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MASTER

INITIATION SENSITIVITY OF HNS I BY HNS II MDF

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DEVELOPMENT DIVISION

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Normal Process Development
Endeavor No. 107

DISCLAIMER

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ABSTRACT

A sensitivity test, previously developed to study the configuration dependent excess transit time for transfer of detonation from a small diameter confined donor to a larger diameter unconfined acceptor via the detonation electric effect technique, has been utilized for evaluation of Pantex synthesized HNS.

DISCUSSION

Two 4.5 kg batches of HNS II, Lots 5171-137-01 and 5178-137-01, were made for Sandia by conversion of HNS I using DMF as the recrystallization solvent. The conversion process, purity analysis, particle characterization, pressing characteristics, and drop hammer results were reported to Sandia in an undistributed report.

Aluminum-sheathed, drawn and hydraulically compacted MDF was manufactured from samples of each batch. Pertinent properties(*1*) are listed in Table I. MDF produced from each powder batch was tested in a sensitivity test(*2*) which was developed at Pantex to measure the excess transit time in a relatively large acceptor pellet when initiated by a small confined donor. The acceptor pellets were all pressed from Pantex-synthesized, high-purity HNS I(*3*), Lot PX-11.

EXPERIMENTAL TECHNIQUE AND RESULTS

The detonation electric effect technique(*4*) was utilized to measure detonation front arrival times at various interfaces in an explosive train. The train consisted of an RP-2 detonator, selected lengths of MDF (including 6.35, 12.70, and 19.05 mm) and an acceptor pellet stack. The length of the acceptor stack was varied from 2.54 to 10.16 mm in order that excess transit time could be measured by the cutback method. The segments of MDF were separated by 25 μm air gaps to create the interfacial signals. There was no air gap, and therefore no interfacial signal between the final MDF segment and the pellet stack. The typical transit time for the final air gap-MDF segment combination was calculated from those measured for all the other gap-segment pairs. This average was then subtracted from the total time measured on each shot for the final air gap-MDF-pellet stack combination, giving the transit time for the pellet stack. The tests were done at five pellet densities - 1.45, 1.50, 1.55, 1.60 and 1.65 Mg/m^3.

Some pertinent properties of the two MDF's, which are listed in Table I, indicate that they have very similar characteristics. In addition they are essentially equivalent in these respects to the MDF's which were manufactured from commercial HNS II and tested(*2*).

Table I. Pertinent Properties of Compacted MDF Containing HNS II

Property	Lot 5171-137-01	Lot 5178-137-01
MDF ID (mm)	0.51	0.51
MDF OD (mm)	1.12	1.12
MDF Load Size (g/m)	0.38	0.38
MDF Velocity (m/s)	7060	7050

PX-11 acceptor pellet transit times as a function of density and length are given in Tables II and III. Representative distance-time plots for PX-11 at two densities are shown in Fig. 1. The dashed lines are two of the least sum-of-squares linear fits from which the excess transit times and detonation velocities listed in Tables IV and V were obtained. Detonation velocity as a function of density for PX-11 is shown in Fig. 2. The solid and open circles are experimental data for PX-11 initiated by the compacted 5171-137-01 and 5178-137-01 MDF's. The dashed line is a linear fit for the density range of 1.45 to 1.65 Mg/m^3. The open triangle is the extrapolated value of detonation velocity at 1.74 Mg/m^3, the theoretical maximum density. The solid triangles are calculated detonation velocities that should occur at TMD based upon the detonation velocities predicted by the linear fit at the densities above which the points are plotted. These values were derived using the empirical equation $D = \Sigma (V_i D_i)$, where D is the detonation velocity of the mixture, V_i is the volume fraction of the i^{th} component, and D_i is the detonation or shock velocity of the i^{th} component(*5*). The shock velocity in air used for the calculations was taken from reference (5) as 1500 m/s.

