



No-Roll Solventless Double-Base Processing for Gun Propellants

Presented to:

CAD/PAD Technical Workshop

Presented by:

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Distribution Statement A (22-109): Approved for public release. Distribution is unlimited.

Project Goals

- Consolidation of paste using the two inch vertical vacuum extrusion press.
- Evaluate double-base compositions that are comparable in performance for the referenced gun propellant.

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Differential Speed and Even Speed Rolling



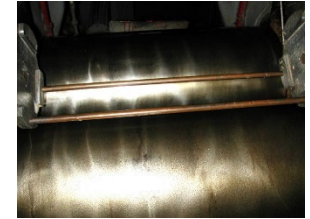
Paste,
12 to 14% Water



Paste Tray

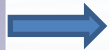


Paste Tray &
Carriage

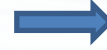
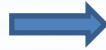


Roll Gap & Temperature

Differential Speed
Roller (pre-roll)
Paste Coverage



Sand blasted finish front roll &
Polished rear roll



Warming Table



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Background

- Nitrocellulose
 - Grade D, 12.2 %N (Collodion)
 - Grade A, 12.6 %N (Pyrocellulose)
 - Grade B, >13.2 %N (Guncotton)
 - Grade C, 13.2 %N (Blends of A & B)
- Grades E and D nitrocellulose colloid more readily and produce higher strain propellants.
- Grades A and B colloid less readily and produce higher modulus (stress) propellants.
- Propellants with a NC/gelatinizer ratio less than 1 are more difficult to process via the roll mill.

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Nitrate Ester Solvency Effect

- Collodion solubility
 - EDGN
 - DEGDN, TEGDN
 - BTTN
 - NG
 - TMETN



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Technical Approach

- Thermochemical modeling of prospective formulations.
- Nitration laboratory quality control
 - Abel heat test (KI-starch paper)
 - %N
- Produce two unique compositions and one composition identical to the reference.



Photo Credits: NSWC IHD, R1 Division

Extrusion Parameters

- Heated Press, 140 to 170 °F.
- Dry paste.
- Full vacuum.
- Thermally condition propellant.
- Work the propellant with multiple dies and passes.
- Finishing die should exhibit polished surfaces.



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Solventless Extruded Double-Base (EDB)

- Solvent free nitrate ester
- Paste slurry
 - 10% Nitrocellulose water slurry
 - AA-16 Extruded Double-Base (NACES); AA-17 EDB; Lead-Free EDB and Gun Propellants.
 - Filtering and Wringing
- Horizontal mixing, flash suppressant and ballistic modifiers.

Paste Slurry



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Extrusion

- Dry paste
- 2-inch extrusion press
 - Heated
 - Full vacuum
 - Size limited
- Consolidation



