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EVALUATION OF KRATON GX-6500
AS A BINDER MATERIAL

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Process Development
Endeavor No. 105

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ABSTRACT

A 23-kilogram batch of a 95% HMX/5% Kraton GX-6500 PBX formulation has been made and subjected to routine safety evaluation and preliminary physical properties screening. No unusual reactivity was seen; drop hammer sensitivity is similar to LX-10. Diametric disc test parts, pressed to about 98% of TMD at 281 MPa/120 C, indicate that the PBX strength lies between LX-04-1 and LX-09.

INTRODUCTION

Kraton GX-6500, a proprietary copolymer of Shell Chemical Corporation, was selected for preliminary evaluation as a potential binder for plastic bonded explosives. This thermoplastic rubber, a block-type copolymer A-B-A, where A represents the polystyrene end blocks and B represents a polyolefin midblock, may be thought of as a two-phase polymer consisting of polystyrene in a rubbery polyolefin matrix. It is stated to have good anti-weathering properties(1).

FORMULATION

Formulation of the HMX/Kraton GX-6500 PBX is relatively straightforward, using a modification of standard slurry manufacturing procedures. A brief outline of a procedure used to formulate the batch is as follows:

(1) Shell Chemical Corporation
Technical Bulletin SC:73-23

1. Weigh 1.134 kg of Kraton GX-6500 into a suitable container.
2. Dissolve the Kraton GX-6500 in 6.43 kg of toluene.
3. Weigh the HMX. This is to consist of (Wt. %):
65% Class A HMX = 14.005 kg
25% Special HMX = 5.386 kg (dry weight, usually handled wet)
10% Class B HMX = 2.155 kg (dry weight, usually handled wet)
4. Slurry the HMX in approximately 118 litres deionized water and stir at approximately 150 rpm for 30 minutes.
5. Add the Kraton GX-6500/toluene lacquer to the kettle and stir for 20 minutes.
6. Increase stirring to 200-250 rpm, add more deionized water (to approximately 250 litres) and

EXB

begin heating by circulating hot water through the jacket.

7. Heat the slurry, using a nitrogen sweep to remove the toluene, until the product temperature reaches approximately 98 - 100 C, or until the granules become firm and hard. This requires 1-1/2 to 2 hours.
8. Cool the slurry by circulating cold water in the jacket.
9. When cool (25 - 30 C) open the bottom drain valve and drop the slurry into a batch buggy and let drain.
10. Place the PBX granules in trays and dry in a recirculating air steam-heated oven at 102 - 110 C for a minimum of 16 hours.
11. When dry, load the PBX granules from the trays into approved shipping containers and ship to a staging area.

A total of three 23 kg batches of the PBX were made by this process. The first two batches were destroyed because high density foreign contaminants were found in the PBX batches. The third batch, No. 7082-148-01, was found to be free of high density foreign inclusions by X-ray.

EVALUATION PROCEDURE

After initial drop hammer sensitivity testing and compatibility testing on a 50 g sample, the larger batches of the HMX/Kraton GX-6500 PBX were then formulated. To obtain preliminary physical properties data diametric disc test parts were made by mechanical pressing at 281 MPa and 120 C.

EXPERIMENTAL DATA

A summary of evaluation data for Batch No. 7082-148-01 is given in Table I. Included in this table are bulk density, sieve analysis,

compositional analysis, drop hammer sensitivity, and CRT test data. The CRT test data show the gas evolved for small (0.25 g) samples held at 120 C for 22 hours for HMX, Kraton GX-6500, and for the 95/5 HMX/Kraton GX-6500 batch. The table also presents comparable properties for LX-14 (HMX/Estane 5702-F1) and LX-10-1 (HMX/Viton A). Figs. 1 through 3 show the DTA thermograms for HMX, Kraton GX-6500, and for a 50/50 mixture of the two, respectively.

The diametric disc specimens were produced by using a 19-mm diameter punch and die in a mechanical press. Several pressing conditions were tried which are summarized in Table II. The punch and die set was heated to the temperature shown before pressing. The percent TMD was compared. Pieces pressed at the lower temperature had a tendency to crumble. The higher temperature was required for acceptable parts.

