Antifoams for oil-based Lubricants

Guideline for solving Foam Problems in non-aqueous oil-based media

Evonik Operations GmbH – Specialty Additives
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Foam is defined as a Dispersion of Air in a Liquid

Different types of foam in an oil-based lubricant

MACROFOAM
surface foam

MICROFOAM
enclosed air

Clear Oil
without air bubbles

Air

0.95 – 0.60 g/cm^3

Density

Oil

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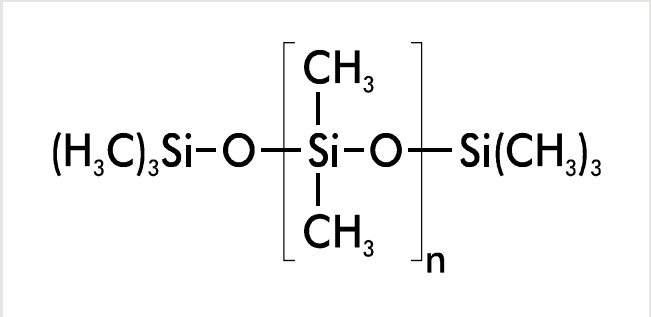
Antifoams for oil-based Lubricants
Current Technology (1)

Polydimethylsiloxanes (PDMS; silicone oil)



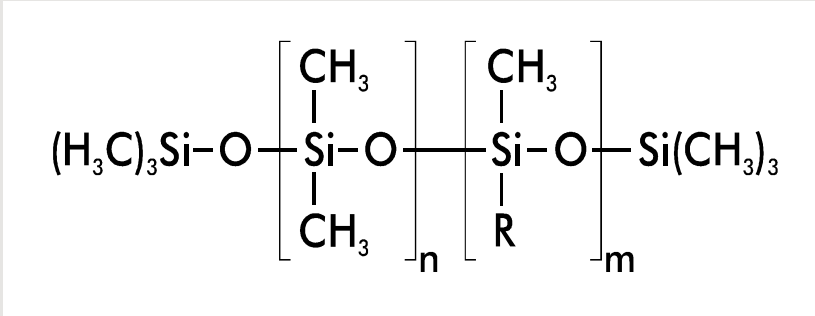
- Chemical inertness
- Good temperature stability
- Excellent surface activity
- Very low surface tension (21 mN/m)

- Poor compatibility with water- and oil-based systems

- Excellent efficiency for avoiding macrofoam, but has a negative impact on air release properties (microfoam)
- Highly incompatible with formulations (phase separation)
- Treat level: 10 – 20 ppm

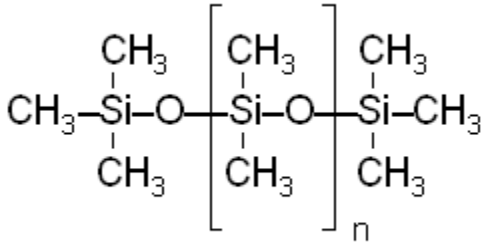
Antifoams for oil-based Lubricants
Current Technology (2)

Organo-modified siloxanes (OMS)