0.25-inch for strand burn and closed bomb



0.5-inch

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Gap Test

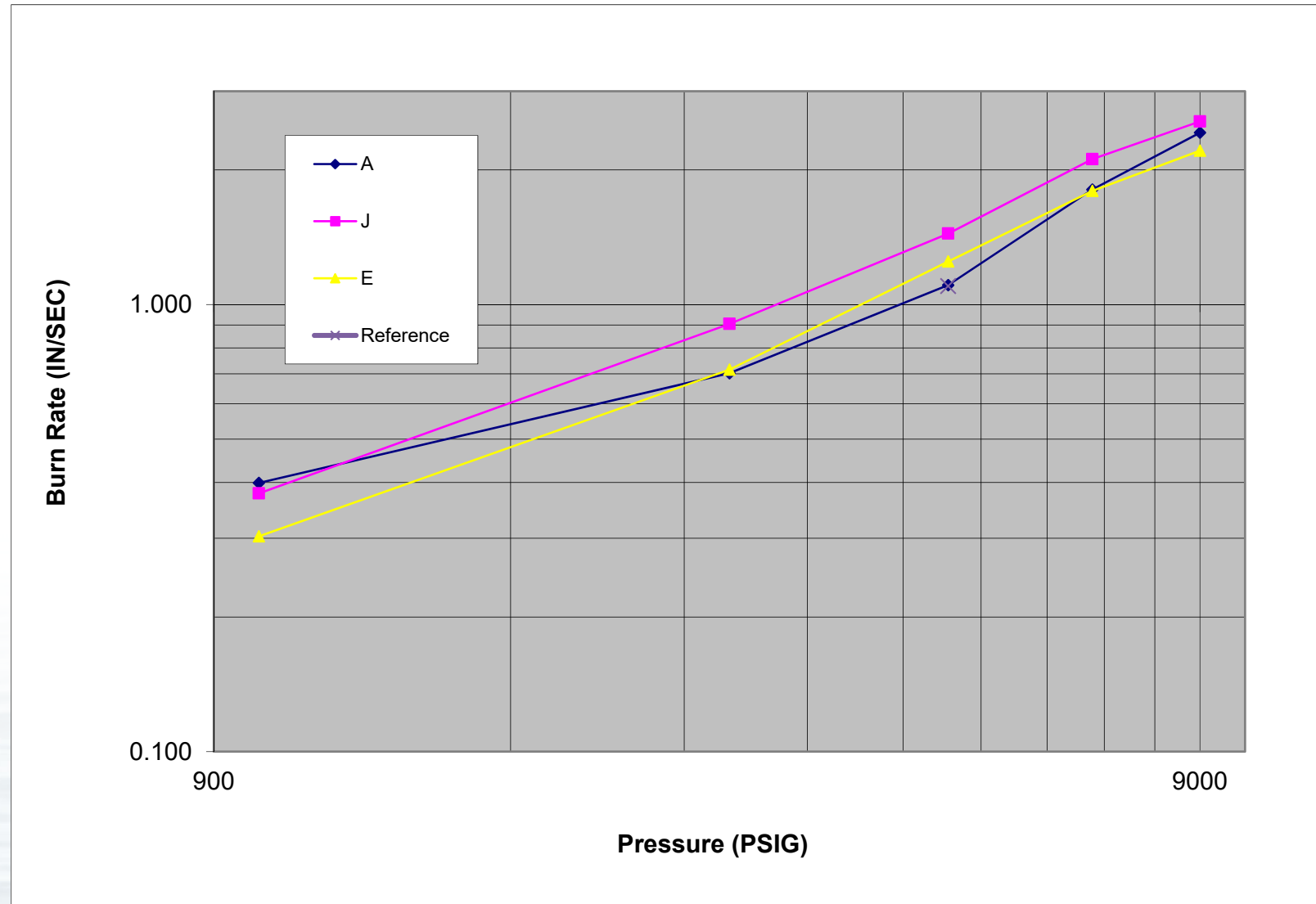
- 2-inch x 0.5-inch sample
- Sample size more appropriate with extruded explosives.



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Strand Burn Rate



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IM Performance

	Reference	A	E	J
HOE, cal/g	955	952	1026	1062
Density, g/cc		1.58	1.58	1.60
VTS @ 90 °C/40-hrs		0.8 ml/g	1.0 ml/g	1.3 ml/g
IHE Card Gap		49 Cards	50 Cards	53 Cards
Large Scale Gap Test	55-60 Cards			
NOS Impact, mm	275	136 (M)	147 (M)	144 (M)
BOE Impact, gos		0	10	10
ABL Friction, psig	>980	420 (M)	420 (M)	315 (M)
ABL ESD, j	>12.5	0.326 (M)	0.165 (M)	0.165 (M)

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Mechanical Properties

@ -65 °F

	A	E	J
Max Stress, psi	23351	21888	22463
Compressive Strain, %	9	8.61	8
Modulus, psi	332729	331823	347100
	@ 77 °F		
	A	E	J
Max Stress, psi	4100	4189	3743
Compressive Strain, %	68	68	69
Modulus, psi	11464	29209	23976

@ 160 °F

	A	E	J
Max Stress, psi	1144	1590	1084
Compressive Strain, %	68.6	70	69
Modulus, psi	2551	5866	5982

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Conclusions

- Extruded samples are well consolidated.
- Gap test results follow trend of:
 - Increasing %N of nitrocellulose
 - Decreasing NC/Gelatinizer ratio
- High BOE results.
- Thermal analysis is consistent with nitrate ester compositions.



Future Plans

- Produce nitrocellulose solventless composite base propellants.
- Explore premix process of nitrate ester and nitrocellulose.



Acknowledgements

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