Diametric disc specimens were tested according to the method outlined in MHSMP-76-30P(1) and the results are listed in Table III. The HMX/Kraton data are compared with LX-14, LX-04, LX-09, RX-03-BB and a TATB/Kraton GX-6500 formulation.

CONCLUSIONS

The HMX/Kraton formulation shows no unusual reactivity or sensitivity hazards for the limited tests conducted. The drop-hammer sensitivity is similar to LX-10. The CRT and DTA data indicate no reactivity problems.

- (1) L. C. Myers and H. D. Johnson, "An Evaluation of a Mechanical Property Test for Small Samples of Plastic Bonded Explosives," MHSMP-76-30P, April - June 1976.

Table I. Comparison of HMX/Kraton GX-6500 Characteristics with Other Materials

HE Lot No.	PBX Type	Bulk Density ρ (Mg/m ³)	Sieve Analysis					Compositional Analysis Wt % HMX	Drop Hammer Sensitivity H ₅₀ in cm		Chemical Reactivity Test μ l g Evolved in 22 Hrs @ 120 C						
			Wt % Retained on SS				No.		12A	12B	N ₂	O ₂	CO ₂	N ₂ O	H ₂ O	Acetone	Total
7082-148-01	HMX/Kraton GX-6500	0.9	0	87.1	12.7	0.2	0	95.2 $\pm$ 0.7	36	48	3.36	0.68	1.41	5.19	0.18	-	10.82
4074-131-01	LX-14-0 (HMX/Estane 5702 F1)	0.9	30.7	64.4	4.4	0.4	0.1	95.12 $\pm$ 0.47	33	75	2.77	-	4.03	6.99	0.37	0.87	15.03
6155-150-01	LX-10-1 (HMX/Viton A)	1.0	0	75.1	23.4	1.5	0	94.3 $\pm$ 0.2	30	55	12.0	-	2.00	2.00	TR	TR	16.00
920-27	HMX	-	-	-	-	-	-	100.0	15	28	6.08	1.36	1.09	6.13	0.17	-	14.83
Kraton GX-5500	-	-	-	-	-	-	-	-	-	-	2.28	0.77	5.26	-	0.10	-	8.41

Fig. 1. DTA Thermogram for HMX

Fig. 2. DTA Thermogram for Kraton GX-6500

Fig. 3. DTA Thermogram for HMX/Kraton GX-6500

The Diametric Disc test data in Table III indicate that the HMX/Kraton formulation offers no unusual advantages over LX-14, LX-04, or LX-09 in mechanical strength.

Kraton GX-6500 may have a long-term stability advantage over other binders. However, this aspect is yet to be evaluated.

Table II. Pressing Conditions

Pressure (MPa)	Temperature (C)	Density (Mg/m ³)	% TMD
207	93.3	1.41	78.2
345	93.3	1.44	79.9
281	120.0	1.776	98.6

Table III. Diametric Disc Test Results

	Pressing Temperature (C)	Density (Mg/m ³)	% TMD	Failure	
				Stress (Kpa)	Strain (%)
HMX/Kraton GX-6500 ^a	120.0	1.776	98.57	825	0.21
LX-14 ^b	120.0	1.834	99.19	2106	0.44
LX-04-1 ^b	120.0	1.865	98.73	933	0.91
LX-09 ^b	90.6	1.839	98.50	623	0.61
LX-09 ^c	90.6	1.835	98.30	885	0.42
RX-03-BB ^b	120.0	1.899	97.69	4182	0.59
RX-03-BB ^c	120.0	1.905	98.00	4751	0.41
TATB/Kraton GX-6500 ^d	120.0	1.796	97.91	3310	0.91

^aParts pressed to shape in a mechanical press

^bFrom MHSMP-76-30P - Parts machined from isostatic pressings

^cFrom MHSMP-76-30P - Parts machine-faced from mechanical pressings

^dFrom MHSMP-76-46D - Parts pressed to shape in a mechanical press

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