

Application Leaflet

DAPRO[®] Defoamers

Mechanism of defoamers
in aqueous systems

Unique chemistry, sustainable solutions

ELEMENTIS



Key Benefits

- Highly effective defoaming
- Depending in the product, suitable for clear and sensitive systems

Introduction

Excessive foam formation is one of the problems that one can face during the formulation of water based paint systems. Foam can develop, and is a major concern, during all stages of a liquid water based paint:

- Production
- Filling
- Transportation
- Application

Foam formation should be avoided by all means possible. During the production- and filling stages, foam leads to inefficiency, overflow in tanks, instability and other problems. Foam formation during paint application can lead to properties like crater forming, loss of opacity and protection.

In order to fight foam formation, anti-foaming agents are used. Almost every water based paint systems will contain an anti-foaming agent, typically in the concentration range of 0.05 to 0.5% by weight.

The number of anti-foaming agents suppliers is huge. Selecting the proper type for a certain application is quite a task. The efficiency of anti-foaming agents strongly depends upon the specific paint system and process utilized.

In this presentation, some test procedures will be presented and properties of our new generation of anti-foaming agents will be discussed.

What is foam?

Foam consists out of stable dispersion of a gas in a liquid or solid phase; in this document it is air, distributed in the water phase of a paint formulation. The air is stabilized by the surface active components in the paint, like emulsifiers, wetting agents and thickeners.

Air is added during several stages like in the mixing-, dispersing, filling-, transportation-, and application stage. Besides the incorporation of air, other gasses can develop as a result of chemical reactions in the paint. An example of this is two component systems like those based on isocyanates in which carbon dioxide is formed when the isocyanate groups react with water.

Pure liquids do not form foam. The entrapped air will be released spontaneously as a result of differences in specific gravity (Stokes Law). In presence of surface active agents, air dispersions will be stabilized.

Defoaming

Optimizing the paint formulation and the production- and application process can reduce the entrapment of air. However, air entrapment cannot be avoided completely. Anti foaming agent are needed in almost every water based system.

The efficiency of anti-foaming agents depends on their ability to spread themselves throughout the media and the ability to penetrate into the foam. The following parameters can be described (ref. 1, 2):

$$\begin{array}{lll} \text{Entering coefficient } E & E = \sigma_f - \sigma_d + \sigma_{int} & [A] \\ \text{Spreading coefficient } S & S = \sigma_f - \sigma_d - \sigma_{int} & [B] \end{array}$$

In which:

σ_f surface tension of liquid to be defoamed
 σ_{int} surface tension of anti-foaming agent
 σ_d interfacial tension between defoamer and the liquid to be defoamed

FIGURE 1

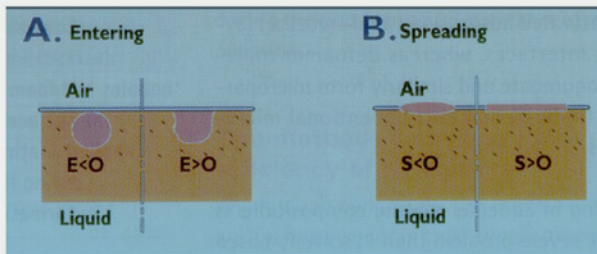
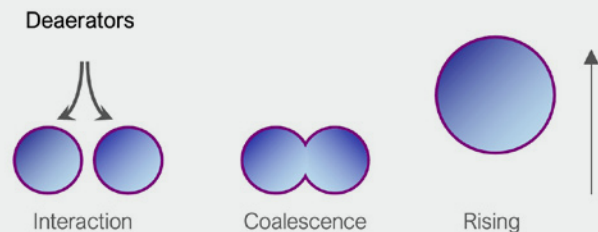


FIGURE 2



A defoamer can penetrate a foam containing medium if $E > 0$ and a defoamer can spread itself spontaneously within the medium if also $S > 0$. A positive value for S is of great importance for a defoamer since $E - S = 2\sigma_{int}$ (FIGURE 1).

Efficiency of anti-foaming agents is increased if surface tensions and /or interfacial tensions are decreased; anti foaming agents, therefore, contain surface active components to warranty this.

Also, the defoamers viscosity and compatibility with the medium to defoam will play an important role in regards to its efficiency. A low viscosity contributes to an efficient penetration and spreading; incompatibility ensures a defoamer concentration build-up at the interface liquid/ air, that is if the specific gravity of the defoamer is lower than the liquid to defoam.

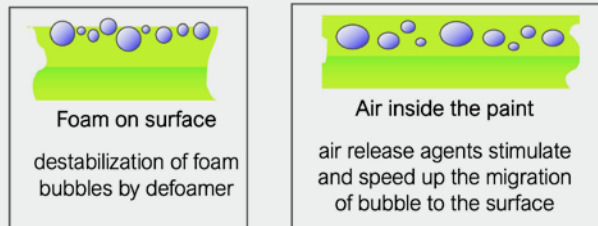
As a consequence, a defoamer requires the following properties:

- Low surface tension to increase its concentration on the boundary layer fluid/air or gas
- Capacity to spread over the foam bubbles when the system is applied in order to cover the entire substrate
- Insoluble in the medium for a longer period to ensure long time stability

Mechanism of defoaming

- Specific incompatibility of the deaerating component allows its concentration at the air/ liquid interface
- Tiny spherical bubbles are covered by non-polar deaerator to reduce surface tension
- Allowing two or more approaching (towards each other) bubbles easy coalescence and rise (Figure 2)

FIGURE 3



Defoamers and deaerators

Defoamer

Works by direct destruction of the foam lamella. This usually happens with macro foam.

