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LX-13 Processing

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MASTER

DEVELOPMENT DIVISION

OCTOBER - DECEMBER 1975

Normal Process Development
Endeavor No. 102

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ABSTRACT

Results were obtained from five LX-13 batches formulated from PETN precipitated previously by the continuous method. Extrudability results indicate that a reduced temperature improves extrudability. Detonability was improved over previous continuous batches.

Three additional batches of PETN have been precipitated at reduced temperatures to evaluate the effect of temperature on extrudability and detonability.

DISCUSSION

DETONATION VELOCITY TESTING

The five PETN batches precipitated previously, three last quarter and two in the second quarter of 1975, were formulated into LX-13 and the extrudability and detonability of the LX-13 were evaluated as before. The results are presented in Table I. Also presented for comparison are LX-13 lots (the last three appearing on the table) prepared from a typical batch-precipitated PETN batch and from typical batches of continuously precipitated PETN which have been reported previously. Details of the formulation parameters used in the five batches of PETN tested are given in Table II along with those batches precipitated this quarter at reduced temperatures which are yet to be tested.

The results in Table I indicate that some improvement in extrudability and detonability have been achieved. Except where noted, all detonation velocities and extrudability results in Table I are averages of measurements on two test blocks loaded from each LX-13 lot. Partial burns were experienced where previously failure to propagate had occurred. The extrudability of the LX-13 lots from each of the first five PETN batches listed in Table I was comparable to that of the previous LX-13 batches shown, which were made from a different parent lot of PETN. (The original PETN lot was changed between batches ending with 5150-02, and batches starting with 5156-01 due to size limitation of the Mil Spec lot.) Comparison of results from different parent lots indicates that the purification of the PETN does eliminate some of the variations between lots such as those observed by production.

The highest overall extrudability (of the five new batches reported) was attained with PETN batch 5259-02, which was made with the small (32 mm) tapered impeller at the lower flow rates and low temperature and agitator speed. However, batch 5259-01, made with the small impeller at the low flow rates, the high (21 C) temperature, and high agitator speed had comparable extrudability with the LX-13 made from production's batch precipitated PETN. Detonation velocities for each batch indicate that batch 5259-01 was slightly better than 5259-02 because one of the DV blocks on batch 5259-01 fired enough to measure the velocity and the other stopped before the seventh (next to last) port on the DV block, whereas 5259-02 stopped at the fifth port of the 15 mil track on one DV block and at the second port of the 15 mil track on the other block.

The phenomenon of incomplete firing in any of the tracks also occurred in batches 5156-01 and 5156-02, possibly indicating a separation problem is occurring in the narrower channels. The low reading of 6.994 km/sec in the 15 mil track on batch 5156-01 might also support this theory. Further work will be done to try to eliminate this problem.

PETN FORMULATION

Continuing the partial factorial experiment outlined last quarter, three more batches of PETN were formulated this quarter for further evaluation of the temperature effect on LX-13 properties. The three batches were planned to simulate conditions used previously in order to evaluate the effect of flow rates, agitation, and impeller size at the lower temperatures on the extrudability and detonability of PETN. Conditions used are summarized in Table II accompanied by the resulting air permeametry [So(P)] and gas adsorption [So(G)] surface areas. Photomicrographs of samples of each of the three batches at a magnification of 160X were obtained and are presented in Fig. 1. LX-13 batches are currently being formulated from each of the three PETN batches. Extrudability results and detonation velocities will be reported in the next quarterly report.

Some difficulty was encountered in lowering the temperature of the water at the high flow rates used in batches 5304-01 and 5304-02, but the surface areas seem to indicate the slightly higher temperature (11 C versus 8 C) did not affect the crystal formation greatly. A new design for the heat exchanger used is in process and when complete will improve the cooling capabilities and allow closer control of the temperature.

CONCLUSIONS, COMMENTS AND FUTURE WORK

The extrudability and detonability of LX-13 formulated from continuously precipitated PETN can be improved by maintaining a relatively slow flow rate, by varying the speed of the small impeller and/or by lowering the temperature of the water. The extrudability and detonability of thermally purified PETN are not affected appreciably by the differences between lots of Mil Spec PETN.