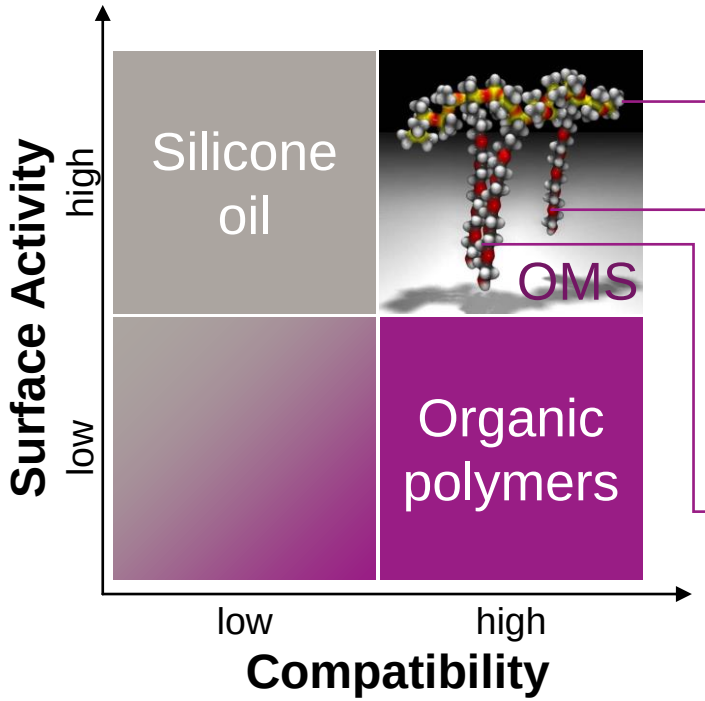


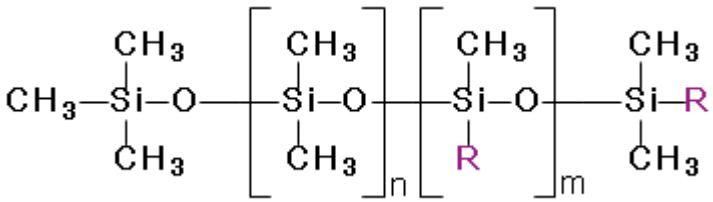
- OMS are based on a PDMS backbone that guarantees a low surface tension typical for PDMS
- Organic side chains that are chemically bonded to the PDMS backbone provide a high compatibility with oil based media (or even with aqueous media depending on the organo substituent)
- Treat level: 10 – 20 ppm

No fear of Antifoams based on 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

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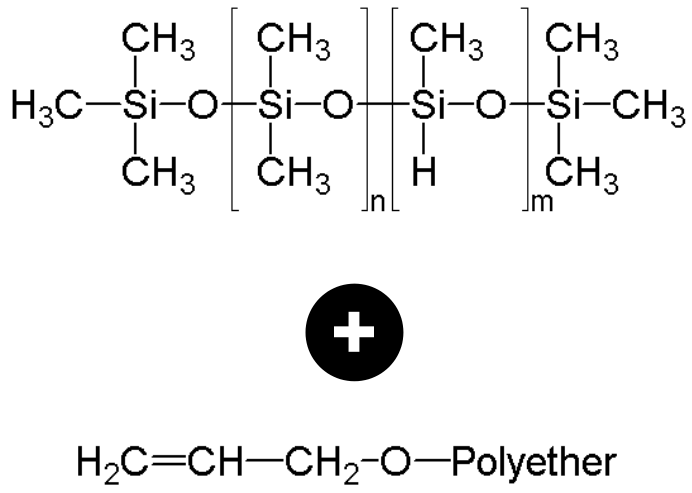
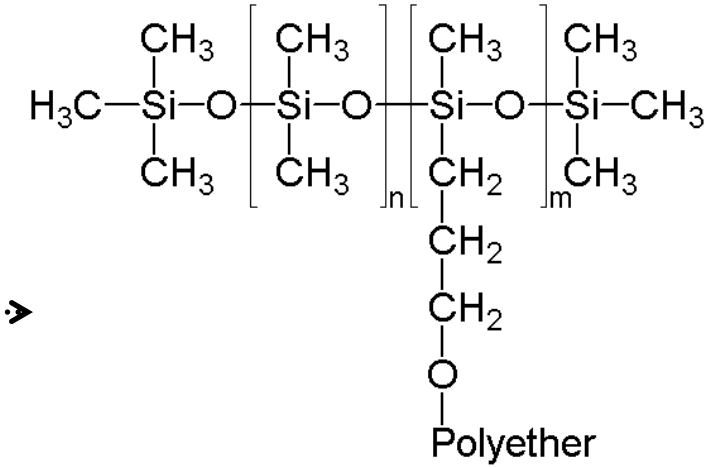
Synthesis of organo-modified Siloxanes (example)

