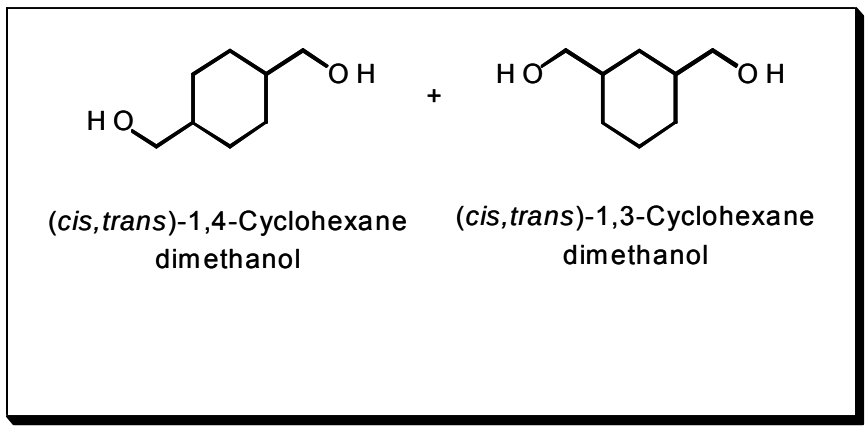
UNOXOL™ Diol

A New Cycloaliphatic Diol for Coatings



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What is UNOXOL™Diol?

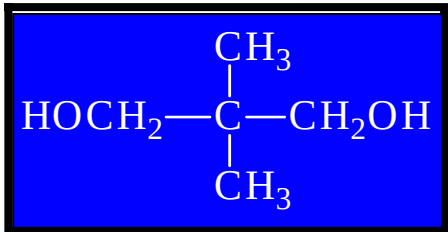
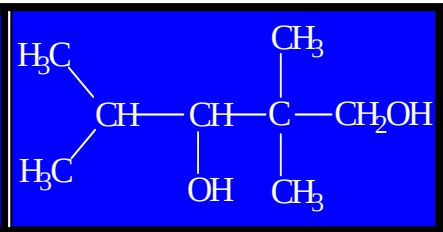
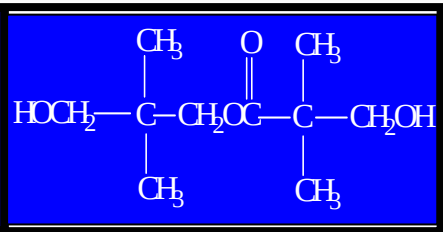
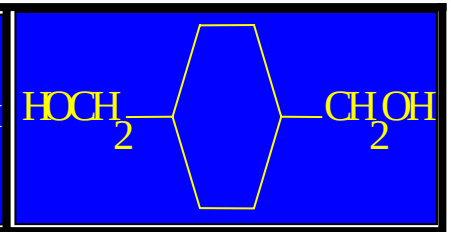
- UNOXOL Diol is a Cycloaliphatic Diol that can be used as a new building block to produce enhanced polymers for coatings and plastics.

- Mixture of cis,trans-1,3- and cis,trans-1,4-CycloHexaneDiMethanol (CHDM). UNOXOL Diol is not made by blending isomers. Because of our unique chemistry (raw materials and production process) we are capable of producing a consistent mixture of the four isomers.

- Because of its unique isomer ratio, UNOXOL Diol is a liquid.

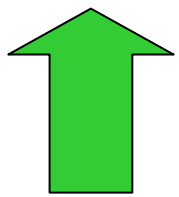
- UNOXOL Diol offers unique performance advantages in different applications like; Powder Coatings, High Solid Coatings, Water Borne Coatings, PUDs (PolyUrethane Dispersions), and PETg (Polyethylene Terephthalate).

Diols For Coatings Markets

			
NeoPentyl Glycol (NPG)	2,2,4-Trimethyl- 1,3-pentanediol (TMPD)	Hydroxypivalyl Hydroxypivalate (HPHP)	CycloHexaneDiMethanol (1,4 CHDM)

- Advantages of 1,4-CHDM for polyester resins:
  - Higher Tg
  - Higher reactivity
- Advantages of 1,4-CHDM for coatings:
  - Excellent balance of hardness and flexibility
  - Excellent hydrolytic and chemical resistance
    - » Excellent salt spray and Cleveland humidity

