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CHROME FREE RAPID GLOVE LEATHER MANUFACTURE

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ABSTRACT

In the current study, we use chrome free tanning process for the production of glove leather and to achieve the required properties without any compromising the quality. To develop a suitable post tanning system for making glove with good softness, run and strength properties. Glove leather predominantly made using chrome tanning system. Conventionally glove leather is done by long liming and ageing in pickling for better fibre splitting in order to achieve the run property. Production Time is very high due to long liming and ageing in pickling. Production cost can significantly reduce if the processing time for making glove is reduced. Acrylic followed by Glutaraldehyde combination tanning system adopted for chrome free tanning option. Long liming and ageing in pickle will be replaced with rapid fibre splitting process.

1. INTRODUCTION

A glove literally means “a cover” for hand with a sheath for each finger, but it is more than that. A good glove has to be a defense against cold and water, should maintain the body temperature and it should also leave the hand mobile enough to drive a vehicle, press a bomb button at the exact second, to grasp some heavy object lying underneath or to operate a machine etc. Leather is unique and ubiquitous, as old as man and yet modern. Leather contributes to a country’s wealth. Leather is an international commodity and in spite of the severe competition from synthetics, the demand for the leather in the world shows a rising trend. So far, these substitutes have remained mainly as supplements. The inherent superiority of leather, rising population, higher incomes and leisure, new uses for leather, rapid changes in fashion snobbery and greater use of resources have all contributed to this continued demand for leather.

The demand for leatherwear has now been growing greater and greater. There is every indication that it will continue to do so for some more time. It is now an accepted fashion that leather is perfect material for all seasons and all moods. As atop fashion material, leather is used in the production of suits, coats, gloves, hats, ties etc. and it has now become a luxury material. The suppleness and wearability of glove leather in every color have captured the hearts of style conscious people everywhere. This raised demand for glove leather.

Chromium has been used as the primary tannage for many leathers for over 100 years. In the early days the tanning form, Cr (III), was produced from Cr (VI) in the form of Dichromate by reduction of the chrome in the tanning

bath by sugars at low pH. When basic chrome sulfate was introduced as a product ready to be used for tanning, tanneries changed to the use of these products either as an aqueous solution or as a dry product.

Environmental concerns about the effects of Cr (VI) and other heavy metals resulted in strict guidelines as to the amount of soluble chrome that could be discharged in a tannery waste stream and disposal of waste leather from shavings, trimmings and buffing dust was limited to contained landfills. There is no doubt that Cr (VI) compounds are both acutely and chronically toxic. The dose threshold effect for this element has not yet been determined accurately enough to allow regulations to be defined. However, some risks assessment analyses are currently being undertaken. Cr (III) is less toxic than some other elements (Hg, Cd, Pb, Ni, Zn) to mammalian and aquatic organism. Probably due to the low solubility of this elements in its trivalent form. Compared to Cr (VI), the toxicity of Cr (III) is insignificant. Hexavalent Chromium has been proven to carcinogenic and causes damage to skin. Mucous membrane, respiratory tract, Kidney, etc. It has also been shown that there are some possibilities for the formation of chromium (VI) during processing conditions (IS-2490/1985) Recent reports suggest that higher levels and under certain ligand environments chromium (III) also toxic. The Problem is aggregated by the fact that the currently practiced chrome tanning procedures lead to an uptake of only 60-65o of the chrome offered by leather and hence substantial amount of chrome is discharged into the effluents.

Even, so the possibility of oxolation of chrome in the landfill to Cr (VI) with leaching into the environment has been a concern to Environmental Protection Agencies (EPA). However, the disposal of leather from worn-out shoes, garments, Glove, Upholstery and the possibilities of ingestion of chrome tanned leather by children has been addressed only recently.

2. MATERIALS AND METHODS

2.1. STANDARDISATION OF TANNING SYSTEM

Wet salted sheep skins of uniform size and weight were taken and processed into chrome free tanning system using Acrylic followed by glutaraldehyde tanning system. The control process for gloving and the process developed with alternate tanning system are shown table, three wet slated skins (processed as mentioned in Table 2.1) of 5 sq. ft (average) were used for the experiments. Each wet salted skin was used for each experimental trial.

2.1.1. SELECTION/STANDARTISATION OF POST TANNING SYSTEM

Wet salted sheepskins of uniform size and weight were taken and processed into Chrome free tanning using process shown in Table 2.1. The post tanning trials was carried out to select suitable fatliquors and retanning agents to obtain glove leather with high run, strength and softness properties.

