



Innovative Bio-based Carrier for Personal Care applications

Poster ID 907

Le Meur, Morgane¹; Van Reeth, Isabelle¹; Vincent, Anne-Marie¹; Collins, Donna²
¹ Home & Personal Care, DOW Silicones Belgium sprl, Senefels, Belgium
² Home & Personal Care, DOW Silicones UK Ltd, Barry, UK

Introduction:

With upcoming European Regulations limiting the use of volatile cyclomethicones in Leave on applications combined with the strong demand from customers and consumers To use bio-based and biodegradable materials, there is a need for new biodegradable carriers using sustainable and upcycled feedstocks. Levulinic acid ketal derivatives, with the INCI Name of Ethyl PG-Acetal Levulinate (EPAL) can be used as a medium-to-low Volatility carrier in leave on skin formulations, providing an additional unique feature, a Broad compatibility profile due to a higher polarity. This innovative fluid produced by the Conversion Of biomass such as by-products from sugar and corn production, is ultimately biodegradable and has a natural Index of 0.7.

This novel levulinic ketal derivative can be used as an alternative to cyclomethicones, fossil Based hydrocarbons and other oils as well as bring additional properties and provide new Formulation possibilities.

- The following evaluations were performed:
- Volatility profiles at room and skin (32°C) temperatures;
 - Sensory comparisons with cyclomethicones and organic fluids using an experienced Dow internal panel;
 - Comprehensive compatibility study with a broad range of cosmetic materials at several ratios;
 - Cleansing properties for waterproof color cosmetics;
 - Preparation of applicative cosmetic formulations;
 - Cleansing properties for waterproof color cosmetics;
 - Preparation of applicative cosmetic formulations.

Materials & Methods:

Materials: INCI Names	Appearance	Typical Properties
Ethyl-PG Acetal Levulinate (EPAL)	Crystal clear liquid	
Cyclopentasiloxane (D5)	Active content	100%
Undecane (and) Tridecane (UT)	Viscosity	3.5 cP@111.5 °C
Dimethicone 2 cSt	Flash point	111.5 °C
Dimethicone 6 cSt	Refractive index 25 °C	1.430
C13-15 Alkane (AK)	Volatility	Low
Caprylyl Methicone (FZ)	Specific gravity	1.033 at 23.9 °C
	Surface tension	31.03 mN/m at 22.2 °C
	Shelf life	2 years
	China compliance	Not listed in the catalogue of cosmetic ingredients
	Biodegradability	Ultimately biodegradable (ASTM E 1720 -01 °C)
	Naturality origin index (ISO 16128)	Plant-based 0.7
	COSMOS by Ecocert	Application in progress

Fig1: EPAL Chemical Structure

Table 1: Typical Properties of EPAL

Methods

1. Spreadability - a droplet of 20 µL of each tested product is deposited on the black section of a Leneta card. Diameters of droplets were measured after 1 min of spreading..
2. Refractive index using the Refracto 30 GS equipment (Mettler Toledo).
3. Volatility profiles-is measured in-vitro by monitoring the weight loss over a fixed period of time at a standardized temperature and relative humidity conditions. 1 g of each product was poured in aluminum cups (diameter 57 mm) and products were tested in triplicate. Water was used as control. Two sets of cups were prepared: one was left at room temperature (climate room with temperature between 18 °C and 22 °C and relative humidity between 45% and 65%), and one was placed in a ventilated oven at 31 °C (±1 °C) for a total period of 6 hours. Weights of cups were recorded at different time interval (30 min, 1h, 2h, 4h and 6h) and the quantity of remaining products (%) was finally plotted versus time.
4. Sensory Profile is evaluated by paired-comparison. The evaluation was conducted in a climatic room (temperature of 22 °C +/- 2 °C and relative humidity of 50 % +/- 5 %) by 18 experienced panelists. 20 mg of each tested product were applied on a dedicated sites on panelists forearms. Each panelist rubbed the two products with a separate finger and rated the different sensorial parameters before and after absorption of the product onto the skin.
5. Compatibility study-is a method used to determine the affinity of a specific ingredient with commonly used cosmetic ingredients of various polarity. The tested product was mixed at three different ratios in a 15 mL glass vial: ratio 1:9, ratio 5:5 and ratio 9:1. All solutions were mixed for 20 s with a high shear equipment (top bench mixer) at room temperature. The clarity of the solution was recorded the day of the testing and the day after. If the solution was one phase and transparent, the trial was recorded as C (compatible). If the solution was one phase and hazy, the trial was recorded as H (compatible and Hazy). If the solution was two phases, the trial was recorded NT (not compatible). NT record means that the specific ratio was not tested.
6. Cleansing properties-The evaluation of removability of color cosmetic products is designed to provide information on the efficiency of an ingredient to act as a make-up remover. A commercial mascara and a commercial liquid lipstick, both positioned as waterproof, were applied on a panelist forearm and left to dry for 1 h. Then both mascara and lipstick were removed using a cotton pad impregnated with a standardized amount of each tested products. Caprylyl Methicone (FZ) was used as a positive control since it is very well-known for its excellent cleansing properties.

