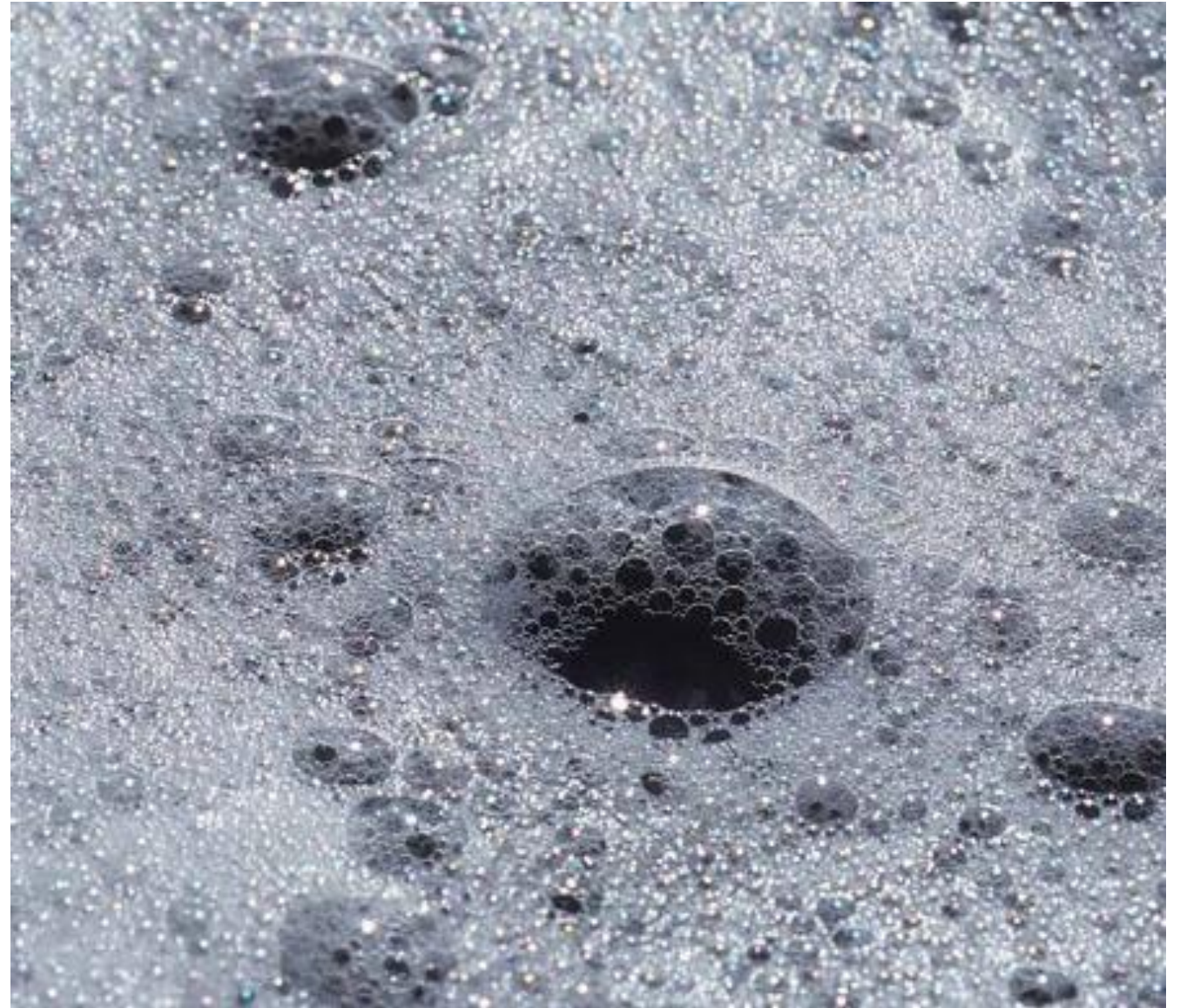


# Antifoams for water-miscible Lubricants

Product Portfolio

Evonik Operations GmbH – Specialty Additives  
Interface & Performance  
August 2023



# Negative Effects of Foam in water-mixed Lubricants on Machining Processes

- Foam in water-mixed emulsions/solutions has a negative impact on lubricity and cooling
- Foam obstructs the visual inspection of work pieces during the metal working process
- Foam promotes oxidation and bacteria growth
- Foam causes problems in fluid supply, especially in large central systems

**The use of antifoams ends up in major cost savings due to increased tool, machinery and fluid life, work piece accuracy etc.**



# Major Requirements on Antifoams for water-miscible Lubricants

## Major Requirements on Antifoams for water-miscible Lubricants

High efficiency with respect to foam suppression and foam knock down

Good stability/compatibility in MWF concentrates

No or only minimum impact on the shelf life of MWF emulsions/solutions

Low surface tension

Insolubility or **at least partially insolubility** in the foaming medium

No adverse effects on finishing processes (painting, electroplating, etc.)

Good filterability (i. e. not or only marginally filterable from the MWF emulsion/solution)

Easy to dose

Highly cost efficient

# Composition of Antifoams

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## Hydrophobic Oils

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### Organic oils

- Mineral oil
- White oil
- Vegetable oil

### Silicone oils

- High viscosity oils
- Low viscosity oils

### Organo-modified Siloxanes

- Branched
- Linear

## Hydrophobic Particles

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### Silica

- Precipitated
- Pyrogenic

### Waxes

- Polyethylene
- Polyamide

### Urea Derivates

- Reaction Amine + Isocyanate

## Adjuvants

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### Emulsifiers

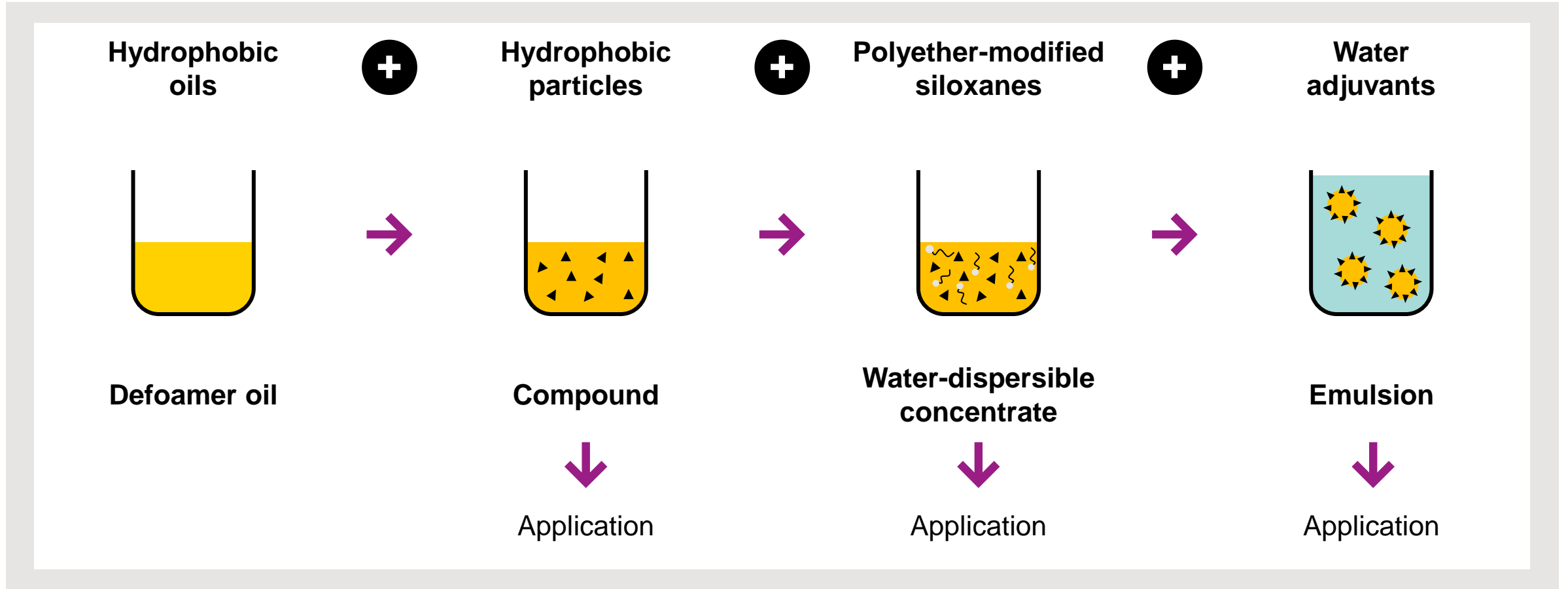
- Fatty Alcohol Ethoxylates
- Sorbitane Ester Ethoxylates
- Organic Polymers
- Polyether Siloxanes

