A novel approach to meet the challenges of sulfate-free formulating – Sodium Lauroyl Methyl Isethionate

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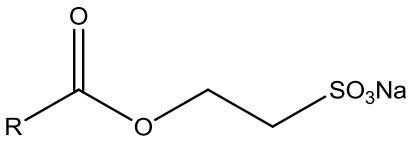
Sulfate-free origins

For many years Sodium Lauryl Sulfate (SLS) and Sodium Laureth Sulfate (SLES) have been the mainstay of the surfactant base in personal care cleansing formulations. Increasingly, however, there is a move to replace these, and other sulfate-containing surfactants, with sulfate-free alternatives. This trend appears to have begun around 8-10 years ago in North America following negative press about safety concerns when using sulfates. Whether or not there is any compelling evidence for this, consumers have picked up on the news and are seeking sulfate-free formulations perceiving the benefits to include mild, gentle, non-stripping, more natural products. The number of sulfate-free cleansing products (hair and body) launched has more than doubled globally since 2007.

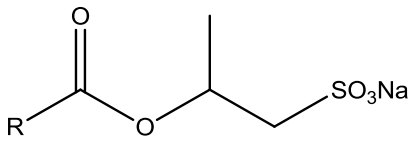
Sulfate-free surfactant alternatives

Many sulfate-free surfactants exist but almost all suffer some drawbacks such as poor foaming, unwanted by-products, non-natural hydrophobe sources, ethylene oxide (EO) moieties present, pH instability and undesirable irritancy profiles.

Sodium cocoyl isethionate (SCI) is widely recognised as a versatile mild primary surfactant providing excellent lather in both liquid and solid formulations. Its limitation comes in terms of aesthetic appeal since it creates opaque products (unless used at very low levels, below that expected of a primary surfactant). Following extensive research, it was found that a minor modification of the structure of SCI (Figure 1) afforded a molecule with all the desired properties of a sulfate-free primary surfactant: SLMI. The added benefit of excellent water solubility sets SLMI apart from SCI and means that transparent formulations are easily created, helping meet today's trends for clear products.



Sodium cocoyl isethionate



Sodium lauroyl methyl isethionate

Figure 1 Structure of SCI and SLMI

The resulting molecule has demonstrated versatility as a primary and secondary surfactant thanks to improved hydrolytic stability and foaming performance. Key features, benefits and applications are detailed in Table 2

Features	Benefits	Applications
• Mild	• Dense creamy lather	• Body wash
• Excellent water solubility	• Long-lasting	• Shower gels
• Can be used in clear systems	• Good slip	• Shampoos
• Natural/renewable feedstocks	• Elegant after-feel	• Facial Cleansers
• Sulfate free	• Reduced tack on drying	• Liquid hand soaps
• 1,4-Dioxane free	• Easy to formulate	• Shaving preparations
• Nitrosamine free	• Structured systems achievable	• Wipes and towelettes
• Broad pH stability		• Intimate cleansing
• Readily biodegradable		• Beauty bars
		• Baby bath and shampoo

Table 2 Features, benefits and applications of SLMI

The technology and processes to create this new molecule, originally developed by Huntsman, have now been optimised by Innospec to deliver both solid and liquid forms of SLMI which can be easily handled and formulated into finished products.

Several parameters have been measured in order to substantiate claims about SLMI and to provide information to help formulators optimise product performance. Some of these are now discussed below.

Viscosity Building Properties

Product viscosity is important since it controls the way a products looks and has an impact on consumer perception of the efficacy and quality of an end product. It is also vital to achieve good viscosity if you wish to create novel visual effects such as suspended air bubbles or wax beads for exfoliation. The simplest and cheapest way to thicken a surfactant solution is using electrolytes like sodium chloride however many of the sulfate-free surfactants are not able to increase viscosity in this way. SLMI in combination with cocamidopropyl betaine (or other amphoterics) shows good thickening. Viscosity can be further increased by the addition of co-surfactants such as taurates and/or sulfosuccinates. Chart 1 shows a typical salt-thickening curve.

