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(54) **Lead-free nontoxic priming mix**

Nicht-toxische, bleifreie Zündmittelzusammensetzung

Composé d'amorçage sans plomb et non toxique

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(72) Inventors:
• **Mei, George C.**
Creve Coeur, Missouri 63141 (US)
• **Pickett, James W.**
Gillespie, Illinois 62033 (US)

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(74) Representative: **Bannerman, David Gardner et al**
Withers & Rogers LLP
Goldings House,
2 Hays Lane
London SE1 2HW (GB)

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(73) Proprietor: **OLIN CORPORATION**
Connecticut 06706-2152 (US)

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Description**BACKGROUND OF THE INVENTION**5 **1. Field of the Invention**

[0001] The present invention is directed to priming mixes for explosives, and more particularly lead-free and non-toxic priming mixes

10 **2. Brief Description of the Related Art**

[0002] Various lead free priming mixtures for use in ammunition have been disclosed over the years. For example, a nontoxic, noncorrosive priming mix described in U.S. Pat. No. 4,675,059 is one such composition. This priming composition is specifically adapted to rim fire cartridges and contains diazodinitrophenol, also known as dinol or DDNP, manganese dioxide, tetrazene and glass. Another example of a nontoxic priming mixture is disclosed in U.S. Pat. No. 4,963,201, issued to Bjerke et al. This composition comprises dinol or potassium dinitrobenzofuroxan as the primary explosive, tetrazene as a secondary explosive, a nitrate ester fuel and strontium nitrate as the oxidizer.

[0003] Dinol (also known as diazodinitrophenol or DDNP), or mixtures based on dinol, exhibit an inherent disadvantage called non-ideality of explosives. This phenomenon is a propagation failure which occurs when the diameter or the cross-section of the explosive becomes too small or too thin - generally smaller than a critical diameter or cross-section. Such effects become prominent in rimfire priming applications where the priming mix is, by necessity, spread thinly.

[0004] Various means have been proposed to mitigate the disadvantage caused by the non-ideality phenomenon, including changing the physical parameters of the explosive used in the ammunition by building up mix stock (to increase cross-section of the explosive), or by using highly consolidated propellant beds on top of the explosive mix. However, these approaches require using either a two-step mix charging process (e.g., one step to spin mix into the rim, and the other step to build the web), or a two-stage propellant charge with a highly consolidated first stage for keeping the propagation active. Unfortunately, both of these approaches are expensive and time-consuming.

[0005] New priming mix compositions have also been proposed. For example, U.S. Patent No. 5,353,707 to Duget discloses a priming charge made from 40-70% dinitrobenzofuran salt (also known as dinitrobenzofuroxane salt, and the potassium salt - "KDNBF"), 3-15% tetrazene, 10-30% cupric oxide, 5-25% pulverulent reducing agent, 0.5-20% of an inert abrasive powder and 0-5% of a binder. U.S. Patent No. 5,538,569 to Carter discloses a nontoxic priming composition comprising a dinitrobenzofuroxan salt, oxidizer, and a friction agent. According to this disclosure, a preferred set of components are potassium salts of dinitrobenzofuroxan salt, potassium nitrate, and ground glass and/or boron as a friction agent. However, tetrazene is explicitly excluded from this composition, and the friction agent comprises a maximum of 45 wt%. U.S. Patent No. 5,993,577 to Erickson et al. discloses a lead-free priming composition made from diazodinitrophenol (DDNP), a low percentage of tetrazene, and a high percentage of an abrasive such as ground glass.

[0006] What is needed in the art is a lead-free, non-toxic priming composition that addresses the phenomenon of non-ideality of explosives, yet is economical and easy to produce. The present invention is believed to be an answer to that need.

SUMMARY OF THE INVENTION

[0007] In one aspect, the present invention is directed to a lead-free, non-toxic priming composition, comprising: 20-40 wt% of a dinitrobenzofuroxan salt; 2-10 wt% of a sensitizer; 0-30 wt% of an oxidizer; and 48-70 wt% of an abrasive, wherein all weight percents are based on the total weight of said composition.

[0008] In another aspect, the present invention is directed to a lead-free, non-toxic priming composition, comprising: 30-40 wt% of potassium dinitrobenzofuroxan salt; 3-8 wt% of tetrazene; 0-15 wt% potassium nitrate; and 50-60 wt% of glass particles having an average particle size of from 90 to 150 microns, wherein all weight percents are based on the total weight of said composition.

[0009] These and other aspects will become apparent upon reading the following detailed description of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0010] It has now been unexpectedly found by the inventors that the problem of non-ideality of explosives may be addressed by a priming mix composition comprising dinitrobenzofuroxan salts, a sensitizer, an oxidizer, and a high weight percentage of abrasive. The present inventors have unexpectedly discovered that in using dinitrobenzofuroxan

salts, the composition of the present invention provides a more "ideal" (in propagation sense) explosive than compositions using dinol or DDNP.