### Rheology Modifiers

- Polyurethanes
- Polyacrylates
- Cellulose

### Preserving Agents

# Composition of Antifoams



# Antifoams based on Silicone Oil (PDMS)

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## Benefits

- Highly efficient due to their low surface tension (~ 22 mN/m)
- Insoluble in the foaming media



## Drawbacks

- PDMS are hydrophobic and oleophobic at the same time
- Highly incompatible with MWF concentrates
- Bad stability in MWF emulsions/solutions
- Adverse effects on finishing processes can occur

# Antifoams based on organic Oils

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## Benefits

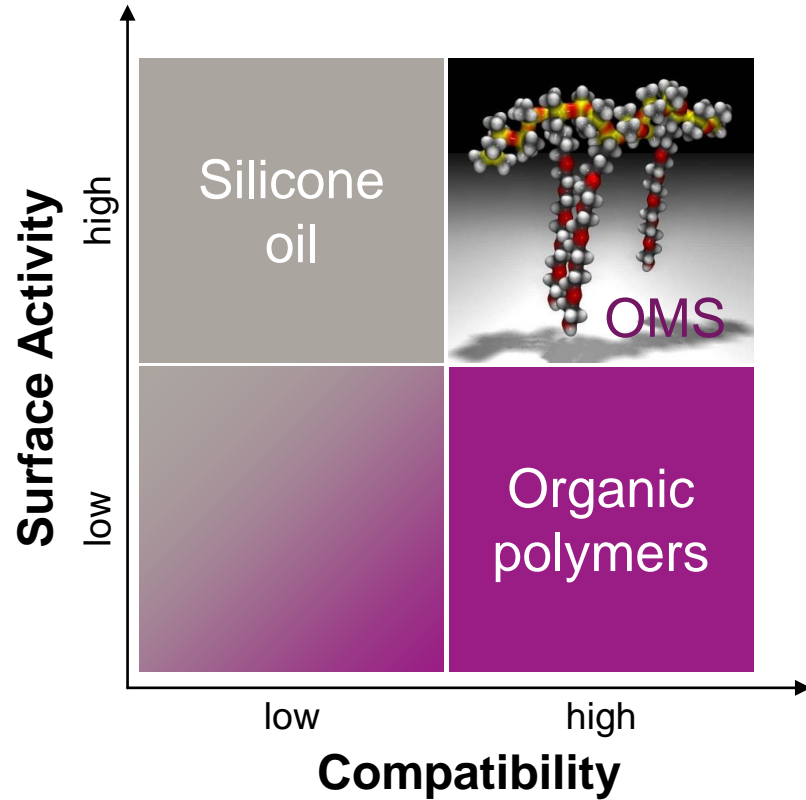
- Highly compatible with MWF concentrates
- Good stability in water-mixed MWF
- Minimum influence on the shelf life of MWF emulsions / solutions
- No adverse effects on finishing processes



## Drawbacks

- Less efficient due to their high surface tension ( $\geq 30$  mN/m)

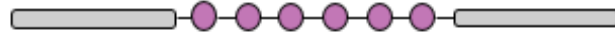
# Antifoams based on organo-modified Siloxanes (OMS)



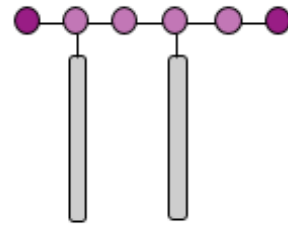
## Organo-modified Siloxanes (OMS)

- Combine the high efficiency of silicone oils due to their low surface tension
- With the high compatibility of antifoams based on organic oils
- Highly stable in MWF concentrates
- Minimum influence on the shelf life of water-mixed fluids
- No adverse effects on finishing processes
- Highly cost efficient

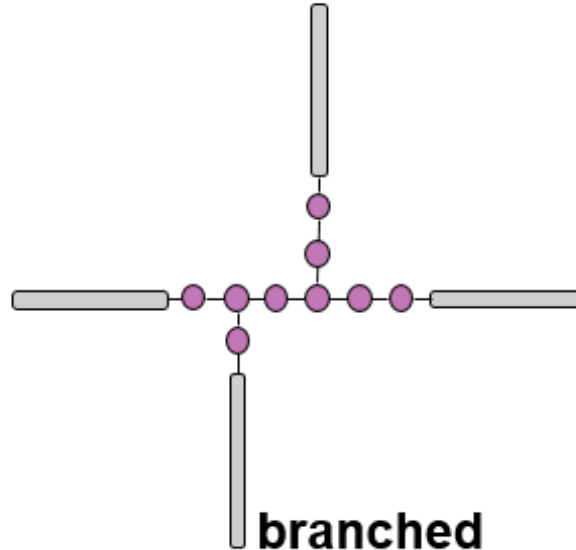
# Structures of organo-modified Siloxanes (OMS)



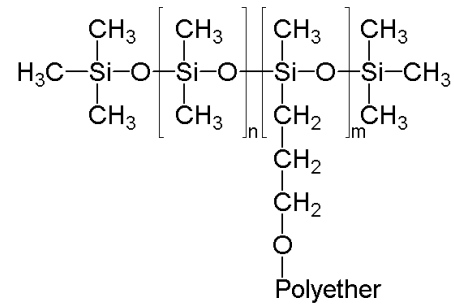
**block**



**comb-like**



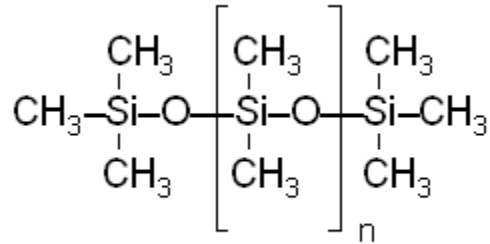
**branched**



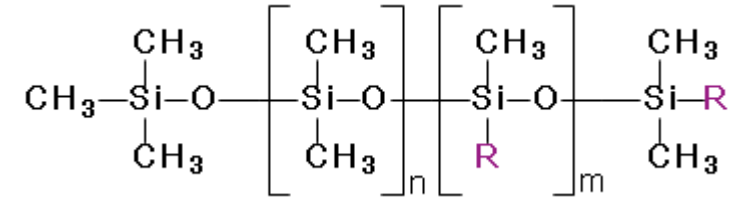
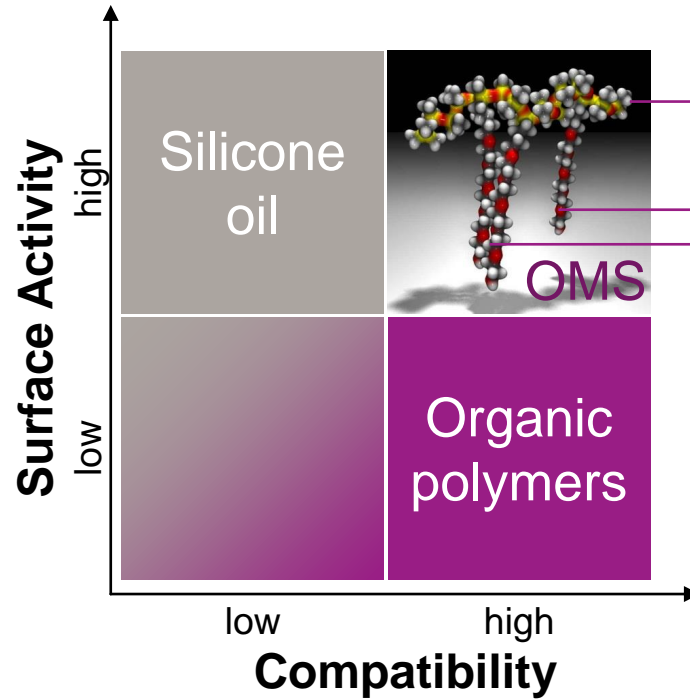
 = silicone backbone

