

INSTRUCTIONS

(a) If Convention application insert "Convention"

(a) CONVENTION

AUSTRALIA **601882**
Patents Act

24452/88

APPLICATION FOR A PATENT

(b) Insert FULL name(s) of applicant(s)

I/We (b)

IRECO Incorporated, a Delaware corporation,

(c) Insert FULL address(es) of applicant(s)

of (c)

APPLICATION ACCEPTED AND AMENDMENTS

ALLOWED 17-7-90

Eleventh Floor Crossroads Tower
Salt Lake City, Utah, U.S.A. 84144

(d) Insert TITLE of invention

hereby apply for the grant of a Patent for an invention entitled (d)

EMULSION EXPLOSIVE CONTAINING ORGANIC MICROSPHERES

(e) Insert "complete" OR "provisional"

which is described in the accompanying (c) COMPLETE specification.

(Note: The following paragraph applies only to Convention applications)

This application is a Convention application based on the basic application(s) for a patent or similar protection identified by number, country, and filing date as follows:

(f) Insert number, country and filing date for each basic application

United States Serial No. 128,096
Filed 3 December 1987

Address for Service:

PHILLIPS ORMONDE AND FITZPATRICK
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367 Collins Street
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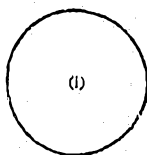
REPRINT OF RECEIPT
MO03941

27/10/88

(g) Insert DATE of signing

Dated (g) 26 September 1988

(h) Signature of applicant(s) (For body corporate see headnote*)



(h) IRECO Incorporated

By Robert A. Bingham
Robert A. Bingham
Sr. Vice President

(i) Corporate seal if any

Note: No legalization or other witness required

PHILLIPS ORMONDE AND FITZPATRICK
Patent and Trade Mark Attorneys
367 Collins Street
Melbourne, Australia

AUSTRALIA

Patents Act

DECLARATION FOR A PATENT APPLICATION

INSTRUCTIONS

- (a) Insert "Convention" if applicable
(b) Insert FULL name(s) of applicant(s)

- (c) Insert "of addition" if applicable
(d) Insert TITLE of invention

- (e) Insert FULL name(s) AND address(es) of declarant(s) (See headnote*)

- (f) Insert FULL name(s) AND address(es) of actual inventor(s)

- (g) Recite how applicant(s) derive(s) title from actual inventor(s) (See headnote**)

- (h) Insert country, filing date, and basic applicant(s) for the/or EACH basic application

- (k) Insert PLACE of signing

- (l) Insert DATE of signing

- (m) Signature(s) of declarant(s)

Note: No legalization or other witness required

In support of the (a) convention application made by (b)

IRECO Incorporated

(hereinafter called "applicant(s)" for a patent (c) for an invention entitled (d)

EMULSION EXPLOSIVE CONTAINING ORGANIC MICROSPHERES

I/We (e) Robert A. Bingham, Sr. Vice President
IRECO Incorporated
Eleventh Floor Crossroads Tower
Salt Lake City, Utah, U.S.A. 84144

do solemnly and sincerely declare as follows:

1. I am/We are the applicant(s):

(or, in the case of an application by a body corporate)

1. I am/We are authorized to make this declaration on behalf of the applicant(s).

2. I am/We are the actual inventor(s) of the invention:

(or, where the applicant(s) is/are not the actual inventor(s))

2. (f)
Lee F. McKenzie, 15090 Rose Canyon Road, Riverton,
Utah, U.S.A. 84065; and
Lawrence D. Lawrence, 2467 East Granite Hills Circle,
Sandy, Utah, U.S.A. 84092

is/are the actual inventor(s) of the invention and the facts upon which the applicant(s) is/are entitled to make the application are as follows:

(g)

Applicant is the assignee of the invention from the actual inventors.

(Note: Paragraphs 3 and 4 apply only to Convention applications)

3. The basic application(s) for patent or similar protection on which the application is based is/are identified by country, filing date, and basic applicant(s) as follows:

(h)

United States 3 December 1987 USSN 128,096
Dr. Lee F. McKenzie and Lawrence D. Lawrence

4. The basic application(s) referred to in paragraph 3 hereof was/were the first application(s) made in a Convention country in respect of the invention the subject of the application.

Declared at (k) Salt Lake City, Utah, U.S.A.

