



Fatliquoring: the heart of the wet end

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Skin's high flexibility depends on the ability of the individual fibres within the structure to slide against each other, the water in and around these fibres, natural fats and the structure of the skin itself. When the water and fats are removed, the skin becomes dry and cracks due to fibre compaction and this can occur both before and after tanning.

Fatliquoring is carried out to impart softness and flexibility to leather by adding lubricating products during wet end processing. The fatty matter introduced into the skin acts as lubricant, and helps the fibres to slide against each other. The process also improves the physical and mechanical properties of the leather.

Market trends demand articles where softness and flexibility are increasingly important. Consumers want leathers that are smooth to the touch and have a texture that can be described as having the 'cuddle factor'. These leathers must be very malleable, soft and warm to handle.

To achieve these effects, fatliquors based on both natural and synthetic raw materials can be used. Numerous combinations of these fatliquors are possible, and they can be applied at many stages within leather processing.

The raw material

An important factor in the development of an article is the choice of raw materials, and wet blue hides must be graded accordingly to suit the article to be produced. This stock selection will define the characteristics of the final article. There are many details to take into account, and these factors, along with how they are best rectified, are set down in *Panel 1*.

The fatliquoring process

In the fatliquoring process, both the penetration and the fixation of fatty matter takes place.

In order to optimise penetration into the leather structure, fatliquors must be emulsified in water and added to the processing vessel. The mechanical effects caused by the drum rotation, the surface tension and the capillary action of the hides, all promote penetration of the fatliquor into the structure.

Fixation of these fatliquors is achieved by adding acid products at the end of the process. This causes the emulsion micelle to break, and results in a series of interactions:

- Reaction of the ionised groups in the oil with the ionised groups on the collagen ►

Panel 1:

The effect of the substrate (wet blue)

Influence factor	Effect	Advice
Natural fat	Although they can be excellent lubricants, natural fats make the penetration of retanning agents difficult. They may oxidise, producing unpleasant odours and/or yellowing. They may migrate causing fatty spues.	Thoroughly remove fats such as triglycerides and free fatty acids. These may be present in the skins in quantities ranging from 0.5% to 2.5%. It is recommended that wet blue hides contain from 0.5% to 1.5 % dichloromethane extractable substances, calculated on the dry weight.
Inorganic salts	Some salts have a negative effect. They add weight and hygroscopicity, and may migrate to the surface.	Whenever possible, carry out intermediary washings to remove inert salts. Test and choose products as per supplier information and the characteristics of the article to be produced.
Chrome content	This indicates the level of tanning. A low content of fixed chrome can impart low thermal, physical and mechanical properties. This can jeopardise further chemical processing and mechanical operations.	Wet blue must contain a minimum of 3.5% Cr_2O_3 calculated on the weight of the dry pelts. Whenever lower amounts are detected, rechroming is necessary in order to raise the chrome content and achieve uniform distribution.
Difference figure	Leathers with a very high difference figure tend to have lower physical and mechanical resistance. (Legend 1)	Neutralisation may be extended to ensure a uniform pH value through the whole thickness of the hides, thereby eliminating excessive acidity.
Humidity	If wet blue hides become dry, fibre, compaction occurs. This makes chemical product penetration difficult and jeopardises wet end operations.	Take steps to avoid any drying of wet blue from the start. If any drying has occurred, then do not begin further processing until hides have been evenly wet back.
Firmness of the grain	Wet blue hides that are loose grained should only be used in the production of articles that do not require a firm, tight grain structure	Hides that show a tendency to loose grain may be treated with special retanning agents to fill the empty space between the grain and the reticular layer. This helps to preserve the grain characteristics so that these leathers can be used for better quality goods.



FATLIQUORING: THE HEART OF THE WET END

- Co-ordination of those groups in relation to chrome complexes and retanning agents in the leather
- Deposition of fatty matter in and between the fibres

Fatliquors may have different characteristics in terms of ionic character. They may be cationic, anionic, amphoteric or non-ionic. The level of penetration and fixation of chemicals depends on the relationship of the fatliquor with the ionic character of the hides. This is closely related to the pI or isoelectric point of hides during fatliquoring.

The collagen chemical structure may be represented as shown in *Panel 2*.

Ionisation of the amino or carboxylic groups depends on the pH of the medium. In acid solutions, carboxylic groups are non-dissociated and the charge becomes positive, which imparts cationic character to hides. When carboxylic groups are in an alkaline state, they are dissociated and the total charge is negative. This imparts an anionic character to the leather, as indicated in *Panel 3*.

