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NEARCHIMICA

THEORY AND PRACTICE IN TEXTILE PREPARATION

Surface-active agents or surfactants as they are now called, have been available for a long time. Their use is widespread throughout all types of industry and is of particular importance in the textile industry.

As the name implies, surfactants are chemicals which are active at surfaces, or interfaces, between two physical phases. In textile preparation there are three such interfaces; fibre-impurity, fibre-liquor and impurity-liquor. Before examining these in detail, a summary of relevant basic principles of surfactants is given.

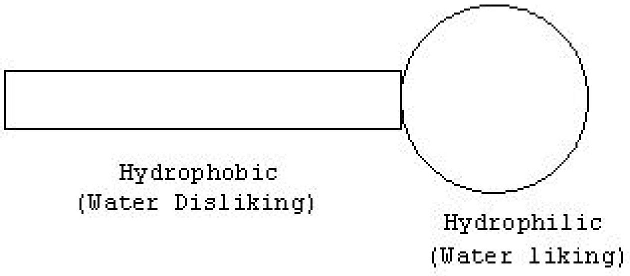
1 Structure of surfactants

Pictorially a surfactant molecule is traditionally shown as in Figure 1.

1.1 Traditional representation of a surfactant molecule

Surfactant molecules are regarded as having two parts or groups. One group is water-liking or hydrophilic. The other is water-hating or hydrophobic and is sometimes described as oil-liking or lipophilic.

Figure 1



1.2 Relative size of hydrophobe and hydrophile

The relative sizes and chemical natures of the hydrophilic and hydrophobic groups determine the properties of the surfactant molecule. The best known example is soap, where the hydrophobic group is a long chain alkyl group $-(CH_2)-_n$, and the hydrophilic group is a carboxylate ion $-COO^-$ neutralised with the sodium ion Na^+. As the length of the alkyl chain is varied with the same sodium carboxylate hydrophile, the properties of the molecule change.

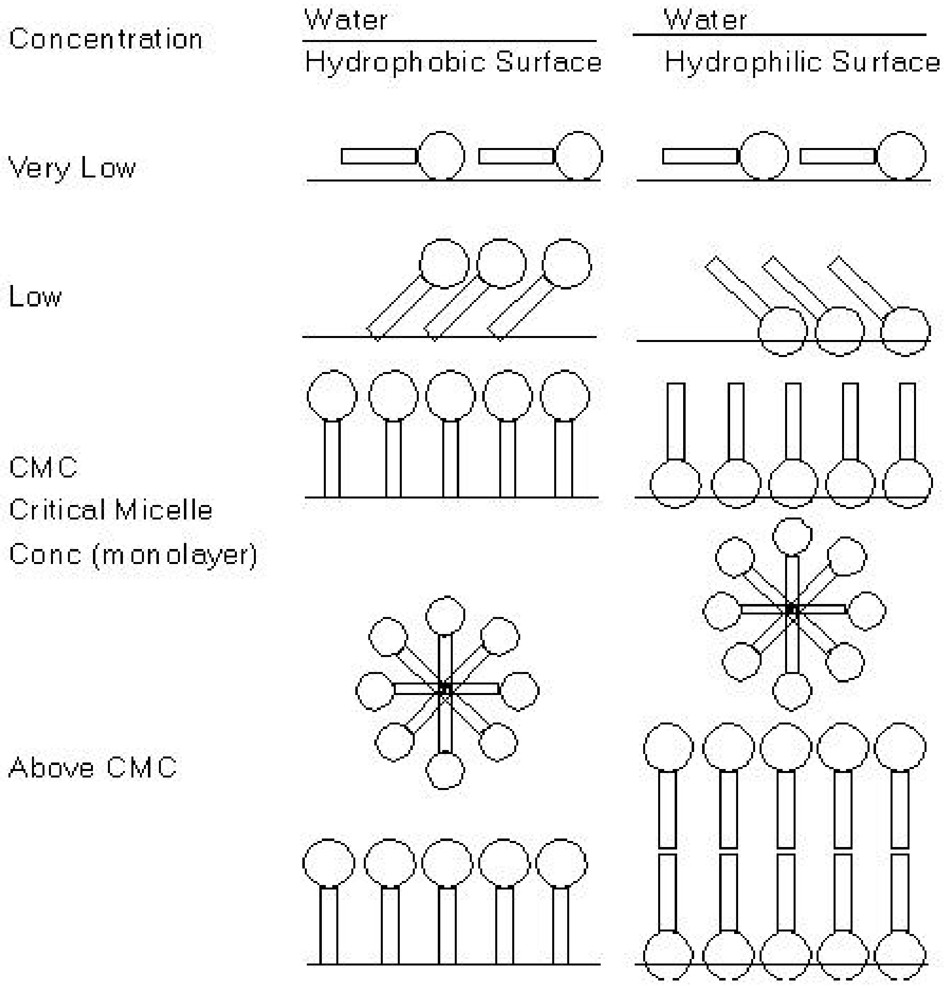
Figure 2: Soap - Variation In Properties

$(CH_2)_nCOO^-Na^+$	Water Solubility	Surfactant Properties
n = 8 or less	Soluble	Minimal
n = 10 to 18	Sparingly Soluble	Maximised
n = 18 or more	Practically Insoluble	Minimal

The unique property of surfactants is the way the molecules are adsorbed at interfaces first before remaining in the body of the continuous phase. If a surfactant is slowly added to water in gradually increasing concentrations, where a solid surface is present, the behaviour of the surfactant molecules may be illustrated as shown in Figure 3.

1.3 Effect of surfactant concentration on adsorption

Figure 3



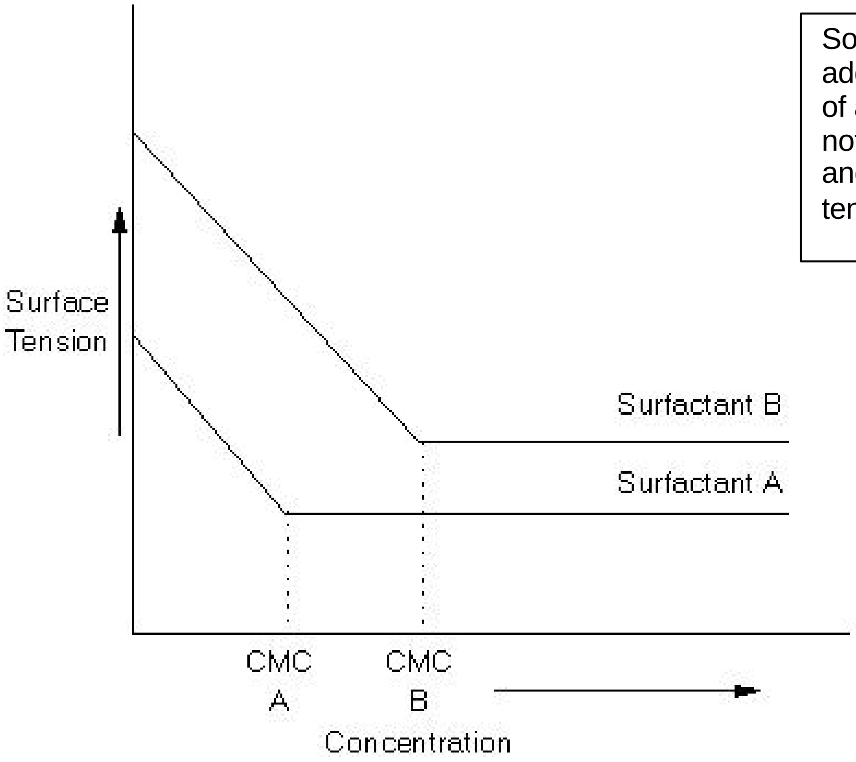
At very low concentrations the molecules lie along the interface between water and the surface. As the concentration increases they gradually align up as available space is filled, until a complete monomolecular layer is formed. At this point, the concentration is called the critical micelle concentration or CMC.

When present at concentrations above the CMC the molecules begin to take up other formations in the water phase. On hydrophilic surfaces a double layer of surfactant molecules is formed, but not on hydrophobic surfaces. Further increase in concentration causes the surfactant molecules to take up formations in the water phase which are called micelles.