Dated (l) 26 September 1988

(m) IRECO Incorporated

By Robert A. Bingham
Robert A. Bingham
Sr. Vice President

To: The Commissioner of Patents

P18/7/81

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STUART TAYLOR

(12) PATENT ABRIDGMENT (11) Document No. AU-B-24452/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 601882

(54) Title
EMULSION EXPLOSIVE CONTAINING ORGANIC MICROSPHERES

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(53) Prior Art Documents
GB 2187182
US 4708753

(57) Claim

1. A water-in-oil emulsion explosive comprising a water-immiscible organic fuel as a continuous phase; an emulsified aqueous inorganic oxidizer salt solution as a discontinuous phase; a polypropene or polybutene derivatized emulsifier; and a copolymer of vinylidene chloride and acrylonitrile as a density reducing agent..

AUSTRALIA

Patents Act

COMPLETE SPECIFICATION
(ORIGINAL)

601882

Class

Int. Class

Application Number:
Lodged:

Complete Specification Lodged:
Accepted:
Published:

Priority

Related Art:

This document contains the
amendments made under
Section 49 and is correct for
printing.

APPLICANT'S REFERENCE: 533 F

Name(s) of Applicant(s):

Ireco Incorporated

Address(es) of Applicant(s):

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UNITED STATES OF AMERICA.

Address for Service is:

PHILLIPS ORMONDE & FITZPATRICK
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Complete Specification for the invention entitled:

EMULSION EXPLOSIVE CONTAINING ORGANIC MICROSPHERES

Our Ref : 108977
POF Code: 1427/1427

The following statement is a full description of this invention, including
the best method of performing it known to applicant(s):

EMULSION EXPLOSIVE CONTAINING ORGANIC MICROSPHERES

The present invention relates to an improved explosive composition. More particularly, the invention relates to a water-in-oil emulsion explosive having improved stability and a lower viscosity. The term "water-in-oil" means a dispersion of droplets of an aqueous solution or water-miscible melt (the discontinuous phase) in an oil or water-immiscible organic substance (the continuous phase). The term "explosive" means both cap-sensitive explosives and noncap-sensitive explosives commonly referred to as blasting agents. The water-in-oil emulsion explosives of this invention contain a water-immiscible organic fuel as the continuous phase and an emulsified inorganic oxidizer salt solution or melt as the discontinuous phase. (The terms "solution" or "melt" hereafter shall be used interchangeably.) These oxidizer and fuel phases react with one another upon initiation by a blasting cap and/or a booster to produce an effective detonation. The explosives contain a polypropene or polybutene derivatized water-in-oil emulsifier and a density reducing agent in the form of expanded organic microspheres having a nonpolar surface and comprising homo-, co- or ter-polymers of vinyl monomers (hereafter "organic microspheres"). This combination of polypropene or polybutene derivatized emulsifier and organic microspheres has been found to be particularly advantageous in the water-in-oil emulsion explosives of the present invention.

BACKGROUND OF THE INVENTION

Water-in-oil emulsion explosives are well-known in the art. See, for example, U.S. Patent Nos. 4,356,044; 4,322,258; 4,141,767; 3,447,978 and 3,161,551. Emulsion explosives are found to have certain advantages over conventional aqueous slurry explosives, which have a continuous aqueous phase, as described in U.S. Patent No. 4,141,767.

An inherent problem with emulsion explosives, however, is their relative instability, due to the fact that they comprise a thermodynamically unstable dispersion of supercooled solution or melt droplets in an oil-continuous phase. If the emulsion remains stable, these supercooled droplets are prevented from crystallizing or solidifying into a lower energy state. If the emulsion weakens or becomes unstable, however, then crystallization or solidification of the droplets results, and the explosive generally loses some of its sensitivity to detonation and becomes too viscous to handle for certain blasting applications. Moreover, it is common to add solid components to emulsion explosives in the form of glass microspheres for density reduction and prills or particles of oxidizer salt such as porous prilled ammonium nitrate (AN) for increased energy. These solid components, however, tend to destabilize emulsions.

