



Back to Basics: A Framework for Leather Manufacture

Richard Daniels and Walter Landmann

Modifying the skin structure

Before first time drying and the formation of a flat stable substrate, the conversion of hides and skins into leather can be viewed as two distinct stages:

THE REMOVAL OF UNWANTED SKIN COMPONENTS

This covers the release of unwanted components by soaking, liming/unhairing, deliming/bating and degreasing, and includes the modification of the main collagen fibre structure. This is dependent upon treatment with alkali, enzymes and specialised products. The technique, process control, and the application and receipt of applied forces shapes the way that the fibre structure is opened. This, in turn, influences the uniformity and aesthetic qualities in the final leathers.

Over and above aspects of chemical processing, this stage includes mechanical operations to remove flesh and water, and to create a uniform substance. These factors set the foundation for making the best use of hides and skins.

THE LOCATION OF SPECIFIC MATERIALS WITHIN THE COLLAGEN STRUCTURE.

This stage is more complicated as it plays a major part in building specific leather properties. Essentially, it can be viewed as developing the fibre structure for events that take place within first time drying. The outcome is dependent upon the properties of the structure, the presentation to drying, the conditions of strain, tension/compression, temperature and time during the loss of bound water. The dried leather needs to carry properties to withstand subsequent mechanical operations and finishing techniques so that the final article fulfils user needs in terms of aesthetic and technical properties.

To develop these needs, all products need carefully locating within the fibre structure. These placings are critical in determining a good balance of final properties. For example, a certain placing of materials may create acceptable soft tight leather, whereas a different placing may result in a similar level of softness, but a coarse break.

This location of materials can include

products that are usually removed from the structure. For example, a limed skin may be completely de-swollen to release all of the non-structured proteins. However, these can be fully retained, such as in the manufacture of firm sole or industrial leathers, precipitated in-situ by weak acids then tanned within the structure. If skins are partially delimed, proteins are released from the outer layers but precipitate in the centre of the skin section. This gives rise to a hard leather, with a tight break, but can be valuable in supporting the structure of leathers of low technical quality. And where low levels of natural grease are emulsified as opposed to absolute degreasing, some retention is acceptable, subject to deep distribution within the structure.

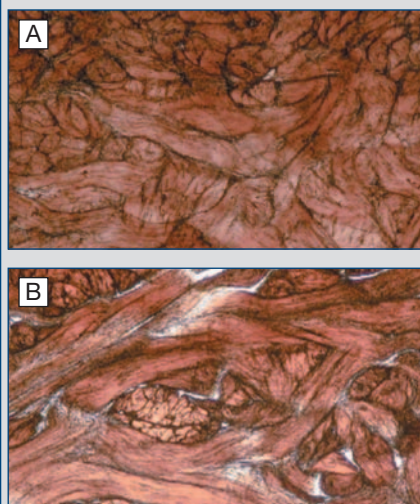
All products such as pre-tanning materials, tanning and retanning agents, softening materials and dyes need locating within the structure with precision. Tanning materials need dispersing

through the whole structure to adequately stabilise the protein structure, although there may be significant differences in concentration layer-wise according to the tanners needs.

Deep penetration might be needed within retannage for making soft leathers, or perhaps deposited nearer to the surface to support a grain layer that might otherwise develop a coarse break. Similarly, the penetration of softening agents needs careful attention so that the right degree of lubrication occurs where needed. Likewise, water-repellent agents need careful placing to provide surface protection only, or throughout the whole structure.

Dyeing needs special care to ensure the right depth of penetration, but especially levelness and uniformity, across the skin structure. And resins and filling-agents are needed to fill the voids left in the more open or looser parts of the skin structure without overloading the parts with a denser structure.

Panel E8/I: Collagen fibre structure in butt and belly areas



Figures A & B respectively show the fibre structure of a cross section of raw hide in the butt and belly areas. The differences in density and angle of fibre weave are considerable. As part of chemical processing, products need very selective placing within the structure to create a uniform substrate.

The outcome of undetected change

As choices are made in creating a leather, to achieve the best results each stage should ensure the best presentation for the next operation. Once a process has been established, control systems can be set up and diligently used to prevent variation.

