RECOMMENDED MIXING EQUIPMENT FOR
Silicone Emulsions

APPLICATION SUMMARY:

Silicone emulsions impart lubricity, softness, water repellency, gloss, anti-slip and other properties to a range of products including cosmetics, pharmaceuticals, coatings, textiles and plastics.

This bulletin describes a number of mixing technologies utilized in the production of silicone emulsions. Mixer selection is based on a number of factors primarily viscosity profile and shear requirement. The resulting droplet size is as much a function of formulation – type of silicone, the surfactant(s) used, the kind of emulsion (w/o, o/w, w/o/w, o/w/o) – as the processing method. Actual testing is recommended when exploring new mixing strategies for a particular silicone emulsion.

High Shear Mixers

Throughout the process industries, manufacturers rely on a range of high speed mixers to accomplish emulsification. In the processing of silicone emulsions, High Shear Mixers are commonly used for low-viscosity formulations up to around 10,000 centipoise (cP). Available in both batch and inline designs, these mixers are comprised of a rotor that turns at 3,000 to 4,000 ft/min within a stationary stator. As the blades rotate, product is continuously drawn into one end of the mixing head and expelled radially at high velocity through the openings of the stator. The differential speed and close tolerance between the rotor and stator generate high levels of hydraulic shear, producing small droplets in a tight and uniform distribution.

To ensure adequate flow, batch-style High Shear Mixers are sized according to the volume of the mix vessel, in addition to emulsion viscosity and density. On the other hand, inline rotor/stator mixers are used in continuous processes, where they are designed to handle a desired flowrate range. They may also be installed within a recirculation loop and service virtually any size tank. It is quite common for large gently-stirred vessels to incorporate an inline High Shear Mixer for recirculation. The greatest extent of droplet size reduction occurs within the first few passes. Past this stage of sharp decrease in droplet size, the emulsion hovers at an equilibrium state despite subsequent recirculation. The same trend applies to batch mixing systems although the actual number of product turnovers is not as easy to define. It is useful to determine the point at which droplet size enters into equilibrium to avoid excessive temperature rise and possible over-processing.
Ultra-High Shear Mixers

Very fine silicone emulsions may require agitation at greater shear levels to achieve stability. When conventional rotor/stator devices fall short in producing an acceptable equilibrium droplet size distribution, the next practical step is to test an Ultra-High Shear Mixer. Several designs are available including the Ross X-Series (US Patent No. 5,632,596), a unique inline rotor/stator engineered to run at tip speeds over 11,000 ft./min. It consists of concentric rows of intermeshing teeth; product enters at the center and moves outward through multiple channels. The extremely close tolerance between adjacent surfaces of the X-Series rotor and stator is adjustable for fine-tuning shear levels and flow rates.

In a typical X-Series production set-up, a batch mixer is used to combine the raw materials (silicone oil, water, surfactant) and the resulting rough emulsion is then pumped through the inline Ultra-High Shear Mixer. For many formulations, a single pass drives median droplet size to submicron levels. Simple to operate and maintain, the X-Series is a practical alternative to expensive colloid mills and high pressure homogenizers as it delivers high throughput emulsification at a fraction of the cost and time.

For more information on Ross Mixers

Visit www.mixers.com or click here to download a brochure.