Emulsion explosives commonly are used as a repumpable explosive, i.e., an explosive that is formulated at a remote facility, loaded or pumped into a bulk container and then transported in the container to a blasting site where it then is

"repumped" from the container into a borehole. Alternatively, the explosive may be delivered (repumped) into a centrally located storage tank from which it will be further repumped into a vehicle for transportation to a blasting site and then again repumped into the borehole. Thus the emulsion explosive must remain stable even after being subjected to repeated handling or shearing action, which normally also tends to destabilize an emulsion. Additionally, the emulsion's viscosity must remain low enough to allow for repumping at reasonable pressures and at the low ambient temperatures that may be experienced during colder months. Repeated handling or shearing action also tends to increase the emulsion's viscosity.

Since a density control agent is required in many instances to reduce the density of an explosive and thereby increase its sensitivity to a required level for detonation, and since hollow microspheres are a preferred form of density control, it is important that the emulsion remain stable and have a low viscosity even when containing solid density control agents. Heretofore, stability has been a significant problem in repumpable emulsion explosives containing solid density control agents. Moreover, certain types of solid density control agents are more destabilizing to emulsions than others. For example, at 20°C one of the more commonly used emulsifiers, sorbitan monooleate, forms a relatively stable emulsion in the presence of glass microspheres but is less effective in the presence of organic microspheres.

A major advantage of the present invention is that the use of a polypropene or polybutene derivatized emulsifier in combination with organic microspheres as the solid density control agent imparts improved stability and lower viscosity to the emulsion, even after repeated handling or shearing action. Another advantage is that the use of polypropene or polybutene derivatized emulsifiers allows for organic microspheres to be used as a density control agent without adversely affecting the stability of the emulsion. Still another advantage is that the organic microspheres are a reactive fuel, rather than an inert like glass microspheres, and thus contribute to the detonation reaction. The presence of organic microspheres in compositions of the present invention has been found to result generally in higher detonation velocities, higher detonation sensitivities and lower critical diameters.

SUMMARY OF THE INVENTION

The invention relates to a water-in-oil emulsion explosive comprising a water-immiscible organic fuel as a continuous phase; an emulsified aqueous inorganic oxidizer salt solution as a discontinuous phase; a polypropene or polybutene derivatized emulsifier; and organic microspheres as a density reducing agent.

DETAILED DESCRIPTION OF THE INVENTION

The immiscible organic fuel forming the continuous phase of the composition is present in an amount of from about 3% to about 12%, and preferably in an amount of from about 4% to about 8% by weight of the composition. The actual amount used can be varied

depending upon the particular immiscible fuel(s) used and upon the presence of other fuels, if any. The immiscible organic fuels ~~can~~^{may} be aliphatic, alicyclic, and/or aromatic and ~~can~~^{may} be saturated and/or unsaturated, ~~so long as they~~^{but preferably} are liquid at the formulation temperature. Preferred fuels include tall oil, mineral oil, waxes, paraffin oils, benzene, toluene, xylenes, mixtures of liquid hydrocarbons generally referred to as petroleum distillates such as gasoline, kerosene and diesel fuels, and vegetable oils such as corn oil, cottonseed oil, peanut oil, and soybean oil. Particularly preferred liquid fuels are mineral oil, No. 2 fuel oil, paraffin waxes, microcrystalline waxes, and mixtures thereof. Aliphatic and aromatic nitro-compounds also can be used. Mixtures of the above can be used. Waxes must be liquid at the formulation temperature.

Optionally, and in addition to the immiscible liquid organic fuel, solid or other liquid fuels or both can be employed in selected amounts. Examples of solid fuels which can be used are finely divided aluminum particles; finely divided carbonaceous materials such as gilsonite or coal; finely divided vegetable grain such as wheat; and sulfur. Miscible liquid fuels, also functioning as liquid extenders, are listed below. These additional solid and/or liquid fuels can be added generally in amounts ranging up to 15% by weight. If desired, undissolved oxidizer salt can be added to the composition along with any solid or liquid fuels.

The inorganic oxidizer salt solution forming the discontinuous phase of the explosive generally comprises



inorganic oxidizer salt, in an amount from ^{preferably} about 45% to about 95% by weight of the total composition, and water and/or water-miscible organic liquids, in an amount ^{preferably} of from about 2% to about 30%. The oxidizer salt preferably is primarily ammonium nitrate, but other salts may be used preferably in amounts up to about 20%. The other oxidizer salts ^{preferably} are selected from the group consisting of ammonium, alkali and alkaline earth metal nitrates, chlorates and perchlorates. Of these, sodium nitrate (SN) and calcium nitrate (CN) are preferred. From about 10% to about 65% of the total oxidizer salt may be added in particle or prill form.