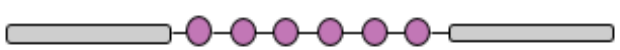
Hydrosylilation



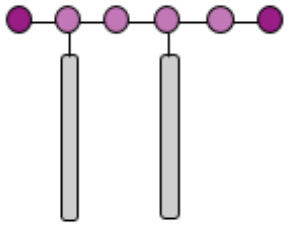
Catalyst



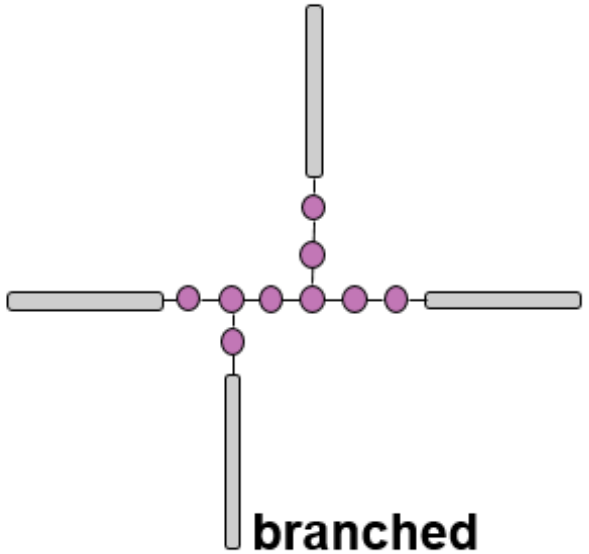
Structures of organo-modified Siloxanes



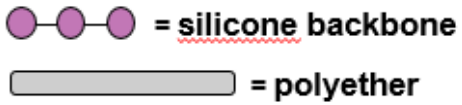
block



comb-like



branched



By variation of

- length of siloxane backbone
- number, kind and length of organic modification

it is possible to design organo-modified siloxanes with tailor-made properties

Organo-modified Siloxanes as Antifoam for oil-based Lubricants

Requirements

- Organic side groups compatibilize the silicone backbone with the non-aqueous oil matrix in order to avoid stability problems

Important note!

- Antifoams have to be dispersed in the non-aqueous oil media in form of fine droplets in order to be effective

- If the antifoam is too compatible with the non-aqueous oil matrix, the antifoam will be dissolved and will no longer act as defoamer but as a foam stabilizer or will even create foam

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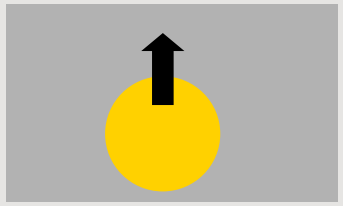
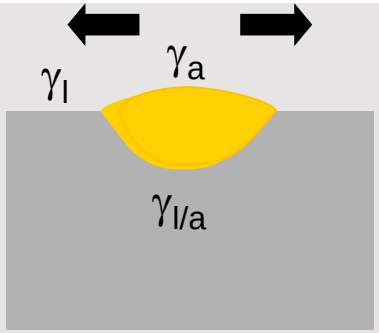
Mode of Action of Antifoams in non-aqueous Systems



Antifoams have to
form droplets



Antifoams have to
enter the liquid/ air interface

Entering coefficient:

$E = \gamma_l + \gamma_{l/a} - \gamma_a > 0$

Antifoams have to
spread

Spreading coefficient:

$E = \gamma_l - \gamma_{l/a} - \gamma_a > 0$

γ_l = Surface tension of liquid | γ_a = Surface tension of antifoam | $\gamma_{l/a}$ = Interfacial tension liquid/antifoam

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TEGO® Antifoam 2080

Composition

- Based on organo-modified siloxane with an active matter of approx. 80 %

Application

- Foam control in non-aqueous media based on mineral oil (e.g. neat oils, lubricating oils)

