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DEVELOPMENT DIVISION

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Process Development
Endeavor No. 106

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ABSTRACT

Pantex formulated RX-03-BB TATB PBX now being produced has physical properties which are acceptable and consistent from lot-to-lot and batch-to-batch. The latest eight large lots, which varied in size from 225 to 544 kg, have consistent tensile strengths and tensile strains in excess of 0.3%. The particle size distributions of the TATB lots used were correlated to physical properties by subjecting the data to a least square linear regression. The physical properties of the PBX are not strongly affected by the TATB particle size distribution.

A comparative physical properties test series conducted between Pantex and LLL showed that the sets of data are in close agreement.

INTRODUCTION

An important part of the TATB PBX formulation effort has been to develop a practical processing procedure which consistently gives acceptable physical properties. During the course of the development work it was found that certain physical properties were quite responsive to the formulation procedure.

For example, the PBX granule size strongly influences mechanical properties. During the initial experience of making TATB PBX at Pantex, large PBX granules were made for pressing. The large granules produced poor physical properties. However, this problem essentially disappeared when the process was modified to produce reasonably small uniform granules in subsequent batches.

Another strong factor found to effect mechanical response was batch concentration or the HE-to-water ratio. The Pantex process has been standardized to use the same HE-to-water ratio.

Another area of interst is the effect of TATB particle size on physical properties. The latest eight large Pantex blends or lots of RX-03-BB represent some 3,360 kg of material. The particle size distribution of the

TATB powder was different for the eight PBX lots. Reference data for the eight lots are given in Table I.

EFFECT OF PARTICLE SIZE ON TENSILE STRAIN

Tensile strain (shown in Fig. 1) is an important physical property providing the stress is satisfactory. In Fig. 1 tensile strain is plotted as a function of the weight percent of TATB particles less than 20 µm for each of the eight lots. The percentage less than 20 µm varied from 10 to 37% for the different lots. The plot indicates that TATB particle size has no apparent effect on strain.

LEAST SQUARES LINEAR REGRESSION - PERCENT EXPLAINED

To examine the effect of particle size more thoroughly the data were subjected to a least squares linear regression. The results are given in Table II. The independent variables shown at the top of Table II are the percent less than 20 and 44 µm, the lower quartile number, Q25, which is simply the size of the particle in a given lot of material for which 25% of the material is smaller than that size, followed by the Q50 and Q75 values.

Considering only tensile stress and strain the percentage of the variation explained by the particle size factors are too small to indicate any effect.

TATB particle size appears to have a limited influence on compression properties. The 30.6 and 34.5% explained are of borderline significance.

The ultimate strain is the only property affected to any significant degree by the presence of fines. The ultimate strain is determined as load is applied after the initial fracture of the specimen until the complete failure of the specimen. The largest number shown is that for the lower quartile with 50.7% of the variation explained. Even at this level it does not indicate a high degree of significance. For real significance the percent explained value will approach 75%.

INFLUENCE OF PARTICLE SIZE ON ULTIMATE STRAIN

The cummulative distribution plotted in Fig. 2 illustrates the influence of the lower quartile numbers on compression ultimate strain.

The TATB particle size curves for the two lots having the lowest and the highest ultimate strain are shown. The lot with the lowest ultimate strain of 5.88% has the smaller lower quartile number, indicating that this lot has more fines of the two.

PHYSICAL PROPERTIES TEST EVALUATION SERIES

Pantex and LLL tensile strain values have shown disagreement in the past. As a result, a large amount of effort has been made to eliminate testing differences to obtain consistent results.

The tensile strength data presented in Fig. 3 represent a culmination of the Pantex and LLL efforts in this area. Twenty-one tensile specimens were fabricated, randomly divided and tested at both facilities.

Shown are only the Pantex results which compare very favorably with the LLL data.

The control group utilized a standard size specimen (20.0 mm in diameter) and a new LLL tapered end cap design.

