INSENSITIVE GUN PROPELLANTS WITH LOW TEMPERATURE COEFFICIENT BASED ON DNDA

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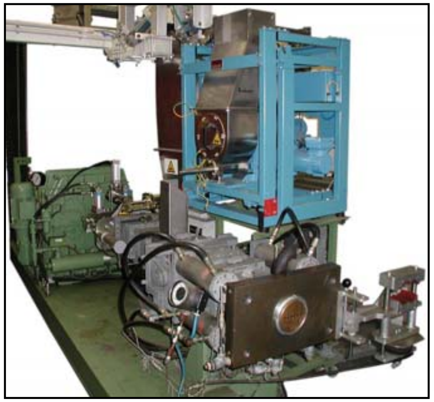
Fraunhofer Institut Chemische Technologie

Content

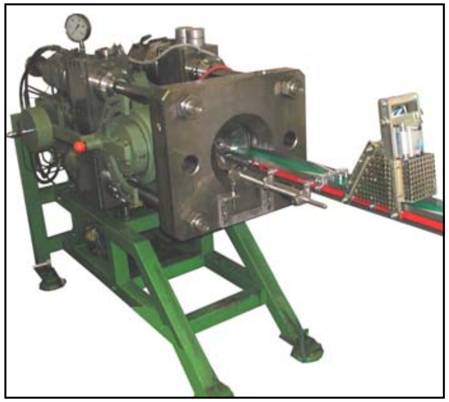
- Processing Technology
- Low Temperature Coefficient (LTC) Propellants
    - Temperature Behaviour
    - Characteristics of the Propellant Components
    - Performance, Safety & Sensitivity Datas
    - Shaped Charge Tests
    - Closed Bomb Tests
    - Gun Firing
    - Erosivity
- Results & Conclusion

Processing Technology for Insensitive Gun Propellants based on DNDA



Continuous Process

- Shear Roll Mill
- Twin Screw Extruder (TSE) ZSK 58 E

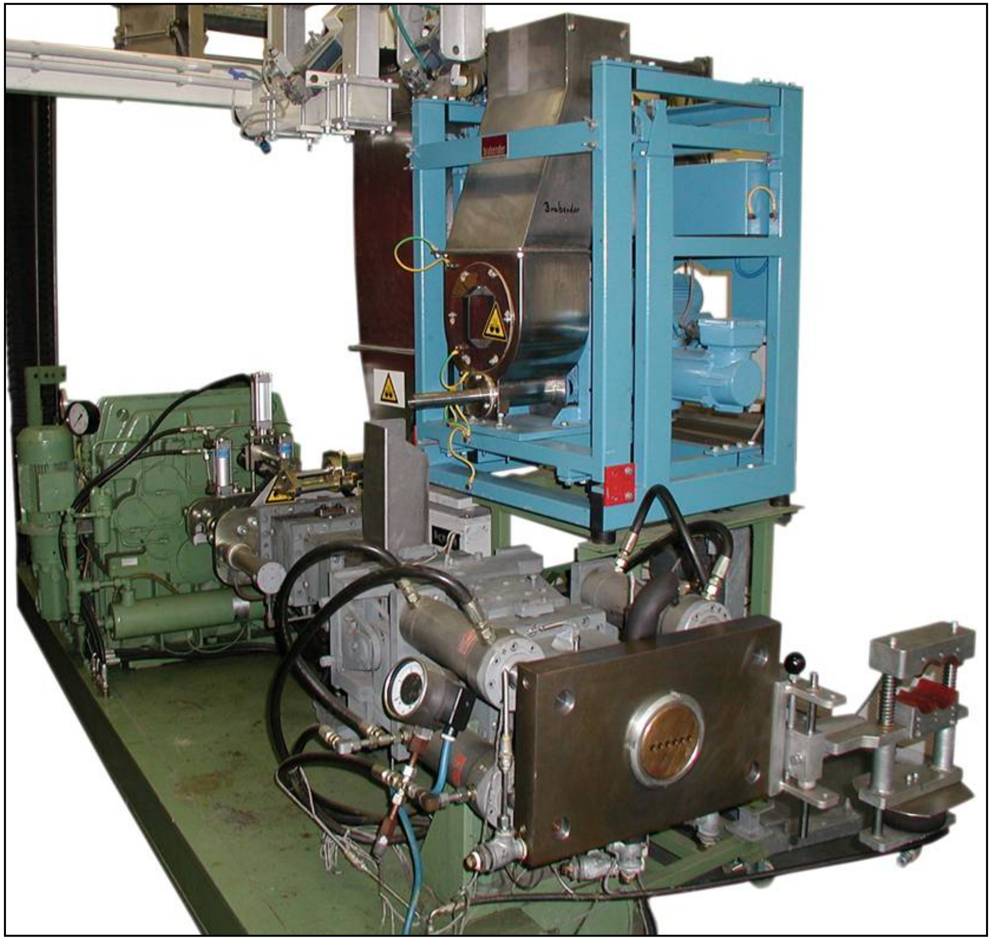


Batch Process

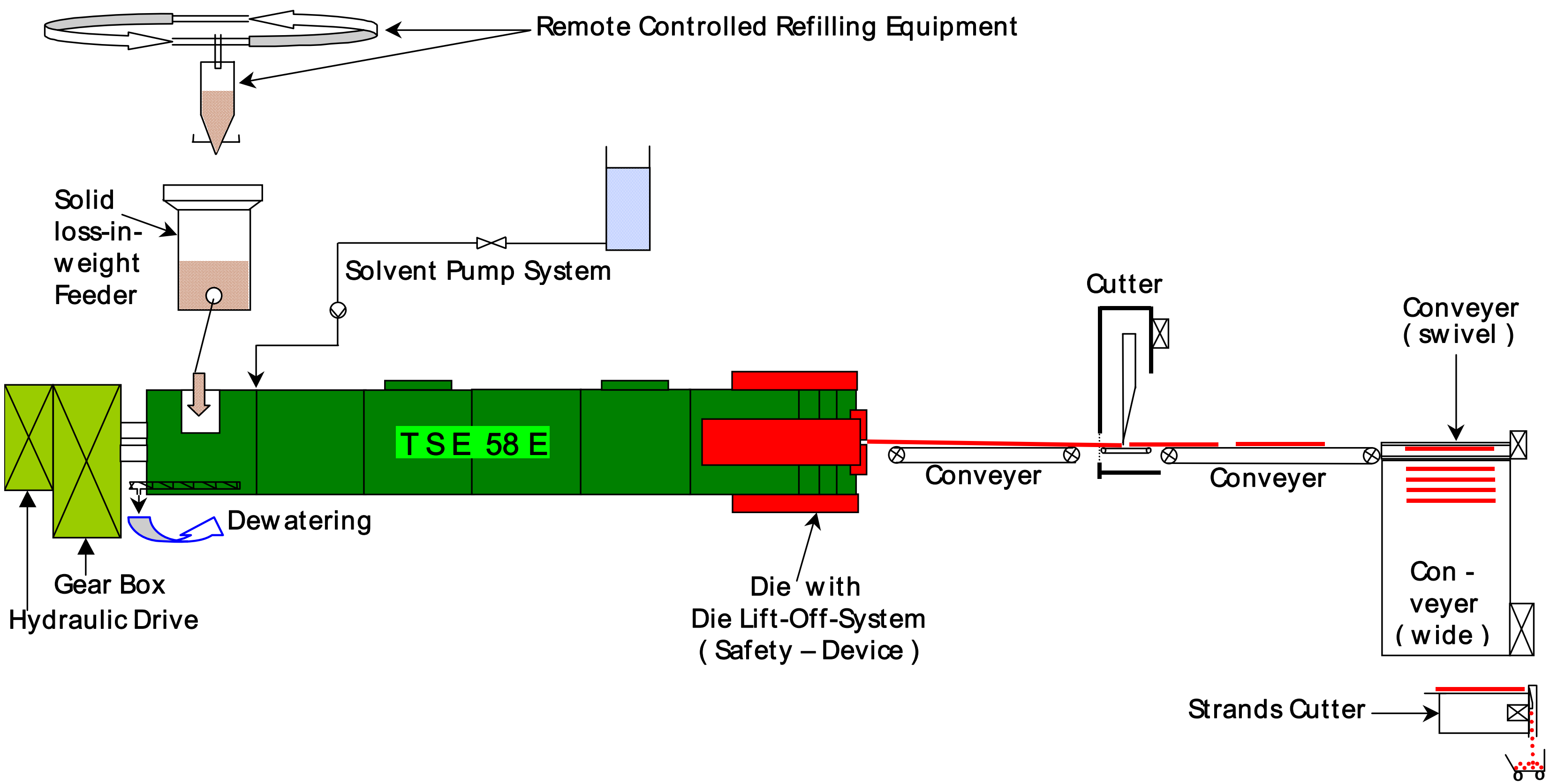
- Kneader / Mixer
- Rampress

Shear Roll Mill (Continuous Process)

