Interim Report on the Development of a Plastic Bonded Explosive

P. B. Archibald

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July 15, 1957

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Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-ENG-48.

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July 15, 1957.

INTERIM REPORT ON THE DEVELOPMENT
OF A PLASTIC BONDED EXPLOSIVE

Paul C. Archibald

Purpose: The purpose of this work was to investigate the possibilities of producing a plastic bonded explosive having greater mechanical strength than that of presently existing plastic bonded explosives.

Target values of such an explosive are:

Compressive strength: 10,000 psi

Sensitivity: Comparable to Comp. B or better.

Density: As high as possible—should be 95% of theoretical or better and assuming that one of the higher density explosives is used.

Stability: Comparable to present plastic bonded explosives.

Explosive Power: The use of a high energy explosive such as RDX, or BIXEN is required.

Formability: The material should be formable by acceptable production techniques. It was further decided that this work would avoid duplication or refinements of presently known plastic bonded explosives and that a radical approach would be desirable.

Method: A preliminary consideration of the problem indicated that a suitable plastic bonded explosive might be produced by either of two approaches:

A: The use of an oxygen-rich explosive which would permit the incorporation of a large amount (i.e. 20% of binder).

B: The use of an oxygen balanced explosive with small amounts of binder which would not subtract too much from the explosive power.

A survey of possible binders indicates that epoxy resins might be suitable. These resins have outstanding strength and adhesions and can be polymerized at moderate temperatures provided a proper curing agent is used.

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July 15, 1957

INTERNAL REPORT ON THE DEVELOPMENT
OF A PLASTIC BONDED EXPLOSIVE

Paul G. Whipple

Purpose: The purpose of this report is to present the results of an investigation into the possibility of producing a plastic bonded explosive having greater mechanical strength than that of presently existing plastic bonded explosives.

Target values of such an explosive are:

Compressive strength: 10,000 p.s.i.

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Sensitivity: Comparable to Comp. B or better

Density: As high as possible, should be 1.1 or greater

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and assuming that one of the higher density explosives is used

Stability: Comparable to present plastic bonded explosives

7/24/96

Explosive Power: The use of a high explosive

James Barron 7/25/96

or better is required.

Formability: The material should be formable by acceptable production

techniques. It was further decided that this work would avoid duplication of refinements of presently known plastic bonded explosives and that a radical approach would be desirable.

Method: A preliminary consideration of the problem indicated that a suitable

plastic bonded explosive might be produced by either of two approaches:

A: The use of an oxygen-rich explosive which would permit the incorporation of a large amount (i.e. 50% or more)

B: The use of an oxygen balanced explosive with small amounts of binder which would not subtract too much from the explosive power.

A survey of possible binders indicated that epoxy resins might be suitable.

These resins have outstanding strength and adhesion and can be polymerized at moderate temperatures provided a proper curing agent is used.

[REDACTED]

[REDACTED]

Method B: This method consisted of diluting the catalyzed resin with toluene to a 25% resin concentration, mixing with HMX until the toluene had evaporated. This procedure was faster than Method A but introduced errors in weighing due to toluene evaporation and the problem of complete solvent removal.

Method C: This procedure, which was finally adopted, consisted of mixing the resin into the HMX with a spatula followed by grinding in a mortar and screening. This method was the most satisfactory, at least for experimental work.

2. Pressing: After the resin and HMX were mixed together and were in the form of a slightly damp powder, they were poured into the mold and pressed at 30,000 psi under vacuum for a period of several minutes. The pills were then pressed out of the die and cured at 80°C for 16 hours.

It was found that the loading of the die was a critical step in obtaining reproducible results. Although the optimum method was not determined, it was found that fairly good reproducibility could be obtained by filling the die without packing and then tapping it gently to settle the material.

The use of a double acting press was also investigated with good results. This consisted of placing the die on a rubber cushion and allowing the bottom ram to project through a hole in the rubber onto the steel base plate. This gave a 25% increase in compressive strength as well as a slight increase in density.

Curing the test specimens under pressure resulted in an additional increase in strength and density. A pill made using the double acting ram and cured under pressure gave the following:

Density: 1.82 gms/cc

Compressive Strength: 11,500 psi

Formulation: Due to the many variables in mixing and pressing of the specimens, the development of the optimum formulation has been delayed. Most of the technique development work has been based on a 4% binder content based on 85% Epon 828,

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10% Thikol plasticizer and 5% piperidine catalyst. Further investigation has indicated Emery S 30-5 (a polymerized fatty acid as a plasticizer yields specimens of higher compressive strength). It also appears that 6% binder content may be more desirable from a strength standpoint.

Other Variables Investigated:

Vacuum Pressing vs Atmospheric Pressing : Specimens molded at atmospheric pressure did not show a significant decrease in strength or density. This may be related to the tendency of Epon 828 under vacuum to foam for a period of time. Exposing the HMX-epoxy resin mixture to a vacuum of 2-3 hours before pressing did not however result in a higher density or strength.

Effect of Pressure on Density: The effect of pressure on the density of the specimens appears to be quite marked. Samples pressed at various pressures gave the following:

10,000 psi	1.63
20,000 psi	1.71
30,000 psi	1.78
40,000 psi	1.81

(The above figures were obtained with a single acting ram pressing under vacuum)

Hot Pressing: Heating the die before pressing gave an increase of $\frac{0.02}{cc}$ in density over cold pressing under the same conditions otherwise.

Die Lubricant: An experiment wherein molybdenum disulfide was rubbed into the die and ram did not result in higher density specimens.

Effect of Fit of Die and Ram: A ram which was made on a lathe by conventional machine shop practice gave much weaker specimens than those produced from a ram with a ground fit

Effect of Post Cure on Strength: Post curing at 100°C for 3 hours did not yield specimens of higher compressive strength. Specimens cured at 65°C for sixteen hours showed a much lower strength than those cured at 80°C.

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