

# Composite applications for Marine

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Moscow, Russia

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# Agenda

- Welcome
- Short introduction DSM & DSM Composite Resins
- Basics on unsaturated polyesters chemistry
- Marine Application
  - Mold Making
  - Blistering of GRP boat hull due to osmosis
  - Gelcoat
  - Tiecoat
  - Structural resins for hull and decks – HLU / SU applications
  - Structural resins for hull and decks – injection techniques
  
- Superb adhesive for marine applications
- Case histories

# DSM today

- Globally active “multi-specialty” chemical company
  - More than 200 locations, approx. 25,000 employees
- Leadership positions in ~75% of the portfolio
- R&D spent appr. € 300 million
- Solid balance sheet
  - Net debt < € 500 mln

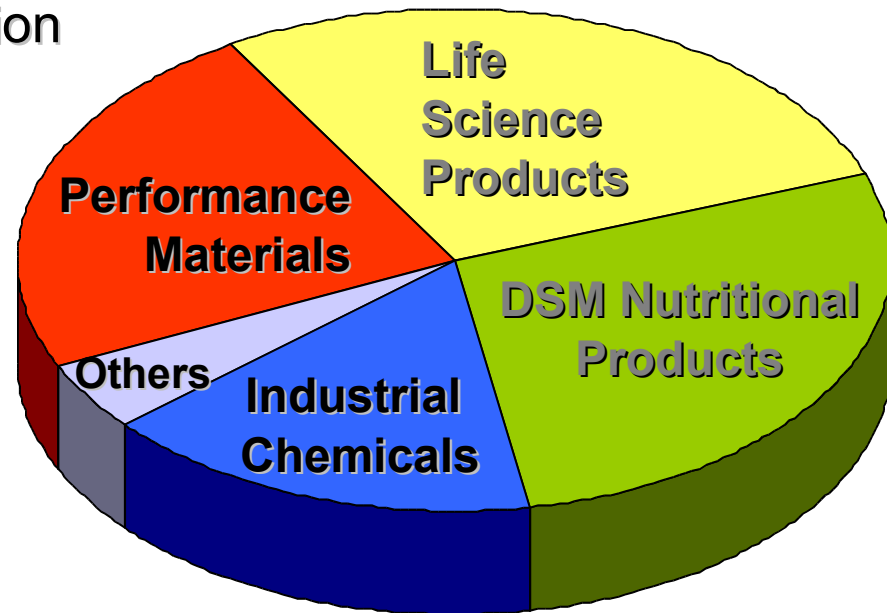
## 2003 key data\*:

Sales : € 6,050 million

EBITDA: € 723 million

EBIT: € 294 million

\* incl. one quarter DNP

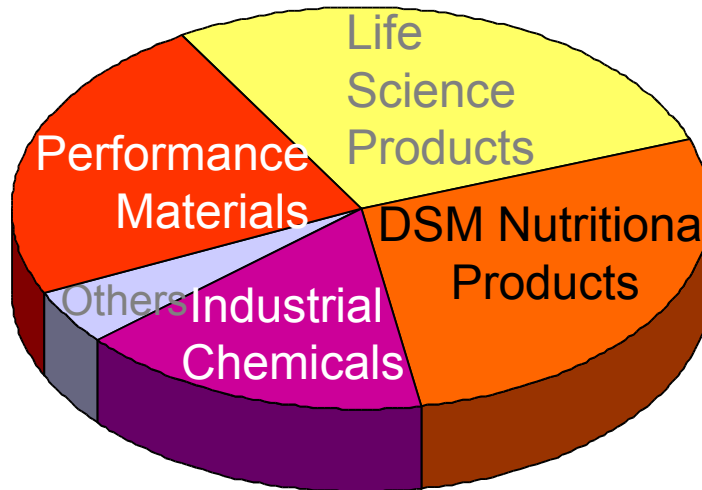
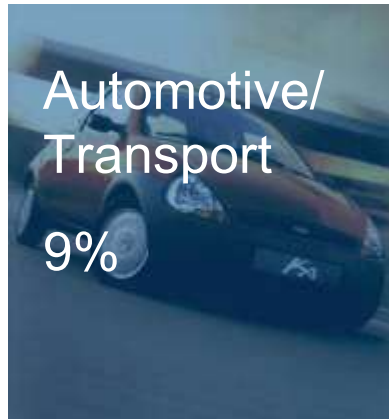