The adsorption of surfactant molecules at a surface causes changes to be observed in the surface tension. Surface tension is the pull exerted by aqueous solutions and is shown most clearly where a free drop of water pulls itself into a sphere (minimum surface area for a given volume). As surfactant is added in increasing concentrations the surface tension falls to a minimum at the CMC. Further increases in concentration after the CMC have little effect.

1.4 Surface tension versus concentration

Figure 4

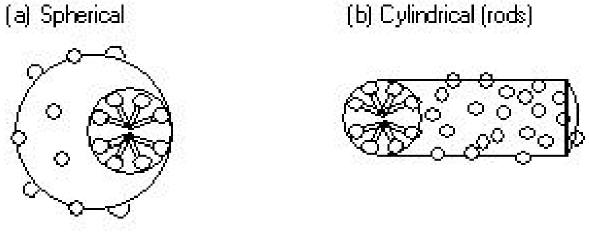


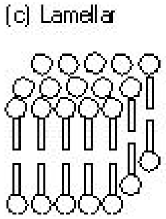
So we can see that adding more and more of any one surfactant will not necessarily reduce and reduce the surface tension

Above the CMC micelle formation takes place. Studies have revealed various possible arrangements, as shown in figure 5.

1.5 Shape of Micelles

Figure 5





The number of surfactant molecules in a micelle is known as the aggregation number. Typical aggregation numbers for anionic surfactants are of the order of 100, while non-ionic have higher values of the order of 1000. It is interesting that aggregation numbers of a given non-ionic surfactant increase as temperature increases, whereas anionics show no such increase and may even decrease slightly.

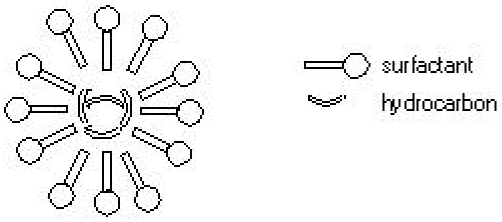
As the concentration of surfactant continues to increase, the shape and arrangement of the micelles change, as the space becomes more crowded. Spheres and cylinders will pack together into various forms sometimes known as liquid crystals, until, ultimately, lamellar formations are achieved. Changes in formation may be accompanied by changes in viscosity. The formations also change with temperature and can be detected by light scattering techniques.

All the above comment applies to the behaviour of surfactants in water. The situation in textile preparation is more complex. Consideration of one more component in addition to surfactant and water alters the situation. If an organic substance, that is nearly insoluble in water, is added to an aqueous solution of the right combination of surfactants, the organic substance appears to dissolve. The reason is that the organic substance is contained in the surfactant micelles. In water solutions, hydrocarbons will be found in the centre of the micelle, whereas polar compounds like fatty acids, alcohols and esters are found in outer regions of the micelle. This effect is known as solubilisation.

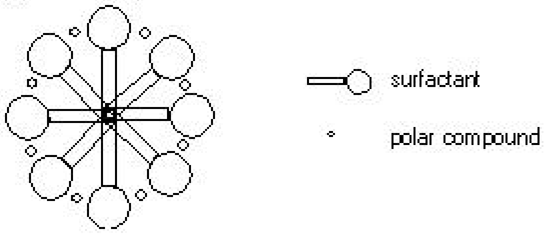
1.6 Solubilisation

Figure 6

(a) Hydrocarbon



(b) Polar Compound



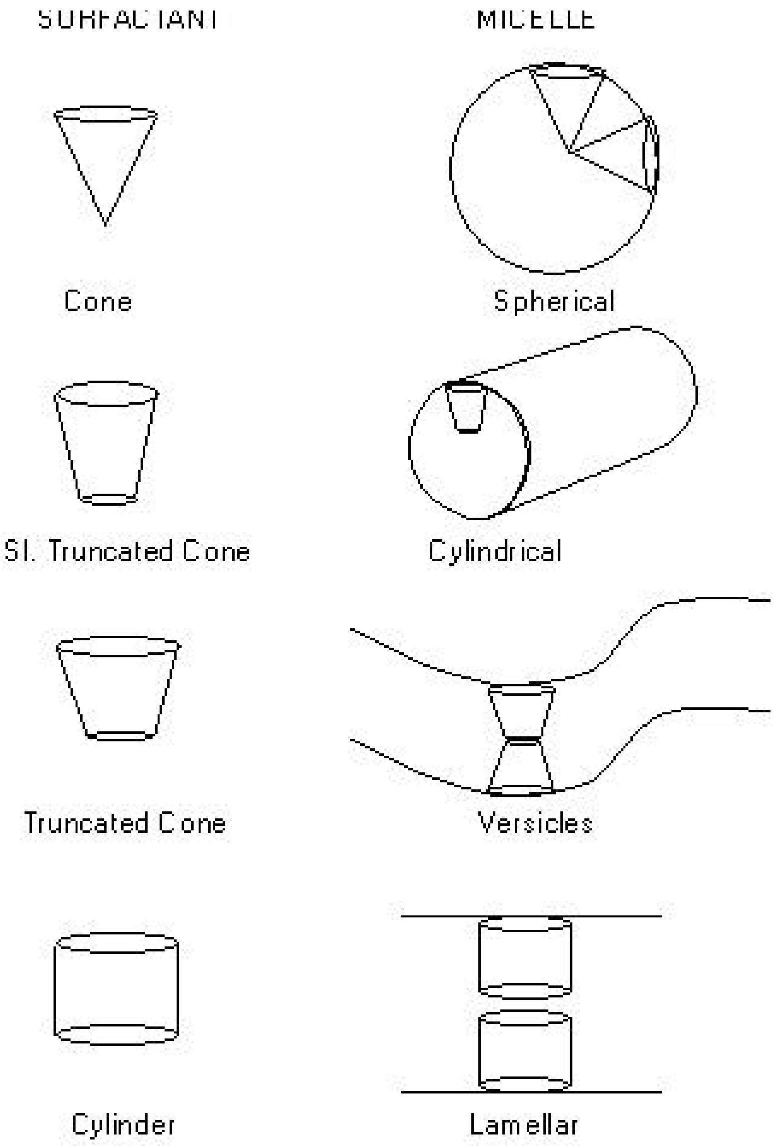
For solubilisation to occur the surfactant concentration must always be well in excess of the concentration of the substance being solubilised. If an oil is added to a solution of specially selected surfactants in water, a much larger amount will apparently dissolve to give an optically clear and indefinitely stable liquid. This is known as a microemulsion. The oil is still solubilised in micelles of increased size, but this only happens if it is possible to reduce the interfacial tension between the oil and the water.

It has recently been shown that the factors which reduce interfacial tension are the same as those which control the shape of the micelles. In simple terms this means the geometrical possibilities of arranging the surfactant molecules at the interface. Depending on the relative sizes of the hydrophilic and hydrophobic groups in the molecule, the micelles tend to be of different shapes.

1.7 Micelle formation – Surfactant in Water

Similar considerations apply to the shape and curvature of the interface between a water-insoluble oil and water. In general the larger groups tend to be on the outside of any curve because there is more space. If the hydrophilic group is larger than the hydrophobic group, then the hydrophilic groups (and the water) will tend to be on the outside. Such surfactants will tend to form oil-in-water (O/W) emulsions. As the size of the two groups approach equality the interface will tend to become planar and the spherical micelles will become larger and take up more oil.

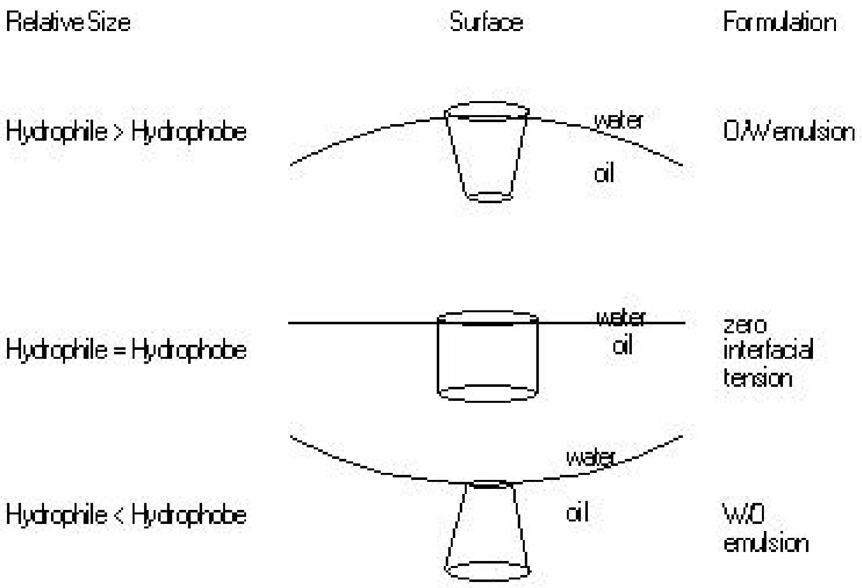
Figure 7



If the hydrophilic and hydrophobic groups become exactly the same in size there would be a planar interface with zero interfacial tension. When the hydrophobic group becomes the larger of the two, it will be on the outside of a curved interface and the system will be a water-in-oil (W/O) emulsion.

