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Leather:

AN OVERVIEW OF MANUFACTURE

(Part 2)

The introduction of new materials and extension of the structure

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Leather: AN OVERVIEW OF MANUFACTURE

Content and Structure:

This section includes a summary of hides and skins as raw materials.

Part 1: The removal of unwanted materials and extension of the structure.

Part 2: The introduction of new materials and extension of the structure.

Part 3: The removal of water and reconfiguration to a flat form.

Part 4: Application of the finish.

Part 5: Different types of bovine leathers.

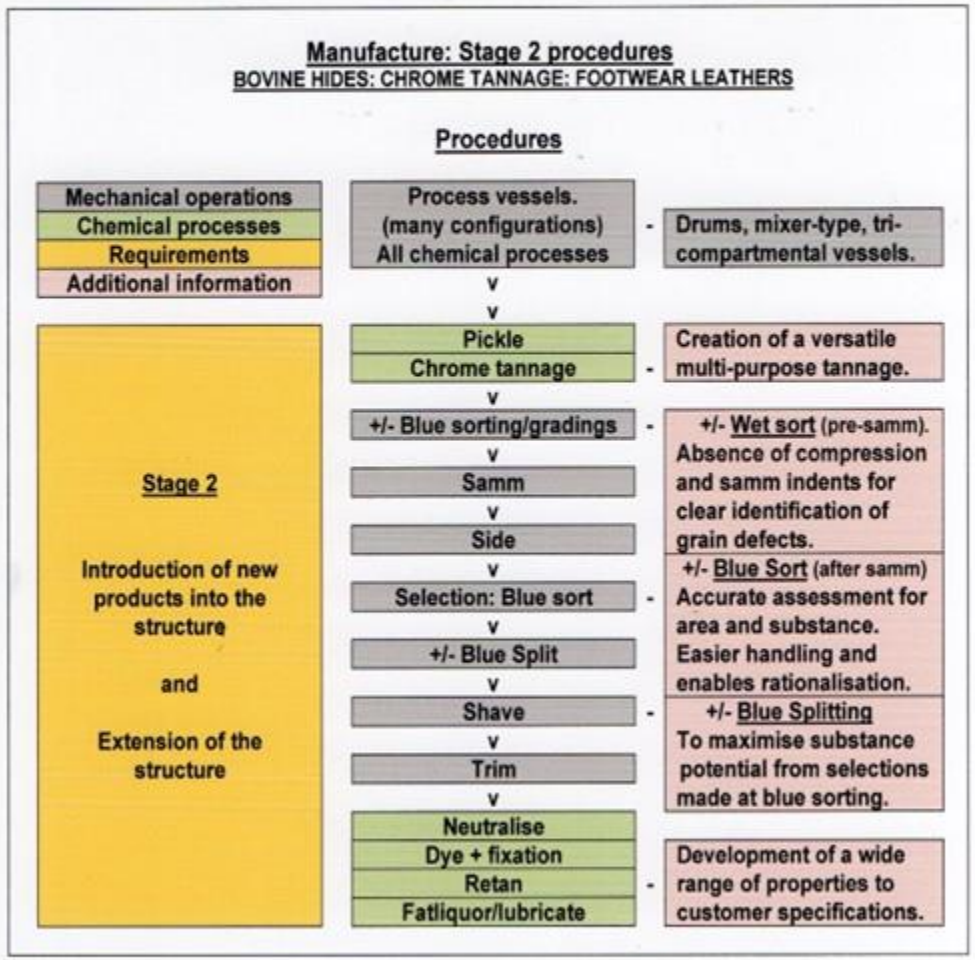
Part 6: Small skins: hair sheep and goat: grain leathers.

Part 7: Small skins: wool bearing sheep: double face, shearling and rugs.

Part 8: Discussion.

Annex.

Stage 2 Procedures



- **Within Stage 2 procedures, new materials are introduced into the collagen structure.**
- **Controlled additions of chemicals are made to stabilise the structure *(tanning)* and to produce leather.**
- **The leather properties are then amended by further chemical offers in retanning, dyeing and fatliquoring processes, to meet customer specifications.**
- **Extension of the hides and skins from a natural rounded structure to a flattened form continues throughout all mechanical operations.**

TANNING PROCESSES

The objective of tanning is to stabilise the collagen structure to provide resistance to putrefaction *(rotting)* under repeated wetting/drying cycles. This chemical processing causes an increase in shrinkage temperature *(Ts)* under high moisture conditions.

Many chemical products can match these technical requirements, but few are able to provide a viable product in terms of aesthetic and physical requirements.

The most common technique is based on chromium salts and is generally known as "chrome tannage". More than 80% of leathers produced globally are manufactured by this method, and these leathers have been in major use for more than 100 years.

This technique provides hydrothermal stability – wet chrome tanned leathers can withstand boiling in water without irreversible damage – and a leather that can be readily amended in subsequent processing to serve many end uses.

Other important tannages use vegetable extracts, glutaraldehyde-type products, syntans and synthetic variants.

The acid/salt pickle process

Controlled chemical additions.

Acid/salt pickled hides.

