



Developing of a dehydration process for bovine leather to obtain a new collagenous material



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ARTICLE INFO

Article history:

Received 21 May 2012

Received in revised form

19 January 2013

Accepted 24 January 2013

Available online 14 March 2013

Keywords:

Dehydration

Leather

Collagen

Tannage

ABSTRACT

The aim of the present work is to develop a dehydration process for bovine hide to obtain a new collagenous material for use in the leather industry. What is obtained through this new process is a dry and very porous collagenous substrate which allows the application of tanning and retanning chemicals by immersion in aqueous solutions. When compared to existing, traditional processes, there are economic and environmental advantages resulting from the use of this new material. More specifically, the new process results in reductions in water use (21.7%), chemical use (46.9%) and processing time (21%).

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1. Introduction

The leather industry can be a source of environmental pollution. For example, the processing of 1000 kg of raw salted hide generates approximately 22 m³ of residual effluent with high concentrations of pollutants, plus approximately 730 kg of solid waste and 40 kg of emissions. Another parameter to bear in mind is the low efficiency of the chemical processes which take place during the process of tanning. An excess of tanning products is needed in order to stabilize 1000 kg of raw leather, that is, approximately 60 kg of chrome salts or more than 450 kg of vegetable extracts (European IPPC Bureau, 2009; International Union Environment of IULTCS, 2008).

Water is abundantly present in the structure of a fleshed hide. Similar to what occurs with crystallised water, approximately 20% of water combines with the collagen fibres. Therefore, this does not help in conferring a feeling of moisture. The water remaining between the fibres of the hide is in free form. The uncharged groups of the protein (i.e. peptide groups, hydroxyl groups and other hydrophilic groups) can bind water molecules via hydrogen bonds. Charged groups (i.e. ammonium and carboxyl types) are able to hydrate themselves strongly by electrostatic attraction. There are two water molecules per tripeptide unit, which are strongly linked by hydrogen bonds in the helical molecule of collagen. This amount of water is 35% by weight of collagen. The remaining water interacts

weakly in different places, forming a multiple layer with characteristics similar to liquids (Buechler et al., 1987; Seymour, 1959).

The hide experiences a swelling through separation and hydration of the charged groups, a charge that is not compensated for when in basic or acid medium. During the liming process, the hide experiences deamidation when it is subject to the alkaline treatment; asparagine and glutamine are transformed into aspartic acid and glutamic acid, which causes swelling in acid or basic medium.

After the delimiting and bating process, the hide dries. The leather obtained is hard, translucent and compact because the leather fibres join together, a fact that makes the penetration of a solution into the leather extremely difficult. If the desired material has to be spongy, flexible and opaque in order to facilitate the rapid absorption of the solution, during the drying process the fibres need to remain separated. One way of obtaining this is by changing the polarity of the medium in which the fibres are, which is usually aqueous in the case of leather. If water is replaced by acetone, an organic medium which is far less polar than water, the material obtained can be completely spongy. This would ensure the readily penetration of the products which are added subsequently during the tanning and retanning stages (Giella et al., 1969; Leberfinger et al., 1972; Ushakof, 1962; Teliba et al., 1993; Chagne et al., 1993; Silvestre et al., 1994).

With the aim of minimising the negative effect of such pollution, a dehydration process for bovine hide will be developed to obtain a new collagenous material. Designing a dehydration process for bovine hide allows for a dry and very porous substrate to be obtained, which facilitates the application of tanning agents, dyes and

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Table 1
Comparison of the new process versus the traditional.

Process part	New process	Traditional	Time process
(On raw salted hide weight): Soaking	The hide is thoroughly washed with 200% water and a 2% of tensoactive (twice) Drain and wash.		24 h.
Unhairing	200% Water at 20 °C 1% Ca(OH) ₂ 1% Na ₂ S 0.8% Amine Filter the hair 1% Na ₂ S 2% Ca(OH) ₂ Washing with 200% Water (twice)		30 min. 3 h. 21 h.
Fleshing and splitting at 2.5 mm (on split weight): Delime bate	Mechanical operations to remove the subcutaneous tissue and the split 200% Water at 30 °C Drain 150% Water at 35 °C 1.5% Dicarboxilic acids 0.7% Bate 1000 LVU g ⁻¹ Drain and wash		15 min. 20 min. 60 min.
Neutralization-dehydration	70% H ₂ O at 20 °C 1.5% HCOOH 4% NaCl 0.75% NaHCO ₃ 100% Acetone (Five floats)		5 min. 30 min. 30 min. 1 h. 1 h.
Pickle		100% H ₂ O at 20 °C 7% NaCl 0.5% HCOOH 0.7% H ₂ SO ₄	20 min. 15 min. 30 min. 90 min.
Tannage		80% H ₂ O 2% Chrome salt 33°Sch. 5.5% Chrome salt 66°Sch. 0.15% MgO Drain Rest Shave	2 h. 6 h. 24 h.
Waterproofing	8% Water repellent agent (PM 4800) 46% Acetone 46% Metoxypropanol Set out at room T Dry at 60 °C Dry at 100 °C		5 min. 2 h. 4 h. 2 h.
(on shaved weight): Retannage-dyeing-fatliquoring		100% Water at 30 °C 0.2% Acetic acid Drain 150% Water at 40 °C 4% Retanning agent 1.5% Sodium formate 1% Soya lecithin 1.5% Sodium bicarbonate Drain 50% Water at 25 °C 4% Retanning agent 2% Dyestuff 3% Naphtalen-sulphonic sytan Drain Wash 150% Water at 60 °C 3% Soya lecithin 2% Sulphonated beef tallow 4% Oxi-sulphited marine oil 0.7% HCOOH Drain Dry at 60 °C	15 min. 1 h. 10 min. 10 min. 2 h. 2 h. 1 h. 15 min. 8 h.
Finishing	Mechanical operations 100 White Pigment 200 Polyurethane 1 100 Polyurethane 2 70 Casein 30 Wax 20 Water repellent agent 10 Crosslinker 480 Water		

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