MODERN COW LEATHER PROCESSING – Version 1

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INTRODUCTION

Since pre-historic times animal skins have been used for protection against the elements. The primitive preservation process was through smoking and drying. Later, vegetable extracts were used to create the first leathers.

Leather making became one of the oldest known industries. The earliest tanning recipe was created around 700 BC. Chemistry and tanning processes have continued to evolve down through the generations.
TODAY SUSTAINABLE LEATHER IS PRODUCED for performance, fashion and luxury

Hides are a no-waste by-product of the food industry. The leather industry uses the hides and skins produced by the meat industry, and only exists because of the meat industry.

No meat = no leather

Hides are very complex organs composed mostly of proteins, fats, water and minerals.

The main proteins in a hide are:
- **Collagen** – to be turned into leather
- **Keratins** – hair and epidermis, that are removed
- **Globular proteins** – removed

**Cow hide composition**
- Proteins: 33%
- Fats: 2-6%
- Minerals: 0.5%
- Water: 65%
DIFFERENCES BETWEEN hide, skin and leather

HIDE + TANNING = LEATHER
SKIN + TANNING = LEATHER

TANNING is the chemical process that stabilizes the hide thermically, mechanically, chemically and microbiologically. Only a few chemicals have tanning properties. They are safe and non-toxic when used correctly.

HIDES are defined as skins of large animals. Eg, cows have hides, goats and sheep have skins.

SUN TANNING IS A DIFFERENT STORY
Here is a cross section of salted hide (bottom) that shows the fat on the lower layer, the hide matrix in the middle and the hair on top layer (this is the grain side).

After processing to remove the hair and the lower layer we have a thick piece of hide. The color is light gray and has a rubbery feel.

The hide can be tanned with chromium, synthetic tanning agents or vegetable extracts. In our illustration we see the full thickness of the hide compared to the size of a one cent coin.
PARTS OF A HIDE AND TYPICAL DEFECTS

- **Belly:** F and G
- **Bend:** D and E
- **Coupon:** D+E
- **Side:** A, B, D and A, C, E
- **Shoulder:** B+C

- Neck wrinkles
- Insect bites
- Scratches
- Belly drawn
- Veins
- Manure damage
- Brand
- Belly drawn
- Brand
TYPICAL NATURAL DEFECTS FOUND ON LEATHER

BRANDS

SCRATCHES

VEINS

WRINKLES

PARASITES
AND INSECT BITES
A LOOK AT LEATHER’S STRUCTURE

LEATHER GRAIN
Area from the surface to the bottom of the hair follicle. Fibers are fine and elastic on the top and get bigger and thicker going down. To get the required thickness, grain leathers usually contain part of the split

LEATHER SPLIT
Area from the bottom of the hair follicle to the flesh side. Fibers are closely interwoven. Closer to the bottom, fibers get finer and sit parallel to the flesh side

LEATHER TYPES

LEATHER GRAIN
- full grain
- snuffed grain
- corrected grain
- nubuck

LEATHER SPLIT
- splits
- suede
- PU splits
WHAT IS A TANNERY?

Tanneries are leather processing units that comprise chemical and mechanical processes alongside waste treatment.

Tanneries can be classified by size:
- **small**: up to 500 hides/day
- **medium**: 500 to 2,000 hides/day
- **large**: more than 2,000 hides/day

Types of tannery:
- **Complete**: from raw to finishing
- **Tanning**: from raw to tanning (also called blueing; can also be white tanning and vegetable)
- **Wet End**: from tanned leather to crust (or to finishing)
- **Finishing**: from crust to finishing

THE DIFFERENT STAGES OF LEATHERMAKING

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw hide</td>
<td>fresh, brine cured or salted hide, wet</td>
</tr>
<tr>
<td>Tanning</td>
<td>hide stabilization by chrome, white tannage or vegetable, wet</td>
</tr>
<tr>
<td>Crust</td>
<td>leather processed after tanning to give color and properties, dried</td>
</tr>
<tr>
<td>Finishing</td>
<td>crust with coatings to change its properties; mechanical operations to change surface appearance</td>
</tr>
</tbody>
</table>
Each stage of the process that takes raw hide to crust is done in batches. Wood and polypropylene drums offer the mechanical action needed for the chemicals to react with the hides or leathers. Mixers (‘Canbar®’) can be used in the beamhouse.
Tannage is essential for stabilizing the hides. After the first and main tannage the leathers can then be re-tanned with other chemicals to change their properties. Chrome leathers are commonly re-tanned with vegetable extracts

**VEGETABLE**

This is the oldest method of tanning, dating back more than 2000 years. It uses only natural plant extracts. These leathers are light brown in color and dense, making them suitable for shoe uppers and soles, belts, handbags, watch bands, and leather goods. They keep their shape very well and age beautifully.

**CHROME**

Was developed in the 1900s. The process uses chrome (III) salts and produces leathers of a blue color that can be dyed to a range of other colors. Produces soft to medium temper leathers. Can be used for a variety of articles from garments, upholstery, shoes, handbags, to other leather goods. It is the most common tannage, accounting for about 80% of leather produced. The intermediate product of the leather is called ‘wet blue’.

