Defoamers & Antifoams

Scientific Information

From

SSC Industries

Topics

- Defoamer Theory
- Defoamer Practice
- Defoamer types
- Determining system constraints
- Historical antifoams
- Material handling
- Application strategy
- Laboratory
- Defoamer screening methods
  - Which method is best?
  - “knockdown”
  - Persistence
  - Spreading

Terms to Know

- Foam
- Defoamer
- Antifoam
- Surfactant
- Surface tension
- Viscosity
- Coalescence

Foam

- Dispersion of a gas in a liquid
- Pure liquids do not produce stable foam
- Surfactant required

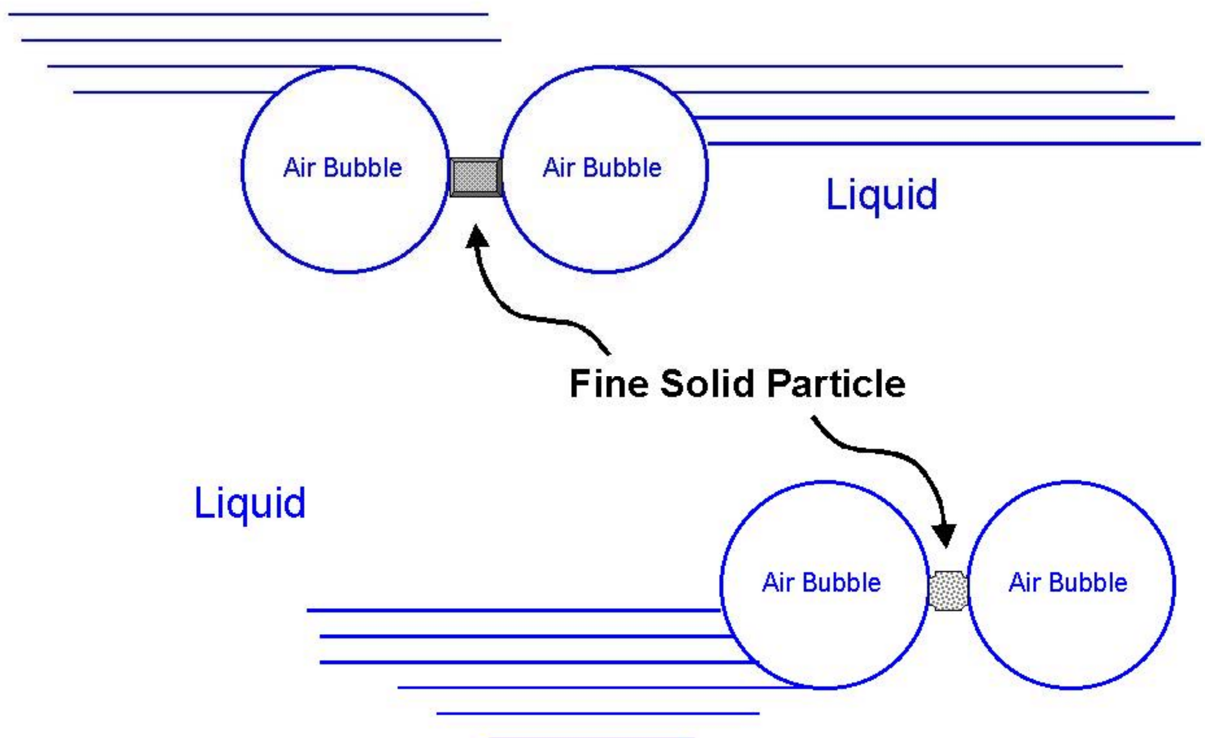
What factors affect foam stability?

- Surface area
- Surface tension
- Viscosity
- Temperature
- Concentration
- pH

Foam Stability

- Polyhedral foam is very stable.
- Formed by the lamellar drainage between spherical bubbles and the resulting stabilization by electrostatic repulsion.
- Further stabilized by certain solids

Solid Stabilized Foam



Other factors

- Viscosity- higher viscosity, more gas entrapment
- Temperature- higher temp, reduced foam stability
- pH- higher pH, usually greater foam stability

Defoamers vs. Antifoams

- Defoamers destabilize an existing foam.
- Antifoams are added to a system to prevent the formation of a stable foam.

SURFACTANT

(SODIUM PALMITATE)

$$\underbrace{Na^{+}\ OOC^{-}}_{\text{Water-soluble (hydrophilic)}} \qquad \underbrace{(CH_2)_{14}\ CH_3}_{\text{Water-insoluble (hydrophobic)}}$$

Surface active agent have a hydrophilic end and hydrophobic end.

Surfactants concentrate at hydrophile/hydrophobe interfaces.