Further work will be done at both low (approximately 8 C) and the higher temperatures (approximately 21 C) to evaluate other variables in the formulation of PETN (drying method, feed method, and water-acetone flow ratio). Efforts will continue to develop the continuous process as a method of eliminating lot-to-lot variations in LX-13 performance.

Table I. PETN/LX-13 Results

Batch No.		PETN Surface Area (m2/kg)		PETN Batch Size	Length Extruded Down The Track (mm) Track Size In Inches			Detonation Velocity (km/sec) Track Size In Inches			
PETN	LX-13	FSSS So(P)	Perkin Elmer So(G)	(kg)	0.015	0.020	0.035	0.015	0.020	0.035	0.080
5156-01	20-75-1020-205	490	960	4.0	13.7	17.8	37.8	6.994[a]	7.185	7.330	7.335
5156-02	20-75-1023-206	455	1090	4.0	10.2	11.4	25.6	PB[d]	7.211[b]	7.342	7.329
5258-01	20-75-1027-209	415	1050	4.0	16.5	29.5	63.5	F	7.095	7.272	7.314
5259-01	20-75-1024-208	500	1170	4.0	18.7	40.4	81.7	7.206[c]	7.252	7.356	7.332
5259-02	20-75-1025-207	410	840	4.0	24.6	31.5	105.6	PB[e]	7.225	7.347	7.346
5150-02	20-75-0717-193	455	755	4.0	14.7	15.7	58.8	7.204	7.239	7.323	7.340
5038-01	20-75-0313-182	375	845	3.6	32.5	51.6	178.3	F	F	7.351	7.295
*	20-73-1120-116	605	870	18.0	34.3	41.7	77.7	7.230	7.250	7.265	7.265

**PETN Batch No. 10-73-0294-103; a production batch-precipitated PETN batch.*

F = Failed to propagate

PB = Partial burn - did not obtain reading on either block.

[a] *Burn stopped before 4th port on one block; 2nd block fired*

[b] *Burn stopped before 2nd port on one block; 2nd block fired*

[c] *Burn stopped before 7th port on one block; 2nd block fired*

[d] *Burn stopped before 6th port on one block; 5th port on the other*

[e] *Burn stopped at 5th port on one block; 2nd port on the other*

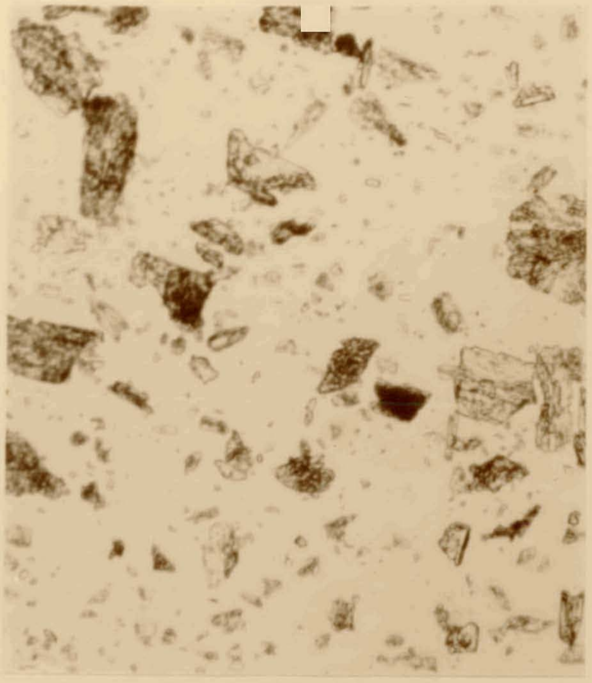
Table II. Formulation Procedures

PETN Batch No.	Batch Size (kg)	Acetone Flow Rate (cm^3/sec)	Water Flow Rate (cm^3/sec)	Water Temperature (C)	Impeller Diameter (mm)	Agitator Speed (rpm)	Surface Area So(P) (m^2/kg)	So(G) (m^2/kg)
5156-01	4.0	13.42	46.67	21	64[a]	1000	490	960
5156-02	4.0	13.42	46.67	21	64[a]	2000	455	1090
5258-01	4.0	13.42	46.67	21	64[a]	1000	415	1050
5259-01	4.0	8.08	26.35	21	32	2000	500	1170
5259-02	4.0	8.08	26.35	8	32	1000	410	840
5304-01	4.0	13.42	46.67	11	32	1000	355	825
5304-02	4.0	13.42	46.67	11	32	2000	375	835
5304-03	4.0	8.08	26.35	8	64[b]	1000	375	855

