Surfactants

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Objectives

- To learn the technical terms relating to surfactants
- To understand the general properties of surfactants
- To understand the criteria for selection of a surfactant for a specific purpose
- To have a knowledge of the applications of surfactants

Resources – Web pages

- www.kcpc.usyd.edu.au/discovery/
- www.surfactants.net
- http://www.uniqema.com/lit/index.htm
- http://www.ultrachem.com/products/chemron.html
- http://surface.akzonobelusa.com/
- http://www.corporate.basf.com/en/produkte/?id=k863M5Pm9bcp1tl

Plan of Segment

- Introduction through Key Centre for Polymer Colloids web site educational resource
- Definitions
- General Anionic, Cationic, Nonionic classes
- Selected specialised surfactants e.g. Hamposyl™ sarcosinate surfactants, N-acyl ED3A
- Surfactant applications e.g. Huntsman Surfactants Formulary

Definitions

- **Aggregation Number**
  The average number of surfactant molecules per micellar aggregate
- **Associators**
  Any substance that "cleans" by penetrating the soil and convincing the soil it would rather be with the associator rather than the surface. These are usually surfactants and solvents. Associators do not necessarily work better with more dwell time, temperature or concentration. They need to be compatible with the soil.

- **Block Copolymer**
  Polymers containing two or more different monomers where the polymer will contain long sequences of one of the polymers
- **Bonders**
  Any substance that "cleans" by physically attaching to the soil, usually through a charge. These ingredients usually work on dirt and do not touch oily road film. Examples are phosphates and carbonates.

- **Brighteners**
  Ingredients that adhere to a surface and transform invisible ultraviolet light (usually from the Sun) into visible white light. This results in a surface looking "whiter than white".

7

- **Builder**
  A chemical used to chelate hardness and allow the surfactants to perform at their potential. Some builders stay soluble when attached to hardness. Others, called precipitating builders, fall out of solution when attached to hardness.

8

- **Cloud Point**
  The temperature at which a clear solution clouds up. As the temperature is raised (or lowered), the chemicals become less soluble in the solution and begin to come out. Many scientists use this number to determine the hydrophobicity of the solution.

9

- **Detergent**
  A cleansing agent
- **Filler**
  A chemical that adds no value to the performance of the solution.
- **Foam**
  Dispersion of gas bubbles in a liquid.
- **Gel Point**
  Concentration (range) of a nonionic surfactant that will form a permanent gel with water.

10

- **Hardness**
  A chemical found in water that bonds to surfactants. The result is decreased detergency and decreased foam. Calcium (Ca^{++}) and Magnesium (Mg^{++}) are the most common forms.

11

- **Hydrotrope**
  The use of hydrotropes by the chemical formulator has become an integral part of developing highly alkaline or acidic products. The function of a hydrotrope in these systems is to stabilize other surfactants in order to allow them to remain soluble. This is especially true in the case of some nonionics which have limited acid and alkaline stability

12

- **Hydroxyl Value**
  Percentage of hydroxyl groups in molecule as determined by acetylation of the hydroxyl groups with acetic anhydride
- **Krafft Point**
  Temperature at which the solubility equals the CMC
- **Pour Point**
  Minimum temperature at which a material will pour

13

- **Reactors**
  Any substance that "cleans" by changing the soil into a different chemical through reaction. Usually an acid or base. These ingredients always work better with more dwell time, temperature and concentration. These ingredients usually work on any soil because they "see" everything as a soil including the surface of the vehicle, the equipment, skin, concrete, etc.

14

- **Saponification**
  The reaction of an alkaline with an oil. When the alkaline is caustic and the oil is animal fat, the result is soap. Many assume that all saponification reactions make something that aids in cleaning. Surfactants that aid in cleaning are made from vegetable oil (palm kernel, coconut) or animal fats (beef tallow).

15

- **Saponification Value**
  A measure of the number of ester groups in a molecule as determined by the amount of alkali consumed in the saponification

16

- **Soap**
  A cleansing agent made from the reaction of an alkali and an animal fat.
- **Surfactant**
  A chemical that is active at the surface or interface (the boundary between two different substances). Taken from the phrase "surface active agent".

17

- **Syndet**
  An abbreviation for "synthetic detergent". This is a cleansing agent made from non-natural (synthetic) compounds.