About ten percent of the shots for each MDF type which were fired last quarter failed because the detonation wave did not propagate down the entire MDF train. The remains of two shots distinctly proved that the failures occurred at an air gap between segments; that is, the detonation wave did not propagate from one segment to the next. The other three shots which failed did so in an area close enough to the detonator that evidence of the failure point was destroyed. Microscopic examination of many MDF segment ends revealed that the cutting procedure left a small burr of aluminum on the outer edge and that an unacceptable degree of HE core cavitation occasionally occurred. Therefore, in the shots made this quarter with 5178-137-01 compacted MDF as the donor, the ends of each MDF segment were examined carefully for cavitation and the burrs were removed. Of the twenty-one shots fired this quarter only one did not propagate the entire length; this was due to the MDF failing to initiate an acceptor pellet of 1.50 Mg/m^3 density.

The primary source of data scatter is due to the effects of the 25 μm air gaps between the MDF segments. Several shots were fired this quarter to evaluate an optoelectronic technique for recording detonation front arrival times. The MDF segments were butted together, thus eliminating most of the air gap. The light which emerged as the detonation front passed each break in the MDF sheath was transmitted via fiberoptics to a photodiode circuit. The reliability of the photodiode circuits responding to the light was only about 50%. The problem is probably that the light from the MDF break did not reach the active element in the photodiode due to misalignment of the fiberoptic on either end.

FUTURE WORK

It is believed that the best way to improve the accuracy of the test is to eliminate the air gaps. Therefore, the optoelectronic method for monitoring the detonation front arrival times at various points in the MDF will be pursued.

Table II. Acceptor Pellet Transit Time Data for PX-11 HNS I Pellets Initiated by Compacted 5171-137-01 HNS II MDF

Density (Mg/m^3)	Length (mm)	Transit Time (μs)
1.45	2.54	0.395
1.45	5.08	0.815
1.45	7.62	1.195
1.45	10.16	1.605
1.50	2.54	0.395
1.50	5.08	0.785
1.50	7.62	1.165
1.50	10.16	1.565
1.55	2.54	0.385
1.55	5.08	0.765
1.55	7.62	1.125
1.55	10.16	1.515
1.60	2.54	0.385
1.60	5.08	0.755
1.60	7.62	1.115
1.60	10.16	1.505
1.65	2.54	0.375
1.65	5.08	0.745
1.65	7.62	1.105
1.65	10.16	1.455

Table III. Acceptor Pellet Transit Time Data for PX-11 HNS I Pellets Initiated by Compacted 5178-137-01 HNS II MDF

Density (Mg/m^3)	Length (mm)	Transit Time (μs)
1.45	2.54	0.402
1.45	2.54	0.422
1.45	5.08	0.802
1.45	7.62	1.202
1.45	7.72	1.192
1.45	10.16	1.602
1.45	10.16	1.632
1.50	2.54	0.382
1.50	2.54	0.402
1.50	5.08	0.782
1.50	5.08	0.792
1.50	7.62	1.172
1.55	2.54	0.372
1.55	2.54	0.392
1.55	5.08	0.772
1.55	7.62	1.132
1.55	7.62	1.152
1.55	10.16	1.502
1.55	10.16	1.562
1.60	2.54	0.392
1.60	2.54	0.382
1.60	5.08	0.742
1.60	5.08	0.742
1.60	7.62	1.132
1.60	7.62	1.122
1.60	10.16	1.492
1.60	10.16	1.492
1.65	2.54	0.372
1.65	2.54	0.372
1.65	5.08	0.752
1.65	5.08	0.732
1.65	7.62	1.122
1.65	7.62	1.092
1.65	10.16	1.472
1.65	10.16	1.482