2004 E

**DSM Composite Resins**

*Unlimited.* **DSM**

# DSM's key end markets



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# DSM Worldwide



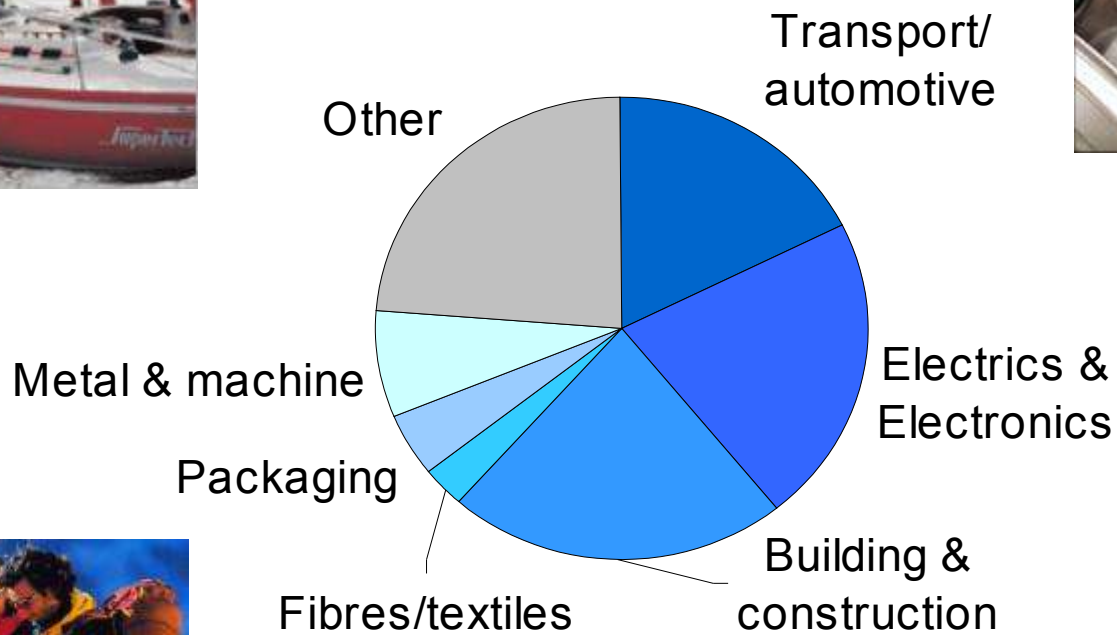
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# DSM Performance Materials