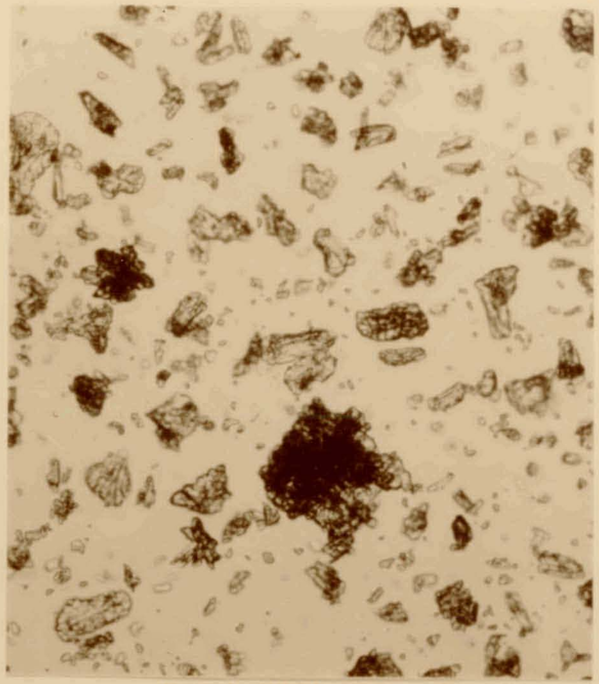
[a] *A 64 mm diameter turbine impeller with six flat blades, each 10 mm wide, pitched at 45 degrees to throw material down when rotated clockwise.*

[b] *A 64 mm diameter impeller with six tapered blades*

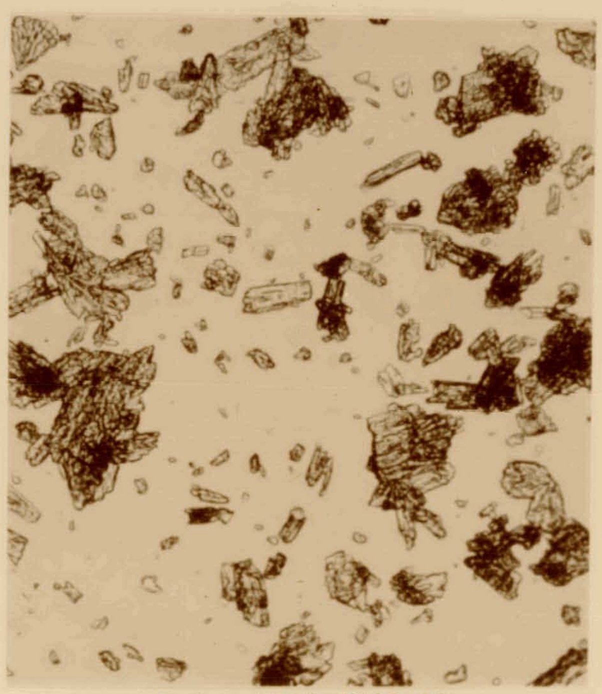
All PETN batches thermally purified twice from DuPont Mil Spec PETN Lot. 398.



Batch 5304-304C-01
So(P) = 355 m^2/kg
So(G) = 825 m^2/kg



Batch 5304-304C-02
So(P) = 375 m^2/kg
So(G) = 835 m^2/kg



Batch 5304-304C-03
So(P) = 375 m^2/kg
So(G) = 855 m^2/kg

Fig. 1. Photographic Samples of Formulated PETN at 160 X Magnification (Temperature Effect on LX-13 Properties)