- Preparation for chrome tannage involves the addition of pre-diluted acids to delimed/bated hides in the processing vessel.
- Mainly a blend of formic and sulfuric acids, common salt is included to prevent the hides from swelling under the moderately acidic conditions created.
- Known as pickling, this process is part of controlling the penetration of the tanning agent into the skin structure.
- At the end of this process, the hides are neutral coloured, clean and relaxed.

The pickle process is very important in tanning as it controls the chemical reactivity of the collagen structure.

In turn, this determines the rate of the chemical combination of the tanning agent with collagen.

Chrome tanning agents require a moderate level of acidity to penetrate the structure before fixation.

The pickle process is common to most tanning systems, but the level of acidity *(pH)* varies according to the tanning product used.

There are some alternative techniques where the conventional acid/salt pickle is replaced by specialty products, but all tannages need a preparation stage.

The chrome *(chromium based)* tanning processes

Clean and secure conditions.

Tannage complete - awaiting unload.

- Once the acid/salt pickle stage is complete, chromium based tanning agents are added to the process.
- These can penetrate throughout the hide structure, and combine slowly under these conditions.
- Once penetration has been achieved, a mild alkali is added to make the system less acidic.
- Careful control of acidity, in conjunction with the processing temperature, helps the chromium based salts to chemically bond with the protein structure.
- This reaction stabilises the collagen structure and creates chrome tanned leather.

Discharge at end of chrome tannage.

Wet blue - awaiting further processing.

- Once tanned, the hides have developed important properties.
- Known as “wet blue” this tannage is stable, heat resistant, and will not putrefy even if kept in a wet state.
- This type of leather has strong affinity for dyestuffs and other chemicals that can modify the physical and aesthetic properties.
- This leather is very versatile - many different effects and characteristics for different end uses can be developed.

Review:

Chrome tannage is the most common method of tanning. Before the tanning process commences the hides need to be in a moderately acidic state.

(Note: replacement tannages – mainly metal free – are under constant evaluation)

The acid/salt pickle:

When received for pickle/tanning, the hides are mildly alkaline. If chrome tanning agents are added directly then a very rapid fixation will occur on the skin surface. The centre of the hide will remain raw and untanned.

The skins are therefore pre-treated in a process called pickling, generally using sulfuric and formic acid to ensure a controlled tannage. Common salt must also be included to prevent the skins from swelling under these moderately acid conditions.

The pickle/tanning process has a degree of flexibility, so the time and conditions within pickle can vary. Some systems require a uniform level of acidity throughout the structure before the addition of tanning agents. Others need a profile that is more acidic on the grain and flesh layers, but moderate in the centre parts.

Chrome tannage:

Based on chromium sulfate, tanning materials can be supplied in powder form in varying basicities. The more "basic" the chrome, the more rapidly it combines with the skin collagen and the less it penetrates before tanning. The higher the basicity, the plumper, softer and looser the leather produced. Chrome tanning agents can be modified *(masked)* within the tanning operation by other chemicals, usually organic acid salts such as formats. This produces softer and lighter coloured leathers that are less chemically reactive in subsequent processes.

The more acid the skins are within the tanning stage, the slower the reaction between the collagen and the chrome, and the deeper the penetration into the skin structure before fixation. However, after penetration of the chrome through the skin structure - usually by a combination of acid conditions, modification of the reactivity of the chrome tanning product *(masking*), and mechanical action - the tanning system is made slightly less acidic.

This lessening of acidity requires a controlled addition of mild alkalis to increase the fixation of the chromium compounds with the carboxyl groups of the collagen.

The combination of final pH, temperature, and float concentration can provide a high quality product with excellent chrome uptake. The length of time in chemical process between commencing deliming until the end of tannage may be around 15 hours.

Known as wet blue, these leathers are a light blue/green in colour, resistant to putrefaction, and exhibit a shrinkage temperature >100°C when saturated with water. They are chemically very reactive with dyestuffs and the major products used to modify the leather properties in subsequent processes *(neutralising, retanning and fatliquoring procedures – pages 2/38 – 2/50)*

OTHER TANNING SYSTEMS

Three other tannages are considered:

- Systems based on glutaraldehyde.
- White tannages.
- Vegetable tannages - based on a range of vegetable extracts.

The use and importance of these three tannages will change, and similarly to chrome tannages, replacement systems for aldehyde-based tannages are under constant development.

New systems will evolve, but the techniques described provides broad guidance into the methodology of all tanning systems.

The “white” glutaraldehyde tanning process

“White” glutaraldehyde tanned leather.

Required: durable & shape retention.

- This is the first tannage specifically developed as an alternative to chrome tannage - mainly for uses within the automotive sector.
- Requires acid/salt pickling systems similar to chrome tannage, with a rise in pH/temperature to achieve fixation.
- Product available in modified forms to assist structural penetration, and to lighten the pale yellow-brown colour.
- Needs syntans/resins in tannage for shape retention during shaving.
- Leathers can be soft, shrinkage temperature approximately 75C, but little filling within the fibre structure.
- Poor reactivity with dyestuffs and agents used in subsequent processes.

White tannages

"White tannages" - variety of shades.

Various properties - can be very soft and tactile.

