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Comparison of Pantex High Purity HNS I to a Chemtronics HNS I for Their Sensitivity to Initiation by HNS II MDF

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DEVELOPMENT DIVISION

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ABSTRACT

Two lots of HNS I have been compared for their sensitivity to initiation by an HNS II MDF donor. The sensitivity test utilized was previously developed to study the 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.

DISCUSSION

Two 4.5 kg batches of HNS II, Lots 5171-137-01 and 5178-137-01, were made for SLA 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.

In work completed last quarter, MDF produced from each powder batch was tested in a sensitivity test 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 pressed from Pantex-synthesized, high-purity HNS I(*2*), Lot PX-11. The results of this work were previously reported(*3*). The MDF manufactured from Lot 5171-137-01 HNS II seemed to produce the better test results, and therefore it was chosen as the donor for another test series in which Chemtronics 66-48 HNS I was the acceptor pellet material.

This test series, with the compacted 5171-137-01 HNS II MDF donor and Chemtronics 66-48 HNS I acceptor pellets, was patterned after those described above in order that the PX-11 and Chemtronics 66-48 could be compared in the acceptor mode when initiated by the same donor. The most significant change in the two test series was that the air gap between MDF segments was reduced from 25 μm in the first series to 5 μm in the last series as an attempt to improve the reliability of the transfer of detonation between the MDF segments.

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, 25 mm of 1 g/m PETN MDF, five segments of compacted 5171-137-01 HNS II MDF (6.35, 6.35, 12.70, 6.35, and 6.35 mm lengths), 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 5 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 segment-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.

Results obtained for the MDF in each test series are summarized in Tables II and III. The methods by which the numbers were obtained are described in the footnotes. It is apparent that the reduction in air gap size from 25 to 5 μm did not reduce the scatter in the transit times for the air gap-MDF segment combinations. The excess transit time due to the insertion of an air gap was reduced by a factor of three when the gap size was decreased by a factor of five. The detonation velocity was calculated in three ways for each test series. The average of the six calculations is 7014 m/s, which compares well with the detonation velocity of 7000 m/s at a density of 1.70 Mg/m^3(*5*). This density is 98% of TMD and is reasonable for compacted HNS MDF.

The acceptor pellet stack data are presented in Tables IV and V. The comments in the tables indicate that the shot loss rate due to failure of the detonation front to propagate between MDF segments was reduced from 12% to 7% by decreasing the gap size. However, there was an increase in the shot loss rate due to the absence of usable air gap signals from 4% to 11%. The net result was no improvement in shot loss rate due to the decreased gap size. The PX-11 series had no initiating failures of the acceptor pellet stack, whereas the Chemtronics 66-48 series had 3 failures (11%), one at each of the densities 1.50, 1.55, and 1.65 Mg/m^3. These data were reduced by linear fits to obtain excess transit times and detonation velocities. Results are given in Tables VI and VII. Figs. 1 and 2 indicate that the excess transit times for Chemtronics HNS are greater than those for PX-11 at all densities tested except for 1.65 Mg/m^3. The excess transit time for Chemtronics 66-48 at 1.55 Mg/m^3 agrees exactly with that found in previous work(*6*).

Detonation velocity as a function of density for both HNS lots is shown in Figs. 1 and 2. The solid circles are experimental data. The dashed line is a linear fit over the density range tested. The open circle 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 obtained for each density 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.

CONCLUSIONS

The Chemtronics Lot 66-48 HNS I is less sensitive to initiation than Lot PX-11, based upon two findings. One, the PX-11 had no ignition failures, whereas the Chemtronics 66-48 failed to initiate in 3 (11%) tests at densities as low as 1.50 Mg/m^3. Two, the PX-11 exhibited an excess transit time which, on the average, is lower by a factor of three than that of Chemtronics 66-48.