2.1.2. SELECTION OF SUITABLE FATLIQUOR

Six fatliquors of different bases were screened for glove leather manufacture. The chosen Fatliquor and their base are shown. Two experimental trials varying the combination of fatliquors have been carried out. The experimental trials on Fatliquor are shown.

Fatliquor screened for experiment on glove leather manufacture

S.NO	Name of fatliqour	Nature
1	Balmol BLSFO	Sulphited fish oil based Fatliquor
2	Balmol SX-20	Synthetic based Fatliquor
3	Balmol SX-25	Sulphited natural oil based Fatliquor
4	Lipoderm liquor LP-16	Lecithin based Fatliquor
5	Vicastol SP	Sulpho chlorinated paraffin wax
6	Vicastol WGF	Synthetic lanoline based Fatliquor

2.2. PHYSICAL TESTING AND HAND EVALUATION OF LEATHER

Samples for various physical tests from experiments and control crust leathers were obtained as per IUP methods (IUP2 2000). Specimens were conditioned at 80 ± 4ºC and 65 ± 2% R.H. over a period of 48 hrs. Physical properties such as tensile strength, tear strength and % elongation at break were examined as per the standard procedures (IUP6 2000, IUP8 2000). Crust leathers were assessed for softness, fluffiness, grain smoothness and general appearance by hand and visual examination. Experienced tanners rated the leathers on a scale of 1-10 points for each functional property, where high points indicate better property.

2.2.1. RUN MEASUREMENT

Run is measured in the following manner. The leather is first stretched lengthwise. In this condition breath wise length of the leather was measured. It was taken as initial length. Then the leather was stretched in breadthwise direction and the stretched breath wise length was found. Difference between the stretched and initial length is a measure of "Run". Similarly, for determining the run in the lengthwise direction, the leather was stretched first in the breath wise direction. The length was measured lengthwise (initial length). Then the leather was stretched in the lengthwise direction. The length of the leather in the stretched condition is measured. Difference of the lengths is a measure of "Run".

$$\%Run = \frac{(Stretched\ length - Initial\ length)}{Initial\ length} \times 100$$

Run measurements in the case of quarter pieces shown in Figure 2.7 is carried(stretched) at line (perpendicular to backbone) 30% of distance L from the centre point A. Similar methodology is adopted for run measurement of all quarter pieces. In the case of half and full pieces run measurements were made at centre position (perpendicular to the backbone) of the total length of the backbone.

2.2.2. SOFTNESS

Softness of the leather was measured using ST300 Digital leather softness tester. The ST300 D is a means of determining the softness of leather without defacing the hide or skin, as it does not require samples to be cut from the leather prior to testing. But the experimental and control crust leathers were conditioned at 80± 4ºF and 65±2% R.H. over a period of 48 hrs. The softness of the experimental sample was noted directly after fixing it to the ST300 Digital leather softness tester. This device has now been adopted as the industry standard by IULTCS (IUP 36).

2.2.3. STRENGTH MEASUREMENT

2.2.3.1. TENSILE STRENGTH & ELONGATION AT BREAK

Tensile strength is the force (kg) per unit area of the cross section (sq.cm) required to cause the rupture of the specimen. Dumbbell shaped specimen, of required shape and size are cut both at the parallel and the perpendicular direction of the back bone of experimental and control crust leathers were obtained as per IULTCS methods (IUP 6) and conditioned at 80± 4ºF and 65±2% R.H. over a period of 48 hrs. Width and thickness of the specimen, at not less than 3 places are measured and the average value is noted. Set the jaws of the tensile tester apart for each sample respectively. Clamp the test specimen in the jaws and run the machine at the rate of 100 ± 2 mm/min until the specimen breaks. Note the distance between the jaws when rupture of the test specimen occurred.

2.2.3.2. TEAR STRENGTH

Tear strength is the load (kg) required to tear the leather beyond the cut made perpendicular to its surface, expressed per unit thickness. Specimen of required shape and size are cut both at the parallel and the perpendicular direction of the back bone of experimental and control crust leathers were obtained as per IULTCS methods (IUP 8)

and conditioned at 80± 4ºF and 65±2% R.H. over a period of 48 hrs. Thickness of the specimen is noted. Insert the slot of the specimen into the test piece holder fixed to the tensile tester. Run the tester at the rate of 100 ± 2 mm/min until the specimen is torn apart.

