



Homogenization Overview

Homogenization is the process of emulsifying two immiscible liquids (i.e. liquids that are not soluble in one another) or uniformly dispersing solid particles throughout a liquid. The benefits include improved product stability, uniformity, consistency, viscosity, shelf life, improved flavor and color. It has become a standard industrial process in food and beverage, chemical, pharmaceutical and personal care industries.

The process of homogenization was invented and patented by Auguste Gaulin in 1899 when he described a process for homogenizing milk. Gaulin's machine, a three-piston thruster outfitted with tiny filtration tubes, was shown at the World Fair in Paris in 1900. Since then, his name has become synonymous with homogenization.

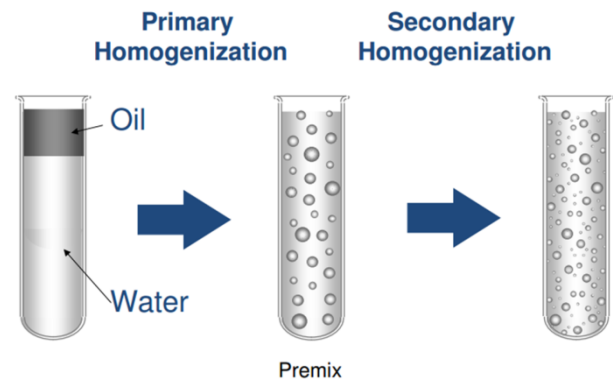
Basic emulsion formation involves adding both a surfactant and mechanical energy to join the two phases. The first step or primary homogenization involves adding surfactants or emulsifiers. Emulsions, by nature, are inherently unstable.

Over time, all emulsions will eventually coalesce or "break". Surfactants work by facilitating the creation of the emulsion and help slow down its eventual break. The resulting particle size of the globules can range in size from 0.1 to 10 microns. Emulsions change their size distribution over time, shifting to larger sizes.

The stability of an emulsion is determined by several factors including the choice of emulsifier, the phase-volume ratio, the method of manufacturing the emulsion and the temperature in both processing and storage.

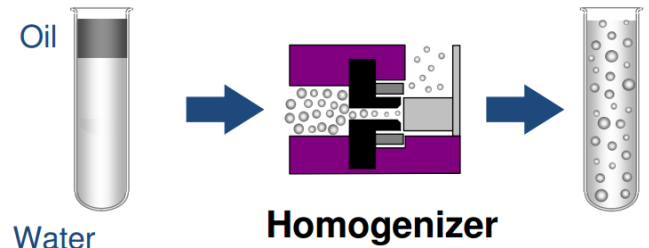
The order of addition, the rate of addition and the energy of the system can have a large impact on the final properties of the emulsion. Ideally, the lipophilic (oil-loving) surfactant should be dispersed in the oil phase. Finer emulsions result when the hydrophilic (water-loving) surfactant is also dispersed in the oil phase. When combining oil and water, the addition of water to the oil phase produces the finest emulsions. If the oil is added to the water phase, more energy is required to produce small droplets. A significant improvement in the emulsion can usually be seen by adding the water phase at a slower rate. Most emulsions are sensitive to the temperature of the system. Generally heat is added to the system since warm oil/fat molecules disintegrate more easily than cold ones.

Micro-emulsions are a dispersion of water, oil and surfactant with particle sizes ranging from 1-100 nm. They are typically characterized as a more stable emulsion and are generally clear in appearance. They tend to have a higher concentration of surfactant relative to the oil content. These are commonly used in the pharmaceutical and personal care industries.



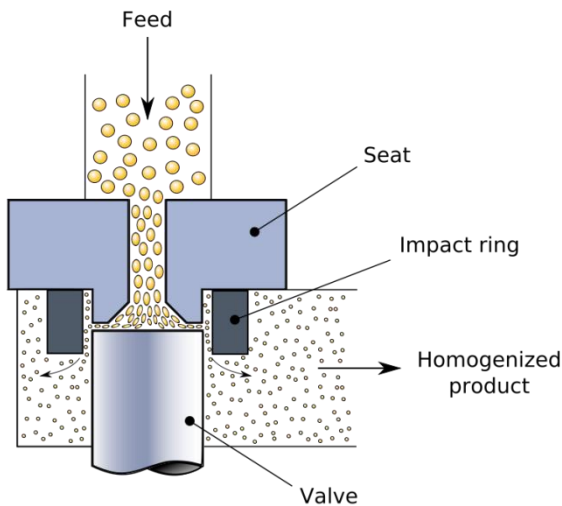
The Homogenizer

In today's environment, homogenizers are used to produce more consistent emulsions in a high efficiency process. A wide variety of homogenizers have been developed to run at different pressures and capacities depending on the product mixture. In addition to product improvements, today's homogenizers also feature reduced noise and vibration and reduced maintenance.

