

PEMULEN™

POLYMERIC EMULSIFIERS

Solutions to Simplify
the Formulation of
Oil-in-Water Emulsions

Formulate With Confidence™

Lubrizol

PEMULEN™ POLYMERIC EMULSIFIERS

Solutions to Simplify the Formulation of
Oil-in-Water Emulsions

From a diversity of actives, textures and sensory profiles to new product forms like wipes, roll-ons and sprayable emulsions — formulating for skin care is complicated. With Pemulen™ polymeric emulsifiers, you can stabilize a wide range of oil types without ever having to do an HLB calculation. Make formulating skin care simple with Pemulen polymeric emulsifiers.



MAKE IT SIMPLE

Pemulen™ polymeric emulsifiers are high molecular weight crosslinked copolymers of acrylic acid and a hydrophobic C10-30 alkyl acrylate co-monomer. They are versatile non-ethoxylated polymers designed to create stable and mild oil-in-water emulsions at low use levels, typically between 0.1 to 0.4 wt%.

KEY FEATURES AND BENEFITS

- PEG-free
- No HLB calculation required
- Wide pH range 5 - 9
- Allow for cold or hot processing
- Mild and non-surface active polymeric emulsifiers
- Enhanced sensory—light, refreshing (quick-break effect); light residue

Versatile stabilizers for lotions and creams that:

- Effectively stabilize oil-in-water emulsions at low use levels
- Can act as sole thickeners, stabilizers and emulsifiers for low oil loadings (< 5%)
- Provide high efficiency in combination with low levels of co-emulsifiers
- Offer best-in-class stability of low viscosity emulsions with Pemulen™ TR-2 polymeric emulsifier

TABLE 1: Typical Properties

Pemulen™ Polymeric Emulsifier	TR-1	TR-2
INCI Designation	Acrylates/C10-30 Alkyl Acrylate Crosspolymer	
PROPERTIES		
Emulsification ¹	Yes	Yes
Oil Loading ²	Medium	High
Emulsion Viscosity (0.2 wt%) (mPa·s) ³	Medium 11,000	Low 3,000
Yield Value	High	High
Effective pH Range	5 - 9	5 - 9
Typical Use Concentration, wt% ⁴	0.2 - 0.4	0.1 - 0.3
APPLICATIONS		
Creams, Lotions (Moderate oil loading)	•	•
Milks, Sprayable Emulsions, Wipes		•
Creams, Lotions (High oil loading)		•

¹ Need to be used with a co-emulsifier for optimal stability and aesthetics

² In presence of co-emulsifier; the actual maximum obtainable is formulation dependent.

³ RV @ 20 rpm

⁴ In high electrolyte systems, combination with carbomer (Carbopol® homopolymer) is recommended.

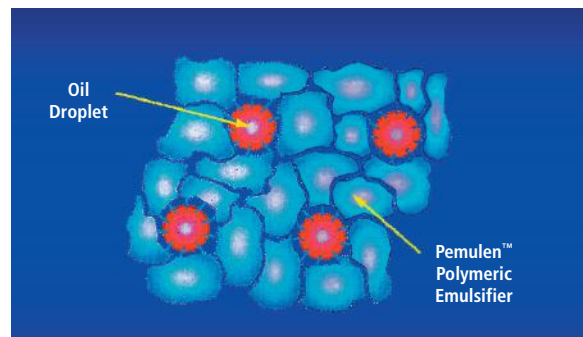
EMULSION STABILIZATION MECHANISM

The exceptional capability of Pemulen polymeric emulsifiers to stabilize a broad range of oils in an emulsion is achieved through two mechanisms:

- The associative stabilization of the oil droplets — via the lipophilic portion of the polymer that adsorbs at the oil/water interface.
- The steric stabilization of oil droplets due to the formation of a swollen microgel network upon neutralization.

Both mechanisms prevent coalescence of the oil droplets, as well as eliminate creaming. However, it is the microgel network with its outstanding suspending power, even at low viscosity, that provides the dominant contribution to stabilization.

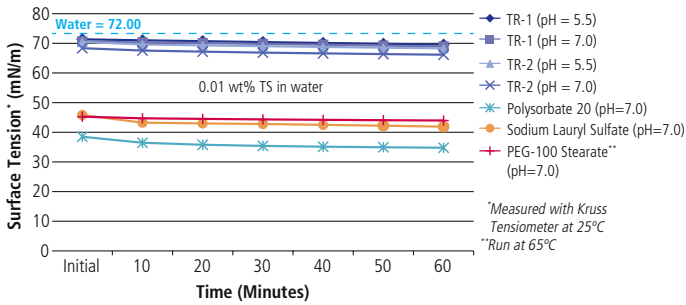
FIGURE 1: Steric Stabilization with Pemulen™ Polymeric Emulsifiers



SURFACE ACTIVITY

Surface tension measurements run on a Kruss Tensiometer for 60 minutes show that the addition of either Pemulen TR-1 or TR-2 polymeric emulsifier reduced the surface tension of water (72.0 mN/m at 25°C) by only 2.0-5.0 mN/m, which means that they provide very little surface activity. Traditional emulsifiers reduce the surface tension to 45 mN/m or less, meeting the definition of surface active agents.

