1. **Tanning (Leather)**

Tanning is the process of treating and hides of animals to produce leather. A tannery is the place where the skins are processed.

Traditionally tanning used tanin , an acidic compound from which the tanning process draws its name .The use of a chromium (III) solution was adopted by tanners in the industrial field.

Tanning is the process that converts the protein of the raw hide or skin into a stable material which will not putrefy and is suitable for a wide variety of end applications. The principal difference between raw hides and tanned hides is that raw hides dry out to form a hard inflexible material that can putrefy when re-wetted (*wetted back*), while tanned material dries out to a flexible form that does not become putrid when wetted back.

A large number of different tanning methods and materials can be used; the choice is ultimately dependent on the end application of the leather. The most commonly used tanning material is chromium which leaves the leather, once tanned, a pale blue colour (due to the chromium), this product is commonly called “wet blue”.

The acidity of hides once they have finished pickling will typically be between pH of 2.8-3.2. At this point the hides are loaded in a drum and immersed in a float containing the tanning liquor. The hides are allowed to soak (while the drum slowly rotates about its axle) and the tanning liquor slowly penetrates through the full substance of the hide. Regular checks will be made to see the penetration by cutting the cross section of a hide and observing the degree of penetration.

Once an even degree of penetration is observed, the pH of the float is slowly raised in a process called basification. This basification process fixes the tanning material to the leather, and the more tanning material fixed, the higher the hydrothermal stability and increased shrinkage temperature resistance of the leather. The pH of the leather when chrome tanned would typically finish somewhere between 3.8-4.2

1. **History:**

The English word for tanning is from medieval Latin *tannāre*, deriv. of *tannum* ([oak bark](https://en.wikipedia.org/wiki/Oak_bark)), from French *tan* (tanbark), from old-Cornish *tann*(red oak). These terms are related to a hypothetical *donu* meaning *fir tree* in Proto-Indo-European. (The same word is source for [Old High German](https://en.wikipedia.org/wiki/Old_High_German) *tanna* meaning fir, related to modern *[Tannenbaum](https://en.wikipedia.org/wiki/Tannenbaum_%28disambiguation%29%22%20%5Co%20%22Tannenbaum%20%28disambiguation%29)*). Despite the linguistic confusion between quite different conifers and oaks, the word *tan* referring to dyes and types of hide preservation is from the Gaulic use referencing the bark of oaks (the original source of tannin), and not fir trees.

Ancient civilizations used leather for [waterskins](https://en.wikipedia.org/wiki/Waterskin%22%20%5Co%20%22Waterskin), bags, harnesses and tack, boats, [armour](https://en.wikipedia.org/wiki/Armour), [quivers](https://en.wikipedia.org/wiki/Quiver), [scabbards](https://en.wikipedia.org/wiki/Scabbard), [boots](https://en.wikipedia.org/wiki/Boot), and [sandals](https://en.wikipedia.org/wiki/Sandal_%28footwear%29). Tanning was being carried out by the inhabitants of [Mehrgarh](https://en.wikipedia.org/wiki/Mehrgarh%22%20%5Co%20%22Mehrgarh) in Pakistan between 7000 and 3300 BC. Around [2500 BC](https://en.wikipedia.org/wiki/2500_BC), the [Sumerians](https://en.wikipedia.org/wiki/Sumer) began using leather, affixed by [copper](https://en.wikipedia.org/wiki/Copper) [studs](https://en.wiktionary.org/wiki/stud#Etymology_2), on [chariot](https://en.wikipedia.org/wiki/Chariot) [wheels](https://en.wikipedia.org/wiki/Wheel).

