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The leading international partner for Explosives and Propellants

TEGDN, Sensitivity Reducing Ingredient for Nitrocellulose Based Propellants

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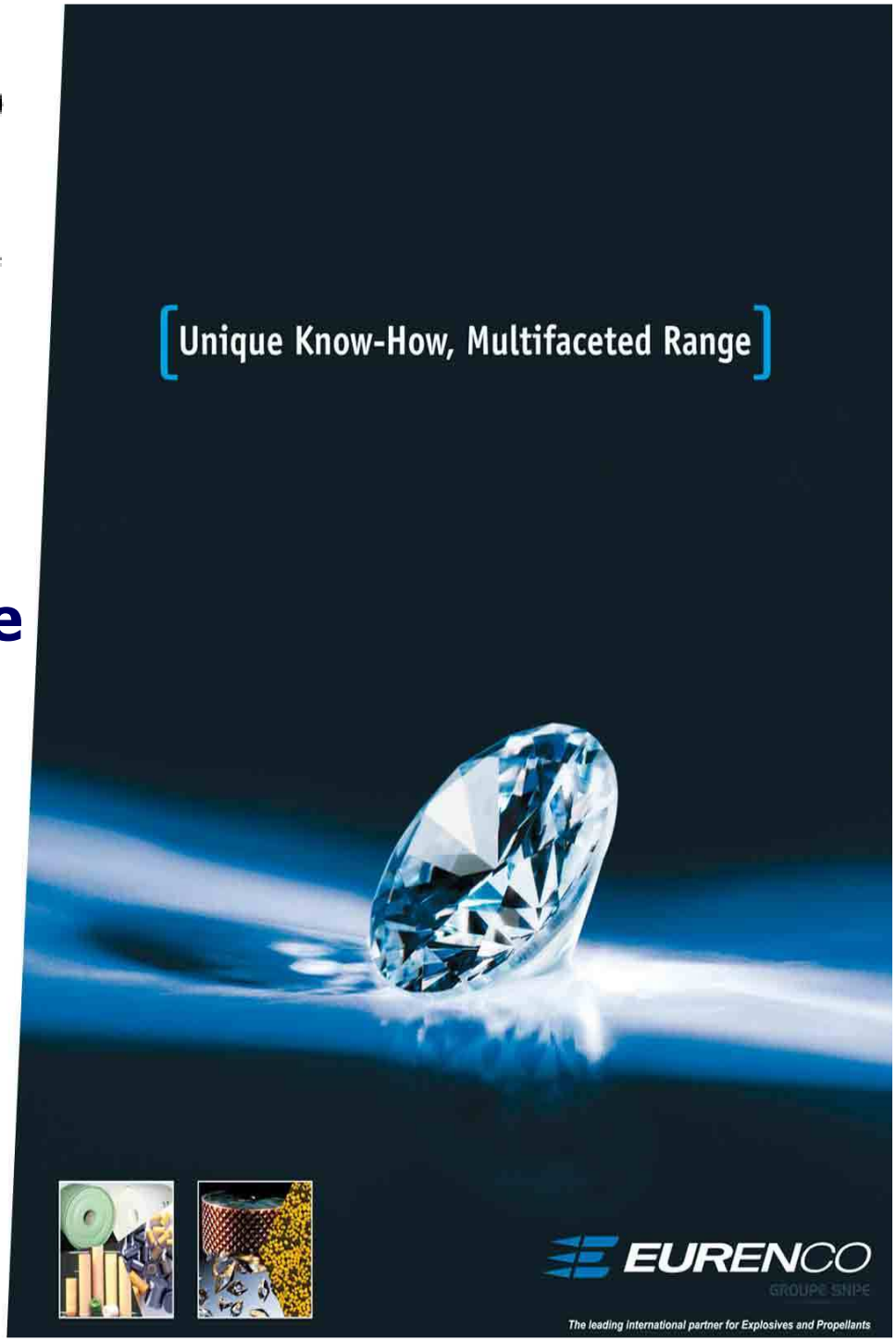
EURENCO Vihtavuori



