

Non-toxic Heavy Metal Free Primers for Small Arms Cartridges – Red Phosphorous Based Introducing ATK Lake City's P₄rimerTM

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Approved for Public Release

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Ignition Mixtures have been ignored



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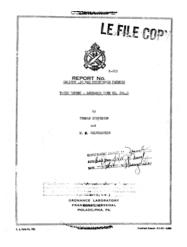
Whereas, a primary initiating explosive is suitable for ignition of small arms propellant, it does not appear to be necessary.

The percussion cap formulations from the 1910 – 50's have more in common with chemical ignition mixtures than primary initiating explosives. Ignition mixtures appeared to have been under-explored as an alternative methodology in the search for an "environmentally friendly primer". A US patent search reveals several ignition mixtures from the 1900 – 1960s assigned for use in percussion caps. This review suggests red phosphorus as a promising candidate.

Phosphorous Primers has previous military use

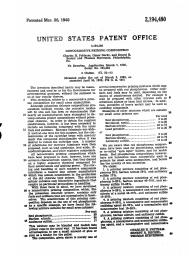


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Frankford Arsenal's P4 primer – 1940's Patent #2194480

Frankford Arsenal's Report Number R-265 Caliber .30 Red Phosphorus Primers Research Item Number 204.0



Olin's Improvements – 1960's Patent #2970900



Clariants' Amorphous P₄ Improvements – 1990's Section Clariant Technical Bulletins

http://www.nip.clariant.com

ATK Testing – 2005 - 2006



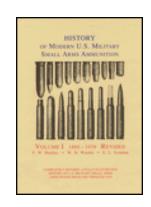
P4 was considered as the alternative to lead styphnate



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History of Modern U.S. Military Small Arms Ammunition by Hackley, Woodin & Scranton, 1978

"Through the 1920s, the U.S. experimented with different primers in an attempt to get away from the corrosive compounds of the time. Some of these tests were identified by special headstamps. Additional tests on primers occurred in the 1930s and again after WWII. Some were plated with tin, nickel or zinc but that alone does not automatically mean a primer is an experimental. In the late 1940s, the U.S. used zinc plating to protect primer cups on the then new **P4** primer. "

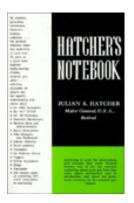


"Hatcher's Handbook" by Maj. Gen. Julian Hatcher, 1956;

"Meanwhile Frankford Arsenal's search for a perfect non-corrosive primer for other service ammunition had been progressing, and they came up with a non-corrosive primer mixture consisting of barium nitrate and red phosphorous, and started its manufacture.

. .

This primer mixture was used for a time (about 1949) with success; but it was finally decided to adopt a lead styphnate primer mixture for all service small arms primers, and such a non-corrosive small arms primer based on lead styphnate was standardized be Ordnance Committee action in August 1949."

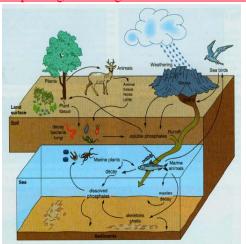


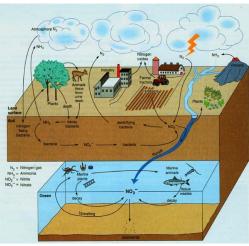
Combustion Products are recycled in bio-cycles



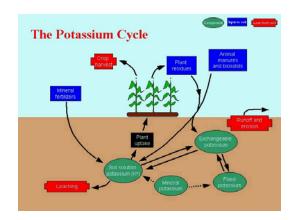
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http://neptune.gsfc.nasa.gov/STAFF/brianc/phospho.html http://neptune.gsfc.nasa.gov/STAFF/brianc/nitro.html

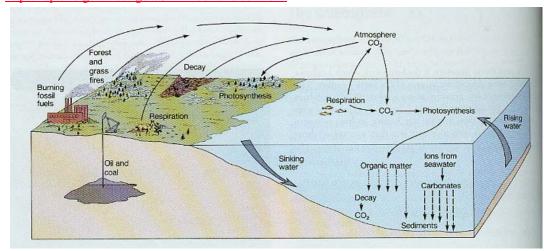




http://www.ppi-far.org/



http://neptune.gsfc.nasa.gov/STAFF/brianc/co2.html



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Elemental Phosphorous is an essential dietary mineral