 = polyether

# No fear of Antifoams based on organo-modified Siloxanes (OMS)



Example for a Polydimethylsiloxane



Example for an organo-modified Siloxane

- **Silicone backbone** provides high surface activity
- **Organic side groups** provide compatibility with the matrix

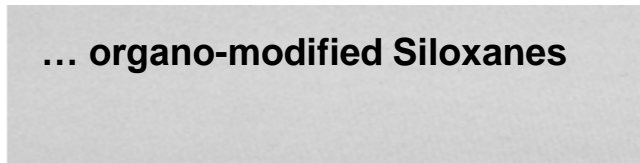
## Downstream Effects

Use of antifoams based on...

... Silicone oils

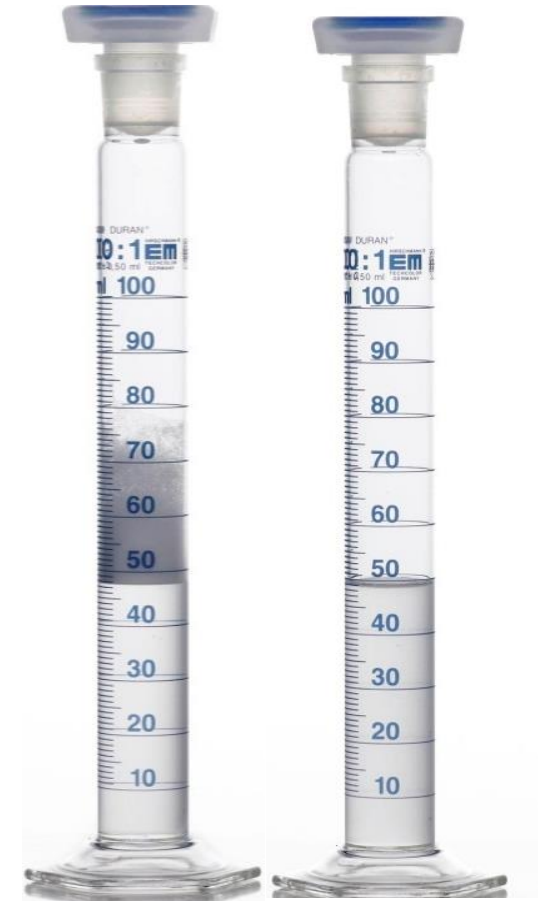
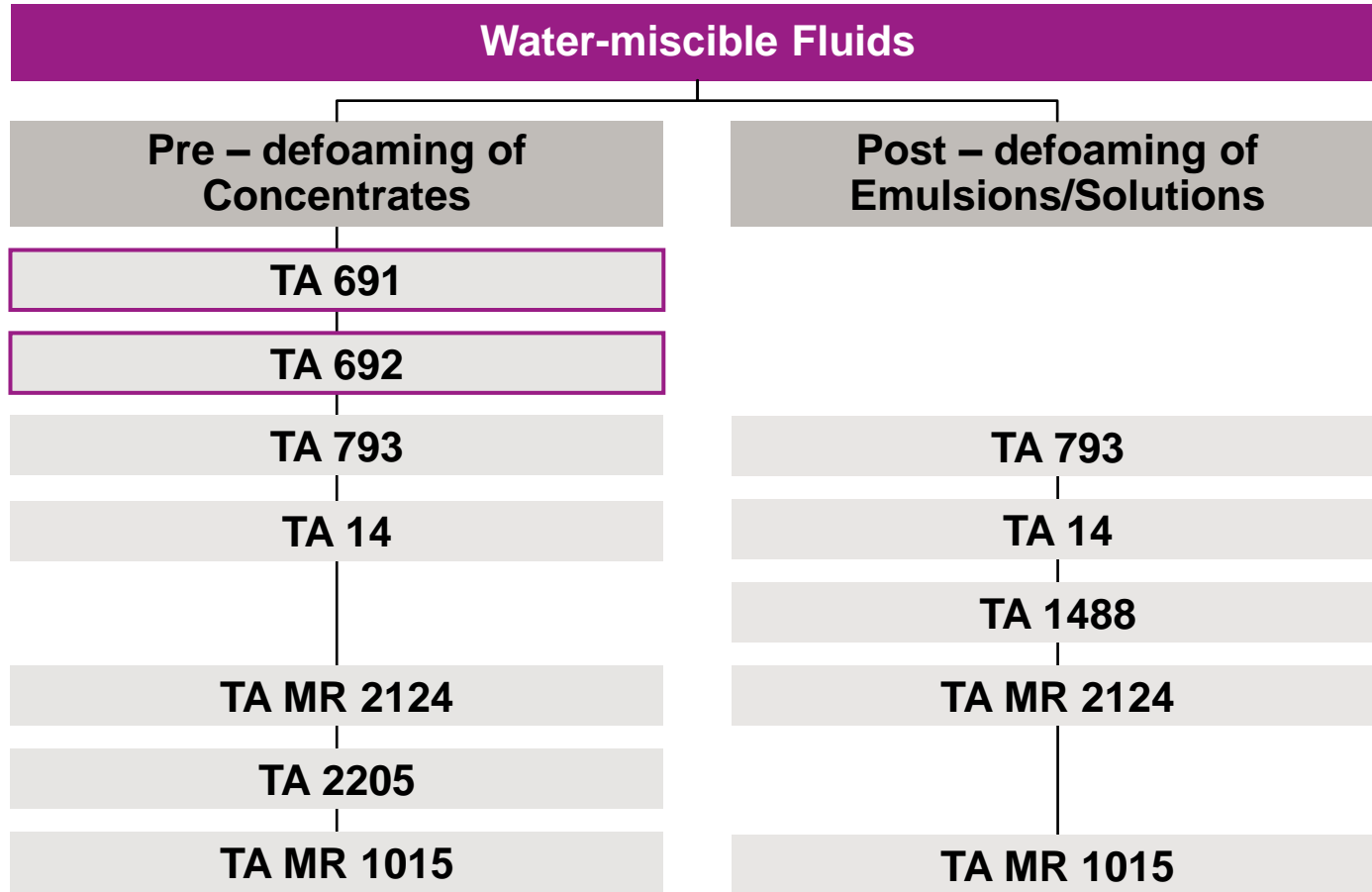


... organo-modified Siloxanes



# Antifoams for water-miscible Lubricants

## Product Overview



# Antifoams for water-miscible Lubricants

## Product Overview

Product	Based on		Active matter [%]	Pre-defoaming of		Post-defoaming of	
	defoamer oil	hydrophobic particle		emulsifiable fluids	water soluble fluids	emulsifiable fluids	water soluble fluids
TEGO® Antifoam 691	OMS	Silica	100	●	○		
TEGO® Antifoam 692	OMS	Silica	100	●	○		
TEGO® Antifoam 793	OMS	Silica	100	●	●	●	●
TEGO® Antifoam 14	OMS	Silica	100	●	●	●	●
TEGO® Antifoam 1488	OMS	Silica	20			●	
TEGO® Antifoam MR 2124 <sup>1)</sup>	Mineral oil	Waxes	100	●		●	
TEGO® Antifoam 2205 <sup>1)</sup>	Vegetable oil	Waxes	100	●			
TEGO® Antifoam MR 1015 <sup>2)</sup>	OMS / Si-oil	Silica	70	●		●	●

