United States Patent Office 3,154,448 Patented Oct. 27, 1964

3,154,448

DINITROPOLYSTYRENE EXPLOSIVE COMPOSITION

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No Drawing. Filed Nov. 28, 1961, Ser. No. 155,498
4 Claims. (Cl. 149—19)

This invention relates to nitropolystyrene and explosive compositions made therewith.

The invention comprises, more particularly, nitrated isotactic polystyrene, nitrated isotactic or atactic polystyrene and either of these forms or other nitrated isomeric polystyrenes compounded with a stabilizer, nitrated plasticizer, oxygen donor, or a material to be disseminated by explosion of the nitrated polystyrene.

The compositions of this invention are distinguished by a velocity of detonation that lies in a range hereto not supplied, e.g., about 2,000 m./sec. for the dinitro compound. This is far above that of standard explosive mechanical mixtures of combustible and oxidizing components such as black powder (about 400 m.) but far below the velocity of TNT and like nitro-explosives (4,000–8,500 m.). This slower rate, we consider, may be due to the molecular structure of our nitropolystyrene. For a given degree of nitration, the explosive force of nitropolystyrene, on the other hand, is strong as compared, for instance, with nitrated toluene. Thus our dinitropolystyrene in the metal plate test for brisance gives a penetration equal to or in excess of that given by trinitrotoluene.

Our dinitropolystyrene melts above 260° C. as compared with melting temperatures within the range about 52°–70° C. for the dinitrotoluenes and 80°–112° C. for the various isomeric trinitrotoluenes.

The nitrated polystyrene, either alone or compounded, may be formed into blocks, i.e., shape retaining plastic-bonded explosives that can be molded into variously formed masses to fit spaces in which the explosive is to be set and then fired. Such are the recesses in rivets that are to be expanded by firing explosive in the said recesses.

As to materials, we obtain the benefits stated and also high density, causing more of the explosive to be insertable into a given drill hole or other space, when we use isotactic polystyrene as the material to be nitrated. When the necessary features of the finished explosive can be provided by admixtures, then we nitrate the usual more conventional form of polystyrene as, for example, any commercial polystyrene. Either of the polystyrenes after nitration and purification by washing may be blended with a nitrated C_1–C_5 polyol plasticizer as, for example, nitroglycerine of dynamite grade, mono- or dinitroglycol, or dinitropentaerythritol in the proportion of 10–50 parts for 100 of the nitrated polystyrene.

A convenient acid for nitrating the polystyrene is mixed nitric and sulfuric acids with substantial sulfur trioxide content. We nitrate to an average nitrogen content corresponding approximately to mono- or dinitropolystyrene, the latter having two NO_2 groups for each monomeric styrene unit (wt. 104) represented in the polymer. As the stabilizer to decrease the autocatalytic decomposition of the nitropolystyrene, if desired, we use one of the organic acceptors of acid so as to reduce the pH that otherwise would result as acid is liberated by slow decomposition. Examples of such acceptors to be used are nitrogen bases, that is, salt formers with acids such as diphenylamine, tetramethylaniline, and urea.

As to the component to modify the explosive properties of the nitropolystyrene, we may use ammonium nitrate, sodium or potassium nitrate, trinitrotoluene or the like. The component may be admixed but for many purposes such as explosive blocks should be bonded by the thermoplastic nitropolystyrene into a firm, shape retaining mass or block.

The stabilizer is used to advantage in the amount of about 0.1–2 parts for 100 part of the nitropolystyrene.

The proportion of the component which is admixed for increasing the explosive force per unit of the nitropolystyrene, when such increase is desired, is within the range 50–400 parts for 100 parts of the nitropolystyrene. When the said component is TNT, then the amount may be varied over a wider range as for example 10–500 parts of the TNT for 100 parts of the nitropolystyrene. The nitrated polystyrene is effective as a disseminating and bonding agent for the admixed components. Thus a composition containing 20% of the nitropolystyrene and 80% of either ammonium nitrate or TNT constitutes a composition that is moldable at the temperature of softening of the composition and that sets on cooling below 170° and 80° C., respectively, to a firm block.