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

Table II. Results Obtained for Compacted 5171-137-01 HNS II MDF with 25 μm Air Gaps in Shots with PX-11 HNS I Acceptor Pellets

	12.70 mm Lengths	19.05 mm Lengths	Both Lengths
Number of Points	12	19	31
Length of Segment (mm)	12.70[a]	19.05[a]	
Transit Time for Gap and Segment (μs)	1.822[b]	2.712[b]	
Standard Deviation (μs)	0.009	0.009	
Transit Time for Segment (μs)	1.780[c]	2.670[c]	
Standard Deviation (μs)	0.013	0.013	
Excess Time Due to Gap (μs)			0.042[e]
Standard Deviation (μs)			0.009
Detonation Velocity (m/s)	6970[d]	7030[d]	7130[f]
Standard Deviation (m/s)	40	20	30

[a] *Value is nominal. Standard deviation assumed to be zero for all calculations.*

[b] *Value is the average.*

[c] *Value is the difference between the average transit time for one gap-segment pair and the excess transit time due to the air gap.*

[d] *Value is the quotient of the average segment length and the average segment transit time.*

[e] *Value is the intercept of the linear fit to all the data.*

[f] *Value is the inverse slope of the linear fit to all the data.*

Table III. Results Obtained for Compacted 5171-137-01 HNS II MDF with 5 μm Air Gaps in Shots with Chemtronics HNS I Acceptor Pellets

	6.35 mm Lengths	12.70 mm Lengths	Both Lengths
Number of Points	36	18	54
Length of Segment (mm)	6.357[a]	12.676[a]	
Standard Deviation (mm)	0.043	0.024	
Transit Time for Gap and Segment (μs)	0.910[a]	1.829[a]	
Standard Deviation (μs)	0.011	0.013	
Transit Time for Segment (μs)	0.905[b]	1.815[b]	
Standard Deviation (μs)	0.016	0.014	
Excess Time Due to Gap (μs)			0.014[d]
Standard Deviation (μs)			0.005
Detonation Velocity (m/s)	6980[c]	6980[c]	6980[e]
Standard Deviation (m/s)	90	50	30

[a] *Value is the average.*

[b] *Value is the difference between the average transit time for one gap-segment pair and the excess transit time due to the air gap.*

[c] *Value is the quotient of the average segment length and the average segment transit time.*

[d] *Value is the intercept of the linear fit to all the data.*

[e] *Value is the inverse slope of the linear fit to all the data.*

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

Density (Mg/m^3)	Length (mm)	Transit Time (μs)	Comments
1.45	2.54		No Record Obtained
	2.54	0.395	
	5.08	0.815	
	7.62	1.195	
	10.16	1.605	
1.50	2.54	0.395	
	5.08	0.785	
	7.62		An MDF Segment Did Not Ignite
	7.62	1.165	
	10.16	1.565	
1.55	2.54	0.385	
	5.08	0.765	
	7.62		No Usable Air Gap Signals
	7.62	1.125	
	10.16	1.515	
1.60	2.54	0.385	
	5.08		An MDF Segment Did Not Ignite
	5.08	0.755	
	7.62	1.115	
	10.16	1.505	
1.65	2.54	0.375	
	5.08	0.745	
	7.62		An MDF Segment Did Not Ignite
	7.62	1.105	
	10.16	1.455	

Table V. Acceptor Pellet Transit Time Data for Chemtronics 66-48 HNS I Pellets Initiated by Compacted 5171-137-01 HNS II MDF

Density (Mg/m^3)	Length (mm)	Transit Time (μs)	Comments
1.45	2.54	0.456	
	5.08	0.856	
	7.62		No Useable Air Gap Signals
	7.62		An MDF Segment Did Not Ignite
	7.62		No Usable Air Gap Signals
	10.16	1.676	
1.50	2.54	0.426	
	5.08		An MDF Segment Did Not Ignite
	5.08		Pellet Stack Did Not Ignite
	5.08		No Usable Air Gap Signals
	7.62	1.226	
	10.16	1.631	
1.55	2.54	0.426	
	5.08	0.801	
	7.62	1.166	
	7.62		Pellet Stack Did Not Ignite
	7.62	1.176	
	10.16	1.566	
1.60	2.54	0.406	
	5.08	0.766	
	7.62	1.152	
	10.16	1.516	
1.65	2.54		Pellet Stack Did Not Ignite
	2.54	0.376	
	5.08	0.756	
	7.62	1.106	
	10.16		Poor Pellet Stack Output Signal

Table VI. 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)	Standard Deviation (ns)	Detonation Velocity (m/s)	Standard Deviation (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 VII. Experimental Results for Chemtronics 66-48 HNS I Pellets Initiated by Compacted 5171-137-01 HNS II MDF