Recommended Daily Allowance 0.7 g

Tolerable upper intake limit 4 g

Important in Kreb's Cycle

Only certain phosphates salts are biologically absorbed

Elemental Potassium is an essential dietary mineral

Recommended Daily Allowance 4.3 g

Tolerable upper intake limit 15 g

Important in Nerve Impulse function and Metabolic Cycle

Water soluble potassium salts are readily biologically absorbed



NASA – Lewis Predicted Mass Fraction after Combustion

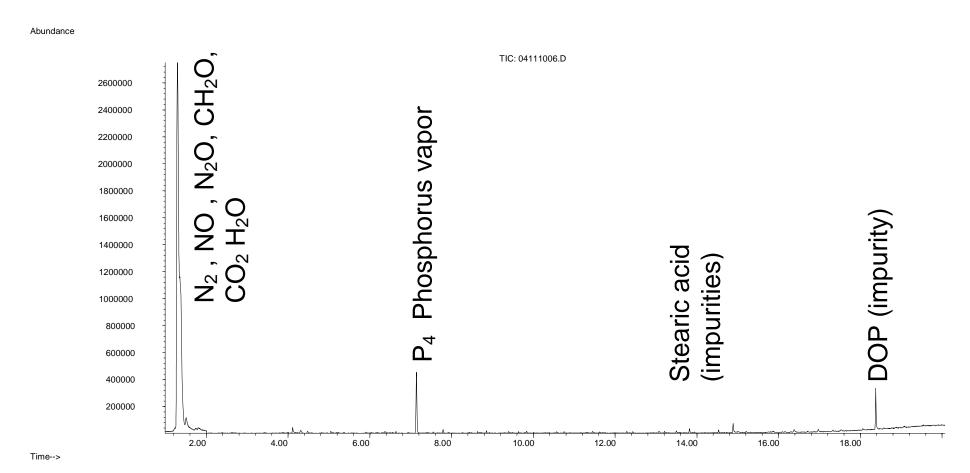
Primer Only				
psi	1000	10000	50000	
P406	36.26	37.86	41.06	
K2CO3 (L)	5.27	17.37	19.75	
PO2	23.96	17.56	13.41	
KOH (L)	0.00	0.00	9.54	
K	17.66	9.36	5.70	
K2	0.72	1.81	3.53	
KOH	13.58	12.77	3.48	
KO	2.02	1.35	1.65	
РО	0.53	1.73	1.59	
PN	0.01	0.17	0.27	
KH	0.00	0.03	0.01	

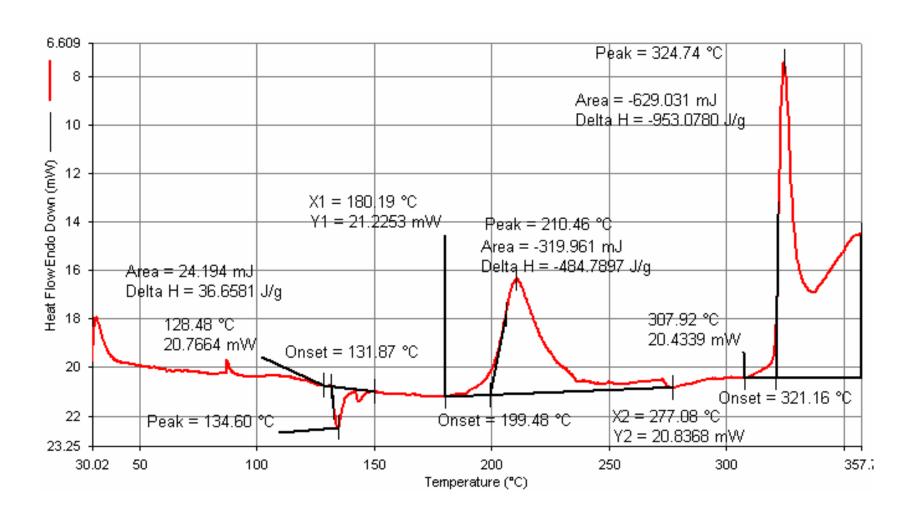
1:16 Primer: Gun Prop.				
psi	1000	10000	50000	
KOH	32.66	39.56	46.11	
PO2	42.83	41.41	33.96	
РО	12.32	11.83	9.66	
PN	0.90	2.36	3.91	
P406	0.00	0.17	3.63	
K	10.86	4.29	2.26	
KH	0.17	0.21	0.28	
KO	0.26	0.13	0.09	
PH	0.00	0.04	0.05	
KCN	0.00	0.00	0.05	