- There are many "white" tannages.
- These have mainly been developed as replacements for glutaraldehyde tannage.
- These are based on a variety of products - syntans, "colourless dyestuffs", cross-linkage systems - and other organic and non-organic products.
- Process techniques often similar to glutaraldehyde tannage employing an acid/salt pickle, but some can commence at a higher pH.
- Mainly need additional products in tannage for shape stability and retention.
- Often reduced reactivity with products required in retannage and fatliquoring.

Vegetable tanning processes

Light leather – wet relaxed and pliable.

Heavy leather – wet firm and compact.

Long established methods, where extracts from barks, leaves and fruits are used to make two types of leather:

1] *"Light leathers"* – low substance, with a moderate level of tanning content for medium softness.

Shown stacked after drum tannage.

End-uses: footwear and leather goods.

2] *"Heavy leathers"* – high substance with high level of tanning content for dense filling and great durability.

Shown draining after a "pit" tannage - sufficiently firm and compact to stand on shanks without any support !

End-uses: Soles/lining for footwear, belts, harness, industrial and carving.

Veg extract addition in drum tannage.

Movement of hides during pit tannage.

Light leather manufacture: **uses low offers of vegetable tannin extracts with fast drum processes. Employs acid/salt pickles of weak acidity.**

Heavy leather manufacture: **uses high offers of extract and can take 4 – 10 days.**

- **Tannages managed by moving hides suspended on frames through a series of pits of tannin solutions of increasing concentration.**
- **Drum/pit combinations, and sometimes drums only.**
- **Various pre-treatments before tannage.**

Review:

Glutaraldehyde tannages:

It is possible to make very soft leathers, but tannages are generally performed in combination with syntans/resins to provide shape stability during shaving.

Offers of fatliquor are also needed for a progressive development of softness throughout the structure. The processing time can be similar to chrome tannage, but because the tannage produces an anionic charge *(negative change)* in the structure, stacking periods at the end of tannage are common to improve the fixation of anionic syntans/resins/fatliquors.

"White tannages":

As replacements for glutaraldehyde tannage, these tend to be similar in physical properties, with the colourations ranging between white and light yellow/brown. When fully processed – supported by high offers of syntans, resins, and vegetable tannins in retannage - they can provide high shape retention and good ageing properties.

Automotive and aircraft seating, interior mouldings and rail-carriage uses. Light in weight, durable and easy-clean for good hygiene in heavy use situations.

Vegetable tannages:

These are based on soluble extracts from shredded bark, wood, leaves and the fruits of various trees and bushes. These are leached with water, with the extracts spray dried to form a powder. The source of the extract gives each type of vegetable tannin a distinct character and this is reflected in the final leather produced in terms of colour, plumpness, tightness and firmness. These extracts may be chemically modified, to increase the tannin solubility and produce a lighter colour.

To help achieve the required leather characteristics it is usual to blend several types of extract together. The most common extracts are mimosa, quebracho, chestnut, and tara, although there are many other products available.

The solutions have a colloidal nature and contain tannins in a range of particle sizes. The smaller molecular clusters penetrate the skin rapidly and help disperse the larger particles. The smaller clusters possess weak tanning properties generating thin leather, whereas larger particles penetrate more slowly, causing more filling between the fibres within the structure.

The process in its simplest form has been established over many centuries. Originally performed in pits where hides inter-layered with chipped bark were stacked, a slow tannage developed as tannins leached into solution.

Pickle systems are very weakly acidic when compared to chrome tannage, or may involve other forms of pre-treatment.

Two types of vegetable tanned leathers are made.

Light leathers:

Tannages use relatively low offers of selected vegetable extracts when compared to heavy leathers. These are usually drum processed and managed on a one-day cycle. Soft, moderately filled with good shape retention, these are used for a range of leathers including shoe upper and lining leathers and small leather goods. Colour - pale to medium brown.

They provide a high level of comfort in footwear, and hygiene advantage due to the anti-bacterial properties of vegetable tanning agents.

Heavy leathers:

These are very firm, dense and heavy duty leathers, often processed using pit tannages. These systems are part-mechanised where the hides suspended on frames are introduced into solutions of increasing concentration. This keeps the pieces separate, but because these systems are essentially static the penetration of tannins is very slow at 10 days (+/-) according to product. Combinations of drum and pit systems are used to shorten/rationalise manufacture to 4 – 10 days. Drum- based tannages are used too, although the fibre density acquired by pit systems is not achieved.

These leathers are for heavy duty uses such as embossing, carving, saddles, belting, craft, footwear components, and some industrial purposes where they provide superb shape retention.

