General information on the theory of foam formation and destruction with Dow Corning® Silicone Antifoams.

**FOAM THEORY**

**General**

The following are some basic facts about foams:

- Pure liquids do not foam.
- In most systems, the presence of a surface active agent or surfactant is necessary; in hydrocarbon systems, mixed isomers are responsible.
- Foams are essentially unstable and tend to collapse to a liquid which is the lowest energy state.
- The strong adsorption of a surfactant at bubble walls opposes this collapse.
- Adsorption occurs because the solvent hating (lyophobic) part of the surfactant molecule (shown as below) tries to escape from the solvent by moving to the liquid surface and orienting away from the liquid; the solvent loving (lyophilic) part remains in the liquid:

![Diagram](image)

- The correct choice of lyophilic and lyophobic groups can cause almost any liquid to foam.
- Primary results of this is to lower surface tension of the liquid, because the surface is now a mixture of lyophobic groups and solvent molecules, for example, hydrocarbon groups of a simple soap in water.
- Surface tension depression eases foam generation (surfaces are more easily stretched) but is not a completed guide to the stability or lifetime of the resulting foam.

Additionally, there are other properties of a surfactant and bulk liquid that are necessary to produce a stable foam. These are:

**Surface Elasticity**

Surface elasticity, also termed Gibbs-Maranongi elasticity or “self-heal” effect, is a way in which thin spots in a bubble wall (points of likely bursting) can be repaired. However, the rate of movement (diffusion) of surfactant molecules through the liquid must be just right.

**ANTIFOAM THEORY**

**General**

Antifoams prevent foam in a system in one of two ways. They either displace the foam stabiliser from the bubble walls or locally burst them.

Foam stabiliser displacement occurs after a thin antifoam layer is spread over the bubbles. Its success depends upon the foam liquid and antifoam surface tensions, and foam/antifoam interfacial tension. The most important factor determining spreading, however, is that the surface tension of the antifoam must be less than the foaming liquid.

Bursting of bubbles is caused by spots of local surface tension depression, as for example those caused by a non-spreading, low surface tension particle as shown in the diagram entitled “Local Surface Tension Depression”.

Also, foam stability is reduced by mixing molecules of different species in the surface. The mixed monolayer will lack stability if the molecule cannot pack efficiently together.

Antifoams of the silicone glycol type work in this way. In cold water, they are soluble and promote foaming. As the temperature rises, the water molecules move faster, weakening forces with the silicone glycol molecules, which become insoluble. This temperature is the cloud point because the solution becomes cloudy. The particles of silicone glycol cannot spread, so they deposit on the bubble walls as sites of low surface tension.

Efficient dispersion of an antifoam is essential to allow action at most sites in a foam. Straight polydimethyl siloxane fluids disperse well in organic solvents, and act as antifoams at low concentrations. However, in water, dispersion is poor, so a finely divided filler is compounded with the fluid. This improves dispersion but increases viscosity. Silicone compounds only work in aqueous, well agitated systems. For maximum dispersion in water it is necessary to emulsify the compound.

Stability and particle size distribution of the emulsion then further influence antifoam effect. Suitable fillers are silica, titania and magnesia.
Efficiency Loss
After a period of time, all antifoams lose their efficiency because of two reasons. One is mutual saturation of the foam and antifoam. Once this occurs, there is no longer any difference in surface tension and the antifoam will not spread.

The second involves solubilisation of the antifoam into molecular aggregates (micelles) of foam stabiliser. This is especially important in strong surfactant solutions above their critical micelle concentration. When this happens, the antifoam is removed from the foam system and cannot operate effectively.

Essential Antifoam Characteristics
In order to successfully displace foam, an antifoam must:
- Be insoluble in the foam system.
- Have a lower surface tension than the foam.
- Disperse well in the foam system.
- Possess none of the foam stabilising properties.
- Produce no secondary effects such as oil spotting or fisheyeing.

BIBLIOGRAPHY

NOTE
The information and data contained herein are based on information we believe reliable. You should thoroughly test any application, and independently conclude satisfactory performance before commercialisation.