18

Methods of Selecting Surfactants

- HLB
- Phase Inversion Temperature
  - Primary emulsifier chosen to give a system close to the PIT → stable small droplet size
  - Secondary emulsifier more soluble in the continuous phase → prevents flocculation and coalescence
- Matching Chemical type
  - Match to oil
  - Process disperse surfactant in oil
  - Gradually add water
  - W/O → Gel → O/W

Method for Initial Screening of Chemical Type

1. Add 100% wt of surfactant in oil
2. Blend oil and surfactant and heat
3. Add water slowly
4. Clear transparent W/O dispersion forms
5. When vol of water = vol of oil system gels
6. With more water Gel thins to O/W emulsion
7. Emulsion too thick ↑ HLB of emulsifier
8. Droplet size too large ↓ HLB of emulsifier

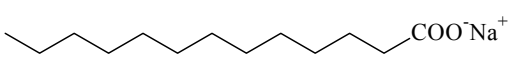
Choice based on Application

- Antistatic – Polyoxyethylene stearates, PEGs and Polysorbates
- Defoamers – polyglycol oleate
- Detergents – nonylphenolethoxylates – anionics
- Dispersants – poly-anionics

- Hydrotropes – alkyl polysaccharides
- Low Foam Surfactants – alcohol alkoxylates
- Softeners and conditioners – cationics
- Solubilisers – polysorbates
- Wetting agents – octylphenol ethoxylates
- Foam Boosters – alkyl ether sulphates and alcohol sulphates

Anionic Surfactants

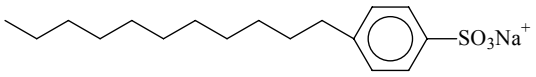
Soap



N = 10 - 16

e.g. sodium stearate

Alkyl aryl sulphonate

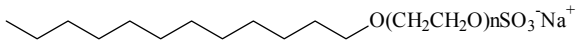


N = 10 - 12

e.g. DDBSA (dodecyl benzene sulphonic acid),sodium salt

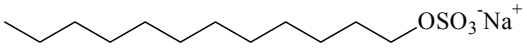
40% of total market

Alkyl ether sulphate



e.g. sodium lauryl ether sulphate n = 2 to 3

Fatty alcohol sulphate



e.g. sodium lauryl sulphate or sodium dodecyl sulphate (SDS)

Counter-ions

- Na^+ - hygroscopic solid
- K^+ - hygroscopic solid
- Diethanolamine – viscous liquid
- Triethanolamine – viscous liquid

Ionic species

- Carboxylate
- Sulphate
- Sulphonate
- Phosphate
- Phosphonate

Alkyl chain length

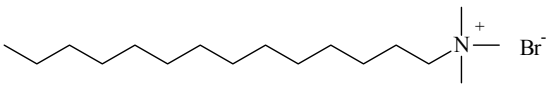
- 10 to 18 carbon atoms

Applications

- Soaps
- DDBS laundry powder
- Alkyl ether sulphates Personal Care products

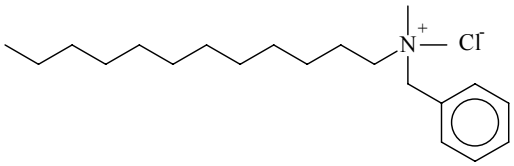
Cationic Surfactants

Cetyl trimethyl ammonium bromide



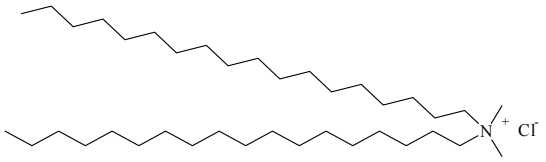
Cetrimide
$(C_{14}H_{29}N(CH_3)_3)^+Br^-$

Lauryl dimethyl benzyl ammonium chloride



Benzalkonium chloride

Distearyl dimethyl ammonium chloride



Chemical Constitution

- Primary Acyl chain C_{12} to C_{18} but variable
- Other acyl chains usually 1 to 3 or benzyl
- Counter ion Cl^- , Br^-, or ethyl sulphate

Solubility

- Solutions neutral
- Mono alkyl compounds insoluble in non-polar solvents
- Di alkyl compounds insoluble in water more soluble in non-polar and slightly polar solvents

Applications

- Disinfectants and sanitisers
- Antistatics
- Fabric softeners
- Hair conditioners
- Sewage flocculants

Nonionic Surfactants

Types

- Glycol and glycerol esters
- Polyoxyethylene esters
- Polyoxyethylene ethers
- Polyoxyethylene – polyoxypropylene copolymers
- Sorbitan derivatives
- Sucrose esters

Glycol and Glycerol esters

- Glyceryl monostearate
  - Mixture of palmitate and stearate
  - Some di and tri glycerides
  - Poor o/w emulsifier but useful stabiliser
  - Self-Emulsifying GMS – has 6% soap added

Polyoxyethylene esters (Macrogol esters)