Corotating intermeshing Twin - Screw Extruder ZSK 58 E

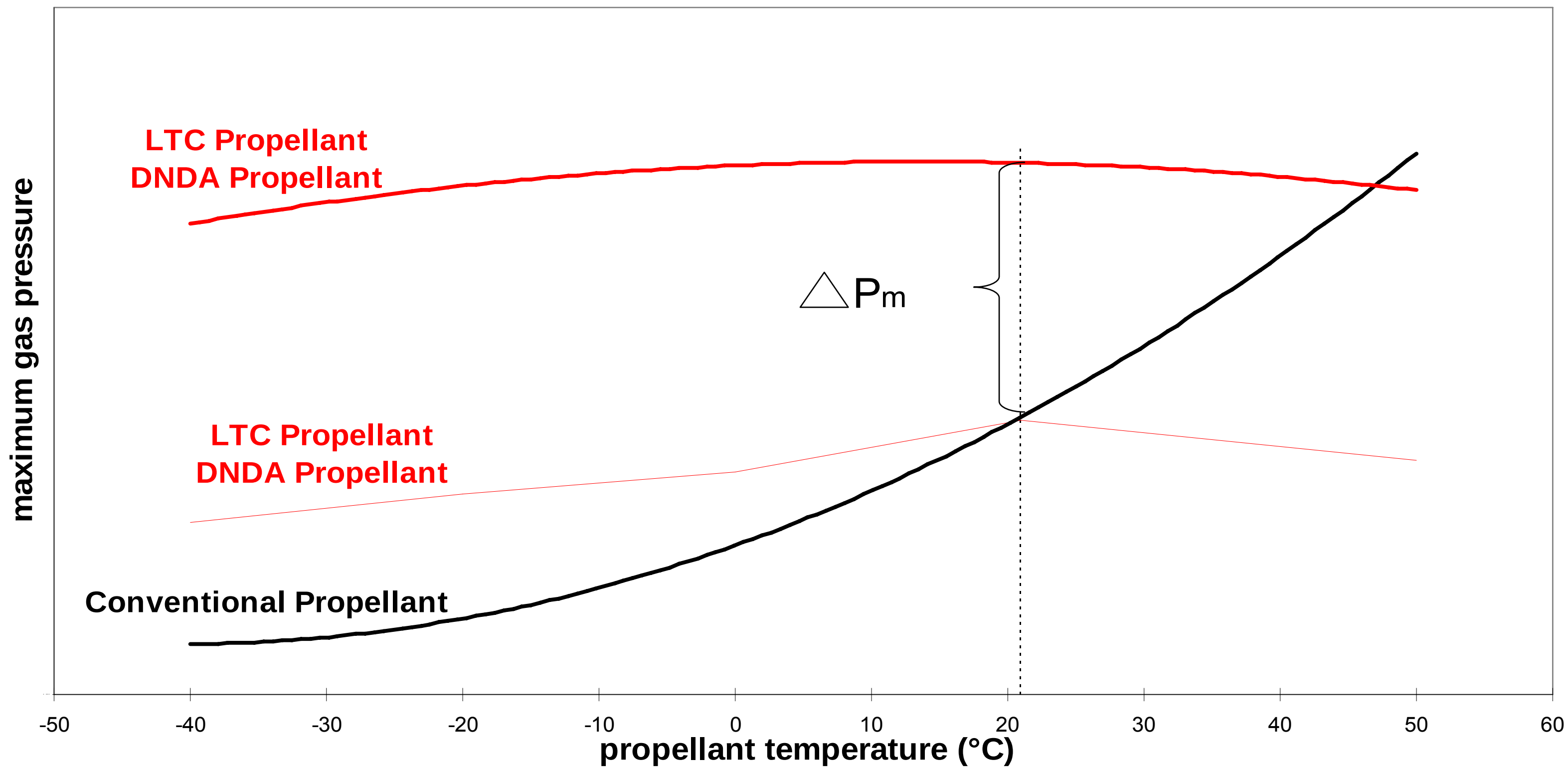


Twin - Screw Extruder Process



Temperature behaviour of gun propellants

Max. gas pressure vs propellant temperature



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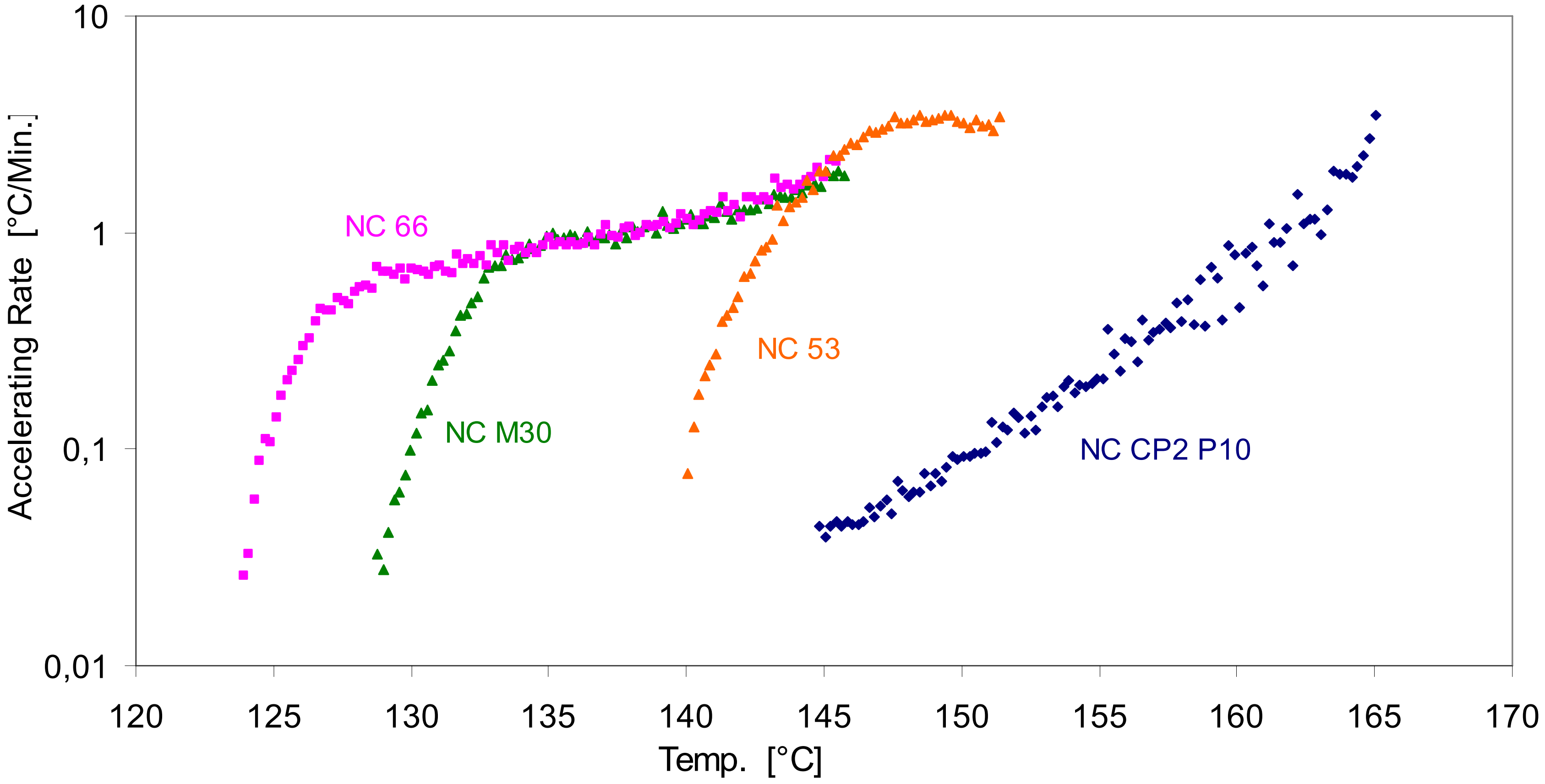
ARC measurement of several Nitrocellulose (NC) types