● recommended    ○ depending on fluid composition | 1) totally Si-free (contains no OMS, no PDMS, no silica) | 2) contains non modified siloxane besides OMS

# TEGO® Antifoam 691 & TEGO® Antifoam 692

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## Composition

100 % active antifoam compounds based on a polyether-modified siloxane of brand new structure (hydrophobic oil) and different silicas (hydrophobic particles)



## Application

- Particularly suitable for pre-defoaming of emulsifiable lubricants such as soluble oils and semi synthetic fluids based on mineral oils or ester oils or blends of those base oils
- Depending on the composition of the lubricant both antifoams may also be applicable for pre-defoaming of full synthetic (water-soluble) lubricant concentrates



# TEGO® Antifoam 691 & TEGO® Antifoam 692

## Composition

100 % active antifoam compounds based on a polyether-modified siloxane of brand new structure (hydrophobic oil) and different silicas (hydrophobic particles)



## Advantages

- Both 100 % active antifoam compounds are homogeneous even after one year storage and show no precipitation



TEGO® Antifoam 691

TEGO® Antifoam 692

- Highly efficient pre-defoamers even at low dosage levels of 0.1 – 0.2 %
- Good compatibility with emulsifiable MWF concentrates, therefore stable MWF concentrates are mainly obtained

- Provide an excellent foam knock down and hold down as well as a long-lasting defoaming persistence
- Show excellent filterability properties, which minimizes the amount of additional tank side defoamer
- Do not deteriorate the shelf life of water-mixed emulsions
  - Have no negative impact on the degree of their dispersity
  - Show often even a stabilizing effect
- Can offer beside defoaming in addition a deaerating effect in water-mixed fluids
- Silicone oil (PDMS) free
  - No adverse effects on finishing processes
- No labelling required



# TEGO® Antifoam 691 & TEGO® Antifoam 692

## Composition

100 % active antifoam compounds based on a polyether-modified siloxane of brand new structure (hydrophobic oil) and different silicas (hydrophobic particles)



## Presence of unmodified polydimethylsiloxane (PDMS)

- We do not use unmodified polydimethylsiloxane (PDMS) as a raw material during the production of the organo-modified siloxanes that are part of TEGO® Antifoam 691 and TEGO® Antifoam 692

- Based on an analytical method that includes
  - isolation of unmodified PDMS by preparative chromatography
  - quantification of the isolated fraction
  - NMR spectroscopic analysis of the isolated fraction

it can be stated that both antifoam compounds do not contain unmodified polydimethylsiloxane (PDMS) above the threshold of the analytical detection (detection limit of the applied method is 0.1 m%)



# TEGO® Antifoam 691 & 692 compared to Competition

## Performance Test Set-up

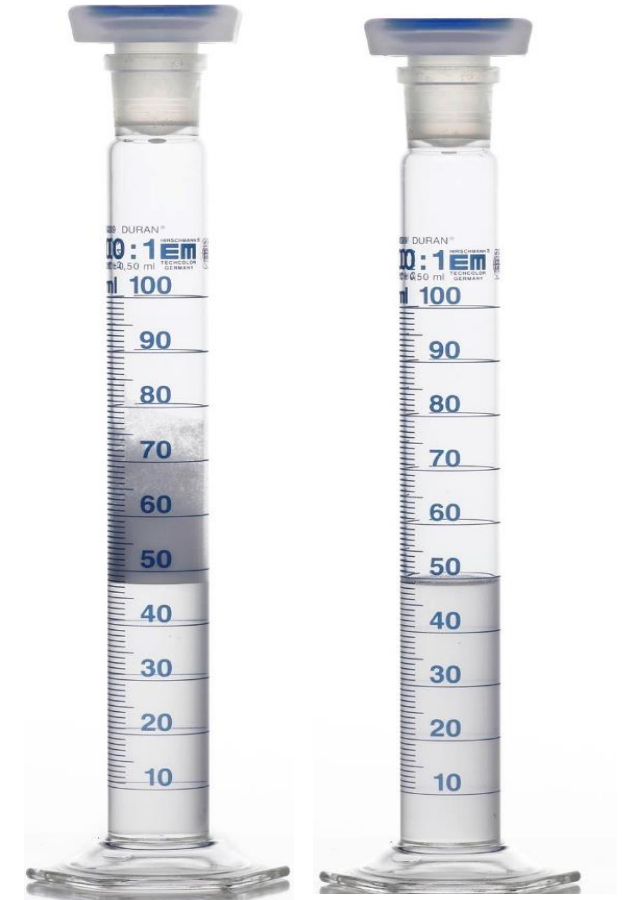
- Comparison of the effectiveness of pre-defoaming was carried out by using an exemplary branded MWF concentrate that was provided without the addition of pre-defoamer
- The boron-/amine free MWF concentrate contained ~40 % mineral oil and ~15 % water
- The MWF concentrate was pre-defoamed with 0.1 % of the respective defoamer
- The MWF concentrates were diluted to 5 % using demineralized water
- The defoaming performance of the respective water-mixed emulsion (translucent) was evaluated by
  - Shaking Test
  - CNOMO Re-circulation Test



# Description of Test Methods for evaluating Antifoams

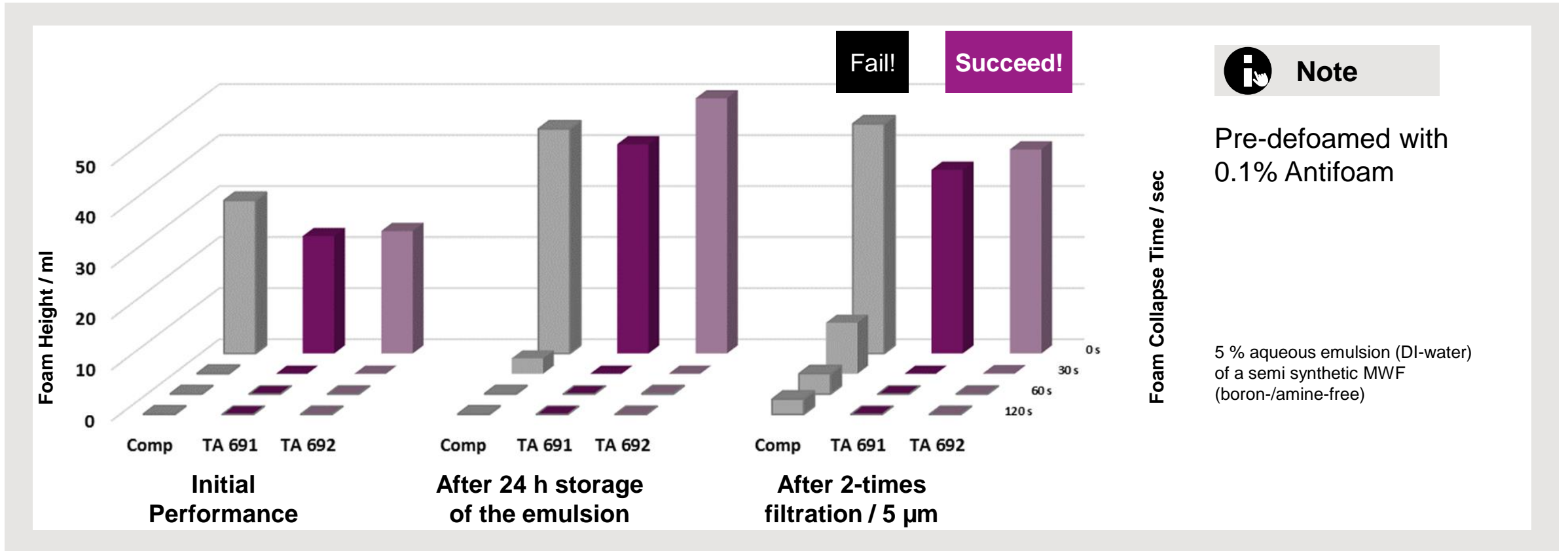
## Shaking Test

- 50 ml of a the water-mixed metalworking fluid are filled into a graduated 100 ml shaking cylinder
- A plug is put on top of the cylinder. The cylinder is shaken vigorously with up and down movements for 10 sec (approx. 30 strokes)
- Initially after stopping shaking as well as after 30 sec, 1 min. and 2 min. the foam height (value in ml) is recorded