2.2.3.3. GRAIN BURST LOAD AND DISTENSION (LASTOMETER TEST)

Circular leather pieces (44.5 mm) from the experimental and control crust leathers were obtained as per IULTCS methods (IUP 12) and conditioned at 80± 4ºF and 65±2% R.H. over a period of 48 hrs. Clamp the test specimen tightly in the lastometer and force the plunger at a rate of 0.20 ± 0.05 mm/second. When the burst appears note down the force and distention

3. RESULTS AND DISCUSSIONS

3.1. EFFECT OF UREA TREATMENT

The experimental trials have been conducted using 3% urea treatment before tanning. The tear strength, softness is good. From the literature table it is observed that usage of 3% urea in pretanning results in maximum run property around 35%, with further increase in urea the %run is found to decrease. Urea is a well-known protein secondary structure destabilizer, beyond a certain concentration they may affect the structure of the collagen matrix significantly because of rupturing protein, which may result in lowering of run. But in our experiments, it Shows better results which had given 35% and 20% run.

3.2. EFFECT OF FATLIQUORS ON GLOVING PROPERTIES

Six different bases of fatliquor have been screened. Since fish oil is known to posses' very good lubricating ability, a fatliquor based on fish oil is very essential for glove leather. Hence, sulfited fish oil fatliquor (Sfo) has been offered for all experimental trails. Trials have been carried out with varying the combination of other five fatliquors as mentioned. The run, softness, visual assessment data for leather processed using different combination of fatliquor is shown

Control

Process	Chemicals	(% Offer)	Time	Remarks
Washing	Water	100	10 mins	
Deliming	Water	100		Completion was checked by Phenolphthalein
	Ammonium Chloride	3	60 mins	
Washing	Water	100	10 mins	
Bating	Water	100		Air bubble to check the completion
	Microbate-R	0.5	60 mins	
Washing	Water	100	10 mins	
Degreasing	Water	100		
	VDG	1	60 mins	
Washing	Water	100	10 mins	
Pickling	Water	100		Check the pH 2.8-3.0 and drain 1/3 rd of pickle liquor
	Sodium Chloride	10		
	Water	10		
	Sulphuric Acid	1	4×5 60 mins	

Tanning				
Control	Water	50		Check cross section for penetration
	BCS	5	60 mins	
Basification	Sodium Formate	1		Check the pH 3.8-4.2 and ageing for 24 hours
	Water	10		
	Sodium bicarbonate	1	4×5 60 mins	

Experiment 1

Process	Chemicals	(% Offer)	Time	Remarks
Washing	Water	100	10 mins	
Deliming	Water	100		Completion was checked by Phenolphthalein
	Ammonium Chloride	3	60 mins	
Washing	Water	100	10 mins	
Bating	Water	100		Air bubble to check the completion
	Microbate-R	0.5	60 mins	
Washing	Water	100	10 mins	
Urea Treatment	Water	100		
	Urea	3	120 mins	pH 7.0
	Sulfone based syntan	2	120 mins	pH 6.0
	Needs foot oil	2	2×5 45 mins	
	GT-50	2	120 mins	pH 5.0
	Electrostatic stable fatliquor	2	2×10 60 mins	Check for the penetration and pile overnight

Experiment 2

Process	Chemicals	(% Offer)	Time	Remarks
Washing	Water	100	10 mins	
Deliming	Water	100		Completion was checked by Phenolphthalein
	Ammonium Chloride	3	60 mins	

Washing	Water	100	10 mins	
Bating	Water	100		Air bubble to check the completion
	Microbate-R	0.5	60 mins	
Washing	Water	100	10 mins	
Urea Treatment	Water	100		
	Urea	3	120 mins	pH 7.0
	Sulfone based syntan	2	120 mins	pH 6.0
	Needs foot oil	2	2×5 45 mins	
	Acrylic syntan	2	60 mins	pH 5.5
	GT-50	2	120 mins	pH 5.0
	Electrostatic stable fatliquor	2	2×10 60 mins	Check for the penetration and pile overnight

3.3. INTEGRATION OF BEST TANNING SYSTEM ALTERNATE TO THE CHROME AND POST-TANNING SYSTEMS FOR GLOVE LEATHER

Experimental trials have been carried out by integrating the treatment of 4% urea treatment before tanning along with the 2% of acrylic and GT-50 at Tanning and best post tanning practices i.e., usage of 4 fatliquors 4% amount each and FB-6 syntans for retanning. The run and other properties of the leathers are given in the table it is clear that the urea treatment has helped to improve the run property of glove to the levels equivalent to run of leathers.