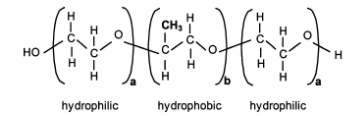
- E.g. Polyoxyethylene 8 stearate
  - O/w emulsifiers
  - Prone to hydrolysis in acid or alkaline conditions
- Condensation products between ethylene oxide and castor oil (Cremophors)
  - Castor oil is mainly triglyceride of ricinoleic acid

Polyoxyethylene ethers

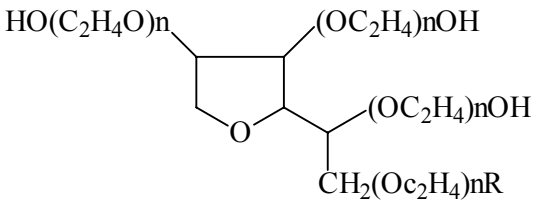
- Cetomacrogol
  - Stable over wide pH range
  - O/w emulsifiers
- Lauromacrogols
  - Laureth series
- Nonylphenol ethoxylate

Poloxamers

- Hydrophilic chain 10 to 80%
- Mwt 1000 to 16000
- Emulgents
- Solubilisers
- Wetting agents



Sorbitan derivatives



Polysorbate series

- Polysorbate 20
  - 20 moles of EtO to each mole of sorbitan
  - R is monolaurate
- Polysorbate 40
  - 20 moles of EtO to each mole of sorbitan
  - R is monopalmitate
- Polysorbate 60
  - 20 moles of EtO to each mole of sorbitan
  - R is monostearate

Polysorbate Series

- Polysorbate 65
  - 20 moles of EtO to each mole of sorbitan
  - Tri-stearate
- Polysorbate 80
  - 20 moles of EtO to each mole of sorbitan
  - R is monooleate
- Polysorbate 85
  - 20 moles of EtO to each mole of sorbitan
  - Tri-oleate

Sucrose esters

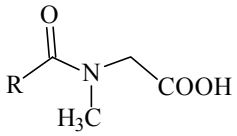
- Esters of sucrose with fatty acids such as stearic or palmitic acid
- Mono, di and tri esters
- Useful for foods and cosmetics

Solubility

- >50% EtO readily soluble in water
- <50% EtO dispersible in water
- Solubility in water dependant on hydrogen bond formation

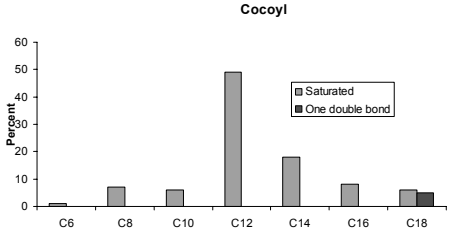
Fatty acid amides of sarcosine

Structure

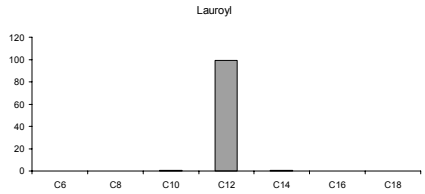


Sodium, ammonium, potassium or triethanolamine salts

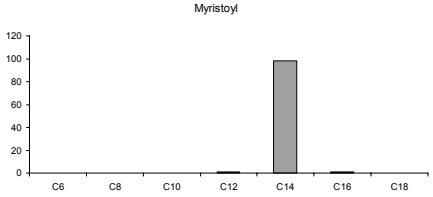
R group



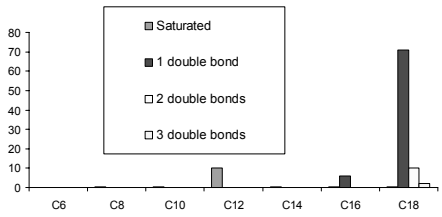
Lauroyl



Myristoyl



Oleoyl



55

Properties

- More acidic than fatty acids – less alkaline salts
- Soluble in most organic solvents
  - Oleoyl most soluble
  - Acids insoluble in water
  - Na^+ and K^+ salts very soluble not salted out by salts or alkali
  - Ca^{++}, Mg^{++} salts more soluble than soaps

56

Surface Tension CMC

	CMC w/w %	*Minimum Surface Tension dynes/cm*
Sodium Lauoryl Sarcosinate	8.0×10^{-2}	24.3
Sodium Myristoyl Sarcosinate	7.9×10^{-3}	27.2
Sodium Cocoyl Sarcosinate	8.7×10^{-3}	22.7
Sodium Oleoyl Sarcosinate	2.6×10^{-3}	28.0
Sodium Lauryl Sulphate	2.4×10^{-1}	33.5