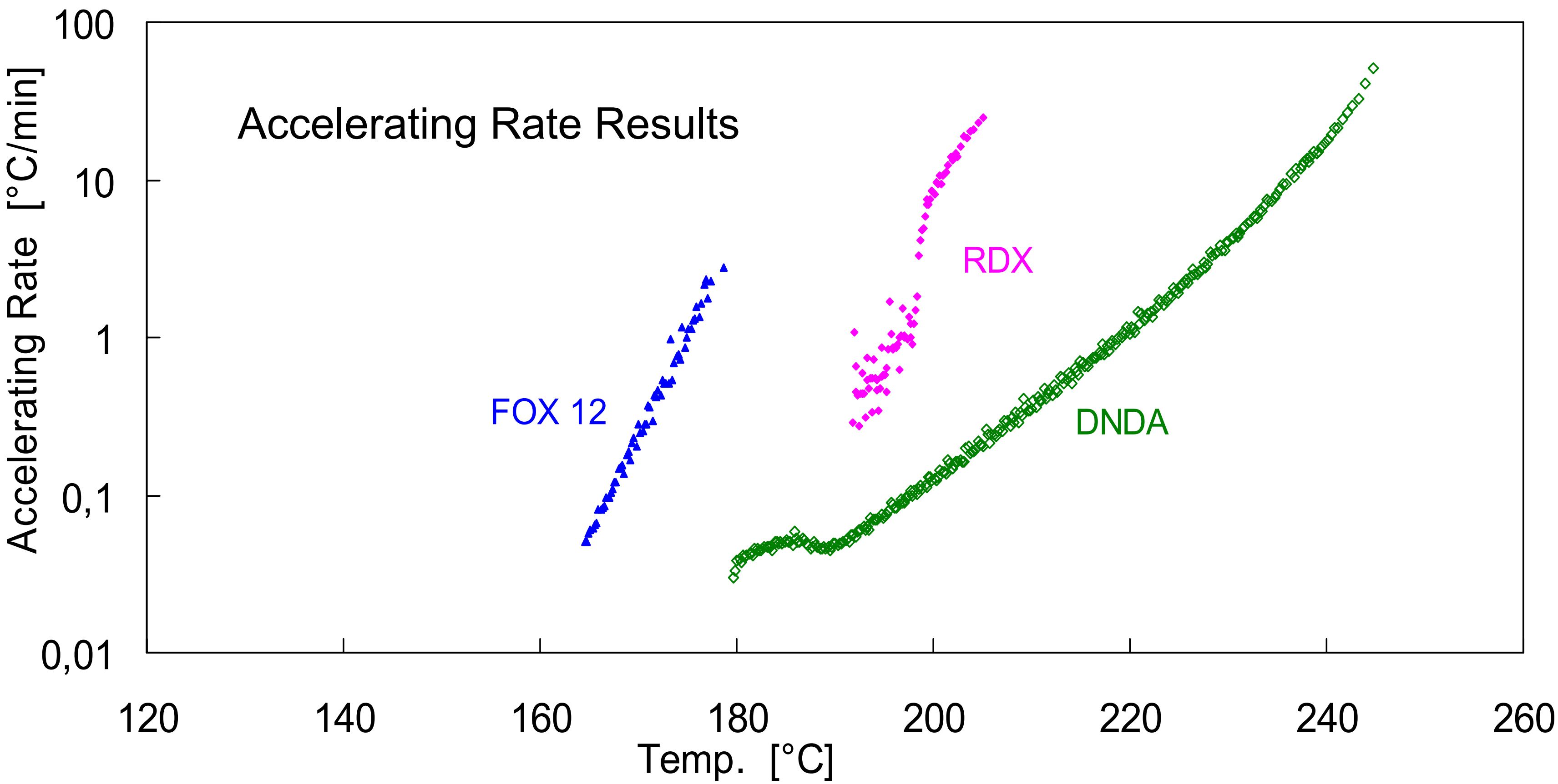
Lightmicroscope pictures of different NC types