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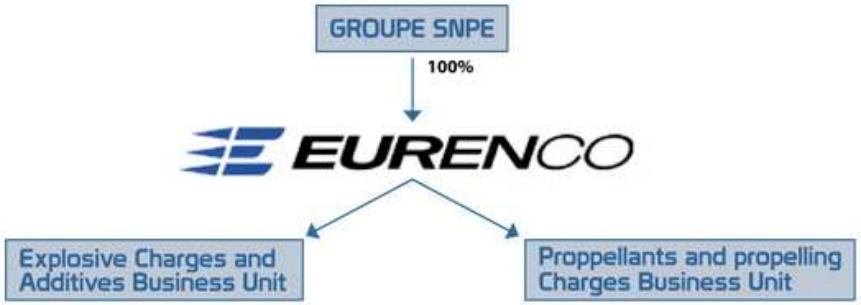
EURENCO Vihtavuori in short

EURENCO (European Energetic Corporation)

- created January 2004
- offers the largest range of cutting-edge energetic materials for both defense and commercial markets
- annual turnover exceeding 150 million Euros
- more than 850 employees in **five** industrial plants
- full support from the world-class SNPE Matériaux Energétiques' Research Centre



EURENCO Vihtavuori

- a plant of the Propellants & Propelling Charges BU
- over 100 employees
- over 300 ha
- close to natural deep lake
- annual turnover 15 million Euros

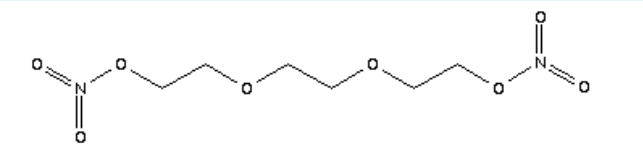
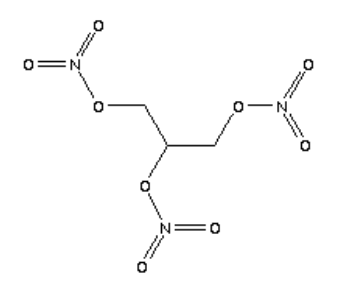
EURENCO Vihtavuori in short

EURENCO Vihtavuori

Core Business

- Propellants
  - *Single Base Propellants*
  - *Extruded Impregnated Propellants*
  - *Ignition Powders*
- Nitrocellulose
- Double Base Premix Paste
- Nitrated Energetic Oils
- Ether

Properties of TEGDN compared to Nitroglycerine

Chemical Property	TEGDN	Nitroglycerine
Chemical Structure		
Chemical name	Triethylene Glycol Dinitrate	Glycerol Trinitrate
CAS number	111-22-8	55-63-0
Molecular weight	240	227
Nitrogen content	11,67 %	18,50 %
Oxygen balance	-66,7 %	3,5 %

Meyer, M., Explosives, 6th Ed, 2007

Toxicity

Properties of TEGDN compared to Nitroglycerine

Physical Property	T E G D N	Nitroglycerine
Appearance	Light yellow oily liquid	Yellow oily liquid
Specific Gravity	1,335 g/cm^3	1,591 g/cm^3
Solidification Point	-19ºC	+13,2ºC stable modification +2,2ºC unstable modification
Boiling Point	327ºC (760 mmHg)	145°C
Decomposition temperature	228ºC (1 atm)	50 – 60ºC[1] 180-200ºC[2]
Flash Point	146,9ºC	12ºC
Viscosity at 20ºC	13,2 cP	37,8 cP

1) TM 9-1300-214, Military Explosives, 1984, p. 8-9
2) Bofors, Analytical methods for powders and explosives, 1960 p. 163

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Properties of TEGDN compared to Nitroglycerine

Explosive Property I	TEGDN	Nitroglycerine
Explosion Temperature	225ºC	222ºC
Detonation gas volume	1 202 l/kg	782 l/kg
Detonation velocity	2 000 m/s	7 600 m/s
Heat of Explosion	725 kcal/kg	1 616 kcal/kg
Impact Sensitivity (2 kg)	100 cm+ (BM) 43 cm+ (PA) 65 cm+ (BAM)	15 cm
Lead Block Test	320 cm^3 /10 g	520 cm^3 /10 g

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Properties of TEGDN compared to Nitroglycerine

