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1,966,090

GELATINIZED HIGH EXPLOSIVE
COMPOSITION

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9 Claims. (Cl. 52-13)

This invention relates to the preparation of gelatinized high explosives, and more particularly to the acceleration of the gelatinization of nitrocellulose with nitroglycerin and with nitroglycerin solutions of other aliphatic nitric esters. This application is a continuation in part of my co-pending application Serial No. 640,051, filed October 28, 1932.

Commercial gelatinized high explosives, which are commonly designated as gelatin dynamites, consist of nitroglycerin or other liquid nitric ester gelatinized with a nitrocellulose, for example nitrocotton, and incorporated with various other ingredients, such as oxidizing agents, carbonaceous combustible ingredients, acid-accepting materials, and the like. In the manufacture of such explosives, the mixture of nitrocotton and nitroglycerin is commonly gelatinized previous to the addition of the other ingredients.

The gelatinization of nitrocotton with liquid nitric esters takes place at varying rates depending on a number of factors; namely, (1) the temperature of the liquid explosive, (2) the nature and amount of nitrocotton used, and (3) the composition of liquid explosive employed, and other nitric esters present in solution in the nitroglycerin. The first two of the above factors, insofar as they are pertinent, may be readily controlled to give the most satisfactory rate of gelatinization. While the liquid nitric ester composition may likewise be controlled, so as to give the best possible gelatinization conditions, the choice of such compositions is commonly made for economic reasons and for the purpose of obtaining the desired freezing and other properties in the finished explosive, rather than to bring about the preferred rate of gelatinization. In other words, it is not always feasible to use the combination of nitric esters known to give the best gelatinization, and it therefore becomes necessary to develop new means for producing the desired physical properties of the gelatin with the nitric ester chosen.

In order to lower the freezing point of nitroglycerin and to obtain finished explosives that will remain unfrozen at the temperatures encountered during winter months, it is customary to dissolve various nitric esters in nitroglycerin, for example, ethylene glycol dinitrate, tetranitrodiglycerin, nitrated sugars, and the like. Nitroglycerin solutions containing ethylene glycol dinitrate are characterized by the property of very rapid gelatinization with nitrocotton. When nitroglycerin solutions of tetranitrodiglycerin are used, however, it is found that the gelatinization

is undesirably slow, and in many cases incomplete. When such insufficient gelatinization takes place, the finished explosive is unsatisfactory in properties, particularly with respect to exudation of the nitroglycerin on long storage.

Moran, in U. S. Patent 1,640,712, has attempted to improve the gelatinization of nitrocotton in nitroglycerin by the use of accelerants comprising aliphatic alcohols having greater solubility in nitroglycerin than that of glycerol. While such monohydric alcohols as methyl and ethyl alcohol are mentioned, preference was given by Moran to the glycols, and more particularly to trimethylene glycol. While the compounds claimed by Moran have some advantages as accelerants, they possess the disadvantage of relatively low solubility in nitroglycerin, which makes their use less satisfactory than would otherwise be the case.

The object of my invention is to provide a high explosive composition containing a gelatinized liquid nitric ester of improved quality. A further object is to provide such a composition, the gelatinization of which with nitrocotton has been accelerated with beneficial effect on the properties. An additional object is an improved process for bringing about the above accelerated gelatinization. Further objects will present themselves as the invention is more fully described hereinafter.

I have found that, when gelatin dynamites are produced containing tetranitrodiglycerin as a portion of the liquid explosive, the gelatinization is accelerated and more thoroughly gelatinized explosives result if there is incorporated with the nitric ester mixture and the nitrocellulose a small amount of a derivative of an aliphatic alcohol having at least two hydroxyl groups in its original structure, said derivative containing at least one unsubstituted hydroxyl group and at least one ether group.

Two types of compounds of the general structure described in the foregoing have been found to give very satisfactory results. The first type comprises the polymerized polyhydroxy alcohols. In this case, the ether group results from the condensation of two molecules of the same polyhydroxy alcohols, a carbon atom of one molecule being joined with a carbon atom of the other by means of an oxygen linkage. The second type consists of those compounds in which the ether group results from the joining of two carbon atoms from dissimilar alcohol groups by means of the oxygen linkage.

