



## **TECHNICAL BULLETIN**

### **Zemea® Propanediol in Broad Spectrum Protection Daily Facial Moisturizers**

#### **Introduction**

The general public is becoming more aware that there is a further need than just the occasional sunburn protection product while performing outdoor activities. Every day, broad spectrum UV protection is necessary to keep the skin looking youthful and healthy. The category is growing, but there continue to be concerns regarding the effectiveness, safety, and aesthetics of the active ingredients.

The United States (US) has far fewer approved sunscreen actives than the rest of the world. Of those available in the US, some are not used due to lack of effectiveness and perceived toxicity. While the industry continues to wait for the FDA approval of actives used in Europe and elsewhere, an evaluation of underutilized Category 1 actives is important. Two actives that should be considered are the water-soluble materials, ensulizole and sulisobenzone. Neither of these actives will work on their own, but both can be part of building innovative sun protection packages that please formulators and consumers.

#### **Actives**

##### **Ensulizole**

Ensulizole is an organic, water-soluble (when neutralized) UVB filter, approved for use in the US up to 4%. Since the mode of action is UV absorption rather than reflection, when too much solvent water is lost from the formulation on the surface of the skin and the product returns to its crystalline state, effectiveness is lost. In addition, being water-soluble, the product may have the potential to wash off the skin. On the positive side, the aesthetics are favorable with a lighter, non-greasy feeling on the skin.

##### **Sulisobenzone**

Sulisobenzone, known as Benzophenone-4, is an organic, water-soluble UVB and short UVA (UVA-II) filter, approved for use in the US up to 10% and Europe at 5%. Like ensulizole, it is a crystalline solid and loses effectiveness if too much solvent water is lost from the formulation. It needs to be combined with an effective UVA absorber to attain broad spectrum protection.

#### **Safety**

Consideration of sunscreen actives that are perceived to be safer is an important step in the formulation process. Both ensulizole and sulisobenzone, as well as titanium dioxide and zinc oxide, two inorganic actives, all score well in perceived safety on such sites as EWG's Skin Deep Cosmetics Database. Part of the perceived safety concern about the use of organic actives is penetration into the skin. Water-soluble materials have a difficult time penetrating the hydrophobic barrier, the stratum corneum. Therefore, ingredients such as ensulizole and sulisobenzone should not easily penetrate the skin. If a strategy of broad spectrum protection and low skin penetration is to be achieved, the use of either of these water-soluble organic actives combined with a slightly larger particle size UVA reducing titanium dioxide or zinc oxide should be strongly considered.

## Zemea® Propanediol an Effective Solvent

Within 20 minutes after application, most cosmetic emulsions have lost the majority of water in the formulation through evaporation. It is likely formulators have been disappointed with the performance of ensulizole and sulisobenzone because the actives returned to their crystalline state as they fall out of solution. Despite concerns around the effectiveness, these two water-soluble actives are utilized in sun care products globally. The addition of Zemea® propanediol in a sun care formulation provides a high-performing solvent with additional performance benefits. Multiple studies were completed. Studies which simulated an aqueous phase of ensulizole at 4% and Zemea® propanediol at 10% showed that solubility can be maintained when 75% of the water in the aqueous phase has evaporated. In parallel, an aqueous phase of 10% sulisobenzone and 10% Zemea® propanediol could also withstand the loss of water at 75%. Zemea® propanediol is an essential ingredient for these actives, successfully keeping them in solution leading to great efficacy for both.

## Materials and Methods

Leveraging the ability of Zemea® propanediol to maintain solubility and fluidity of the two water-soluble actives, two broad spectrum UV protection daily facial moisturizer formulations were created by ACT Solutions Corp., Newark, Delaware. One oil-in-water (O/W) system and one water-in-oil (W/O) system were formulated.

**Table 1.** O/W Broad Spectrum Daily Facial Moisturizer (Formula ACTS 2014)

Phase	Ingredient	INCI Name	Supplier	Function	Wt. %
A	Water	Water	-	-	45.00%
	Zemea® propanediol	Propanediol	DuPont Tate & Lyle Bio Products	Sunscreen Solvent	10.00%
	NaOH (10% solution)	Sodium Hydroxide	-	-	5.00%
	Eusolex® 232	Ensulizole	EMD	Active	4.00%
	KerrPoly GA	Acacia Senegal Gum	Kerry	Thickener	1.50%
B	Solaveil™ AT-300	Caprylic/Capric Triglyceride (and) Titanium Dioxide (and) Polyhydroxystearic Acid (and) Stearic Acid (and) Alumina	Croda	Active	15.00%
	KerrSoft AVG	Acetylated Hydrogenated Vegetable Glyceride	Kerry	Emollient	10.00%
	KerrEmul GSSL	Glyceryl Stearate (and) Sodium Stearoyl Lactylate	Kerry	Emulsifier	5.00%
	CosmoSurf® CE-140	Stearyl/Octyldodecyl Citrate Crosspolymer	SurfaTech	Emollient	2.00%
C	Structure® ZEA	Hydroxypropyl Starch Phosphate	AkzoNobel	Thickener	2.00%
	Phenonip™	Phenoxyethanol (and) Methylparaben (and) Ethylparaben (and) Butylparaben (and) Propylparaben (and) Isobutylparaben	Clariant	Preservative	0.50%
Total					100.00%

## Procedure:

- 1) Mix phase A and heat to 70°C.
- 2) Mix phase B and heat to 70°C.
- 3) Add phase B to phase A with propeller stirring.
- 4) Homogenize at 40°C.
- 5) Add phase C with propeller mixing when below 40°C.