Surface Tension

$$\text{Elasticity} = 2A \frac{(d\gamma)}{(dA)}$$

where

A = surface area of liquid film

γ = surface tension of liquid film

Factors affecting surface tension

- Surfactant concentration
- Surface viscosity
- Electric charge effects
- Marangoni Effect (self-healing films)

Defoamer Surface Tension

	Surface Energy
Silicone	21 - 25 dynes/cm^2
Paraffinic oil	31 - 34 dynes/cm^2
Naphthenic oil	34- 40 dynes/cm^2
Water	60- 70 dynes/cm^2

Viscosity

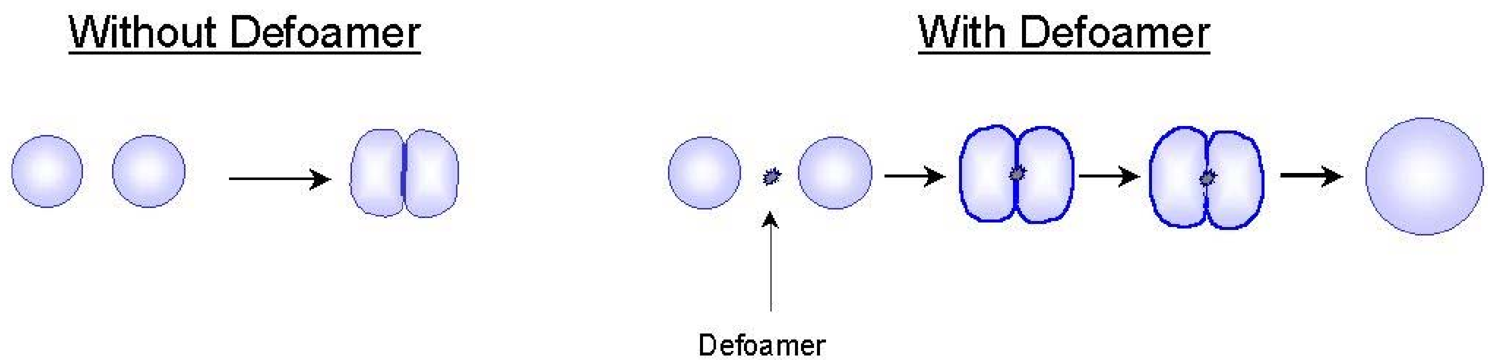
$$\text{Rate of bubble rise} = k\,\frac{r^2}{\eta}$$

where

r = radius of bubbles

η = viscosity of the liquid

Effect of Defoamer on Coalescence



Nomenclature of Silicon Materials

- SILICON — The basic metal. Symbol: Si
- SILICA — The oxide form of the metal, produced in powder form. Can be hydrophobized with 5 - 35% by weight silicone fluid. Symbol: SiO_2
- SILICATE — The sodium, calcium, magnesium, aluminum, etc.,form of silica. May be soluble (Na form) or insoluble (CaO, MgO, BaO, Al_2O_3 - forms). Generally soluble at pH>10 Symbol: $[Na_2O]_x[SiO_2]_y$
- SILICONE — Normally, the methylated polymer form of silica. The low viscosity fluid forms are used in defoamers. Symbol: $(CH_3)_3SiO[(CH_3)_2SiO]_xSi(CH_3)_3$

Why use a defoamer?

- Effect on production
- Housecleaning
- Environmental
- End product quality

Why so many different defoamers?

- Different foaming conditions
- Additive restrictions due to side effects
  - silicone
  - oil
  - particulates
  - surfactants

A Balancing Act

- "Selective incompatibility"
- The goal is to defoam or prevent foam formation with minimum side effects in the process.

