DEFOAMERS

Additive used to reduce or eliminate foam in a coating or coating constituent. The terms ‘defoamer’ and ‘antifoaming’ agent are often used interchangeably. In fact, they are not quite the same. A defoamer is a surface-active agent that stops the foam and breaks the bubble once it has been formed. It is a bubble breaker. An antifoaming agent prevents the formation of foam so it never forms.

The term “foam-control agent” is a more appropriate term to use. In an aqueous formulation, it is almost impossible (at acceptable use levels) to totally eliminate all foam. The correct foam control agent will help to prevent foam formation, but more importantly, it will allow the dried film to be free of foam and any resultant film defects that might result from an air void in a film.

There is a difference between macrofoam and microfoam. Macrofoam is located mostly on the coating surface and is surrounded by a duplex film with two liquid/air interfaces (double layer), whereas microfoam occurs inside of a coating film (air entrapment) and is characterized by a single liquid/air interface. These two types of foam also differentiate defoamers from deaerators. Defoamers are mostly effective against macrofoam, whereas deaerators suppress microfoam. In practice, the terms are frequently confused and used interchangeably. Many of the commercial products are optimized to prevent macro- as well as microfoam.

Both kinds of foam impair the surface optics of the coating and cause surface irregularities, as well as reduce gloss and transparency. Microfoam also adversely affects the coating’s protective properties because the effective film thickness is reduced and pinholes can form from the micro bubbles.

The function of defoamers is based on disturbance of the double layer of the macrofoam lamella. Substances with very low surface tension are used as they are not wetted by the foam bubble. Foam-stabilizing substances move away from the defoamer droplet, which finally causes collapse of the bubble. Surfactants are often used with defoamers to improve the spreading of the defoamer droplet on the bubble surface.

Foam may be introduced at various stages of manufacture and use of the coating. The raw materials used to make a coating, such as surfactants, dispersants, etc., enable foam to form. Entrapped air, or foam, is introduced into the manufacture of most paints as part of the process. Manufacturing care must be taken to avoid entrapping air during production by choosing the correct stirring equipment and stirring conditions. Letting the product stand for as long as possible is also helpful in preventing air entrapment.

High levels of foam may occur during the milling stage, and defoamers are often used as a component in a grinding paste. Due to the activity of some surfactants at the air/water interface, foam is often created and stabilized in both the pre-mixing and milling chambers of dispersing equipment. Foam slows down the process of dispersion and adversely affects the moisture resistance of the coating. Using silicone anti-foam agents may present an additional potential for surface defects.

Foaming occurs during application to some degree, depending on the method of application. For example, curtain coating carries entrapped air continuously around in the system. Entrapped air also occurs with airless spray systems. Airless spray does not use compressed air. Paint is pumped at increased fluid pressures through a small opening at the tip of the spray gun to achieve atomization. When the pressurized paint enters the low-pressure region in front of the gun, the sudden drop in pressure causes the paint to become an aerosol. Airless spraying has several distinct advantages over conventional air-spray methods. It is more efficient than the air spray because airless spray is less turbulent and, therefore, less paint is lost in bounce back. The droplets that are formed are usually larger than conventional spray guns and produce a heavier paint coat in a single pass. The system is also more portable, production rates are nearly double and transfer efficiency is usually greater. Other advantages include the ability to use high-viscosity coatings and to have good penetration in recessed areas of work pieces. One major disadvantage of airless spray is that pinhole formation from air entrapment is possible. Air-assisted airless spray is similar to airless application except that a small amount of atomizing air is used to further improve coating atomization. Spray application in relatively low humidity conditions or in high-temperature conditions can increase the tendency for foam entrapment.

Latex paints are stabilized with surfactants that easily generate foam under agitation. Elimination of this foam is essential for the manufacturing process, for storage and for good application properties. Foam reduction can also be somewhat controlled by optimizing the settings on a spray gun and by adjusting the viscosity/solids level in the formulation.

Foam is a dispersion of a relatively large volume of gas in a small volume of liquid. Gases are soluble in liquid media to different extents and are influenced by temperature. As the paint film starts to dry, the dissolved gases try to escape in the form of bubbles. A bubble, as a sphere, requires the least amount of surface energy. Large bubbles rise faster than small ones and collect on the surface. They are often covered by a surface film of surfactant or other additive in the coatings system. On the surface, the bubbles pack side by side as densely as possible. In some systems, densely packed microfoam can form on the surface and remain there even after the film has cured. This is possible for high-build systems like some plastisols.