**WHITE (chrome-free)**

Most white tannage is made using a synthetic product called glutaraldehyde. It produces a leather that has a light-yellow coloration. This leather needs to be processed further with other chemicals like vegetable extracts, syntans, acrylics to give a final level of finish and performance.
# DIFFERENT TANNAGE PROPERTIES

<table>
<thead>
<tr>
<th></th>
<th>CHROME</th>
<th>VEGETABLE</th>
<th>WET WHITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color of the intermediate</td>
<td>Blue</td>
<td>Light brown</td>
<td>Light yellow</td>
</tr>
<tr>
<td>Lightfastness</td>
<td>Excellent</td>
<td>Good/Fair</td>
<td>Good</td>
</tr>
<tr>
<td>Temper (softness)</td>
<td>Soft to medium</td>
<td>Medium to firm</td>
<td>Medium</td>
</tr>
<tr>
<td>Print retention</td>
<td>Poor</td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Versatility</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Waterproofness</td>
<td>Possible</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Elongation</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Mechanical properties</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Soil resistance</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Washability</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
The hide (or leather) in the wet stage can be split horizontally after hair removal or tanning by a large ‘splitting machine’ making two uniform slices.

The top side is called ‘grain side’ and the bottom part is called ‘split’ or ‘flesh side’. The grain side is the most used, to make full grain leathers. The flesh side can be finished or used as suede leather.
THE CHANGING APPEARANCE OF LEATHER as it goes through the wet end

**WASHING**
Cleans the tanned leather intermediate (wet white, wet blue), uniformizes the moisture and pH, removes some natural fats and salts.

**NEUTRALIZATION**
Reduces the leather’s acidity and prepares it for retanning: 1 to 3% of chemicals are added here.
Percentages are based on the shaved weight of the leather.

**RETANNING**
A combination of retanning chemicals is added to transform the leather’s properties. Typically, 10 to 30% chemicals are added at this stage.

**COLORING**
Dyes are used to give color. Usually a mixture of dyes is used to give the color. A typical amount is from 0.5 to 4%.

**FATLIQUORING**
Mixtures of natural and/or synthetic oils and waxes are added to soften the leather. Usually, the amount is between 6 and 20%.
TYPICAL LEATHER DRYING METHODS

TOGGLE
Leather is hooked in a perforated screen that stretches to increase area. The screens are put on an oven for uniform drying.

AIR DRYING
Leathers are hung on moving racks below the tannery roof, providing the most natural form of drying.

VACUUM DRYER
Leather is stretched over a hot plate in a vacuum chamber and the water vapor is sucked out.

OVEN DRYING
Leathers are hung up on racks as they are for air drying, and these racks go inside a hot air tunnel for forced – and quick – drying.
HOW DIFFERENT STAGES OF FINISHING APPEAR
from crust to topcoat

- CRUST AFTER SANDING
- DYE STAIN
- SEALER COAT
- BASECOAT
- EMBOSSEN
- GLOSSY TOPCOAT
TYPES OF FINISHES

The finish coatings can be summarized in four types:

- **Aniline** dye can be applied alone or with transparent finish, can be applied on the top of oils and waxes. Small amounts of pigments are added to the coating reducing the transparency and uniformizing the leather. Most expensive leathers are in this category.

- **Semi-aniline** has more pigments added to the coatings. The leather pores are still visible, and quality is still high.

- **Semi-pigmented** when highly pigmented coats are applied to the leather and pores are not visible. Many automotive leathers are in this category.

- **Pigmented** when highly pigmented coats are applied to the leather and pores are not visible. Many automotive leathers are in this category.

**DIFFERENCE BETWEEN DYE AND PIGMENT**

- **DYE** (soluble in water or solvent, transparent)
- **PIGMENT** (insoluble particles dispersed in water, non-transparent)

**BASIC TYPES OF FINISHES (REPRESENTATION)**

- **Aniline** - Transparent coat
- **Semi-aniline** - Low pigment coat
- **Semi-pigmented** - Medium pigment coats
- **Pigmented** - Full pigment coats

- **DYE** - Transparent coat
- **PIGMENT** - Transparent coat
- **LOREM IPSUM DOLOR SIT AMET, EU EST LAU**
THE MAIN FINISHED LEATHER TYPES

ANILINE
These leathers require the best grades and are the most expensive. They look very natural; dyes can be applied alone or with a transparent finish that may include oil and waxes. In the best examples all leather pores are visible. This leather type must not be sanded.

SEMI-ANILINE
Small amounts of pigments are added to the coating, reducing the transparency and uniformizing the leather to improving the cutting yield. These leathers are still high value and can be used in very expensive leather articles. The leather pores are still visible.

SEMI-PIGMENTED
More pigments are added to the coatings to improve the uniformity. The leather pores are less visible, and quality is still high.