NC M30

NC CP2

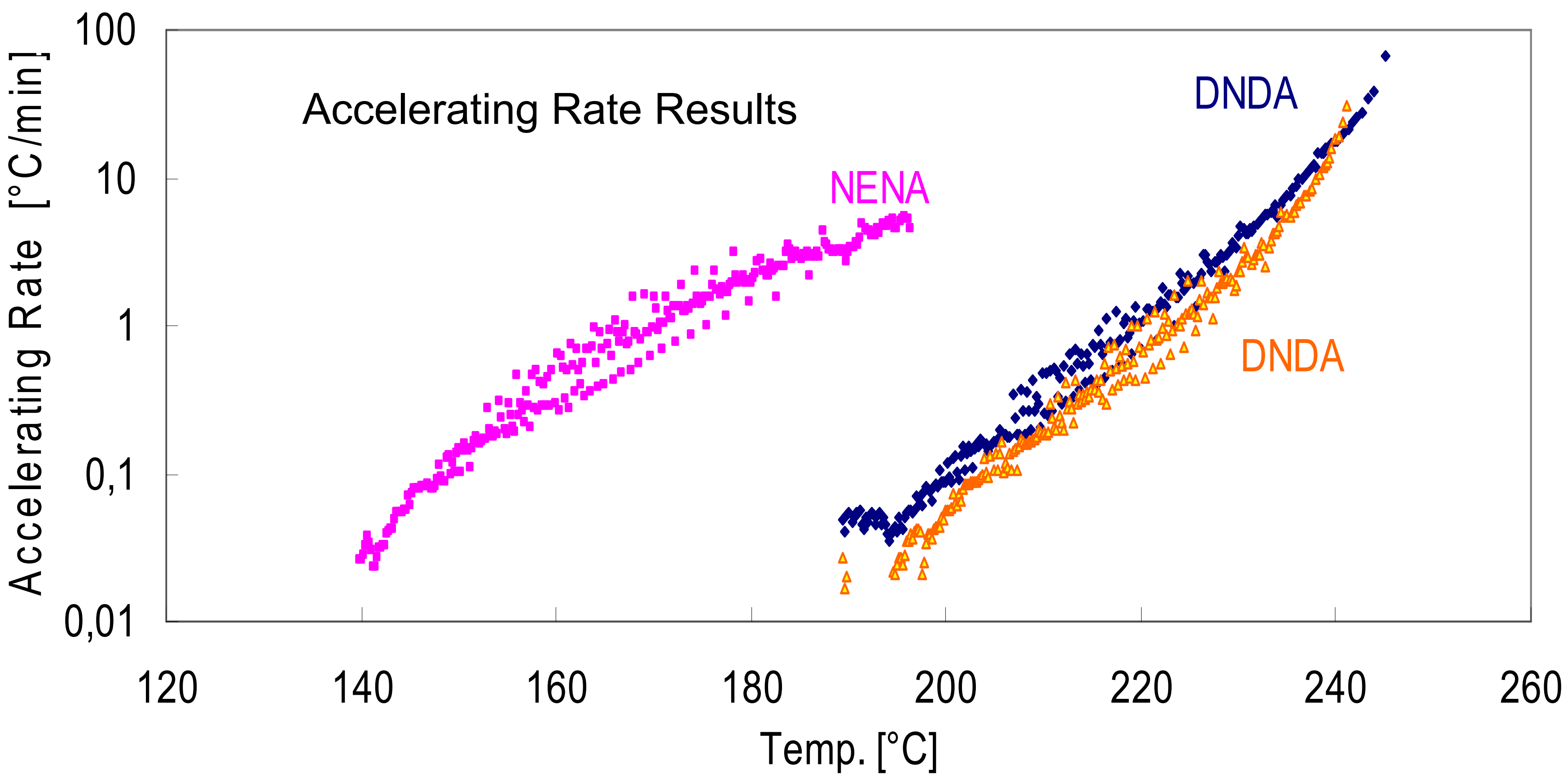
NC 53

ARC measurement of RDX, FOX-12 and DNDA

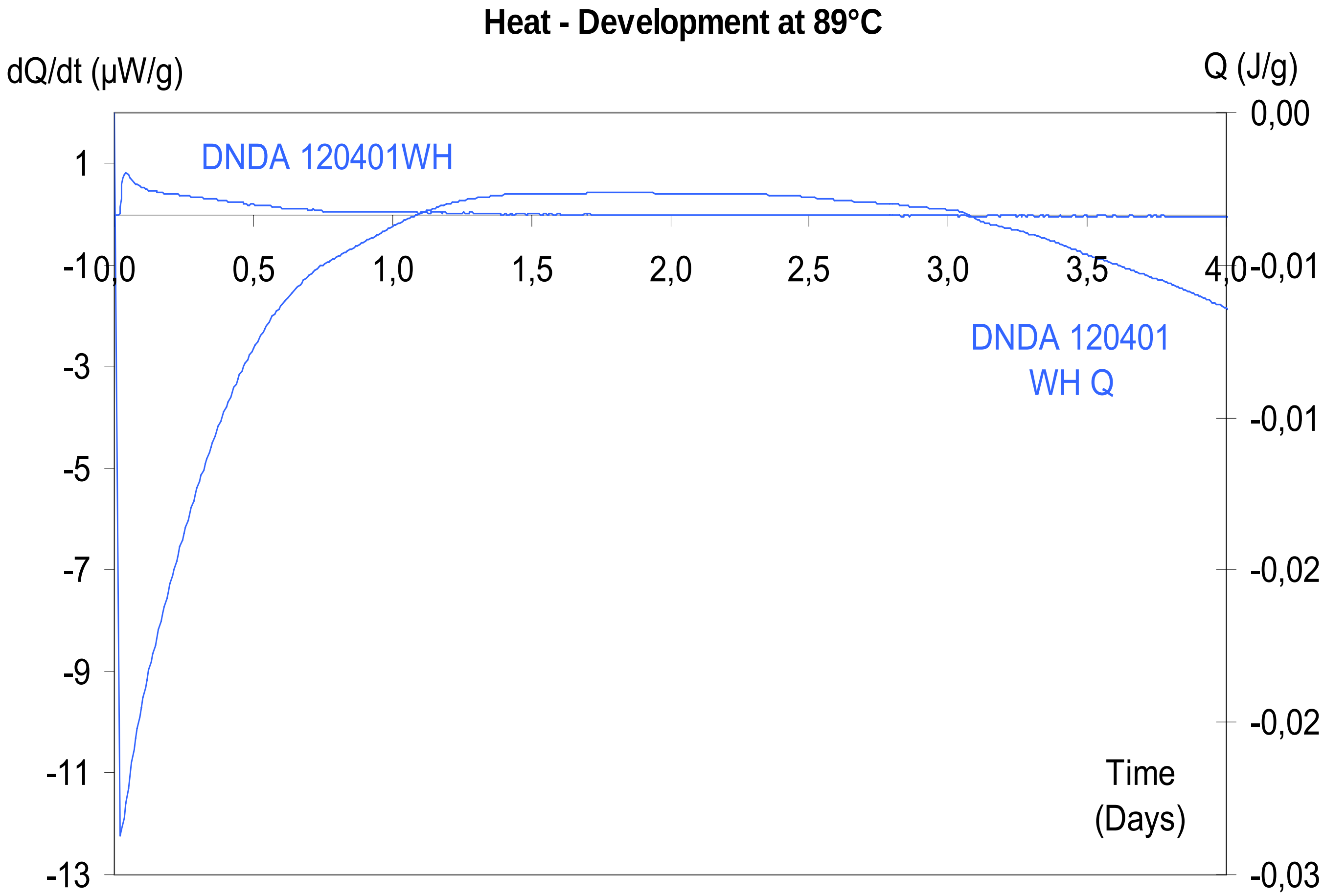


ARC

DNDA-5,7 compared with NENA



Microcalorimeter Result of DNDA-5,7
Endothermic Behaviour



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Performance Data of LTC Propellants

RDX / FOX-12	x	x	x	x	x	x	x
	till max. 59 Wt. - %						
NC	x	x	x	x	x	x	x
DNDA-5,7	x	x	x	x	x	x	x
Stab., Additives	x	x	x	x	x	x	x
T [K]	2540	2913	3118	3160	3264	3335	3390
Force [J/g]	1080	1182	1212	1229	1250	1263	1300
Q_{ex} [J/g]	4000	4204	4347	4411	4519	4594	4730
Mw [g/mole] Reaction gas	19,4	20,8	21,4	21,4	21,7	21,9	22,1

Safety Data of selected LTC Propellants

Mass - Loss weight after 18 days, 90 °C	0.50 till 0.70 %
Mass - Loss weight after 30 days (no autocatalytic effects)	1.10 till 1.40 %
Ignition temperature	> 215 °C
Cook - off temperature approx.	> 210 °C

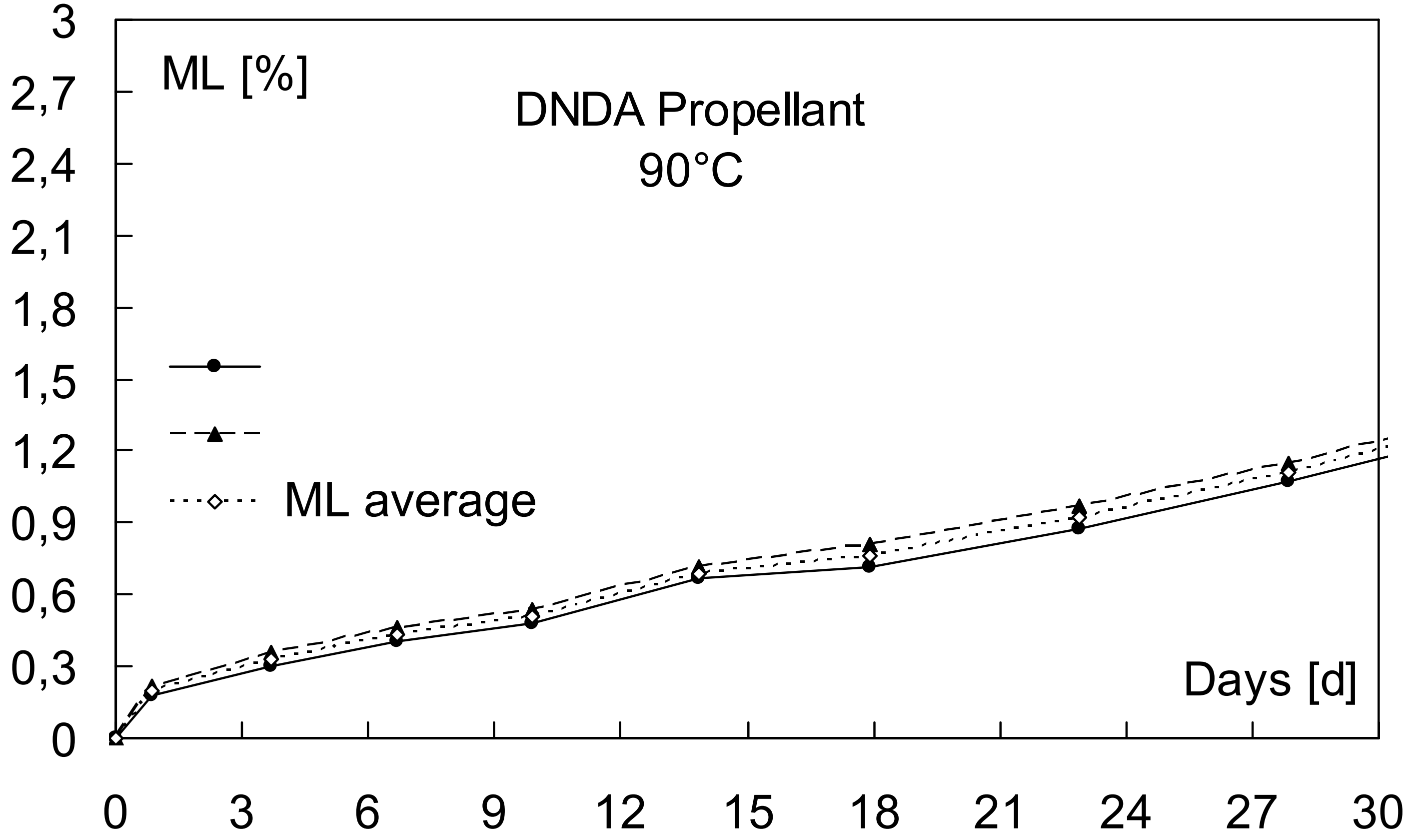
Sensitivity Data of different DNDA - Propellants

	FOX - Prop. ICT 8	FOX - Prop. ICT 7	RDX - Prop. ICT 1	i -RDX - Prop. ICT 2	RDX - Prop. mod. DNDA ICT 3
Reaktion Class Shaped Charge Test cal. 35 mm	O no Reaction	A	A	A	B
Friction Sensitivity [N]	240	252	288	240	240
Impact Sensitivity [Nm]	6,0	7,5	6,0	6,0	5,0
Ignition Temperature [°C]	~ 200	~ 200	~ 220	~ 216	~ 219
1“ Detonationtube	no Detonation				
MG cal.50 /12.7 mm	IM Reaktiontype 5 (MIL – STD 2105B)				

