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EXPLOSIVE COMPOSITIONS CONTAINING SORBITAN TETRANITRATE SENSITIZER

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The present application is a continuation in part of application Serial Number 60,806, filed October 6, 1960, now abandoned.

The present invention relates to explosive compositions, and more particularly to explosive compositions containing ammonium nitrate as a base.

It is an object of this invention to provide an improved explosive composition free from headache-producing properties.

It is another object of this invention to provide an explosive composition which has a high degree of water resistivity.

It is a further object of the present invention to provide an explosive composition of uniform sensitiveness.

A further object of this invention is to provide a novel sensitizer for explosive compositions.

A further object is to provide explosive compositions in which sorbitan tetranitrate is associated with explosive salts, oxidizing agents, oxidizable agents, heat producing agents and other agents used for causing effects in the character and condition of explosive mixtures.

Other objects of the present invention will appear as the description of the invention proceeds.

As is well known, commercial explosive compositions frequently include nitroglycerin or nitroglycol or mixtures of these as ingredients. Explosive compositions containing nitroglycerin and nitroglycol have been used with considerable satisfaction over a long period of years. No other materials have been available that possessed the generally desirable properties of nitroglycerin and nitroglycol as sensitizers for explosive compositions. Notable among the desirable characteristics of nitroglycerin and nitroglycol as sensitizing agents is excellent water resistance. Nitroglycerin and nitroglycol, however, have the objectionable property of causing severe headaches in the case of persons coming in contact with them or breathing their vapors.

Now in accordance with the present invention, it has been found that sorbitan tetranitrate may be substituted for nitroglycerin or nitroglycol in explosive compositions which heretofore contained these products as a sensitizing ingredient. The explosive compositions embodied by the present invention will be found to include desirable characteristics of nitroglycerin explosive mixture such as sensitivity, power, rate of detonation, water resistivity, but do not give off toxic vapors such as those given off by nitroglycerin and nitroglycol.

The explosive compositions contemplated by the present invention comprise essentially oxygen supplying salts generally useful in dynamite compositions for example: nitrates of ammonium, sodium and potassium, sensitized with sorbitan tetranitrate. The explosive compositions of the present invention may also include other customary constituents of dynamite compositions such as: fuels, for

example, sulfur or carbonaceous combustible materials such as wood pulp, coal, apricot pit pulp, bagasse, ivory meal and corn flour; acid-accepting materials, for example, calcium carbonate; materials to improve water resistivity, for example, manno galactan; additional sensitizing agents, for example, powdered aluminum or magnesium, dinitrotoluene, trinitrotoluene, cyclotrimethylenetrinitramine, nitromannite and pentaerythritol tetranitrate.

In preparing an explosive composition in accordance with the present invention it is only necessary to admix sorbitan tetranitrate with the other ingredients of the composition. The explosive composition produced by the admixing of the ingredients may then be cartridged by any well-known method to produce an explosive composition in a form suitable for commercial use.

Commercial explosive compositions generally have a sensitivity response to detonation by means of a No. 6 or No. 8 blasting cap, or by a detonating fuse. Since these methods of initiation are relatively standard in the blasting art, it is usually desirable that the explosive compositions of the present invention be sufficiently sensitive to be susceptible to detonation by the above listed means.

It has been found generally that satisfactory sensitivity of explosive compositions may be obtained when at least about 10% by weight of the composition to be sensitized is comprised of sorbitan tetranitrate. Amounts of sorbitan tetranitrate of over about 15% by weight of the composition usually do not markedly increase the beneficial effects, although amounts above that figure may be used if desired, provided, of course, that the amount employed does not deleteriously affect the desired properties of the explosive composition. In case additional sensitizing agents, such as, for example, powdered aluminum or magnesium, TNT, DNT, RDX, PETN or nitromannite, are included in the mixture, the minimum amount of soribtan tetranitrate required to sensitize the composition satisfactorily may be reduced. Generally the beneficial effects of sorbitan tetranitrate are not appreciably manifested when amounts below about 3% of the weight of the finished explosive mixture are used.