[0011] As indicated above, the present invention is directed to a lead-free, non-toxic priming composition, comprising: 20-40 wt% of a dinitrobenzofuroxan salt; 2-10 wt% of a sensitizer; 0-30 wt% of an oxidizer; and 48-70 wt% of an abrasive wherein all weight percents are based on the total weight of said composition. Each of these components are discussed in more detail below.

[0012] The dinitrobenzofuroxan salt may be any salt, including potassium salt, sodium salt, calcium salt, magnesium salt, and the like, with the potassium salt being preferred. The preferred amount of this component in the composition of the present invention ranges from about 20-40 wt%, and more preferably from about 30 to about 40 wt%, based on the total weight of the composition. A particularly preferred amount is 35 wt%.

[0013] The sensitizer component of the present invention is preferably tetrazene. Preferred ranges of this component in the composition of the invention are from about 2 to about 10 wt%, and more preferably from about 3 to about 8 wt%, based on the total weight of the composition. A particularly preferred amount of tetrazene sensitizer is 5 wt%.

[0014] The oxidizer component of the present invention includes any oxidizer known in the art such as sodium nitrate, potassium nitrate, barium nitrate, and the like. Potassium nitrate is particularly preferred. Useful amounts of the oxidizer component range from about 0 to about 30 wt%, and more preferably from about 0 to about 20 wt%, based on the total weight of the composition. About 3 wt% of potassium nitrate is preferred.

[0015] The abrasive component of the present invention is preferably glass fines, although other abrasives common and known in the art may also be used. Preferably, the abrasive component comprises from about 48 to about 70 wt%, and more preferably from about 50 to about 60 wt%, based on the total weight of the composition. A particularly preferred amount of glass abrasive is about 57 wt%. In addition, a preferred range of particle sizes for the abrasive component ranges from about 75 to about 150 micrometer, and more preferably from about 90 to about 150 micrometer. A particularly useful average size is about 110 micrometer. It is believed that coarser (e.g., larger) abrasive particle sizes provide larger interstitial spaces where larger aggregates of materials can form, thereby providing more focused energy generation.

[0016] The relatively large proportion of abrasive component of the present invention is believed to provide a more rigid support matrix and provides more anvil points which improve the sensitivity of the composition of the invention.

[0017] The composition of the present invention is easily substituted for leaded priming mixtures, and can be processed using conventional techniques.

EXAMPLES

[0018] In general, the composition of the invention is made using conventional techniques well-known in the art.

[0019] Typically, the appropriate amounts of dinitrobenzofuroxan salt and tetrazene sensitizer are processed in water to minimize the chance of premature explosion. Following mixing in water, the dinitrobenzofuroxan salt and tetrazene are allowed to settle, and excess water is decanted off. The resulting paste is further processed by adding appropriate amounts of abrasive and, if desired, oxidizer. The paste is mixed while moisture is maintained within the paste to a level of approximately 10-30% for safety reasons.

[0020] The processed paste is formed into pellets by pushing the paste into a block having a plurality of holes, each having a specified size and volume. The processed pellets may be isolated and installed into cartridges using procedures well known in the art.

[0021] Pressure and velocity testing of 22 and 27 caliber pellets was performed by shooting control and experimental rounds in a test barrel. Control rounds used in the testing of the 22 caliber was a round primed with a standard leaded mix known as 22LRPAT purple. The control used in the testing of the 27 caliber was a round primed with a leaded mix known as 27SR-1 Red. The experimental round contained approximately 35 wt% potassium dinitrobenzofuroxan salt, approximately 5 wt% tetrazene, approximately 3 wt% potassium nitrate, and approximately 57 wt% glass fines, wherein the glass fines have an average particle size of approximately 120 micrometer.

[0022] Prior to firing the control or experimental rounds, a test barrel was rigged with a pressure gauge or copper crusher to measure the pressure generated by each round. The test barrel was also rigged with a velocity screen at the muzzle to measure the velocity of the nail exiting the muzzle. Function and casualty tests were performed on each round by shooting it in commercial tools. The following tables show the results of ballistic testing performed with the rounds. In Tables 1 and 2, "sd" refers to the standard deviation of each firing, and "ev" refers to the extreme variation between firings (defined as the difference between the maximum value and minimum value in the data set).