Explosive Property II	TEGDN	Nitroglycerine
Vacuum stability 120ºC	0.8 – 0.99 ml in 8 h	The least stable of the standard military explosives
Heat test, 100ºC first 48 h **second 48 h**	1,8 % 1,6 %	3,6 % 3,5 %
Friction pendulum test - **Steel shoe** - **Fibre shoe**	 Unaffected Unaffected	No reaction up to 353 N
Critical diameter (steel sleeve test)	26,7 mm	24 mm
Card Gap test	0,48 cm (0.19 in)	2,31 cm (0,91 in)

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Test results

	TEGDN (EURENCO Vihtavuori)	Method
Purity	more than 99,5 %	NMR & HPLC
Stability	more than 10 min	Abel at 80ºC
Stability	about 190ºC, after 1 300 min	ARC calorimeter • Accelerating Rate Calorimeter • repeated three phase – cycle • heat – hold – observe • almost adiabatic circumstances
Stability	78 µW/g after 24 days	HFC microcalorimeter • Heat Flow Calorimeter • isothermal @70ºC • measures heat flow

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Properties of TEGDN compared to Nitroglycerine

Advantages

- insensitive to detonation
- chemical stability
- thermal stability
- impact resistance
- shock resistance
- friction resistance
- less mobile

Nitroglycerin → DEGDN → TEGDN

Sensitivity decreases

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Manufacture of TEGDN

Principle

- Manufacture similar to Nitroglycerin
- Continuous process
- Nitration of pure Triethylene glycol with Mixed Acid
- Critical point Spent Acid treatment
- Capacity 500 kg/h
- Nitrocellulose-paste manufacture capability

Manufacture of TEGDN

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Manufacture of TEGDN

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Applications

Solid propellant formulation as energetic plasticizer in

- Guns
- Powering missiles
- Rockets
- Explosives
- Air bag gas generation
- Ground launched interceptors
- Air launched tactical motors
- Space boosters

Literature: Journals, Patents

Applications

Other

- in liquid explosives
- fuel additive
- plasticiser in fabrication of flexible explosive sheets
- plasticiser in pyrotechnic flares

Literature: Journals, Patents

IM Technology

Lightweight Torpedo (MK-45 Mod 5)

Modular Charge System, Top Charge Modules

SB Propellant in Combustible Case

MSIAC, EURENCO Vihtavuori

Application in development by EURENCO

Modular Charges

- Product: TCM
- Propellant: HUX – TEGDN QB
- Status: Development

IM Signature:

FCO	SCO	BI	FI	SD	SCJ
V	IV	IV / V	IV	III	

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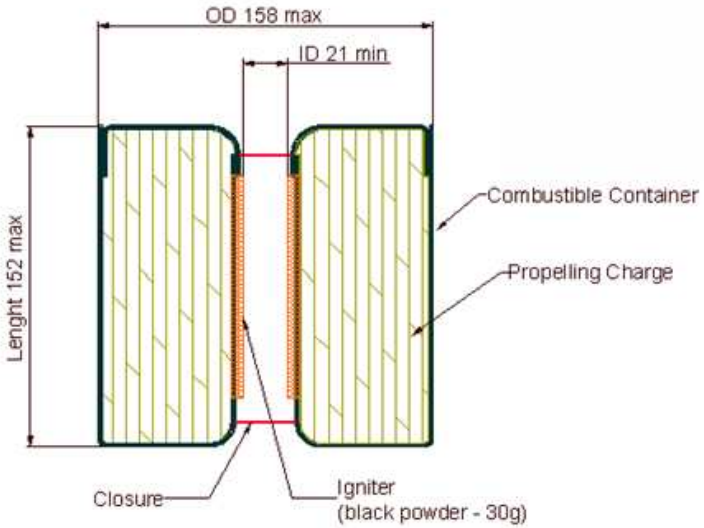
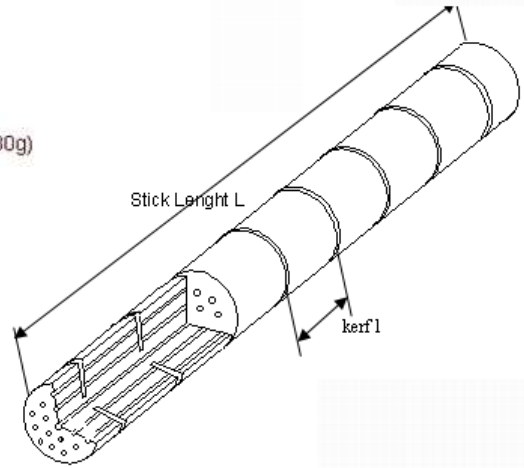
Application in development by EURENCO

