Effect of Manufacturing Processes on Nitrocellulose in Extruded Double Base Propellants

Presented by James Tucker

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Research aims

- Thesis Title ‘Whole life assessment of extruded double base propellant’

- This research aims to investigate how the process of extrusion can affect the chemical composition the extruded double base propellant
Contents of this presentation

• Introduction to Double Base Propellant
• Theory
• Samples
• Results from Chemical Analysis
• Results from Thermal and Mechanical Analysis
• Discussion
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Introduction to Double Base Propellant

- Nitrocellulose (NC)
- Energetic, Oxygen Balance ~ -30%
- Polymer, acts as binder
- Degraded over time
Introduction to Double Base Propellant

- Chain Scission
- $E_a \approx 160,170$ kJ/mol
Introduction to Double Base Propellant

- De-Nitration
- Ea ~100kJ/mol
Introduction to Double Base Propellant

- Nitroglycerine (NG)
- Energetic, Oxygen Balance 3.5%
- Acts as a plasticiser
Introduction to Double Base Propellant

- Uses of Double base propellants
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Theory

• Ram Extrusion
• Heat
• Pressure
• Decomposition, Chain Scission, De-nitration
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- Introduction to Double Base Propellant
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- **Samples**
- Results from Chemical Analysis
- Results from Thermal and Mechanical Analysis
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Samples

- Samples from different parts of the propellant grain were analysed
- Polymer chain length (GPC)
- Concentration of NG (HPLC)
- Thermal and mechanical properties (DSC)(DMA)
Samples
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Results from Chemical Analysis

- The HPLC confirmed that the concentration of NG remained constant.

- The GPC measured no variations in the polymer chain lengths or distribution between samples.
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DMA Analysis

- DMA
- Temperature range: -100 to +20°C
- Heating Rate: 5°C/min
- Geometry: Single Cantilever Bend
- Frequency: 1 Hz
DMA Results

Dynamic Properties vs Temperature

- Modulus
- Tan Delta
DSC Results
DMA and DSC Results

[Graph showing DMA and DSC results with annotations: Tan δ and Heatflow]
Future Work

• Determine the effect of repeated extrusion
• Investigate the effects of plasticisers using thin films
• Investigate the effect of ageing
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Questions