Feature: Surfactants 2004
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Surfactants are fundamental to cosmetic products with few formulations "surfactant free", although there is a niche market for such claims. Whether used to solubilise a fragrance compound in an aqueous system, clean the hair, and put bubbles into the bath and creamy foam onto the body or to create an elegant emulsion for a skin care product, a surfactant is used. However the choice of surfactant will vary according to the function required. Ethoxylated compounds are the most useful surfactants for solubilising purposes whereby the solute becomes part of the micelle formed by the surfactant. Polysorbates, PEG-40 hydrogenated castor oil, PPG-2-Ceteareth-9 and polyethylene glycol ethers are the most commonly used.

For cleaning the hair or putting bubbles in the bath the surfactant combination of choice is almost invariably sodium laureth sulfate in combination with cocamidopropyl betaine. The mix is almost odourless, colourless and very cost effective, however it may not be the best. The author presented a paper on shampoo formulation before the Society of Cosmetic Scientists, Chepstow 2001 entitled ***Formulators, it is time to widen your horizons***, in which a number of alternatives and new developments were described. However a quick glance at ingredient listings of current retail products confirms that there is little change and the same mix predominates for the majority of shampoos, shower gels and foam baths.

Sodium laureth sulfate so dominates the market that when Sugar & Schmucker [IFSCC Congress 2000, Berlin] wanted to measure skin absorption of SLES they found that 97 out of 100 subjects already had quantifiable amounts of SLES in their skin and they found that a single application of SLES solution would remain on the skin for at least five days. Not all alkyl ether sulphates are the same. The higher the degree of ethoxylation the less irritating they are but foam character diminishes and the ammonium and magnesium lauryl ether sulphates are less irritating than the corresponding sodium versions. In summary, magnesium laureth sulfate with 3 moles of ethylene oxide is the least irritating variant with the most stable foam.

Alternative anionic surfactants include alkyl sulphates, olefin sulphonates, acyl lactylates, isethionates and sarcosinates, taurates and sodium lauryl sulfoacetate. Although alkyl sulphates are used extensively in American formulations they are not popular in Europe. Olefin sulphonates are dioxane-free, foam as readily as alkyl ether sulphates, work well in hard water and are stable at a lower pH. It is relatively easy to build viscosity into the system and they are competitive in price but are said to leave the hair feeling harsh, although this can be overcome by careful choice of a secondary surfactant.

Other primary surfactants in common use include sodium caproyl lactylate, said to be an excellent foam booster and stabiliser when used in conjunction with cocamidopropyl betaine and alkyl polyglycosides. Sodium lauroyl Isethionate is claimed to have a very low irritation potential. Sodium lauroyl sarcosinate is said to foam well, have good cleaning properties and be mild to use. The taurates are known to possess excellent wetting, foaming, detergent and dispersing properties, and have a conditioning effect on hair and sodium lauryl sulfoacetate is an excellent foaming, wetting, emulsifying and cleansing surfactant with good stability in hard water. However, although it is possible to formulate satisfactory products with these materials they are more commonly used in conjunction with alkyl ether sulphates to provide a low irritating system with good foaming characteristics and at an affordable cost.

Sugar and Schmucker found absorption of SLES by human skin could be considerably reduced by the addition of sodium cocoyl glutamate to the SLES solution. Acyl glutamates are a group of mild, biodegradable products made from natural fatty acids and L-glutamic acid. They are anionic in character with a near neutral pH that contributes to the mildness of these products, which translates into excellent skin compatibility, detergency, skin lubricity, and notable lather properties. **Vama Farmacosmetica** supply sodium lauroyl glutamate and sodium cocoyl glutamate through their UK distributor **Gemro Chemicals**. Both materials foam well and because of their amino acid origins, impart a pleasant skin feel and have moisturising properties. Published data shows that adding 2.5% acyl glutamate to SLES solution reduces its skin absorption by 55%. The acyl glutamates are also said to be excellent emulsifiers, forming o/w emulsions with very small droplet size. Emulvama EGW is a mixture of sodium cocoyl glutamate, sodium cocoyl hydrolyzed wheat protein, disodium capryloyl glutamate and potassium cocoyl PCA that is entirely of vegetable origin and which can be used for cold processing emulsions.

Cognis has long been advocating the use of milder surfactants and in 2003 it added sodium cocoyl hydrolysed wheat protein glutamate to its Plantapon portfolio. It is claimed to have a reduced odour compared to other protein hydrolysates and to provide excellent foaming, even with hard water. It is exceptionally mild and can be added to SLES systems to reduce irritation without destroying product viscosity. Additions of 10% to 20% of sodium cocoyl hydrolysed wheat protein glutamate to SLES, based on active concentration, significantly improved skin feel and the foaming characteristics were also improved.

Another recent addition to the Cognis Plantapon range is Plantapon LGC SORB; a mixture of lauryl glucosidecarboxylate and lauryl glucoside. It shows improved foaming characteristics when compared to lauryl glucoside alone, has an excellent sensory profile and can be used as the primary surfactant or combined with SLES/CAPB systems, depending on the formulators requirements. Obtaining sufficient viscosity with systems based on glucoside is often a problem; the author has had excellent results using Glucamate LT from **Amerchol Corporation**. It is PEG-120 methyl glucose trioleate in water/propylene glycol solution and may be added at any stage of the formulation for viscosity control. It does not have the rubbery feel so often associated with other glucamate thickeners.

