

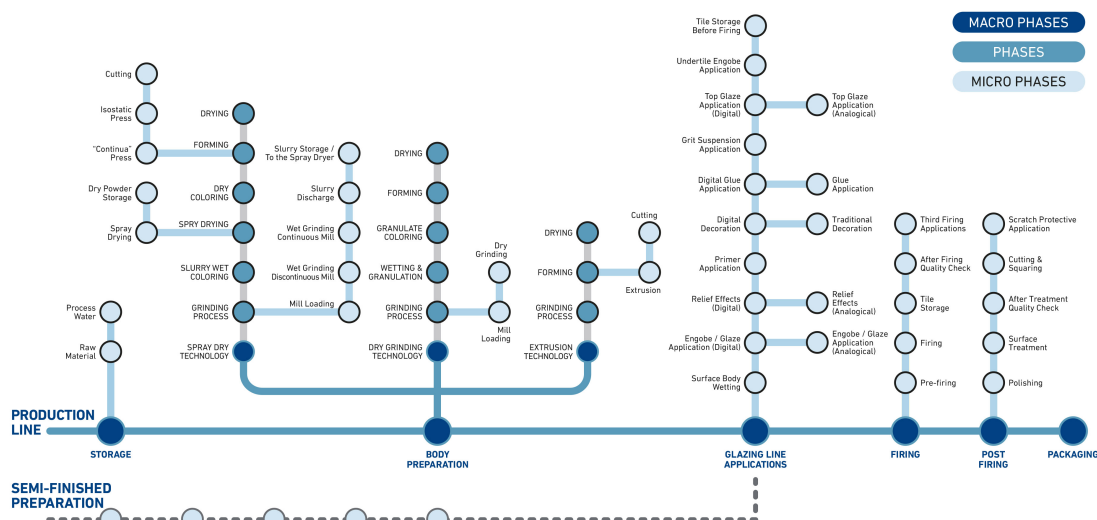


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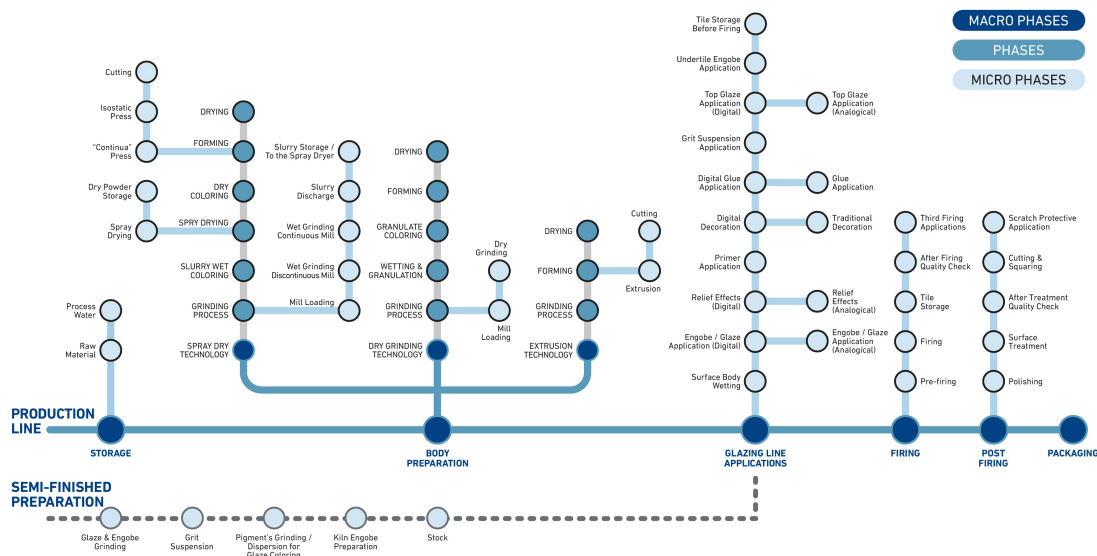
APPARENTLY INVISIBLE YET CONSTANTLY PRESENT

At every stage of the ceramic production process

A journey through problems & solutions



#63 BUBBLES, SURFACTANTS, AND DEFOAMERS





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Short-Cut Version

Foams: A Fascinating and Diverse World

From a chemical point of view, foam can be seen as a heterogeneous mixture where gas is trapped inside a medium that can be liquid, solid, or gel-like. In simple terms, bubbles of gas become enclosed within a continuous phase, creating a distinctive structure. A familiar everyday example is sea foam — when waves churn the water, air gets incorporated, forming countless bubbles that cluster on the surface.