**Table 2.** W/O Broad Spectrum Daily Facial Moisturizer (Formula ACTS 1737)

Phase	Ingredient	INCI Name	Supplier	Function	Wt.%
A	Water	Water	-	-	39.80%
	Zemea® propanediol	Propanediol	DuPont Tate & Lyle Bio Products	Sunscreen Solvent	10.00%
	Benzophenone-4 USP	Sulisobenzone (Benzophenone-4)	SandreamImpact	Active	10.00%
B	SF 1202	Cyclopentasiloxane	Momentive	Emollient	15.00%
	Crodamol™ AB	C12-15 Benzoate	Croda	Emollient	10.00%
	Zano® 10 Plus	Zinc Oxide (and) Triethoxycaprylylsilane	Ultra/Umicore	Active	10.00%
	Silube® 316	Lauryl, bis-hydroxymethyl butyl propyl ether, dimethicone (proposed)	Siltech	Emulsifier	5.00%
C	Cab-O-Sil® TS-610	Silica Dimethyl Silylate	Cabot	Thickener	0.20%
Total					100.00%

**Procedure:**

- 1) Mix phase A until clear and uniform.
- 2) Mix phase B with propeller stirring until uniform.
- 3) Slowly add phase A to phase B with fast propeller stirring.
- 4) Add phase C with propeller stirring.
- 5) Homogenize until glossy.

**Protection**

Research has demonstrated that combining organic and inorganic sunscreens yield SPF's that are higher than would be expected given the level of actives. In most cases, a small amount of inorganic sunscreen enhances the effect of oil-soluble organic sunscreens. With restrictions in the US of the use of titanium dioxide and avobenzene, utilization of this strategy has been limited. The new concept of combining water-soluble organic UVB absorbers with inorganic UVA/UVB absorbers open new possibilities for formulation.

The O/W formulation containing ensulizole and titanium dioxide had an in-vitro SPF of just above 15 and a critical wavelength of 373nm, placing it well within the broad spectrum definition of 370nm. The W/O formulation with sulisobenzone and zinc oxide was heavily biased toward UVA protection, with an in-vitro SPF of around 15 and critical wavelength of 377nm. In-vitro measurements often underestimate the SPF of inorganic sunscreen containing formulations. By completing additional in-vivo testing, SPF's of these two formulations may be higher.

**Resistance**

When formulating with water-soluble organic actives, there is a concern they will wash off of the skin, becoming ineffective. Several steps were taken to address the issue through ingredient and formulation technology. The O/W formulation uses Cosmosurf® CE-140, a Zemea® propanediol-based, water-resistance agent to protect against wash off. W/O emulsions have inherent water resistance; however, the W/O formulation uses a PEG-free emulsifier and modified silica to further enhance the water resistance, build thickness of the film on the skin, and provide a powdery dry feeling when applied.

## Aesthetics

Customers of sun protecting daily facial moisturizers are searching for products that look, feel, and keep the skin moisturized. Formulators that solely utilize inorganic sunscreen actives can make the skin look pasty. Including water-soluble organic actives with inorganic actives that have a larger particle size in the emollient phase, can yield products that have lower whitening for a given SPF. Also, by eliminating other oil-based organic sunscreens in the phase where inorganic sunscreens reside, it may help maintain the integrity of the dispersion. This will help keep whitening to a minimum.

To achieve formulations that are light and non-greasy on the skin, various ingredients were selected for the formulations. The O/W formulation utilized a food emulsifier blend with components that build liquid crystalline phases that offer moisturization and more resistance to wash off than convention O/W systems containing high levels of hydrophilic surfactant components. The resulting emulsion has a smooth application and light feel after drying. In the W/O formulation, the emulsifier chosen allows for the use of a blend of volatile and non-volatile emollients, inclusion and dispersion of the zinc oxide sunscreen active, and a relatively high internal phase ratio, all with a soft and dry feeling finish.

One of the main reasons for using sun protecting daily facial moisturizers is to keep the skin moisturized and healthy. The use of 10% Zemea® propanediol in both formulations help build moisturization. It also provides additional benefits including lack of skin irritation and excellent sensory characteristics, ultimately improving the aesthetics of the formulation.

## Conclusion

- Zemea® propanediol is useful in formulating effective, innovative sun protection products, primarily daily facial moisturizers with SPF.
- Consumers are seeking lighter-feeling, broad spectrum protection daily facial moisturizers.
- Ensulizole and sulisobenzene are two water-soluble, light, non-greasy, underutilized OTC Category I sunscreen actives. Two main drawbacks associated with these actives are performance and tendency to wash off the skin.
- Zemea® propanediol is a high performing solvent for both ensulizole and sulisobenzene, keeping each of these actives in solution through the evaporation process on the skin, leading to greater efficacy for these actives.
- Two formulation strategies for maximizing sun protection efficiently are combining organic and inorganic actives and placing actives in both the aqueous and emollient phase.
- The addition of Zemea® propanediol in a daily facial moisturizer with SPF improves aesthetics. Zemea® propanediol is non-irritating, provides increased moisturization, and excellent sensory characteristics, eliminating stickiness and greasiness in the formulation.

### **For additional information or samples:**

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