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HIGH-ENERGY PLASTIC-BONDED EXPLOSIVE

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ABSTRACT OF THE DISCLOSURE

A high-energy, plastic-bonded explosive of the nominal composition 95 wt. percent HMX, 2.5 wt. percent Estane, and 2.5 wt. percent DNPAF having improved temperature stability and significantly better handling safety than standard plastic-bonded explosives.

BACKGROUND OF THE INVENTION

The invention described herein was made in the course of, or under, a contract with the U.S. Atomic Energy Commission. It relates to high explosives and more particularly to high-energy, plastic-bonded explosives.

Plastic-bonded explosives represent a class of explosives which can be made into pressings from which can be fabricated—usually by machining—desired shapes. These explosives are pressed from so-called molding powders which are typically prepared by the slurry technique. Powdered explosive and water are mixed in a kettle equipped with a condenser and agitator. A lacquer composed of the plastic (together with a plasticizer, if necessary) dissolved in a suitable solvent is added to the slurry. The solvent is removed by distillation, causing the plastic phase to precipitate out on the explosive. The plastic-explosive agglomerates into "beads" as the stirring and solvent removal continues. Finally, water is removed from the beads by filtration and drying; the resultant product is the molding powder. The powder is then pressed into shape by either compression molding with steel dies or hydrostatic or isostatic pressing under vacuum. The pressing may readily be machined into a desired shape for actual use.

A well-known and useful high-energy, plastic-bonded explosive is known as PBX–9404 and has the formulation 94 wt. percent HMX, 3 wt. percent NC (containing 12 wt. percent nitrogen), and 3 wt. percent CEF. Difficulties associated with PBX–9404 are that its handling safety is not as good as desired and it lacks sufficient thermal stability for use in certain high-temperature environment.

DEFINITION OF TERMS

As used within this application, HMX is an explosive having the chemical name 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane also designated as cyclotetramethylenetetranitramine; Estane is a trade name for a thermoplastic, polyurethane elastomer generally prepared from long chain diols and toluene diisocyanate and manufactured by the B. F. Goodrich Co.; DNPAF is a eutectic mixture of the formal and acetal of 2,2-dinitropropanol; NC is nitrocellulose; CEF is tris-(β-chloroethyl) phosphate; DPA is diphenylamine; and PBX means plastic-bonded explosive.

SUMMARY OF THE INVENTION

A plastice-bonded explosive containing 95 wt. percent HMX and having Estane as the plastic bonding agent, and DNPAF as the plasticizer has an explosive energy comparable to that of PBX–9404 but possesses greater temperature stability and significantly better handling safety. Optimum characteristics are exhibited by the composition 95 wt. percent HMX, 2.5 wt. percent Estane, and 2.5 wt. percent DNPAF.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The explosive of this invention is designated as PBX–9501.

PBX–9501 may readily be prepared in pilot plant quantities using the following slurry process. A lacquer of Estane and DNPAF is prepared by soaking 397 g. of Estane 5703, F–1 in 4.7 l. of 1,2-dichlorethane for a 12-hour period, adding 443 g. of DNPAF, and then heating and agitating the solution. The DNPAF weight is increased by a factor of 0.115 over 2.5 wt. percent to correct for loss of impurities and water solubility. An HMX slurry is prepared by mixing 23.25 lb. of coarse HMX and 10.00 lb. of fine HMX in 20 gal. of water. The slurry is then heated to 60° C. and 600 ml. of toluene is added. The toluene is used to control the particle size. It acts as a transient plasticizer and maintains a sufficient tack in the binder during the forming stage to allow the production of particles of the desired size. After toluene addition, the lacquer at 50° C. is added to the slurry and the resulting dispersion is heated to 85° C. The dispersion is cooled to 50° C. and filtered and the resulting powder is dried at 60° C. in a forced draft oven. This results in 35 lb. of powdered PBX–9501. The powder is then pressed into desired shape at 20,000 p.s.i. and 100° C. With three intensifications, over 99% of theoretical density is obtained.

Table I shows a comparison of the properties of PBX–9501 and PBX–9404. The handling safety of PBX–9501 is indicated by the skid test data of Table II. In the skid test, samples are skidded onto sandpaper targets at a 45° angle from the heights indicated. As used in Table II, N indicates no detonation and E indicates detonation. The H_{50} of 26 ft. and overpressure of about 0.7 p.s.i. are exceptional for a high-energy plastic-bonded explosive. Other materials in this energy class are markedly more sensitive and hazardous. For example, PBX–9404 has an H_{50} of 4 ft. and an over-pressure of 8 p.s.i. Table III compares the decomposition rates for the binders of PBX–9501 and PBX–9404, respectively, at the temperatures indicated. The compound DPA is added to the PBX–9404 to retard the decomposition of the nitro compounds contained therein. The PBX–9501 binder does not degrade autocatalytically as does that for PBX–9404 and degrades at a much lower rate.

TABLE I.—PROPERTIES

	9501	9404
Composition (wt. percent):		
HMX	95	94
Estane	2.5	
DNPAF	2.5	
NC		3
CEF		3
Theoretical density (g./cm.^{3})	1.855	1.866
Typical density (g./cm.^{3})	1.843	1.844
Cylinder-test comparison at 5 mm	0.995	1.000
Cylinder-test comparison at 19 mm	1.022	1.000
Plate-dent comparison (P_{CJ})	1.011	1.000
ρD^2 comparison (P_{CJ})	1.008	1.000
Detonation velocity (m./s.)	8,826	8,782
Vacuum stability (ml./g.—120° C./48 h.)	0.8	3.5
DTA exotherm (° C.)	240	180
Impact sensitivity (cm., 12/12B)	44/80	42/47
Small-scale gap (inch of brass)	0.060	0.097
Minimum priming (mg. Extex)	67	24
Spark sensitivity (joules, 3-mil Pb foil)	0.88	0.53

TABLE II.—SKID-TEST RESULTS—45°, SANDPAPER TARGETS

PBX-9501 (0.5 wt. percent calcium stearate)

Drop height (ft.)	Results											
64								E				E
32	E		E				N		E		N	
16		N		E		N				N		
8					N							

50% height, 25 ft. Overpressure—0.7 p.s.i. (avg.)

PBX-9501

Drop height (ft.)	Result									
64			E							
32		N		E		E		E		E
16	N				N		N		N	

50% height, 26 ft. Overpressure—no measured, but but E's judged to be of same magnitude as with calcium stearated version.

TABLE III.—ESTIMATED TIME FOR 3% DECOMPOSITION

° C.	Estane/DNPAF	NC/CEF + DPA
50	8.7×10^4 years	0.34 year.
75	4.7×10^2 years	3.7 days.
100	5.1 years	4.3 hours.
120	0.2 year	0.5 hour.

NOTE.—DTA and vacuum stability results given in Table I also demonstrate the greater thermal stability of PBX-9501 as compared with 9404.

What I claim is:

1. A high-energy, plastic-bonded explosive of the nominal composition 95 wt. percent 1,3,5,7-tetranitro-1,3,5,7-tetrazacylooctane, 2.5 wt. percent thermoplastic, polyurethane elastomer prepared by reacting long chain diols with toluene diisocyanate, and 2.5 wt. percent of a eutectic mixture of the formal and acetal of 2,2-dinitropropanol.

References Cited

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