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ADN/AN PROPELLANTS AS GREEN ADVANCED HIGH ENERGY PROPELLANTS FOR LAUNCHERS

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ABSTRACT

Within the frame of the Horizon 2020 project GRAIL (www.grail-h2020.eu) Fraunhofer ICT develops green solid propellants based on ammonium nitrate and ammonium dinitramide in cooperation with FOI and AVIO.
The poster gives an overview about the work performed at Fraunhofer ICT and focuses on the feasibility of inert binder based aluminized ADN/AN propellants.
An overview of the GRAIL project can be found in the paper 3125163 "Green Solid Propellant for Launchers" in this conference presented by Niklas Wingborg.

Selected Propellant Ingredients

- Binder: HTPB and Polyester
- Oxidizer: ADN and AN
- Fuel: 18 % Al

Thermodynamic Calculations

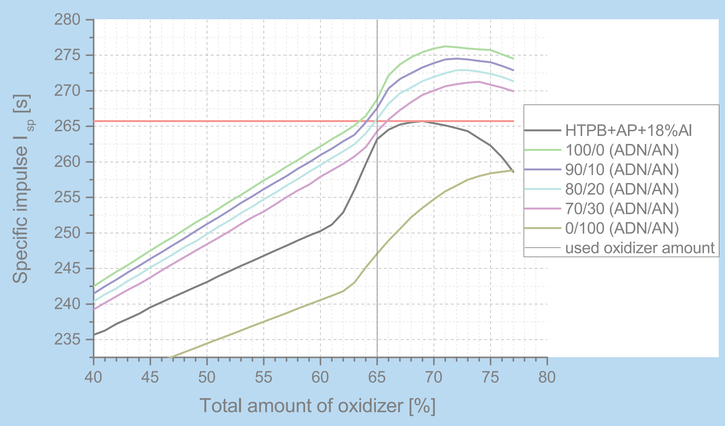

Figure 1. Isp of ADN/AN/HTPB/Al propellants with different amount and ratio of oxidizer

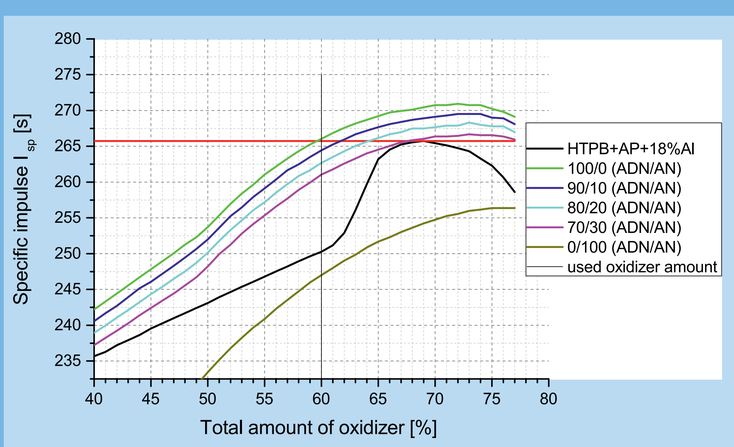

Figure 2. Isp of ADN/AN/Polyester/Al propellants with different amount and ratio of oxidizer

- To achieve a similar Isp of AP/HTPB/Al
  - ➔ Amount of oxidizer >60 % for Polyester
    - Total amount of filler >78 %
  - ➔ Amount of oxidizer >65 % for HTPB
    - Total amount of filler >83 %

Investigated Propellants

Selected by processability and not by necessary specific impulse of formulation

- 2 inert binders:
  - HTPB: oxidizer/HTPB/Al (65/17/18)
  - Polyester: oxidizer/polyester/Al (60/22/18)
- Oxidizers:
  - ADN and AN
  - Variation of the ADN/AN ratio at a fixed total amount of oxidizer
    - ➔ 100/0, 70/30, 50/50, 30/70, 0/100
- Constant ratio of coarse/fine particle size distribution (70:30)

