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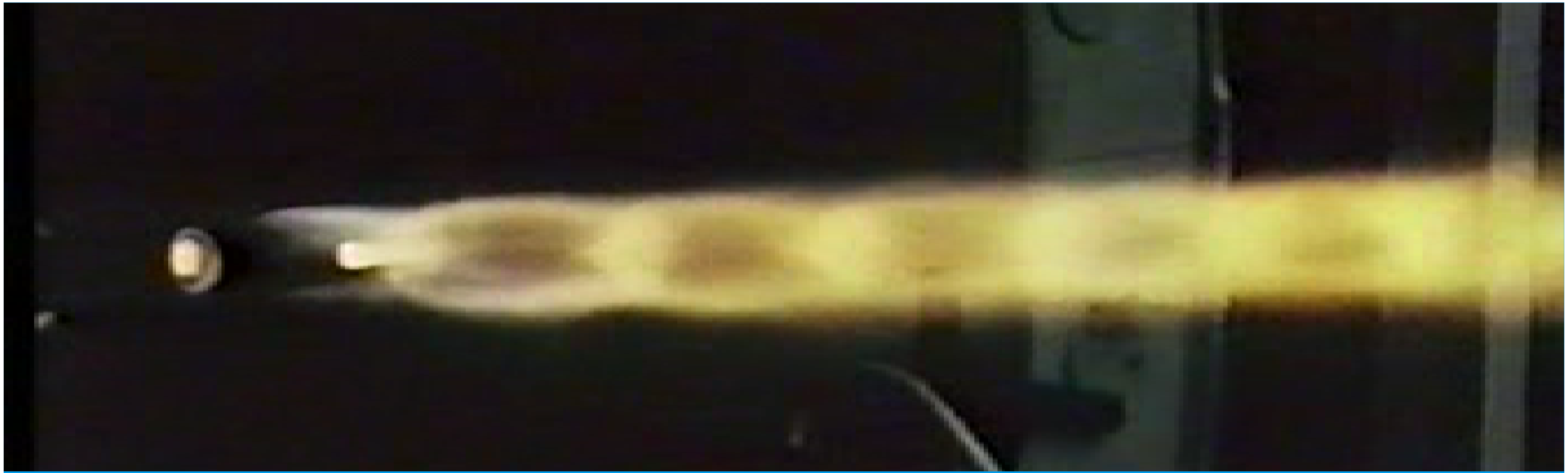

The application of bipropellant systems in IM tactical missiles

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QinetiQ

Contents

Introduction

Background

Can bi-propellant rocket motors offer the possibility of both improved IM compliance & missile performance?

- We have looked at that question within the UK MOD, DEC (DTA) - Munitions Vulnerability & Surface Rockets research programmes
- Aims of this presentation:
  - Brief outline of some UK research on the issues
  - Provide overview of relevant aspects on IM & safety
  - Encourage possible future use