Formerly, tanning was considered a noxious or "odoriferous trade" and relegated to the outskirts of town, amongst the poor. Indeed, tanning by ancient methods is so foul smelling, tanneries are still isolated from those towns today where the old methods are used. Skins typically arrived at the tannery dried stiff and dirty with soil and gore. First, the ancient tanners would soak the skins in water to clean and soften them. Then they would pound and scour the skin to remove any remaining [flesh](https://en.wikipedia.org/wiki/Flesh) and [fat](https://en.wikipedia.org/wiki/Fat). Next, the tanner needed to remove the hair from the skin. This was done by either soaking the skin in urine painting it with an [alkaline](https://en.wikipedia.org/wiki/Alkaline) [lime](https://en.wikipedia.org/wiki/Lime_%28material%29) mixture, or simply allowing the skin to putrefy for several months then dipping it in a salt solution. After the hairs were loosened, the tanners scraped them off with a knife. Once the hair was removed, the tanners would "bate" (soften) the material by pounding [dung](https://en.wikipedia.org/wiki/Feces) into the skin, or soaking the skin in a solution of animal brains. Bating was a fermentative process which relied on enzymes produced by bacteria found in the dung. Among the kinds of dung commonly used were those of dogs or pigeon.

Historically the actual tanning process used vegetable tanning. In some variations of the process, [cedar oil](https://en.wikipedia.org/wiki/Cedar_oil), [alum](https://en.wikipedia.org/wiki/Alum), or tannin were applied to the skin as a tanning agent. As the skin was stretched, it would lose moisture and absorb the agent.

Following the adoption in medicine of soaking gut [sutures](https://en.wikipedia.org/wiki/Surgical_suture) in a chromium (III) solution after 1840, it was discovered that this method could also be used with leather and thus was adopted by tanners.

1. **Crusting:**

Crusting is when the hide/skin is thinned, retanned and lubricated. Often a coloring operation is included in the crusting sub-process. The chemicals added during crusting have to be fixed in place. The culmination of the crusting sub-process is the drying and softening operations. Crusting may include the following operations:

* [Wetting back](https://en.wikipedia.org/w/index.php?title=Wetting_back_(leather_processing)&action=edit&redlink=1) - semi-processed leather is [rehydrated](https://en.wikipedia.org/wiki/Rehydrated).
* [Sammying](https://en.wikipedia.org/w/index.php?title=Sammying_(leather_processing)&action=edit&redlink=1) - 45-55%(m/m) water is squeezed out the leather.
* [Splitting](https://en.wikipedia.org/w/index.php?title=Splitting_(leather_processing)&action=edit&redlink=1) - the leather is split into one or more horizontal layers.
* [Shaving](https://en.wikipedia.org/w/index.php?title=Shaving_(leather_processing)&action=edit&redlink=1) - the leather is thinned using a machine which cuts leather fibres off.
* [Neutralisation](https://en.wikipedia.org/w/index.php?title=Neutralisation_(leather_processing)&action=edit&redlink=1) - the ph of the leather is adjusted to a value between 4.5 and 6.5.
* [Retanning](https://en.wikipedia.org/w/index.php?title=Retanning_(leather_processing)&action=edit&redlink=1) - additional tanning agents are added to impart properties.
* [Dyeing](https://en.wikipedia.org/w/index.php?title=Dyeing_(leather_processing)&action=edit&redlink=1) - the leather is coloured.
* [Fatliquoring](https://en.wikipedia.org/w/index.php?title=Fatliquoring_(leather_processing)&action=edit&redlink=1) - fats/oils and waxes are fixed to the leather fibres.
* [Filling](https://en.wikipedia.org/w/index.php?title=Filling_(leather_processing)&action=edit&redlink=1) - heavy/dense chemicals that make the leather harder and heavier are added.
* [Stuffing](https://en.wikipedia.org/w/index.php?title=Stuffing_(leather_processing)&action=edit&redlink=1) - fats/oils and waxes are added between the fibres.
* [Stripping](https://en.wikipedia.org/w/index.php?title=Stripping_(leather_processing)&action=edit&redlink=1) - superficially fixed tannins are removed.
* [Whitening](https://en.wikipedia.org/wiki/Whitening_%28leather_processing%29) - the colour of the leather is lightened.
* [Fixation](https://en.wikipedia.org/w/index.php?title=Fixation_(leather_processing)&action=edit&redlink=1) - all unbound chemicals are chemically bonded/trapped or removed from the leather
* [Setting](https://en.wikipedia.org/w/index.php?title=Setting_(leather_processing)&action=edit&redlink=1) - area, grain flatness are imparted and excess water removed.
* [Drying](https://en.wikipedia.org/w/index.php?title=Drying_(leather_processing)&action=edit&redlink=1) - the leather is dried to various moisture levels (commonly 14-25%).
* [Conditioning](https://en.wikipedia.org/w/index.php?title=Conditioning_(leather_processing)&action=edit&redlink=1) - water is added to the leather to a level of 18-28%.
* [Softening](https://en.wikipedia.org/w/index.php?title=Softening_(leather_processing)&action=edit&redlink=1) - physical softening of the leather by separating the leather fibres.
* [Buffing](https://en.wikipedia.org/w/index.php?title=Buffing_(leather_processing)&action=edit&redlink=1) - abrasion of the surfaces of the leather to reduce nap or grain defects.
1. **Surface coating:**

