



REINOLWAX LQ

The theory of stabilising an emulsion through the formation of a network of liquid crystals is different to the HLB theory or the Schulman couple's theory. In a reticular network structure the presence of a contrasting emulsion that acts as a stabiliser and consistency factor is less important. These functions can be performed by the network structure in which the hydrophilic relative grade of the lipids used in the internal phase of the emulsion (therefore the polarity factor or required HLB), are less important values in respect to a normal system. The gelification of the water phase obtainable with hydrosolvatable polymers or with emulsifiers that are able to form a reticular organised structure in liquid crystal form, eliminates the need to use waxy components in large quantities and consistency factors (cetearyl alcohol, glyceryl stearate, stearic acid...) that are no longer in harmony with the modern conception of light and easy to spread emulsions.

For this modern conception of emulsions, REINOL has created an emulsifying system called **REINOLWAX LQ**. Chemically it is a combination of C16-18 fatty alcohol and an original C12-16 alcohol, both ethoxylated and of plant origin. The INCI name is CETEARETH-20, CETEARETH-2. The unusual properties of this emulsifier are attributable to the particular ethylene-oxide distribution of its components.

From both the dermatological and "skin-feel" points of view, polar oils usually offer better emollient properties than mineral, or paraffin oils; ester-type oils are chemically much closer to the natural human skin sebum than paraffin oils. Furthermore, polar oils are easier to spread onto the skin and have better solvent and carrier properties. However, pure polar oils are not easily emulsified. **REINOLWAX LQ** is well suited for O/W cosmetic emulsions as it has these advantages:

- ◆ A wide range of emollients can be formulated.
- ◆ A high or low internal oil phase can be emulsified.
- ◆ Extraordinary versatility of use.
- ◆ Speed of processing. Low processing costs.
- ◆ Excellent temperature stability.
- ◆ Constant viscosity after induction period.

- ◆ Creams and lotions with attractive surface gloss.
- ◆ Extra emollient and moisturising effect through liquid crystals system.

The liquid crystal form is the result of a complex molecular settlement phase that occurs in a particular temperature range, activated by intermolecular forces unable to give the system fluidity.

Apart from the well known states of matter, crystal solid, liquid and gassy, in the '80's Glenn Brown introduced a fourth state, between the crystal and liquid states, calling it the liquid crystal state. So from then on tidy and organised systems formed through the combination of amphiphile and watery substances became known as liquid liotropic crystals. Liotropic liquid crystals are a mixture of amphiphilic compounds stabilised by the attraction of the molecules of a polar solvent, usually water. In a liotropic crystal the molecules of the surfactant and water are organised and aligned as in a solid crystal, not free and disorganised as in liquid solutions.

The co-existence between water and amphiphile molecules and the presence of an interface and of an hydrophobic effect, important factors in the formation of micelle of surfactants in watery solutions (Charles Tanford), determine the progressive organisation of the structure in *mimetic membranes*; when the micellar structures come together in structures of layered, hexagonal or cube form, the liquid crystal structure is formed.

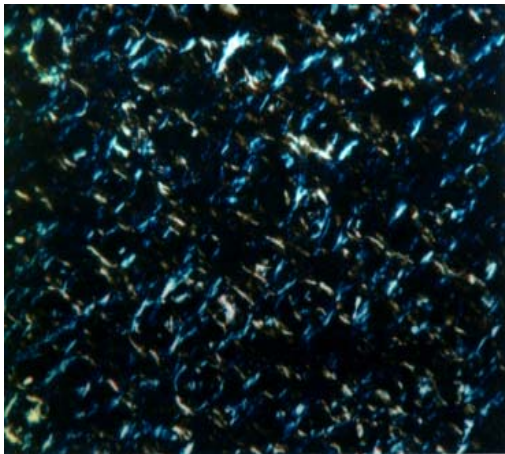
As with every substance containing a mesophase, liquid crystals are characterised by a very compact structure in which slightly longer formed molecules are arranged along parallel axes. The action of specific molecular interaction compacts and organises them in parallel. The temperature in a liquid crystal system is very important. The tendency to align is reduced by thermal agitation, while the cooling of the system increases the forces that cause the alignment, allowing the molecules to form a crystal state.

Observed through a microscope under polarised light, the crystal form shows bands of intense colour. Rays of light vary in speed as they pass through the crystals in different directions and create the phenomenon of double coloration. All this occurs when water and amphiphile molecules meet at the interface. Seen in this light, the surfactant activity and the superficial and interfacial tension non-longer depend upon

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specific surfactant chemical aspects, detergency, solubilization and emulsiology alone, but they appear as chemical-physical processes of a general interest, and are extensible to many biological phenomenon.