# TEGO® Antifoam 691 & 692 compared with Competition

## Initial performance (Shaking Test)



TA = TEGO® Antifoam | Comp = Competitor

# Description of Test Methods for evaluating Antifoams

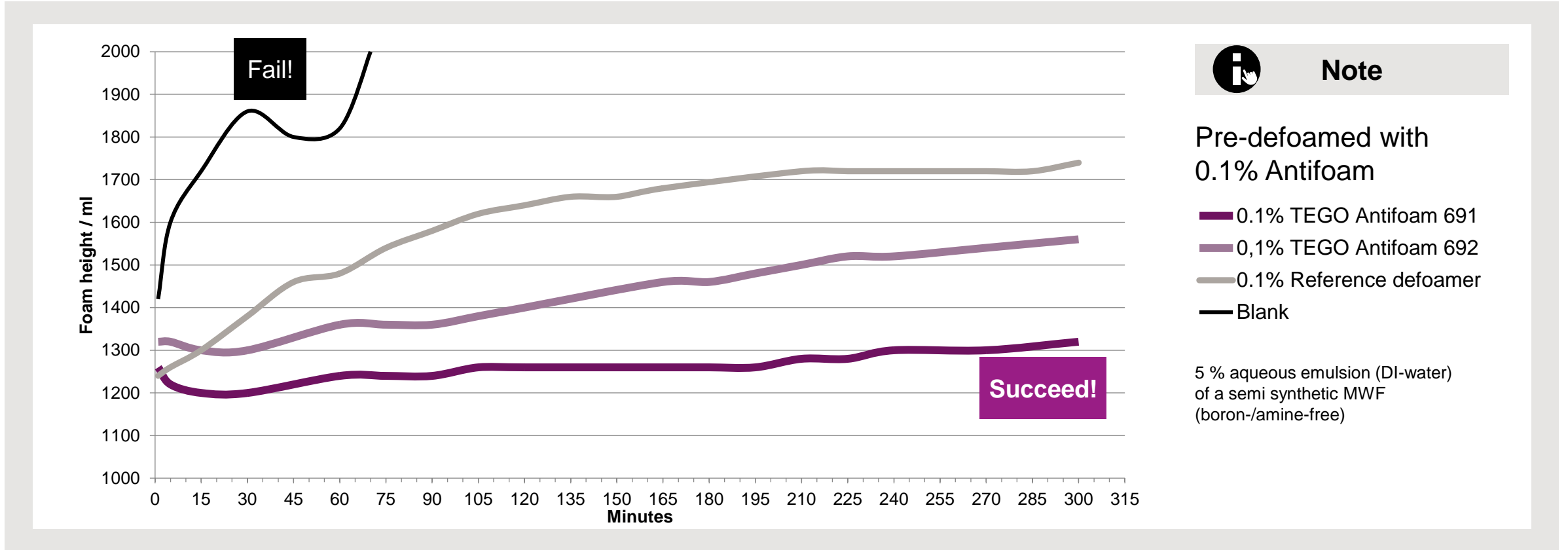
## CNOMO Re-circulation Test

- The water-mixed fluid is filled into the cylinder up to its 1000 ml graduation. It must be taken into account that all hoses as well as the circulation pump are also filled with the water-mixed fluid
- The circulation pump is switched on and the aqueous dilution is re-circulated at a flow rate of  $250 \pm 10$  litres per hour for up to a maximum of 5 hours, or till the foam level reaches the 2000 ml graduation
- During the re-circulation the total height (foam + liquid) is recorded (in ml) every 15 minutes
- If the foam level does not reach the 2000 ml graduation within 5 hours re-circulation time, the pump will be switched off after 5 hours and total height (foam + liquid) is noted



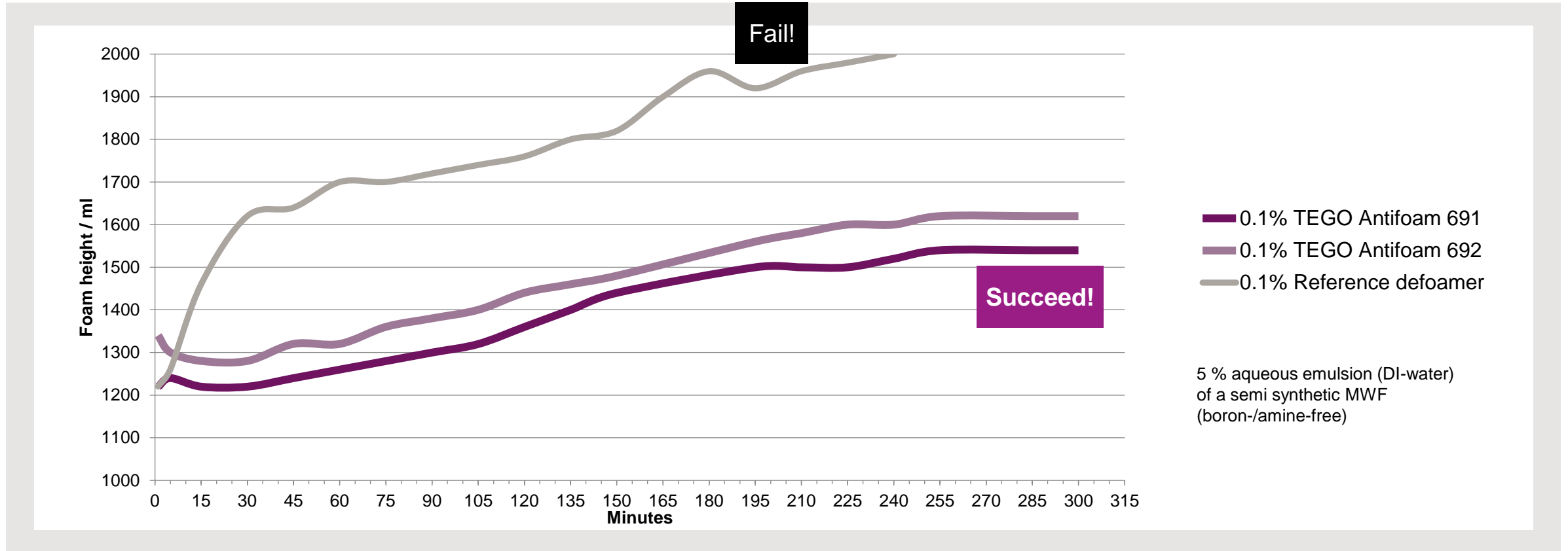
# TEGO® Antifoam 691 & TEGO® Antifoam 692 compared with Competition

## Initial performance (CNOMO Re-circulation Test)



# TEGO® Antifoam 691 & TEGO® Antifoam 692 compared with Competition

After 4 weeks storage of the MWF concentrates at RT (CNOMO Re-circulation Test)



# TEGO® Antifoam 793 & TEGO® Antifoam 14

## Composition

100 % active antifoam compounds based on polyether-modified siloxanes of different hydrophilicity (hydrophobic oils) and different silicas (hydrophobic particles)

TEGO® Antifoam 793 is more hydrophilic and thus more water-dispersible than TEGO® Antifoam 14