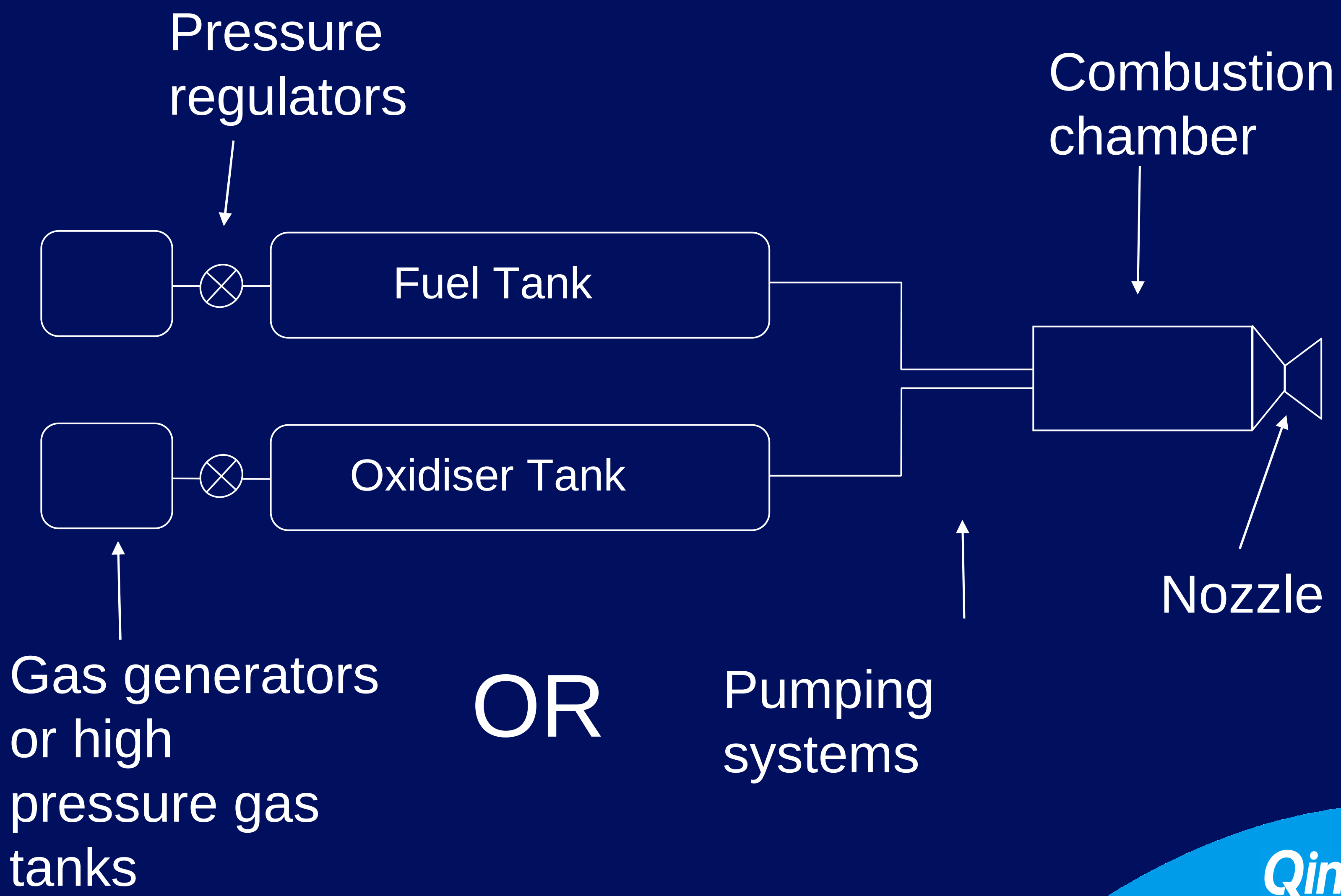
Introduction

QinetiQ Research - Overview

- Eventual target of producing a viable system within the tight volumetric constraints of a tactical missile.
- Made use of prior UK research whenever possible.
- Research targeted in key areas expected to lead to innovation or cover where data was missing.
- Currently available and novel propellant versions assessed.
- Modelling & firing to be used assess the performance of bipropellants versus solid propellants.
- Study intended to draw useful conclusions for future development work.

Introduction

Simplified bipropellant schematic



Introduction

Bipropellants overview

Bipropellants seem capable of achieving

- IM compliance for **all stimuli!**
- Other advantages, e.g. thrust control

Have been in service - Lance and Bullpup (IRFNA/UDMH)

But they have been perceived as unsuitable due to:

- The toxic & often carcinogenic nature of propellants
- Potential tank corrosion problems

Introduction

Reasons for renewed interest

Two key areas of advancement may now make bipropellants viable for tactical use:

- **Gelled propellants**:
  - Lowers toxicity of spilled propellant by reducing dispersion and vaporisation
  - Effect is localised and poses low risk
- **Greater missile intelligence**:
  - Advanced/miniaturised missile guidance & control systems
  - Future tactical missiles can effectively use controllable thrust in real time

Advantages (1)

- IM compliance:
  - Type V response - likely for all test stimuli & without propulsion, maybe even Blashill's Type VI possible !
  - Fire fighting easier & can proceed without the threat of detonation.
- Thrust control:
  - Range extension, end-game manoeuvre & variable velocity.
  - Future tactical missiles can take full advantage due to sensor, communication & processing developments.
- Well proven concept (for other applications):
  - Many successful examples of non-gelled systems,
- 'No smoke' class, minimal IR plume !!

Advantages (2)

- WLC implications:
  - Not classified as an explosive during storage,
  - Low disposal costs,
  - Extend life by easy refills.
- Adaptable propellant storage:
  - Ideal for non-circular airframes,
  - Options for distributed tanks - help maintain C of G.

Disadvantages

- More complex than solid motors: but not compared to whole missile system.
- Involves toxic and corrosive materials:
  - But are not exposed during normal operation,
  - Gelling significantly reduces contamination & vaporisation,
  - Clean-up easily performed, usually with water,
  - Solutions for suppressing corrosion being developed.
- Combustion can occur if fuel and oxidiser meet:
  - Can be extinguished with water, and oxidiser diluted to an unreactive state,
  - Still is not explosive.

IM & Safety

Overview of IM data

- Previous research was examined:
  - Some testing performed by DERA (1990s)
    - Tests not to current STANAG standards, but illustrate effect of various stimuli
    - Testing included bullet impact and cook off
  - In all tests the worst response was combustion, i.e. Type V
  - Extinguishing propellant fires and the treatment of spilled propellants was demonstrated
  - Old-style propellants used: IRFNA and MAF (hypergolic and prone to vaporisation)
- None on gelled variants seen.

IM & Safety

IM characteristics

- The very good IM responses are due to separation of oxidiser and fuel.
- Hence, stimuli directed to either one cannot cause an explosive reaction.
- But, some oxidisers (HAN or HTP) are monopropellants in their own right, i.e. can react without a fuel.
  - Thus, such oxidisers have potentially different IM response to that stated here, but we have not seen IM tests for these.
  - Best to take care to avoid wherever possible.

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IM response (1)

The anticipated responses to the IM tests for gelled hypergolic propellants:

- **Stimuli:** Shaped charge & all fragment and bullet threats.
- **Response:** Propellant spillage. If two tanks holed, then combustion at interface of the spilled propellants.

IM response (2)

The anticipated responses to the IM tests for gelled hypergolic propellants:

- **Stimuli:** Thermal – Cook off.
- **Response:** The main failure mode would be rupture of the tanks due to pressure build up:
  - Reduce deflagration effect by controlled venting at a pressure below that which would cause tank failure.
  - But, the vented propellant could increase the intensity of the surrounding fire (FCO) or start one (SCO).

Treatment of accidents

- Leave fire to burn itself out.
- Extinguish fire with water.
- Dilute any spillage with water.
- Remove damaged tanks for disposal
  - (e.g. burning-off of the fuel and controlled aqueous-based reaction of the oxidiser).
- Personnel in the near vicinity may require suitable breathing apparatus &/or normal fire-fighting attire.

Conclusions

Findings

- Gelled bipropellants offer:
  - the opportunity of achieving full IM compliance, plus,
  - the operational advantages of thrust control.
- There is a wealth of previous research, but further development of firing system is required to produce viable tactical systems that are acceptable for service.
- Work on best & acceptable propellants still needed.
- The UK perspective on this area of technology is improved - which may ensure a balanced view of future propulsion.

The End

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