It is interesting to observe an emulsion made with 5% of **REINOLWAX LQ** under a microscope at



250 magnifications with polarised light.

The double coloration phenomenon highlights the presence of a crystalline form that appears structured in organised lamellar/hexagonal phases. The viscosity/temperature equation has shown a linear activity that is perfectly reversible. Emulsions made with **REINOLWAX LQ**, after being subjected to reticular disturbance (heating/cooling) recuperate their original viscosity within 24 hours of their preparation.

Gel phases in structured emulsions

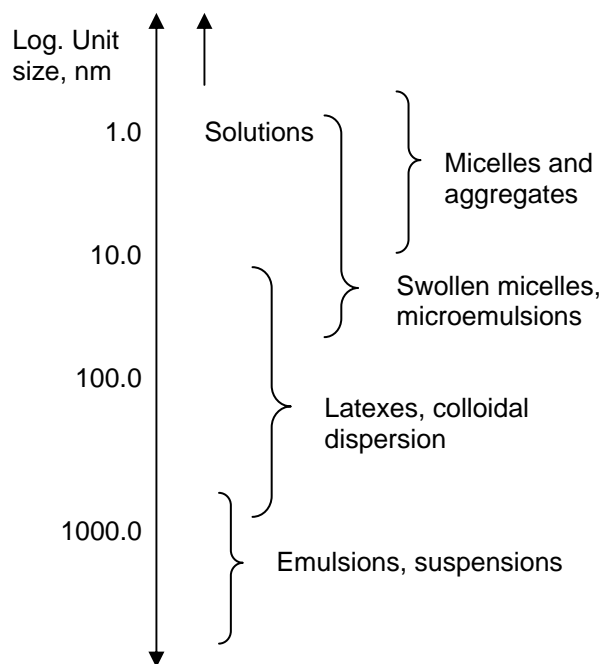
With **REINOLWAX LQ**, the ideal emulsifying system is that which requires the heating of the oily phase containing the emulsifier to 50°C and the subsequent slow and gradual addition of the cold watery phase. This procedure, instead of producing simple crystals and water (coagel phase), forms a crystalline-gel phase simplified by the gradual addition of the cold watery phase into the melted oily phase containing the emulsifier.

Furthermore, this method considerably reduces production time and costs due to the fact that the watery phase does not need to be heated and its gradual addition to the oily phase causes the cooling of the emulsion and therefore allows the rapid addition of the perfume, conservatives and termolable active principles. At the emulsifying temperature, the oil globes are stabilised by a molecular film that is absorbed at the interface by the oil/water drops.

During cooling the **REINOLWAX LQ** becomes less soluble in oil and, from this phase, immigrates to the watery micellar environment forming both mixed spherical micelle and lamellar liquid crystals.

The theory of the gel network connects the stability and the physical properties of the emulsion to the viscoelastic nature of the continuous phase. The function of a viscoelastic continuous phase is strictly connected to the way in which the emulsifier and the components of the oily phase react with water. When the temperature of the emulsion arrives at lower levels than the temperature of fusion of the hydrocarbon chain of the emulsion ($T_c < 40^\circ\text{C}$), the liquid crystal phase transforms itself into a complex phase of many components, a viscoelastic network gel.

According to the size of the particles, the various types of aggregations with which a lipidic substance can be combined with water in the presence of a surfactant are indicated on the following scale.



The micelle, as they are, or containing solubilized lipids are the first example of aggregation, with a size varying between 1 and 10 nm. When a drop with a surfactant dispersed around it is formed, it is possible that micro-emulsions (diameter between 5 e 150 nm) or macro-emulsions (diameter from 500 to 5000 nm that is 0,5 to 50 um) may be reproduced. Schulman's rule regarding the combination of primary surfactants and secondary surfactants is applicable to both micro and macro emulsions.

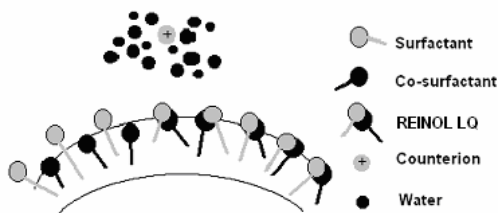
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This rule determines the formation of an interface in the micro-emulsion that renders the system thermodynamically stable and stabilises the macro-emulsion.

The **REINOLWAX LQ** emulsion system includes two components, one of hydrophilic behaviour and the other lipophilic. The schematic representation of the increased efficiency of assembly in the presence of polar additives in respect to the classic emulsifying/co-emulsifying system is shown below.

While in micro-emulsions the problem of stability does not exist, in macro-emulsions, which is the chemical physical form most widely used in cosmetics, stability is an important factor.

The stability and physical properties of O/W emulsions are dependent on the stability and swelling capacity of the crystalline gel phase.