57

Surface Tension

- Minimum at pH 6 to 7
- Combination with other surfactants decreases minimum surface tension achievable
- Wetting action rapid on wool at low pH
- Wetting action more rapid on cotton at higher pH

58

Foaming

- Foam well at sl acid to neutral pH
- SCS and SOS better in alkaline region
- SLS and SMS better in neutral and mildly acidic range
- Foams decay by less than 10 percent in ten minutes

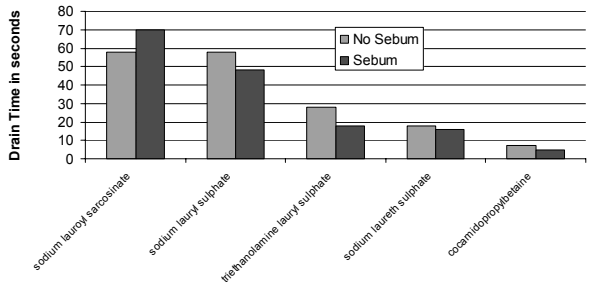
59

Calcium Tolerance

- Poor at dilute solutions
- Good at “in use” concentrations
  - 3% SLS remains clear and gives a stable lather at 250 ppm Ca^{++}

60

Lather stability to sebum



61

Electrolyte Tolerance

- Sodium chloride increases solubility and foam height to a maximum about 7% NaCl
- Effective foam up to concentration 0f 20% NaCl (cf 10% with Sodium lauryl sulphate)

62

HLB

	HLB
ACIDS	
Lauroyl sarcosinate	13.1
Myristoyl sarcosinate	12.1
Cocoyl sarcosinate	10
Oleoyl sarcosinate	9.6
SODIUM SALTS	
Sodium lauroyl sarcosinate	29.8
Sodium myristoyl sarcosinate	28.9
Sodium cocoyl sarcosinate	27
Sodium oleoyl sarcosinate	26.6
Sodium lauryl sulphate	40

63

Substantivity

- Adsorb to proteins
- Adsorbs to skin
- Reduces permeability of skin
- Reduces irritation
- Adsorbs to metals by surface chelation

64

Compatibility

- Compatible with QUATS
- Phenolics

65

Biodegradability

- Similar to sodium lauryl sulphate

66

Toxicity

	LD_{50} mg/kg rats
Sodium lauroyl sarcosinate	5000
Sodium cocoyl sarcosinate	4200
Cocoyl sarcosinate	5400
Sodium oleoyl sarcosinate	6000
Sodium lauryl sulphate	1288

Applications- Personal Care

- Skin cleansers
- Shampoos
- Hand soaps
- Oral care products
- Surgical scrubs
  - Conditioning
  - Detergency
  - Foam
  - Skin feel

Applications – Cleaning Products

- Rug Shampoos
  - Reduced resoiling
  - Foam stabilisation
  - Reduced wetting of backing
  - Non-toxic
  - Detergency
  - Lower Krafft point
  - Prevents corrosion
  - Static reduction

Applications - Cleaning

- Specialty detergents
  - Salt water
  - Dishwashing – reduced irritancy
  - Dishwasher rinse aids – increases cloud point of non-ionics
  - Alkaline cleaners
  - Alcohol based window cleaners – no oily film
  - Food machinery – non-toxic and corrosion preventative

Industrial Chemical

- Biotechnology – isolating agents
- Corrosion inhibition
- Dispersants
- Leather treatment – water proofing
- Pesticides – to aid permeation
- Textiles

Petroleum and Lubricants

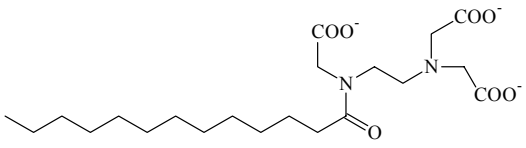
- Motor fuels – corrosion inhibitor
- Fuel Oils
- Lubricants
- Transmission fluids

Applications

- Polymer films – anti-fogging, anti-static
- Mold release – injection molding for polyether polyurethanes
- Metalworking – corrosion inhibition

Anionic Chelating Surfactants
N-Acyl ED3A

Lauroyl ethylenediaminetriacetate



Counter-ions

- Sodium
- Potassium
- Ammonium
- Monoethanolamine
- Diethanolamine
- Triethanolamine
- etc

Properties

- Efficient hydrotrope – clears SDBS solutions
- Low toxicity
- Non-irritant
- Biodegradable
- Lather enhancement for hard water