Burning Behavior of aluminized ADN/AN Propellants

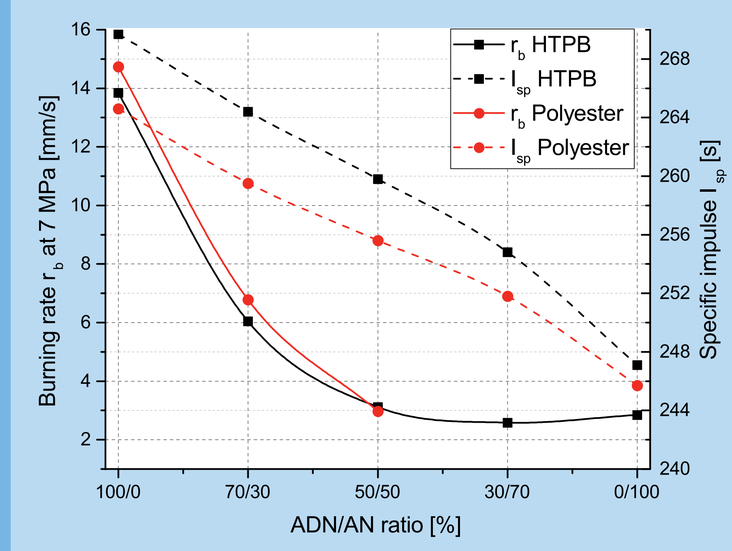

Figure 3. Burning rates (solid lines, left y-axis) and Isp (dashed lines, right y-axis) at 7 MPa as a function of ADN/AN ratio

- High ADN/AN ration > 70:30 to reach a burning rate > 7 mm/s at 7 MPa
- High pressure exponent in combination with inert binder
- Low ADN/AN ration (<30:70) to reach a low pressure exponent

Propellants with polyester binder show an high pressure deflagration limit (PDL) @ high AN content

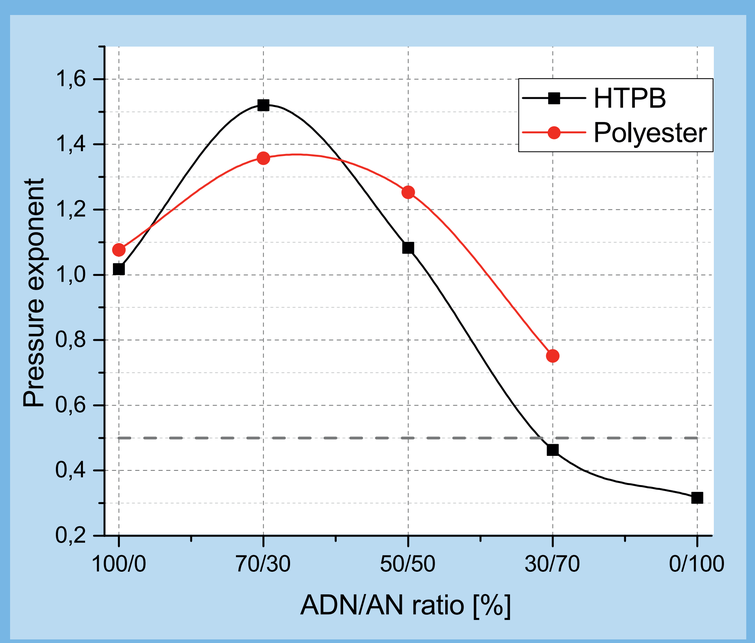

Figure 4. Pressure exponents as a function of ADN/AN ratio

CONCLUSION

- For the replacement of Al/**AP**/HTPB propellants by an Al/**ADN/AN** based propellant a high amount of oxidizer and filler is needed for Isp similar to Al/AP/HTPB
- Partial replacing of ADN by AN leads to a reduction of burning rate
- Ballistic exponent *n* increases with decreasing ADN/AN ratio
  - Too high *n* (*n* >1) at desired burning rates (7-15 mm/s)
  - Too high *n* at desired specific impulse
  - Low *n* only at high amount of AN
  - ➔ Suitable burning rate modifiers have to be found
- Requirements often in contrast to each other
  - ➔ r_b and Isp require high amounts of ADN
  - ➔ *n* and sensitivity require high amounts of AN

The replacement of ammonium perchlorate (AP) by a mixture of ammonium dinitramide (ADN) and ammonium nitrate (AN) in propellant formulations with inert binder is still a challenge. Upcoming work will show if it is possible or not.

ACKNOWLEDGEMENT

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