Table I. Physical Properties Data RX-03-BB PBX

RX-03-BB Lot No.	TATB Lot Number	Compression Stress (MPa)	Compression Maximum Strain (%)	Compression Ultimate Strain (%)	Tensile Stress (MPa)	Tensile Strain (%)	Bulk Density (kg/m^3)	Granule Size % Retained Sieve Size 4	12	20	40	PAN	Arithmetic Mean (µm)	% < 44 (µm)	% < 20 (µm)	Lower Quartile	Median Quartile	Upper Quartile
6114-145-02	Cordova (20, 17)	23.5	2.39	6.78	10.7	0.36	0.93	0	72.0	27.9	0.1	0	46.2	47.0	36.8	14.0	55.3	75.9
6191-145-03	PX & Cordova Lots	24.3	1.95	7.24	10.1	0.37	0.91	0	78.4	21.0	0.6	0	50.2	38.1	19.6	28.3	52.7	67.3
6197-145-03	Cordova (20, 26, 29)	23.7	2.15	6.56	9.5	0.31	0.95	0	69.3	30.5	0.2	0	49.1	38.5	25.8	19.4	57.8	68.5
6288-145-02	Cordova (25, 28)	24.5	2.25	7.16	9.3	0.32	0.89	0	11.4	86.4	2.2	TR	43.8	50.0	26.7	19.0	44.0	63.0
6184-145-01	LLL Blend 11 Cordova (1, 7)	25.1	2.94	8.50	10.5	0.37	0.94	0	71.9	27.9	0.2	0	48.6	40.1	20.8	25.6	53.8	66.6
6209-145-02	LLL Blend 12 Cordova (68)	23.7	2.75	8.52	10.1	0.30	0.91	0	81.1	18.9	0	0	48.3	32.9	10.1	40.7	52.1	60.2
6217-145-03	LLL Blend 13 Cordova (36, 72)	23.7	2.53	9.27	9.9	0.41	0.89	0	88.3	11.7	0	0	48.4	32.4	14.36	39.8	53.3	63.0
6227-145-01	LLL Blend 14 Cordova (5, 10, 35, 39, 51)	27.4	2.43	5.88	10.5	0.34	0.92	0	76.4	23.6	0	0	44.8	46.5	19.98	26.2	47.1	62.0

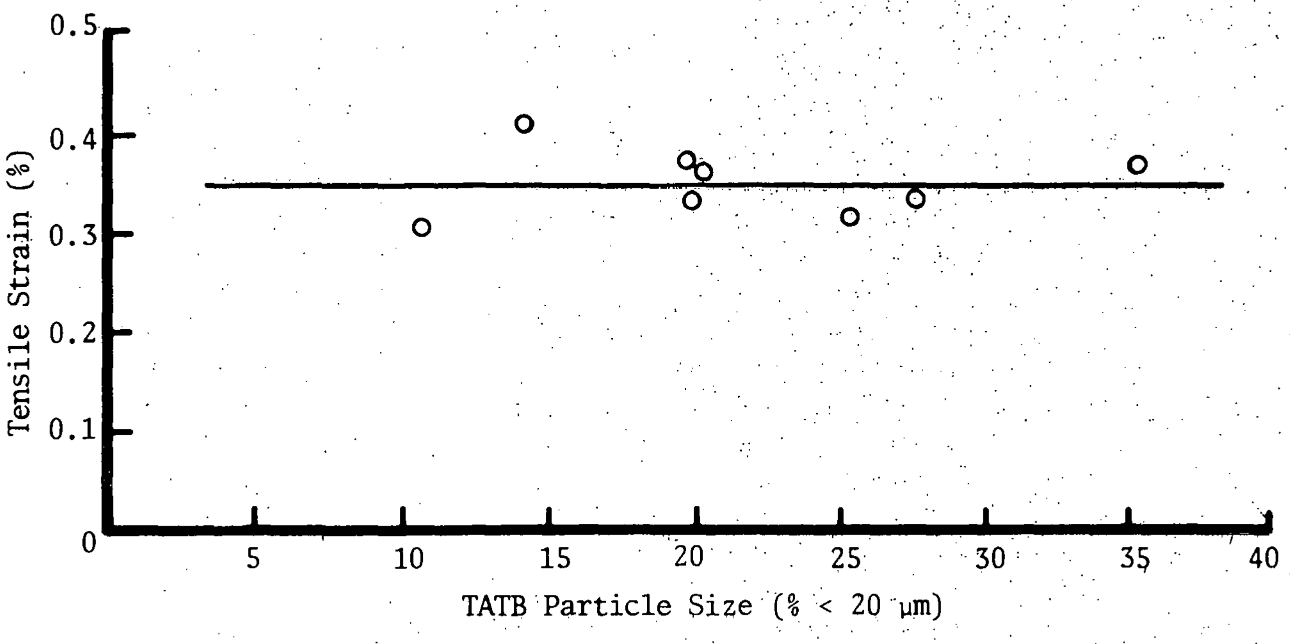

Fig. 1. Tensile Strain Versus Weight Percent Less Than 20 μm (Eight RX-03-BB Lots)

Table II. Least Squares Linear Regression Percentage of Total Variation Explained