## Application/Advantages

- Both antifoams are suitable for pre- and post-defoaming of a broad range of different emulsifiable fluids such as soluble oils and semi synthetic fluids as well as full synthetic (water-soluble) fluids
- TEGO® Antifoam 793 in particular shows its strength as post-defoamer for all kinds of water-mixed emulsions and solutions
- Highly compatible with MWF concentrates, therefore clear MWF concentrates are mainly obtained even at high dosage levels
- Water dispersible, therefore suitable for post-defoaming
  - Can be added as concentrates or in their diluted forms
- Provide an excellent foam knock down and hold down as well as long-lasting defoaming persistence
- Show good filterability properties, which minimizes the amount of additional tank side defoamer
- Does not deteriorate the shelf life of water-mixed emulsions and solutions
- Silicone oil (PDMS) free
  - No adverse effects on finishing processes



# TEGO® Antifoam 793 & TEGO® Antifoam 14

## Composition

100 % active antifoam compounds based on polyether-modified siloxanes of different hydrophilicity (hydrophobic oils) and different silicas (hydrophobic particles)

TEGO® Antifoam 793 is more hydrophilic and thus more water-dispersible than TEGO® Antifoam 14



## Presence of unmodified polydimethylsiloxane (PDMS)

- We do not use unmodified polydimethylsiloxane (PDMS) as a raw material during the production of the organo-modified siloxanes that are part of TEGO® Antifoam 793 and TEGO® Antifoam 14
- Based on an analytical method that includes
  - isolation of unmodified PDMS by preparative chromatography
  - quantification of the isolated fraction
  - NMR spectroscopic analysis of the isolated fraction

it can be stated that both antifoam compounds do not contain unmodified polydimethylsiloxane (PDMS) above the threshold of the analytical detection (detection limit of the applied method is 0.1 m%)



# TEGO® Antifoam 1488

## Composition

20 % active defoamer emulsion based on polyether-modified siloxane (hydrophobic oil) and silica (hydrophobic particle)

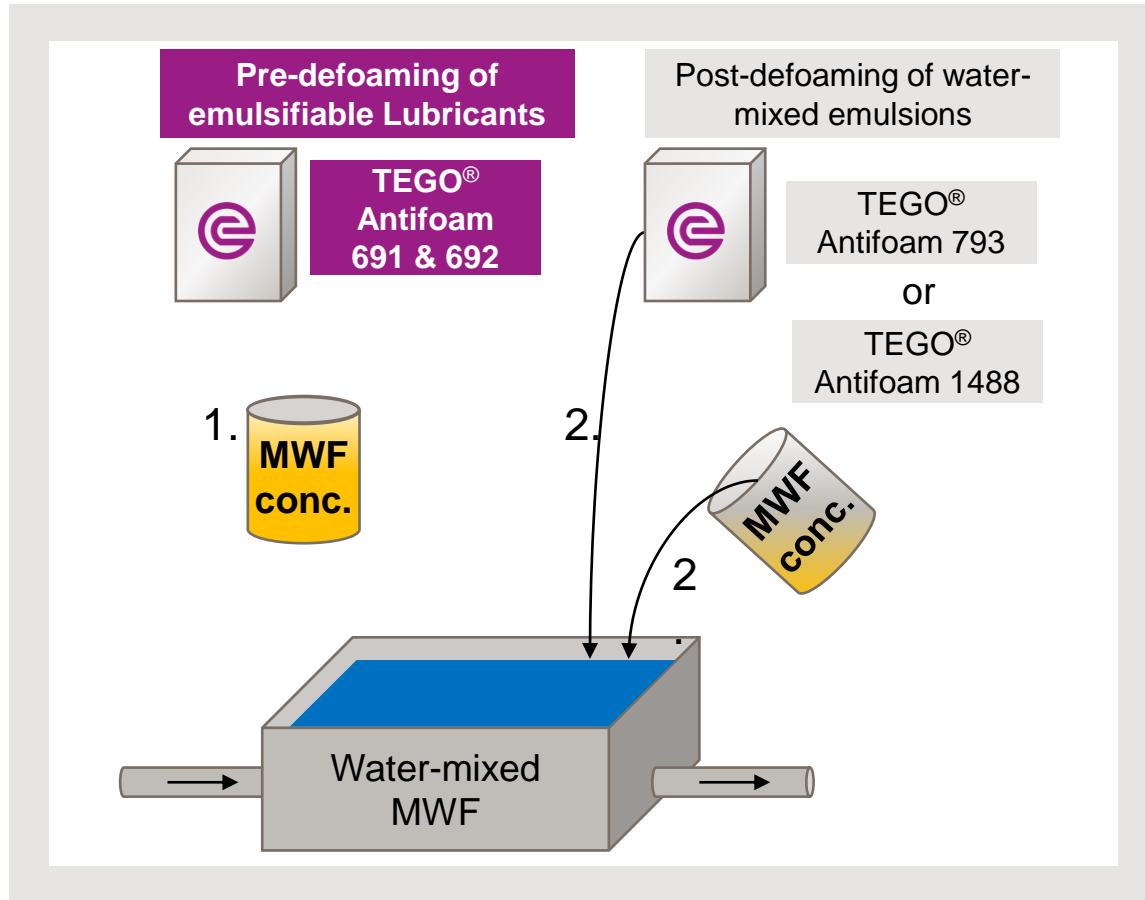


## Application/Advantages

- Highly suitable for post-defoaming of a broad range of emulsifiable lubricants such as soluble oils and semi synthetic fluids
- Is in particular recommended
  - for processes in which water-mixed emulsions show low foaming tendency
  - for preventing overdosing by end-users (as cost-reducing measure)
- Easily dispersible in water, is therefore characterized by ease of handling
  - Can be applied as delivered
- Provides a good foam knock down and hold down as well as a long-lasting defoaming persistence
- Shows excellent filterability properties, which minimizes frequent addition as tank side defoamer
- Does not deteriorate the shelf life of water-mixed emulsions
- Silicone oil (PDMS) free
  - No adverse effects on finishing processes
- Highly cost efficient