For some leathers a surface coating is applied. Tanners refer to this as finishing. Finishing operations may include:

* [oiling](https://en.wikipedia.org/wiki/Oiling_%28leather_processing%29)
* [brushing](https://en.wikipedia.org/w/index.php?title=Brushing_(leather_processing)&action=edit&redlink=1)
* [padding](https://en.wikipedia.org/w/index.php?title=Padding_(leather_processing)&action=edit&redlink=1)
* [impregnation](https://en.wikipedia.org/w/index.php?title=Impregnation_(leather_processing)&action=edit&redlink=1)
* [buffing](https://en.wikipedia.org/w/index.php?title=Buffing_(leather_processing)&action=edit&redlink=1)
* [spraying](https://en.wikipedia.org/w/index.php?title=Spraying_(leather_processing)&action=edit&redlink=1)
* [roller coating](https://en.wikipedia.org/w/index.php?title=Roller_coating_(leather_processing)&action=edit&redlink=1)
* [curtain coating](https://en.wikipedia.org/w/index.php?title=Curtain_coating_(leather_processing)&action=edit&redlink=1)
* [polishing](https://en.wikipedia.org/w/index.php?title=Polishing_(leather_processing)&action=edit&redlink=1)
* [plating](https://en.wikipedia.org/w/index.php?title=Plating_(leather_processing)&action=edit&redlink=1)
* [embossing](https://en.wikipedia.org/w/index.php?title=Embossing_(leather_processing)&action=edit&redlink=1)
* [ironing](https://en.wikipedia.org/w/index.php?title=Ironing_(leather_processing)&action=edit&redlink=1)
* [combing (hair-on)](https://en.wikipedia.org/w/index.php?title=Combing_(leather_processing)&action=edit&redlink=1)
* Glazing
1. **Preparation:**

Tanned rabbit pelt. The fur has been left on, apart from small patches exposing leather.

The tanning process begins with obtaining an animal skin. When an animal skin is to be tanned, the animal is killed and skinned before the body heat leaves the tissues. This can be done by the tanner, or by obtaining a skin at a slaughterhouse, farm, or local fur trader.

Preparing hides begins by [curing](https://en.wikipedia.org/wiki/Curing_%28food_preservation%29) them with salt. Curing is employed to prevent putrefaction of the protein substance (collagen) from bacterial growth during the time lag from procuring the hide to when it is processed. Curing removes water from the hides and skins using a difference in osmotic pressure. The moisture content of hides and skins is greatly reduced, and osmotic pressure increased, to the point that bacteria are unable to grow. In wet-salting, the hides are heavily salted, then pressed into packs for about 30 days. In [brine](https://en.wikipedia.org/wiki/Brine)-curing, the hides are agitated in a saltwater bath for about 16 hours. Curing can also be accomplished by preserving the hides and skins at very low temperatures.

1. **Beamhouse operation:**

The steps in the production of leather between curing and tanning are collectively referred to as beamhouse operations. They include, in order, soaking, [liming](https://en.wikipedia.org/wiki/Liming_%28leather_processing%29), removal of extraneous tissues (unhairing, scudding and fleshing), [deliming](https://en.wikipedia.org/wiki/Deliming%22%20%5Co%20%22Deliming), bating or puering, drenching, and pickling.