1.8 The Oil – Water Interface: Molecular packing

Figure 8



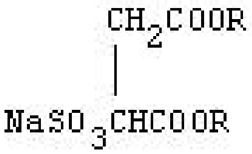
The actual chemical groups most often found in commercial surfactants within the textile industry are shown in Figures 9, 10 and 11.

1.9 Hydrophilic Group Chemistry

1.9.1 ANIONIC SURFACTANTS

Figure 9

Carboxylate (soap)	$RCOO^-$
Sulphonate RSO_3^-	
Sulphate	$ROSO_3^-$
Phosphate	e.g. monophosphate $ROPO(OH)O^-$
Sulphosuccinate	e.g. diester

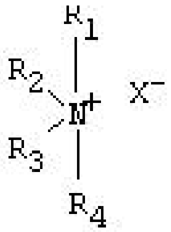


$$\begin{array}{l} \quad\;\; CH_2COOR \\ \quad\;\; | \\ NaSO_3CHCOOR \end{array}$$

1.9.2 CATIONIC SURFACTANTS

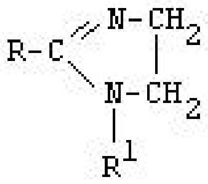
Figure 10

Quarternary Ammonium



Amine Salt eg primary amine hydrochloride $RNH_2H^+Cl^-$

Imidazoline



eg R^1 is $CH_2CH_2NH_2$ amino ethyl

or R^1 is CH_2CH_2OH amino ethoxy

1.9.3 NONIONIC SURFACTANTS

Figure 11

Hydroxyl	R-OH
Ether	R-O-R
Amine Oxide	RN-->0
Phosphine Oxide	RP-->0
Sulphoxide	RS-->0
Triple unsaturation	$R-C\equiv C-$
Ester Group	R-COO
Amide Group	R-CONH

In practice the usual hydrophilic group used in non-ionic surfactants is the ether group, repeated many times in a chain of ethylene oxide molecules:

$-O-CH_2-CH_2-O-CH_2-CH_2-O-CH_2-CH_2-O$
OR
$-(CH_2-CH_2-O)-_n$

The suppliers of auxiliaries to the textile industry make careful examinations of the properties of individual surfactants before selecting the ones to be tried for a new formulation. The most usual combination of hydrophobe and hydrophile encountered in textile preparation include those listed in Figure 12.

1.10 Surfactant chemistry found in textile preparation

Figure 12

ANIONIC

Ether Carboxylates	Very high cloud point
Phosphate Esters	Good wetting in moderate alkali
Alcohol Sulphates	Low temperature detergents for delicate fabric Very high alkali stability
Sulphated Oils	Wetting agents
Alkyl Benzene Sulphonates	High foaming. Washing off after dyeing
Sulphosuccinates	Wetting agents

NONIONIC

Ethoxylates of fatty acids	} Excellent detergents, moderate foam
fatty alcohols	} moderate wetting, very high emulsifying } power } excellent soil suspending properties
alcohol phenols	} good emulsification
propylene oxide	defoamer components

All surfactants exhibit the properties of foaming, wetting, emulsifying, dispersing, detergency and antifoam in varying degrees. The difficulty is that no one molecule, or type of molecule, is best at everything. Thus when functions, calling for several surfactant properties to be combined, are involved, a number of compromises may be necessary to achieve a satisfactory answer.

Detergency is the chief property required of auxiliaries to be used in preparation of textile substrates prior to combining. It is a combination of three processes involving the majority of surfactant properties.

1.11 Steps in Detergency

Figure 13

- Wetting the surface to be cleaned.
- Removal of dirt and impurities from the surface.
- Suspension of dirt to prevent redeposition.

Speed of wetting is dependent upon how quickly the surfactant molecules reach the interface concerned. This is governed by the speed of diffusion through the water by the surfactant. In general small molecules diffuse more quickly than large ones. Once the surfactant arrives at the interface the surface tension is reduced, the interface "relaxes" and wetting takes place. In textiles it is found that the majority of wetting agents are anionic, although in non-colour treatments there is wide use of non-ionic as well.

Wetting the surface of a grey textile substrate is complicated by the impurities on the fibre surface. Suppose there is some oily contamination present on the fibre. The oil drop wets the surface of the fibre and both are surrounded by an aqueous solution of surfactant.

1.12 Oil and soil impurities on Fibre Surface

If the aqueous solution has a greater tendency to wet the fibre surface than the oil drop, then the aqueous solution will replace the oil drop and the oil will be released from the fibre surface.

The lower the interfacial tension between the oil and the water, the lower the wetting tension needed to release the oil drop.

The process of wetting and then subsequent removal of oily contamination is known as the 'roll-back' mechanism. The contact angle between the oil and the fibre increases to either just below or just above 90°. In both cases the oily layer, or drops, are rolled back and then released. Where the contact angle (?) is less than 90°, a neck is formed and a small amount of oil may remain. This will be removed by mechanical action.

Figure 14

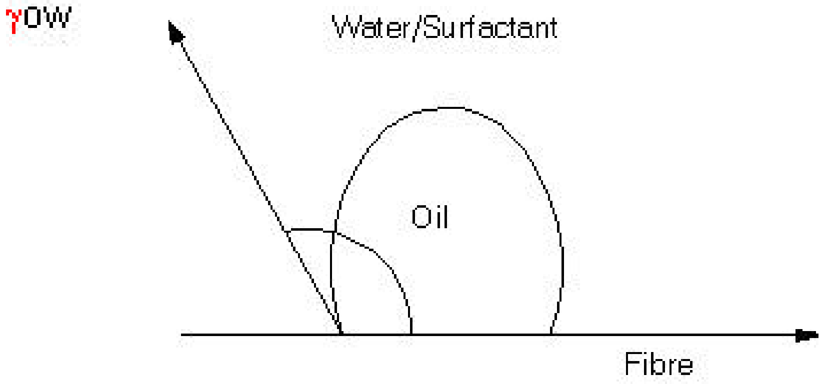
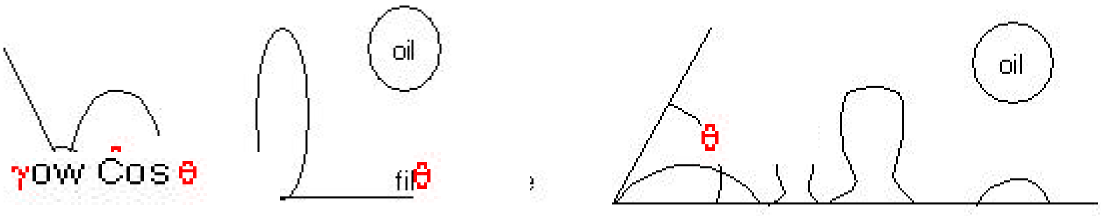


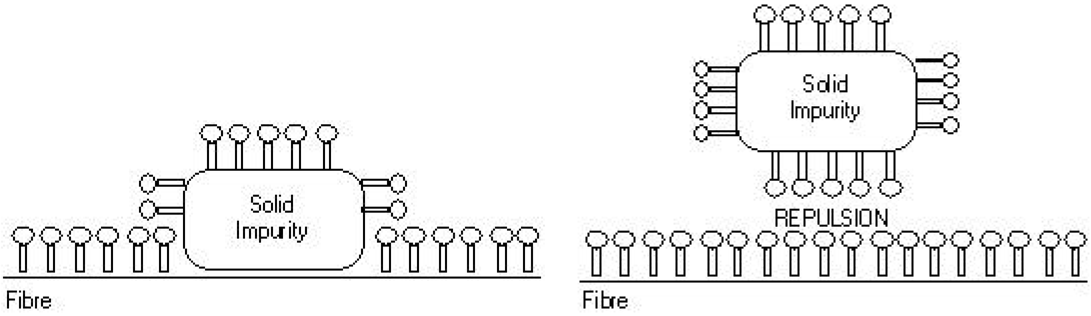
Figure 15: Roll Back Mechanism



? >90° soil separates spontaneously ? <90° work must be done to separate soil

Removal of solid (particulate) impurities is possible because there is no electrical double layer at the point of contact between impurity and fibre.

