gas for turbine drives, tank pressurization, and auxiliary thrust control units. The problem encountered in the previous attempted use of such alkyl hydrazines as monopropellant resided in the formation of solid carbon deposits. A significant amount of carbon is formed in the decomposition of the alkyl hydrazines to the degree that a catalyst bed so covered by the deposit could extinguish the combustion. Additionally, the carbon particles ejected from a combustion chamber could present an undesirable smoke or coat associated equipment against which the gas was directed.

Others who have recognized the problem with regard to the formation of carbon deposits in a monopropellant system, as described, have attempted to prevent this occurrence through the addition of oxygen sources, with the hope of converting the carbon to CO gas prior to it being deposited. However, the sources of oxygen such as water and other materials have produced higher than desired flame temperatures and gave poor impulse performance of the propellant. In other words, prior attempts to eliminate the carbonaceous deposit resulted in significantly affecting the performance of the monopropellant fuel so as to often make it unsuitable for its desired purposes. As can be seen, the herein invention forms methane, CH_4, as a gaseous product, tying up all of the carbon present in the starting composition. The methane is stable at the operating conditions of the system so that it will not break down to give the carbonaceous deposit, but rather will be emitted as a gas from the combustion chamber.

Thus, it is an object of this invention to present a novel monopropellant system for use as a source of gas where virtually no carbon deposits are formed during the combustion thereof.

A further object of this invention is to provide a method of producing thrust in a reaction motor which employs as a monopropellant an alkyl hydrazine containing a suitable additive to prevent the formation of carbonaceous deposits upon combustion.

Still another object of this invention is to provide a novel monopropellant system which does not form carbonaceous deposits upon combustion yet has a vapor pressure less than 250 psi at 165° F. and a critical point above 200° F. so as to be useful in applications where higher temperatures could be encountered.

Still another object of this invention is to provide novel monopropellant systems which do not form carbonaceous deposits upon combustion and have a freezing point of less than −65° F. such that the propellant will operate in space environments where low temperatures are found.

The herein invention applies to alkyl hydrazines as monopropellants selected from the class consisting of monomethyl hydrazine, MMH, and ethylene dihydrazine, EDH.

It has been found that when these two hydrazine compounds react with either ammonia, hydrazine, or both, in certain percentages the reaction products formed thereby are CH_4, N_2 and H_2, with virtually no solid carbon particles resulting. The amount of additive material, namely ammonia, hydrazine, or both, required to achieve the production of the foregoing gases without any solid carbon being formed is dependent upon the chamber pressure in which the reaction occurs. It has been found for example that at 100 psi chamber pressure, 16 weight percent ammonia is required to prevent the formation of carbon, while 60 weight percent of the composition of hydrazine is required if hydrazine alone is used. Alternatively, at 1,000 psi chamber pressure, only 8.7 weight percent of ammonia is required, and when only hydrazine is utilized, 30 weight percent is needed. Thus, it can be seen that at 1,000 psi approximately half the amount of either additive should be present to achieve the desired end result.

Ammonia is a particularly desirable additive to achieve a lowering of the freezing point of the composition where such is desired, yet the impulse of the propellant system will decrease somewhat. Alternatively, there is no decrease in performance of the propellant system utilizing hydrazine. However, the freezing point is not lowered to the degree when ammonia is the additive. Thus, often it is desirable to use mixtures of both ammonia and hydrazine to obtain a balance of the desired properties. For example, as will be seen from the following table, various admixtures of the ammonia and hydrazine will suffice to achieve the results. It is to be noted, as seen from Table I, that the amount of ammonia required, for example, to prevent the formation of the carbonaceous deposit decreases in approximately a straight line function in accord with the additional amount of hydrazine added to the ternary mixture.

TABLE I

Chamber Pressure 100 psi			Chamber Pressure 1000 psi		
Compositions in Wt. Percent					
MMH or EDH	Ammonia	Hydrazine	MMH or EDH	Ammonia	Hydrazine
84	16	0	91.3	8.7	0
76.6	13.4	10	84.3	5.7	10
69.2	10.8	20	77.2	2.8	20
62.0	8.0	30	70	0	30
54.6	5.4	45			
40.0	0	60			

At a chamber pressure of 3,000 psi only 3 weight percent of ammonia is required to achieve the prevention of formation of carbonaceous deposits, while only 10 weight percent of hydrazine alone is required. If 3,000 psi is chosen as the maximum potential chamber pressure, then the range of ammonia needed within this invention for range of 100 psi to 3,000 psi would obviously be from 3 to 16 weight percent. Alternatively, if hydrazine alone is the additive within the pressure range stated, from 10 to 60 weight percent is required.

It is believed the invention will be better understood from the following detailed examples, in which a pressure fed gas generator was utilized. The gas generator was a stainless steel chamber having a single jet injector

and a square shouldered orifice for a nozzle. A catalyst bed was utilized in the generator, comprising 180 grams of a transitional metal oxide catalyst which was an HA-3 catalyst (Harshaw Chemical Co., Catalyst N1 1601 T 1/8" LA 51-494 5-1). Ignition was accomplished by a hypergolic start utilizing 5 grams of iodine pentoxide, I_2O_5 . The reaction after the start was then self-sustaining. In all of the examples, the flow rate of the propellant was 0.01 pound per second.