Surface Activity

	CMC % w/w	*Minimum Surface Tension Dynes/cm*
Sodium lauroyl ED3A	0.17	25
Sodium cocoyl ED3A	0.17	24.7
Sodium myristyl ED3A	0.027	21.5
Sodium oleoyl ED3A	0.099	28.0
Sodium lauryl sulphate	0.24	33.0

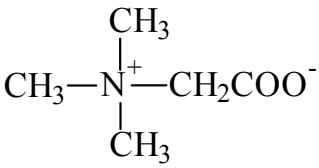
Chelation Properties

- $Mg^{++} < Cd^{++} < Ni^{++} = Cu^{++} < Pb^{++} < Fe^{+++}$
- 1 mole of Na LED3A chelates 0.9 mole Cu^{++} at pH 5 to 10

pH profile

- At pH 5, 2 acetate groups neutralised
- At pH 8 third acetate begins to react
- Surface tension reduction optimum between pH 5 and 8
- Soluble in up to 20% sodium hydroxide

Betaines



Application of Emulsions

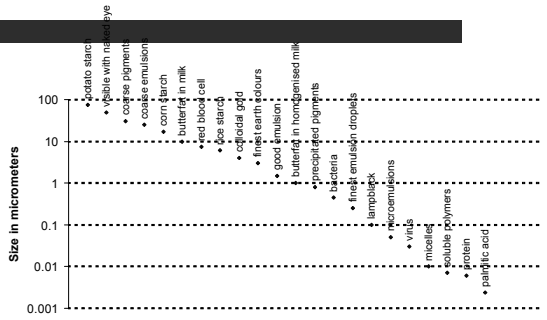
- Cosmetic
- Pharmaceutical
- Polishes
- Paints
- Agricultural sprays
- Foods
- Miscellaneous

Miscellaneous

- Asphalt
- Plastic production
- Leather treatment
- Textile treatment
- Metal dispersions
- Transport media
- Drilling fluids

Cosmetic Emulsions

- Uses of emulsions
  - application of oil and water soluble ingredients simultaneously
  - elegance
  - cosmetic acceptability
  - cleansing
  - moisturising



- Emulsion types
  - o/w
  - w/o
  - o/w/o
  - microemulsions
  - liposomes

Cold Creams - W/O

	Per Cent
• Oils	50 - 70
• Borax/ waxes	0 - 20
• Lanolin	0 - 15
• Water	30 - 35
• Preservatives etc	

Cold Creams O/W

• Oils	40 - 50 %
• Alkali/ waxes	0 - 15 %
• Soaps/ esters	0 - 5 %
• Water	33 - 45 %
• Preservatives etc	

Vanishing Creams

	Per cent
• Oils/waxes	0 - 10
• Stearic acid/ esters	10 - 25
• Alkali or amine	0 - 2
• Glycerin	0 - 5
• Water	60 - 80
• Preservatives etc	

Dry Skin Moisturizer Phase A

- PVP/water 2.0
- Propylene glycol 4.0
- Methyl paraben 0.2
- Water 48.9
- Triethanolamine 99% 1.8
- Chitosan/water 4.0

91

Dry Skin Moisturizer Phase B

- Glyceryl stearate/ PEG 100 stearate 6.0
- Stearic acid 6.0
- Cetyl alcohol 1.0
- Isopropyl myristate 15.0
- Propyl paraben 0.1
- Dimethicone 1.0
- Fragrance q.s.

92

Dry Skin Moisturizer

- Add PVP to the water-glycol solution and dissolve. Mix constantly.
- Add Chitosan and TEA.
- Heat phase A in batch tank until 70°C.
- Heat phase B in a separate container to 75°C.
- Mix vigourously
- Begin cooling to room temperature and q.s. to volume with cold water at 50°C.

93

Facial Care Cleansing Cream

Part A

- Glyceryl stearate 4.0
- Cetearyl alcohol 1.6
- Sodium cocoyl lactylate 0.5
- Mineral oil 20.0
- Mineral oil/ lanolin alcohol 4.0

94

Facial Care Cleansing Cream

Part B

- Distilled/deionized water 64.7
- Glycerine 5.0

Part C

- DMDM hydantoin .2

95

Facial Care Cleansing Cream

- Combine phase A and heat to 80ºC.
- Combine phase B and heat to 80ºC.
- Add phase A to phase B.
- Cool to 30ºC.
- Add phase C.