Figure 16: Release of Solid Impurity



As the surfactant adsorbs to available interfaces, a double electrical layer is formed by diffusion of the surfactant into the contact point between impurity and fibre. The resultant repulsion releases the impurity.

Once impurities have been removed, they must be kept in suspension and prevented from redeposition back onto the fibre. Several mechanisms contribute to this including solubilisation in micelles, dispersion (of solid particles) and emulsions (liquid or oily contaminants).

Dispersions are best achieved by larger molecules than those which give good wetting properties. Emulsions too are stabilised by larger molecules. Non-ionic emulsifiers stabilise by steric hindrance, while anionics stabilise by electrostatic repulsion.

Figure 17: Stabilising Emulsions with Anionic Surfactants

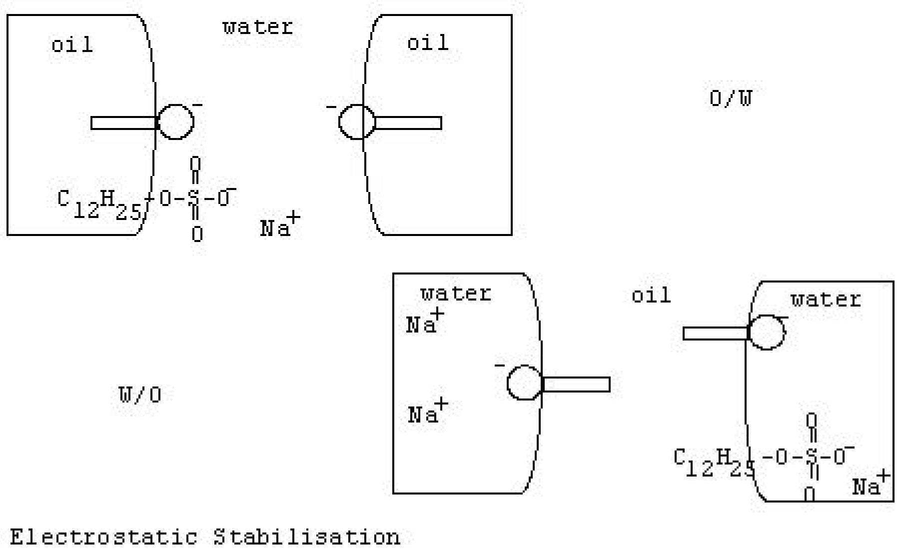
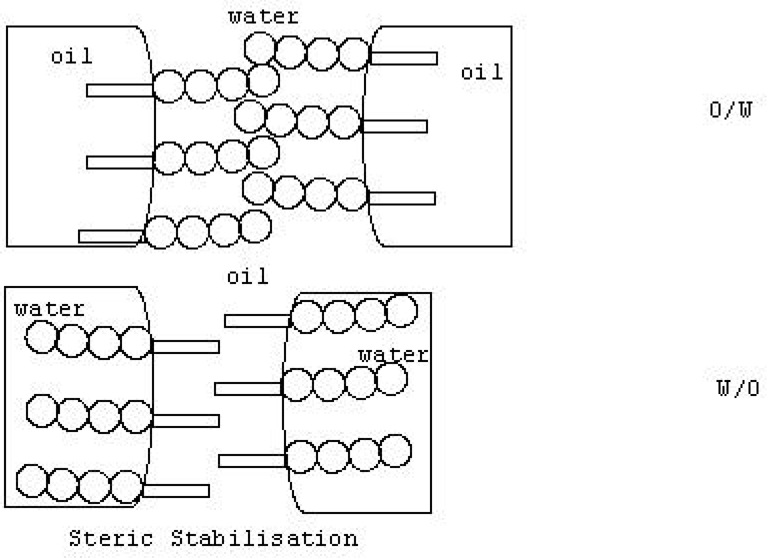


Figure 18: Stabilising Emulsions with Non-ionic Surfactants



The world of the textile industry is far removed from surfactant theory. From the beginnings of the industrial revolution in the last half of the nineteenth century, world-wide industrial conditions have been in a constant state of change. The periods of change have varied, both in length of time and intensity, but the one being experienced now, at the end of the twentieth century, must rank as one of the most intense. This is true of the textile industry too.

Since the first invention of powered machines to spin yarn and weave fabric the textile industry has changed a great deal. It can rightly claim to be a world-wide industry with the majority of industrialised countries having their own national textile sectors. There is a vast range of standards. At the basic end, small units operating largely by hand, with direct heating to the bath of treatment liquor by a fire for example, can still be found. At the top end there are large, well-planned and co-ordinated sites, employing the very latest in machinery, control mechanisms and process techniques.

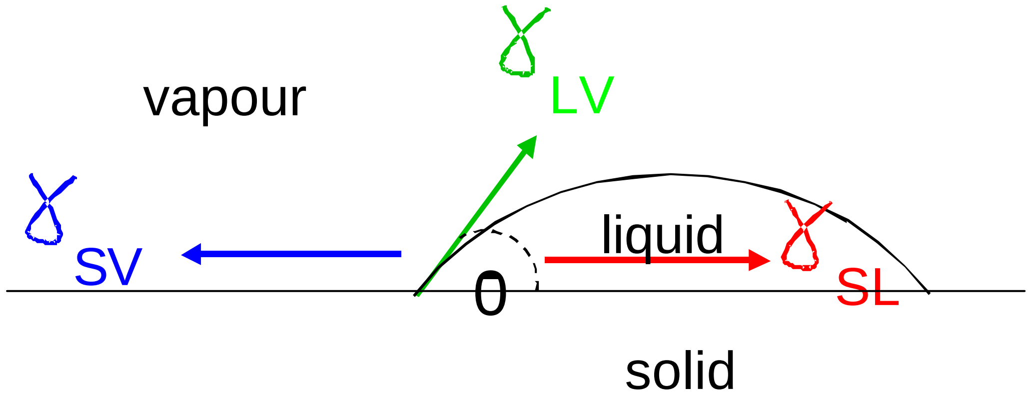
It is the latter end that leads the industry. It is the latter end where new developments, of whatever kind, first become evident and it is the latter end that is addressed in this article. Some of the important areas of change evident in the textile finishing industry will be considered. The effect they have on selection of textile auxiliaries for preparation will be discussed.

2. Properties of Surfactant in Textile production

2 .1 Wetting

Consider a droplet of water sitting on a textile fabric surface. If the droplet is at equilibrium, that is it is not being absorbed into the fibres, then all the forces acting on that droplet must be at equilibrium.

Figure 19



$$\overset{\text{surface free energy}}{\gamma_{SV}} = \operatorname{Cos}\theta\ \overset{\text{surface tension}}{\gamma_{LV}} + \overset{\text{surface free energy}}{\gamma_{SL}}$$

If we reduce the surface tension of the water, γ_{LV} to a value below the surface free energy of the fibre, γ_{SV} then the liquid will wet the fibre.

If the solid is nylon 66, its surface free energy is 46 millinewtons / m.