Modular Charges





TCM Design – Propelling charge

Composition of propellant	
DB NC/NGL	56.5/34.8
QB NC/TEGDN/NQ/RDX	52/26/8.6/10.7

Geometry of the grain
Kerfed sticks 7 perf/19 perf

Composition of igniter	
Consolidated powder	100 %
Weight	30 g

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Summary

T E G D N

- less sensitive to temperature, shock, impact and detonation
- manufacture in continuous process
- possibility to make NC-TEGDN paste
- very potential substitute to Nitroglycerin in IM applications

At the NATO AC/326-Sub-Group-1, on Energetic Materials, Fall 2010 meeting on 5th – 6th October, at Thun, in Switzerland, was agreed, that the group will develop a standard on TEGDN. Finland has assumed the Custodianship. The work should be completed by Fall 2013.

Source of information

Source of information:

•EURENCO Vihtavuori, own R&D projects

•Urbanski, Chemistry and technology of explosives, Volumes II and IV

•Wildlife Toxicity Assessment for NITROGLYCERIN (NG), USACHPPM Document No: 37-EJ-1138-01F

•SAFETY MANUAL AMC-R 385-100, DEPARTMENT OF THE ARMY HEADQUARTERS, UNITED STATES ARMY MATERIEL COMMAND

•HAZARDS OF CHEMICAL ROCKETS AND PROPELLANTS HANDBOOK, solid rocket propellant processing, handling, storage and transportation, Vol II, 1972

•Meyer, R., Explosives, 6th Ed, 2007

•TM 9-1300-214, Military Explosives, 1984, pages 8-22, 8-25, 8,26

•Biazzi, Process know-how

•Development study for improvement of the manufacturing process for trietyhylene glycoldinitrate (TEGDN), Propellex Chemical Division, 1961.pdf

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Thank You for your attention!

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Detonation velocity

Steel tube test	TEGDN
- Slight steel tubing ∅ 3.175 cm - Density 1.33 g/cm^3	No detonation!
- Heavily confined	Less than 2 000 m/s (30 % TNT)

200 g sand test	TEGDN	Nitroglycerin
Brisance	30.6 % of TNT (14.7 g sand crushed)	120 % of TNT