FIGURE 2: Surface Activity of Pemulen™ Polymeric Emulsifiers vs. Traditional Emulsifiers



TR-1 = Pemulen™ TR-1 Polymeric Emulsifier TR-2 = Pemulen™ TR-2 Polymeric Emulsifier

EMULSIFICATION PERFORMANCE

High Efficiency – More is not always better

Typical use levels of Pemulen polymeric emulsifiers are in the range of 0.1 - 0.4 wt%. As the amount of oil increases in the oil/water emulsion, the level of Pemulen polymeric emulsifier required for emulsification is often reduced.

TABLE 2: Viscosity and Stability Performance of Pemulen™ TR-2 Polymeric Emulsifier at Various Use Levels in a 60% Non-Polar Oil (Mineral Oil) Basic Oil/Water Emulsion at pH 5.5

Pemulen™ TR-2 Polymeric Emulsifier Use Level (wt %)	Viscosity (mPa·s)	Stability
0.20	5,000	Stable
0.50	10,000	Stable
0.90	20,000	Unstable

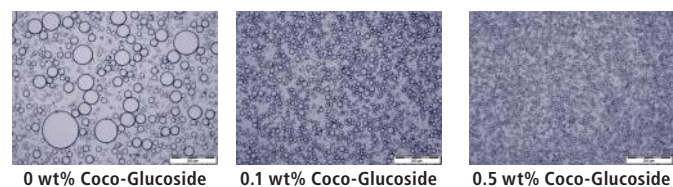
Adjustment of Particle Size

Due to their minimal surface activity, the use of a Pemulen polymeric emulsifier as the sole emulsifier typically yields 20-200 µm oil droplet size.

To further improve the system stability and reduce the oil droplet size, the addition of low levels (0.1 - 1.0 wt%) of nonionic co-emulsifiers with medium to high HLB value, or anionic co-emulsifiers is recommended. Typical examples such as sucrose stearate, coco-glucoside or PEG-20 methyl glucose sesquistearate can be used.

In a demonstrational emulsion made with 0.2 wt% Pemulen TR-2 polymeric emulsifier and 20 wt% Isohexadecane at pH 5.5 - 6.0, the addition of low levels of co-emulsifier (coco-glucoside) reduces the oil droplet size and results in a whiter, creamier product.

FIGURE 3: Particle Size of Oil/Water Emulsion at Various Use Levels



FORMULATING WITH PEMULEN POLYMERIC EMULSIFIERS

Pemulen polymeric emulsifiers are adaptable to a variety of emulsification techniques to prepare oil-in-water emulsions. The most traditional method is to use the "Direct Method". This process consists of adding the dry polymer directly into rapidly agitating water. Once a homogeneous dispersion is obtained, the oil phase is added for emulsification. Finally, the emulsion is neutralized with a base to pH 5 - 7 for optimal stability. The main advantage of this method is its flexibility for use of all oil types. However, as Pemulen polymeric emulsifiers are hydrophobically modified, the aqueous surface wetting is hampered, therefore dispersion process may require special attention.

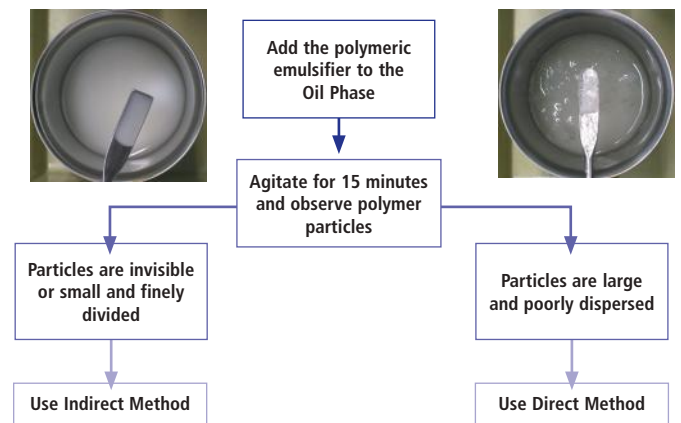
The dispersion process can be simplified by blending Pemulen polymeric emulsifiers and the oil phase to form a pre-mix ("Indirect Method") with up to 10 wt% Pemulen polymeric emulsifier. The polymer-oil mixture is immediately added into the water phase. At this stage, the polymeric emulsifier migrates from the oil phase to the water phase. In order to make sure the polymer fully transfers to and swells in the water phase, an additional 20 - 30 minutes* of mixing is highly recommended before neutralization with a base to pH 5 - 7.

At high temperatures (>70°C) or in the presence of some polar oils or ingredients with multiple hydroxyl or ethylene oxide functions (high HLB emulsifiers), Pemulen polymeric emulsifiers may plasticize or clump.

*Recommendation based on lab scale data with mixing of 250 - 500 rpm and full agitation.

Selection of Direct vs. Indirect Addition

For selection of the optimal dispersion method we recommend using the following process:



Enhance sensory and stabilize emulsions without ever having to do an HLB calculation. Multifunctional and easy-to-use, Pemulen polymeric emulsifiers are an essential part of a skin care formulator's tool kit.

For product details, more information, samples and starting formulations visit www.lubrizol.com/personalcare



Formulate With Confidence™

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