Water generally is employed in an amount ^{preferably} of from about 2% to about 30% by weight based on the total composition. It is preferably employed in an amount of from about 10% to about 20%. Water-miscible organic liquids can partially replace water as a solvent for the salts, and such liquids also function as a fuel for the composition. Moreover, certain organic liquids reduce the crystallization temperature of the oxidizer salts in solution. Miscible liquid fuels ^{may} ~~can~~ include alcohols such as methyl alcohol, glycols such as ethylene glycols, amides such as formamide, and analogous nitrogen-containing liquids. ~~As is well known in the art, the~~ ^{The} amount and type of liquid(s) used can vary according to desired physical properties.

The emulsifiers of the present invention are ^{preferably} derivatives of polypropene or more preferably polyisobutylene, and preferably are used in an amount of from about 0.2% to about 5%. Since most isobutylene feedstocks are contaminated with 1-butene and



2-butene, certain manufacturers use the terms polybutene and polyisobutylene interchangeably or designate polymers derived from predominantly isobutylene feedstocks as "polybutenes." As used herein, the term "polybutene" shall include polyisobutylene. Similarly, the term "polypropene" shall include polypropylene. In emulsifiers prepared from such polymers, the polybutene or polypropene moieties form the hydrophobic ends of the emulsifier molecules. The molecular weights of hydrocarbon chains which are useful in the present application may ^{preferably} vary from 300 to 3000, but more preferably are from 500 to 1500 g/mole and particularly preferably from 700 to 1300 g/mole.

Hydrophilic moieties may be attached directly to the terminal double bond on polypropene or polyisobutylene chains, or may be attached via an intermediate linking group. The type of hydrophilic groups which are effective include acid anhydrides, carboxylic acids, amides, esters, amines, alcohols, oxazolines, imides or combinations thereof.

One type of linking group between hydrophilic and hydrophobic parts of these "polymeric emulsifiers" is succinic anhydride. The terminal olefin on polypropene or polyisobutylene is reacted with maleic anhydride via an "ene" reaction. The resulting polybutenyl or polypropenyl succinic anhydride readily reacts with amines or alcohols to form amides or esters. Depending upon the ratio of reactants and reaction conditions, mixed derivatives are possible. For example, if polybutenyl succinic anhydride is reacted at lower temperatures with one molar equivalent of ethanolamine, ring opening of the anhydride



occurs with the formation of amide or ester and carboxylic acid functional groups. Further heating of the product can be done to remove one equivalent of water and form an imide. If two equivalents of ethanolamine are reacted with polybutenyl succinic anhydride with sufficient heat to remove water, bis-amide bis-ester and mixed amide/ester products are possible.

A second type of linking group for polyisobutylene or polypropylene polymeric emulsifiers is phenol. The terminal olefinic group on polyisobutylene, for example, can be reacted with phenol via a Friedel-Crafts alkylation. Hydrophilic functionality can then be attached to the polyisobutenyl phenol via reaction with formaldehyde and a polyamine such as tetraethylene pentamine.

Direct attachment of hydrophilic groups on polyisobutylene or polypropylene can be done in a variety of ways. The terminal olefin on polybutene, for example, can be halogenated. Reaction of the resulting alkyl halide with an amine or polyamine can then be accomplished via bimolecular nucleophilic substitution of halide ion by amine. Similarly, polybutenyl epoxide can be reacted with acids or amines to attach a hydrophilic moiety onto a polybutene chain without the aid of a linking group.

The emulsifiers of the present invention can be used singly, in various combinations or in combination(s) with conventional emulsifiers such as sorbitan fatty esters, glycol esters, substituted oxazolines, alkyl amines or their salts, derivatives thereof and the like.

The compositions of the present invention are ^{preferably} reduced from their natural densities by addition of organic microspheres as density reducing agent in an amount sufficient to reduce the density to within the range of from about 0.9 to about 1.5 g/cc. The preferred organic microspheres are copolymers of vinylidene chloride and acrylonitrile ^{preferably} with an isobutane blowing agent. Other density reducing agents that may be additionally used include perlite and chemical gassing agents, such as sodium nitrite, which decomposes chemically in the composition to produce gas bubbles.