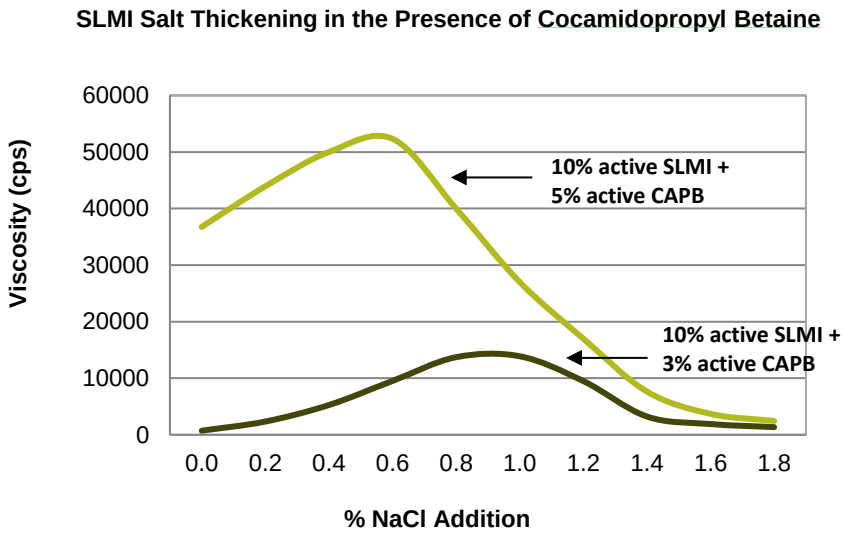
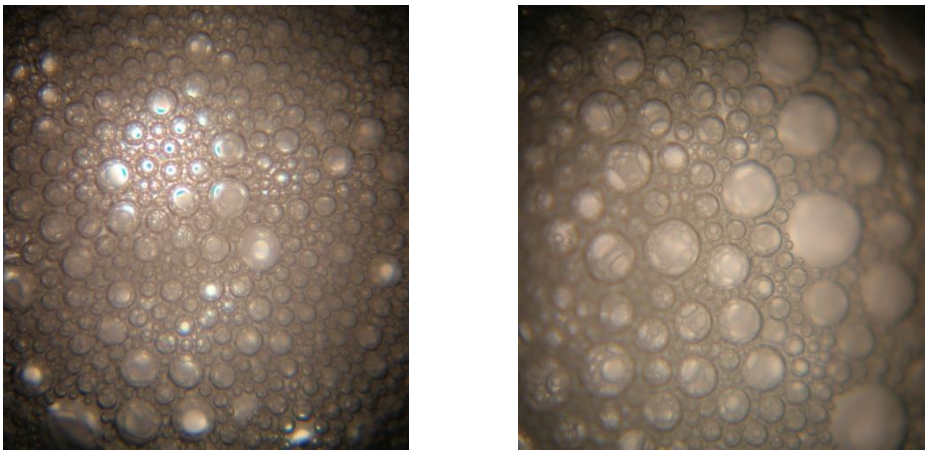


Chart 1 SLMI salt thickening in the presence of cocamidopropyl betaine (CAPB)

Foaming

The appearance, density and longevity of foam are perhaps the most important parameters in judging a good surfactant. A dense creamy foam which persists in the presence of hard water or high soil level is the ultimate goal. SLMI was benchmarked against SLES in tests on each of these parameters and performed very well. Close up inspection of the bubbles under a microscope revealed a much smaller bubble size than those of SLES which means a much denser, creamy-looking foam. Bubbles were measured and the size distribution compared. SLMI contains a greater number of small bubbles which supports the observations made just by looking at the foam with the naked eye.



Sodium Lauroyl Methyl Isethionate **SLES**

Figure 2 Blender foam photographs x10 magnification (0.3% w/w active surfactant, 20°C, Water Hardness: 50ppm $Ca^{2+,}$ 10ppm Mg^{2+}); SLMI (l) and SLES (r)

Foam height tests using the Ross Miles methodology demonstrated that initial foam height using SLMI at 1% active in distilled water was in fact higher than SLES at the same concentration. The results after 10 minutes still showed SLMI to have the greater volume of foam with minimal loss in volume over that time. After 30 minutes SLES had retained the greater volume but SLMI compares favourably. The same trend in results was found when using hard water (100ppm Ca^{2+}, 200ppm Mg^{2+}).

Blends of SLES/CAPB and SLMI/CAPB were also tested for foam quality and again SLMI containing blends gave a smaller bubble size distribution that SLES blends.

Irritation, Biodegradation and Stability

Irritancy tests (skin) at 0.5% active solutions of SLMI showed that it is less irritating than SLS, SLES-2 and CAPB. It was also proven that SLMI can have a mollifying effect in combination with other surfactants, reducing the inherent irritancy of individual surfactants.

SLMI is deemed to be readily biodegradable according to OECD 301B test protocol.

SLMI also shows good hydrolytic stability over extended time periods with no loss in activity over 28 days. Activity was also maintained across a broad pH range (4.5-9.5) over 30 days.

Commercial launches

Since the introduction of SLMI more than 30 consumer products have been launched by some of the biggest names in personal care. The formulations include shampoo, body wash, shower gel, foaming sugar scrub and liquid handwash, with many more products currently being trialled. SLMI is proving to be a simple cost effective and efficient way to go sulfate-free.

Conclusion

Sodium Lauroyl Methyl Isethionate has been developed as a sulfate-free primary surfactant for use in personal care cleansing applications. It performs well when benchmarked against the widely used SLES surfactants showing good foaming, stability and thickening. It is nitrosamine-free, EO-free, is derived from renewable resources and is readily biodegradable. SLMI can also be used to form structured systems.

SLMI is unique to Innospec and is manufactured and sold under the trade name Iselux®

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