The shape and arrangement of these bubbles can differ widely. In some foams, they are regular and uniform; in others, they appear uneven and randomly distributed. These variations have a direct impact on the foam's physical properties — including its viscosity, mechanical strength, and ability to retain gas.

Liquid foams are the most common and include familiar examples such as whipped cream, shaving foam, the head on a beer, or the natural foam that forms on the sea. There are also solid foams, where gas is trapped inside a rigid structure — as in expanded polystyrene, sponges, or thermal insulation materials.

In the ceramics industry, the appearance of foam within suspensions like glazes or slips can be a real problem, as it may affect both the visual appeal and functional quality of the finished product. In other industries, however, foam formation isn't necessarily unwanted — in fact, it can even be a desired effect, as in certain food products or insulating materials.

When it comes to **ceramic glazes**, two main conditions are particularly favorable to foam formation. On one side, low **viscosity** makes the liquid more prone to turbulence during mixing, allowing air to be easily trapped. On the other, a **high water content** raises the surface tension of the suspension, which prevents natural degassing — the process by which bubbles rise and burst spontaneously. When these two factors come together, foam not only forms but tends to persist — both in the mixing tanks and on the surface of the glaze once applied to the ceramic body. If not properly managed, this can lead to visual flaws and structural imperfections that ultimately reduce the overall quality and finish of the product.

Managing Foam

There are several ways to deal with foam, but the most effective approach almost always involves the use of chemical additives designed to act directly on the mechanism that generates bubbles. These additives generally fall into two broad categories.

Hydrophilic products, which are water-soluble, interact with the molecules responsible for foam formation and alter the system's balance, helping the bubbles break down. **Hydrophobic products**, on the other hand, do not dissolve in water and instead act by physically destabilizing the foam's structure through a direct effect on surface tension.

It's within this latter group that defoamers (or antifoaming agents) are found — essential tools for controlling foam during the ceramic manufacturing process. Because they are only slightly soluble



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in water, they can effectively interfere with bubble stability in a targeted way. Foam owes its stability to the presence of surfactants — molecules that sit at the interface between air and water. These molecules have a distinctive dual nature: hydrophobic tails pointing toward the inside of the bubble and hydrophilic heads immersed in the liquid phase. This orientation forms a thin film that reinforces the bubble and prevents it from collapsing on its own.

When a defoamer is introduced into the system, it disperses as tiny droplets that slip between the surfactant molecules. This breaks the stabilizing film around the bubble, causing the foam structure to collapse quickly and release the trapped air.

From a functional standpoint, the key difference between surfactants and defoamers lies in the opposite direction of their actions. Surfactants — acting as wetting agents — lower surface tension, helping the foam remain stable and sometimes even promoting its formation. Defoamers, by contrast, disrupt this balance: they create localized increases in surface tension that lead to the breakdown of the bubbles.

In the ceramic production process, the role of defoamers becomes particularly critical at two key stages. The first is during mixing, when the glaze is agitated in tanks and tends to trap air. The second occurs after the glaze has been applied to the ceramic surface, when any remaining bubbles may rise to the top, compromising the coating's uniformity and visual quality.

Defoamers and Surfactants

Despite their usefulness, defoamers must be used with care. Because they are only partially soluble, they can sometimes create side effects if not properly controlled. In glazes with low plasticity — that is, with a reduced clay content — or in harder, frit-rich glazes, defoamers may remain dispersed as microdroplets. This condition can lead to surface defects such as pinholes or craters. For this reason, the amount of defoamer needs to be carefully calibrated: too little will fail to control foam formation, while too much may cause visible flaws and compromise the final quality of the product.

In the ceramic process, surfactants and defoamers are often used together, even though they act in opposite ways. Surfactants are essential to ensure proper wetting and application of the glaze, allowing it to spread evenly and form a smooth, uniform surface. However, these same compounds can also promote foam formation — which makes the use of defoamers necessary. This creates a delicate balance: on one side, surfactants stabilize bubbles; on the other, defoamers work to break them down. If one component dominates, the entire system loses stability, and surface defects can appear.

Maintaining this equilibrium requires careful fine-tuning, considering the specific characteristics of the glaze, the production conditions, and the desired results. In most cases, only through laboratory testing and direct production trials can a formulation be developed that delivers optimal performance — effectively preventing foam formation without introducing new issues.