PRESSING PROCEDURE FOR PBX 9501

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DEVELOPMENT DIVISION

MASTER

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Normal Process Development
Endeavor No. 105

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ABSTRACT

PBX 9501 can be pressed to yield a minimum density of 1.830 Mg/m³. The compaction cycle consists of two 140 MPa pressure applications, interrupted by a one-minute relaxation period at ambient pressure. Preheat temperature and time-at-temperature are not critical factors.

DISCUSSION

PBX 9501 is a plastic bonded explosive having a nominal composition of 95% HMX, 2.5% Estane, 1.25% Bis-2-2-dinitropropylacetal (BDNPA) and 1.25% Bis-2-2-dinitropropylformal (BDNPF). The formulation was originally developed by the Navy and has now been adopted as the main charge explosive for future weapon programs.

Pantex received information, ahead of actual material arrival, that the plasticizer (BDNPA/BDNPF) could be driven out of the formulation by high or prolonged preheat temperatures. This aspect became the first concern.

Testing via TGA indicated a weight loss of 0.15% when heated to 120 C at the rate of 10 C/minute. This small weight loss at such an elevated temperature resulted in further tests along limits of actual production conditions for HE pressing.

Weight loss was measured on heating 40 g samples of PBX 9501 at 82 C in containers at atmospheric pressure. Containers were covered with a loose-fitting glass to observe sublimation characteristics. Observations were:

<u>Time at 82 C</u> <u>(Hrs)</u>	<u>% Weight Loss</u> <u>(At Atm. Pressure)</u>	<u>% Weight Loss</u> <u>(At 280 μHg Pressure)</u>
1	0.005	0.015
2	0.005	0.018
3	0.005	0.178
4	0.006	NOTE*
6	0.003	
8	0.003	
10	0.004	
12	0.003	
14	0.004	
24	0.005	

NOTE: The samples tested under vacuum sublined on the glass covers at test termination. The PBX 9501 did not change colors.

These small weight losses are not considered detrimental. E. M. Wewerka, et al of LASL, at the Y-12 Compatibility Meeting, October 1974, show the molecular weight of the Estane binder to decrease slightly after 16 weeks of exposure at 75 C. Preheating processes are only concerned with periods of 3 - 5 hours so the molecular weight loss is not considered to be a problem.

DENSITY VERSUS TIME AT PRESSURE

The density of PBX 9501 can be increased by repeated application of compacting forces or extending the time held under compaction. Both aspects were investigated; process conditions were normal and constant except for the variable being investigated and some drifting of pre-heat temperatures. All compaction pressures were 140 MPa.

<u>Piece No.</u>	<u>Preheat (C)</u>	<u>Dwell (Min)</u>	<u>Machined Density (Mg/m³)</u>
86310Y1301	76	5	1.827
86310Y1302	76	10	1.829
86317Y1301	79	20	1.829
86317Y1302	79	30	1.830
86343Y1302	77	40	1.831
86318Y1301	79	60	1.832

DENSITY VERSUS REPRESSING CYCLES

Several pressings were made to determine the effect of repeated pressure applications. Again process conditions were stable except for the point of observation and drifting of preheat temperatures. These results were:

<u>Piece No.</u>	<u>Preheat (C)</u>	<u>140 MPa/5 Min</u>	<u>Machined Density (Mg/m³)</u>
86343Y1301	77	X 2	1.831
86338Y1301	88	X 3	1.833
86345Y1301	79	X 3	1.834
86338Y1302	88	X 5	1.836
86345Y1302	79	X 5	1.836

These pressings were wet-bag only. The relaxation period at ambient pressure between cycles was one minute.

FORMING MANDRELS

These early test parts have been pressed on an aluminum mandrel that forms a hemispherical inner cavity and a smooth equatorial rim. The outer surface is an approximate hemisphere, which results in a shell that is thickened in the polar area. The reduced cross-section is needed for reduced material usage and machining effort.

All WR programs have used preform mandrels of this general configuration. Separating the mandrel and the pressing became difficult when the present "hat" shape was adopted for use with the wet-bag technique.

The stripping problem has been more or less severe, according to the material being compacted. PBX 9501 has presented a severe stripping problem. The material has an adhering quality that prevented separation of mandrel and part.

The stripping effort can be reduced to an acceptable level by:

- (1) Separate the interface of HE/mandrel-brim with a thin layer of felt
- (2) Use a conventional mold release technique on the hemispherical surface, in conjunction with a vibratory packing method when loading the assembly
- (3) Strip as quickly as possible after depressurization
- (4) Secure the exposed surface of the mandrel on a vacuum fixture, and lift the HE with a hoist and vacuum cup.

DENSITY SPREAD

A reasonable process expected to produce the minimum acceptable density is: preheat the PBX 9501 and the forming mandrel for 3 - 4 hours at ~ 80 C, load the HE into a wet-bag assembly, evacuate to an absolute pressure of < 270 Pa, press at 140 MPa for 5 minutes, depressurize to ambient pressure for 1 minute and repress at 140 MPa for 5 minutes. Disassemble and remove the part.

A pressing formed by the above process was sectioned and a pattern of small cores were machined from the section plane to allow measurement of the internal density variations. The measured density of the cores was used to form the contour areas of Fig. 1. These areas represent only three density zones; (average ± 1 kg/m³), (low) and (high). The area outlines are not intended to be absolutely quantitative but rather the best subjective representation. The section plane and the data interpretation are assumed to continue through the pressing for a full rotation.

Actual core densities averaged 1.832 Mg/m^3 on the right side with a range of 2 kg/m^3 and a standard deviation of 1 kg/m^3 . The left side was a repeat except that the range was 3 kg/m^3 .

CONCLUSIONS AND COMMENTS

Preheating PBX 9501 at 82 C for normal processing time periods for compaction should not cause detrimental effects.

A minimum density of 1.830 Mg/m^3 can be achieved by a compaction cycle of two 140 MPa pressure applications, interrupted by a one-minute relaxation period at ambient pressure.

Hand-packing of wet-bag assemblies using the conventional mold release technique should be avoided. Hand-packing definitely distorts the mold release coating and may cause some dispersion of coating material into the HE. Hand-packing also produces uneven densities in the as-loaded state, which could be expected to result in uneven pressures against the forming mandrel, producing a stripping problem. This condition seems to arise only when the forming mandrel is such that it produces a part with an included angle that approaches 90° . The felt, described as forming an interface between the brim of the mandrel and the HE functions to offset the tendency to bind by preventing a purchase point between the brim and the spherical surface.

Fig. 1. Density Contour PBX 9501