



Back to Basics: A Framework for Leather Manufacture

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Water within the skin structure

Water plays a major role within the living skin, in making leather, and the manufacture and behaviour of the final product. Nevertheless, the way that water is held within the structure, and the changes that take place in chemical processing, drying and ageing are not understood in fine detail.

Water in the living skin

The skin comprises mainly collagen, water, keratin, non-collagenous proteins, poly-saccharides and fats. The strength of the skin is provided by the fibre weave. This is mainly collagen, formed by long chains of amino acids held together by peptide links, and spiralling as a triple helix. A balance of anionic/cationic charges and hydrogen bonding determines the spacings between these chains.

However, water molecules exhibit weak charges and are contained throughout the skin structure from molecular to macro level. This is held in a very precise balance, and among other life-functions, lubricates and provides the degree of flexibility and elasticity needed by the living animal.

The effects of removing water

Within leather manufacture matters change. Hair, poly-saccharides, non-fibrous proteins and fats are removed as a result of soaking, liming and deliming/bating/degreasing processes to isolate the collagen. Moreover, the collagen is chemically modified in liming and bating, resulting in an increase in cationic charge.

The physically held water, or free water is loosely held within the fibre structure. This provides lubrication, and can be squeezed out by pressure alone.

However, bound water is held by hydrogen bondings and as part of the protein structure. In wet processing, weakly bound water is released by changes in charge brought about by pH adjustments, uptake of anionic or cationic products, increases in

temperature, and any other reaction that affects hydrogen bonding. Physically held water is removed in machine operations, and both physically and bound water by drying. The removal of water that is more strongly bonded requires very high temperatures and will cause an irreversible breakdown.

Replacing water as a lubricant

If bound water is released within processing, it can act as a lubricant at molecular level and increase softness and mobility. As skin or leather dries, the removal of bound water represents the loss of a plasticiser, so the structure begins to firm. If carried to excess a combination of loss of lubrication and cross-linking between collagen chains causes a massive hardening. Skin can become as hard as bone and show high resistance to both bacterial action and high temperature. If cross-linking is prevented by removing water by solvent washing then drying, a considerable degree of softness is retained. However, this condition is not permanent as rewetting and drying leads to crosslinking and hardness.

One definition of leather is the replacement of bound water as a lubricant by tanning agents. Although not strictly correct, there is considerable value in this statement. In the leather making process, unwanted products are removed from the skin, then replaced by products that prevent bondings between collagen chains. These products, to a greater or lesser degree, act as lubricants between and around the collagen chains, and at higher structural levels. The skin structure, therefore, remains soft and flexible.

The role of water within physical change

When completely dry, all leathers can stand temperatures well in excess of 100°C without breakdown. However, if a little moisture is introduced the leathers become more pliable so that considerable stretch and permanent deformation is possible. This continues

until a critical moisture content is reached whereby massive shrinkage occurs at temperatures considered normal for the different types of fully saturated leathers.

This knowledge is applied extensively within footwear construction. Heat alone can be used in shaping vamps during lasting footwear but, however, where technically possible, the introduction of moisture vastly speeds and improves the operation. The physical properties of temperature resistant chrome tanned leather can thus be used to considerable advantage.

To a lesser degree these effects can be found in leather making. If a dry leather is placed on a vacuum drying plate for a short period, the level of grain flattening is far less than if the leather is slightly dampened. If a dry crust leather does not lay flat, then often a slight dampening is needed to improve extension within toggling and to ensure the retention of flatness. And in dry milling the introduction of moisture can bring about a permanent softening that otherwise may not develop.

So, the role of water is not only significant within the living skin, but also within leather making.

Clearly these effects are not a function of water alone. There is also a sensitive balance according to the products used in making a particular leather and applied forces.

This is taken into close account where the outcome can be easily seen. Changes in conditions during first time drying can lead to dramatic results, and the effects of variation within following operations to an otherwise consistent product is also very clear.

However, the effects of change are not so easily observed within chemical processing and wet machine operations, and the way that water is held within the structure may produce unexpected effects. Closely associated with temperature, the outcome of these effects can be found in the degree of softness, flexibility, relaxation and shape retention. 🌐