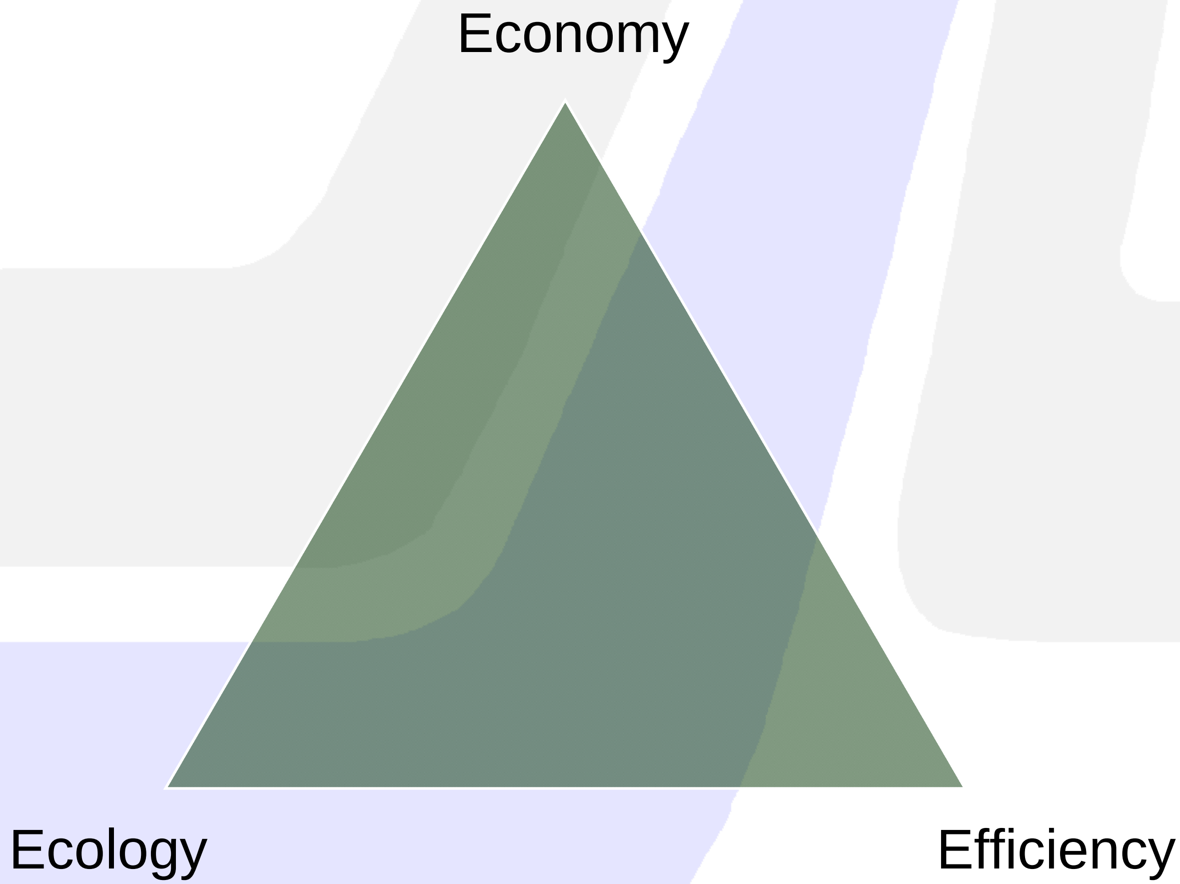
Defoamer types

- Water-based
- Solvent-based
- Oil-based (with or w/out particles)
- Oil in water emulsions
- Silicone emulsions
- Silicone concentrates
- Polymer

Water-based Defoamers

- Only used in industrial applications or in effluent systems where temperatures are at or below 135°F.
- Shelf life is dependent on storage conditions and agitation.

Defoamer/Antifoam Selection Constraints



Defoamer selection process

- End product
- Questions I need to ask
- Component restrictions?
- Environmental
- Regulatory

End product

- What is the customer making?
- Could defoamer get in the finished product?
- Is the process loop closed or open?
- If effluent application, is the water further treated prior to discharge?

Questions

- pH
- Temperature
- Viscosity of the foaming media
- Dissolved and suspended solids
- What is causing foam stabilization?

Environmental

- Effluent- no “sheen” on the river
- Air pollution- VOC’s

Regulatory

For example, all products used in the manufacture of paper must be FDA-approved under 21 CFR 176.170, 176.180, and/or 176.210.

Food grade defoamers must be approved under 21 CFR 173.340.

Some applications need Kosher certification.

Defoamers Must:

- Be insoluble in the medium to be defoamed
- have a positive entering coefficient
- have a positive spreading coefficient

Shelf Life

- Dependent on storage, agitation, temperature
- Water-based are subject to water evaporation, causing thickening and crusting
- Particle suspensions (40-303 type)
  - Do not lose activity if made homogenous
- Clear blends are stable indefinitely in sealed containers.

Material Handling

- Provisions for re-circulation or agitation are essential for most defoamers.
- Positive displacement piston pumps- will handle varying viscosities and head pressures.

How to Apply

- If possible, add at a point of agitation
- Multiple feed points are better than one
- Dilution lines
- Spray systems
- Drip feed at a last resort!

LAB

- On-site screening
  - Foam re-circulator
  - Jar tests
  - Grad. Cylinder
- Knockdown
- Persistence
- Spreading

Dosage

- Lab dosage does not correlate with actual field dosage.
- This is due to capillary action and film stabilization by the container wall.
- Relative comparisons can be made with the incumbent defoamer.