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EFFECTS OF FATLIQURING PROCESS ON LEATHERS COLOURED WITH IR REFLECTIVE DYES AND PIGMENTS

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Abstract: *Black coloured materials and consumer goods are known to be heating up more, because they absorb sun radiation more than light colours. This heating is a problem for the users for black automotive or motorcycle leathers and also for dark shoes and boots which are exposed to sun heat. Human vision system can distinguish visible colours between the wavelengths of 390-700 nm. So reflecting the sun radiation in the infrared area of radiation spectrum higher than 700nm, is a solution for heating problem without affecting the visible colour. For this reason IR reflective dyes and pigments are designed. A leading Leather Chemical Company has developed an IR reflecting dyeing system for leather keeping the dark coloured leathers cooler under sun radiation. Additionally in theory, fat and water content of leather affects its heating properties. In this study, effect of natural, synthetic and waterproof fatliquoring systems on heating properties of leathers coloured with IR reflective dyes and pigments are investigated.*

Key words: *Leather, IR Reflective, Dyes, Pigments, Fatliquoring*

1. INTRODUCTION

Colours almost always align with certain emotions and they have their own meanings for most people. For example black colour is associated with power, elegance, formality, death, evil, and mystery. Fashion industry uses this simple colour strategy in almost every item. Black is the indispensable colour for motorcycle seats, motorcycle clothes, car interiors, elegant shoes and boots.

Let's have a look how black colour is formed: Light is an electromagnetic radiation within a certain part of the electromagnetic spectrum. Human vision perceive the light reflections which have wavelengths between 390-700nm as colours. If all the radiation is reflected we see the white colour and if all the radiation is absorbed we see the black colour.

The electromagnetic radiation below 390 nm is called ultraviolet (UV) and beyond 700 nm is called Infrared (IR). Infrared radiation in sun was discovered by Herschel at 1800. Herschel was testing filters for the sun so he could observe sun spots. When using a red filter he found there was a lot of heat produced. Further experimentation led to Herschel's conclusion that there must be an invisible form of light beyond the visible spectrum [1]. Nearly half of the solar radiation consists of near-infrared (NIR) radiation (700–2500 nm) which is a direct consequence of heat [2].

Black coloured products absorb all the sun radiation including near IR and cause a heating problem. This causes comfort problems for motorcycle, automobile drivers and black shoe wearers. So reflecting the sun radiation in the infrared area of radiation spectrum higher than 700nm is a solution for heating problem without affecting the visible colour. For this reason IR reflective dyes and pigments are designed.

Modern IR-reflecting pigments enable formulators to create products showing less interaction with solar radiation compared to using normal pigments, and therefore showing lower heat build-up [3]. This technology is finding use in the area of coil coatings for facades and roofs and also in transportation and other areas where the ability to stay cool is a valuable benefit [4]. A leading Leather Chemical Company has developed an IR reflecting dyeing system for leather keeping the dark coloured leathers cooler under sun radiation [5].

However leather production is a result of continuous process steps which effect on the produced leather. Among these processes, tanning has its major importance; because the tanning process is the stabilization of the collagen matrix to retain a separated fibre structure and to increase the hydrothermal stability [6]. Another important process in leather making is the fatliquoring process which these separated fibres structure is kept during drying, thus allowing the fibres move laterally over each other. In essence, fatliquoring is a simple lubrication phenomenon [7]. However the chemical industry has many different raw materials available for the production of fatliquors. Fatliquors can be classified according the ionic character, composition or origin of raw material. Based on origin of raw materials, fatliquors can be classified as in two main groups as: Natural raw oils and fats, and synthetic oils. [8, 9]. Each fatliquoring class like sulfited natural and synthetic products, sulphated natural and synthetic products, lecithin-based sulphated natural and synthetic products, polymeric acrylic syntans, water-proofing fatliquors, etc. has their own characteristic effect on properties of leathers [9], [10], [11],[12].

In this study, effect of natural, synthetic and waterproof fatliquoring systems on moisture content, water absorption properties and heating properties of leathers coloured with IR reflective dyes and pigments are investigated.

2. EXPERIMENTAL

2.1. Material

2 wet blue sides each weighting approximately 10 kg were used as the raw material for wet-end processes. The thicknesses of leathers were adjusted to 1.2-1.4 mm by shaving.

