RDX/SYLGARD EXTRUDABLE EXPLOSIVE DEVELOPMENT

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Process Development
Endeavor No. 103

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ABSTRACT

Formulation procedures for X-0208, an 80% RDX/20% Sylgard extrudable, have been developed. The extrudable explosive, made from a mixture of micronized RDX and Class E RDX, will sustain detonation in a 1.65 mm (0.065-inch) channel and can be mechanically extruded into ribbon-type configurations.

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INTRODUCTION

The firing performance criteria established by LASL for X-0208 consist of detonability and propagation in a 1.65 mm channel. Most conventional RDX crystal types, however, are not sufficiently sensitive to propagate in a channel of that diameter. Therefore, the initial phase of the development was the preliminary selection of an RDX crystal size of sufficient sensitivity. After surveying several RDX crystal types the micronized RDX crystal was selected as the most sensitive(1).

Conventional Class E RDX can be mixed into the extrudable formulation in various proportions, within limits, without significantly altering sensitivity in order to achieve the appropriate texture or consistency. The

final phase of the endeavor included developing a loading procedure and an extrusion test method, and verifying detonability.

EXPERIMENTAL PROCEDURE

After the selection of the precipitation method, twenty-two 2.3 kg batches of RDX were processed in the micronizer. A 5% RDX/acetone solution was metered into the micronizer chamber at 409 cc/min. Water setting was 953 cc/min with the air pressure set at 100 psi. Run time was 2 hours 18 minutes.

These small batches were sampled prior to wet blending in the 300-gallon kettle to provide a single 47 kg lot of micronized RDX.

Several of the samples were used to make small 100 g batches of X-0208. A sample of the blend was also made into an extrudable. The procedure included hand blending RDX and the

(1) A. G. Osborn, et. al., "RDX/Sylgard Extrudable Explosive Development," March 1977, MHSMP-77-18B.

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catalyzed Sylgard in a small cup and then mill the composition on the laboratory 3-roll mill for 15 passes.

EXPERIMENTAL DATA

Extrudability samples were subjected to various tests as reported in Tables I and II. Extrudability was measured in two configurations: (1) in a sunburst arrangement as shown at the top of Fig. 1, and (2) in a ribbon-type arrangement as shown at the bottom of Fig. 1. Fig. 2 shows the test fire fixture. Table I contains data from the extrudable made from 75% mixtures of the small 2.3 kg RDX batches with Class E RDX. Table

II presents extrudability and firing data obtained by varying the percent Class E RDX mixed with the blended lot. Fig. 4 presents a photomicrograph of a sample of the blended lot (No. 7236-01).

Extrudability data for the 75% micronized/25% Class E mixtures are graphically represented in Fig. 3 to show the effect of the surface area (determined by Fisher Sub-Sieve Sizer) of the micronized RDX on mean extrudability. Several of the small micronized batches are repeated, and the 75% mixture of the blend (Table II) is also included in the results presented in Fig. 3.

Fig. 1. Extrudability Test Configurations

Fig. 2. X-0208 Test Fixture

Table I. Extrudability of 75 Micronized/25 Class E RDX

RDX/Sylgard Lot No.	2.3 kg Batches Micronized RDX Lot No.	S_o^p (m ² /kg)	Extrudability	
			Sumburst (mm)	Ribbon
7131-02	7123-01	1415	0.0 ± 0.0	No Fill
7213-03	7123-01	1415	0.0 ± 0.0	No Fill
7131-01	7122-01	1355	5.6 ± 1.6	No Fill
7096-01	7087-01	1330	0.8 ± 0.1	No Fill
7131-04	7125-01	1325	0.0 ± 0.0	No Fill
7124-01	7118-01	1265	12.8 ± 1.6	No Fill
7213-02	7088-01	1240	21.9 ± 3.1	No Fill
7117-01	7115-01	1205	12.1 ± 6.9	No Fill
7131-03	7069-01	1150	14.4 ± 3.5	No Fill
7070-02	7069-01	1145	32.4 ± 4.2	Partial Fill
7061-01	7056-01	1070	28.0 ± 5.3	Partial Fill
7200-01	7056-01	1070	47.9 ± 10.6	Partial Fill
7210-01	7055-01	1070	18.2 ± 2.1 ^a	Partial Fill
7161-02	7159-01	950	41.9 ± 10.3	Full
7200-03	7159-01	950	31.6 ± 6.4	Full
7168-05	7167-01	920	62.1 ± 5.5	Full
7200-04	7167-01	920	53.2 ± 11.5	Full
7161-03	7160-01	915	58.7 ± 11.6	Full
7213-01	7160-01	915	42.9 ± 4.7	Full
7168-04	7166-01	830	82.3 ± 0.0	Full
7168-02	7165-01	815	82.3 ± 0.0	Full
7168-03	7165-02	795	82.3 ± 0.0	Full
7168-01	7164-01	740	82.3 ± 0.0	Full
7213-04	7164-01	740	82.3 ± 0.0	Full