96

Pharmaceutical Emulsions

- Topical Preparations
  - creams
  - lotions
- Internal emulsions
  - paraffin emulsion
  - Intralipid®

Cream Bases O/W

- Anionic - Aqueous Cream
  - emulgent System SLS/CSA
- Cationinc - Cetrimide Cream
  - emulgent system cetrimide/CSA
- Nonionic - Cetomacrogol Cream
  - emulgent system cetomacrogol 1000/CSA

Creams W/O

- Wool fat - wool alcohols
- Beeswax
- Calcium soaps
- Sorbitan esters

Polishes

- Oil or wax dispersed in water
- Emulsion cracks on spreading leaving a film of wax
  - if emulsion does not crack spotting will occur
- Must retain some degree of emulsifiability to facilitate removal

Furniture Polish

Paraffin Oil	40
Ethofat 60/15 (ethoxylated fatty acid)	2.5
Ethofat 60/20	2.5
Water	55

Silicone Polish

Silicone DC-200	2
Kerosene	8
Ethomeen S/12 (ethoxylated amine)	0.25
Arquad 2C (QUAT)	0.25
Water	89.5

Floor Polish

- Carnauba wax 10
- Tween 80 3
- Water 87

Waxes

- Carnauba
- Beeswax
- Candelilla
- Ceresin
- Paraffin
- Montan

Emulgents

- Amine and alkali soaps
- Sulphated oils
- Glyceryl fatty esters
- Glycol ethers

Polymer Based Polishes

- Epolene E 40
- Brij 30 11.2
- Span 85 0.8
- 50% KOH solution 1.2
- Water 150

Molten polyethylene added to emulgents and KOH then agitated with the water at 95°C. Stirring continued until cooling to room temperature.

Emulsion Paints

- Pigment
- Volatile component
- Vehicle
  - evaporation
  - polymerisation
- Emulsions
  - reduce volatile components
  - easier to use

Agricultural Sprays

- Emulsifiable concentrates
  - active ingredient
  - organic solvent
  - oil soluble emulgent
  - insensitive to water hardness

Chlordane Emulsifiable Concentrate

- Chlordane 74
- Kerosene 21
- Atlox 3404 (alkylbenzene sulphonates) 2.5
- Atlox 3403 2.5

Food Emulsions

- Mayonnaise
  - O/W emulsion
  - 60 - 80 % oil
  - emulgents
    - egg yolk
    - mustard

Egg Yolk

- Fats 22.5
- Protein 16
- Lecithin 10
- Cholesterol 1.5
- Salts 2
- Water 48

Emulsifiers in Baked Goods

- Assist in mixing of dough and dispersion of ingredients
- Retard staling
  - GMS in cakes
  - polyoxyethylene stearate in bread

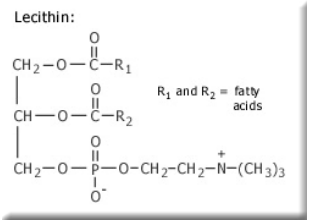
Food Emulsifiers

- Mono- and diglycerides
  - used in bakery products, frozen desserts, icings, toppings, and peanut butter
- Stearoyl Lactylates
- Sucrose Esters
- Sorbitan Esters (SPAN)
  - used in conjunction with polysorbates in oil toppings, cake mixes, etc.

Polysorbates (TWEEN)

- *Polysorbate 60* -polyoxyethylene sorbitan monostearate
  - HLB = 14.9
  - sample applications include oil toppings, cake mixes, and cake icing
- *Polysorbate 65* - polyoxyethylene sorbitan tristearate
  - permitted for use in ice cream, frozen custard, ice milk, etc.
- *Polysorbate 80* polyoxyethlene sorbitan monooleate
  - HLB = 15.0
  - some special applications are fro oils in special dietary foods, vitamin-mineral preparation, and fat-soluble vitamins.

Lecithin



- widely used in baked goods, low-fat baked goods, chocolate, instant foods, confectionery products, and cooking spray

Asphalt

- Ease of application
  - more fluid than molten asphalt
  - quicker application
  - smoother coating
  - can be used on damp surfaces
  - emulsion must break after application to allow the bitumen to set

Asphalt Emulsion

• Asphaltic Bitumen	55
• Water	44
• Sodium linoleate/Alkali	1

Alkali forms naphthenate soaps with free naphthenic acid

Plastic Production

- Emulsion polymerisation
  - dissipate heat of reaction
  - viscosity controlled
  - catalysts more effective
- Alkaline conditions thus soaps suitable
- Cationic and Nonionic can be used under appropriate conditions

Rubber Formula

• Butadiene	25
• Styrene	8.5
• Emulgent	1
• Catalyst (potassium persulphate)	0.5
• Water	65

Leather Treatment

- Lubricate leather fibres after tanning
- improve softness, stretchiness & elasticity

