United States Patent Office 2,954,284 Patented Sept. 27, 1960

2,954,284

FUEL COMPRISING A MIXTURE OF AMMONIUM NITRATE AND METAL PARTICLES

Harry A. Toulmin, Jr., Dayton, Ohio, assignor to The Commonwealth Engineering Company of Ohio, Dayton, Ohio

No Drawing. Filed Feb. 13, 1958, Ser. No. 714,942

4 Claims. (Cl. 52—.5)

This invention relates to improved fuels and methods of increasing the calorific value of fuels. The invention is particularly useful in providing a fuel which is composed of metal particulates such as substances which are decomposable to release large volumes of gas heated to high temperatures.

The principal object of the invention is to provide a solid fuel which forms a suitable burning mixture useful as propellants, missiles, rockets, power plants, etc., and which may be used as a fuel for jet-driven airplanes, turbines, and the like, as employed in the fields of aviation, rail transportation and military equipment and operations.

It is another object of the invention to provide a composition useful as fuel which is adapted to burn at a non-explosive rate and produce a large amount of gases.

It is a further object of the invention to provide a powdered fuel mixture which can be used in the form of a slurry or admixed with liquid hydrocarbons, and which releases a large amount of exothermic heat upon burning.

A still further object of the invention is to provide a method for carrying out the combustion of powdered metal fuel mixtures of the character described which supply or release a sufficient amount of oxygen to maintain the combustion of the mixture once it is initiated.

The invention utilizes ammonium nitrate as one of the principal constituents and which decomposes to release nitrous oxide and water as steam.

Ammonium nitrate when heated, as shown below, decomposes in accordance wtih the equation—

$$NH_4NO_3 \xrightarrow[200\text{–}260^\circ\ C.]{\text{heated}} \underset{N_2O}{\text{Gas}} \quad \underset{2H_2O}{\text{Steam}}$$

The reaction may be carried out safely and even when the reaction is rapid it is controlled by the burning mixture. The heat developed, being an exothermic reaction, is sufficient to decompose the nitrous oxide into nitrogen gas, and oxygen, two volumes of nitrogen being formed and one volume of oxygen.

The ammonium nitrate is finely divided prills and dried as follows—

Example I

Ammonium nitrate used in the propellent fuel preferably is of fertiziler grade and consists of prills which are free-flowable, and substantially free of moisture, the prills being ground to a particulate size of 1 to 10 microns.

The ammonium nitrate is dried at a temperature of approximately 90° F. to prevent physical change until the moisture contact is reduced to about 0.1% by weight.

Control of the burning is provided by limiting the size of the nitrate particles, the burning rate increasing as the particulates are decreased in size. In this way by selective use of different size particulates the rate of burning of the fuel may be varied and controlled.

Examples of the powdered metal fuel containing ammonium nitrate are illustrated below, it being understood

that the proportions may be varied 5–10% either way to produce a powdered metal fuel mixture in accordance with applicant's invention.

Example II

	Parts by weight	Range
	Percent	
Ammonium nitrate (Dry Ex. I)	80	70–90
Metal particles (Al, Mg, Zn)	20	10–30

Example III

	Parts by weight	Range
	Percent	
Ammonium nitrate (Dry Ex. I)	70	60–80
Metal Particles (Al, Mg, Zn)	15	10–20
Metal soap (Aluminum stearate)	15	10–20

In preparing the powdered metal mixture, ammonium nitrate is admixed with the metal particulates. The metal particulates are relatively small particle size and on the order of one-half to one micron, with particle size of less than one micron in diameter preferred. The mixture of ammonium nitrate and metal powder may be suitably compressed and used as a solid block fuel or used as a slurry mass by adding hydrocarbon liquids such as kerosene or an aromatic alkane in amounts from 10 to 30% by weight of the total mixture.

In Example III, a small amount of metallic soap is incorporated with the metal powder to catalyze its oxidation. The metal soap may be admixed into the fuel as a powder or melted and sprayed onto the metal particulates, the latter method being preferred since a more uniform distribution of the soap in the fuel is obtained. The metallic soaps employed are preferably selected from the polyvalent metals consisting of aluminum, magnesium, zinc; fatty acid esters of these metals, e.g., the metal stearates, palmitates, oleates and ricinoleates and the like are employed. One readily available commercially is aluminum stearate.

This metallic soap catalyzer may approximate the weight of the metal particulates or range downward to 50% of the metal content of the fuel, depending upon the temperature of burning desired. For higher burning temperatures of the propellent gas larger amounts of metal particulates are used.

It has been found by tests that the combination of the metal particles with the ammonium nitrate when heated to burning in air releases large quantities of nitrogen, oxygen and gases heated to very high temperatures and on the order of 5000° C. and higher. The powdered metal particles along, such as aluminum metal, burn at a temperature of around 3500° C. and produce an intense heat. The high temperatures produced during burning of the metal particles causes rapid decomposition of the admixture and release of large volumes of gases. Vaporization of any water formed during the reaction forms steam, which is decomposed into hydrogen and ozygen at the high temperature of the burning metal.

Metal particulates are preferably selected from the light metal group and consisting of aluminum, magnesium, zinc, tin and the like or mixtures thereof. The presence of metallic soap catalyzes the burning so that the same takes place at a uniform rate and yet is under sufficient control so that the fuel does not explode but provides a continuing expanding gaseous force useful as a propellant or propulsion jet prime mover.

The rate of combustion or burning of the mixture is varied by varying of the proportionate amounts of the constituents and particulate size of constituents.

Ignition of the fuel mixture may be achieved by electrical means such as that produced by a spark plug or by the heating of a wire to incandescence in contact with the mixture.

It is understood that various changes and additions in equivalent materials may be substituted for those set forth in the above examples when compounding the composition of this invention and that the proportionate amounts of the constituents may be varied, as heretofore described, and depending upon the particular use to which the mixture is to be put. Such changes and variations are deemed to be contemplated to come within the spirit and scope of this invention and which are particularly set forth in the appended claims.

What is claimed is:

1. A fuel consisting of the following constituents in parts by weight:

	Percent
Ammonium nitrate	70
Metal particles selected from the group consisting of aluminum, magnesium and zinc and mixtures thereof	15
Aluminum stearate	15

said metal particles having a size on the order of one-half micron to one micron in diameter.

2. A fuel consisting of the following constituents in parts by weight:

	Percent
Ammonium nitrate	70
Metal particles of aluminum	15
Aluminum stearate	15

said aluminum metal particles having a size on the order of one-half micron to one micron in diameter.

3. A fuel consisting of the following constituents in parts by weight:

	Percent
Ammonium nitrate	70
Metal particles of magnesium	15
Aluminum stearate	15

said magnesium metal particles having a size on the order of one-half micron to one micron in diameter.

4. A fuel consisting of the following constituents in parts by weight:

	Percent
Ammonium nitrate	70
Metal particles of zinc	15
Aluminum stearate	15

said zinc metal particles having a size on the order of one-half micron to one micron in diameter.

References Cited in the file of this patent

UNITED STATES PATENTS

1,506,322	O'Neill	Aug. 26, 1924
2,159,234	Taylor	May 23, 1939
2,416,639	Pearsall	Feb. 25, 1947
2,477,549	Van Loenen	July 26, 1949
2,530,493	Van Loenen	Nov. 21, 1950

OTHER REFERENCES

43rd Report National Advisory Committee for Aeronautics (1957), pages 2–4.

Chem. and Eng. News (II), Jan. 6, 1958, pages 79–81.

Chem. and Eng. News (I), May 27, 1957, pages 22–3.