Depending on pH adjustment, there is a value where the total charge of the hide is in balance with the medium. That is, where the quantity of positive charges equals that of the negative charges. That pH value is the pI.

It must be stressed that the pI depends on the type of tanning and retanning the hide is subjected to. When the hide/float pH is lower than the pI, hides will show cationic behaviour and fix anionic products. On the other hand, if the pH is higher than the pI, the hides will show anionic behaviour and combine with cationic products. These details are important because they affect the uptake of the fatliquor within the leather structure.

The neutralisation process is central to the pH of the system and the distribution of these fats within the leather structure. In the wet blue stage, hides are highly cationic, and the function of neutralisation is to partially minimise cationic charges, leaving hides less reactive to anionic products.

As most fatliquors are anionic, when they come into contact with neutralised hides they do not react instantly. They penetrate into the leather structure and cause a softening of the fibres.

If the hides were not neutralised, the fatliquor emulsion would split on the surface and softness would not be achieved. Essentially, softness is related to a high degree of penetration, while surface smoothness, feel and silkiness depends on the fixation of fats on the surface. Many factors in wet processing affect fatliquoring. Some examples are given in *Panel 4*.

When fatliquoring has to take place during mineral tanning, such as chrome tanning, cationic fatliquors must be used—not ionic ones—because of their compatibility with the chrome salts used in the process.

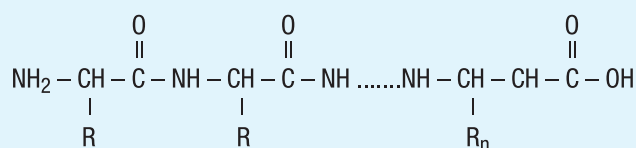
The classification of fatliquors

There are various types of fatliquors, and they may be categorised according to:

<i>Ionic character:</i>	anionic, cationic, amphoteric or non-ionic.
<i>Origin of raw materials:</i>	animal, vegetal, mineral or synthetic.
<i>Composition:</i>	pure or with emulsifiers.

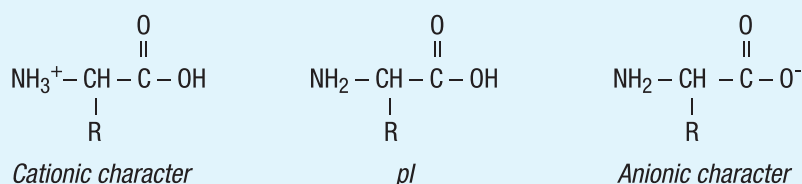
Panel 2:

Representation of the chemical structure of collagen



Panel 3:

Representation of ionised leather



Panel 4:

Factors relating to the fatliquoring process

Factor	How fatliquoring is affected
Volume of the float	The larger the volume of the float, the lower the penetration speed. Short floats increase both the float concentration and mechanical effects. This increases the diffusion rate into the inner layers of the leather structure.
Drum rotation speed	When using traditional drums the higher the speed, the greater the mechanical action. This provides greater penetration and dispersion throughout the hides.
Neutralisation	The more neutralised the hide, the lower the reactivity with anionic groups and the higher the penetration of anionic products.
Intermediary washes	Washing, especially after neutralisation and retanning, eliminates salts from the system that would normally reduce fatliquoring emulsion stability. As a result of washing, a better penetration of fatty matter is achieved.
Hide thickness	The greater the thickness, the longer the time needed for fatliquors to penetrate into the deeper layers of hides.
Water hardness	Salinity deriving from water hardness usually reduces fatliquoring emulsion stability. It can even form insoluble calcium and magnesium soaps that can cause the fatty matter to precipitate onto the surface of hides.
Temperature	The higher the temperature, the lower the penetration. This is because collagen/fatliquor reactivity is increased, causing superficial fixation. However, it is recommended that fatliquoring is carried out at temperatures between 50°C and 60°C in order to increase the fatliquoring emulsion stability during penetration into the hides.
Acidity	The quantity of acid ions in the float may also interfere with the stability of anionic fatliquor emulsions. These are more stable in a neutral or slightly alkaline medium.
Product compatibility	The composition of the fatliquor blend must be chosen carefully. The characteristics of each should allow the formation of a stable emulsion in water.



