



Back to Basics: A Framework for Leather Manufacture

Richard Daniels and Walter Landmann

Hides and skins: Temperature and physical change

Temperature has a profound influence on the physical properties of hides and skins within every stage of leather manufacture. Apart from increasing the rate of a chemical process, a higher temperature will ease the ability of the skin to stretch under load.

An example is given as *Panel E5/1* where the extension of saturated bovine samples under constant load and rising temperature is shown. Moreover, as the temperature rises, there is an increasing tendency to remain in an extended state.

Over and above any lubricating effects of fats, this softening may be attributed to:

CHANGES IN BOUND WATER

It has been proposed that within wet processing a small rise in temperature will cause a breaking of weak hydrogen bonds and release bound water. This increases softness, hence the ability to extend more easily, by increasing lubrication at nano-level.

DEFORMATION OF THE POLYPEPTIDE BACKBONE

Collagen shows both structured and non-structured regions. It is believed that structured parts are set in a more permanent

state, whereas other regions can rotate and deform. Consequently, under tension and inline with temperature rise, these less structured components can re-orientate at molecular level into an extended form.

In effect, collagen softens and extends more readily as temperatures rise, but in addition, the structure becomes less elastic with a shift towards plastic-like characteristics. Accordingly, there is a move towards permanent deformation in the stressed form, and this shift is greater with increasing moisture levels.

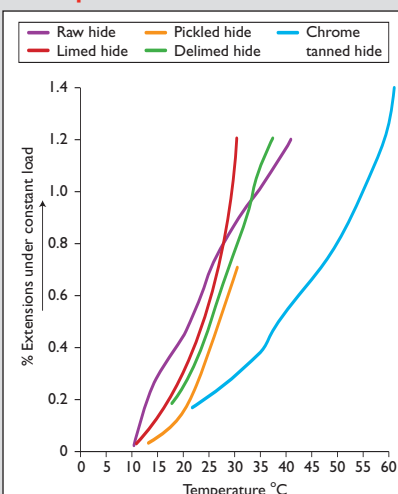
Such behaviour is common to polymers, where as temperatures rise, the original form gradually softens and becomes more plastic. At a point, known as the glass transition temperature (T_g), the material may be readily-shaped into a new configuration, with a retention of shape on return to the original temperature.

A shift from elastic to plastic-like behaviour under rising temperature can be identified by subjecting samples to rapid stress cycles and measuring the delay in recovery or time lag in elastic behaviour.

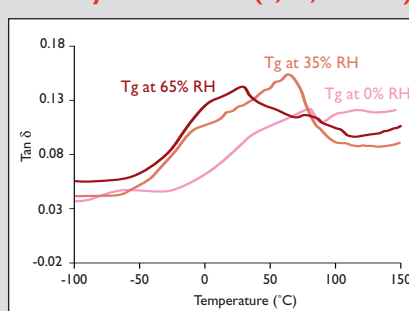
In the case of raw skins, a rise in temperature increases these effects, while an increase in moisture content further lowers the (T_g). This is indicated in *Panel E5/2*, being expressed mathematically as $\tan \delta$.

Over and above this behaviour, the effect of tanning agents increases softening and further reduces the T_g .

Panel E5/1: Effects of temperature on the extension of a sample under constant load



Panel E5/2: Loss tangent, $\tan \delta$, as a function of temperature for acetone-dried skin samples pre-conditioned in a given relative humidity environment (0, 35, 65% RH).



Panel E5/3

Definitions

Elastic behaviour: When a force is applied, the material will stretch and store the applied energy. On release, the energy causes the material to return to its original form.

Plastic behaviour: When a force is applied, the material will stretch but use the energy to deform permanently. On release, the material remains in its new configuration.

PLASTIC-LIKE BEHAVIOUR AND SET AS PART OF LEATHER MAKING

These properties are easily recognised in leather-making where a stressed shape is retained, such as after first time drying, or a smoother grain following pressure-contact with a heated vacuum dryer plate. And within leather goods manufacture, the combination of high temperature, moisture and tension can be used to extend pieces into new permanent forms. Examples are found in the lasting of footwear, and forming and moulding of leather goods.

Throughout all leather processing, warmer temperatures favour a shift from elasticity towards more plastic behaviour, and a tendency to set in an extended form if stress is maintained. This includes all machine operations, and the mechanical forces applied within processing vessels during chemical processing.

This phenomenon is very significant, and is sensitive to only a few degrees change in temperature. The effects are over and above differences in skin structure, chemical modifications or the degree of swelling. These strongly influence the outcome of all machine operations, and the movement of pieces—hence the outcome—within chemical processing.

Additional information

- Observations: Temperature related relaxation within liming and other wet processes (includes Panel E5/1): R.P.Daniels, WL, Aug/Sept 2004.
- The glass transition temperature of leather and its implications to the leather sector (includes Panel E5/2): Sujee Jayapalina. WL, Aug/Sept 2004.