A sorbitan tetranitrate product aptly suited for use in the present invention may be prepared by nitrating sorbitan using a mixture of nitric and sulfuric acids and recovering the sorbitan tetranitrate product from the reaction mixture by solvent extraction. The sorbitan tetranitrate so produced without further purification steps is a mixture of isomers of sorbitan tetranitrate with some nitrated sorbitan degradation products, and is a liquid easily disseminated in dynamite compositions. As one example of such a preparation a sorbitan starting material, 100 parts by weight, at a temperature of between 50° C. and 100° C., was added to 600 parts by weight of a nitrating mixture comprised of 37% by weight of concentrated nitric acid and 63% by weight of concentrated sulfuric acid. After the sorbitan starting material had been added, 67 to 335 parts by weight of methylene chloride were added to the mixture and the mixture vigorously agitated. The nitration temperature was in the range of from 15° C. to 19° C. The total mixture was then allowed to stand for one-half hour. The sorbitan tetranitrate product formed dissolves in the methylene chloride. The methylene chloride layer, containing the sorbitan tetranitrate product, was then separated and washed with about 250 parts by weight of water. The methylene chloride-sorbitan tetranitrate

layer was then separated from the wash water and the washing step repeated. After the second water wash, the methylene chloride-sorbitan tetranitrate layer was separated and washed with about 200 parts by weight of a 5% sodium carbonate solution. After the sodium carbonate solution wash, the methylene chloride-sorbitan tetranitrate layer was separated and the methylene chloride evaporated at a temperature of about 40° C. The sorbitan tetranitrate was a somewhat viscous, brown product. Utilizing the foregoing method the product yield will generally be found to be between about 180 and about 190 parts by weight.

A crystalline sorbitan tetranitrate material consisting of substantially a single isomer of sorbitan tetranitrate may be prepared by either initially nitrating a purified (substantially single isomer) sorbitan product, or by crystallizing a purified sorbitan tetranitrate product from a liquid sorbitan tetranitrate mixture. A suitable method of producing a sorbitan product which may be nitrated to obtain sorbitan tetranitrate products useful in the present invention is described in U.S. 2,390,395.

The following examples, shown in tabular form, are illustrative of compositions produced in accord with the present invention.

In Example I of the following table, an explosive composition was compounded comprised of 15.0% by weight of sorbitan tetranitrate, 35.7% by weight of fine ammonium nitrate (100% through a 50 mesh U.S.S. screen), 29.4% by weight of 14 mesh (U.S.S.) sodium nitrate, 11.0% by weight of ground sodium nitrate (90% through a 20 mesh U.S.S. screen, 50 to 75% through a 100 mesh U.S.S. screen), 2.9% by weight of corn flour, 5.0% by weight of sulfur and 1.0% by weight of guar flour. The ingredients were incorporated together by dry mixing and the mixture packed into standard 1¼" x 8" paper cartridges. The explosive composition was found to have a cartridge count of 112 per one hundred pounds, and a gap sensitivity of ½". The gap sensitivity was tested by halving a 1¼" x 8" cartridge into two 1¼" x 4" portions, priming the outer end of one portion of the cartridge with a #6 blasting cap and determining the largest gap between the portions through which the detonation of one will carry to the other. The explosive composition was found to have an open detonation velocity of 7761 f.p.s. (feet per second) and a confined detonation velocity of 11,662 f.p.s. The water resistivity of the composition was tested in a pressure water resistance test and found to have a 4.5 pound pressure water resistance of 16 hours. The aforementioned pressure water resistance test was conducted by placing the explosive to be tested in a waxed 1¼" x 8" cartridge shell and perforating the shell with 4 rows of 4 holes each. Each hole was ¼" in diameter and is just deep enough to extend through the shell wall. A skewer hole, ¼" in diameter and 2¼" long was made in top of the cartridge and a piece of safety fuse positioned in the hole. The cartridge was then immersed in sufficient water to cover the cartridge to a depth of 2 to 3". An air pressure of about 4.5 p.s.i.g. was applied to the water surface for a measured time interval. Upon the passing of the time interval the cartridge was removed from the water, the safety fuse removed from the skewer hole and replaced by a #6 blasting cap. The cap was then fired. The length of time that an explosive could survive the described exposure to water and still evidence cartridge detonation for three trials without having an unexploded cartridge butt was taken as the measure of pressure water resistance. The method of preparation and the tests used in Examples II, III and IV of the following table were similar to those described above in regard to Example I, the only differences being in the composition of the explosive mixtures and in the test results. The coarse ammonium nitrate utilized in Examples II, III and IV is of a size that 100% will pass through a 14 mesh U.S.S. screen and essentially 100% will be retained on a 50 mesh U.S.S. screen. The sorbitan tetranitrate material in Example IV was a crystalline product produced by the nitration of a purified sorbitan product.