A further thickener that the author has successfully used with surfactant systems that are difficult to thicken with salt or where the addition of salt is to be avoided, is Carbopol AQUA SF-1 from **Noveon**. This acrylates copolymer is best added to the mix after the primary surfactant, the pH is then raised to about 8 to make processing easier as the other ingredients are added. The final stage is to reduce the pH to below 7 by the addition of citric acid solution. Viscosity is very pH dependant and it is necessary to find the optimum for each system under test.

Ease of processing is often overlooked in laboratories that are remote from the production area but materials that can be readily processed in beakers can be difficult in production. One such is guar hydroxypropyltrimonium chloride that is used to confer conditioning properties to many shampoos. AquaCat CG518, from **Aqualon** is a 10% aqueous solution that may be added at any stage to a cold mix and shampoo made with it can be crystal clear.

Many surfactants claim to be mild and to reduce the irritation of the primary surfactant, particularly when it is sodium laureth sulfate. Under the title “The Price of Mildness [SPC Vol77 No.9 p15] Dr Hans Brand suggested that shampoos should declare their RBC values. Brand writes that it is fully possible to produce beautiful, mild shampoos with an RBC value below 5, while a value below 10

should be acceptable. Those who care for their customers should be prepared to accept double or triple the raw material costs for their formulations, wrote Brand.

For formulators wishing to follow Brand's advice a group of surfactants that are interesting as possible substitutes for alkyl ether sulphates are glycinate and amphoacetate compounds. These imidazoline derivatives have been known to the industry for several decades; they are amphoteric in nature, are extremely mild and can be used to reduce irritation of other surfactants. They have good foaming action and work well in combination with SLES. They are hard water tolerant and stable over a wide pH range but products made with them can be difficult to thicken. Vama Farmacosmetica has added cotton, mango and babassu to its Vamasoft range of amphoacetates, which also includes amphoacetates of shea butter, olive oil, cocoa butter, sweet almond oil and sunflower oil. Babassu oil, correctly termed Orbignya oleifera seed oil, is also the basis of Orbignya Beta from Vama; an amphoteric surfactant with excellent antistatic and conditioning properties for skin and hair. It enhances the viscosity of shampoos and foam baths and improves the texture and stability of the foam.

Incorporating significant levels oils into shower gels without adversely affecting foaming and cleansing is made possible by the use of two surfactants available from **Sasol** through **S. Black Ltd**. They are Marlinat 242/90M, INCI Name: MIPA laureth sulfate , which is used at up to 30% and Marlowet LVS, INCI Name: PEG-18 castor oil dioleate, incorporated at between 1% and 7%. These enable the formation of microemulsions with droplet size below 100nm and which can hold 10% or more of non-polar oils in apparent solution. Skin test results show low irritation with good skin feel and positive moisturising. Lower levels of surfactant and oil may be used to formulate shampoos and cleansing products for non-aerosol foamer application.

Adding anti-inflammatory materials is another way of reducing potential irritation caused by surfactants. Croval maracuja from **Croda Oleochemicals** is a non-ionic extract from a member of the Passiflora (passionflower) family and test results published by the supplier show levels as low as 1% reduce inflammation caused by surfactants. It has solubilising properties, is unaffected by electrolytes and does not depress foam.

Surfactants for preparing emulsions are very diverse but the demand for spray-on emulsions and foaming skin care products have resulted in some interesting introductions. Inutec surfactants from **Adina Chemicals Ltd**. are a new type of polymeric emulsifier and emulsion stabiliser that can be used to prepare fluid emulsions for spray-on applications. Inutec SP1, INCI Name Inulin Lauryl Carbamate**,** is a 100% active powder based on the polysaccharide inulin, obtained from chicory, with a C12 alkyl chain. It is added as 0.5% to 2% of the oil phase and can form stable o/w emulsions with up to 60% oil phase. It is suitable for cold processing, is not affected by electrolytes and being non-ionic, it is compatible with cationic and anionic ingredients. In association with sorbitan laurate it may be used to form nano emulsions with particle sizes of less than 500nm. It is an effective emulsifier for low viscosity silicone fluids, which makes it of interest for spray-on water resistant sun lotions.

Also suitable for cold-processing fluid emulsions is an emulsifier from Degussa Goldschmidt, ABIL® Care 85 INCI Name: Bis-PEG/PPG-16/16 PEG/PPG-16/16 dimethicone with caprylic/capric triglyceride, that is used in association with sorbitan monooleate to form emulsions with a nice skin feel that are suitable for spray applications. For hot processing Tego Care CG90, INCI Name: cetearyl glucoside, in combination with potassium stearate or Axol C62, INCI Name: glyceryl stearate citrate, with glyceryl stearate is recommended. Degussa have produced an informative

presentation on formulating foaming emulsion systems and the effects that various additives may have on them. Briefly the parameters that affect performance in descending order of importance are the type of surfactant > amount of surfactant > method of production> emulsion viscosity > type of emulsifier > type of oil >amount of oil component. Sasol and Cognis have also produced informative literature on formulating spray and foaming emulsions.