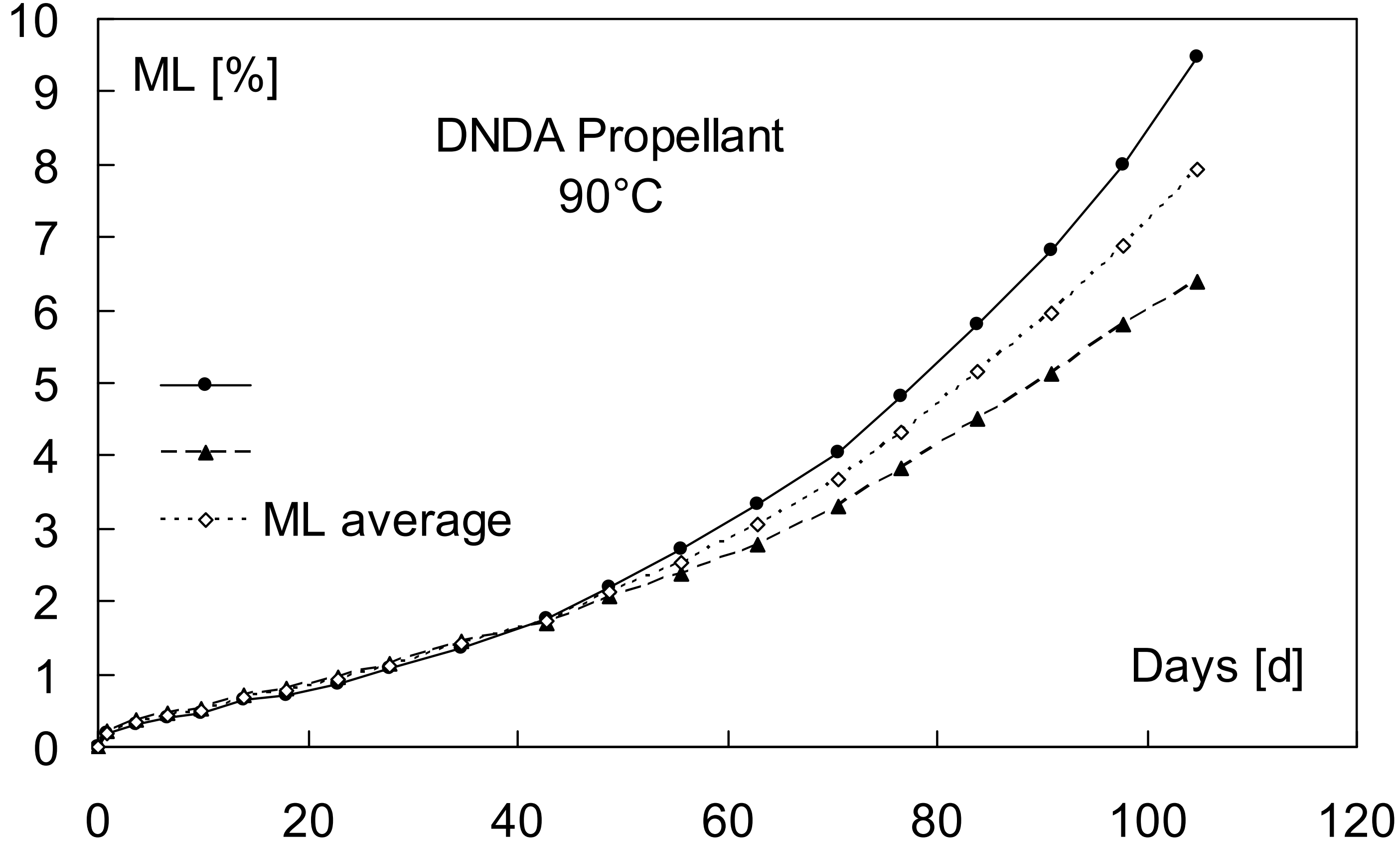
WIWEB Results

Shaped Charge Tests,
FOX Propellant ICT 8 and RDX Propellant ICT 1

Longtherm - Storage Stability at 90 °C
Mass - Loss over Time



Longtherm - Storage Stability at 90 °C
Mass - Loss over Time



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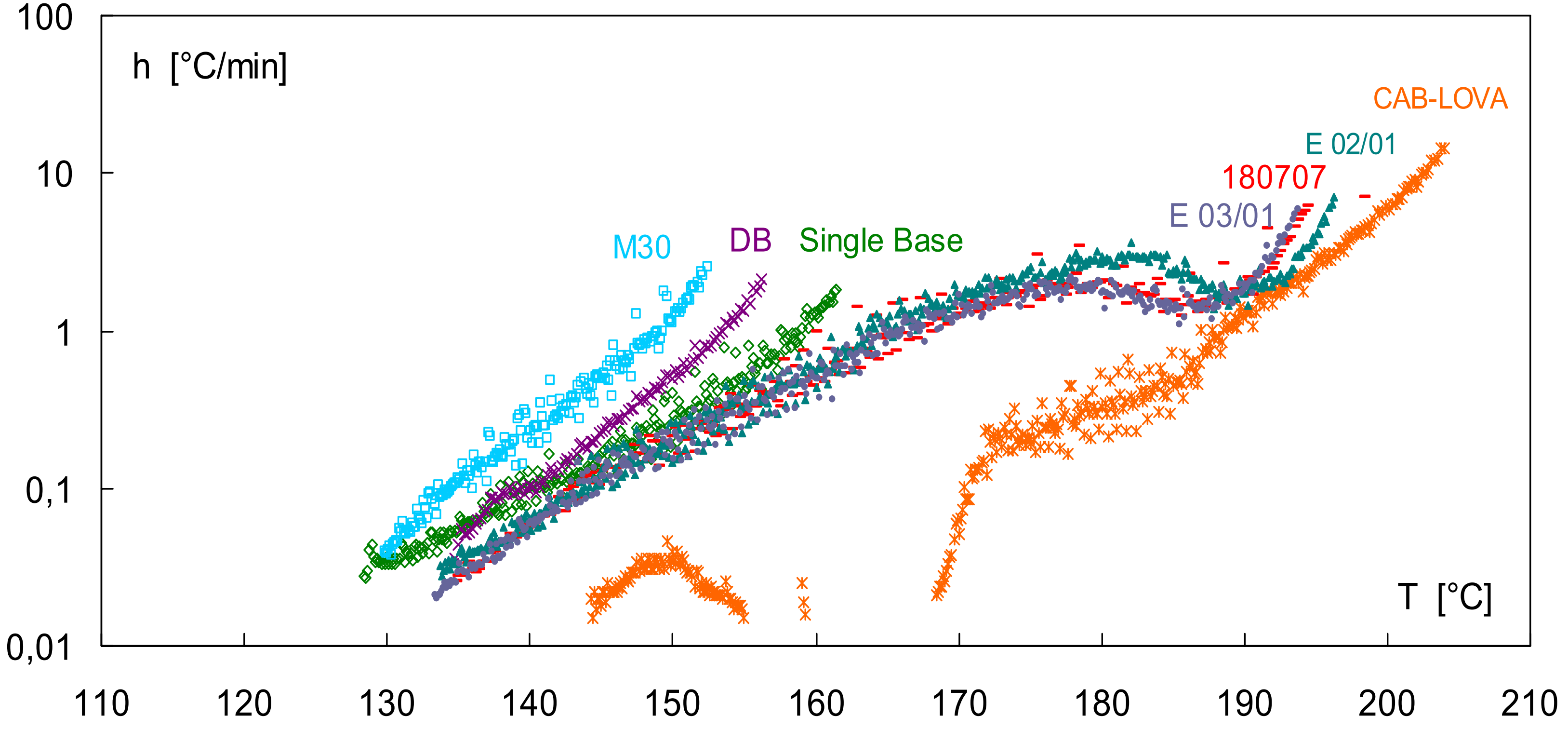
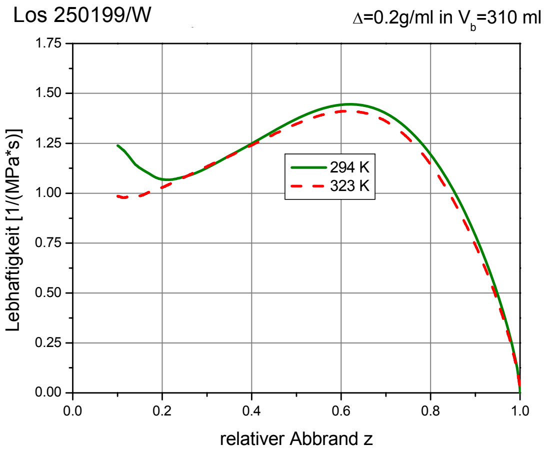
Accelerating Rate Investigations of DNDA - Propellants compared with CAB-Lova, M30, Single Base and Double Base