1. **Soaking:**

In soaking, the hides are soaked in clean water to remove the salt left over from curing and increase the moisture so that the hide or skin can be further treated.

To prevent damage of the skin by bacterial growth during the soaking period, [biocides](https://en.wikipedia.org/wiki/Biocide), typically dithiocarbamates, may be used. Fungicides such as 2-thiocyanomethylthiobenzothiazole may also be added later in the process, to protect wet leathers from mold growth. After 1980, the use of [pentachlorophenol](https://en.wikipedia.org/wiki/Pentachlorophenol) and [mercury](https://en.wikipedia.org/wiki/Mercury_%28element%29)-based biocides and their derivatives was forbidden.

1. **Liming:**

After soaking, the hides and skins are taken for liming: treatment with [milk of lime](https://en.wikipedia.org/wiki/Milk_of_lime) (a basic agent) that may involve the addition of "sharpening agents" (disulfide reducing agents) such as sodium [sulfide](https://en.wikipedia.org/wiki/Sulfide%22%20%5Co%20%22Sulfide), [cyanides](https://en.wikipedia.org/wiki/Cyanides), [amines](https://en.wikipedia.org/wiki/Amines), etc. The objectives of this operation are mainly to:

* Remove the hair and other keratinous matter
* Remove some of the interfibrillary soluble proteins such as mucins
* Swell up and split up the fibres to the desired extent
* Remove the natural grease and fats to some extent
* Bring the [collagen](https://en.wikipedia.org/wiki/Collagen) in the hide to a proper condition for satisfactory tannage

The weakening of hair is dependent on the breakdown of the disulfide link of the amino acid cystine, which is the characteristic of the [keratin](https://en.wikipedia.org/wiki/Keratin) class of proteins that gives strength to hair and [wools](https://en.wikipedia.org/wiki/Wool) (keratin typically makes up 90% of the dry weight of hair). The hydrogen atoms supplied by the sharpening agent weaken the [cystine](https://en.wikipedia.org/wiki/Cystine%22%20%5Co%20%22Cystine) molecular link whereby the [covalent](https://en.wikipedia.org/wiki/Covalent) [disulfide bond](https://en.wikipedia.org/wiki/Disulfide_bond%22%20%5Co%20%22Disulfide%20bond) links are ultimately ruptured, weakening the keratin. To some extent, sharpening also contributes to unhairing, as it tends to break down the hair proteins.

The [isoelectric point](https://en.wikipedia.org/wiki/Isoelectric_point) of the collagen in the hide (this is a tissue-strengthening protein unrelated to keratin) is also shifted to around pH 4.7 due to liming.

1. **Unhairing and scudding:**

Peeling hemlock bark for the tannery in [Prattsville, New York](https://en.wikipedia.org/wiki/Prattsville%2C_New_York%22%20%5Co%20%22Prattsville%2C%20New%20York), during the 1840s, when it was the largest in the world

Unhairing agents used at this time include [sodium sulfide](https://en.wikipedia.org/wiki/Sodium_sulfide), [sodium hydroxide](https://en.wikipedia.org/wiki/Sodium_hydroxide), [sodium hydrosulfite](https://en.wikipedia.org/wiki/Sodium_hydrosulfite), calcium hydrosulfide, [dimethyl amine](https://en.wikipedia.org/wiki/Dimethyl_amine), and [sodium sulfhydrate](https://en.wikipedia.org/wiki/Sodium_sulfhydrate). The majority of hair is then removed mechanically, initially with a machine and then by hand using a dull knife, a process known as scudding.

1. **Deliming and bating:**

The pH of the collagen is brought down to a lower level so the enzymes may act on it, in a process known as deliming. Depending on the end use of the leather, hides may be treated with enzymes to soften them, a process called bating. In modern tanning, these enzymes are purified agents, and the process no longer requires bacterial fermentation (as from dung-water soaking) to produce them.

1. **Pickling:**

Once bating is complete, the hides and skins are treated first with common salt (sodium chloride) and then with [sulfuric acid](https://en.wikipedia.org/wiki/Sulfuric_acid%22%20%5Co%20%22Sulfuric%20acid), in case a mineral tanning is to be done. This is done to bring down the pH of collagen to a very low level so as to facilitate the penetration of mineral tanning agent into the substance. This process is known as pickling. The salt penetrates the hide twice as fast as the acid and checks the ill effect of sudden drop of pH.