The formation of lamellar type stratified structures tends to cause the retention of the water phase and therefore favours the moisturising action of the emulsion. In fact, the lamellar phases tend to swell with water and increase to notable degree the thickness the layers of water between the adjacent lipidic layers (up to 20nm). On the surface, these layers a sort of barrier that considerably reduces the transepidermic loss of water. For this reason, emulsions produced with **REINOLWAX LQ** have an attractive shiny surface appearance and after use leave the skin feeling light and fresh.

The effect upon the viscosity of the emulsion

The emulsifying system affects both the stability and the rheologic properties of an emulsion. The viscosity of the emulsion will only be affected when the emulsion concentration is sufficient to cause the formation, in the external phase of the emulsion, aggregations, micelle or network gels. Djacovic and his team found a relationship between the diameter of the drops and the specific surface of the internal phase that is directly linked to the drop to drop correlation and consequently to the viscosity of the emulsion.

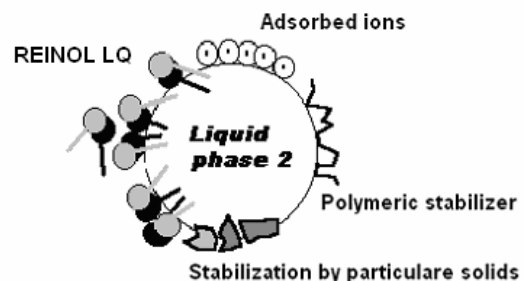
The size of the drops of the internal phase affects the viscosity of the emulsion; the vaster the distribution range the lower the viscosity.

This emulsifying system has the ability of forming lamellar liquid crystals with orientated multiple layers of emulsion and water. A liquid crystal system of this type joins the structured interfacial film and therefore helps to increase the stability of the system.

The **REINOLWAX LQ** is able to stabilise and control the consistency of emulsions produced with the gel network mechanism. (Gel network, Barry & Eccleston). This type of phase is formed during the preparation of the emulsion and manifests itself during cooling when the formation of a crystalline gel phase, rather than just simple liquid crystals and water, is apparent.

These lamellar phases determine the homogeneous consistency of the system more than the interfacial rheology. During cooling **REINOLWAX LQ** becomes less soluble in oil and, from this phase it migrates into the watery micellar area forming both mixed spherical micelle and lamellar liquid crystals.

Liquid phase 1



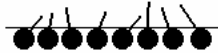
This theory is given further value by the fact that the polarities and the other chemical-physical characteristics of the components of the internal phase of the emulsion made with **REINOLWAX LQ** have little effect on the rheology of the system. Colloidal polymers, solid particles or salts can be used to try and make the macro-emulsion, which is fairly unstable in itself, as stable as possible.

Experiments have shown that the **REINOLWAX LQ** emulsion system offers an efficient stabilising effect that increases the stability of the system and its viscosity. The liquid crystals act as stabilisers in an emulsion as they give thickness and limit the fluctuation of the interfacial substances. The coalescence of the drops in the internal phase is prevented by the weakening of the force of attraction (Van der Waals) that no longer allow the drops of oil to move freely.

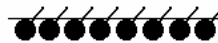
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The type of monolayer at the interface contributes to the stability of the emulsion. Some examples of mono layered films at the interfaces L/L e L/V follow.

Moderately close-packed with significant chain mobility - liquid expanded



Close-packed with tilted orientation and reduced chain mobility - liquid condensed



Closed-packed with essentially vertical orientation and very limited chain mobility - condensed solid



For the stability of an emulsion the formation of a proper liquid-crystalline phase at the interface or around the dispersed drop is a determining factor. For a non-ionic stabilised emulsion, a logarithmic relation between emulsifier concentration and viscosity was observed and these results confirm Sherman's equation. It is interesting to see the effect of **REINOLWAX LQ** concentration on the viscosity of an O/W emulsion. If we examine the following formula:

REINOLWAX LQ	2 – 10.00
Caprylic/capric Triglyceride	5.00
Paraffinum Liquidum	5.00
Stearic Acid	1.50
Hydrogenated Castor Oil	1.00
Glycerin	4.00
Aqua	up to 100
Preservatives	q.s.

We can note that the relationship between emulsifier concentration and viscosity shows this behaviour:

REINOLWAX LQ conc.	Viscosity, mPa s at 20
2 %	1,500
3 %	6,000
5 %	10,000
8 %	27,000
10 %	50,000

REINOLWAX LQ is able to influence the viscosity of an emulsion only when it is used in sufficient quantities to form a network gel in the external phase of the emulsion having thickening and stabilising properties. Such properties are not effected by the polarity of the oily phase or by the existing relationship between the phases.