	% < 20	% < 44	Q25	Q50	Q75
Tensile					
Stress	1.0	0.5	0.1	3.6	11.1
Strain	0.1	4.5	4.0	3.5	4.5
Compression					
Stress	1.6	17.1	0.3	30.6	13.8
Strain (Max)	12.8	6.4	15.3	0.2	7.5
Strain (Ult)	34.5	50.0	50.7	3.6	10.3

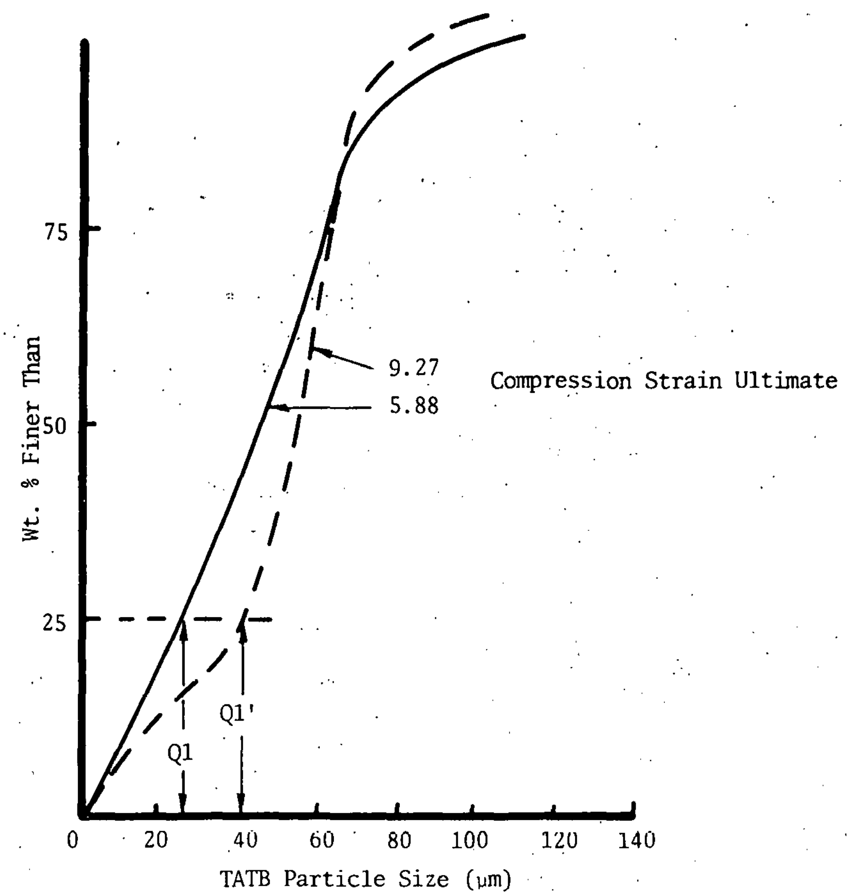

Fig. 2. Cumulative Distribution

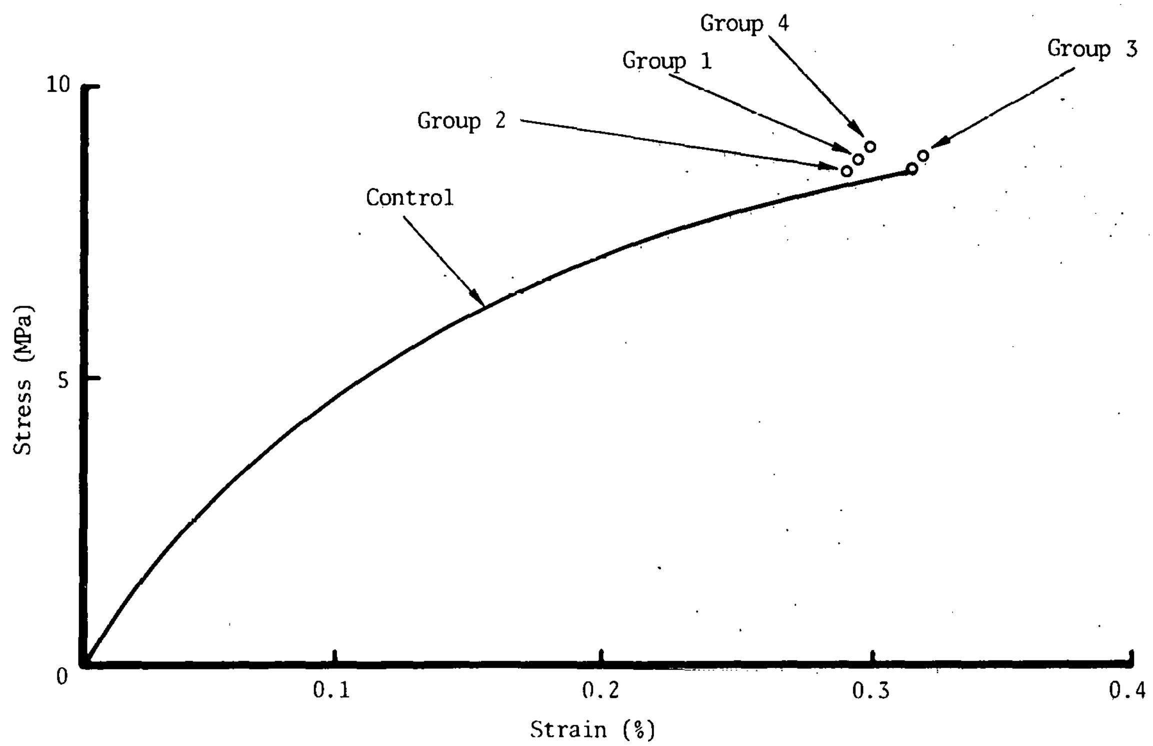

Fig. 3. Physical Properties Test Evaluation Series

In the past Pantex used a square end cap design, which resulted in an excessive number of breaks in the region of the end cap.

For the other groups, a small (12.7 mm) tensile specimen with LLL aluminum end caps was used. The only differences in the test groups shown were different testing speeds, the use of different extensometers and a small variation in temperature. Results are reasonably consistent demonstrating that the reproducibility of the physical properties testing is acceptable.

REPRODUCIBILITY OF PROCESSING

Fig. 4 contains a summation of the maximum stress and strain data obtained for a 440 kg LLL blend, B-11. Included are five individual batches used in the blend and the blend itself. The tensile stress, tensile strain and compression data are consistent and acceptable. Compression strain is measured at maximum stress, when the specimen first starts to fail.

Fig. 5 contains tensile data from the eight large PBX lots. These lots represent approximately 3,360 kg of RX-03-BB. Individual lot sizes ranged from 225 to 544 kg. The larger lots are a blend of five batches. Tensile strengths were consistent and tensile strain was in excess of 0.3%.

CONCLUSIONS

Reproducibility of physical properties is excellent both from the standpoints of testing and processing. The process procedure developed for formulating RX-03-BB will yield large quantities of PBX which have consistently good physical properties from lot-to-lot and batch-to-batch.

The physical properties of RX-03-BB are not strongly affected by TATB particle size distribution. However, the TATB particle size distributions did not include extremely fine material.