Post tanning process

Control

Process	Chemicals	(% Offer)	Time	Remarks
Washing	Water	200		
	Wetting agent	0.3	30 mins	
	Degreasing agent	0.2		
Rechroming	Water	100		
	Formic acid	0.3	2×10 + 30 mins	Check pH 2.8-3.0
	Noval Tan PF	1	10 mins	
	BA	1	10 mins	
	BCS	4	60 mins	
	Fish oil	1	15 mins	
	Water	100		
	Sodium acetate	1	20 mins	
	Sodium bicarbonate	0.75	60 mins	Check pH 3.8-4.0
Neutralization	Water	100		
	Sodium formate	1	20 mins	
	Fish oil	0.5	10 mins	
	Sodium bicarbonate	1	2×10 + 60 mins	Check pH 6.0

Retanning	Water ASR 94S MAP VOS Novel Tan PF Dye	100 2 2 1.5 2 1 2	 20 mins 20 mins 10 mins 20 mins 45 mins	Check for penetration
Fat liquor	BA 94S Fish oil MBS Soft styrene	1 2 1 2 0.5	 60 mins 15 mins	
Fixing	Formic Acid	3	3×10 + 60 mins	

Experiment 1

Process	Chemicals	(% Offer)	Time	Remarks
Washing	Water Wetting agent	200 0.3	 30 mins	
Neutralization	Water Neutralizing syntan Sodium formate Sodium bicarbonate	100 1 1 1	 45 mins 10 mins 2×10 + 60 mins	 Check pH 6.5
Pre fat liquor	Water Balmol SX 100 Lipoderm liquor	100 3 3	 60 mins	
Retanning & Fat liquor	Water Melamine syntan Dye Balmol BLSO Balmol SX 25 Balmol SX 20 Lipoderm liquor	100 1.5 3 2 4 4 2	 20 mins 20 mins 10 mins 20 mins 45 mins	 Check for penetration
Fixing	Water Formic Acid	10 3	 3×10 + 60 mins	

Experiment 2

Process	Chemicals	(% Offer)	Time	Remarks
Washing	Water Wetting agent	200 0.3	 30 mins	
Neutralization	Water Neutralizing syntan Sodium formate Sodium bicarbonate	100 1 1 1	 45 mins 10 mins 2×10 + 60 mins	 Check pH 6.5

Pre fat liquor	Water Balmol SX 100 Lipoderm liquor	100 3 3	 60 mins	
Retanning & Fat liquor	Water Melamine syntan Dye Balmol BLSO Balmol SX 25 Balmol SX 20 Lipoderm liquor	100 1.5 3 2 4 4 2	 20 mins 20 mins 10 mins 20 mins 45 mins	Check for penetration
Fixing	Water Formic Acid	10 3	 3×10 + 60 mins	

Table 3.1: Strength measurements of glove leathers

SAMPLE	Tear strength Kg/cm^2	Tensile Strength kg/cm2	%ELONGATION AT BREAK	LOAD AT GRAIN BURST kg	DISTENTION AT GRAIN BURST Mm
	Average	Average	Average	Load	Distention
Control	33.40	26.80	72.65	20	14.38
E1	28.90	15.41	41.50	22	11.84
E2	32.45	21.65	44.00	17	13.10

4. CONCLUSIONS AND RECOMMENDATIONS

The chrome free glove leather produces lesser effluent discharge when compared to conventional process. Lecithin based fat liquor is found to improve the softness and run property of glove leather, synthetic fat liquor is found to improve the tear strength property .4% fat liquor each of LP-16, SX-20, SX-25 has been found to be the better combination of fat liquors for good gloving properties. Syntans of 2% offer of DLE and FB-6 have been found to be the optimum amounts. Ageing after pickling have been found to enhance the run property of the glove leathers. 3% Urea pretreatment before glutaraldehyde tanning has been found to be effective which result in glove leather with superior run and strength property, integration of pretreatment of skin with urea followed by glutaraldehyde tanning and post tanning with optimized post tanning practices have resulted in better glove leathers compared to the conventional process.

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CONFLICT OF INTEREST

The author have declared that no competing interests exist.

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