These different characteristics of tannages are summarised

Panel 1 *"Overview" © R.P.Daniels*

Characteristics of different tannages

Tannage	Properties of dried leathers (tanned only)	Shrinkage temperature (saturated) and Charge	Dyeing, retanning and fatliquoring. (anionic products)	Properties of final leathers and End uses
Chrome	Blue-green colour. Hard and thin.	100C. Cationic	Good dye properties. High uptake of retanning agents and fatliquors.	Very versatile. Very soft to firm. Footwear, auto, furniture, bags, leather goods etc.
Glutaraldehyde	Light yellow brown colour. Soft to medium. Thin with poor retention of shape unless heavily supported by syntans/resins.	Approx 75C. Anionic	Poor dye properties. Poor uptake of retanning agents and fatliquors.	Very soft to firm. Good aging properties. Auto use – mouldings and seats if heavily retanned. Footwear, upholstery.
Other tannages (Many options)	White to pastel colours range. Moderately soft / firm.	75C – 85C. Anionic	Poor dye properties. Lower requirements for retanning agents and fatliquors.	Soft to firm. Many variations, with mainly glutaraldehyde – type properties.
Light vegetable	Cream to light brown colour. Moderately soft.	Approx. 85C. Anionic	Poor dye properties. Low requirement for retanning agents and fatliquors.	Soft to firm with good shape retention. Well filled leather suited for shoe linings and leather goods. Anti-bacterial properties and warm handle.
Heavy vegetable	Light to red-brown. Firm, with dense structure.	Approx. 85C. Anionic	Dyeing and retannage mainly not required.	Offers excellent shape retention. Suited for soling, harness, belts, moulding and carving.

Note:

- Information for general guidance only.

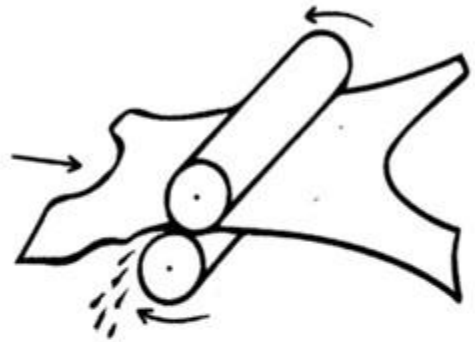
SAMMING, GRADING, SPLITTING AND SHAVING OPERATIONS

After tannage the leathers carry significant variations in substance and quality.

Assessment and grading are required, and substance adjustment for specified end use.

The samming operation *(through-feed action)*

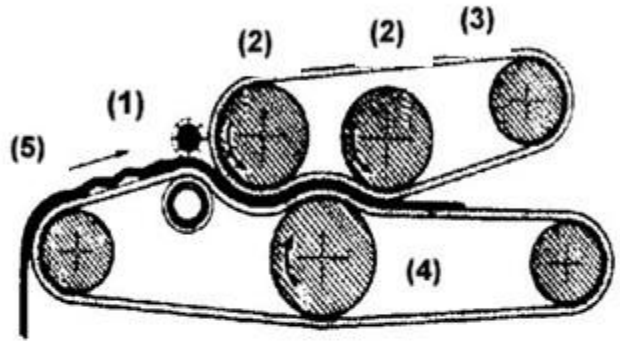
The basic samming action.



Presentation: the samming operation.

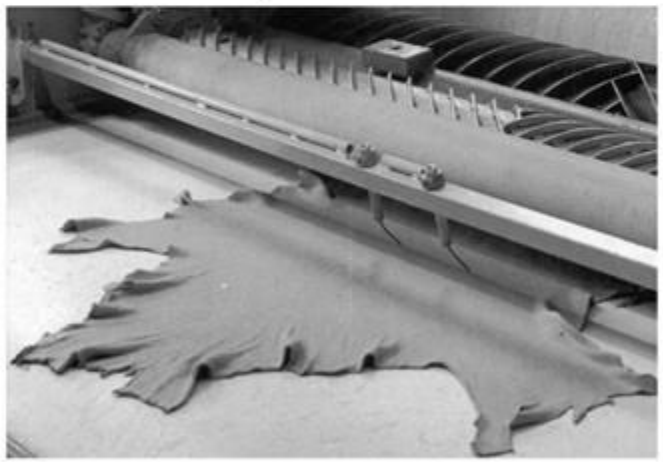
- **After tanning, the wet leather is lightly squeezed to flatten and part-dewater the structure.**
- **Leather is presented grain up in this operation.**
- **Variations in cross hide substance are accommodated by dewatering felts fitted over the pressure rollers.**
- **If hides have not been limed split, these variations can be considerable.**

General assembly showing rollers and dewatering felt arrangement.



1) Spread *(or setting)* roller.
2) Upper pressure rollers.
3) Felt dewatering belt.
4) Main pressure roller.
5) Leather: grain up – samming action as a through feed operation.

Feed to the spread roller.



The spread roller extends the hide before the samming action commences.

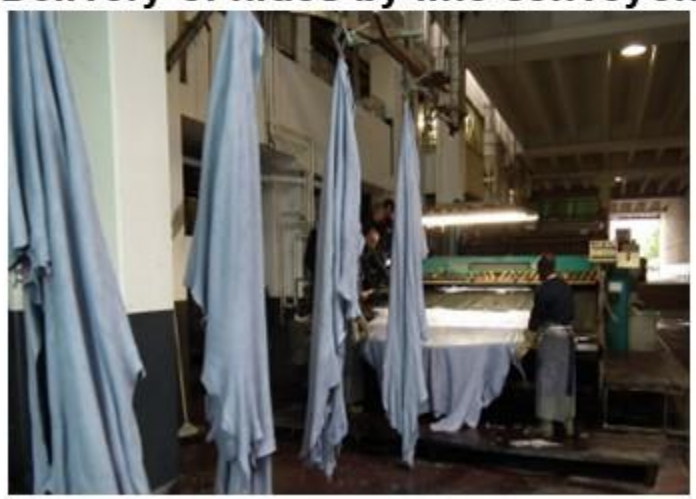
Gentle pressure is applied in the samming action to squeeze water from the leather.