One of the main advantages of a water-in-oil explosive over a continuous aqueous phase slurry is that thickening and cross-linking agents are not necessary for stability and water resistancy. However, such agents can be added if desired. The aqueous solution of the composition can be rendered viscous by the addition of one or more thickening agents and cross-linking agents of the type commonly employed in the art.

The explosives of the present invention may be formulated in a conventional manner. Typically, the oxidizer salt(s) first is dissolved in the water (or aqueous solution of water and miscible liquid fuel) at an elevated temperature of from about 25°C to about 90°C, depending upon the crystallization temperature of the salt solution. The aqueous solution then is added to a solution of the emulsifier and the immiscible liquid organic fuel, which solutions preferably are at the same elevated temperature, and the resulting mixture is stirred with sufficient vigor to invert the phases and produce an emulsion of the aqueous solution in a



continuous liquid hydrocarbon fuel phase. Usually this can be accomplished essentially instantaneously with rapid stirring. (The compositions also can be prepared by adding the liquid organic to the aqueous solution.) Stirring should be continued until the formulation is uniform. The solid ingredients, including the organic microspheres then are added and stirred throughout the formulation by conventional means. The formulation process also can be accomplished in a continuous manner as is known in the art.

It has been found to be advantageous to predissolve the emulsifier in the liquid organic fuel prior to adding the organic fuel to the aqueous solution. This method allows the emulsion to form quickly and with minimum agitation.

Sensitivity and stability of the compositions may be improved slightly by passing them through a high-shear system to break the dispersed phase into even smaller droplets prior to adding the density control agent.

Reference to the following Table further illustrates the invention.

The examples in the Table indicate that to obtain the same composition density, glass microspheres were required in a weight amount of about six times that required with the organic microspheres used.

Data in the Table indicate that in all cases lower viscosity compositions are obtained with organic microspheres than with

glass microspheres at a similar composition density. For example, at -22°C in Mixes 5 and 6, glass microspheres gave a product viscosity of 28,200 cps while organic microspheres gave a product viscosity of 23,480 cps.

At 20°C compositions with a polybutene derivatized emulsifier have much better stability than compositions prepared with sorbitan monooleate, a commonly used emulsifier (see Mixes 1-4). Furthermore, at 20°C emulsions having a polybutene derivatized emulsifier in combination with organic microspheres (Mix 4) are more stable than formulations with glass microspheres (Mix 3). This appears to be opposite of what was found when sorbitan monooleate was the emulsifier, since a composition with glass microspheres was slightly more stable than one with organic microspheres (compare Mixes 1 and 2). (Sorbitan monooleate produced somewhat more stability at -13°C , however, than did the polybutene derivatives.)

Mixes 9-12 illustrate that two types of polybutene derivatized emulsifiers gave better cold temperature stability when used with organic microspheres than with glass microspheres.

Detonation results were obtained for Mixes 21 and 22. At 5°C , Mix 21 detonated in a 75mm diameter charge at 5.77 km/sec and had a minimum booster of 4.5g pentolite and a 25mm critical diameter. At -15°C , the respective figures were 5.52 km/sec, 4.5g and 32mm. Similarly, the respective figures for Mix 22 at 5°C were 5.52km/sec, 4.5g and 25mm. The respective figures for Mix 22 at -15°C were 5.77 km/sec, 4.5g and 32mm.

The compositions of the present invention can be used in the conventional manner. The compositions normally are loaded directly into boreholes as a bulk product although they can be packaged, such as in cylindrical sausage form or in large diameter shot bags. Thus the compositions can be used both as a bulk and a packaged product. The compositions generally are extrudable and/or pumpable with conventional equipment. The above-described properties of the compositions render them versatile and economically advantageous for many applications.

While the present invention has been described with reference to certain illustrative examples and preferred embodiments, various modifications will be apparent to those skilled in the art and any such modifications are intended to be within the scope of the invention as set forth in the appended claims.