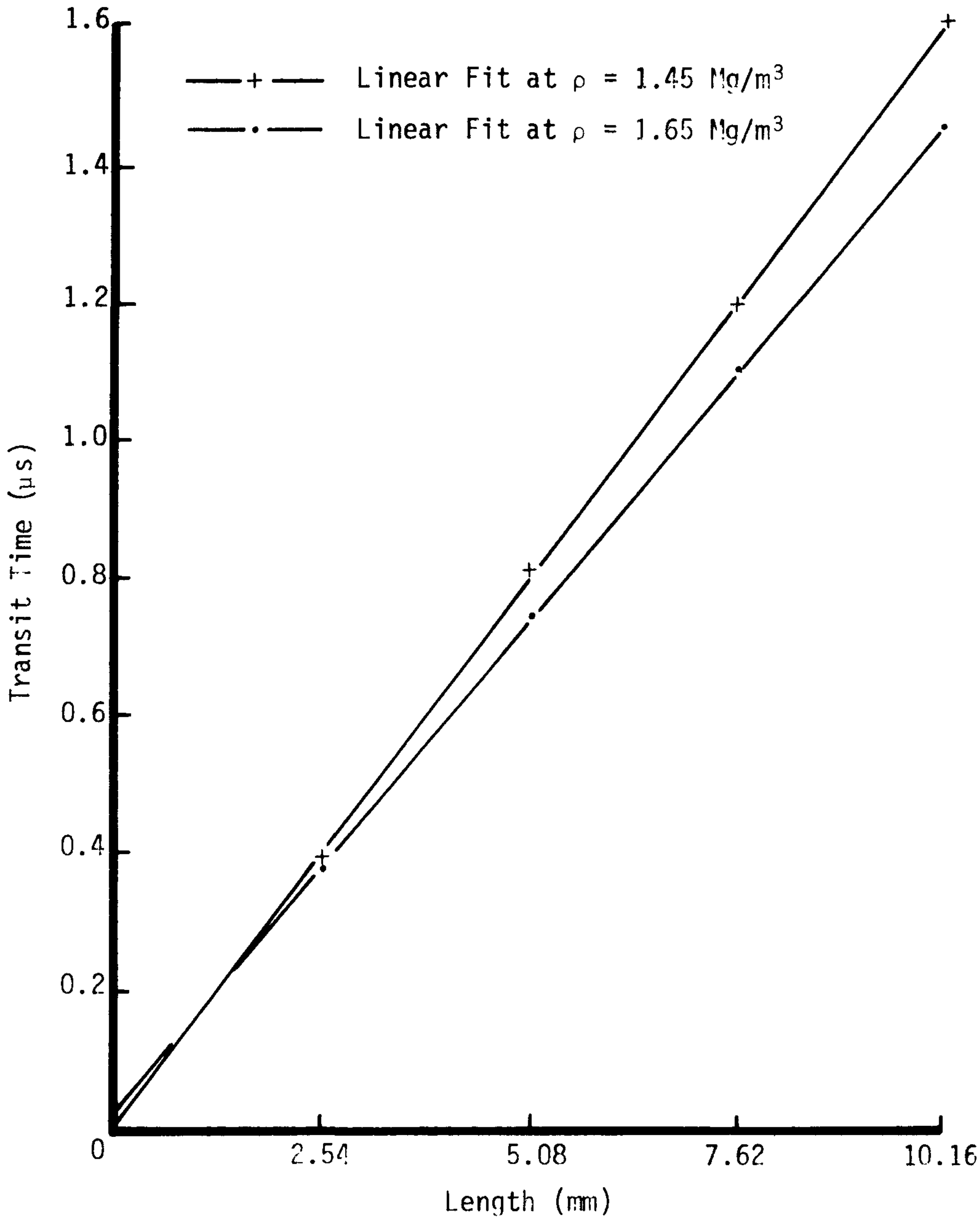

Fig. 1. Representative Data at Density Extremes for PX-11 HNS I Pellets Initiated by Compacted 5171-137-01 HNS II MDF

Table IV. Experimental Results for PX-11 HNS I Pellets Initiated by Compacted 5171-137-01 HNS II MDF

Density (Mg/m^3)	Excess Transit Time (ns)	Sigma (ns)	Detonation Velocity (m/s)	Sigma (m/s)
1.45	0	14	6332	82
1.50	5	7	6528	44
1.55	10	10	6771	69
1.60	10	11	6826	77
1.65	20	8	7054	61

Table V. Experimental Results for PX-11 HNS I Pellets Initiated by Compacted 5178-137-01 HNS II MDF

Density (Mg/m^3)	Excess Transit Time (ns)	Sigma (ns)	Detonation Velocity (m/s)	Sigma (m/s)
1.45	5	19	6333	77
1.50	3	12	6509	70
1.55	0	19	6632	119
1.60	11	7	6862	47
1.65	4	9	6898	64