A compact and uniform structure is required for good shape retention during the shaving operation.

(Image: credit unknown)

Presentation: hides ”floated” in water.

Delivery of hides by line conveyor.



- After tanning, hides are often down loaded from drums into trucks or containers that hold both the hides and water.
- The buoyancy provided eases the handling for the feed operatives.
- This “floating” also prevents creasing and uneven compression of the hides at the bottom of the hide mass.
- Hides can also be dumped beneath the processing vessels, then delivered by line conveyor to the samming operation.
- Leathers are usually transported away from the samming operation on a belt conveyor.

Sorting and siding arrangements

Siding after blue samming operation.

Sammed/sided hides awaiting selection.

- **For footwear leathers, hides are usually cut along the backbone *(siding)* to produce two sides.**
- **Each side can then be assessed separately for grain quality and potential instead of the whole hide.**
- **There can be technical advantages in processing whole hides. However, a combination of tradition and grain selection advantages has resulted in side manufacture from the tanned state for footwear leather.**

Splitting in the tanned wet blue state

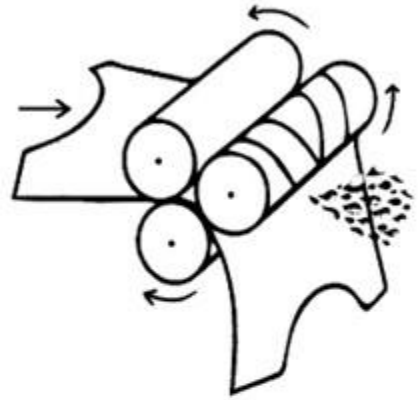
Angled-jack assist for optimum presentation.

Siding can also take place after blue splitting to produce a larger flesh split.

- The splitting operation can take place after samming instead of in the limed state.
- The operation is similar, but the machines are slightly modified.
- Sammed leather is easier to handle, and the grain layer is more uniform in substance.
- It also offers the widest substance selection.
- The substance can also be very close to the shaving substance, hence less waste.

The shaving operation *(in-feed action)*

The basic shaving action.

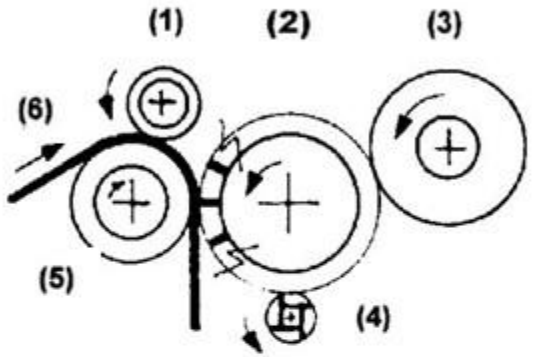


Presentation: the shaving operation.

The butt part is presented grain down using a feed roller *(or table)*.

- **On in-feed, a small amount of the substrate is cut from the butt structure.**
- **The machine is re-opened, the leather turned, and operation repeated on the neck area.**
- **On completion, the machine is opened by the operatives for leather removal.**
- **Care is required at the time of in-feed to prevent cutting damage to peripheral parts.**
- **This operation can be managed by one person, but often a second is employed to minimise damage to the shanks.**

General roller / shaving cylinder assembly.



Cylinder mounted cutting blades.

1) Transport roller.
2) Bladed shaving cylinder.
3) Grind stone.
4) Deflection roller *(anti-wrap rotor).*
5) Transport roller rubber coated.
6) Leather: grain down – shaving action as in-feed operation.

The angle of the cutting blades ensures that the leather is stretched and extended from the centre of the piece at the time of cutting.

This flattened structure improves the grain appearance and quality.

Blue trimming

Trimming away machine damaged parts.

Often managed in conjunction with the shaving operation.

- To minimise damage, leathers are extended when presented to the shaving operations.
- However, there is often cutting damage, especially in shank parts.
- The damaged edge is cut away to avoid tangling and tearing in following processes and operations.
- This may take place after shaving a full batch as a separate operation.
- It can also be team-managed.
- Here, once shaved, each piece is dropped onto a table for trimming.
- Similarly, trimming can be performed on a belt conveyor.

Review:

Samming operation:

After tannage, the leather is unloaded from the processing vessel, and surplus water squeezed from the hides or skins. This is generally a through-feed operation that combines a pre-stretching action known as setting before the main squeezing action to press water from the structure.

Hides and skins tend to form pleats and folds in the peripheral parts, especially the fore shanks and hind shank areas. If the setting action does not extend these parts before compression, then creases will form that will then be sliced or chopped on blue splitting *(if performed)* and shaving, causing a loss in usable area.

