Green Solution for Ecology and Economy in Tanning - Phosphonium and Polyamide Combination Process

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Abstract

Chrome tanning though a preferred method of tannage is threatened by serious perceived concerns about chromium. A transition towards process innovations involving part or complete elimination of minerals or atleast chromium is gaining momentum. Combination tannages involving phosphonium salts, oxazolidines and vegetable tannins have been studied in detail by many research groups. In the present work combination of phosphonium and polyamide based auxiliaries has been studied and found to yield encouraging results. The quantity of phosphonium and polyamide has been optimized through detailed application trials. The hydrothermal stability of tanned leathers is (Ts) 90±2^{0}C as inferred by DSC studies. The experimental leathers had compact fibre structure when compared to full chrome tanned leathers as inferred through SEM studies. The resultant leathers were found to be fuller with smooth texture and better strength characteristics. In addition, better absorption and exhaustion of post tanning auxiliaries were obtained. The study has resulted in ensuring retention of natural character to leather while ensuring needed functional and aesthetic properties in finished leathers.

Keywords: Chlorides, Chromium, Phosphonium, Pollution, Polyamide, Salinity, Skins and hides, Tanning.

1. Introduction

In the present environment, the world is driving researchers to explore eco-friendly products and processes. The leather industry similar to most other potential polluting industries is continuing to implement environment friendly procedures in proportion to the regulatory legislation. Use of chromium in leather industry is being questioned owing to reports emerging on the toxicity and disposal problems associated with it (Dasgupta, et al. 2002). Special attention has been given to suitable technologies for the elimination or reduction of pollution load in the tanneries (Sundar, et

al. 2009). A concerted effort has been made to overcome the environment crisis that engulfed the leather industry (D'Aquino, et al. 2004; Fathima, et al. 2005; Kumar et al. 2009; Ren et al. 2009; Stephen, et al. 1995). There is a growing demand for various types of environment friendly leathers in the global market and the Indian leather Industry is far ahead in supplying such leathers. The increasingly stringent limits for various substances pose a deep concern. The growing environmental consciousness of the consumers and their increasing demand for eco-acceptable products forces the industry to adopt eco-acceptable technologies.

In the present study, the research is focused on developing products that lead to leathers which satisfy all physical and environmental requirements, without compromising the typical characteristics and make leather a natural, attractive and uniquely desirable product. There is a huge interest for mineral free leathers and especially for organic tanned leathers (Altan, et al. 2008; Taylor, et al. 2011; Wolf, et al. 2001). So a study has been undertaken to analyse the phosphonium compounds with polyamides to produce leathers which are suited for all end products. These mineral free leathers are easier to recycle/dispose of and they can be incinerated without the risk of generating Cr (VI). This forecasted increase in demand has opened up new opportunities for producing leathers tanned without chrome but retaining the characteristic feel and handle (Shuangxi et al. 2008). The results of this research and development are encouraging with logical, practical and reproducible leathers with excellent aesthetic properties and high mechanical properties.

2. Material and Methods

The pickled goat skins (of weight range 1 – 2 Kg at wet salted stage) were chosen as raw material for tanning studies. All the chemicals used for the experiments were of commercial grade.

2.1 Process details

The left half of the pickled pelts meant for experiment were treated with phosphonium salts (3 - 8% *(w/w)* for 90 mints in the drum. Then cationic fatliquor 1% was followed with addition of synthetic tanning agent 6% and drumming for 1 hour followed by addition of 1% *(w/w)* sodium formate and 1.5% *(w/w)* sodium carbonate is added in six installments and further drumming for one hour. The pH of the leather was found to be about 5.0 at the end of tanning. The right half pickled pelts were processed by conventional chrome tanning process using conventional pickling and tanning in 50% pickle bath using 8% basic chromium sulphate. The pH of the bath was adjusted to 4.0 after flooding with 50% water. The pH profile of both the experiment and control process liquors has been monitored continuously and recorded. Then the tanned leathers were aged for twenty four hours and were assessed. Then the leathers were processed into finished leathers and assessed for their organoleptic properties and dyeing characteristics.

2.2 Optical Microscopic Analysis

The combination tanned leather samples were analyzed through optical microscope at magnification 200µm.

2.3 Strength property analysis

Strength characteristics of the crust leathers such as tensile strength and tongue tear strength were tested using an Instron tensile tester and grain crack and grain burst were tested using lastometer (SATRA 1992). Leather samples for the physical testing were taken parallel to backbone following the official procedure for sampling and testing (IUP 1958).

2.4 Organoleptic functional property analysis

Combination tanned and crust leathers were subjected to organoleptic assessment for softness, fullness, grain smoothness, grain tightness (break) and general appearance by hand and visual examination. The leathers were rated based on a scale of 0 –10 grade points for each functional property by six experts.