PIGMENTED
Additional pigment coats are applied to the leather and pores are not visible. Stamps can give effects to simulate pores or other textures. These leathers have much better cutting yield and are still valuable. Many automotive leathers come from this category.

Note: Crust type and quality, thickness, finish and mechanical operations dictate the price of the finished product. All these types can produce outstanding quality, high value leathers.
EMBOSSING EFFECTS
– creating textures
COLOR MANAGEMENT
in the tannery

Color is one of the most important parameters for leather

Standard swatches are made to be the color and article reference. Color can be visually compared to the standard in a calibrated light source.

White light temperatures can be selected for proper visual color comparison on the light cabinet. International color standards can be used as reference.
COLOR MANAGEMENT
in the tannery 2

Color can also be measured by spectrophotometers where color is measured and expressed in a color space, eg, CIELAB. This way the color can be measured and compared to the stored standard and transmitted and stored digitally.

Pull up leathers have a different color when folded (pull up color). Surface and pull up color need to match.
LEATHER BIODEGRADABILITY

- All leather is biodegradable/degradable. For example, very few ancient Egyptian, Chinese, Indian, Greek and Mesopotamian leathers have survived from antiquity.

- The breakdown time varies – with a commonly quoted time 0.05 to 45 years.

- Type and degree of tannage, re-tannage, finish composition and thickness affect leather’s biodegradability.

- The tannage order of biodegradability: vegetable (least) < chromium < wet white < chamois (most biodegradable).

- New biodegradability studies are being carried out now and, in a few months, we will have more data.
# TABLE OF ESTIMATED BIODEGRADABILITY*

<table>
<thead>
<tr>
<th>Material</th>
<th>Time in Years</th>
<th>Material</th>
<th>Time in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>Forever</td>
<td>Acrylic</td>
<td>10 to 100</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>+ 1,000</td>
<td>Leather</td>
<td>0.05 to 45</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>+ 1,000</td>
<td>Paper</td>
<td>2 to 5 months</td>
</tr>
<tr>
<td>PE Low density</td>
<td>100 to 1,000</td>
<td>Cotton</td>
<td>1 to 5 months</td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>100 to 500</td>
<td>Banana peel</td>
<td>10 days</td>
</tr>
<tr>
<td>Polyester and PU</td>
<td>20 to 200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* This is an estimate only. There are numerous variables in the materials and the conditions of biodegradability which are not directly comparable.
BEST ENVIRONMENTAL PRACTICES for tannery effluent treatment

Tannery wastewater is a complex mixture of organic substances derived from the hide and organic and inorganic substances which are added during leather processing. The challenge for tanneries is to reduce environmental impacts by:

- Improving chemical uptake
- Reducing chemical and water use
- Recycling process chemicals and water
- Reducing energy requirements
- Reducing emissions and sludge generation

Tanneries worldwide are continuously improving their environmental performance and are modernizing their effluent treatment plants to fulfil consumer demand, to achieve strict new norms and regulations and to continuously improve their environmental situation and sustainability.

Key current environmental technologies applied by tanneries are shown on the IUE webpage:

https://iultcs.org/tannery-effluent-treatment-videos
LEATHER REPAIR AND REDRESSING

Repairability is one of leather's best qualities.

Leather articles can be rejuvenated at home with the simple use of consumer polishes, stains, waxes and oils. Even waterproofness can be restored with consumer grade products. Professional repair work is available all over the world when any mechanical damage to a leather item needs doing. Here are some examples of before and after:
### MAIN TYPES OF LEATHER

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full Grain</strong></td>
<td>Leather with the grain (surface) intact</td>
</tr>
<tr>
<td><strong>Snuffed Grain</strong></td>
<td>Leather with light sanding on the surface to uniformize and reduce defects</td>
</tr>
<tr>
<td><strong>Corrected Grain</strong></td>
<td>Leather with heavier sanding on the surface to reduce defects</td>
</tr>
<tr>
<td></td>
<td>It can be finished, oiled/waxed or impregnated to make box leather</td>
</tr>
<tr>
<td><strong>Nubuck</strong></td>
<td>Type of corrected grain leather with deep coarse buffing that has no finish but can be oiled/waxed</td>
</tr>
<tr>
<td><strong>Split</strong></td>
<td>Leather from the lower split part of the leather, sanded</td>
</tr>
<tr>
<td></td>
<td>Can be unfinished, finished or oiled/waxed</td>
</tr>
<tr>
<td><strong>Suede</strong></td>
<td>Leather from the lower split part of the leather, sanded, not finished</td>
</tr>
<tr>
<td></td>
<td>Can have wax/oils or other superficial treatments</td>
</tr>
<tr>
<td><strong>PU Split</strong></td>
<td>Leather from the lower split part of the hide coated with a polyurethane (PU) film less than 0.15 mm thick</td>
</tr>
</tbody>
</table>

* *Top Grain* leathers can have *Snuffed* or *Corrected Grain*
THANK YOU FOR YOUR ATTENTION