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TATB PBX FORMULATIONS

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DEVELOPMENT DIVISION

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Endeavor No. 106

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ABSTRACT

A series of six processing parameter studies were conducted in the 30-litre reactor. Batch concentration emerged as the most important single variable affecting physical properties other than granule size which has previously been reported.

INTRODUCTION

Since the beginning of the production of TATB PBX there has been a large degree of variability in the physical properties of the pressed material. It became apparent very early that much of the variability in physical properties could be attributed to PBX processing or manufacturing techniques. The first parameter found to significantly affect physical properties was the granule size of the molding powder. This was determined by viewing the manner in which the physical test specimens broke. In the case of the LLL B4, which had large granules, breakage was along the PBX granule boundaries. An in-depth discussion of granule size effects has been given previously(1). It will not be addressed in this series of processing experiments because the formulation process has been adjusted to produce small uniform granules. Other variables including concentration, TATB particle size and processing time were evaluated this quarter.

DISCUSSION

LARGE SCALE PBX PRODUCTION

The following lots of TATB PBX were formulated:

RX-03-AB - 90% TATB/10% Kel-F 800

Lot No. 5184-133-02	350 kg
Lot No. 5227-133-01	294 kg
Lot No. 5268-133-01	297 kg

RX-03-BB - 92.5% TATB/7.5% Kel-F 800

Lot No. 5218-145-01	272 kg
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RX-03-AU - 95% TATB/5% Kel-F 800

Lot No. 5246-141-01	45 kg
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The RX-03-BB and the RX-03-AU were made from the 309 kg TATB powder blend, No. 5175-135-01, LLL B7, blended in the Day Nauta Mini-Mixer last quarter.

(1) H. D. Johnson, A. G. Osborn, T. L. Stallings, "TATB PBX Formulation," MHSMP-75-5M, October - December 1974.

The compression and tensile strength curves of PBX made with LLL B7 are given in Figs. 1 and 2, respectively. Also included for comparison are results from previous lots. The overall trend for each successive lot of PBX to have improved properties is clearly shown. The reason for this will be discussed and illustrated in the next section of this report (Processing Parameter Study). All the physical properties data presented are summarized in Table I.

PROCESSING PARAMETER STUDY

The purpose of this series of experimental studies is to more precisely identify the major contributing factors affecting physical strength. Those factors suspected of affecting physical properties have been included for examination.

For practical considerations this study was conducted predominately in the 30-litre reactor. Unless otherwise stated, the processing parameters and materials conditions were as follows:

Vessel - 30-litre reactor
TATB - LLL B6 Lot 5123-135-01
Kel-F 800 - Lot 552 - precipitated from acetone
Batch Size - 1.8 kg - 96 g of HE per litre of water
Processing Time - 1 hr
Pressing Size - 3.4 kg

Test conditions for physical properties specimens were:

Compression - 0.001 mm/sec constant crosshead speed
Tensile - 0.002 mm/sec constant crosshead speed

A constant pressing size of 3.4 kg was chosen because of variations in physical properties observed between specimens made from small 2-7 kg pressings and larger 100 kg pressings. Pressed density is not reported here because generally density has not been a problem; it has been on the order of 1.900 Mg/m³.

The basic slurry procedure is to strip the solvent in the kettle until small hard granules are formed. The granules are not pulled "green" (with much solvent remaining). This is the same procedure used in the past for producing large quantities of PBX.

I. BATCH CONCENTRATION

Physical strength data for the batch concentration experiments are shown in Figs. 3 and 4. Maximum stress and strain at complete failure are shown as functions of batch concentration in Fig. 5. Results obtained from material made in the 300-gallon kettle are also included for comparison. Fig. 6 shows examples of specimen breakage. Notice that the largest batch, 7.3 kg, with the poor strength failed at the granule interface although the granules are small. Batch concentrations of 100

to 140 grams TATB per litre of water produced near optimum physical properties.

II. PROCESSING TIME

The effects of processing time are shown in Figs. 7 and 8 and summarized in Fig. 9. Previous work indicated that the length of time the PBX was in the kettle affected physical properties, i.e., the longer the batch remained in the kettle after the stripping of the solvent began, the poorer the properties. Therefore, this series was run for 1 hour to 3 hours. The compression data show a loss in strain at 3 hours, however, the tensile data do not show a clear difference. It is concluded from these results that a processing time of 1.5 to 2 hours is satisfactory.