The IR reflecting dyes & pigments, mixture of natural and synthetic fatliquors and waterproofing fatliquors were provided from TFL Turkey. Natural and synthetic fatliquors were provided from Zschimmer & Schwarz

2.2. Method

Each side of wet-blue leathers were divided into 8 pieces, totally 16 pieces. The study was conducted with two parallels. 4 different fatliquoring systems:

1- Combination of Selected Natural and Synthetic Fatty Substances (Lecithin)
2- Synthetic Fatliquoring Agent
3- Natural Fatliquoring Agents
4- A Waterproof Fatliquoring system

And 2 dyes were used in trials :

A- Standard acid dye
B- IR reflecting acid dye

2.2.1. Wet-end Process

The wet-blue leathers were processed according recipes given in Table 1 and Table 2. Then the leathers were hang-dried and mechanical processes like milling and toggling were carried out.

Table 1: *Standard wet-end process*

Process	Product	Dosage (%)	Temperature (°C)	Duration (min)	Remarks
Washing	Water	200	40		
	Oxalic Acid	0.2		45	
Washing	Water	100			
Neutralization	Water	150	35		
	HCOONa	1.5		20	
	$NaHCO_3$	1		45	pH:5.5
Washing	Water	100	40	30	
Dyeing / Fatliquoring	Water	100	35		
	Anionic Neutralization Syntan	1.5		30	
	Standard Dye / IR Reflecting Dye	3		30	
+	Water	50	55		
	Fatliquoring*			90	
	HCOOH	1.5		20	
	HCOOH	0.5		30	pH:4
Washing	Water	100			

* Fatliquoring variations:
1- 10% Fatliquoring Agent (Combination of natural and synthetic fatty substances (Lecithin))
2- 10% Synthetic Fatliquoring Agent
3- 7 % Natural Fatliquoring Agent (Combination of sulfonated and sulfited natural fats)
+ 3 % Natural Fatliquoring Agent (Sulfited fish oil)

Table 2: *Waterproof wet-end process*

Process	Product	Dosage (%)	Temperature (°C)	Duration (min)	Remarks
Washing	Water	200	40		
	Oxalic Acid	0.2		45	
Washing	Water	100			
Neutralization	Water	150	35		
	HCOONa	1.5		20	
	$NaHCO_3$	1		45	pH:5.5
Washing	Water	100	40	30	
Dyeing / Fatliquoring	Water	100	35		
	Anionic Neutralization Syntan	1.5		30	
	Standard Dye / IR Reflecting Dye	3		30	
+	Water	50	55		
	Waterproof Fatliquoring Agent A*	10			
	Waterproof Fatliquoring Agent B**	5			
	Waterproof Fatliquoring Agent C***	3		90	
	HCOOH	0.8		20	
	HCOOH	0.8		30	pH:4
Washing	Water	100			
Metal Capping	Water	200			
	Chromium (%33)	3		60	
Washing	Water	100			
	Water	200			

	Waterproof Fatliquoring Agent C***	1.5		30	
	HCOOH	0.5		20	
Washing	Water	100			

*Waterproof Fatliquoring Agent A : (Milky Emulsion Based on a Combination of Synthetic Fatty Substances)
**Waterproof Fatliquoring Agent B : (Milky Emulsion of an Acrylic-Based Polymer)
***Waterproof Fatliquoring Agent C : (Water Miscible Fluorochemical Compound)

2.2.1.Finishing processes

The leather samples dyed with standard dye were finished with a standard upholstery finishing recipe while the IR reflective dyed samples were finished by using IR reflective pigments according to Table 3.

Table 3: *Finishing recipe of leathers*

Product	**1st Coat**	**2nd Coat**	**3rd Coat**	**Procedure / Remarks**
Water	150	150	50	Drying After 2nd Coat
Binder (Compact)	500	500		Press After 3rd Coat (200 bar, 125 °C, 2 second)
Black Pigment / IR Reflective Black Pigment	100	100		
Binder (PU, Dull)			250	
Binder (PU, Glossy)			100	
Crosslinker (%3)			10	

2.2.3.Tests

The leather samples were exposed to IR radiation by using Rotlichtlampe, Typ IR 150 W lamp and temperatures were measured with a portable IR thermometer (Benetech GM320).