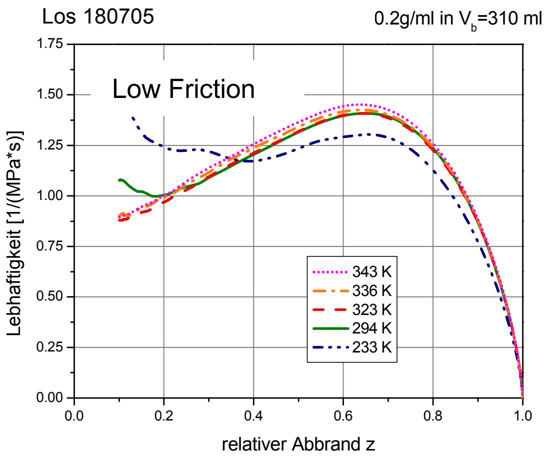


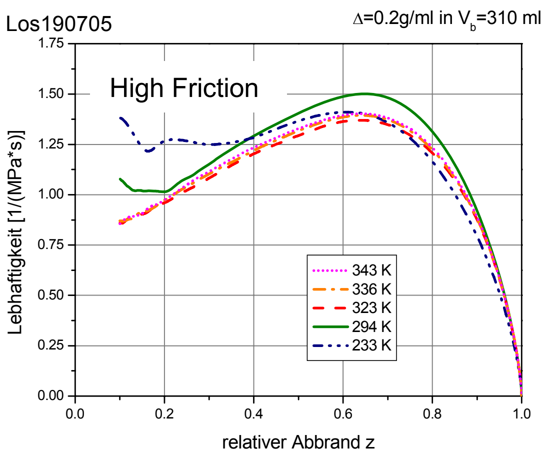
INSENSITIVE GUN PROPELLANTS

Batch Process Mixer compared with Shear Roll Mill

vivacity of the propellants

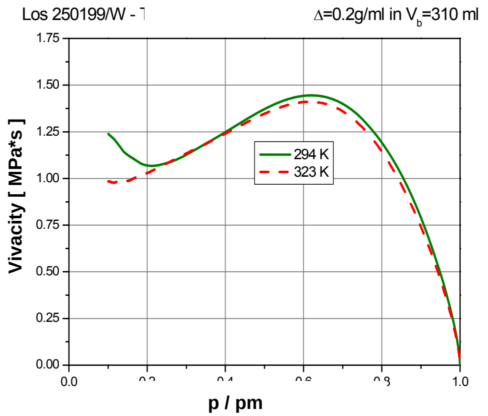


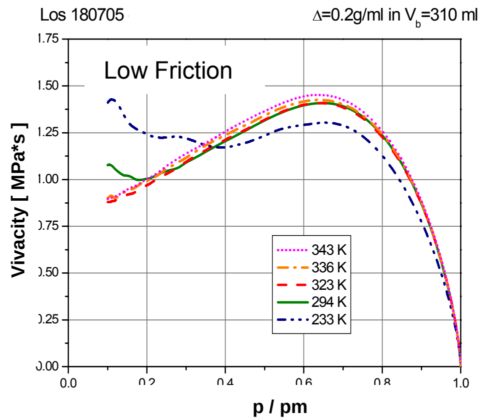


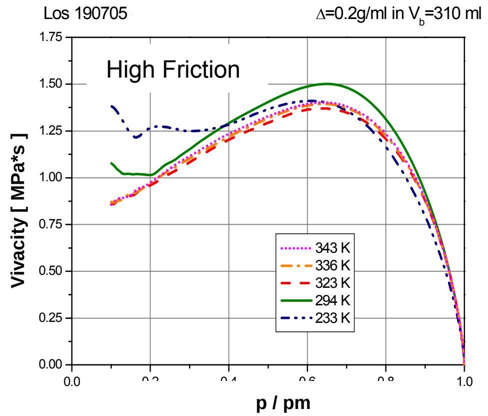


Batch Process Mixer compared with Shear Roll Mill Process

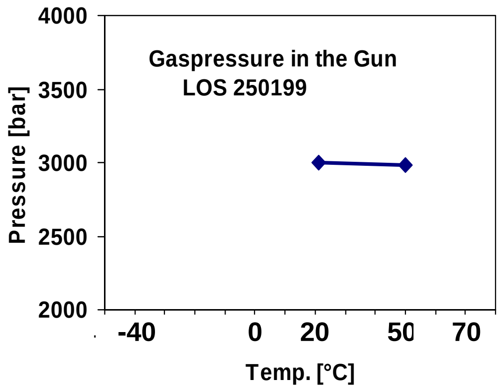
vivacity of the propellants

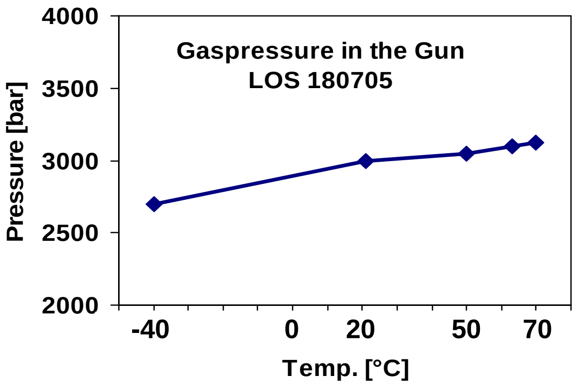


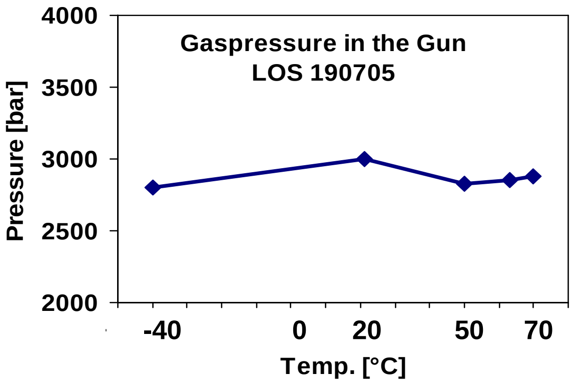




gas pressure of the propellants







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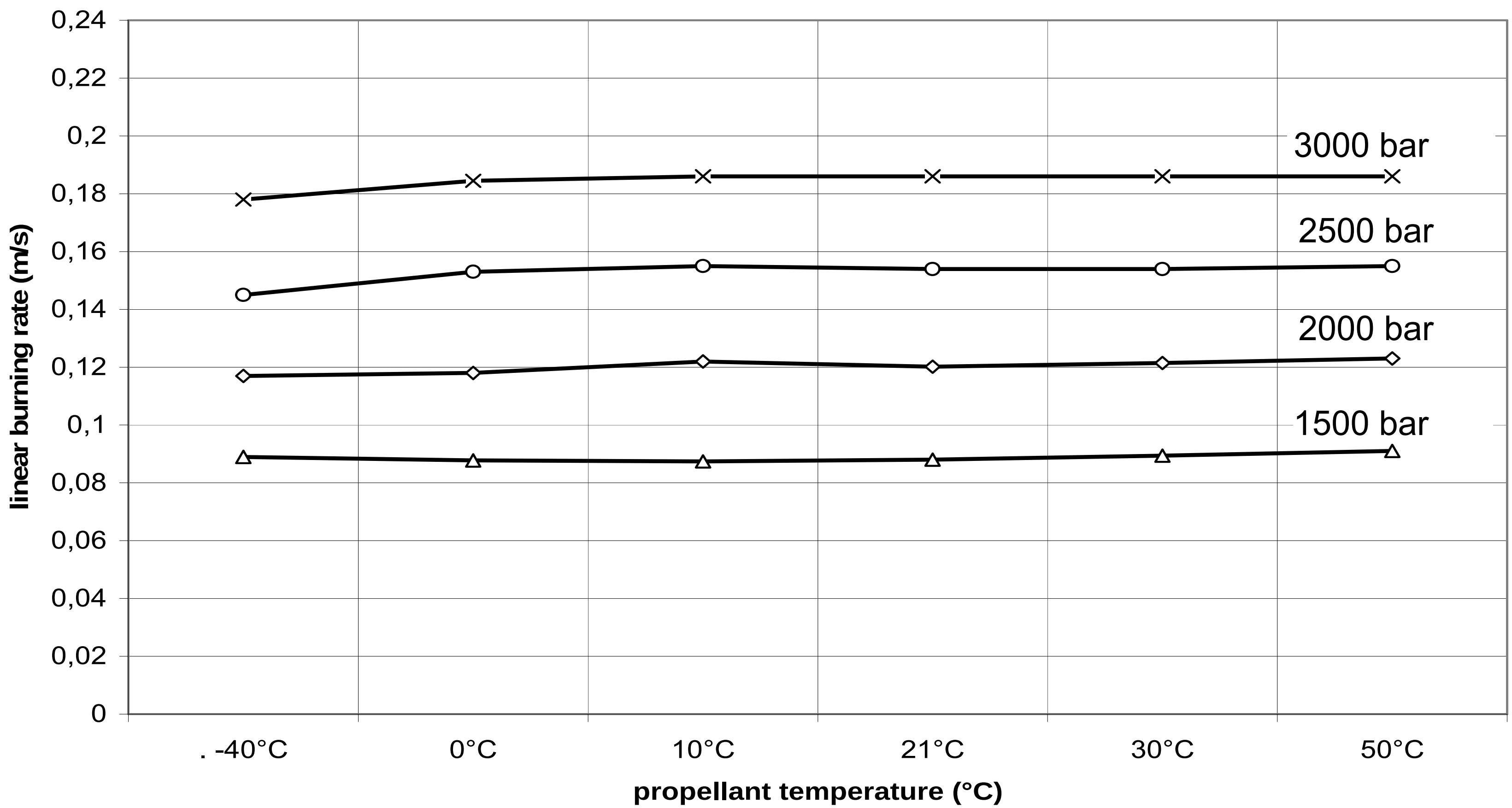
Linear burning rate of LTC Propellants at different pressures