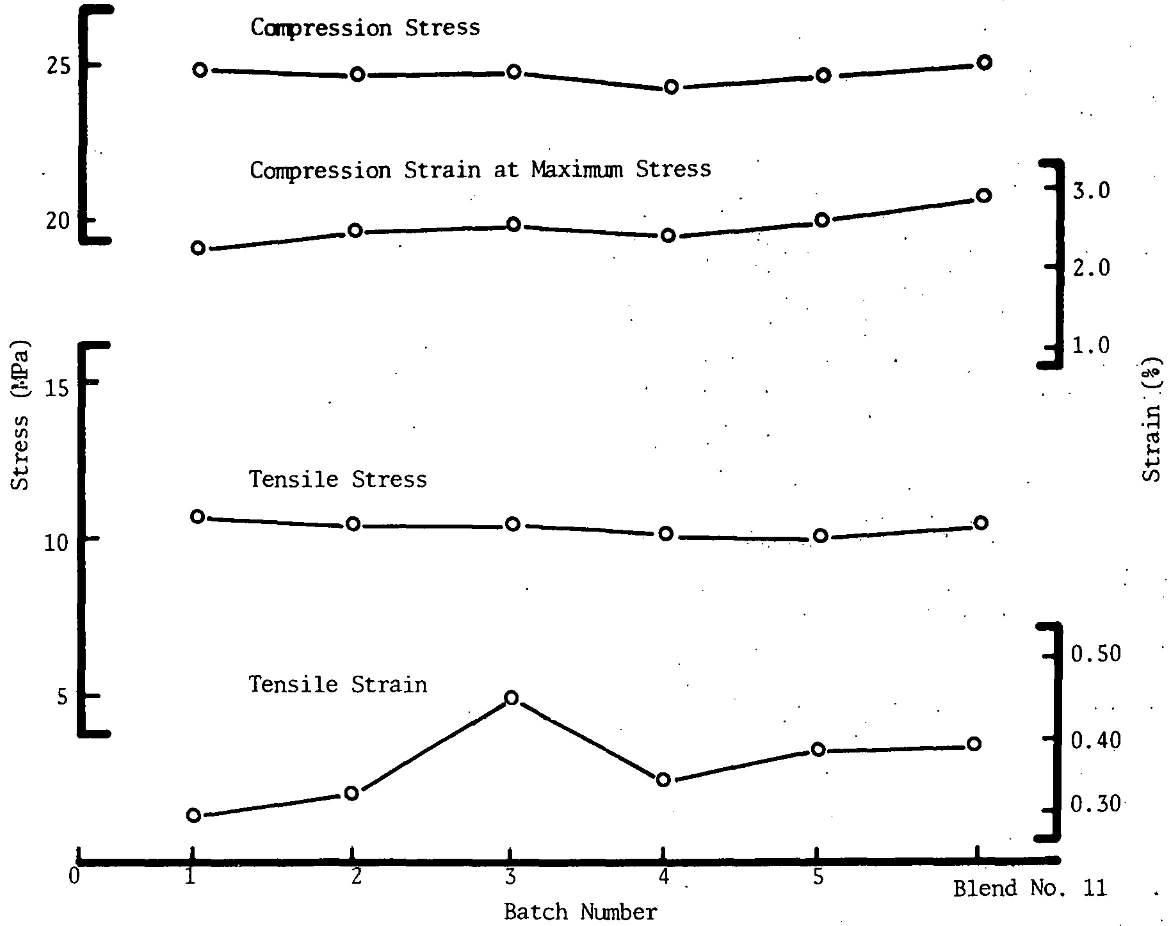

Fig. 4. Physical Properties of LLL Blend 11, Sub-Batch

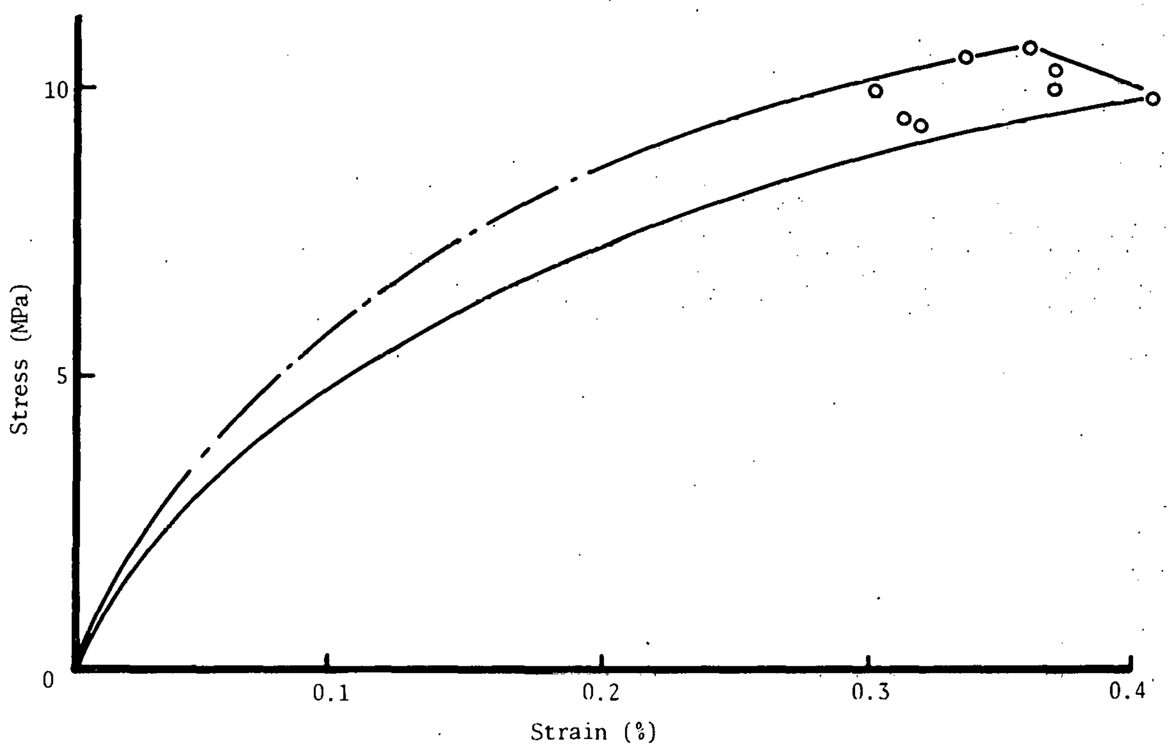

Fig. 5. RX-03-BB Tensile Strength
for 8 Large Lots