The dewatering action relies on a slow feed with relatively gentle compression to avoid distortions through the vertical hide section. The hides presented are not uniform in thickness, and the water retained within the structure will vary due to cross-hide differences. The uniformity of outcome is highly dependent upon the choice of dewatering felts used in the assembly. A well extended crease-free structure is required, with uniform cross-hide moisture content and compression to ensure shape stability on shaving *(+/- splitting)*. It is also important to avoid felt indentations in the grain surface due to over compression.

The key intent is to provide leathers with consistent physical properties to the shaving operation *(+/- splitting)* so that these machines can function at their optimum settings. If leathers are insufficiently compacted or too soft, they will not retain their shape, resulting in gouging and cutting damage. If the outcome is too dry, over compressed or hard, then cutting damage will occur and the leathers at the end of manufacture may be too high in substance.

Grading and selections:

One of the objectives of the tanning process is to make a consistent product that can be used for a variety of different purposes. On selection, the suitability and potential for different uses can be ascertained. This includes grain quality and appearance, potential substance and area.

If leathers are graded as whole hides without limed splitting, then there is the potential of gaining a large flesh side split for other purposes. If these hides are split down the backbone after samming *(siding)*, the splits will be of less value, but each half of the hide can be graded with the opportunity of improved overall selections.

Siding:

This is common practice for shoe upper leather manufacture as the components required by the footwear manufacturer tend to be relatively small in size.

Splitting in the tanned state:

Limed splitting may have been omitted and in this event the leather is split in the wet blue sammed state.

Advantages include the widest possible selections for substance, and splitting close to the shaving substance. This means little loss of substrate as shavings, and maximum potential for the substance of the flesh split. The flesh section contains the irregularities in substance, but can be shaved to an accurate substance for suede-type use or finishing with heavy surface coating.

Shaving operations:

The thickness is slightly reduced in this precision operation where leather substrate is cut from the inner section of the skin. This cutting is provided by the action of very sharp, spiral knives mounted on a rotating cylinder. The piece is extended at the time of cutting by the angled blades to produce a very uniform and accurate final substance *(accurate to 0.1mm).* It also provides a flat, extended and smooth grain layer.

Trimming operations:

Trimming is normally performed to remove torn parts after shaving. This damage usually occurs during in-feed to shaving as it is difficult to fully extend the shanks at time of offer. There may also be some previous damage caused by blue splitting and this is often compounded in shaving. This removal should be minimal to avoid losses of usable/saleable area.

Trimming helps to prevent tangling in dyeing/retanning and fatliquoring, and subsequent poor chemical distribution and staining. It also helps to avoid tearing in subsequent machine operations.

NEUTRALISATION, RETANNING, DYEING AND FATLIQUORING PROCESSES.

The tanning process provides leather with distinct properties, but requires considerable modification to meet specifications and properties required by the end-users.

Considerable change can be provided by further chemical processing to the shaved hides in the neutralisation, dyeing, retanning and fatliquoring processes.

Preparation for neutralising, dye, retan, and fatliquoring

Avoiding drying between operations.

Water use: close control of both volume and temperature.

- After shaving and trimming to remove any damaged parts, the damp leather is weighed.
- All chemical additions are based on this weight.
- Between shaving and drum processing the leathers are often sealed in cling film or polythene to prevent drying of the structure.
- After loading the drum – often manually to ensure that each piece is fully open and separate – the leather is fully saturated and washed before the neutralisation process commences.

The neutralisation process

Clean conditions for consistency.

Checking cross-section for pH.

- In this stage the wet blue leather is made less reactive to dyestuffs, retanning and fatliquoring products.
- This involves lowering the acidity *(raising the pH)* of the wet blue using mild alkalis.
- The depth of this "neutralisation" within the section helps control the depth of penetration of subsequent product additions.
- The neutralisation process is checked by monitoring the pH of the float and inspection of the cut section with pH indicators *(colour sensitive)* to gauge the degree of penetration.

The dyeing process

Dye penetration – mainly determined by neutralising and dye properties.

Pre-weighed dyes awaiting offer.

- Dyestuffs are used to create almost any colour - light pastel to intense dark shades.
- Dyeings may be limited to the surface, or may penetrate completely through the structure.
- There are many different types of dyestuffs available.
- These can be added to process in the powder form, or pre-dissolved in water.
- The fixation at the end of the process may be controlled by pH adjustment, or by use of selected fixatives.

The retanning process

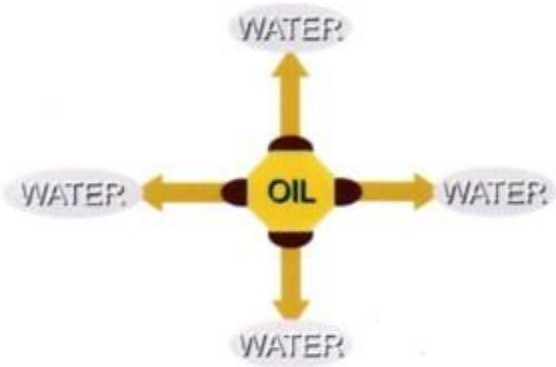
Processes: performed manually.