III. COMPARISON OF KEL-F LOTS

The effects of Kel-F purity are given in Figs. 10 and 11. The precipitated Kel-F 800 was dissolved in acetone and precipitated into water prior to being made into a lacquer. Removal of the emulsifier by this technique aided in obtaining the exact composition but did not result in improved physical properties compared with Kel-F as received from the manufacturer. This indicates that there is no real physical property advantage in the use of precipitated Kel-F 800.

IV. TATB MANUFACTURER AND PARTICLE SIZES

There appears to be variations in particle size distribution between manufacturers of TATB although this series is incomplete and additional work is necessary before firm conclusions can be drawn. The physical strength curves for formulation batches made from various lots of TATB are shown in Figs. 12 and 13 and the TATB particle size distributions are shown in Figs. 14 and 15. These data are currently being subjected to statistical correlation in order to evaluate possible relationships. Physical properties do appear to be a function of the TATB source and particle size distribution.

V. EVALUATION OF CORDOVA LLL B7

Blend 7 of RX-03-BB as shown in Figs. 1 and 2 gave excellent mechanical properties. Sub-batches and a 30-litre batch are compared in Figs. 16 and 17. Data obtained in the 30-litre reactor on the LLL B7 are very similar to those produced in the larger 300-gallon kettle. The data from the sub-batches are similar to that from the blend.

V. MISCELLANEOUS

A formulation with 10% Kel-F has higher tensile and compression strain than the 7.5% Kel-F batches. Data are presented in Figs. 18 and 19. Other variables investigated which appeared not to affect physical strength were (1) treating the TATB crystals with a surface active agent, the polysaccharide MRL 22A, prior to making the TATB into PBX, (2) the use of a non-porous TATB crystal which was synthesized by a water amination process, and (3) the use of acid washed TATB.

CONCLUSIONS

The latest large PBX blend, LLL B7, gives superior mechanical properties to previous blends. As a result of the past and present processing experiments, it is concluded that next to PBX granule size, the batch concentration, i.e., the ratio of HE to water, has the strongest influence on physical strength. Now that some of the factors affecting physical strength have been identified and it is possible to reproducibly make "good" lots of TATB PBX of any size, experimental studies and statistical correlations will be made to understand how these factors influence strength.