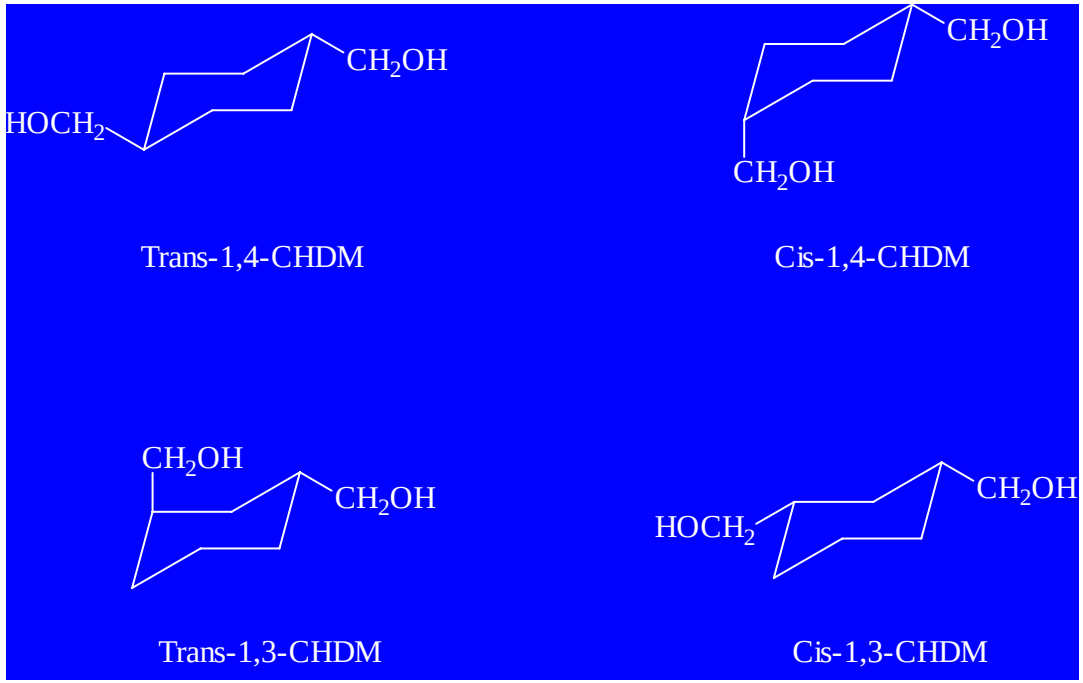
- Disadvantages of 1,4-CHDM for polyester resins:
  - Higher viscosity
  - Lower solvent solubility
  - Tendency to crystallize



Limits Use In Coatings!

UNOXOL™ Diol Structure

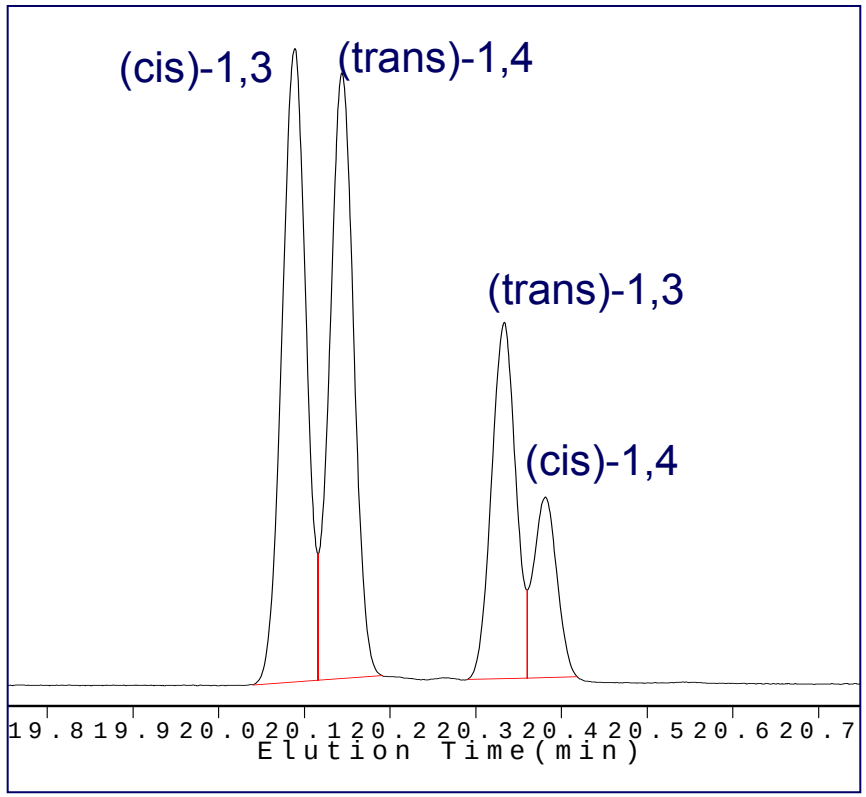
- Mixture of 1,3- and 1,4-cyclohexanedimethanol
- Cycloaliphatic Structure
- The diol is a liquid at room temperature!