• Paraffin Oil	60
• Sulfonated cod oil	40
• Borax	2
• Water	160

Textile Treatment

- Lubricant emulsions
- anti-static and waterproofing

Metal Dispersions

- Sodium in hydrocarbon emulsion

Transport Media

- transport of nitroglycerine
- pumpable dispersion of hydrocarbons

Drilling Fluids

- Aid in the boring of wells
- Assist transport of bit cuttings to surface
- emulsifying agent
  - soaps
  - lignosulphonates
  - starch
  - CMC
  - finely divided solids

Water
Peg-6 Stearate
Glycol Stearate
Peg-32 Stearate
Soy Bean Oil
Glycolproteins
Phospholipids
Thymus Extract
Sphingolipids
Horse Tail Extract
Hydrocotyl Extract
Sunflower Oil
Sodium Hyaluronate
Tocopheryl Acetate
Diazolidinil Urea
Fragrance

Manufacture of Emulsions

Producing Emulsions

- Brute force
- Persuasion

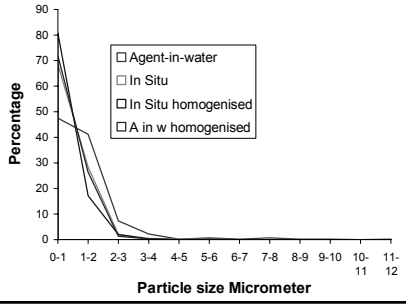
Mode of Addition

- Agent-in-water
  - dissolve emulgent in water
  - add oil with stirring → O/W
  - add further oil → inversion → W/O
- Agent-in-oil
  - dissolve emulgent in oil then either
    - add mixture directly to water → O/W
  - or
    - add water to mixture → W/O
    - add further water → inversion → O/W

Mode of Addition

- Agent *In Situ* Method
  - Fatty acid dispersed in oil
  - alkali dissolved in water
  - soap forms when phases mixed
- Alternate Addition Method
  - water and oil added alternatively to the emulgent

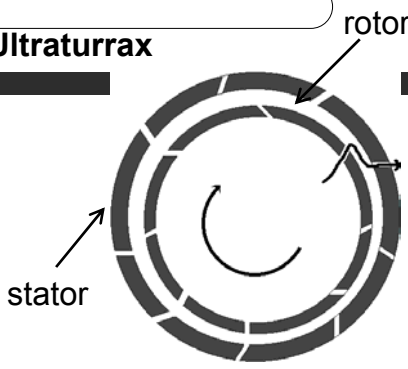
Particle Size Distribution for Olive Oil Emulsions



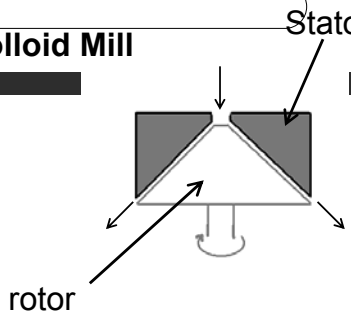
Equipment for Emulsions

- Stirrers
  - propellor
  - turbine
- Colloid mills
- Ball mills
- Homogenisers

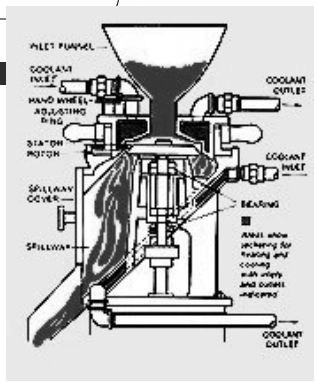
Ultraturrax



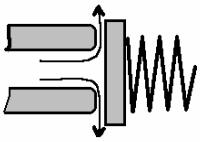
Colloid Mill



Colloid Mills



Homogeniser



Characteristics of Apparatus

	Colloid Mill	Homogeniser
Viscosity range mPa.s	1 - 5000	1 - 20 000
Optimum Viscosity mPa.s	2000	1 - 200
Particle size μm	1 - 100	0.5 - 20
Optimum particle size μm	1 - 3	0.1 - 2
Power requirement kW	2 - 150	2 - 220

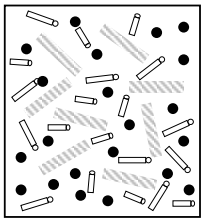
Microemulsions

Microemulsions

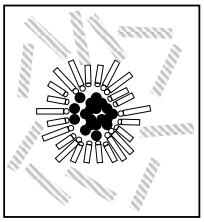
- Swollen Micellar solutions
- Transparent Emulsions
- Droplet diameter 0.01 – 0.1 μm
- During formation one phase

Conditions for Formation of Microemulsions

- Formed near the phase inversion temperature (PIT)
- Large size of non-ionic surfactant
- HLB's at optimum
- Close PITs for two surfactants in the system
- Emulsifier concentrations 20 –30% of oil phase