Table I. TATB Physical Properties

Lot No.	Process Description	Compression		Work To Rupture (kJ/m ³)		Tension	
		Stress (MPa)	Strain (%)	Compression	Tensile	Stress (MPa)	Strain (%)
RX-03-BB BLENDS							
4221	Powder Only	19.51	1.8	277.7	1.5	4.41	0.06
4288	Kel-F 551, 233 kg, LLL B4	*	*	*	3.4	5.51	0.09
5055	Kel-F 551, 117 kg, LLL B5	17.05	4.73	699.7	9.7	7.31	0.22
5136	Precipitated Kel-F 552, 105 kg, LLL B6,	14.13	5.82	718.5	18.1	10.70	0.26
5218	Precipitated Kel-F 552, 93 kg, LLL B7	20.45	5.81	1007.4	19.2	9.71	0.28
BATCH CONCENTRATION							
5196-03	1.8 kg/96 g/l ^a	18.38	6.2	978.8	12.9	8.45	0.26
5190-03	2.7 kg/132 g/l	18.24	5.8	923.6	18.2	8.76	0.32
5196-04	3.6 kg/180 g/l	18.13	4.9	726.4	9.6	7.38	0.18
5192	5.4 kg/276 g/l	18.61	1.9	270.4	11.3	7.94	0.25
5191	7.3 kg/360 g/l	17.40	2.0	269.8	7.5	7.05	0.19
PROCESSING TIME							
5176-03	1.0 hr ^b	16.70	7.0	996.1	12.3	7.78	0.25
5196-03	1.5 hr ^a	18.30	6.2	1009.1	14.4	8.45	0.26
5197-03	2.0 hr	16.97	7.6	1102.9	18.5	8.73	0.33
5205-03	3.0 hr	18.60	5.2	863.9	15.1	8.73	0.29
COMPARISON OF KEL-F							
5206-05	552 Plain	17.91	7.1	1064.3	17.4	8.07	0.30
5176-03	552 Purified ^b	16.70	7.0	996.1	12.3	7.78	0.25
5210-03	553 Purified	17.73	7.6	1102.3	11.7	8.40	0.22
5210-06	554 Purified	17.04	6.5	923.4	11.9	7.94	0.23
TATB MANUFACTURERS AND PARTICLE SIZE							
5212-03	Cordova Coarse (Lot 004)	18.95	6.4	1184.0	3.1	7.43	0.07
5232-06	PX Coarse (5178-16-02)	16.38	7.0	971.0	10.4	7.00	0.23
5213-03	Cordova Bimodal (Lot 007)	21.58	4.8	924.8	13.9	9.51	0.22
5226-06	PX BiModal (5174-16-02)	17.26	6.6	974.1	13.4	7.79	0.26
5213-06	Cordova Fine (Lot 003)	20.14	4.5	791.4	20.4	9.61	0.31
5226-03	PX Fine (4128-16-01)	18.51	7.5	1188.0	11.0	7.97	0.20
CORDOVA LLL B7							
5216-03	30-Litre Reactor (1.8 kg)	22.32	5.5	1018.7	18.6	10.40	0.30
5209	300-Gal Sub-Batch 132 g/l	19.79	7.5	1309.6	19.0	9.88	0.33
5206	300-Gal Sub-Batch 132 g/l	19.63	6.2	1036.7	21.9	9.76	0.32
5218	Blend 7	19.93	6.0	1004.4	19.6	9.77	0.28
MISCELLANEOUS							
5176-03	Control ^b	16.70	7.0	996.1	12.3	7.78	0.25
5211-03	TATB/MRL 22A	17.81	7.6	1120.7	10.8	8.02	0.20
5216-06	Water-Aminated TATB	18.21	6.2	1004.1	11.4	7.85	0.22
5211	10% Kel-F 800	16.38	8.6	1174.5	23.3	8.23	0.40
5233-03	Acid Washed TATB	17.27	6.2	955.6	13.6	7.60	0.27

* No data available - used different method

^a Same batch

^b Same batch - Control

NOTE: Unless otherwise stated conditions were: 30-litre reactor. LLL B6 TATB. purified Kel-F Lot 552: 1.8 kg (4 lb) batch size. 1 hr processing time. 96 g HE/litre water (0.8 lb HE/gal water), 3.4 kg (7.5 lb) pressing.

Fig. 1

RX-03-BB 7.5% KEL-F 800 COMPRESSION TESTS

Fig. 2

RX-03-BB 7.5% KEL-F 800 TENSILE TEST

Fig. 3

RX-03-BB BATCH CONCENTRATION COMPRESSION TESTS

F-10

Fig. 4
RX-03-BB BATCH CONCENTRATION - TENSILE TEST

Fig. 5

RX-03-BB - MAXIMUM STRESS & STRAIN at FAILURE

Fig. 6
Broken Test Specimen

Fig. 7

RX-03-BB PROCESSING TIME - COMPRESSION TEST

Fig. 8

RX-03-BB PROCESSING TIME - TENSILE TEST

Fig. 9

RX-03-BB - MAXIMUM STRESS & STRAIN at FAILURE

Fig. 10

RX-03-BB KEL-F COMPARISON - COMPRESSION TEST

Fig. 11

RX-03-BB KEL-F COMPARISON - TENSILE TEST

Fig. 12

RX-03-BB TA 'B' MANUFACTURERS PARTICLE SIZE COMPRESSION TEST

Fig. 13

RX-03-BB TATB MANUFACTURERS PARTICLE SIZE TENSILE TEST

Fig. 14

Sieve Analysis of Cordova Chemical Co. Synthesized TATB

Fig. 15

Sieve Analysis of Pantex Synthesized TATB

Fig. 16

LLL B7RX-03-BB COMPRESSION TEST

Fig. 17

LLL B7 RX-03-BB TENSILE TEST

F-24

Fig. 18
COMPRESSION TEST

Fig. 19
TENSILE TESTS