TM 9-1300-214, Military Explosives, 1984

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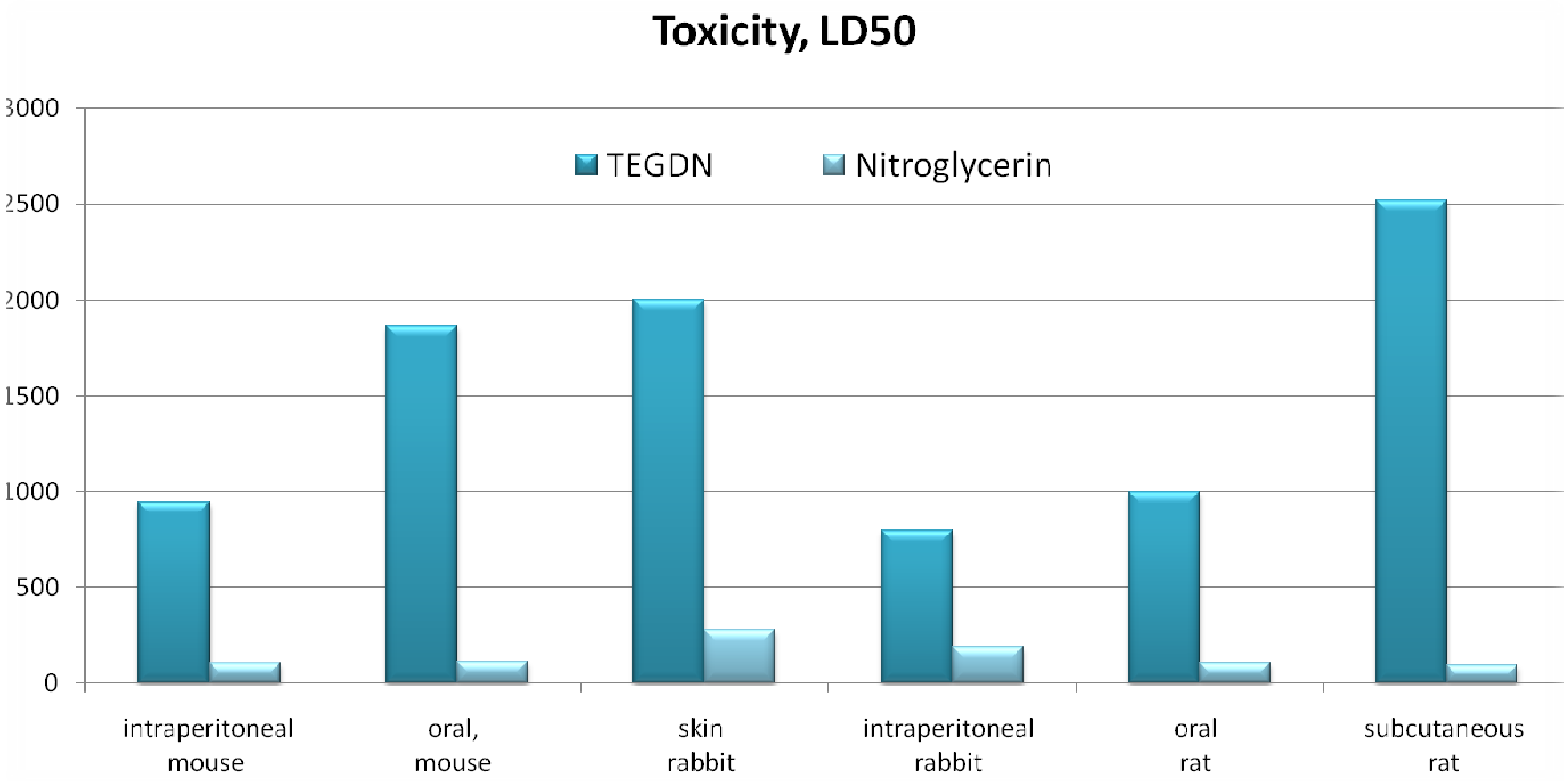
Properties of TEGDN compared to Nitroglycerine

Toxicity	TEGDN	Nitroglycerine
LD50, intraperitoneal, mouse	945 mg/kg[1]	104 mg/kg[7]
LD50, oral, mouse	1866 mg/kg[2]	115 mg/kg[8]
LD, skin, rabbit	> 2000 mg/kg[3]	>280 mg/kg[9]
LD50, intraperitoneal, rabbit	796 mg/kg[4]	189 mg/kg[10]
LD50, oral, rat	1000 mg/kg[5]	105 mg/kg[11]
LD50, subcutaneous, rat	2520 mg/kg[6]	94 mg/kg[12]

1) American Industrial Hygiene Association Journal. Vol. 34, Pg. 526, 1973.
2) Acute Toxicity Data. Journal of the American College of Toxicology, Part B. Vol. 12, Pg. 606, 1993.
3) Acute Toxicity Data. Journal of the American College of Toxicology, Part B. Vol. 12, Pg. 604, 1993.
4) American Industrial Hygiene Association Journal. Vol. 34, Pg. 526, 1973.
5) American Industrial Hygiene Association Journal. Vol. 34, Pg. 526, 1973.
6) American Industrial Hygiene Association Journal. Vol. 34, Pg. 526, 1973
7) Iyakuhin Kenkyu. Study of Medical Supplies. Vol. 13, Pg. 90, 1982.
8) Yakuri to Chiryo. Pharmacology and Therapeutics. Vol. 13, Pg. 3649, 1985
9) Drugs in Japan Vol. -, Pg. 786, 1990.
10) Drugs in Japan Vol. -, Pg. 786, 1990
11) Yakuri to Chiryo. Pharmacology and Therapeutics. Vol. 13, Pg. 3649, 1985.
12) Yakuri to Chiryo. Pharmacology and Therapeutics. Vol. 13, Pg. 3649, 1985

Properties of TEGDN compared to Nitroglycerine



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