Main combustion components are chemical precursors for agricultural fertilizer



Total Ion Chromatogram from PyGC/MS Analysis of P₄rimerTM





Modified Vacuum Thermal Stability:

Mil Std 1751A Method 1063 at equal mass

Frankford Arsenal Formula 956 – 0.375 ml gas

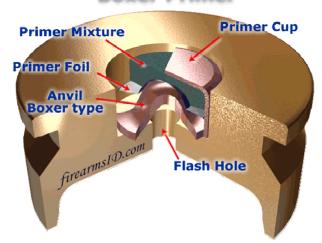
P4rimerTM – 0.125 ml gas

Primer Design Does Not Change with P₄rimerTM



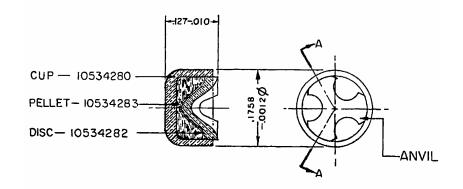
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Boxer Primer



Engineering Constraints

- •Non-Toxic
- Stable
- •Cost effective



Ingredients

Light Metal Nitrates

Encapsulated Red

Phosphorus

Secondary Explosive

Light Metal

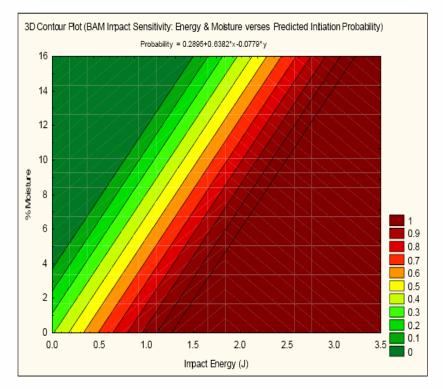
Binder

P₄rimerTM has the same mechanical activation energy

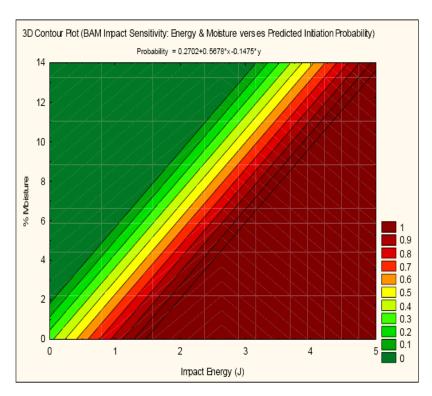


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BAM Impact Ignition Probability for ATK P4



BAM Impact Ignition Probability for FA 956



as functions of Energy and Moisture

Impact ignition for P4rimerTM and FA 956 are very similar.

P₄rimerTM is a viable substitute for Pb Styph formulations (ATK)

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- Can be used in current primer, case, cartridge metal parts
- Same Impact energy
- Meets Percussion Cap performance paragraphs of Military Specification MIL-P-46610E (MU)



- P₄rimerTM is a Non-corrosive, "Green",
 - Non-Toxic, Heavy Metal Free Ignition Mix
 - Non-corrosive as tested in "Frankford Arsenal's Report Number R-265 Caliber .30 Red Phosphorus Primers Research Item Number 204.0"
 - Meets requirements for Section 5 of the US Federal Trade Commission Act; Federal Trade Commission Guides for the Use of Environmental Marketing Claims, Part 260 and US Environmental Protection Agency in publication EPA 260-B-01-001 as applied to the terms; "green", "heavy metal free" and "non-toxic"
 - Mix Chemicals and Combustion Products are chemical precursors for agricultural fertilizer
 - Uses Biologically tolerant and recyclable chemicals



ATK P₄rimerTM Milestones:

- 1) US Patent Application, March 2006
- 2) US Army Feasibility Study Contract DAAA09-99-D-0016/0012, Mod 7; July 2006
- 3) EU Patent Application, February 2007

US Army Points of Contact – Feasibility Study



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PM-MAS – Jim McGrath ARDEC – Lucas Lopez ARL – Paul Conroy