Density (Mg/m^3)	Excess Transit Time (ns)	Standard Deviation (ns)	Detonation Velocity (m/s)	Standard Deviation (m/s)
1.45	46	7	6238	38
1.50	26	0[a]	6350	0[a]
1.55	43	7	6694	45
1.60	31	10	6835	63
1.65	16	19	6959	165

[a] *Only two data points available for linear fit.*

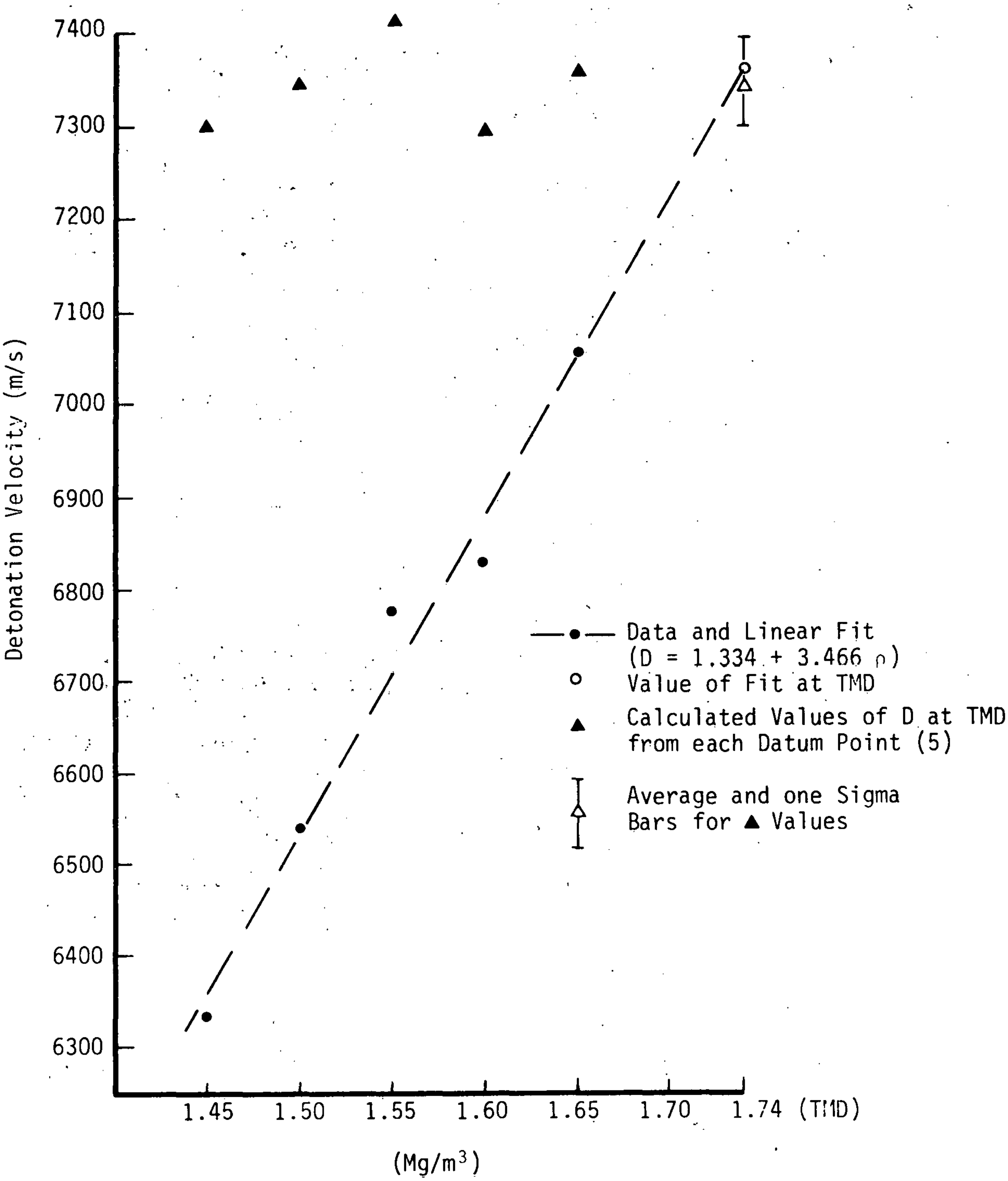

Fig. 1. Detonation Velocity as a Function of Density for PX-11 HNS I

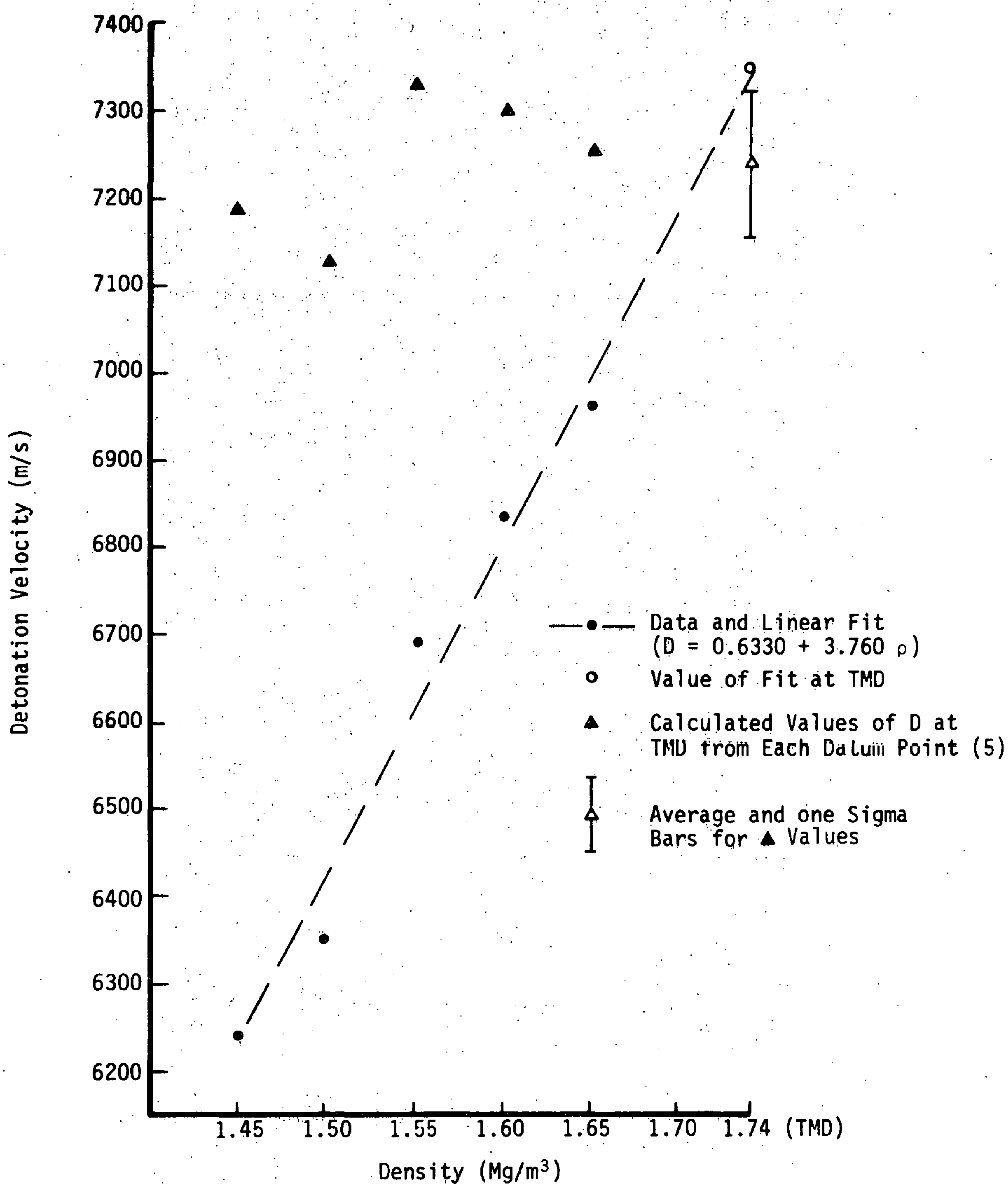

Fig. 2. Detonation Velocity as a Function of Density for Chemtronics 66-48 HNS I

REFERENCES

1. Properties obtained in private communication with H. W. Lichte.

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

3. L. D. Hanes, "Initiation Sensitivity of HNS I by HNS II MDF," MHSMP-76-5N (December 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 1974).

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