# TEGO® Antifoam 691 & 692 and TEGO® Antifoam 793 & 1488 complement perfectly for use in emulsifiable MWF



## Formulator

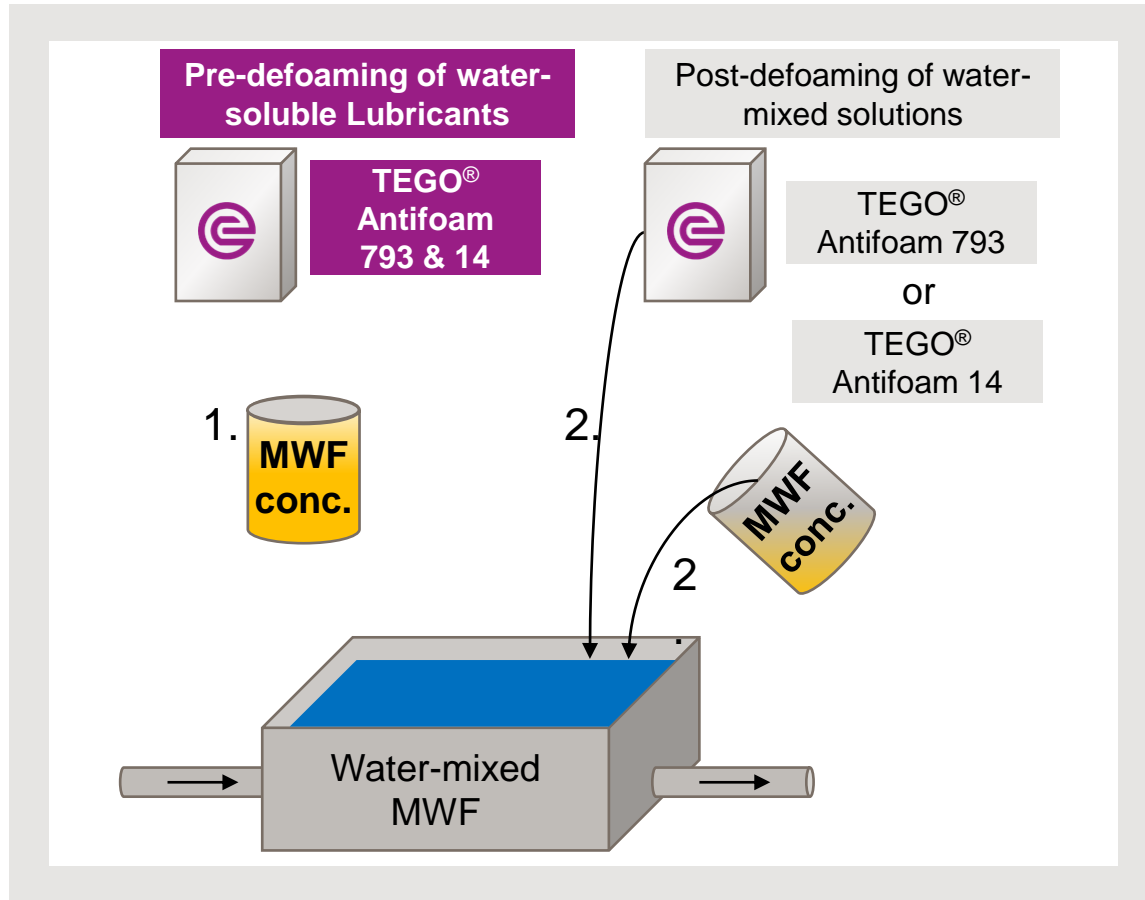
1. Formulator incorporates **pre-defoamer** into the emulsifiable MWF concentrate (~0.1 – 0.2 %)  
**TEGO® Antifoam 691 & 692** are particularly suitable for pre-defoaming of emulsifiable MWF concentrates that are based on mineral and/or ester oil



## End User

2. End user dilutes MWF concentrate with water for obtaining a water-mixed emulsion  
If foam problems occur in the water-mixed emulsion during application, post-defoamer **TEGO® Antifoam 793** (~50 ppm) or **TEGO® Antifoam 1488** (~250 ppm) will be added as **tank side additive**

# TEGO® Antifoam 793 & 14 have proven successful as pre-defoamers and as tank side additives for use in water-soluble (full synthetic) MWF



## Formulator

1. Formulator incorporates **pre-defoamer** into the water-soluble MWF concentrate (~0.05 – 0.1 %) **TEGO® Antifoam 793 & 14** are particularly suitable for pre-defoaming of water-soluble MWF concentrates that are based only on water soluble components plus high amounts of water



## End User

2. End user dilutes MWF concentrate with water for obtaining a water-mixed solution  
If foam problems occur in the water-mixed solution during application, post-defoamers **TEGO® Antifoam 793** or **TEGO® Antifoam 14** ( $\leq 50$  ppm) will be added as **tank side additive**

# TEGO® Antifoam MR 2124

## Composition

100 % active antifoam compound based on mineral oil and special finely dispersed waxes as hydrophobic particles

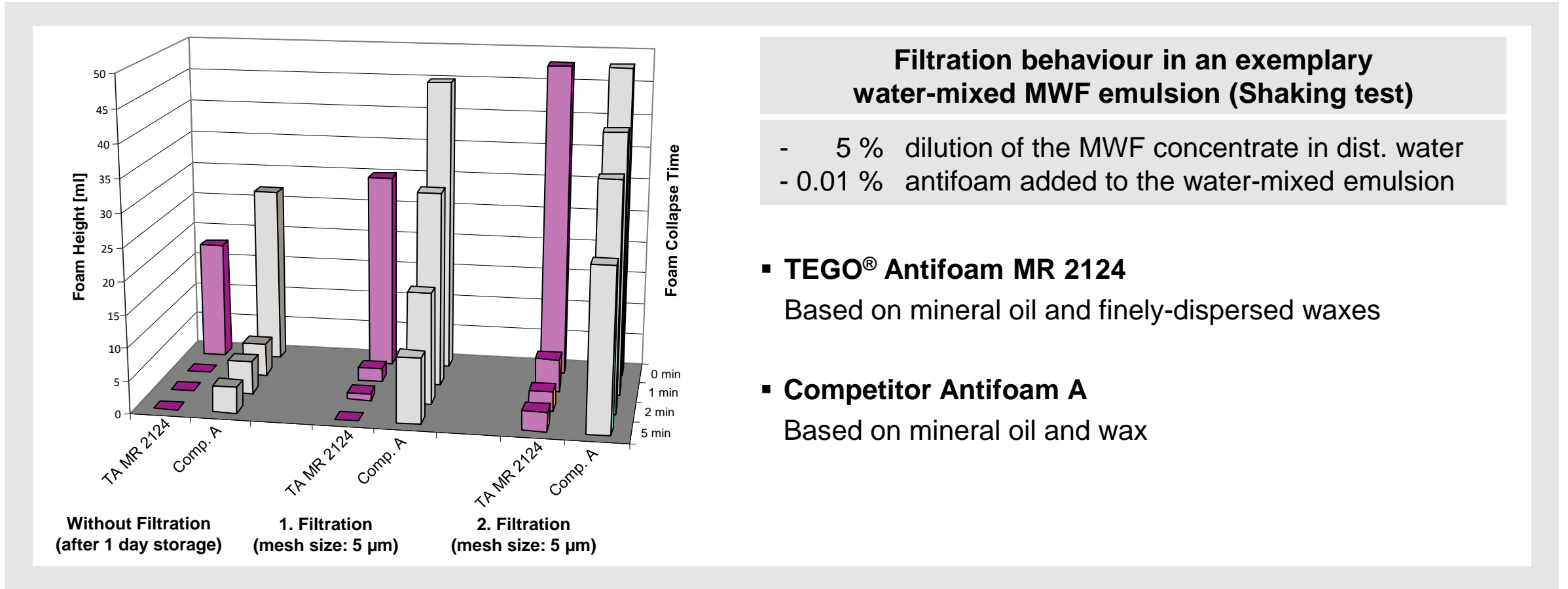


## Application/Advantages

- Totally Si-free defoamer, i. e. it does not contain any siloxanes or silica
  - Therefore, particularly recommended for applications where the use of silica and siloxane is not appreciated
- Water-dispersible, therefore highly suitable for post-defoaming of all kinds of emulsifiable lubricants
- Under certain circumstances also suitable for pre-defoaming of emulsifiable lubricants
  - May cause fine flocculation in emulsifiable lubricant concentrates
  - Upper concentration limit of tolerance in emulsifiable lubricant concentrates is usually 0.2 %
- Shows improved filterability in comparison to most competitive wax-based antifoams, which minimizes the amount of additional tank-side defoamer
- Provides a good foam knock down and hold down
- No adverse effects on finishing processes of treated metal parts
- Highly cost efficient



# TEGO® Antifoam MR 2124



# TEGO® Antifoam 2205

## Composition

100 % active antifoam compound based on vegetable oil and special finely dispersed waxes as hydrophobic particles



## Application/Advantages

- Totally Si-free defoamer, i. e. it does not contain any siloxanes or silica
  - Therefore, particularly recommended for applications where the use of silica and siloxane is not appreciated
- Specially designed for pre-defoaming of a broad range of emulsifiable lubricants
- Often more compatible with emulsifiable MWF concentrates than TEGO® Antifoam MR 2124 in terms of the tendency to flocculate
- Shows improved filterability in comparison to most competitive wax-based antifoams, which minimizes the amount of additional tank side defoamer
- Provides a good foam knock down and hold down
- No adverse effects on finishing processes of treated metal parts
- Highly cost efficient