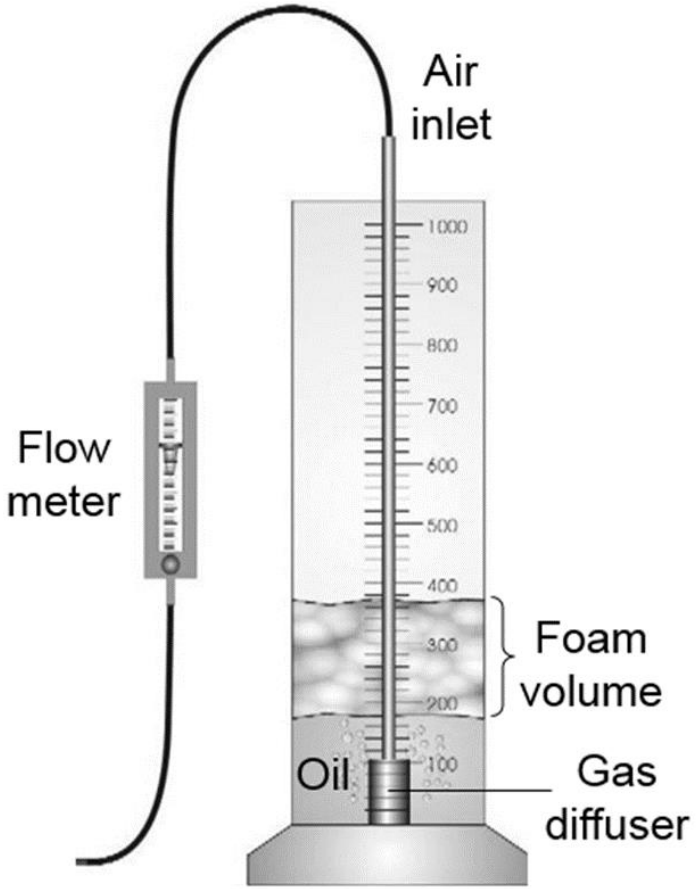
Dosage / Handling

- For first tests we recommend a dosage of 20 ppm of TEGO® Antifoam 2080, which can be increased up to 40 ppm if required
- The antifoam should be used in form of a 5 – 10 % pre-dilution in e.g. DINA / diisononyl adipate to enable an optimal distribution of fine droplets in the non-aqueous oil media

Benefits

- TEGO® Antifoam 2080 outperforms organic defoamers e.g. polyacrylates at a much lower dosage level. It shows the high efficiency of pure silicone oil ***without showing a negative impact on the deaeration rate of the non-aqueous oil matrix***
- TEGO® Antifoam 2080 is not water soluble. Therefore, the antifoam will maintain its defoaming activity, even if the non-aqueous media is contaminated with traces of water.

TEGO® Antifoam 2080 Performance in ASTM D 892 Test



Gear oil (mineral oil based)	Sequence 1 24 °C	Sequence 2 93.5 °C	Sequence 3 24 °C
without antifoam	60 ml / >300 s	750 ml / 300 s	80 ml / >300 s
with 20 ppm TA 2080*	0 ml / 0 s	0 ml / 0 s	0 ml / 0 s

*** 5 % TEGO® Antifoam 2080 dilution in DINA/ diisononyl adipate**

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TEGO® Antifoam 2080

Important note!

- Efficient antifoams for non-aqueous oil media require to be, at least, partially incompatible with the oil system
- TEGO Antifoam 2080 will normally fulfil this criterion – as least as long as the oil system is based on mineral oil
- In the presence of ester oil, the non-aqueous media turns to become more polar and consequently, TEGO® Antifoam 2080 will be solved in the oil media, will no longer be able to form fine droplets and can therefore not act as efficient antifoam
- For pure ester oil-based systems or for those systems that are based on mineral oil-/ ester oil blends, we highly recommend the use of our **TEGOPREN® 5831**!

TEGOPREN® 5831

Composition

- Based on polyether-modified siloxane with an active matter of approx. 100 %

Application

- Foam control in non-aqueous media based on ester oil or based on mineral oil-/ ester oil blends as well as polyalkylene glykols (e.g. neat oils, lubricating oils)

Dosage / Handling

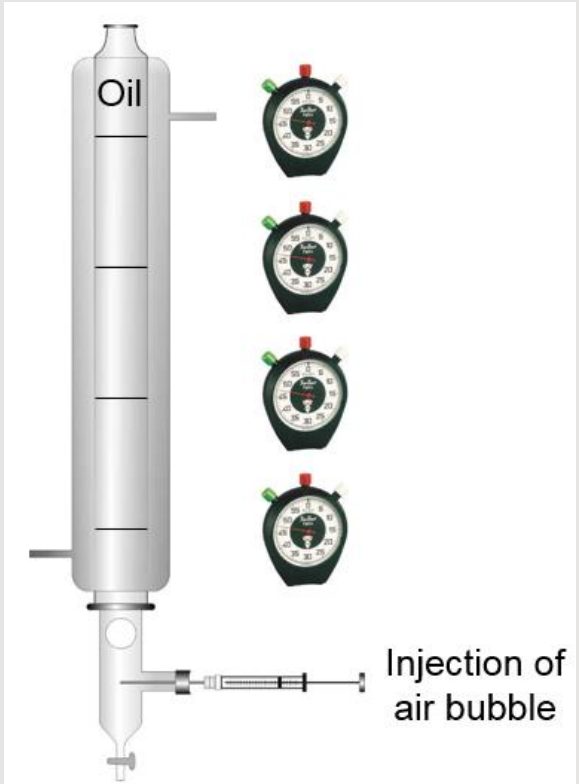
- For first tests we recommend a dosage of 10 ppm of TEGOPREN® 5831, which can be increased up to 20 ppm if required
- The antifoam should be used in form of a 5 – 10 % pre-dilution in a solvent to enable an optimal distribution of fine droplets in the non-aqueous oil media