## End-markets



Sales 2003 € 1.6 bn

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# Welcome to

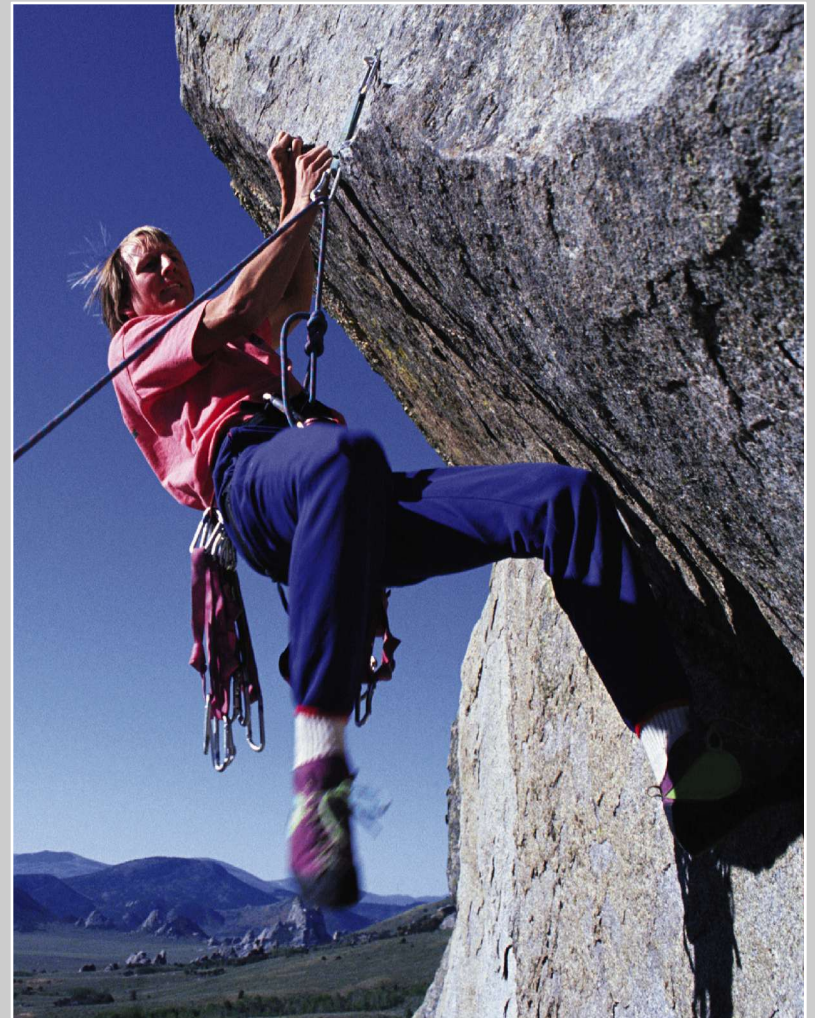
## DSM Composite Resins

Leading the Composite Resins Industry by

**focusing**

on Customer's

**needs for Success**



# DSM Composite Resins

- European market leader in unsaturated polyester resins
- Global leader in sizings and binders
- Euroresins is part of DSM Composite Resins and a leading distributor group in Europe

## Product lines

- Unsaturated Polyester Resins
  - Gel coat Products
  - Polymeric Plasticizers
  - Sizings & Binders
- 
- Sales: > EUR 400 million
  - Employees: > 750 people





# Our presence in the world

The image features a world map with a callout to Europe. A detailed map of Europe is centered, with blue circles indicating DSM locations. A red circle highlights the location of Schaffhausen (CH). Surrounding the European map are photographs of various DSM facilities, each with a label and a bullet point.

- Augusta (USA)
- Deeside (GB)
- Ellesmere Port (GB)
- Compiegne (F)
- Tarragona (ES)
- Zwolle (NL)
- Schoonebeek (NL)
- Ludwigschafen (D)
- Warsaw (P)
- Nanjing (CHN)
- Como (I)
- Filago (I)
- Schaffhausen (CH)

**DSM Composite Resins**

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# Polyester resins chemistry

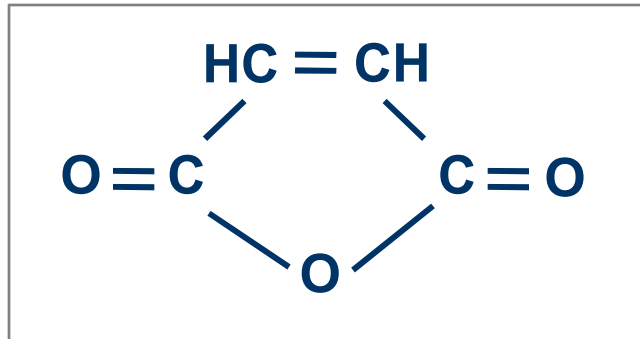
Polyesters are polymers resulting of the polycondensation (or poly esterification) at high temperature between multifunctional acids and alcohols.

Most of the times di-acids and di-ols (2 functionalities) are used :



# Polyester resins chemistry

To obtain unsaturated polyesters, at least one of the components must contain a double bond (  $\diagup$  C = C  $\diagdown$  ) able to react with a vinylic or acrylic monomer :

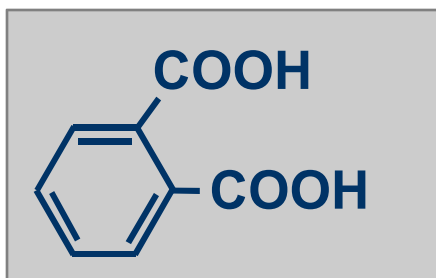


Maleic anhydride

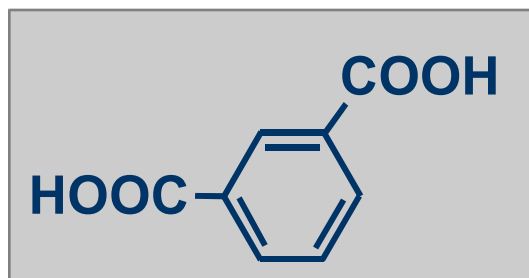
# Polyester resins chemistry

Many different diacids and glycols types are used in the polyester polymer, providing a wide range of properties.

