Highly Aesthetic Lightweight Leather

Dr. Marc Hombeck, Alexander Hippel, Christoph Roth, Christopher Tysoe*

Several important trends have been observed in the tanning industry during recent years.
One of those is the reduction in both availability and quality of hides leading to greater demand for leather "upgrading". Another increasing trend, especially regarding leather destined for use in the transportation industry, concerns weight reduction without compromising the aesthetic characteristics.

In this article we would like to give an update on the most recent findings of our lightweight technology (LWT) which has proven to be a solution for both market requests. The products and the technology details of LWT have already been reported in detail (*The structural upgrading of leather: A new micro-sphere application, Tegtmeyer and Tysoe, World Leather Nov 2007 p.27-30), (Genuine lightweight leather: A new micro-sphere application concept, Tegtmeyer and Tysoe, World Leather Oct/Nov 2009 p.XX*). Thus, only a brief description of the technology is outlined below.

Preparation and production details

Leather preparation for LWT begins with splitting and shaving the grain leather thinner than the current required standard production substance. During the retannage, the LWT-product is commonly added in the neutralization step without any further change of the process flow. The product is comprised of microcapsules that have a thermoplastic shell containing a hydrocarbon propellant. The product is available in different grades which differ in capsule size and expansion force and thus allow tailor made articles.

After pre-milling, the microcapsules are thermo-expanded by steam to form microspheres with up to 40 times increased volume. This expansion in turn exerts pressure on the fibers and leads to a thickness increase of the leather back to the standard substance. It is followed by a second milling step ensuring better microsphere realignment as well as fitting in the voids and loose areas giving an overall more uniform leather result. The resulting leather, therefore, has a lower density and thus reduced area weight compared to standard leather of the same thickness.

For thermo-expansion steam has been identified as the optimum vehicle for heat transfer.
A steam expansion machine has been co-developed with an Italian tannery machine supplier which is available in two sizes: a lab scale machine with a capacity of up to 60 sides per hour and a production size machine which can expand up to 150 full hides per hour. The special design of the machine ensures delivery of uniform pressure-less steam which is ideal for the expansion process and is combined with a good exhaustion mechanism that avoids problematic condensation issues.

Significant weight reduction

Analytics conducted during the retanning process revealed that the penetration of the microcapsules takes place predominantly from the flesh side and the product uptake is above 98%. They aggregate in the voids and other loose areas like e.g. veins and mostly in the voluminous corium layer. After expansion the resulting microspheres completely fill the voids commonly present in bellies and flanks. These generally thinner and emptier areas are bolstered up leading to an overall increase in substance uniformity, a unique phenomenon which has been confirmed by independent studies.

Simply, the weight reduction of up to 20% is achieved by the splitting the grain leather thinner, then the standard required substance is obtained by subsequently increasing the thickness through the application and expansion of the microspheres. Aesthetic characteristics are at least maintained and can even be improved. Average area weights for automotive leather of 580-750 g/m^2 (@ 1.2-1.3 mm), as well as for airplane leather of 470-580 g/m^2 (@ 0.9-1.1 mm) can be achieved. This fulfills one of the performance requests stated above.

Characteristics of LWT leather

Leather treated with LWT is generally described as soft, tight and appealingly full. Comparison trials demonstrate that the bolstering up of the leather by microspheres leads to a significant increase in tightness. This beneficial effect has also been proven on laminated leather. Hereby the leather fulfils the other market request stated above.

The structural stability of the leather is also increased by LWT. Total and static deformation of the leather was tested by applying punciform pressure and subsequent relaxation for a defined time. This was repeated on five different areas of the leather following storage at various temperatures. In this trial series also the thickness and dimensional stability were also tested.

Comparing leather treated with LWT versus the same recipe without it, generally a more uniform substance was achieved. Furthermore, both the total and the static deformations are significantly decreased and also more uniform upon storage at various temperatures. This means that leather treated with LWT is generally more structurally stable and more uniform even upon temperature treatment.

Potential side effects of this technology were also investigated and measured. First and foremost, there have been questions raised about the propellant which consists of liquid hydrocarbons, even though present in very small quantities. Can this increase flammability or lead to difficulties during VOC-tests? Independent flammability studies (FAR 15.853 (a) (ii)) revealed that the application of LWT does not increase flammability and LWT leather treated with flame retardants pass the test. Leather articles which pass common automotive VOC tests (VDA 276/278) still pass these tests following treatment with LWT.

Embossing and heat resistance tests have shown no negative effect of LWT treated leather. Due to the resilience of microspheres, a potential negative impact on embossing properties cannot be confirmed. The same embossing pattern is achieved on leather with or without LWT. Due to a thermo-plasticity temperature of ca. 100°C a thickness decrease might be expected after several weeks of heat exposure at 100° or 120°C. Studies did not confirm this phenomenon.

A major topic for lightweight leather achieved by thinner shaving is the accompanying reduction of tear resistance. Here numerous studies revealed that an adjustment in the retanning by utilizing special polymers resulted in a significant increase of tear strength without negative side effects like hardening or change of the character of the leather article. Tear strength of above 25N (at 1.3mm) for automotive and >20N (at 1.0mm) for aviation leather were achieved.

Remedies to counter the effect of over expansion of veins have been found. LWT has a dramatic and complete vein filling effect. However, overexpansion can lead to a more pronounced convex (instead of the usual concave) appearance. Dry-splitting of crust with convex veins arising by LWT results in a similar appearance with the original material. The retanning adjustment mentioned above can improve a potential tear strength issue up to a pass level of normal specifications.

Commercial evaluation

The commercial impact of the LWT has been carefully analyzed. Comparing the full costs for the same area of an article with and without LWT, the overall cost structure looks beneficial. Even though there are higher costs in chemistry, steam and energy and an additional investment in machinery is necessary, these costs are more than compensated by the following advantages:

- Reduction in retanning chemicals: Due to the thinner substance a reduced amount of retanning chemicals are needed to achieve the same area.

- More and higher value drop split: A thinner shaving of the grain split automatically yields in a thicker thus heavier drop split. Drop splits are sold per weight and in different weight classes. Thus a heavier split generates more weight and potentially in a higher weight class – a double benefit.

- Higher cutting yield: As mentioned before LWT fills the voids especially found in bellies and flanks. Thus, these generally looser structures are filled and tighter and, therefore, increasingly cutable. This is improving yield. In several trials a pack of full hides was carefully cut along the dorsal line, right sides were treated as usual; the left sides were shaved thinner and treated with LWT using absolutely the same retanning system. Loose areas were then marked by skilled auto leather cutting production workers. Then total area and loose areas were measured by a laser cutting system. As a result, the total surfaces of right and left sides were found to be similar and the cutting yield was noticeably increased by the use of LWT.

Summary

This presentation shows that the technology described has matured toward production process. Machines for production scale are available and the technology is used in production; advantages regarding the leather article and the commercial feasibility have been carefully evaluated and proven.