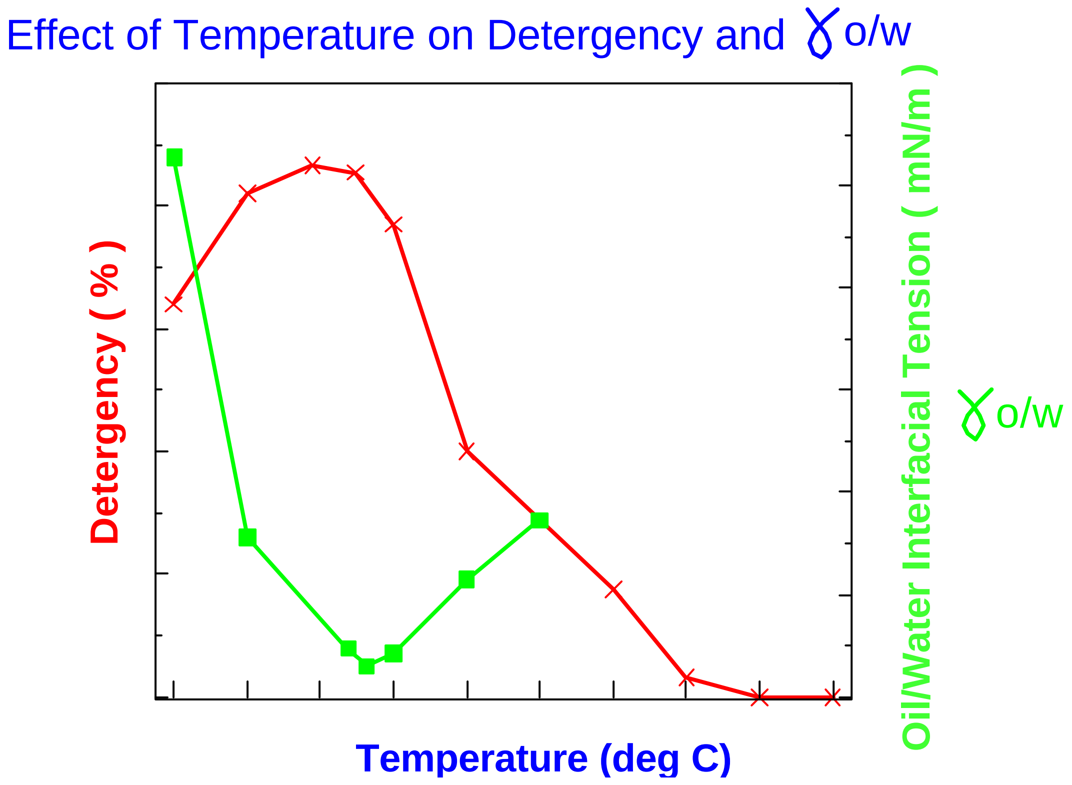
If the liquid has a surface tension below 46, the liquid will spontaneously wet the nylon 66. The surface free energy of polyester is 40, if the liquid has a surface tension lower than 40, the liquid will spontaneously wet polyester.

The surface free energy of cotton is 44, if the surface tension of the liquid is below 44, the liquid will wet the cotton, and so on.

2.2 Detergency

As temperature increases, the interfacial tension between an oil and water will decrease to a minimum at a particular temperature. This means that detergency, in this case the amount of oil removed from a textile fibre, will increase to a maximum at that same temperature.
This is the point, discussed above under **Micelle formation**, at which the hydrophilic and hydrophobic groups become exactly the same in size where there would be a planar interface with zero interfacial tension. This is called the “Phase Inversion Temperature”.
Before this temperature, we are making an oil-in-water emulsion; after this temperature we begin to form water-in-oil emulsions, and gels and other physical forms may form at the fibre surface which make it more difficult to remove the oil, and detergency is reduced.

Figure 20



Surfactants can be designed such that optimum detergency is reached at whatever temperature we wish. For cotton preparation the temperature must be approximately 95 C in order to be above the melting point of the natural waxes in the cotton fibre.

Figure 21

Composition and removal properties of cotton wax

Component	Content (%)
Wax ester	22
Phytosterols	12 - 14
Polyterpenes	1 - 4
Hydrocarbons	7 - 8
Free wax alcohols	42 - 46
Saponifiable	36 - 50
Non-saponifiable	50 - 63
Inert	0 – 3

Between 50 and 63% of the natural waxes found in cotton will not be saponified when we scour with caustic soda. If we want an absorbent fibre, receptive to subsequent dyeing, these waxes must be removed.

Figure 22

Detectable wax acids and alcohols in cotton

Chemical Formula	Systematic name	Trivial Name	Melting Point deg C
C15H31COOH	hexadecanoic acid	Palmitic acid	64
C17H35COOH	octadecanoic acid	Stearic acid	69
C19H39COOH	eicosanoic acid	Arachinic acid	76
C21H43COOH	docosanoic acid	Behenic acid	81
C23H47COOH	tetracosanoic acid	Lignoceric acid	81
C25H51COOH	hexacosanoic acid	Cerotic acid	88
C27H55COOH	octacosanoic acid	Montanic acid	91 - 93
C29H59COOH	triacontanoic acid	Mellisic acid	92
C31H63COOH	dotriacontanoic acid	Locca acid	
C33H67COOH	tetratriacontanoic acid	Ghedda acid	
C17H33COOH	octadecanoic-9-acid	Oleic acid	13
C19H37COOH	eicosanoic-9-acid	Gadoleic acid	
C24H49OH	tetracosanol	Lignoceryl alcohol	75 - 77
C26H53OH	hexacosanol	Ceryl alcohol	79 - 81
C28H57OH	octacosanol	Montanyl alcohol	83
C30H61OH	triacontanol	Gossypyl alcohol	
C32H65OH	dotriacontanol		
C34H69OH	tetratriacontanol		92
C30H60(OH)2	tricontandiol	Coceryl alcohol	
C3H5(OH)3	propantriol	Glycerol	18

The high melting point of some of these waxes therefore forces us to use a temperature of 90 – 95 ^{o}C for scouring and bleaching. For best results our detergent should have optimum detergency at this temperature. That means the Phase Inversion Temperature should be in the region of 90 – 95 ^{o} C.

Detergency is a combination of emulsification, solubilisation, dispersing, wetting and suspending effects.

Areas of major change affecting the textile industry include the following:

3 The World Textile Industry

3.1 Change and Trends

Areas of Major Change

Figure 23

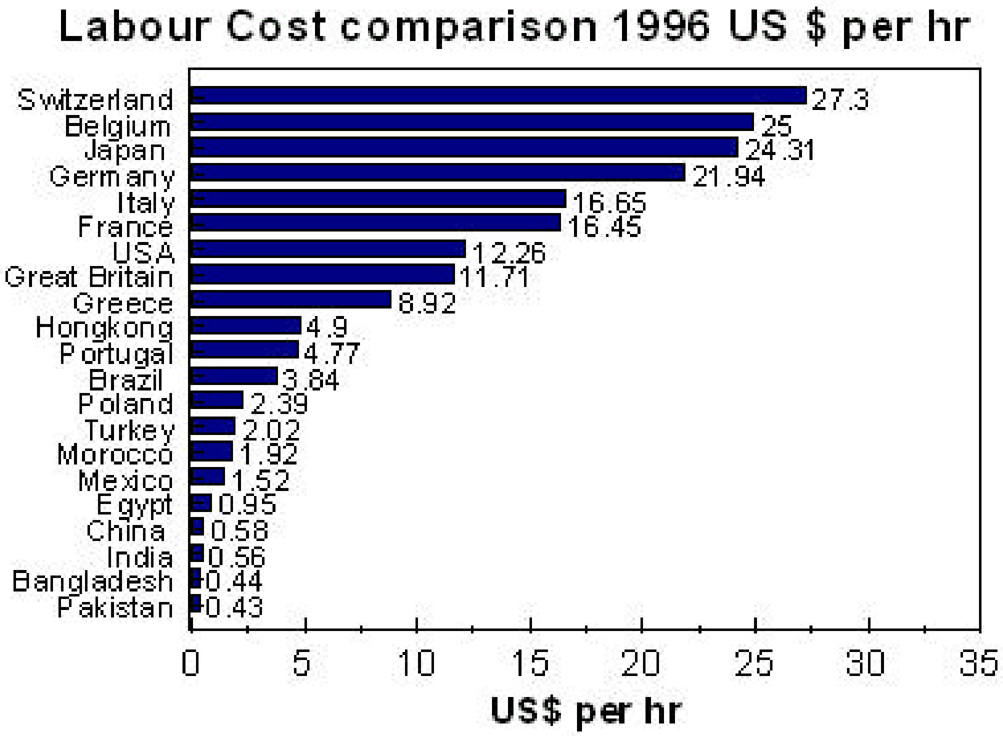
- Costs
- Process Control
- New Machinery
- Environment
- Quality

3.1.1 Costs

The reduction of costs, in order to improve profits, is an ever present challenge to textile finishers. The drive to reduce money spent on processing indicates many of the changes in techniques, machinery and manpower.

Labour costs often have a direct influence on the style of production.
Werner International Inc produced a survey of labour costs in the textile industry in 52 industrialised countries in the world. The results are summarised in Figure 24.