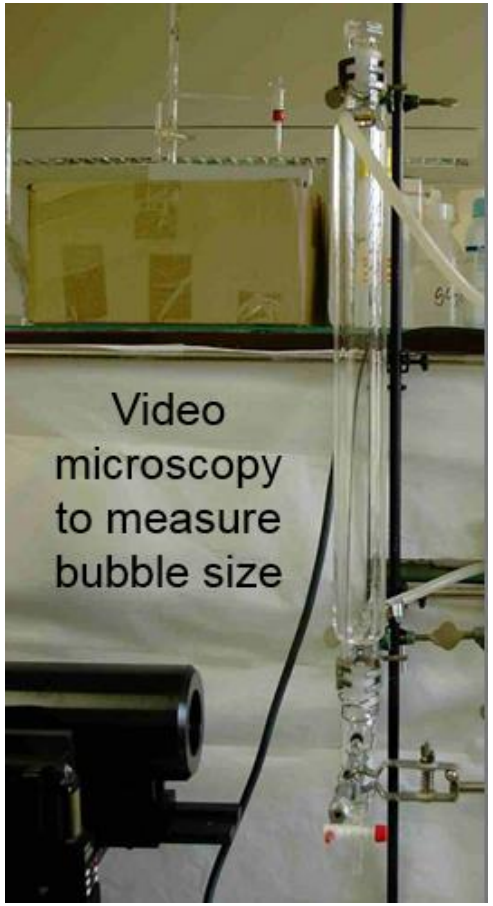
Benefits

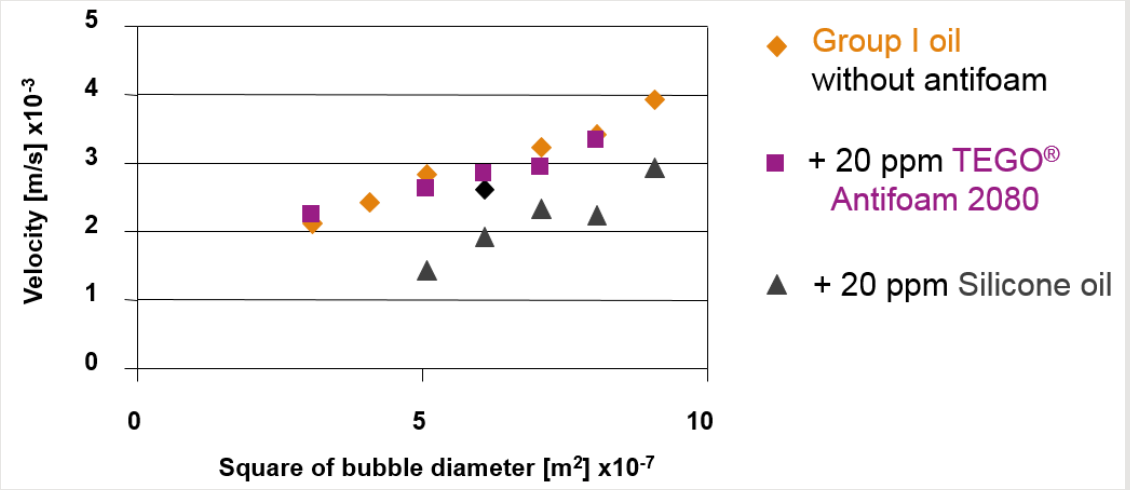
- TEGOPREN® 5831 outperforms organic defoamers e.g. polyacrylates at a much lower dosage level. It enables the high efficiency of pure silicone oil ***without showing a negative impact on the deaeration rate of the non-aqueous oil matrix***
- In addition, ***TEGOPREN® 5831 improves water separation capacity and also enhances wetting/ spreading properties of non-aqueous lubricants***