Cosolubilisation

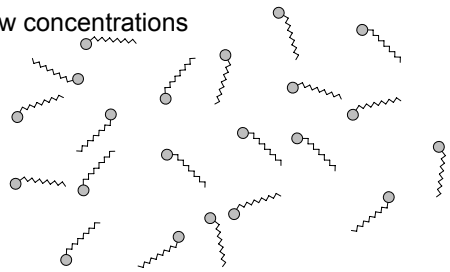


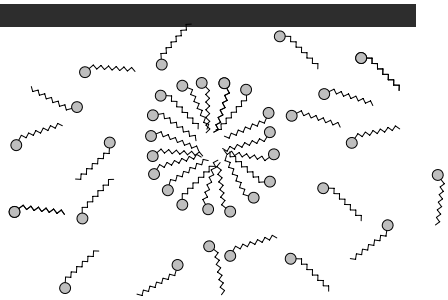
Microemulsion

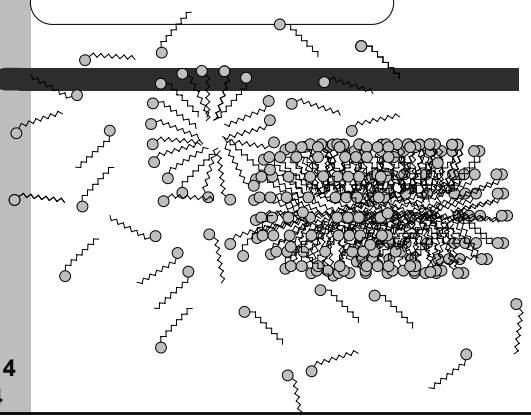
Liposomes

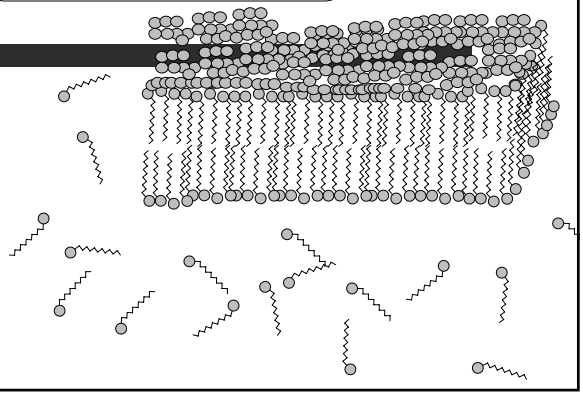
Effect of Increasing concentration of surfactant

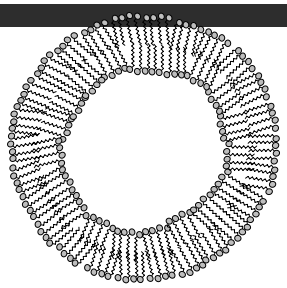
- Low concentrations



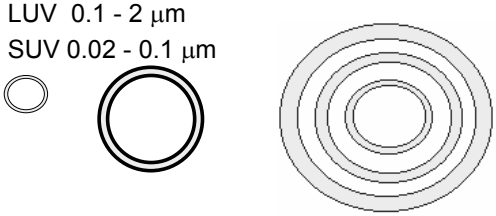








- MLV 0.5 - 50 μm
- LUV 0.1 - 2 μm
- SUV 0.02 - 0.1 μm



Terminology

- Phospholipids
  - Esters of glycerol with fatty acids and phosphoric acid derivative
- Vesicles
  - Lamellar phase micelles
  - Closed spherical or ellipsoid structures
- Liposomes
  - Vesicles based on amphiphilic lipids of biological origin

Preparation

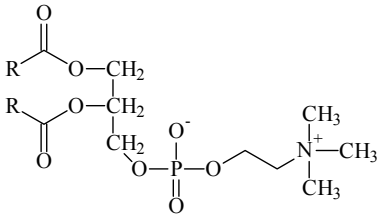
- Reverse-phase evaporation
- Size fractionation by filter extrusion
- Ultrasonication

Formulas

- Distearoylphosophatidylcholine 2
- Cholesterol 1

- Dipalmitoylphosphatidylcholine 55
- Cholesterol 45

Phospatidyl choline



Comparison of Micelles, Microemulsions and Liposomes

	Micelles	Microemulsions	Liposomes
Molar mass	2000 – 6000	10^5 -10^6	> 10^7
Diameter Å	30 - 60	50 - 1000	300 - 5000
Solubilizer	Little	Much	Much
Dilution with water	Destroyed	Altered	Stable