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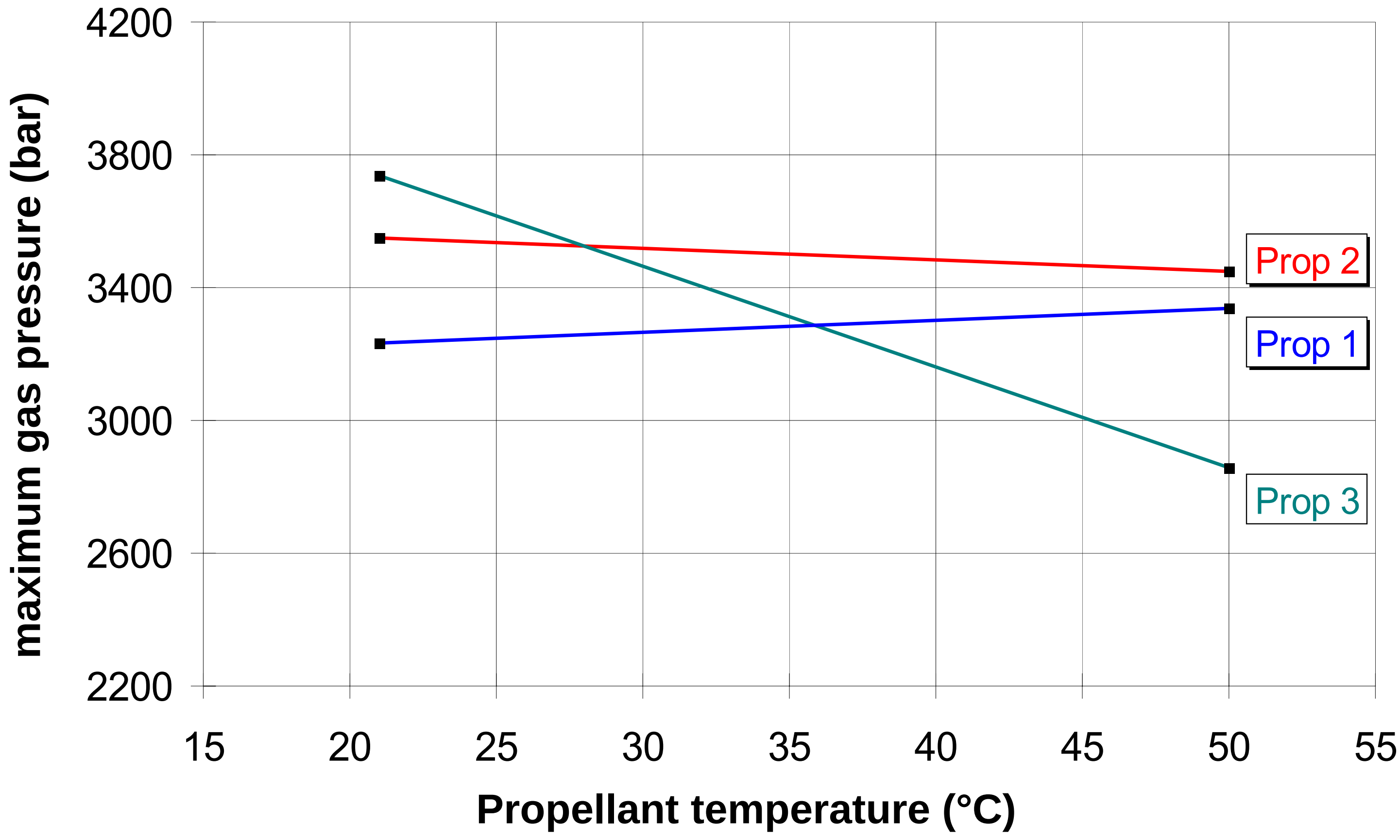
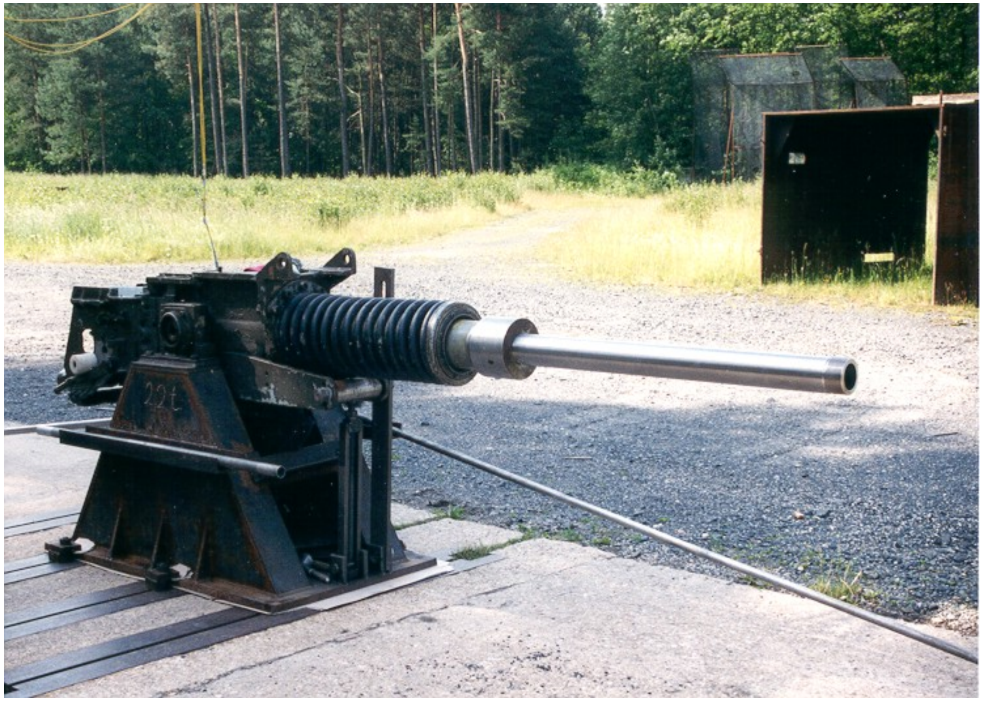
DIEHL BGT Defence

40 mm Gun Firing Tests of 3 LTC Propellants based on DNDA, NC, RDX



75 mm Scale model gun derived from cal. 120 mm tank gun (Diehl BGT)

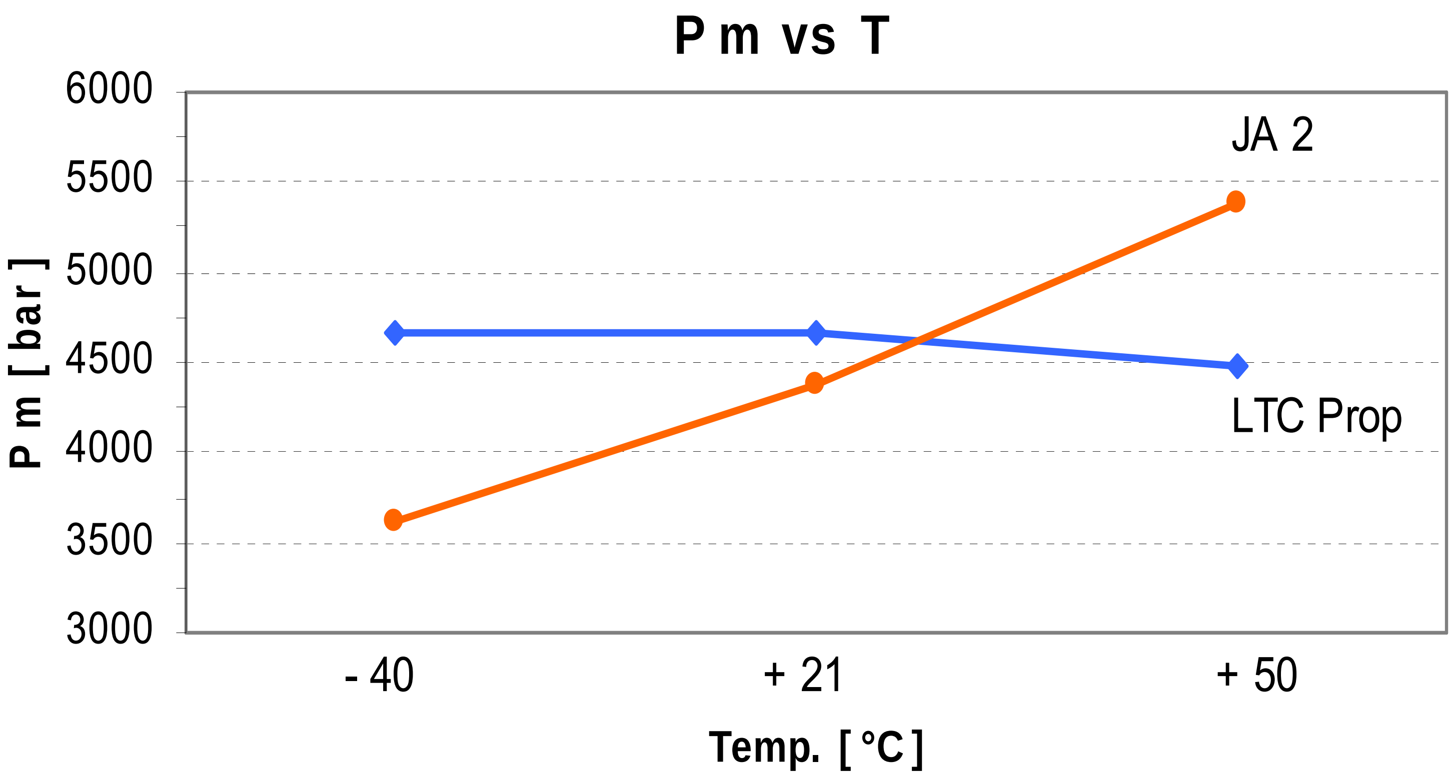
- based on interior ballistic similary laws
- less cost (combustible paper case, less propellant mass)



Test Firing in 75 mm cal. Model Gun (Diehl BGT)

Optimized propellant for firing at 21°C

Gas pressure vs temp.