	Examples			
	I	II	III	IV
Ingredients:				
Sorbitan tetranitrate (crystalline)				15.0
Sorbitan tetranitrate (liquid)	15.0	15.0	10.0	
Ammonium nitrate (coarse)		12.8	38.0	12.8
Ammonium nitrate (fine)	35.7	51.5	37.6	51.5
Sodium nitrate (14 mesh)	29.4	11.7	6.2	11.7
Sodium nitrate (ground)	11.0	5.0		5.0
Corn flour	2.9	3.0	4.2	3.0
Aluminum			3.0	
Sulfur	5.0			
Guar flour	1.0	1.0	1.0	1.0
Characteristics:				
1¼" x 8" cartridge count	112	123	130	128
Gap Sensitivity	½"	1"	10"	8"
Open velocity (f.p.s.)	7,761	8,205	8,088	10,605
Confined velocity (f.p.s.)	11,662	12,109	9,912	10,936
4½# Pressure water resistance (hours)	16	16	16	24

Although this invention has been particularly described with reference to an explosive composition having ammonium nitrate as a base, it will be understood that sorbitan tetranitrate may be utilized as a sensitizer in other explosive compositions having other bases. It will further be obvious that various changes may be made in details without departing from the spirit of this invention.

The term "consisting essentially of," as used in the claims, includes compositions containing the named components and other components which do not deleteriously affect the composition for the purposes stated in the specification.

What is claimed is:

1. An explosive composition consisting essentially of a sensitizer of sorbitan tetranitrate, an inorganic oxidizing salt and a fuel material.

2. An explosive composition consisting essentially of a sensitizer of sorbitan tetranitrate, an inorganic oxidizing salt, and carbonaceous fuel material.

3. The explosive composition of claim 1 wherein the inorganic oxidizing salt is ammonium nitrate.

4. The explosive composition of claim 1 wherein the inorganic oxidizing salt is sodium nitrate.

5. The composition of claim 1 wherein sulfur is included.

6. A dynamite composition comprising an inorganic oxidizing salt and a carbonaceous fuel material, said ingredients sensitized by sorbitan tetranitrate.

7. The composition of claim 6 wherein the sorbitan tetranitrate is liquid containing a mixture of isomers.

8. A dynamite composition comprising ammonium nitrate, sodium nitrate and carbonaceous fuel material, sensitized by sorbitan tetranitrate in an amount of at least about 10% of the total weight of the composition.

9. The composition of claim 8 wherein sulfur is included.

10. A dynamite composition comprising ammonium nitrate, sodium nitrate, carbonaceous fuel material and a powdered metal selected from the group consisting of aluminum and magnesium, sensitized by sorbitan tetranitrate in an amount of at least about 8% of the total weight of the composition.

11. The dynamite composition described in claim 10 wherein the powdered metal is aluminum.

12. The composition of claim 10 wherein sulfur is included.

13. An explosive composition consisting essentially of an inorganic oxidizing salt selected from the group consisting of ammonium nitrate, sodium nitrate and potassium nitrate sensitized with sorbitan tetranitrate.

14. An explosive composition consisting essentially of a sensitizer of sorbitan tetranitrate, an inorganic oxidizing salt selected from the group consisting of ammonium

nitrate, sodium nitrate and potassium nitrate, and fuel material.

15. An explosive composition consisting essentially of a sensitizer of sorbitan tetranitrate, an inorganic oxidizing salt selected from the group consisting of ammonium nitrate, sodium nitrate and potassium nitrate, and carbonaceous fuel material.

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