Figure 24: Labour Cost Comparisons Summer/Autumn 1996



European countries with Japan, Canada, Australia, Israel and the USA constitute the twenty countries with highest labour costs. They are followed by Greece, Taiwan, Korea and Hong Kong. The latter three have cheaper labour, at about one-sixth the rate paid in the most expensive country of Sweden. Yet thriving textile companies exist in all the countries. How?

3.1.2 Process Control

One of the explanatory reasons is that companies in countries with high labour costs, have invested heavily in machines with as much automatic control by computers, as they can afford. This has eliminated the high cost of retaining a large labour force and has also eliminated as much human-based error as possible. The result has been better reproducibility with fewer mistakes which has given levels of 90%+ in 'right first time' goods.

3.1.3 New Machinery

Examples of latest developments in continuous preparation centre on 'high add-on' devices where liquor pick-up is around 130%-150%. Such machines include:

Figure 25: High add-on Developments

'BOOSTER'	Benninger
'DIP-SAT'	Goller
'FLEXNIP'	Kusters
'OPTIMAX'	Menzel
'RACO-YET' then ‘PRE-YET’	Ramisch Kleinewefers
'SUPER SAT'	Babcock

They all offer single stage combined scour-bleach processes as a possibility with small volumes of liquor in the add-on device.

Figure 26: Claims for High Add-on Preparation

. Maximum pick up	better scour-bleach
	less creasing (steamer)
	low chemical concentrations
. Minimum 'trough volume'	less wastage
	less pollution
. Automatic dispensing	less human error
. Short steam times	saves energy
	less exhaust gases
. Speedy process	improves productivity

3.1.4 Environment

Clearly a product with low foam, good (fast) wetting and good whiteness is not easy to find. In the recent past results have been obtained about different alcohols with different levels of ethoxylation. For example a summary of technical and environmental properties has given the table in Figure 27.

Figure 27: Surfactant vs Ecological Properties

	Foaming	Detergency	Ultimate Biodegradability	Toxicity
(EO)(PO) Polymer	Low	Good	Poor	Good
C12-15 + 7eo	High	Good	Good	Poor
C12-15 + 11eo	High	Moderate	Moderate	Moderate
C12-15 + 3eo	Low	Moderate	Good	Poor
C12-15 (EO)(PO)	Low	Moderate	Moderate	Poor
C12-15 + 7eo + end cap	Moderate	Moderate	Moderate	Poor
C6-C10 Alkyl polysacch	High	Poor	Good	Moderate
C12 Alkylpolysacch	High	Good	Good	Poor
C9-C11 + 2.5 eo	Low	Fair	Good	Moderate
C9-C11 + 6 eo	High	Fair	Good	Moderate

Aquatic toxicity of non-ionic surfactants varies with the size of the hydrophobe and the degree of ethoxylation, the size of the hydrophile.

Figure 28

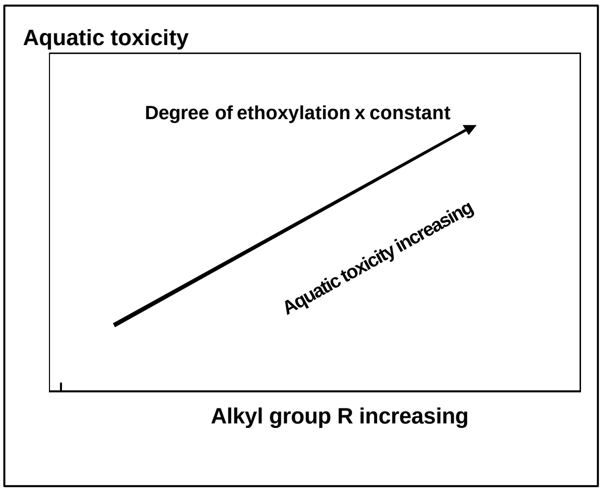
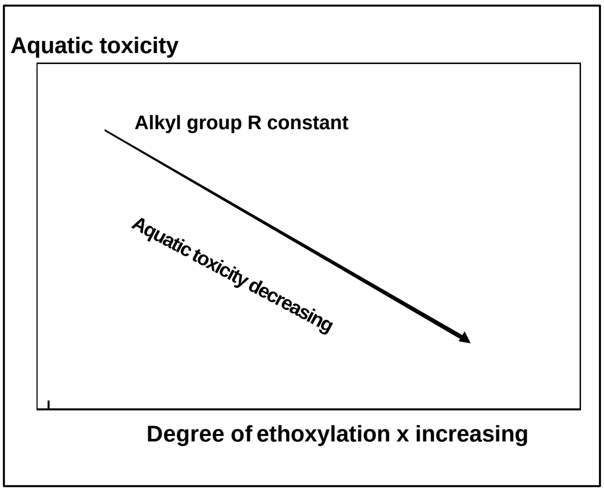


Figure 29



Fatty alcohol ethoxylates reproducibly and consistently give more than 90% biodegradation
Linear alcohol ethoxylates show a faster rate of biodegradation than branched chain alkyl phenol ethoxylates.
Choice of the most environmentally acceptable surfactant is thus often a compromise between biodegradability and aquatic toxicity.

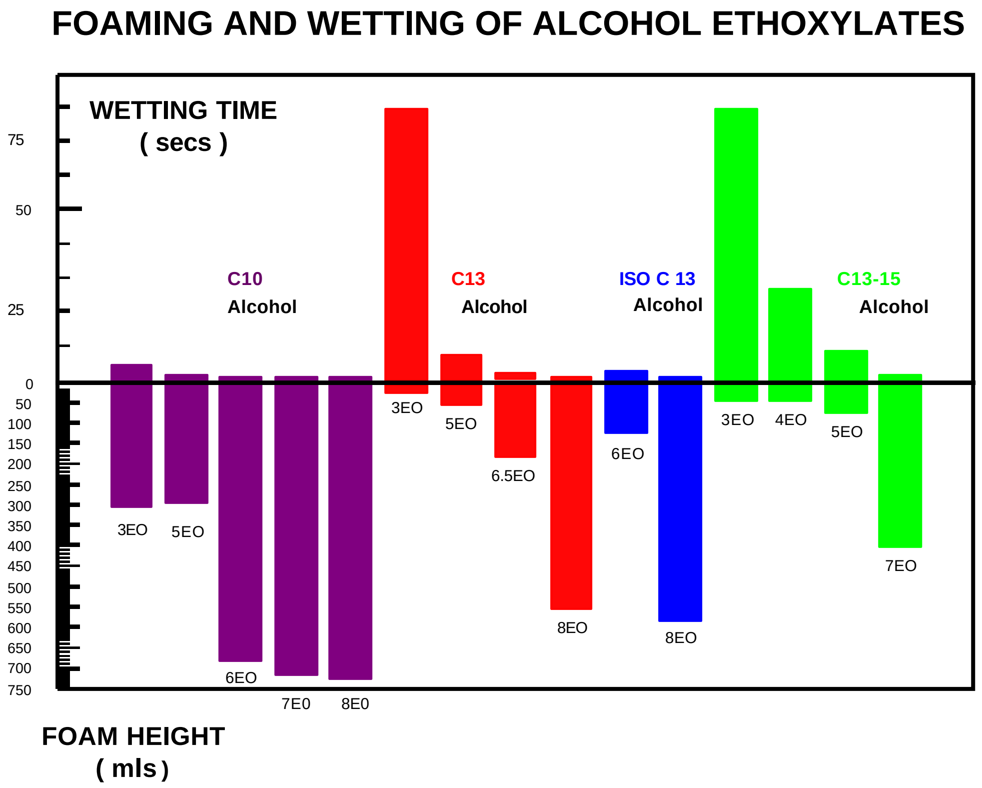
3.1.5 Quality

In order to consider what impact surfactants can have on textiles quality we must look at the relative advantages and disadvantages of the surfactants available.

4 Selecting the most appropriate surfactant

In many textile applications the choice of surfactant involves a careful balance of emulsifying properties, detergency properties, foaming, wetting, alkali stability, solubility, viscosity, biodegradability and other properties

Figure 30



We may decide from a study of the foaming and wetting properties of fatty alcohol ethoxylates, for example, that branched chain C13 ethoxylates, and linear C13 to C15 alcohols offer the best compromise in performance.