The following formulations are here indicated in order to give general directions for the employment of **REINOLWAX LQ**. Although they have been realised according to best information we owe, this does not exonerate the user from verifying their validity. REINOL's technical service is at the user's disposal in order to contribute to the development of new formulations, and to give the needful information for a correct use of our products.

'Anti-aging' fluid emulsion

REINOLWAX LQ	4.50
Butirospermum Parkii	2.50
Diocetyl cyclohexane	3.00
Caprylic/capric Triglyceride	3.00
Stearic Acid	1.00
Cetyl Palmitate	1.00
Tocopheryl Acetate	1.00
Olea Europaea Oil Unsaponifiables	1.00
Cetearyl Alcohol	0.50
Aqua	up to 100
Diglycerin	2.00
Resveratrol	0.70
Panthenol	0.30
Perfume and preservatives	q.s.

Hand cream

REINOLWAX LQ	4.00
Buxus Chinensis (Oil)	4.00
Hydrogenated Lanolin	1.50
Isopropyl Myristate	1.50
Ciclomethicone	0.60
Aqua	up to 100
Diglycerin	2.00
Allantoin	0.20
Carbomer 934	0.30
NaOH 2% solution	2.20
Perfume and preservatives	q.s.

Cleansing milk

REINOLWAX LQ	3.50
Paraffinum Liquidum	10.00
Lanolin	1.50
Glyceryl Stearate	1.00
Aqua	up to 100
Diglycerin	5.00
Anthemis Nobilis Extract	1.50
Perfume and preservatives	q.s.



Idroalcoholic after shave emulsion

REINOLWAX LQ	6,00
Caprylic/capric Triglyceride	2.00
C12-15 Alkyl Benzoate	2.00
Olea Europaea Oil Unsaponifiables	0.50
Aqua	up to 100
Diglycerin	2.00
Hedera Helix Extract	1.50
Carbomer 934	0.50
Ethanol	30.00
Allantoin	0.30
NaOH 2% solution	2.50
Perfume and preservatives	q.s.

Moisturizing body lotion

REINOLWAX LQ	4,00
Caprylic/capric Triglyceride	3.50
Diethylcyclohexane	3.00
Paraffinum Liquidum	3,00
Caprylic/capric Triglyceride	2.00
Hydrogenated Castor Oil	2.00
Stearic Acid	1.00
Tocopheryl Acetate	1.00
Glyceryl Stearate	1.00
Cetearyl Alcohol	0.50
Aqua	up to 100
Glycerin	2.00
NMF (Normal Moisturizing Factor)	3.00
Allantoin	0.20
Disodium EDTA	0.05
Perfume and preservatives	q.s.

REINOLWAX LQ allows the formulation of low viscosity emulsions, lets attempt to formulate a super fluid 'sprayable' products. They have an evident 'Tyndall' effect and the stability is confirmed through severe and prolonged heat and centrifuge tests. They vaporize easily, forming a homogenous, impalpable, light and extended mist.

Moisturizing fluid emulsion

REINOLWAX LQ	2.50
Hydrogenated Poly-1 Decene	3.00
Caprylic/capric Triglyceride	2.50
Octyl Stearate	1.50
Glyceryl Stearate	1.20
Aqua	q.b. a 100
NMF (Normal Moisturizing Factor)	3.00
Perfume and preservatives	q.s.

Sunscreen 'sprayable' emulsion

REINOLWAX LQ	2.50
Octyl Methoxycinnamate	6.00
Octyldodecyl Stearoyl Stearate,	
Octyl Alcohol	1.50
Palmitic Acid	1.00
Butyl Dibenzoylmethane	1.00
Tocopheryl Acetate	0.40
Aqua	up to 100
Panthenol	1.20
Perfume and preservatives	q.s.

Conclusion

REINOLWAX LQ is able to influence the viscosity of an emulsion by forming a reticular structure that has interesting stabilising and thickening properties and that are little effected by the polarity of the oily phase and the existing relationship between the phases. The viscosity/temperature equation has shown a linear activity that is perfectly reversible.

When using **REINOLWAX LQ** at between 3 and 8%, if in the oily phase lipids of different polarities are used, particular differences in stability are not apparent, even if from a functional and organoleptic point of view, the best results are obtained using lipids of medium to high polarity.

The formation of organised reticular structures in liquid crystal form, also called secondary droplets, creates the tendency of retaining the watery phase and therefore favouring the moisturising action of the formula. The stability of these emulsions and their shiny appearance and original, fresh feeling when used is exceptional. The best method of emulsification has proved to be that of adding the watery phase at a low temperature into the oily phase.

This method also favours production time and therefore production costs. **REINOLWAX LQ** offers the opportunity to simplify the production of stable, safe, modern and quality formulations that have interesting functional activities.

For Additional Informations Please Contact

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