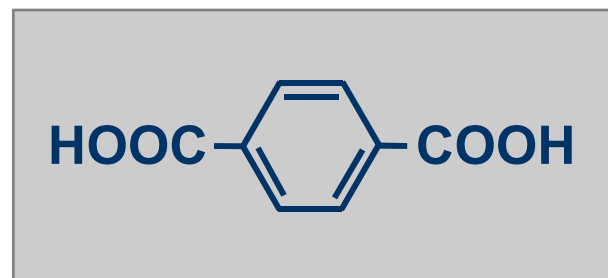
## Main acids :



Orthophthalic  
acid/anhydride



Isophthalic acid



Terephthalic acid

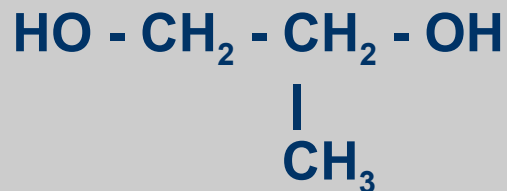


# Polyester resins chemistry

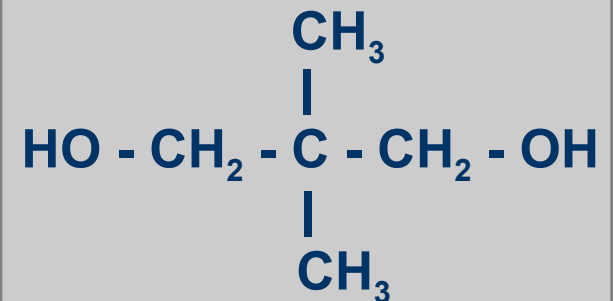
## Main glycols



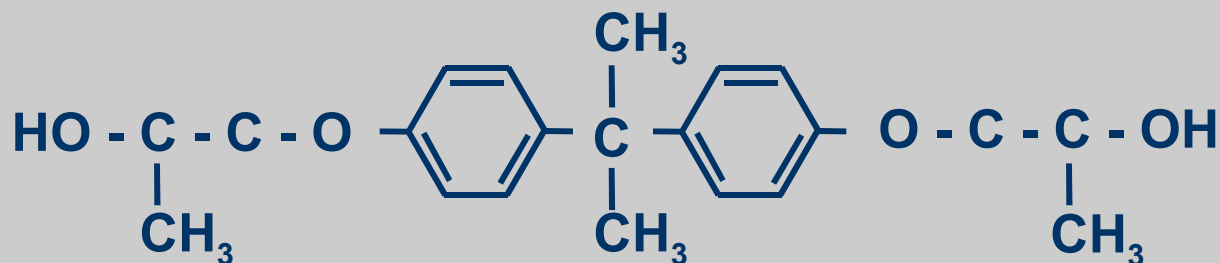
(Di-)Ethylene glycol



(Di-) Propylene glycol



Neopentyl glycol

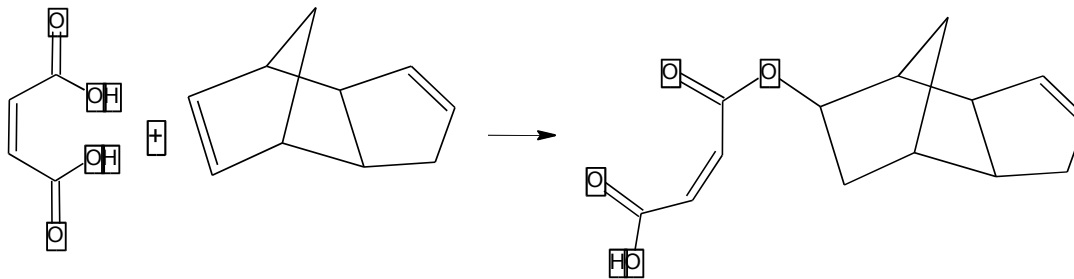


Propoxylated bisphenol A

# Polyester resins chemistry

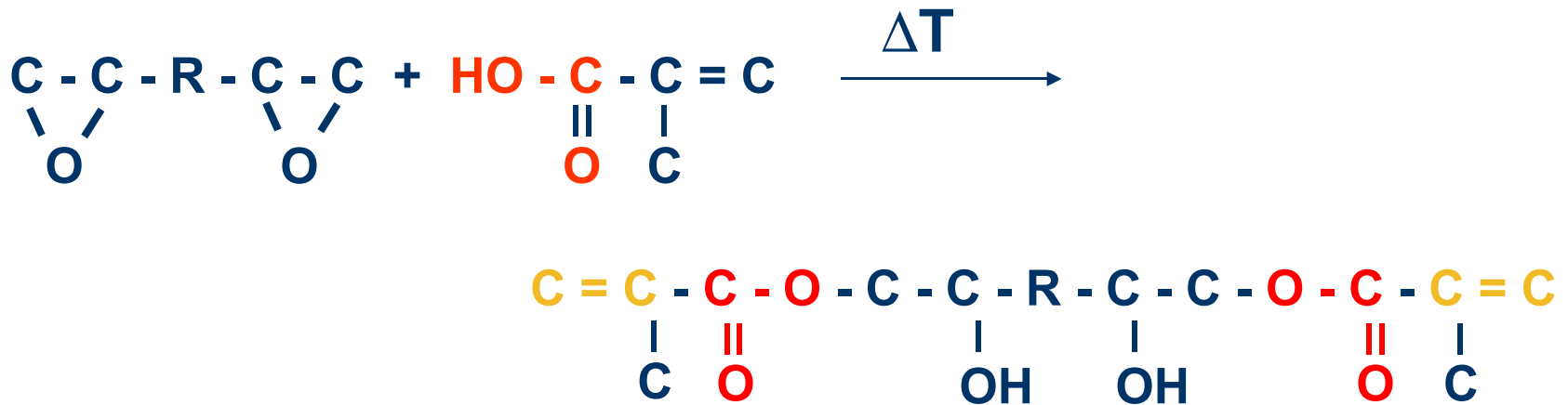
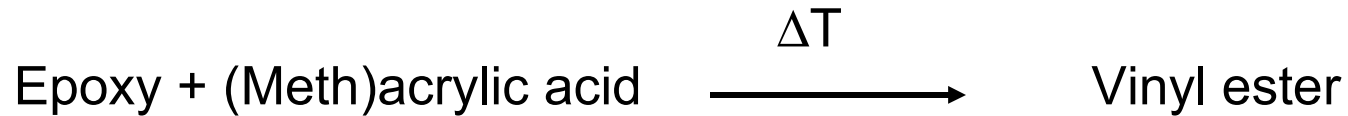
## DCPD (dicyclopentadiene)

To comply with regulation concerning styrene emission we developed resins based on DCPD . Resins with less styrene



# Polyester resins chemistry

## Vinylester



## Vinylester Urethane



# Polyester resins chemistry

## Unsaturated polyester resins

- Ortho-, iso- and terephthalic resins
- DCPD resins

## Vinyl ester resins

- Epoxy-acid

## Vinyl ester urethane resins

- Isocyanate-hydroxyl (meth)acrylate



## End of introduction

Start of the marine related topics

# Marine market – Production of GRP boats

DSM systems for every stage :

Mold making

Hull and Deck construction

Bonding and fixing

# Marine application - Mold Making

## Traditional mould making

- Double gel, tissue, low wt / tex first layer
- Structural - < 2 x 450 CSM / day.
- Exotherm must be minimised.
- Typical 6-10 days per mould.