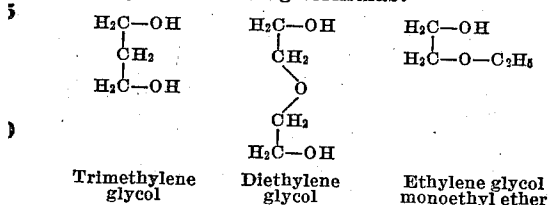
As examples of compounds of the first type, namely the polymerized polyhydroxy alcohols, I may cite diethylene glycol, triethylene glycol,

diglycerol, and the like. Preferably, however, as representative of this group of compounds, I employ diethylene glycol for the purpose of accelerating gelatinization. This compound is designated in Beilstein as β - β' -dioxy-diethylether.

As illustrative examples of compounds of the second type, which exert a marked accelerating action on gelatinization, I may cite mono- and diethylin, mono- and dimethylin, di-isopropylin, ditertiary butylin, di-isoamylin, epihydrin alcohol, and ethers of ethylene glycol, such as the monomethyl and monoethyl ethers, the monobutyl ether of diethylene glycol, and the like. While various of the compounds mentioned are suitable for use according to my invention and give desirable improvements in accelerating gelatinization, I prefer to use ethylene glycol monoethyl ether.

The heretofore cited derivatives of polyhydroxy alcohols have marked advantages over materials previously used for the acceleration of the gelatinization of nitrocotton in nitroglycerin.

As stated previously, trimethylene glycol and other alcohols used by Moran have only a limited solubility in nitroglycerin. The compounds covered by my invention, on the other hand, possess greatly increased solubility in liquid nitric esters, this increased solubility being probably due largely to the presence of the ether group, in addition to one or more hydroxyl groups. The presence of the modifying group in the accelerants, according to my invention, as compared to the trimethylene glycol used by Moran, is illustrated by the following formulas:



In the application of accelerants to the manufacture of explosives, varying amounts may be used, depending on the nature of the material and on the composition of the nitric ester mixture and its content of other aliphatic nitric esters. When ethylene glycol monoethyl ether is used as the accelerant, I introduce into the liquid explosive oil an amount of the accelerant between 0.1 and 8.0% of the amount of nitroglycerin used. Preferably, I use between 0.5% and 2.0% of the weight of the liquid explosive. Amounts between these limits give the most satisfactory results, when a nitroglycerin containing approximately 30% of tetranitrodiglycerin is used.

The following examples of gelatin dynamites containing accelerants covered by my invention may be given, (1) being of the straight gelatin type, (2) an ammonia gelatin in which ammonium nitrate has been substituted for a portion of the nitroglycerin in the explosive, and (3) a blasting gelatin.

	1	2	3
Nitroglycerin.....	32.0	25.0	90.0
Nitrocotton.....	0.75	0.4	7.5
Ammonium nitrate.....		9.0	
Sodium nitrate.....	53.75	51.0	
Carbonaceous combustible.....	6.0	7.1	
Sulfur.....	6.0	6.0	
Chalk.....	1.0	1.0	1.0
Ethylene glycol monoethyl ether.....	0.5	0.5	1.5
	100.0	100.0	100.0

In the above formulas, while ethylene glycol monoethyl ether has been used as accelerant, it will be understood that others from the compounds cited may be used, if desired. In this case, as elsewhere throughout the description, the ingredient designated as nitroglycerin is to be understood not as simply the chemical compound nitroglycerin, but also as containing a variable amount of a dissolved nitric ester such as tetranitrodiglycerin.