But the end results are not just a function of the process, control systems and equipment. Over and above hide and skin variables, and the technical parameters that influence the rate of chemical uptake, the behaviour of skins in process has a fundamental role in shaping these effects. This includes properties that might change within a process, such as inflexibility and softness, and the balance between elastic and plastic-like behaviour.

Furthermore, the outcome of forces applied to the skin are often unseen and non-detected. Within chemical processing the physical properties of hides and skins that prevail, and the way that forces are received by those hides and skins, strongly affect both the release of unwanted components from the skin, and the uptake and location of replacement products. 🌐



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Interactions: hides & skins, and mechanical forces

It is appreciated that the role of the process vessel in leather manufacture is greater than that of a chemical reactor. While chemical reactions take place, considerable forces are applied to the goods undergoing process. The way that these forces are received, and the outcome—flexing, extension, compression and relaxation—strongly affects the chemical distribution within each hide or skin. Consequently, these physical interactions not only help achieve aesthetic qualities that can be attributed to good hide relaxation, but are significant within the development of the technical properties of the leather.

Physical interactions between pieces and machines

The way that hides and skins react to force affects more than the outcome from chemical processing, and important effects are found throughout all mechanical operations. This involves, for example, the effects at the edge of a band knife during splitting, a blade during setting, or the cutting action during shaving. The direction, duration and pressure of this force causes a change in accordance with the nature of the operation and the properties of the substrate.

But these effects are not uniform within a piece. For example, when leather is offered to a shaving machine, the peripheral parts extend more due to the setting action of the angled cutting blades. These parts therefore move towards the cutting cylinder more readily than the centre areas, being controlled by the operator applying pressure to the piece. Regardless of this, some areas are extended and distorted more than others at the cutting edge, so the action and results are different. These effects are readily observed and are common to all operations where stresses are involved. There is never full dimensional stability, and for this reason the actions are best viewed as the application of force to a series of points on a piece.

Furthermore, the outcome of a machine

operation is not simply dependent upon the equipment, machine adjustments or wear and tear. Every chemical process and mechanical operation—and variations within previous events—changes the physical properties of the substrate as it progresses through the leather making process. If there have been variations within previous chemical processing, machine operations, or within the method of presentation to the operation, then the substrate is changed and the outcome is different.

When the outcome is non-predictable

To a degree the operative, through experience, can take these variations into account by altering conditions or machine settings. But many of the effects are not fully understood and the outcome, although significant, is not entirely predictable.

These effects are commonly found in the physical outcome and aesthetic properties of leather. For example, there may be a sudden change in predicted substance when leathers are dried, or there may be a trend in falling lastometer results where the cause is not clear. In these examples the blame may be placed respectively on the shaving machine operator or on some aspect of raw materials. But often these judgements do not sit comfortably.

Seeking normality

Within operations, the forces applied from raw materials to the shaved condition may be seen as either acting on fully wetted skins, or on skins where the moisture content has been reduced.

The fully wetted state includes all drum processing, fleshing, lime splitting and samm/setting. Over and above inherent skin properties, when forces are applied to a piece within these operations, the only remaining variable is temperature. Raise the temperature of the goods, and the spreading action and resultant set are

increased.

When splitting and shaving tanned goods, matters are more complex, as extensibility and shape retention are largely dependent on temperature and moisture content. It is clear that fully saturated leather at a given temperature is softer and stretches more easily than when dewatered to conditions ideally suited to splitting. So the samm/setting operation does not simply remove water. In combination with temperature, it helps to control the dimensional stability of leather.

If leather is warm and samm/set to a given moisture content, the handling properties and dimensional stability may be in the optimum state for offer to splitting. But if the leather is cold, then the only way to achieve the same stability is to leave more water in the leather! Clearly, this is not acceptable within manufacture, but if the standard moisture content is maintained, then the leather will be more rigid and less easily extended.

With awareness that the outcome of the splitting operation will change according to the ease of extension and compression of the leather, the splitting operative will adjust the machine settings. But this creates other changes in the outcome. The greater the shift from 'perfect and predictable' leather behaviour—or normality—then the greater the variation within the finished goods.

Shifts from normality

These matters are complex, and continue throughout the preparation for drying, the drying operations, and subsequent processing of both leather and leather goods.

The central issue remains of maintaining a uniform outcome through each manufacturing stage so that results are predictable. To meet these requirements the action and objectives of all mechanical operations, and the balance between elastic/plastic behaviour need the closest consideration. 🌀