Table 1:

Pressure and Velocity Tests for 22 Caliber Pellets						
N=20	Velocity (m/s (ft/s))			Pressure (10 ⁸ Pa (100 psi))		
	Mean	ev	sd	mean	ev	sd
Control	209.7 (688)	9.8 (32)	2.4 (8)	3.48 (504)	0.50 (72)	0.15 (22)
Experimental	208.2 (683)	12.2 (40)	2.7 (9)	3.29 (477)	0.61 (88)	0.20 (29)

Table 2:

Pressure and Velocity Tests for 22 Caliber Pellets						
N=20	Velocity (m/s (ft/s))			Pressure (10 ⁸ Pa (100 psi))		
	Mean	ev	sd	mean	ev	sd
Control	192 (630)	15.2 (50)	3.7 (12)	1.30 (188)	0.45 (65)	0.12 (18)
Experimental	189.6 (622)	6.4 (21)	1.8 (6)	1.26 (182)	0.61 (88)	0.18 (26)
(ev = extreme variation; sd = standard deviation)						

Table 3:

Function and Casualty Test				
Sample	Tool	Fastener	N	Results
92 J (22 cal) Control	OMARK721	HD-150	50	OK
92 J (22 cal) Experimental	OMARK 721	HD-150	50	OK
113 J (27 cal) Control	Hilti DX450	NK -42	20	OK
113 J (27 cal) Experimental	Hilti DX450	NK-42	20	OK

[0023] The results shown in the tables above indicate that the experimental rounds with the lead-free mixture perform substantially the same as the control rounds that are primed with a leaded mixture. These results confirm that the lead-free, non-toxic composition of the present invention can be easily substituted for rounds that are primed with leaded priming mixtures.

Claims

1. A lead-free, non-toxic priming composition, comprising:

20-40 wt% of a dinitrobenzofuroxan salt;
2-10 wt% of a sensitizer;
0-30 wt% of an oxidizer, and
48-70 wt% of an abrasive

wherein all weight percents are based on the total weight of said composition.

2. The lead-free, non-toxic priming mix of claim 1, wherein said dinitrobenzofuran salt is the potassium salt.
3. The lead-free, non-toxic priming mix of claim 1, wherein said dinitrobenzofuran salt comprises from about 30 to about 40 wt%, based on the total weight of said composition.
4. The lead-free, non-toxic priming mix of claim 1, wherein said dinitrobenzofuran salt comprises approximately 35 wt%, based on the total weight of said composition.

5. The lead-free, non-toxic priming mix of claim 1, wherein said sensitizer is tetrazene.
6. The lead-free, non-toxic priming mix of claim 1, wherein said sensitizer comprises from about 3 to about 8 wt%, based on the total weight of said composition.
7. The lead-free, non-toxic priming mix of claim 1, wherein said sensitizer comprises approximately 5 wt%, based on the total weight of said composition.
8. The lead-free, non-toxic priming mix of claim 1, wherein said oxidizer is a nitrate salt.
9. The lead-free, non-toxic priming mix of claim 1, wherein said oxidizer is potassium nitrate.
10. The lead-free, non-toxic priming mix of claim 1, wherein said oxidizer comprises from about 0 to about 15 wt%, based on the total weight of said composition.
11. The lead-free, non-toxic priming mix of claim 1, wherein said oxidizer comprises approximately 3 wt%, based on the total weight of said composition.
12. The lead-free, non-toxic priming mix of claim 1, wherein said abrasive is glass particles.
13. The lead-free, non-toxic priming mix of claim 1, wherein said abrasive comprises from about 50 to about 60 wt%, based on the total weight of said composition.
14. The lead-free, non-toxic priming mix of claim 1, wherein said abrasive comprises approximately 57 wt%, based on the total weight of said composition.
15. The lead-free, non-toxic priming mix of claim 1, wherein said abrasive has an average particle size of from about 75 to about 150 micrometer.
16. The lead-free, non-toxic priming mix of claim 1, wherein said abrasive has an average particle size of from about 90 to about 150 micrometer.
17. The lead-free, non-toxic priming mix of claim 1, wherein said abrasive has an average particle size of approximately 110 micrometer.
18. The lead-free, non-toxic priming composition of claim 1, comprising:
 - 30-40 wt% of potassium dinitrobenzofuroxan salt;
 - 3-8 wt% of tetrazene;
 - 0-15 wt% potassium nitrate; and
 - 50-60 wt% of glass particles having an average particle size of from 90 to 150 microns,wherein all weight percents are based on the total weight of said composition.

Patentansprüche

1. Bleifreie, nicht-toxische Zündmittelzusammensetzung, enthaltend:

20-40 Gew.-% eines Dinitrobenzofuroxansalzes,
2-10 Gew.-% eines Sensibilisierungsmittels,
0-30 Gew.-% eines Oxidationsmittels, und
48-70 Gew.-% eines Abrasivmittels,

wobei sämtliche Gewichtsprozent auf dem Gesamtgewicht der Zusammensetzung basieren.

2. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Dinitrobenzofuransalz das Kaliumsalz ist.

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3. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Dinitrobenzofuransalz ungefähr 30 bis ungefähr 40 Gew.-% basierend auf dem Gesamtgewicht der Zusammensetzung ausmacht.