Figure 31

INFLUENCE OF DEGREE OF ETHOXYLATION

	C13/15 alcohol					isotridecanol				
Degree of Ethoxylation	4	5	6	7	8	4	5	6	7	8
Emulsifying Action	VERY GOOD	VERY GOOD	GOOD	SATIS.	POOR	VERY GOOD	VERY GOOD	GOOD	SATIS.	POOR
Detergency on Cotton	SATIS.	VERY GOOD	GOOD	GOOD	GOOD	SATIS.	VERY GOOD	GOOD	GOOD	GOOD
Dissolving Rate	GOOD	GOOD	SATIS.	POOR	POOR	GOOD	GOOD	SATIS.	SATIS.	SATIS.

Continuous preparation ranges put particular requirements on the auxiliaries in the impregnation liquor. These are summarised in Figure 32.

4.1 Continuous preparation

Figure 32: Requirements for Auxiliaries In Continuous Preparation

. Rapid wetting of substrate
. Good penetration of substrate (batching or steaming)
. Stability to chemicals (NaOH, H_2O_2)
. Low foam
. Easy removal
. Good dirt suspension

Speed of wetting as dry fabric enters the first liquor application point is vital. There are only a few seconds or less of contact time between the fabric and the source of liquor.

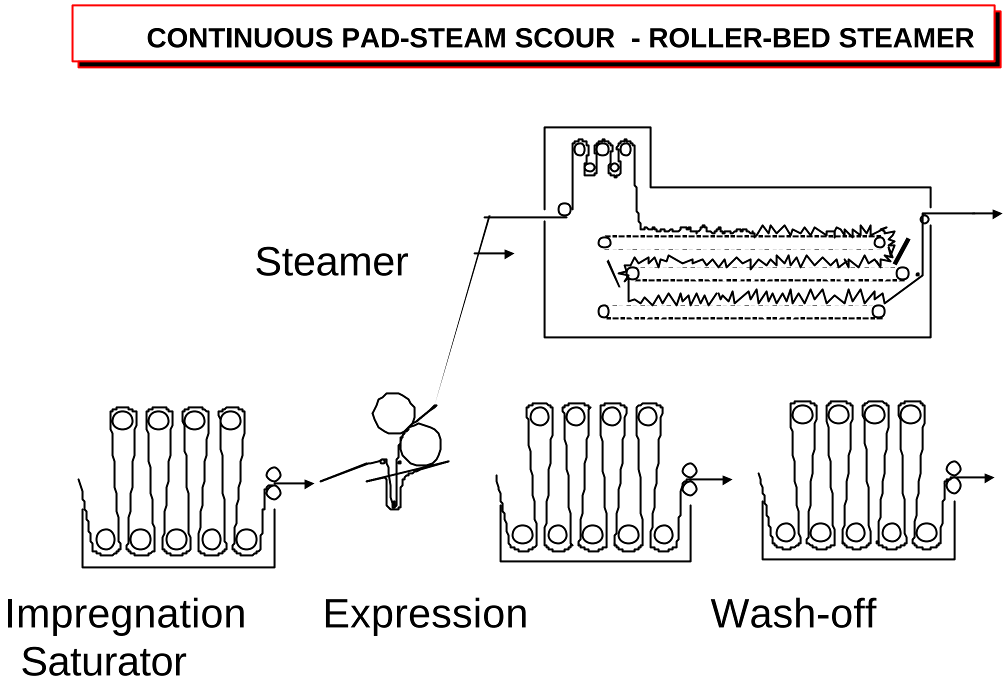
Uniform application (and rapid wetting) at this stage is essential if there is to be a chance of even colouration and finishing of the fabric. Good penetration after initial wetting is equally important, otherwise the fabric will not be evenly clean and unlevelness problems are likely to occur.

Let us consider a continuous pre-treatment installation for the desizing, scouring and bleaching of cotton and cotton blends with Pad-Steam equipment.

If we define “Detergency” as the removal of soil (matter out of place), from a substrate immersed in some medium, generally through the application of a mechanical force, in the presence of a chemical substance, which may lower the adhesion of the soil to the substrate. And we say that the process is completed when the soil is maintained in suspension so it can be rinsed away.

Then in this installation, where is the detergency happening?

Figure 33

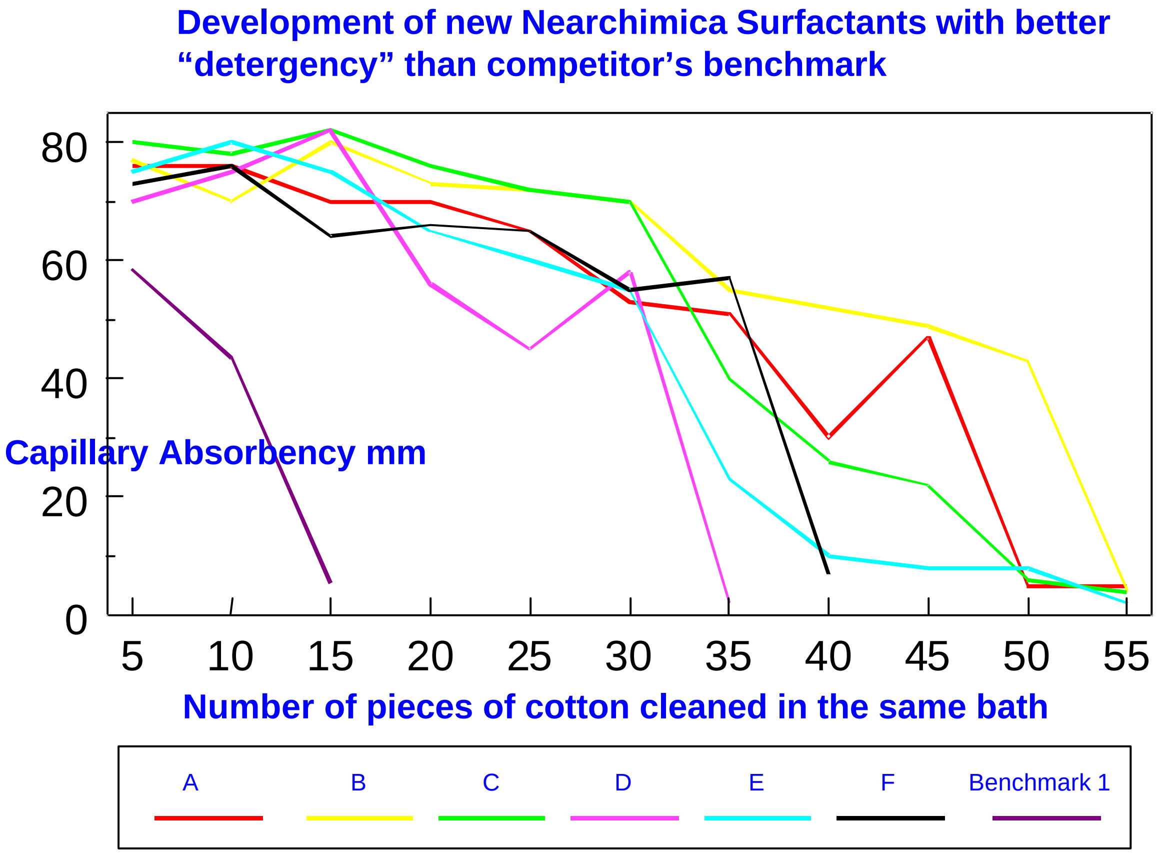


We have already considered the properties of anionic and non-ionic surfactants (in Section 1.10 above). We have seen that anionic surfactants are very good wetting agents, and that, in general, they are very hydrophilic products. If we use an anionic surfactant in the impregnation bath shown here, it will probably give very good wetting, but it will prefer to remain in the water of the impregnation bath rather than be picked up by the fabric travelling through the bath. This means that very little surfactant will be carried over into the wash-off range. It is in this wash-off range where the “detergency”, by our definition, the removal of soil, is occurring.

Nearchimica has developed a new non-ionic surfactant which will be carried over into the wash-off range of a continuous pre-treatment installation where it will assist in the removal of soil, efficiently emulsify oils and waxes, suspend that soil in the wash liquors and prevent re-deposition onto the fabric.