Panel 5: Fatliquor characteristics		
Composition	Characteristics	Recommended articles
Sulfited natural and synthetic products	Deep penetration into the hide structure to produce leathers with a very soft and smooth touch, and with good filling.	Light leathers for garments, upholstery, floaters and nappa leathers.
Sulfited and synthetic natural products	Excellent stability to electrolytes, a high level of penetration and softness.	Soft, nappa-like leathers mainly for garments and upholstery.
Modified fatty alcohol-based products	Soft and silky touch, good filling and light fastness. Improvement of the physical and mechanical properties of leather.	Soft leathers such as soft nappa, garment and upholstery leathers, floaters and soft white leathers.
Modified lanolin-based sulfited natural and synthetic products	Improved tensile strength and tear resistance. Good brushing properties.	Nappas, upholstery and semi-chrome leathers.
Lecithin-based sulfated natural and synthetic products	Soft leathers with lower density and a pleasant, silky touch. These products may be used in rechroming and fatliquoring and as top coats.	Suitable for many types of articles that require a silky, pleasant feel.
Sulfated natural and synthetic products	These products impart a full, silky touch.	Suitable for firm grain leathers with a soft and medium touch.
Modified paraffin-based synthetic products	Used in the production of several types of articles, these products also contribute to waterproofing. They impart a characteristic velvety, very soft feel.	Suitable for many types of leathers that require a high level of softness, such as garment, upholstery, floaters and nappa leathers.

Chemical nature: hydrocarbons, natural triglycerides, synthetic and natural esters, modified alcohols, etc.

Chemical modification: sulfated, sulfited, chlorinated, sulfo-chlorinated, epoxidated, etc.

The simplest and most common ways of classification are by the origin and the chemical modification of the fatty matter. The main characteristics are:

SULFATED

These products are obtained from the reaction of animal or vegetable oil with sulfuric acid or gaseous SO_3 at low temperatures. Through this reaction, polar groups that are hydrophilic are introduced into the structure of the fatty matter. This enables the final product to form an emulsion in water.

The higher the sulfation rate:

- The higher the emulsifying power of fatliquors
- The higher the stability to acids
- The greater their penetration power into the hides

But the higher the sulfation rate, the lower the lubricating power. The balance between the need for emulsification and the lubrication power may be achieved by controlling the content of fixated SO_3 . Sulfated fatliquors usually impart softness, filling and elasticity to leather as well as preserving grain firmness.

SULFITED

These products are obtained from the reaction of natural oils with sodium metabisulfite in oxidative conditions and are more stable to electrolytes than sulfated ones. Their emulsions are stable to acid media, hard water and even chrome tanning agents. They form very fine micelle emulsions, which greatly facilitate penetration into the deepest layers of the leather and impart a very high degree of softness.

SYNTHETIC

These fatliquors are obtained from sources other than animal

or vegetable. The products are mainly based on mineral oils, although many alcohols and fatty amines derived from triglycerides also belong to this group.

Most of these oils are modified by sulfation, sulfition, sulfo-chlorination, ethoxylation or epoxydation. This makes emulsification and reaction with collagen possible.

Some of these fatliquors will dissolve natural fats remaining in the tanned hides, which significantly improves their distribution. Depending on the type and degree of modification, these products may form fine emulsions in water and offer good emulsion penetration and stability.

NATURAL

As their name suggests, these products are in their natural form and have not been modified by chemical processing. However, they undergo physical processes in their preparation such as filtration, distillation, decantation and cooling. They are usually non-polar products, and have no functional groups capable of fixating themselves to collagen through chemical links. Because they are non-reactive, these fatliquors simply settle between the leather fibres and work as lubricants.

When natural fatliquors are used for lubrication they must be blended with modified fatliquors. Alternatively, emulsifiers can be used as they promote emulsion formation and the subsequent penetration of the oil into the leather structure.

Natural fatliquors of animal origin usually have an affinity with leather and impart good filling, softness and superficial smoothness. But those of mineral origin generally do not impart filling and give a drier superficial feel. In addition, heat may cause them to migrate and return to the surface of the leather with an oily feel and appearance.

Clearly, there are a vast number of combinations of different raw material origins, chemical modifications and auxiliary products added to fatliquors. Some examples of fatliquor characteristics are given in *Panel 5*.

Legend

1. A high difference figure (0.7 - 1.0) indicates that strong acids (if $\text{pH} < 4$) are present in the leather as opposed to weak acids or a high buffering capacity. Method of determination: EN ISO4045|IUC11|FLC13.