For a more exact understanding of my invention, the process of producing improved gelatinous explosives is illustrated below, the amounts of ingredients being based on the production of a 25-lb. experimental mixing of gelatin dynamite. 6.25 lbs. of nitroglycerin is introduced into the bowl, in which the mixing is to be made, and 0.125 lb. of ethylene glycol monoethyl ether is added to the explosive oil and brought into solution. 0.1 lb. of a suitable nitrocotton is then introduced into the nitroglycerin, and the mixture is properly agitated, while maintaining the solution at a temperature of approximately 120° F. At the end of seven minutes, or at such time as the gelatinization of the nitrocotton has caused the proper thickening of the solution, the other solid ingredients of the gelatin are added for incorporation, these ingredients having been already thoroughly mixed. Suitable amounts of such ingredients for use in the present case are 2.25 lbs. ammonium nitrate, 12.75 lbs. sodium nitrate, 1.775 lbs. carbonaceous combustibles, 1.5 lbs. of sulfur, and 0.25 lb. of chalk. After the addition of the above, the materials in the bowl are mixed thoroughly for another seven minutes, or for whatever time appears suitable. The finished explosive is then removed from the bowl and cartridged in the usual manner.

In carrying out my invention, as has been stated in the foregoing, nitroglycerin may be used either alone as the explosive oil or when containing in solution various other aliphatic nitric esters, such as tetranitrodiglycerin, nitrated sugars, nitrochlorhydrins, and the like. It should be understood that the invention is applicable to all types of gelatinous high explosives, both straight and ammonia gelatins, including blasting gelatin. Many variations in detail from the procedure described in the preceding may be made without departing from the spirit of the invention. I therefore intend to be limited only as indicated in the following patent claims.

I claim:

1. A high explosive composition comprising a liquid explosive nitric ester gelatinized by means of nitrocellulose, and a gelatinization accelerant comprising a derivative of an aliphatic alcohol having at least two hydroxyl groups, said derivative containing at least one unsubstituted hydroxyl group and at least one ether group.
2. A gelatin dynamite composition comprising a solution of tetranitrodiglycerin in nitroglycerin, said solution being gelatinized by means of nitrocellulose, and a gelatinization accelerant comprising a derivative of an aliphatic alcohol having at least two hydroxyl groups, said derivative containing at least one unsubstituted hydroxyl group and at least one ether group.

3. A high explosive composition comprising a liquid explosive nitric ester gelatinized by means of nitrocellulose, and a gelatinization accelerant consisting of a derivative of an aliphatic alcohol having at least two hydroxyl groups, said derivative comprising a polymerized polyhydroxy alco-

hol containing at least one unsubstituted hydroxyl group and at least one ether group.

4. A high explosive composition comprising nitroglycerin gelatinized by means of nitrocellulose, and a gelatinization accelerant comprising diethylene glycol.

5. A high explosive composition comprising a liquid nitric ester gelatinized by means of nitrocellulose, and a gelatinization accelerant consisting of a derivative of an aliphatic alcohol having at least two hydroxyl groups, said derivative containing at least one unsubstituted hydroxyl group and one ether group, said ether group resulting from the joining of two carbon atoms of dissimilar alcohols by means of an oxygen linkage.

6. A high explosive composition comprising nitroglycerin gelatinized by means of nitrocellulose, and a gelatinization accelerant comprising ethylene glycol monoethyl ether, in an amount between 0.1 and 8.0% of the nitroglycerin present.

7. The process of accelerating the gelatinization of nitrocellulose with a liquid explosive nitric

ester, which comprises bringing about said gelatinization in the presence of a derivative of an aliphatic alcohol having at least two hydroxyl groups, said derivative containing at least one unsubstituted hydroxyl group and at least one ether group.

8. The process of accelerating the gelatinization of nitrocellulose with nitroglycerin containing dissolved tetranitrodiglycerin, which comprises bringing about said gelatinization in the presence of a derivative of an aliphatic alcohol having at least two hydroxyl groups, said derivative containing at least one unsubstituted hydroxyl group and at least one ether group.

9. The process of accelerating the gelatinization of nitrocotton with nitroglycerin containing dissolved tetranitrodiglycerin, which comprises bringing about said gelatinization in the presence of ethylene glycol monoethyl ether, in an amount between 0.1 and 8.0% of the amount of nitroglycerin present.

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25	100
30	105
35	110
40	115
45	120
50	125
55	130
60	135
65	140
70	145
75	150