1. **Health and environmental impact:**

The tanning process involves chemical and organic compounds that can have a detrimental effect on the environment. Agents such as chromium, vegetable tannins, and aldehydes are used in the tanning step of the process.

However, other processes and chemicals are involved.

Chemicals used in tanned leather production increase the levels of [chemical oxygen demand](https://en.wikipedia.org/wiki/Chemical_oxygen_demand) and [total dissolved solids](https://en.wikipedia.org/wiki/Total_dissolved_solids) in water when not disposed of responsibly. These processes also use large quantities of water and produce large amounts of pollutants. [Kanpur, India](https://en.wikipedia.org/wiki/Kanpur%2C_India) stands as a prime example of how tannery chemicals and wastewater can negatively affect health and ecosystems.

 In 2013, the city became the largest exporter of leather. About 80% of the wastewater is untreated and dumped straight into Kanpur's main water source, the River Ganges. Farmland is swamped with blue-tinted water, poisoned with chromium III, lead, and arsenic.

 Decades of contamination in the air, water, and soil have caused a variety of diseases in the people who live in the area. Health problems include asthma, eyesight problems, and skin problems include: contact dermatitis, urticaria, hand eczema, fungal infection and atopic eczema. The tannery in [Leon, Nicaragua](https://en.wikipedia.org/wiki/Leon%2C_Nicaragua), has also been identified as a source of major river pollution.

Boiling and sun drying can oxidize and convert the various chromium(III) compounds used in tanning into [carcinogenic](https://en.wikipedia.org/wiki/Carcinogenic) [hexavalent chromium](https://en.wikipedia.org/wiki/Hexavalent_chromium), or chromium(VI). This hexavalent chromium runoff and scraps are then consumed by animals, in the case of Bangladesh, [chickens](https://en.wikipedia.org/wiki/Chickens) (the nation's most common source of protein). Up to 25% of the chickens in Bangladesh contained harmful levels of hexavalent chromium, adding to the national health problem load.

Chromium is not solely responsible for these diseases. [Methyl isothiazolinone](https://en.wikipedia.org/wiki/Methyl_isothiazolinone), which is used for microbiological protection (fungal or bacterial growth), causes problems with the eyes and skin. [Anthracene](https://en.wikipedia.org/wiki/Anthracene%22%20%5Co%20%22Anthracene), which is used as a leather tanning agent, can cause problems in the kidneys and liver and is also considered a [carcinogen](https://en.wikipedia.org/wiki/Carcinogen). [Formaldehyde](https://en.wikipedia.org/wiki/Formaldehyde) and arsenic, which are used for leather finishing, cause health problems in the eyes, lungs, liver, kidneys, skin, and lymphatic system and are also considered carcinogens. The waste from leather tanneries is detrimental to the environment and the people who live in it. The use of old technologies plays a large factor in how hazardous wastewater results in contaminating the environment. This is especially prominent in small and medium-sized tanneries in developing countries.

1. **Pollution due to tanning:**

Tanning cause mostly air and water pollution. Air pollution contain ammonia gas , hydrosulphuric acid and volatile organic compounds. Water pollution contain different chemical products that has been released from tanning industries.

**16. Environmental Impact:**

1.Contamination of the soil

-flesh , hairs , hide chipping and scrapings.

2.Large amount of water consumption

3.Chrome has high level of contamination.

Environmental degradation is occur as well as it also causing to increase threat to human and animal life.

**17. Way to reduce:**

1.Use ammonia free deliming

2.Use less salt

3.Awareness related health issues should be addressed.

4..Recycling

**References:**

* 1. [https://en.wikipedia.org/wiki/Tanning\_(leather)](https://en.wikipedia.org/wiki/Tanning_%28leather%29)
	2. <https://www.mastrotto.com/tanning-process/>
	3. <http://www.assignmentpoint.com/business/management/leather-manufacturing-process.html>