In the process of bubble escape, tiny pores may be formed in the film. In lower solids films that dry quickly, the viscosity of the coating is increasing quickly with drying. As this is happening, the smaller micro bubbles are still rising to the surface but quite slowly; in the process these bubbles can form small channels. If the rising bubble penetrates the surface, lack of flow allows for the formation of pinholes – a surface defect. Sometimes these micro bubbles cannot penetrate the surface, but they will push a very thin, viscous layer of coating to the front surface. This layer will remain on the surface after drying or curing and becomes a spherical blister.

Good defoamers not only need to be good bubble breakers, but they need to be able to keep the action sustained and maintain good defoaming over time in both oven and room temperature aging studies. Good defoamers need to be insoluble in the foaming system. If the product is too soluble it will only increase foaming. Defoamers need to have excellent dispersibility throughout the systems. Spread ability is the ability of the product to spread evenly and uniformly on the surface, coating the bubble particles and eliminating them. They work by lowering the surface tension around the bubble and cause them to coalesce to larger bubbles and eventually to break.

Most foam-control agents for aqueous systems consist of carrier, actives (hydrophobic materials) and other additives that enhance spreading, compatibility, product stability, etc.

Some examples of carriers include mineral oils, vegetable oils, glycols, glycol ethers, alcohols, silicone oils and water. Three types of actives are most common: hydrophobic silica, hydrophobic silicone and organic materials that are hydrophobic/lipophilic. Many foam-control agents are blends of the above actives. The other additives vary from surfactants, co-solvents, thickeners, etc.

The actual foam-control agent that functions the best is based on its spreading rate, compatibility, persistency and cost/performance. Many of the above factors oppose each other in a formula. For example, the most compatible is usually the least persistent; the least compatible often spreads the best; etc.

Many defoamers are colloidal suspensions of particles that act as seeds to allow bubbles to collect and burst. These types of additives can be simple alcohols, oils or complex silicone oils on fine particle silicas. Defoamers should spread instantaneously on the bubble surfaces and into the underlying layers, and cause immediate rupture of the bubble.

Silicone defoamers are usually based on a polysiloxane-type structure. For example, there are acrylate-functional polydimethylsiloxanes, polyether-modified polydimethylsiloxane, etc. To select the proper antifoam, the formulator needs to be aware of the nature of the foaming agent, the foaming tendency, the solubility and concentration, pH, temperature and viscosity of the system. Each of these factors has a direct influence on the antifoaming agent of choice. Some examples of other compounds that function as defoamers are waxes, fatty acids, aluminum stearate; amyl, capryl, decyl, nonyl, and octyl alcohols; caster, corn, mineral, pine, silicone, and turkey red oil; palmitic and stearic acid diethylene glycol monolaurate, sulfonic acid salts, tributyl citrate, and tributyl phosphate.

Some foam-control agents have an effect on gloss; but not all do, so the formulator must carefully evaluate this effect. Color acceptance of emulsion paints is also important, and some defoamers can have a negative influence on color development that needs to be evaluated.

Foam-control agents are very formula/system dependent and the best way of selecting them is to test them. This is usually done quickly in the lab by adding various defoamers to a known volume of paint sample, shaking for a set time, and then measuring the height of the foam that is generated. The method actually works quite well.

Foam-control agents should be used with some degree of caution to minimize cratering. It is important for wood sealers and topcoats that the defoamers used do not cause surface defects or create haziness in the final finish. Incorrect use of antifoaming agents can cause craters, fisheyes, floating, flooding, crawling, etc.

New, liquid, mineral-oil-free defoamers based on renewable raw materials have been introduced into the market. These new defoamers are ideally suited for use in the manufacture of synthetic latex, waterborne matte to satin finish architectural coatings, plasters, and aqueous adhesives. They display remarkable performance characteristics retaining defoaming capabilities even after prolonged paint storage. Some of these new materials may be used as an alternative to replace tributylphosphate (TBP).

Another approach has been to replace mineral oil with natural oils like soybean, rape seed, sunflower and rice bran oils.

There are no universal defoamers, although certain types function better with certain emulsions, certain plant processing requirements, etc. Most suppliers are willing to provide technical support to make the selection process easier.