3. Results and Discussion

3.1 Shrinkage temperature

The shrinkage temperature of experimental and conventional tanned leathers are given in Table 1. The results indicate that leathers tanned with phosphonium 4% and polyamide could have thermal strength comparably with mineral and vegetable tanned leathers.

3.2 Optical Microscopic (SEM) Analysis

Optical micrographs of cross section of experiment as well as chrome and vegetable tanned leathers with magnification of 200 µm are shown in Figure 1, 2 and 3 respectively. The results indicate that experimental leathers have more compact and uniform fibre structure as compared to that of chrome and vegetable tanned leathers (Li, et al. 2006).

3.3 Strength and Organoleptic functional property analysis

The physical testing characteristics of the crust leathers are shown in Table 2. The results indicate that strength properties such as tensile, tear, grain crack are comparable for experimental and control leathers. The results indicate that experimental leathers have comparable organoleptic properties with conventionally processed leather.

4. Conclusion

This mineral free tanning system employing phosphonium and polyamide have been identified as a possible replacement of chrome or vegetable tanning. The tanned leathers have been converted into various end products and found to have comparable properties. The use of phosphonium salts in this system enabled to achieve comparable properties with existing tanning systems, thereby protecting against the hazards by chromium and at the same time, through standardization of post tanning operations, it was possible to produce softer type leathers. The leathers obtained through mineral free tanning system possessed better hydrothermal stability and organoleptic and strength characteristics. Hence, the developed new tanning system is environmentally and commercially viable for the manufacturing all types of end products with economic benefits.

5. References

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Table 1 shrinkage temperature

Tanning	Shrinkage Temperature (°C)
Phosphonium + Polyamide	84 ± 2
Chrome Tanning	112 ± 2
Vegetable Tanning	80 ± 2

Table 2 Physical Characteristics

Tanning	Tensile strength (Mpa)	Elongation at break (%)	Tongue Tear strength (N/mm)	Grain crack, (kg)	Distention at grain crack (mm)
Phosphonium + Polyamide	19.66±2	55.33±5	45.76±3	>26	9.41±1.5
Chrome Tanning	13.83±2	47.00±5	46.80±3	>20	7.90±1.5

Vegetable Tanning	15.87±2	47.92±5	43.76±3	>30	9.63±1.5

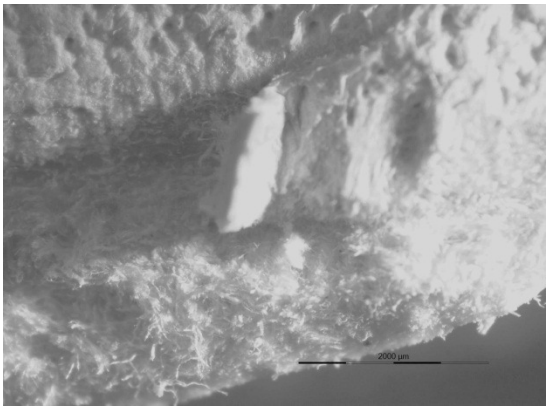

Fig 1. Chrome tanned leather (200 µm)

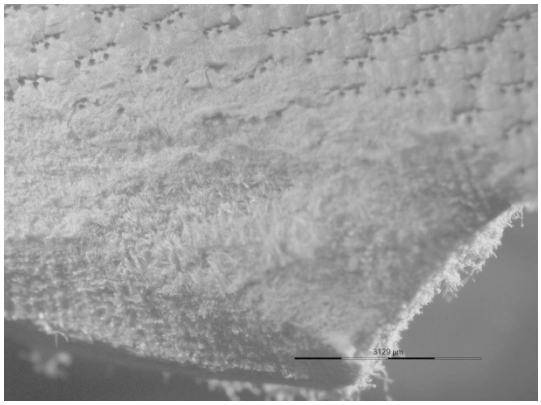

Fig 2.Vegetable tanned leather (200 µm)

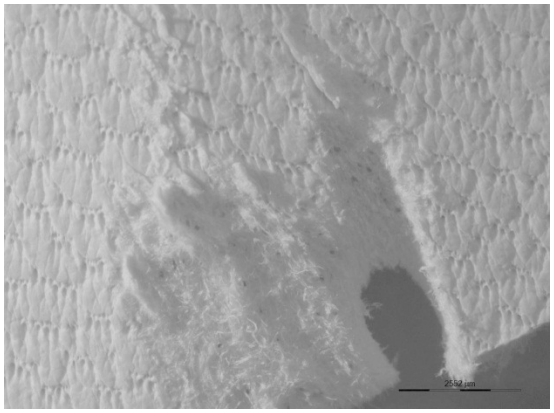

Fig 3. Phosphonium with polyamide tanned leather (200µm)