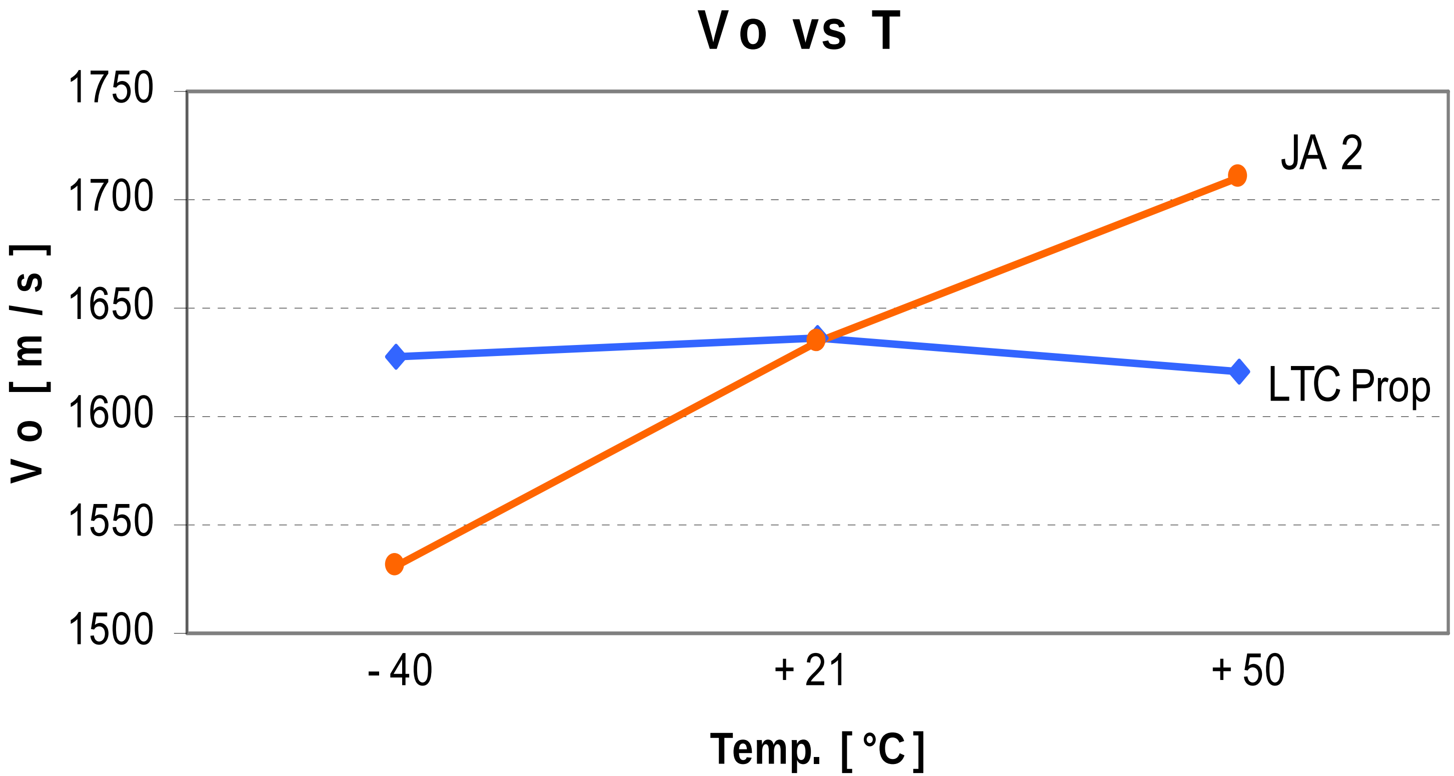


Test Firing in 75 mm cal. Model Gun (Diehl BGT)

Optimized propellant for firing at 21°C

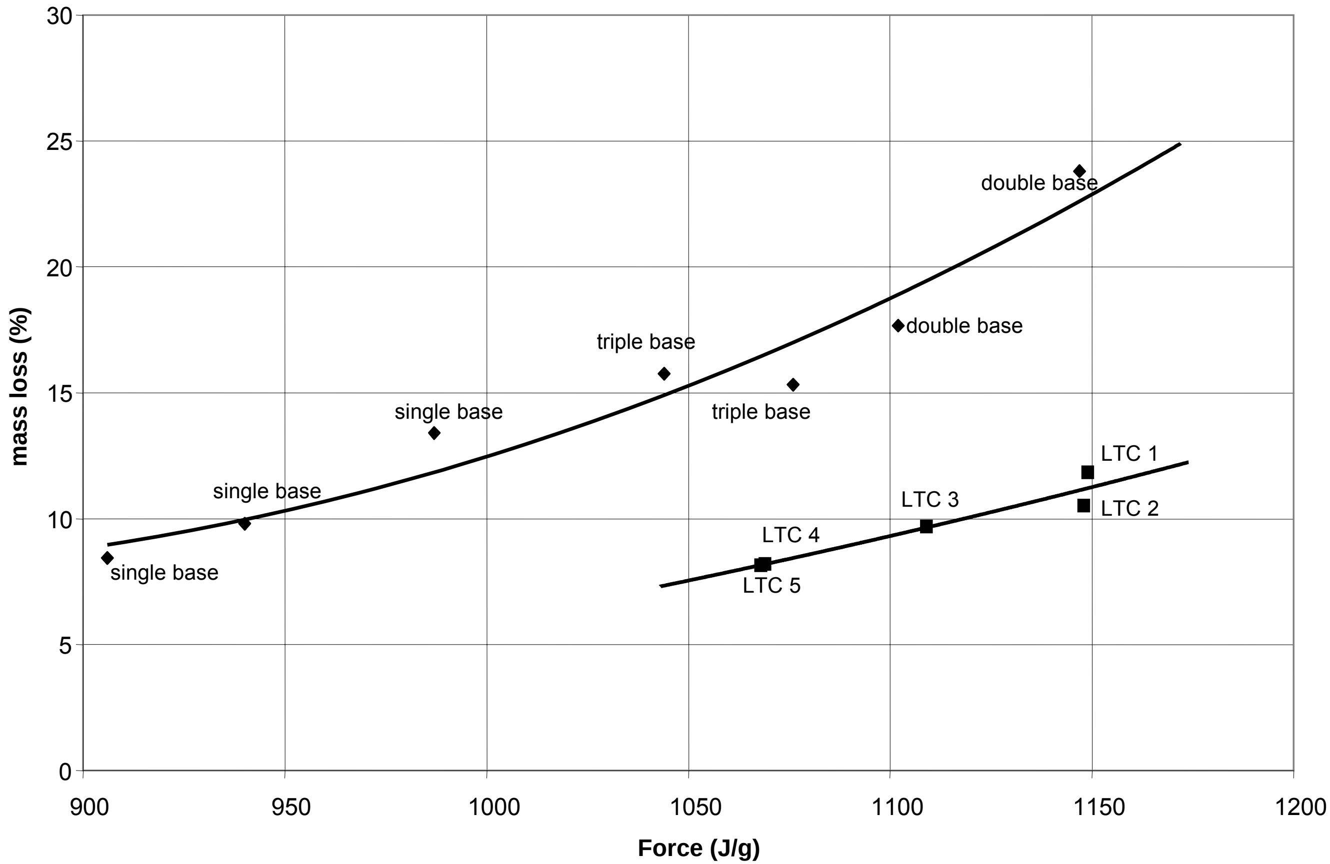
Muzzle velocity vs temp.

Muzzle velocity of LTC propellant same at 21°C like JA 2



Erosivity of LTC - Propellants and Conventional Propellants

Results from Diehl BGT



Results & Conclusion

- LTC Propellants based on DNDA 5,7 for a wide Caliber - Range
- Excellent Shaped Charge Testresults (Reaktion Class 0 or A)
- High Ignition Temperature > 215 °C
- Insensitive, Reactiontype 5 (MIL - STD 2105 B)
  Shaped Charge Test
  MG cal. 12.7 mm firing on Steeltube with propellant
- Excellent Longtherm Stability
- Low Combustion Temperature at High Force
- Low Gun Tube Erosion
- Pilot Lot for Eurofighter - Gun, Mauser cal. 27 mm