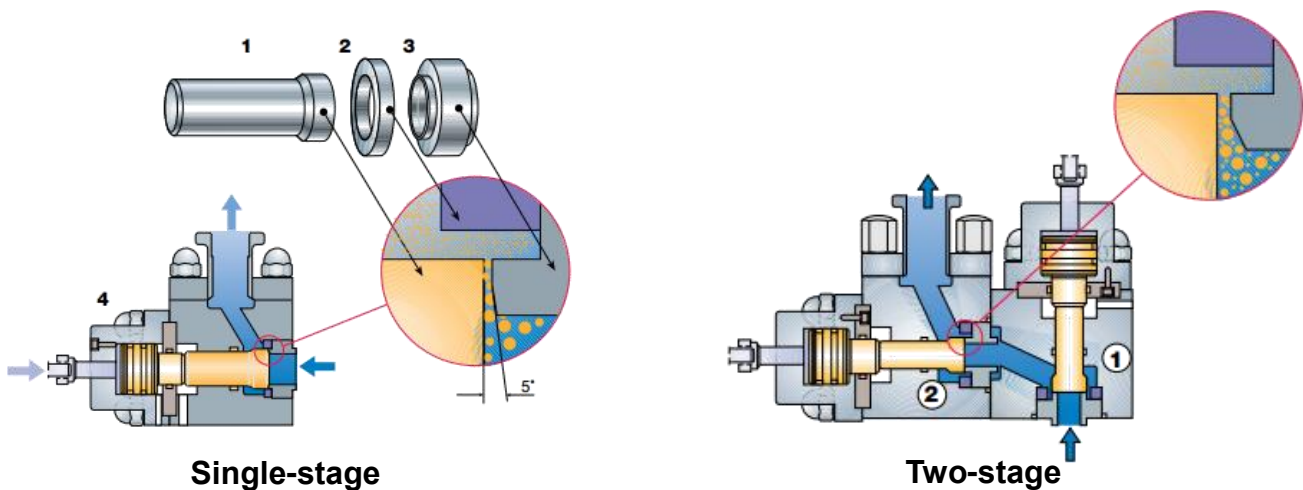


So how do homogenizers work?

- The non-homogenized product enters the valve seat at high pressure and low velocity.
- As the product enters the close (and adjustable) clearance between the valve and the seat, there is a rapid increase in velocity and decrease in pressure.
- The intense energy release causes turbulence and localized pressure differences which tear apart the particles.
- The homogenized product impinges on the impact ring and exits at a pressure sufficient for movement to the next step.



Homogenizers may be equipped with a single valve assembly (single-stage) or two valves connected in a series (two-stage). For most products, a single-stage valve is sufficient. A two-stage assembly, where ~10% of the total pressure is applied to the 2nd stage, controls back pressure and minimizes clumping. This improves the droplet size reduction and narrows the particle size distribution. Generally, two-stage homogenization is used for products with a high fat content or products where high homogenization efficiency is required.



The valve technology is one of the most critical components of the homogenizer. Poppet valves are typically used for low-viscosity, moderately abrasive products such as ice cream, dairy, vegetable oils or silicone emulsions. Ball valves are used for high-viscosity, abrasive products such as peanut butter, evaporated milk or wax emulsion.

Potential Problems

To minimize potential problems with your homogenizer, one should realize that not all products are conducive to produce in a homogenizer. If you are running one of these types of products or process conditions, you should review the product, process and equipment with one of our technical representatives. Alternatives such as high-speed blending or colloid mills may be recommended.

- Air in the product
- Heavy particles in the product
- Wearing or abrasive products
- High viscosity products
- Aggressive products (i.e. chlorine ions)
- High temperatures (max 105°C)
- Low flash point products
- Products with high solids content

Selecting a homogenizer

When purchasing or replacing a homogenizer, discuss the following parameters with one of our representatives.

1. Define the desired product characteristics
 - What particle size and size distribution is desired?
 - What is the product viscosity?
2. Define the desired production conditions
 - Batch vs continuous
 - Volume desired
 - Temperature
3. Identify and test homogenizers
 - Should I use a high-speed blender vs a high-pressure homogenizer vs a colloid mill
 - Rent a homogenizer for a trial period
4. Optimize homogenization conditions
 - Pressure
 - Flow rate
 - Time and temperature
 - Emulsifier type and concentration