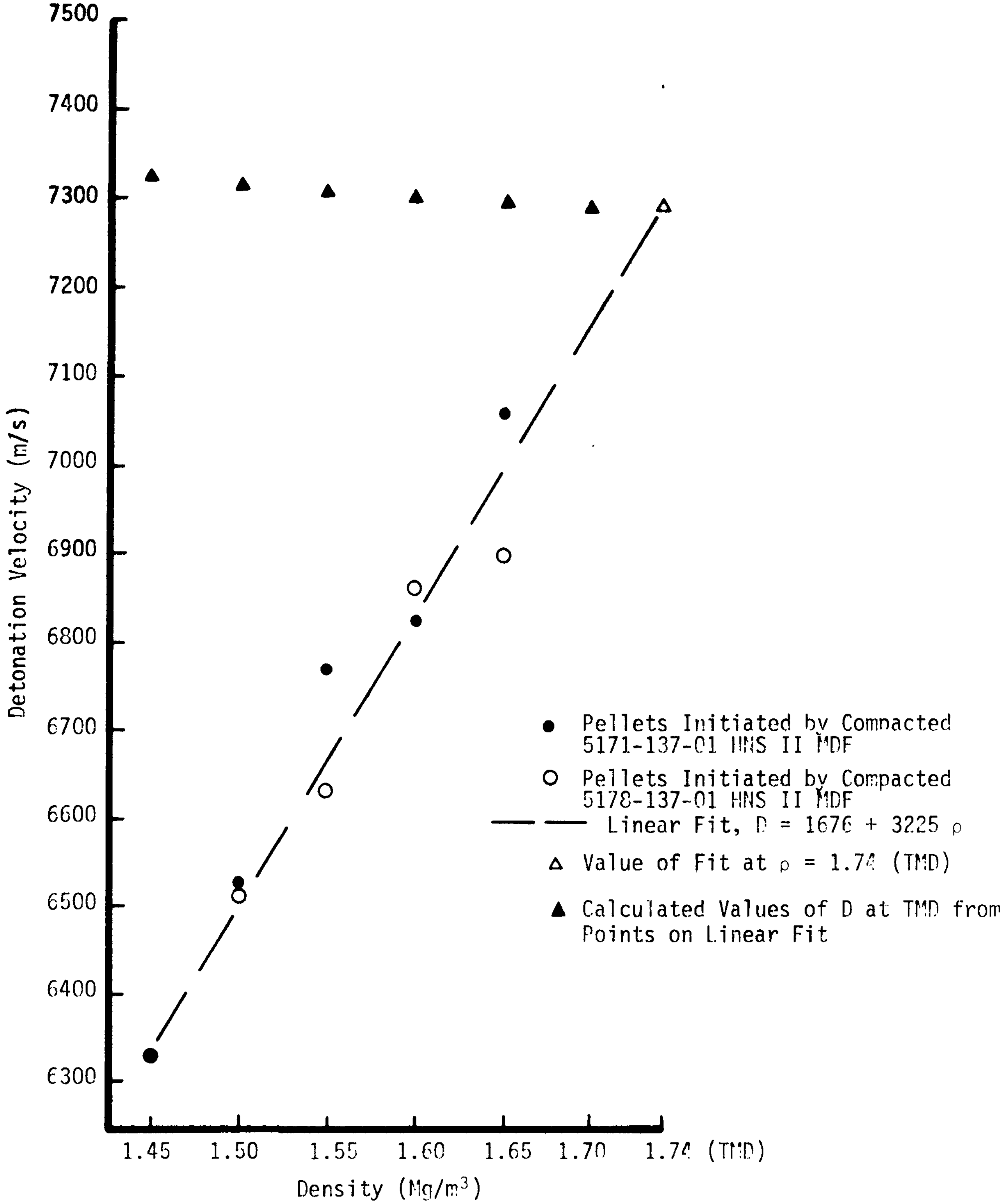

Fig. 2. Detonation Velocity as a Function of Density for PX-11 HNS I

REFERENCES

1. H. W. Lichte, Private Communications.

2. C. E. Canada and L. D. Hanes, "Detonation Electric Effect Studies," MHSMP-75-24L (June 1975).

3. T. W. Stull, "Synthesis of High Purity Hexanitrostilbene," MHSMP-75-37 (September 1975).

4. Bernard Hayes, "The Detonation Electric Effect," Journal of Applied Physics, Vol. 38, No. 2 (February 1967).

5. B. M. Dobratz, Properties of Chemical Explosives and Explosive Simulants, UCRL-51319 (July 31, 1974).