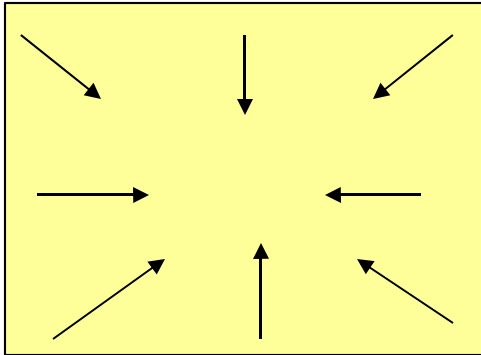
TIME  
CONSUMING

## WHY SUCH A SLOW PROCESS ?

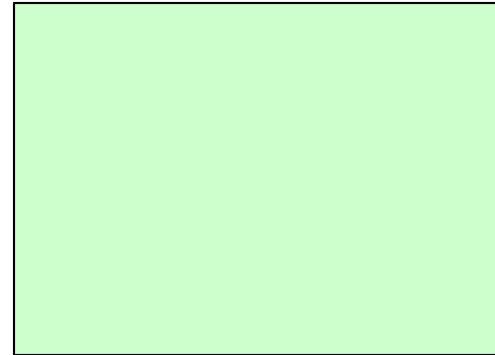
- PE'S shrink typically 8% volumetric, 1% laminate linear.
- High build = High exotherm = Rapid, uncontrolled shrinkage = Distortion of pattern and mould = Loss of original dimensional accuracy.
- Built-in stresses = Difficulty in mould release from pattern

# Mold Making : How to improve

## SHRINKAGE ELIMINATION BY LOW PROFILE TECHNOLOGY



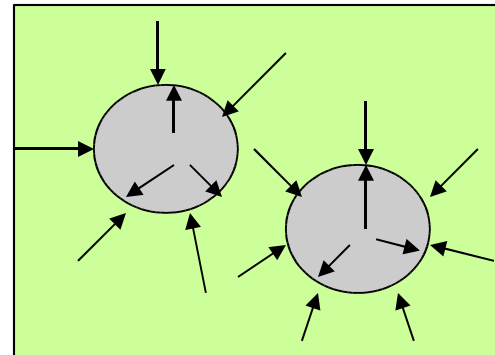
SHRINKAGE STD POLYESTER



LIQUID LP PE - ADDITIVE IS COMPATIBLE



GELLED LP PE - ADDITIVE PHASES OUT



EXOTHERM EXPANDS THERMOPLASTIC DROPLETS, SHRINKAGE OF PE IS COUNTERACTED



# Mold Making : the solution

- Exotherm is important - More is better.
- Special catalyst needed - Counteracts residual Benzaldehyde ( cure / odour).
- Effective phase out of LP additive is evident from colour change.

## HOW

**Euroresins RAPID TOOLING SYSTEM**  
A LOW SHRINK MOULD LAY UP SYSTEM

## RTS – STAGES OF PROCESS

- Double Gelcoat (ISO / VE)
- (Surface tissue)
- 1 Layer low tex light weight MAT / ERTS Resin
- 5 X 300 GM layers / ERTS Resin (4mm)
- Allow exotherm to subside (2 hrs)
- 4 X 450 GM layers ( 5mm)

# Mold making – High standard molds

## RTS FOR HIGHER DEMAND MOULDS

- Double gelcoat ( VE)
- 1 layer low tex light weight MAT / VE TOOLING RESIN (ATLAC 580 ACT). Cure overnight
- 4 X 450 GM layers / ERTS Resin (5 mm)
- Allow exotherm to subside (2 hrs)
- 4 X 450 GM layers ( 5mm)

# Mold making steps



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# Mold Making : Technical advantages of the RTS

- ✓ TOTAL MOLD MAKING TIME REDUCED TO 1-2 DAYS
- ✓ EASY RELEASE FROM PATTERN
- ✓ EXCELLENT DIMENSIONAL REPRODUCTION
- ✓ FULLY PRE FORMULATED - **JUST ADD CATALYST** (MAJOR ADVANTAGE OVER COMPETITIVE SYSTEM SYSTEM)
- ✓ MIX IS STORAGE STABLE
- ✓ MINIMAL SLIP / DRAIN FROM VERTICAL SURFACES
- ✓ HIGH HDT
- ✓ CAN BE USED FOR **HLU / SU AND RTM MOULDS**
- ✓ OFFERS EXCELLENT SYSTEM POTENTIAL WITH 8397-W-0100 VE TOOLING GEL