Deaerator

Acts during film formation allowing micro foam (finely distributed air) to rise quickly to the surface (**FIGURE 3**).

In practice the differentiation is often not clear!

Mechanism of defoaming

The composition of defoamers is extremely divers. However, characteristic components of defoamers are:

One or more hydrophobic compounds

The hydrophobic component destabilizes the foam dispersion because it displaces the stabilizer. Hydrophobic components are considered amongst the most active ingredients in defoamers.

Also, hydrophobic components prevent the formation of stable interfacial surfaces between air / liquid. As a consequence, the air bubble can penetrate the interface and release itself or it can form a bigger, less stable, air bubble by coalescing with another air bubble.

Typical hydrophobic components are the following either liquid or particles

- Wax
- Silica
- Metal stearates
- Silicones
- Etc.

Mineral oil

Acts typically as the carrier for the hydrophobic components.

Surface active dispersing agents/emulsifiers

The dispersing agent ensures an optimum distribution of the hydrophobic component in the oil while the emulsifier eases the spreading of the defoamer throughout the medium to defoam. The type and quantity of emulsifier to be used depend upon the application of the defoamer and should be selected carefully. The minimum possible quantity of emulsifier should be used since emulsifiers themselves can contribute to the foam formation. Also, a very fine distribution and stability of the defoamer in the medium to defoam is hindering its efficiency since the working mechanism is based on a surface activity, partly caused by a certain incompatibility and strong activity on the interface air-water.

The quantity of emulsifier added will be dependent on the final application of the anti-foaming agent: for applications in which the defoamer is added with high shear forces or for applications of defoamers in media with high emulsifying properties, the quantity of emulsifier in the defoamer should be limited.

Together with the dispersant -and in many formulations also the oil- the emulsifier determines for a great extent the interface activity of the defoamer. Also contributing to this are silicones. Silicones however can cause negative side effects such as crater-building and adhesion problems.

Potential side effects

Imperfectly fitting defoamers might cause or affect the following system properties:

- Seeding
- Cratering
- Color development/acceptance
- Gloss reduction
- Flocculation

Principles of selection

- **Combination of grind and letdown defoamers**
- **Dispersible defoamers**
Improve compatibility, gloss, color acceptance and film defects
- **Glycols and polyglycols**
Do not reduce gloss, have good compatibility with resins, however, are less persistent than oils
- **Mineral oil defoamers**
Cost effective, excellent persistence, might affect the gloss
- **Silicone based defoamers**
Very efficient, but might cause surface defects

DAPRO® defoamers

DAPRO® DF 696

| | |
|----------------------------|--|
| Chemistry | <ul style="list-style-type: none"> • Silicone based |
| Incorporation | <ul style="list-style-type: none"> • Grind or letdown using adequate shear • Good compatibility |
| Market/ Application | <ul style="list-style-type: none"> • Filler dispersions, color pastes • Industrial coatings • Architectural paints • Inks |
| Strength | <ul style="list-style-type: none"> • Better spreading rate • Fast foam knock down • Low risk of film defects • Low viscosity for easy handling |

DAPRO® DF 52

| | |
|----------------------------|--|
| Chemistry | <ul style="list-style-type: none"> • Organic esters • Emulsifiers • Hydrophobic silica • Silicone free |
| Incorporation | <ul style="list-style-type: none"> • Letdown using adequate shear |
| Market/ Application | <ul style="list-style-type: none"> • Inks, e.g. flexo and screen • Paper coatings • Clear coatings |
| Strength | <ul style="list-style-type: none"> • Minor influence on optical properties • Excellent compatibility |

DAPRO® DF 17

| | |
|----------------------------|--|
| Chemistry | <ul style="list-style-type: none"> • Hydrophobic silica • Mineral oil |
| Incorporation | <ul style="list-style-type: none"> • Grind or letdown using adequate shear |
| Market/ Application | <ul style="list-style-type: none"> • Mat- semi-gloss latex coatings |
| Strength | <ul style="list-style-type: none"> • Suitable for all water based paints and coatings • Good compatibility |

DAPRO® BIO 9910

| | |
|----------------------------|--|
| Chemistry | <ul style="list-style-type: none"> • Vegetable oil based • Alternative to mineral oil defoamers |
| Incorporation | <ul style="list-style-type: none"> • Grind or letdown using |
| Market/ Application | <ul style="list-style-type: none"> • Industrial coatings • Architectural paints • Wood coatings • Adhesives and plasters |
| Strength | <ul style="list-style-type: none"> • Similar or even better performance than mineral oil based alternatives • Contribution to renewable and sustainable characteristics • No impact on surface quality • Universal use for different chemistries - pigmented and non - pigmented |

DAPRO® DF 21

| | |
|----------------------------|--|
| Chemistry | <ul style="list-style-type: none"> • Hydrophobic silica • Emulsifiers • Mineral oil |
| Incorporation | <ul style="list-style-type: none"> • Letdown using adequate shear |
| Market/ Application | <ul style="list-style-type: none"> • Gloss paints, all paints • Adhesives • Resins • Industrial coatings • Clear coatings |
| Strength | <ul style="list-style-type: none"> • Suitable for sensitive systems • Readily dispersed in water • Minor influence on optical properties • Excellent compatibility |

Literature

J.H. Bieleman, W. Heilen, S. Silber, „Additives for coatings“, Wiley-VCH (2000)

NOTE:

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sustainable solutions