Processes: computer managed.

- **Various retanning agents are added to fill the structural voids as required within the fibre structure and create special effects.**
- **These are both natural and synthetic based products.**
- **The amounts offered to process and choice of retanning agent vary according to the degree of support and filling required within the structure.**
- **These additions are often manual, but very sophisticated equipment can be used to measure and add chemicals.**

The fatliquoring process

Oil in emulsion in water.



Oil + water, and a stable oil emulsion.

- **Fatliquors are non-miscible oils that have been modified to form a stable emulsion in water.**
- **The oils/fats and the techniques used in fatliquor manufacture have a strong influence on leather softness and handle.**
- **These are mainly added as an emulsion after retannage and dyeing.**
- **The emulsions penetrate and then split to deposit oils into the leather structure.**
- **These lubricate the fibre to reduce fibre adhesions on drying.**

(Images: Credit unknown)

Review:

It is not possible to build the exact properties required into the leathers during the tanning operation. It is practice to develop the leather character by further wet processing of the shaved hides.

Neutralisation:

This treatment prepares the leather for dyeing, retanning, and softening. In this first part of often complex processing, mild alkalis are added to the leather to reduce the moderate acidity of the leather. This is to enable deep penetration of reactive chemicals and agents into the leather structure in subsequent processes. The reactivity of the leather can also be modified by including masking agents such as formates, and specialised products of low molecular size known as auxiliary syntans.

The dyeing process:

There are many types of dyestuffs but anionic dyes are the most frequently used. Acid and direct dyes are used for penetration, surface dyeings and selected fastness properties, while 1:2 premetallised dyes are mainly used for light fastness.

Whole ranges of colour are covered by these dyestuffs and the tanner is able to colour match accurately to a pattern. The dye can be added to the processing vessel either pre-dissolved or as a dry powder.

The dyeing process can be on neutralised leather, or after a suitable retannage. Several additions can be made according to the intensity of colour required or dye penetration into the leather. The dyes are usually fixed by acidification or the use of specialised fixatives.

Sometimes specialised pigments are included, mainly for black and white leathers.

The retanning process:

Selected materials are applied to the neutralised leather to combine with and modify the leather structure. Normally these products are vegetable tanning materials, synthetic tanning agents *(syntans)*, acrylic resins and fillers. These provide very specific properties to the final leather, and several different retanning agents are normally used together. Their combined effects can make the leather feel softer and fuller.

Objectives include selective filling of the grain, the junction between the grain and corium, and deep into the main corium structure. They can also target the belly parts as these contain more voids than the butt parts, where they can provide more filling. This improves the cross-side uniformity and shape retention/stability between the areas of different fibre density and structure.

This is part of creating a more consistent product, a defined leather break, and a uniform grain structure in preparation for finishing operations.

It is noted that the colour and intensity developed on dyeing is changed by retannage. This needs taking into account in the dyeing procedures and may affect the choice of retanning agents where pastel shades are required.

Retanning materials provide leather softening by filling spaces within the leather structure and moderate adhesions that develop within the fibre structure on drying. Fatliquors are used to lubricate those fibres:

The fatliquoring process:

A fatliquor is an oil chemically treated so that it will emulsify with water to penetrate and lubricate the leather fibre structure. The deeper this penetration, and the greater the offer, the softer the leather, but the greater the tendency to develop a coarse break.

Leather making properties are strongly dependent upon the raw oils used - synthetic, fish, vegetable, animal, tallow and even greases. These oils may be sulfonated or sulfited to ensure good emulsification.

Fatliquors strongly influence the final characteristics of leathers, and can provide a degree of filling within the structure too.

A leather with a soft, plump chrome tannage will not require as much fatliquor as leather produced by a firm tannage.

Polymeric softening products:

Water soluble acrylic polymers of high molecular weight are often used for retanning, but are also modified for leather softening. These products can be made chemically active to combine with collagen, providing good light fastness, heat resistance and improved physical properties. In practice they are used in combination with reduced offers of fatliquors.

Waterproofing agents:

Modified acrylic polymers with long molecular side chains can be used to both soften and develop waterproofing properties in suitably prepared leathers. These products often incorporate silicon in their structure, but under carefully controlled conditions can form an emulsion in water and penetrate the leather structure. Acidification deactivates the emulsion, and the water repellent properties are normally achieved by chrome fixation.

Special effects:

Specific properties can be introduced in the retanning/fatliquoring sequences. For heavy duty walking boots, hot waxes and grease can be drummed into the leather. Complete dye penetration or two-tone effects can be managed. As part of specialised production, very level dyeings are possible by processing the leather to the dry state *(crust state)*, then, after sorting and grading, re-wetting and re-dyeing.

Process variations:

The sequence of these process stages can be altered. Fatliquors can be added both before and during retannage. Sometimes neutralisation and dyeing are performed together, and can include retanning agents. Different floats can be used with each process stage, or multi-addition processes used.

Different tanning systems:

Other tanning systems have different requirements within retannage and fatliquoring than are required by chrome tanned bovine leathers.

Heavily vegetable tanned leathers need little or no retannage as the structural filling in tannage and the development of characteristics in tannage is considerable. They may only need a light surface lubrication to improve the grain.