In addition to its outstanding antifoam characteristic our OMS – based TEGO® Antifoam 2080 provides in non-aqueous media excellent air release properties

TEGO® Antifoam 2080
Velocity of rising Air Bubbles in SHELL SN 150







- TEGO® Antifoam 2080 has no influence on the velocity of bubble rise
- Silicone oil causes a decrease in the velocity of rising bubbles

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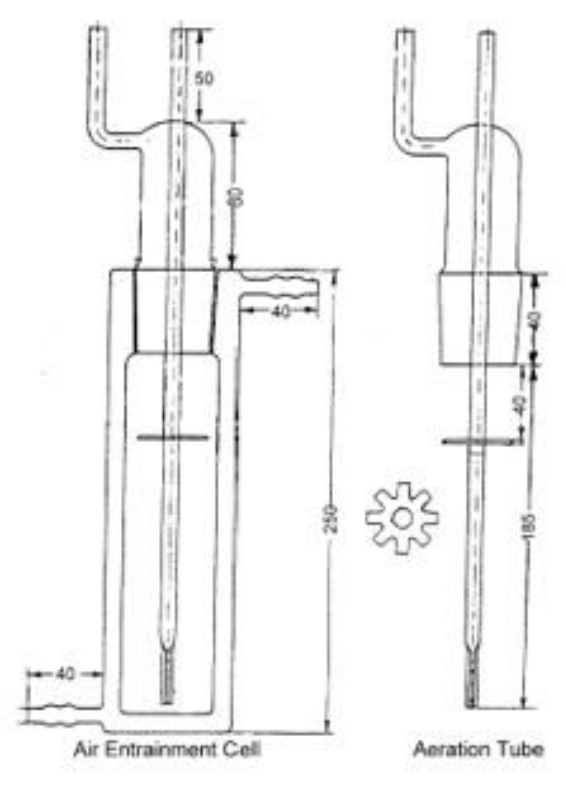
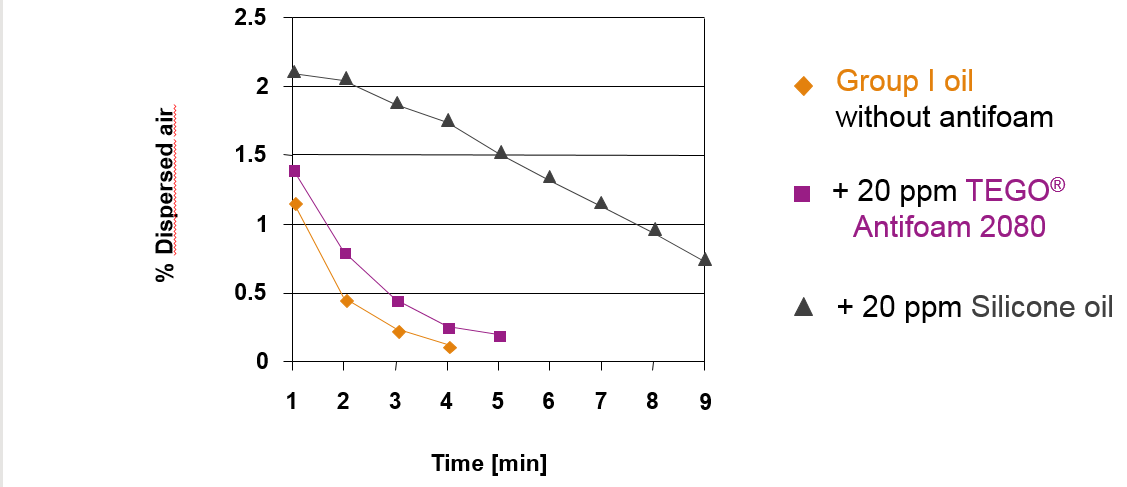
TEGO® Antifoam 2080
Air Release (IMPINGER Method) in SHELL SN 150



Air entrainment cell
DIN 51381

- Air is blown into the oil for 7 min
- Air flow is stopped
- Escape of dispersed air bubbles is followed by density measurement as a function of time



- TEGO® Antifoam 2080 has only a minor impact on air release
- Silicone oil has a strong negative impact on air release

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