TABLE

Mix No:	1	2	3	4	5	6	7	8	9	10	11
INGREDIENTS											
AN	63.7	64.7	63.7	64.7	63.5	64.8	63.1	64.8	63.1	64.8	63.1
CN (a)	14.9	15.1	14.9	15.1	14.8	15.1	14.7	15.1	14.7	15.1	14.7
H ₂ O	12.1	12.2	12.1	12.2	12.3	12.6	12.3	12.6	12.3	12.6	12.3
#2 Fuel Oil	4.37	4.44	4.37	4.44	5.73	5.85	5.70	5.85	5.70	5.85	5.70
Mineral Oil	1.32	1.34	1.32	1.34							
Emulsifier:											
(b)	1.09	1.11					1.09	1.12			
(c)			1.09	1.11	1.10	1.12			1.09	1.12	
(d)											1.09
(e)											
(f)											
(g)											
(h)											
Density Control:											
(i)	2.50		2.50								
(j)					2.50		3.00		3.00		3.00
(k)		1.00		1.00		0.50		0.50		0.50	
Density g/cc					1.23	1.17	1.17	1.19	1.19	1.13	
Storage Temp °C	20°	20°	20°	20°	-22°	-22°	-13°	-13°	-13°	-13°	-13°
Initial Viscosity at Storage Temp (cps)	15,720	12,440	16,880	11,200	28,200	23,480	22,200	19,880	33,760	22,200	20,400
Weekly Stress Mixing Rate (rpm)	1000	1000	1000	1000	1000	1000	500	500	500	500	500
Degree of Crystallization:											
1 Week	None	None	Slight	None	Slight	None	None	Slight	Slight	None	Slight
2 Weeks	Slight	Slight	Slight	Slight	Heavy	Mod.	Slight	Slight	Mod.	Slight	Heavy
3 Weeks	Slight	Mod.	Slight	Slight		Mod.					
4 Weeks	Mod.	Heavy	Mod.	Slight		Heavy					
5 Weeks	Heavy		Mod.	Slight							
6 Weeks			Mod.	Slight							
7 Weeks			Mod.	Slight							
8 Weeks			Mod.	Slight							

Key:

- a Fertilizer grade CN comprising 81:14:5 CN:H₂O:AN
- b Sorbitan monooleate
- c The reaction product of 1018 mol. wt. polybutenyl succinic anhydride and two equivalents of trihydroxymethyl amino methane. The active component is diluted to 65% activity with #2 fuel oil.
- d A 920 ave. mol. wt. polybutene, derivatized with a low molecular weight polyethylene polyamine via a phenolic linking group. The active ingredient is diluted to 45% activity with a petroleum distillate.
- e A low mol. wt. polyethylene polyamine derivative of a polyisobutenyl succinic anhydride.
- f An alkanolamine derivative of polyisobutenyl succinic anhydride diluted with a petroleum distillate.
- g The reaction product of 1018 mol. wt. polyisobutenyl succinic anhydride and one molar equivalent of diethanolamine. The active ingredients were diluted to 65% activity with #2 fuel oil.
- h Undiluted polyisobutenyl succinic anhydride with an average mol. wt. of 1018.
- i C15/250 glass microspheres from 3M.
- j B23/500 glass microspheres from 3M.
- k 551 DE organic microspheres from Expancel.

TABLE CONTINUED...

Mix No.:	12	13	14	15	16	17	18	19	20	21	22
INGREDIENTS											
AM	64.8	63.1	64.8	63.1	64.8	63.1	64.8	63.3	64.9	61.9	61.9
CN (a)	15.1	14.7	15.1	14.7	15.1	14.7	15.1	14.7	15.1	13.9	13.9
H ₂ O	12.6	12.3	12.6	12.3	12.6	12.3	12.6	12.3	12.6	16.6	16.6
#2 Fuel Oil	5.85	5.70	5.85	5.70	5.85	5.70	5.85	6.09	6.24	4.48	3.99
Mineral Oil										1.40	1.40
Emulsifier:											
(b)											
(c)										1.12	
(d)	1.12										1.13
(e)		1.03	1.12								
(f)				1.03	1.12						
(g)						1.03	1.12				
(h)								0.71	0.73		
Density Control:											
(i)											
(j)		3.00		3.00		3.00		3.00			
(k)	0.50		0.50		0.50		0.50		0.50	0.60	0.60
Density g/cc							1.21			1.12	1.13
Storage Temp °C	-13°	-13°	-13°	-13°	-13°	-13°	-13°	-13°	-13°		
Initial Viscosity at Storage Temp (cps)	18,280	-	23,600	-	29,560	>40,000	25,960	>40,000	>40,000		
Weekly Stress Mixing Rate (rpm)	500	500	500	500	500	500	500	500	500		
Degree of Crystallization:											
1 Week	Slight	Heavy	Slight	Heavy	Slight	Mod.	Slight	Mod.	Slight		
2 Weeks	Mod.	-	Mod.	-	Slight	Heavy	Heavy	Heavy	Heavy		
3 Weeks											
4 Weeks											
5 Weeks											
6 Weeks											
7 Weeks											
8 Weeks											