^aThe value is one standard deviation

Table II. Mix Ratio Testing - Class E/Micronized RDX 47 kg Blended Lot

RDX/Sylgard Lot No.	Micronized HE Lot No.	Ratio Micronized Class E	Micronized RDX S_o^p (m ² /kg)	Micronized BET S_o^p (m ² /kg)	Extrudability			Firing Performance in Track			
					1.65 mm Channel		Ribbon	1.40 mm	Dent Depth	1.65 mm	Dent Depth
7243-01	7236-01	75/25	750	1175	70.5	8.7	Full	Go	0.005	Go	0.006
7252-01	7236-01	70/30	750	1175	82.3	0.0	Fill	No Go	-	Go	0.006
7252-02	7236-01	60/40	750	1175	82.3	0.0	Fill	No Go	-	Go	0.006
7243-02	7236-01	50/50	750	1175	82.3	0.0	Full	No Go	-	Go	0.006
7243-03	7236-01	40/60	750	1175	82.3	0.0	Partial Fill	No Go	-	No Go	-

Fig. 3. Effect of Surface Area on Extrudability

DISCUSSION

The X-0208 batches made from the micronized RDX batches exhibited a wide variation in extrudability, with the best extrudability resulting from micronized RDX with a Fisher surface area (S_o^P) in the range of 750 m²/kg as shown in Fig. 3. The best fit line for the data is shown.

The resulting equation for the line is $E = -0.10780 (FS_o^P) + 148.35153 + \epsilon$ where ϵ is an error term assumed to be normally distributed with a zero mean and standard deviation equal to 8.66 (the standard error of estimate for the fit). The correlation coefficient is -0.93, which, for 12 degrees of freedom, is significant at better than the 0.001 level. In other words, we can be more than 99.9% certain that there is a linear relationship between extrudability and surface area. However, this does not necessarily mean the line we have obtained is good for prediction. The data contain a large amount of variation (probably due to uncontrolled factors, such as temperature, time from manufacture to testing etc.) and limited data are available.

Fig. 4. Micronized RDX
Lot 7236-105M-01
 $S_o^P = 750$ m²/kg
 $S_o^G = 1175$ m²/kg

The slope and intercept for the fit are subject to error and thus lead to uncertainties in predicted values. The most positive statement that can be made is that a significant linear relationship exists between extrudability and surface area - extrudability decreases as surface area increases. By carefully controlling other variables in addition to surface area, very probably meaningful predictions could be made from the surface area measurements.

The 47 kg blended lot gave a Fisher surface area (S_o^P) of 750 m²/kg, which was lower than expected because many of the extremely fine RDX crystals disappeared upon blending. However, as shown in Table II, extrudability is acceptable.

Of primary interest was the detonability in a 1.65 mm channel. The X-0208 made from the blended lot, Table II, propagated a detonation in all cases but one in the 1.65 mm channel, even with as much as 50% Class E RDX in the formulation.

When 60% Class E was added, no propagation was observed. Any composition up to 50% Class E will meet the LASL test criteria.

CONCLUSIONS AND FUTURE WORK

A mixture of up to 50% Class E RDX with 50% micronized RDX may be used to formulate the LASL extrudable X-0208. The resulting formulation meets the LASL evaluation criteria. Sufficient micronized RDX is available to produce to 117 kg of X-0208.

A linear equation was developed to predict the extrudability of the material. The fit was good and the resulting 47 kg lot of micronized RDX yielded a batch (7243-01) which fell close to the predicted range. More significantly, the ribbon was filled completely.

Further work is required to transfer the technology to production. A 76 x 127 mm laboratory 3-roll mill and a small mixer (one-litre size) to manufacture the extrudable will be required. Quality Acceptance procedures will be developed.

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