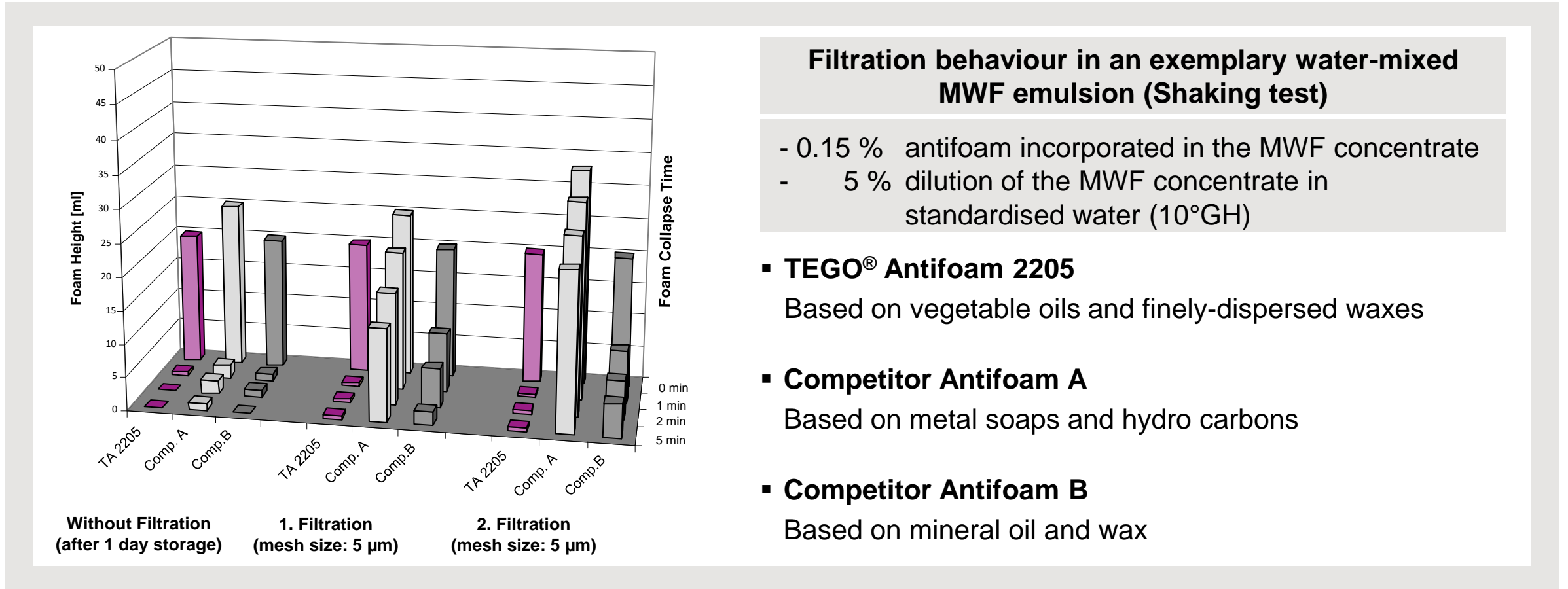


## Note

- Not water dispersible, therefore not applicable as tank-side additive



# TEGO® Antifoam 2205



# TEGO® Antifoam MR 1015

## Composition

70 % active antifoam compound based on organo-modified siloxanes, silicone oil and silica as hydrophobic particles



## Application/Advantages

- Very effective antifoam for the pre- and post-defoaming of a broad range of different water miscible fluids
- The special organo-modification of the siloxane and formulation technology of the active components result in a unique product profile, which cannot be achieved neither with organic nor with traditional silicone oil-based antifoams
- Provides a good foam knock down and hold down
- Excellent alkaline and electrolyte stable, even at elevated temperatures
- Easily water dilutable
- Especially suitable for post-defoaming of alkaline metal cleaner
- Undesirable effects associated with silicone-based antifoams (fish-eyes, etc.) do normally not occur



## Note

- Not compatible with lubricant concentrates that contain a high amount of water
- Prohibition to use silicone oil limits the possible application



# Pre-defoaming of water-miscible Lubricants

## General Advice

- In general, manufacturer of lubricants incorporate pre-defoamers as last components into the finished lubricant concentrate
- Efficient antifoams will sometimes cause turbidity or instability, if incorporated within the Lubricant concentrate
- This might occur especially in high water containing MWF (e. g. in full synthetic or semi synthetic fluids)
- In that case an incorporation of the pre-defoamer during the mixing process of the MWF concentrate (especially before water is added) will often lead to a clear and stable, pre-defoamed MWF concentrate

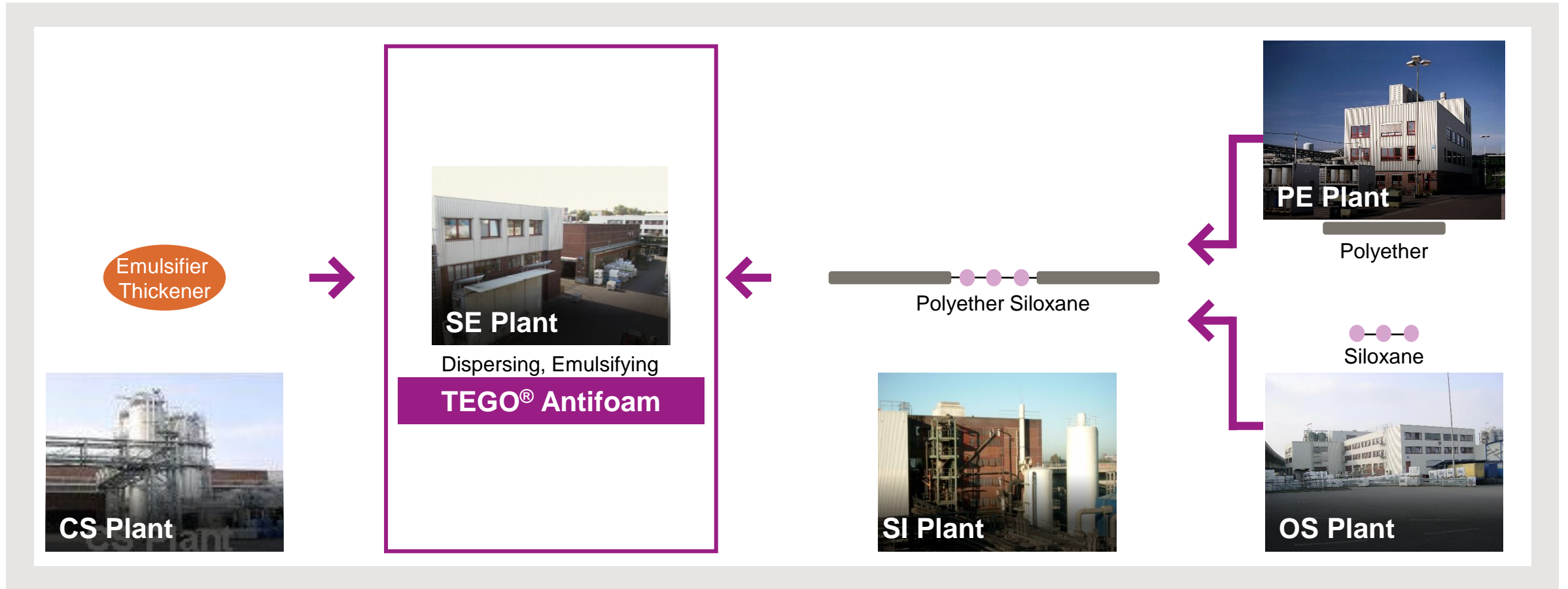


# Components manufactured by Evonik Operations GmbH

- Polyethers
- Amphoteric surfactants
- Oleochemicals
- Organo- modified siloxanes
- Carbohydrate surfactants
- Cationic surfactants
- Polyacrylates



# Producing an Antifoam at Essen-Site





**EVONIK**

**Leading Beyond Chemistry**