Key:

- a Fertilizer grade CN comprising 81:14:5 CN:H₂O:AM
- b Sorbitan monooleate
- c The reaction product of 1018 mol. wt. polybutenyl succinic anhydride and two equivalents of trishydroxymethyl amino methane. The active component is diluted to 65% activity with #2 fuel oil.
- d A 920 ave. mol. wt. polybutene, derivatized with a low molecular weight polyethylene polyamine via a phenolic linking group. The active ingredient is diluted to 45% activity with a petroleum distillate.
- e A low mol. wt. polyethylene polyamine derivative of a polyisobutenyl succinic anhydride.
- f An alkanolamine derivative of polyisobutenyl succinic anhydride diluted with a petroleum distillate.
- g The reaction product of 1018 mol. wt. polyisobutenyl succinic anhydride and one molar equivalent of diethanolamine. The active ingredients were diluted to 65% activity with #2 fuel oil.
- h Undiluted polyisobutenyl succinic anhydride with an average mol. wt. of 1018.
- i C15/250 glass microspheres from 3M.
- j B23/500 glass microspheres from 3M.
- k S51 OE organic microspheres from Expancel.

The claims defining the invention are as follows:

1. A water-in-oil emulsion explosive comprising a water-immiscible organic fuel as a continuous phase; an emulsified aqueous inorganic oxidizer salt solution as a discontinuous phase; a polypropene or polybutene derivatized emulsifier; and a copolymer of vinylidene chloride and acrylonitrile as a density reducing agent..
2. An explosive according to claim 1 wherein the density reducing agent is present in an amount sufficient to reduce the density of the explosive to within the range of from about 1.0 to about 1.5 g/cc.
3. An explosive according to claim 1 or 2 wherein the derivative or polypropene or polybutene is selected from the group consisting of carboxylic acids, acid anhydrides, amides, esters, amines, alcohols and mixtures thereof.
4. An explosive according to any one of the preceding claims wherein the emulsifier is a derivative of trishydroxymethylaminomethane and polybutenyl succinic anhydride.
5. An explosive according to any one of claims 1 to 3 wherein the emulsifier is a polyalkylenepolyamine derivative of polybutenyl phenol.
6. An explosive according to any one of claims 1 to 3 wherein the emulsifier is an alkanolamine derivative of polybutenyl succinic anhydride.
7. A blasting agent according to any one of the preceding claims wherein the organic fuel is selected from the group consisting of tall oil, mineral oil, waxes, benzene, toluene, xylene, petroleum distillates such as gasoline, kerosene, and diesel fuels, and vegetable oils such as corn oil, cottonseed oil, peanut oil and soybean oil.



8. An explosive according to any one of the preceding claims wherein the norganic oxidizer salt is selected from the group consisting of ammonium and alkali and alkaline earth metal nitrates, chlorates and perchlorates and mixtures thereof.

9. An explosive according to claim 8 wherein the inorganic oxidizer salt comprises ammonium nitrate in an amount of from about 10% to about 40% by weight.

10. A water-in-oil emulsion explosive comprising a water-immiscible organic fuel as a continuous phase in an amount of from about 3% to about 12% by weight based on the total composition; an emulsified aqueous inorganic oxidizer salt solution as a discontinuous phase, comprising inorganic oxidizer salt in an amount of from 20% to 55% and water in an amount of from 10% to 20%; particulate oxidizer salt in an amount of from 35% to 54%; a polybutene derivatized emulsifier in an amount of from 0.1% to 65% and organic microspheres as a density reducing agent in an amount sufficient to reduce the density of the explosive to within the range from 1.0 to 1.5 g/cc.

11. An explosive as claimed in claim 1, substantially as hereinbefore described with reference to any one of the examples.

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