5 4. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Dinitrobenzofuransalz ungefähr 35 Gew.-% basierend auf dem Gesamtgewicht der Zusammensetzung ausmacht.

5. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Sensibilisierungsmittel Tetrazen ist.

10 6. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Sensibilisierungsmittel ungefähr 3 bis ungefähr 8 Gew.-% basierend auf dem Gesamtgewicht der Zusammensetzung ausmacht.

15 7. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Sensibilisierungsmittel ungefähr 5 Gew.-% basierend auf dem Gesamtgewicht der Zusammensetzung ausmacht.

8. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Oxidationsmittel ein Nitratsalz ist.

20 9. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Oxidationsmittel Kaliumnitrat ist.

10. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Oxidationsmittel von ungefähr 0 bis ungefähr 15 Gew.-% basierend auf dem Gesamtgewicht der Zusammensetzung ausmacht.

25 11. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Oxidationsmittel ungefähr 3 Gew.-% basierend auf dem Gesamtgewicht der Zusammensetzung ausmacht.

12. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Abrasivmittel Glasteilchen sind.

30 13. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Abrasivmittel von ungefähr 50 bis ungefähr 60 Gew.-% basierend auf dem Gesamtgewicht der Zusammensetzung ausmacht.

35 14. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Abrasivmittel ungefähr 57 Gew.-% basierend auf dem Gesamtgewicht der Zusammensetzung ausmacht.

15. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Abrasivmittel eine mittlere Teilchengröße von ungefähr 75 bis ungefähr 150 Mikrometer aufweist.

40 16. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Abrasivmittel eine mittlere Teilchengröße von ungefähr 90 bis ungefähr 150 Mikrometer aufweist.

17. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, wobei das Abrasivmittel eine mittlere Teilchengröße von ungefähr 110 Mikrometer aufweist.

45 18. Bleifreie, nicht-toxische Zündmittelzusammensetzung nach Anspruch 1, enthaltend:

30-40 Gew.-% Kaliumdinitrobenzofuroxansalz,

3-8 Gew.-% Tetrazen,

0-15 Gew.-% Kaliumnitrat, und

50 50-60 Gew.-% an Glasteilchen mit einem mittleren Teilchendurchmesser von 90-150 Mikrometer,

wobei sämtliche Gewichtsprozent auf dem Gesamtgewicht der Zusammensetzung basieren.

55 Revendications

1. Composition d'amorçage sans plomb et non toxique, comprenant :

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20 à 40 % en poids d'un sel de dinitrobenzofuroxane ;
2 à 10 % en poids d'un sensibilisateur ;
0 à 30 % en poids d'un oxydant ; et
48 à 70 % en poids d'un abrasif

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dans laquelle tous les pourcentages en poids sont données par rapport au poids total de ladite composition.

2. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit sel de dinitrobenzofurane est le sel de potassium.

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3. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit sel de dinitrobenzofurane représente environ 30 à environ 40 % en poids, par rapport au poids total de ladite composition.

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4. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit sel de dinitrobenzofurane représente environ 35 % en poids, par rapport au poids total de ladite composition.

5. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit sensibilisateur est le tétrazène.

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6. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit sensibilisateur représente environ 3 à environ 8 % en poids, par rapport au poids total de ladite composition.

7. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit sensibilisateur représente environ 5 % en poids, par rapport au poids total de ladite composition.

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8. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit oxydant est un nitrate.

9. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit oxydant est le nitrate de potassium.

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10. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit oxydant est compris à environ 0 à environ 15 % en poids, par rapport au poids total de ladite composition.

11. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit oxydant représente environ 3 % en poids, par rapport au poids total de ladite composition.

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12. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit abrasif est constitué de particules de verre.

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13. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit abrasif représente environ 50 à environ 60 % en poids, par rapport au poids total de ladite composition.

14. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit abrasif représente environ 57 % en poids du poids total de ladite composition.

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15. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit abrasif a une taille moyenne de particules d'environ 75 à environ 150 micromètres.

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16. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit abrasif a une taille moyenne de particules d'environ 90 à environ 150 micromètres.

17. Mélange d'amorçage sans plomb et non toxique selon la revendication 1, dans lequel ledit abrasif a une taille moyenne de particules d'environ 110 micromètres.

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18. Composition d'amorçage sans plomb et non toxique selon la revendication 1, comprenant :

30 à 40 % en poids de sel dinitrobenzofuroxane de potassium ;
3 à 8 % en poids de tétrazène ;

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0 à 15 % en poids de nitrate de potassium ; et

50 à 60 % en poids de particules de verre ayant une taille moyenne de particules de 90 à 150 microns,

dans laquelle tous les pourcentages en poids sont données par rapport au poids total de ladite composition.

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