UNOXOL Diol (1,3/1,4-CHDM)

UNOXOL™ Diol Isomer Composition

Isomers	Composition %	Content %
trans-1,3-CHDM	56.8	24
cis-1,3-CHDM		32.8
trans- 1,4 CHDM	43.2	30.2
cis-1,4 CHDM		13.0



UNOXOL™ Diol Physical Properties

Boiling Point:	275.6ºC
Vapor Pressure (20°C):	<0.01 mm Hg
Density (20ºC):	1.05 g/ml
Solubility in Water:	100%
Flash Point:	118ºC (closed cup)
Melting Point:	Liquid
Pour Point:	-21ºC
Viscosity (23°C)	10,000 cp
Odor:	Mild

UNOXOL™ Diol in Coatings

High Solid Coatings

- **Isophthalate/Adipate Polyester Properties**
  - Polyesters based on UNOXOL™ Diol have the best solvent solubility --- Lower viscosity than 1,4 CHDM
  - Polyester based on 1,4-CHDM is insoluble
  - Polyester based on UNOXOL™ Diol has the highest Tg (42 C)

- **Melamine Cured Resins**

	UNOXOL™ Diol	NPG
• Acid-etch improved	73	71
• Hardness improved (Pendulum Hardness)	190	160
• Good UV stability		

- **Polyisocyanate Cured Coatings**

• Allows harder coatings (Konig, seconds)	190	153
• Better Pencil hardness	2H	H

Improved hardness, solubility, viscosity, and increased glass transition temperature (Tg)

UV Curable Coatings

- UNOXOL™ Diol diacrylate has higher hardness and better scratch resistance than commonly used diacrylate monomers used in UV applications
  - Pencil Hardness comparison

Diacrylate:	Pencil Hardnes
UNOXOL™ Diol Diacrylate	3H
HDDA	H
TPGDA	B
DPGDA	H
NPGPODA	B
CD 580	B
CD 581	< B
CD 582	H

HDDA = 1,6 hexanediol diacrylate
TPGDA = tripropylene glycol diacrylate
DPGDA = dipropylene glycol diacrylate
NPGPODA = neopentyl glycol propoxylate diacrylate
CD 580, CD 581, CD 582 = alkoxylated cyclohexane dimethanol diacrylates (Sartomer)

Pencil Hardness Scale: (Softest - Hardest)			
6B < 5B < 4B < 3B < 2B < B < HB < F < H < 2H < 3H < 4H < 5H < 6H			

- UNOXOL™ Diol diacrylate has similar viscosity to commonly used diacrylate monomers used in UV applications, and is lower in viscosity than liquid alkoxylated cyclohexane dimethanol diacrylates
- UNOXOL™ Diol diacrylate has equivalent optical properties to commercial diacrylates (i.e. initial haze and transmittance)

Low viscosity and outstanding hardness and flexibility balance (toughness)

Powder Coatings

- Lower melt viscosity

	UNOXOL™ Diol	NPG
Melt Viscosity at 150○C (cps) Cone and Plate Rheometer	27,785	153,700

- Better impact resistance

Direct Impact resistance (in.-lb.) ASTM D2794	160	60

- Better Hardness

Hardness ASTM D 3363Pencil	2H	H

Lower melt viscosity and outstanding hardness and flexibility balance (toughness)

Waterborne Coatings

- Adipate polyesters based on UNOXOL™ Diol are liquids, whereas 1,4-CHDM adipates are solids.
- Adipate polyesters based on UNOXOL™ Diol have good solubility in typical coating solvents, whereas 1,4-CHDM adipates are crystalline and insoluble.
- Adipate Polyester with much better hydrolytic resistance than BDO based adipates
- Adipate Polyester with much better Acid etch resistance than BDO based adipates

UNOXOL™ Diol Literature

UNOXOL™ Diol Sales Specification

NAME: UNOXOL(TM) Diol

MATERIAL DESCRIPTION:

Color: colorless

Odor: pungent

Appearance/Physical State: liquid

TEST REQUIREMENTS

TEST ITEM AND CONDITION	LIMIT	UNIT	METHOD	N
Total Diols	99.5 Min	% wt	DOWM 102151	
Water	0.20 Max	% wt	ASTM E1064	
Acidity, as acetic acid	500 Max	ppm wt	ASTM D1613	
Appearance	Pass		DOWM 101967	1
Color, Pt-Co	10 Max		ASTM D1209	

TEST REQUIREMENTS NOTES:

1. Clear, colorless liquid free of suspended matter.

READ PRECAUTIONARY INFORMATION AND MATERIAL SAFETY SHEETS. THIS PRODUCT IS SHIPPED IN COMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS REGARDING CLASSI- FICATION, PACKAGING, SHIPPING AND LABELING.

UNOXOL™ Diol Summary

- UNOXOL™ Diol is a new liquid diol for coating applications
- UNOXOL™ Diol produced polyesters that are soluble in typical coating solvents, whereas 1,4-CHDM based polyesters have limited solubility and tend to crystallize
- Allows the formulation of very stable waterborne PUDs
- Exhibits excellent hydrolytic resistance properties
- Is ideal for formulating high-solids, low-VOC coatings
- Results in lower viscosity and density with excellent solubility in solvents
- Exhibits outstanding hardness and flexibility balance (toughness)