MIXING EMULSIONS MADE EASY

Many of today's products contain or are in the form of emulsions. It is but natural that, as a mixing company, we devote a special report on preparing stable, high-quality emulsions.

An emulsion, made up of an aqueous and an oil phase, is a common type of delivery system used for personal care products, enabling a wide variety of ingredients to be quickly and conveniently put on hair and skin. In the pharmaceutical industry, they are used to make medicines more palatable, to control dosage of active ingredients, and to improve aesthetics for topical drugs such as ointments. Emulsions are also used as delivery vehicles for insecticides, fungicides and pesticides. Furthermore, many paints and inks are based on emulsions. Such products may be true liquid-in-liquid emulsions or they may be dispersions (where the suspended phase is composed of finely divided solid particles). Lastly, many food products are in the form of emulsions. Milk is a naturally occurring food emulsion in which globules of milk fat are dispersed in water. Salad dressings, sauces, whipped toppings and ice cream are also examples of emulsions of various edible oils. Emulsions affect not only the physical form of food products but also their taste as emulsified oils coat the tongue, imparting mouthfeel. The virtually infinite number of combinations of emulsion systems necessitates the continuing effort to study them and the processes by which they can be prepared efficiently.

By themselves, oil and water will not mix. If combined in a container and shaken, the oil breaks up into smaller particles and may be dispersed momentarily. However, after the agitation is stopped, the dispersed oil particles quickly separate from the water.

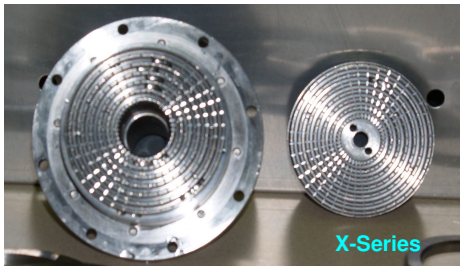
When an emulsifier (also called surface active agent, surfactant for short) is present, the oil particles are stabilized because they become incorporated into the interior part of spherical particles aligned in a manner that reduces interfacial tension between the two phases. This prevents them from combining and separating from the water. The result is a more stable system.

Increasing both the amount of emulsifier and the amount of shear will improve emulsion stability. But emulsifiers (surfactants) can be a costly part of the formulation, and processing with a high-energy emulsifying machine can reduce the cost of these additive chemicals.

Striking a balance between the two parameters spells a huge savings for the emulsion manufacturer. The bottom line is generally to make the oil droplet size as small as possible to best bring out the properties of the emulsion. The Ross Ultra-High Shear Mixers have been proven time and again to achieve excellent product quality without the need for as much emulsifiers in the formula.

EMULSION STORY #1:

One customer making various cosmetic products was making a base formulation made up of silicone oil, surfactant and water. As most silicone polymers are not water-soluble, they are usually formulated as an emulsion. Mechanical emulsification and emulsion polymerization allow silicones that are difficult to handle to be used with ease in this aqueous formulation, eliminating the need for solvents to disperse the polymers. Looking for a better way to make their creams and lotions, the customer decided to look beyond their first-generation inline high shear mixers. Rental of the Ross X-Series Ultra-High Shear Mixer promised improvement in their production in terms of higher throughputs and more streamlined processing. Inevitably, the rental turned into a purchase and spawned several additional orders.



The X-Series head (US Patent No. 5,632,596) does not resemble a traditional single stage rotor/stator or even a multistage head design. Instead, this rotor/stator generator is composed of a matrix of interlocking channels. The rotor turns at an extremely high tip speed (11,300 fpm) and the product being mixed is subjected to far more intense mechanical and hydraulic shear than with any conventional rotor/stator mixer.

EMULSION STORY #2:

Another Ross customer produces silicone oil-in-water emulsions. During the early stages of their project, the customer sent materials to the Ross Test & Development Center for mixing trials on the Ross Model HSM-703 Ultra-High Shear Mixer

RESULTS:

Test 1: 3" MegaShear Rotor/Stator

Speed:	14,400 rpm
Starting Particle Size:	71 microns
Particle Size after 1 pass:	9 microns

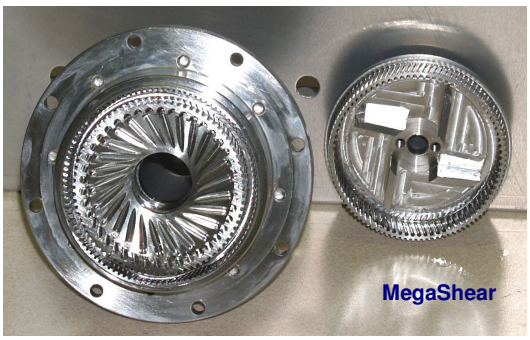
However, there was a significant split in the resulting distribution (bi-modal, peaks at 10µ and 2µ). It was theorized that the material is shear-sensitive and a less intense rotor/stator should be evaluated.

Test 2: 3" X-Series Rotor/Stator (0.010" gap setting)

Speed:	14,400 rpm
Starting Particle Size:	71 microns
Particle Size after 1 pass:	6.5 microns (mono-modal)

Compared to their existing high-pressure homogenizers (HPH), the inline Ross X-Series mixers produce higher throughputs (a 6" rotor/stator head produces a flowrate of around 35 gpm based on water). The X-Series units are also easier to maintain. The life of mechanical seals in high-pressure homogenizers is significantly shorter due to the extreme operating conditions. And while an HPH achieves very low micron particle

sizes, capital and operating costs can be prohibiting. All in all, higher throughput, low maintenance and low initial cost made the Ross X-Series a more efficient alternative for this customer.



In comparison to the X-Series, the MegaShear rotor/stator (US Patent No. 6,241,472) operates at the same tip speed, but is more aggressive and shear-intensive. The generator assembly consists of parallel semi-cylindrical grooves in the rotor and stator towards which product is motivated by high velocity pumping vanes. Different streams are induced within the grooves and the resulting flow pattern causes these streams collide several times. The MegaShear is capable of generating flowrates 3 to 4 times the throughput produced by a same-size X-Series rotor/stator.

The Ross MegaShear has been extremely successful in demanding applications such as fruit pulp disintegration, soft polymer disintegration, specialty chemical processing and nanopigment dispersions.

Ultra-High Shear Mixers: Are They For You?

For many emulsion applications today, the only way to know for sure what kind of mixer will work best is to test several designs in a controlled setting and evaluate the results quantitatively. Consult an experienced mixer manufacturer with a well-equipped testing laboratory. Make sure there are test units on hand to evaluate a variety of designs thoroughly. Use your own ingredients to control as many variables as possible. Steer clear of vendors who claim to know what the answer will be before any tests have been run. A mixing engineer may have an idea, which type of mixer will be the winner, but no

one knows for sure without testing. Partner with a trusted manufacturer who will help find out the answers and not just guess them for you.

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