Results & Discussion:

1. Spreadability & Refractive Index: Diameters of droplets are presented in Table Polydimethylsiloxane, both D5 and 2 cSt have higher spreadability with values of 19 and 23.3mm respectively, confirming their ability to facilitate spreading of formulations. Although EPAL, UT, FZ and AK have lower values ranging from 14.0 mm to 16.7 mm, they still demonstrate good spreadability. EPAL has a RI of 1.430, significantly higher than silicone fluids and therefore having the potential to bring more shine.

Products	Spreadability (mm)	Refractive Index
EcoSmooth™ Universal Fluid 1100	14.3	1.430
Dimethicone 2 cSt	23.3	1.390
Cyclopentasiloxane	19.0	1.402
Undecane (and) Tridecane	16.7	1.418
Caprylyl	15.0	1.413
C13-15	14.0	1.430

Table 2: Spreadability and RI of materials tested

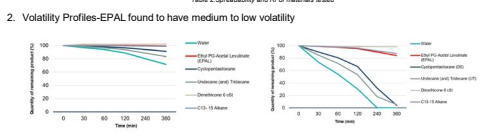
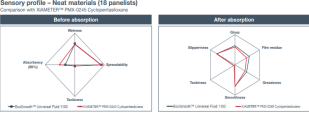


Figure 2: Comparison of volatility profiles at room temperature Figure 3: Comparison of volatility profiles at skin temperature (32 °C)

3. Sensory Comparisons: EPAL vs D5 on 18 panelists Before Absorption-comparable wetness, spreadability and tackiness After Absorption-similar slipperiness, gloss, tackiness, gloss, smoothness, greasiness and film residue.



4. Compatibility - EPAL is compatible with common cosmetic ingredients such as alcohols, glycols, Hydrocarbons, vegetable oils and butters. It is incompatible with water and glycerine.
5. Cleansing Properties: Results of the colour cosmetics removability test, Fig.4, shows EPAL Has excellent cleansing props for removing mascara.



Figure 4: Mascara removability - Photos taken before and after application (right)
 Product 1: Caprylyl Methicone (FZ) - Product 2: Ethyl PG-Acetal Levulinate (EPAL)
 Finally, four different cosmetic formulations were developed with EPAL showing ease of preparation-AP/DEO Stick and Roll on. DOW Emulsion body cream and Foundation.

Ratio EPAL / ingredient	1:9	5:5	9:1
Polar ingredients			
Water	NC	NC	NC
Ethanol	C	C	C
Glycerol	NC	NC	NC
Propylene Glycol	C	C	C
Silicones			
Cyclopentasiloxane	C	C	C
Dimethicone 2 cSt	C	C	C
Dimethicone 4 cSt	C	C	C
Caprylyl Methicone	C	C	NC
Phenyltrimethicone	C	C	C
Dimethicone (and) Dimethiconol	C	NC	NC
C13-15 Alkane (and) Dimethiconol	C	NC	NC
Dimethicone (and) Dimethiconol	NC	NC	NC
Dimethicone (and) Dimethiconol	NC	NC	NC
Caprylyl Methicone (and) PEG-12 Dimethiconol/PEG-20 Crosspolymer	NC	NC	NC
C13-15 Alkane (and) Dimethiconol	NC	NC	NC
Vinyl Dimethicone Crosspolymer	NC	NC	NC

Table 3: Compatibility of EPAL

Conclusions:

Ethyl PG-Acetal Levulinate(EPAL) is an excellent solution for formulators looking at using more sustainable ingredients in their formulation development. It has a Naturality Index of 0.7 and is ultimately biodegradable. It has a similar sensory profile to Cyclopentasiloxane after product absorption on the skin providing a soft skin feel with a non-tacky and non-greasy feel combined with a good spreadability. Although being less volatile than D5, EPAL can be considered as a suitable alternative to D5 knowing that the final volatility of a cosmetic formulation can be increased by adding more volatile ingredients. EPAL has been demonstrated to be an effective bio-based emollient. Its excellent compatibility profile with cosmetic ingredients makes it an ingredient of choice to prepare high naturality content cosmetic formulations. Several cosmetic formulations have been also developed, demonstrating the feasibility of using this new fluid in AP/Duo, skin care and colour cosmetics. And its ability to cleanse and remove colour cosmetics opens a wider type of applications within skin care.

Acknowledgements:

The authors would like to thank all the panelists who kindly participated to the study.