Lightly vegetable tanned leathers can be retanned to change their characteristic and provide more filling within the fibre structure.

They will need some fatliquor offer for lubrication and softness, but less than required for chrome tanned leathers at the same thickness.

Glutaraldehyde and wet white leathers may be supported in the tanning system by syntans and resins to provide the shape stability required during shaving. However, further applications are needed in retannage to sufficiently fill the structure. Fatliquors may be used in the tanning stage, but further additions will be needed in conjunction with retannage to produce softness.

When making leathers based on wet-white tannages, more retanning and fatliquoring products are needed than required by chrome tanned leathers at the same substance to produce leathers with similar tactile properties.

The cationic charge *(positive charge)* of chrome tanned leathers enables a high fixation of the mainly anionic products in retanning and fatliquoring. An anionic charged wet white does not enable such a high degree of fixation, so the offers of retanning and fatliquoring products are significantly greater.

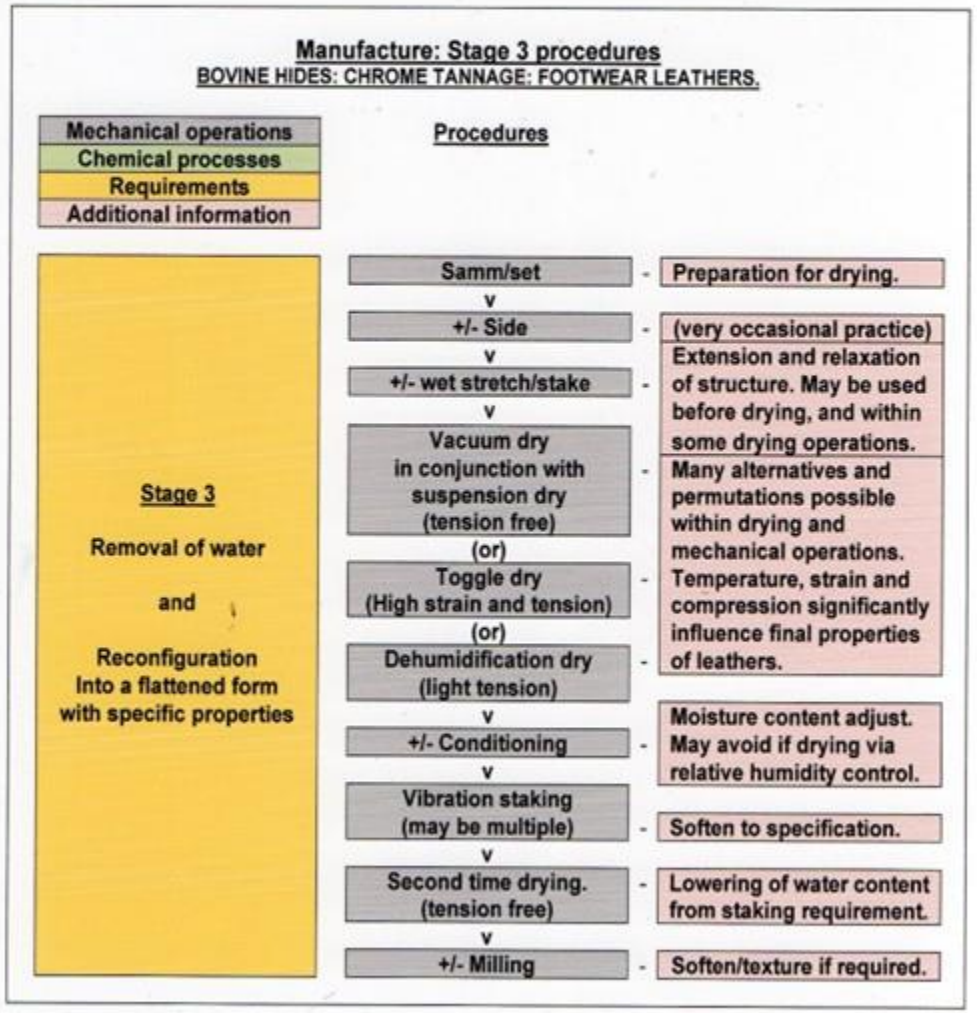
If systems are developed for a wet-white tannage with a strong cationic charge, then uptake of these anionic products will be improved.

Wide range of uses and properties.

- Stabilising materials are introduced into the collagen structure in the tanning process.
- Retanning and fatliquoring agents are then applied to make a wide range of leathers.
- From durable work boots where the tough comfortable leather uppers outlast the soles - to elegant fashion leathers for men and women.
- And, of high importance, footwear designed to meet the growing needs of children.
- An extraordinary range of products !

Continues as:

"Overview" Part 3



- Within Stage 3 procedures, water is removed from the structure to produce dry leather.
- The mechanical operations used in preparation for drying, followed by water removal by evaporation, produce a flat and useful substrate.
- The outcome from processes and operations used in Stages 1 and 2, are mainly completed within Stage 3 procedures.
- The extension of hides and skins from a natural rounded structure to a flattened form is made complete, providing very specific properties to the structure.