In the following test (Figure 34) we have scoured one piece of cotton in a bath containing caustic soda and detergent, taken the fabric out of the bath, rinsed it and dried it. Then we have measured the capillary absorbency of the cotton. The absorbency is a measure of how effectively the oils and waxes have been removed from the cotton. If the oils are not removed, the fabric will not be absorbent. Then we have repeated the experiment, putting a second, third, fourth piece of fabric, always into the same bath without adding more detergent, and continued to measure the capillary absorbency. Eventually so much oil and wax has been removed into the scouring bath that the detergent can no longer emulsify the oil, or prevent re-deposition onto the fabric. At this point the fabric comes out of the bath with more oil than before scouring, and the fabric will not be absorbent. The test of the detergent is to find how many pieces of cotton can be cleaned before the fabric becomes non-absorbent.

Figure 34



The best of these new developments was given the name "NEARPON CLF".

4.2 Batchwise (or Exhaust) preparation.

New developments in batchwise machines have concentrated on developing the jet concept and low liquor ratios, designed to save both water and energy. Always there is a requirement for very little or no foam. Otherwise requirements of auxiliaries in batchwise preparation are remarkably similar to those for continuous process.

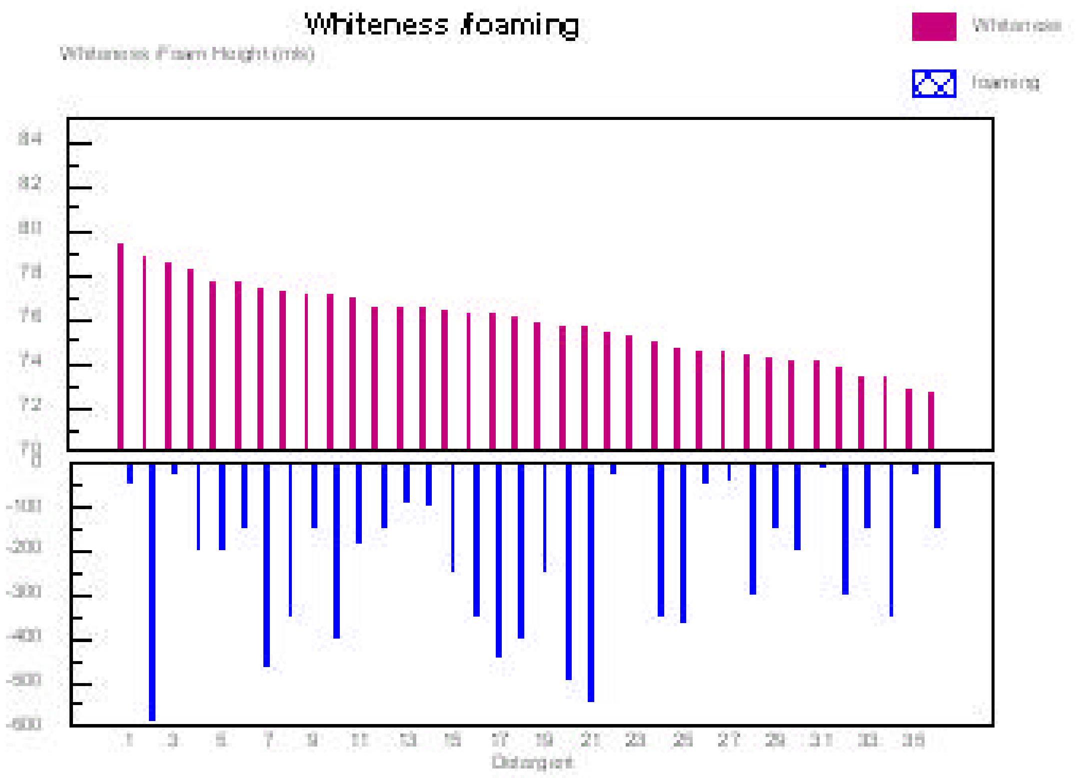
Figure 35: Requirements for Auxiliaries in Batchwise Preparation

- Good, thorough wetting of substrate
- Stability to chemicals (NaOH, H_20_2)
- Absence of foam
- Easy removal of impurities (dirt)
- Good dirt suspension

In the batchwise processing equipment of today, the most important requirement is zero or low foaming. If the liquor produces foam, the liquor circulating pump cavitates and tries to pump air, the fabric stops circulating and we produce an unlevel dyeing. The problem is to combine low foam with good cleaning properties.

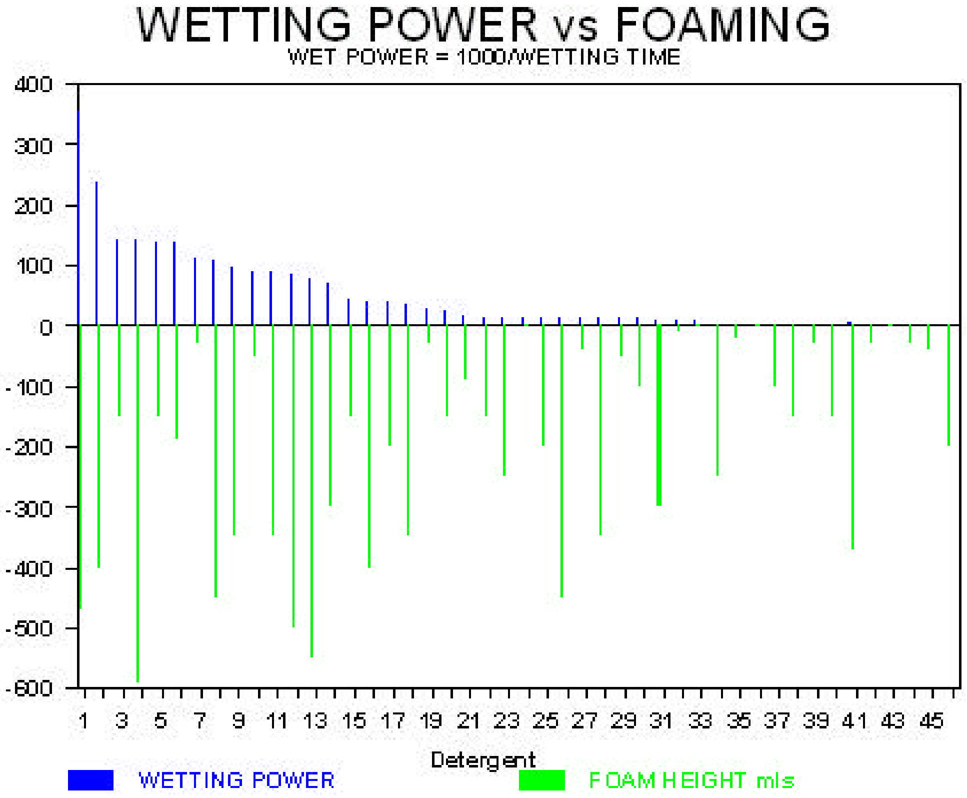
To achieve the ideal single product suitable for all users is very difficult as these results on a number of commercially available products will show. Evaluation of the whiteness achieved by a peroxide bleach was taken as evidence of the dirt suspending power and this was compared with foam height. We have examined the whiteness achieved in a peroxide bleach and the foaming properties of many different competitors' detergents. In general, those products which give the lowest foaming do not give good whiteness in bleaching.

Figure 36: Whiteness/Foaming



Similar comparisons were made between wetting power with foaming.

Figure 37: Wetting Power/Foaming



Similarly, those products which give the best wetting properties, are not those which show the lowest foaming.

But it is possible to provide low foaming and good emulsifying and cleaning powers as we can show with our market-leading product for batchwise pre-treatment, “NEARPON LF-JET”.

Considerations such as these have led to the range of products which Nearchimica have introduced recently. All are based on essentially linear alcohol ethoxylates, all of them have acceptable environmental properties by today's standards and all are proven technically in bulk application in Europe. There are six detergent products:

Figure 38: New Products for Preparation

'Nearpon' MK 91 S	continuous preparation cotton and polyester-cotton
'Nearpon' CLF	continuous preparation cotton and polyester-cotton
'Nearpon' LF-JET	batch wise preparation cotton and polyester-cotton
‘Nearpon’ EMS	batch wise preparation cotton and synthetic fibres
'Nearpon' KR	for removal of obstinate grease contamination
‘Nearpon’ TKR	for removal of very hydrophobic oils from synthetic fibres

‘Nearpon’ KR is a result of the work we have done on producing a detergent with very low surface tension, by which means we can achieve, for example, removal of silicone oils from microfibre polyamide, polyester, and elastomeric fibres like “Lycra” ®.