The invention will be further illustrated by description in connection with the following specific examples of the practice of it. In these examples and elsewhere herein proportions are expressed as parts by weight.

Example 1

Dinitro-isotactic-polystyrene is made as follows:

Fifty parts of isotactic polystyrene, made as described by Natta in Die Makromalekulare Chemie, vol. 16, pp. 213–237 (1955), and elsewhere, is gradually added with stirring to a mixture of 450 parts of nitric acid of specific gravity 1.50, 200 parts of sulfuric acid of sp. gr. 1.84 and 100 parts of sulfur trioxide, the latter being dissolved in advance in the sulfuric acid. The temperature of the mixing during the introduction and solution of the polystyrene is maintained at 15°–20° C. by external cooling. After all of the polystyrene has been introduced and dissolved, the temperature is raised to 50°–55° C. and kept within that range for 2 hours.

The resulting mixture of nitro-isotactic-polystyrene and spent acids is cooled to 25° C. and poured into approximately 5,000 parts of cold water. This precipitate is separated from the aqueous phase by decantantion, washed with cold water, and finally with a dilute solution of sodium carbonate and ammonium hydroxide until the washings are not acidic to Congo red.

The product is dried at 80° C., to a firm hard relatively dense solid. Stabilizers are not necessary for the nitrated isotactic product. The stabilizers and/or other compounding ingredients shown herein may be admixed, however, as in the proportion of 0.5 part of the stabilizer and 200 parts of the nitrate or TNT component for 100 parts of the nitropolystyrene.

Example 2

The procedure and compositions of Example 1 are used except that the polystyrene used for the nitration is the commercial atactic polystyrene of molecular weight about 80,000. The yield of the washed and dried product is 70 parts or 99.5% of theory on the basis of the polystyrene used.

The product starts to decompose on heating gradually at 260° C. and is not fully melted at temperatures as high as 300° C. The nitrogen content is 14.2%. The theory is 14.3% for dinitropolystyrene having 2 NO_2 groups for each monomeric styrene unit.

In testing, the dried dinitropolystyrene is loaded into aluminum cups 11/16 inch in diameter and 7/8 inch deep, pressed therein by hand, and then equipped with detonating means including a conventional detonating cap assembly. The whole is then placed on a 1/4 inch steel plate

supported on a steel ring, with the dinitropolystyrene resting on the steel plate. The charge is fired and the depth of penetration of the steel plate noted and compared with the penetration caused by firing an equal volume of TNT, in a comparable assembly. The results follow:

Explosive	Overall Density of Explosive, g. per ml.	Depth of Penetration, inch
Dinitropolystyrene	0.65	0.145
Do	0.67	0.153
Trinitrotoluene	0.95	0.194

Corrected for its lower density, the dinitropolystyrene explosive on an equal weight basis shows a calculated brisance at least approximately equal to that of the more highly nitrated trinitrotoluene.

In spite of the high brisance, the dinitropolystyrene has a relatively low velocity of detonation, about 2,000 meters per second, as compared to about 4,700 for TNT at a density of 0.95 g./ml. This rate for our product adapts it especially for dispersing, to the right degree, materials mixed therewith that are to be disseminated into air.

Example 3

The procedure and composition of Example 2 are used except that the washed and dried nitropolystyrene is mixed with 0.5%–1% of its weight of each of the following stabilizers used separately and in turn: diphenylamine, tetramethylaniline and urea, to retard development of instability on storage.

Example 4

The procedure and composition of Example 2 are used except that the washed and dried nitropolystyrene is mixed thoroughly and in the amount of 100 parts with 100 parts of sodium nitrate and potassium nitrate used separately and in turn. The nitrate used supplies available oxygen during the explosion of the composition and thus promotes combustion to the stage of increased energy release and less smoking.