EXAMPLE I

A propellant mixture of 89 weight percent monomethylhydrazine and 11 weight percent ammonia was injected into the gas generator chamber. The chamber pressure achieved was 700 psi. After a run of 75 seconds, the combustion was stopped and the catalyst bed analyzed by conventional metallurgic techniques for carbon deposited on the surface thereof. Analysis indicated a 0.10 weight percent of the catalyst bed was carbon. Under the same conditions, monomethyl hydrazine alone without additives produced 3 weight percent carbonaceous deposits on the catalyst bed. During this example the catalyst bed achieved a measured temperature of 1,300° F.

EXAMPLE II

In order to obtain a higher temperature on the catalyst bed, the chamber was insulated with a phenolic liner. This served to raise the catalyst temperature during operation to 1,640° F. The monopropellant injected comprised 60 weight percent monomethyl hydrazine and 40 weight percent hydrazine. The chamber pressure was 700 psi. A glass wool filter in a steel chamber was connected to the exit of the reaction chamber to collect the carbonaceous deposits blown off the catalyst bed. Inspection of the bed after a run of 75 seconds indicated that there was no carbon formed thereon. Thus, it was assumed that all of the carbon resulting from the run was collected in the filter. Only 0.50 percent of the theoretical amount of carbon in the propellant was collected on the filter. To indicate the accuracy of this determination, which is based upon the theoretical amount of carbon present, it is important that the reaction did proceed as predicted. To confirm this, the flame temperature was measured during the run and was determined to be 1,640° F., ± 10° F. This compared accurately with the theoretical flame temperature for the combustion of the mixture which was 1,640° F. At the foregoing conditions, it was calculated that monomethyl hydrazine alone as a monopropellant would yield a carbonaceous deposit equivalent to 28 percent of the theoretical amount of carbon present in the compound.

EXAMPLE III

The same conditions as described in Example II were repeated. However, the fuel comprised 70 weight percent monomethyl hydrazine, 20 weight percent hydrazine, and 10 weight percent ammonia. A chamber temperature of 1,500° F. was achieved. The amount of carbon collected in the filter was 0.80 percent of the carbon theoretically present in the starting propellant.

In the above examples having an ammonia additive, the freezing point of the propellant was less than −65° F. The vapor pressure of the starting monopropellants was less than 250 psi at 165° F. and all of the compositions has a critical point above 200° F. Though the specific examples related to the use of monomethyl hydrazine, equally good results are obtainable when the monopropellant is ethylene dihydrazine.

Though the detailed description of the invention in the specific examples sets forth a particular catalyst bed and hypergolic igniter, it should be readily apparent to those skilled in the art that the invention is not in any way limited to these particular components set forth. Neither the catalyst bed used to sustain the combustion of the monopropellant nor the igniter form part of the herein invention and substitution of conventional known materials is contemplated within the realm of this invention.

We claim:

1. A monopropellant composition comprising:
a lower alkylhydrazine, and ammonia present in an amount up to 16 weight percent sufficient to prevent formation of carbonaceous deposits upon combustion of the monopropellant.

2. The composition of claim 1 wherein said alkylhydrazine is selected from the class consisting of monomethyl hydrazine and ethylene dihydrazine.

3. The composition of claim 1 including hydrazine present in an amount up to 60 weight percent of the composition, said hydrazine contributing to the prevention of carbonaceous deposits upon combustion of the monopropellant composition.

4. The composition of claim 1 wherein the ammonia is present in an amount of 3 to 16 weight percent of the composition.

5. The method of claim 4 wherein said alkylhydrazine is selected from the class consisting of monomethyl hydrazine and ethylene dihydrazine.

6. A method of producing thrust in a reaction motor without formation of carbonaceous deposits comprising:
providing a monopropellant composition made up of a lower alkylhydrazine, and ammonia with the ammonia present in an amount up to 16 weight percent sufficient to prevent formation of carbonaceous deposits upon combustion of the monopropellant composition, and
burning said composition in a reaction motor.

7. The method of claim 6 wherein the monopropellant composition includes hydrazine present in an amount up to 60 weight percent of the composition, said hydrazine contributing to the prevention of carbonaceous deposits.

8. A method in accordance with claim 6 wherein the ammonia is present in an amount of 3 to 16 weight percent of the composition.

9. A monopropellant composition comprising:
an alkylhydrazine selected from the class consisting of monomethylhydrazine and ethylenedihydrazine,
ammonia,
hydrazine,
said ammonia and hydrazine being present in a combined amount sufficient to prevent the formation of carbonaceous deposits upon the combustion of said alkylhydrazine,
the ammonia can vary up to 16 weight percent of the

composition, while the hydrazine can vary up to 60 weight percent of the composition,

wherein as the amount of hydrazine increases, the amount of ammonia required to prevent the formation of carbonaceous deposits decreases, and wherein as the amount of ammonia increases the required amount of hydrazine decreases.

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