Example 5

The procedure and composition of Example 3 are used except that the washed and dried dinitropolystyrene is mixed thoroughly and in the amount of 100 parts with 500 parts of ammonium nitrate. The ammonium nitrate provides oxygen for the more nearly complete combustion of the dinitropolystyrene and also its own powerful explosive force.

Example 6

The procedure and composition of Example 5 are used except that the mixture so made is heated to the temperature of softening thereof, then molded to shape desired, and cooled to set the molded mass to firm condition. The dinitropolystyrene acts as an explosive bonding agent for the nitrate.

Example 7

The procedure and composition of Examples 5 and 6 are used, in turn, except that a liquefying agent is mixed with the dinitropolystyrene in the proportion of 20–50 parts for 100 parts of the dinitropolystyrene, to lower the temperature of softening of the explosive composition to moldable consistency.

This agent is a solvent when in liquid condition for the dinitropolystyrene, substantially non-volatile under the conditions of use, and chemically inert to all the components of the explosive composition. Examples of the agent that we use are dibutyl, dioctyl and dibenzyl phthalates; triphenyl and tricresyl phosphates; acetamide; and formanilide, any one of them being selected for use in this example and being admixed in the proportion of 40 parts for 100 parts of the nitrated polystyrene.

Example 8

An explosive is made as described in Example 2 but with admixing of each of the nitrated polyols disclosed earlier as plasticizer, separately in the proportion of about 10–50 parts by weight for 100 parts of the dinitropolystyrene. This admixing follows immediately after the nitropolystyrene has been dried. The whole is then warmed and stirred, to fuse and blend the composition.

The compositions so made are warmed to the temperature of softening of the mass, molded to desired shape as at 125°–200° C. and then cooled to give a firm mass in which the dinitrostyrene is the principal bonding agent.

In making these blends and in fact in making or handling the dinitropolystyrene itself, the usual precautions for hazardous explosives must be observed. These include, among the many other precautions, starting first with very small, gram quantities of the explosive material and continuing to work with such small amounts until the conditions that may be safely used have been determined repeatedly for each combination of components compounded.

It will be understood that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the purpose of illustration which do not constitute departures from the spirit and scope of the invention.

We claim:

1. An explosive composition comprising nitrated dinitropolystyrene; an admixed plasticizer therefor selected from the group consisting of nitroglycerine, mono and dinitroglycol and dinitropentaerythritol; an oxidizing component disseminated in the dinitropolystyrene and selected from the group consisting of nitrates of ammonium, sodium and potassium; and a stabilizer distributed therein and selected from the group consisting of diphenylamine, tetramethyl aniline and urea, the proportions by weight, for 100 parts of the dinitropolystyrene, being approximately 10–50 parts of the plasticizer, 50–400 parts of the oxidizing component, and 0.1–2 parts of the stabilizer.

2. An explosive composition comprising a fused and then cooled and solidified blend of dinitropolystyrene and ammonium nitrate in the proportion of about 50–400 parts by weight for 100 parts of the dinitropolystyrene, the dinitropolystyrene serving as a bonding agent for the nitrate.

3. An explosive composition comprising dinitropolystyrene and trinitrotoluene disseminated therein in the proportion of about 50–400 parts by weight for 100 parts of the dinitropolystyrene, the dinitropolystyrene serving as a bonding agent for the trinitrotoluene.

4. An explosive composition comprising dinitropolystyrene, an admixed plasticizer therefor selected from the group consisting of nitroglycerine, mono and dinitroglycol and dinitropentaerythritol, and a stabilizer distributed in the composition and selected from the group consisting of diphenylamine, tetramethyl aniline and urea, the proportions by weight being about 10–50 parts by weight of the plasticizer and 0.1–2 parts of the stabilizer for 100 parts of the dinitropolystyrene.

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