Measurement of static absorption of water (IUP 7) [13] and Determination of volatile matter (IUC 5) [14] analysis were done related to standards to determine the moisture and water content of leathers which were processed with different fatliquoring materials.

3. RESULTS AND DISCUSSION

The Volatile Matter % of leather samples are given in Fig.1. According to the findings, leather samples with waterproof fatliquoring system had the least volatile matter (8.42%), while the combination of natural and synthetic fatty substances (Lecithin) had the most volatile matter % (10.12%). The volatile matter% is also an indication of the moisture content of the leather.

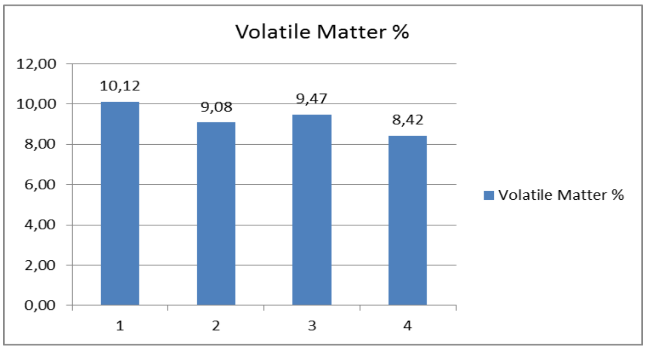

Fig.1: *Volatile Matter% of leather samples with various fatliquoring*

Static water absorptions of leather samples for 30, 60 and 120 minutes are given in Figure 2. At the end of 2 hours, leather samples proccesed with waterproof fatliquoring system had the minimum absorption of 29%. Leathers processed with natural fatliquoring agents, combination of selected natural and synthetic fatty substances (lecithin) and synthetic fatliquoring agent had higher water absorption at the end of 2 hours as 248%, 192% and 149% respectively.

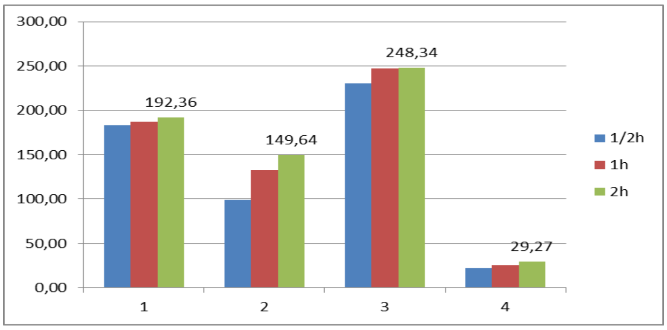

Fig.2: *Static absorption of water %*

The surface temperatures of leather samples dyed with standard dyes and pigments (A) and samples dyed with IR reflective dyes and pigments (B), and further processed with different fatliquoring systems (1-4) are given in Fig. 3. When the surface temperatures of leathers dyed with standard dyes and pigments are investigated, it is seen that waterproof leathers heat up the least 102°C, and all other fatliquoring systems heat up similar around 118°C. This can be related to the moisture content of leathers.

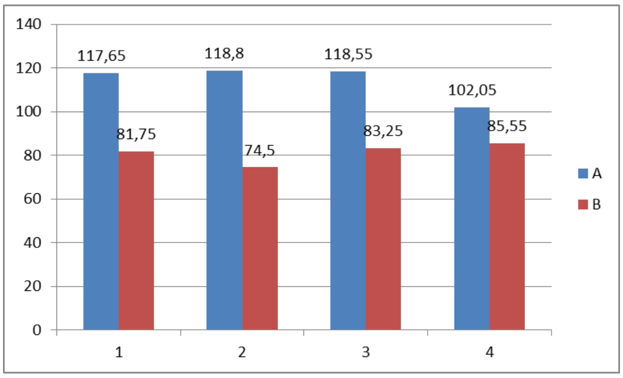

Fig.3: *Surface temperatures of leather samples*

Surface temperatures of leathers dyed with IR reflective dyes and pigments change between 75-86 °C. When the surface temperatures of leathers dyed with IR reflective dyes and pigments (B) are compared with the samples dyed with standard dyes and pigments (A), it is seen that IR reflection theory works and the leathers are cooler. However the temperature relation between moisture content cannot be seen here as seen in standard colours. This can be explained as the cool system works dominantly and take away the fatliquoring process differences.

4. CONCLUSIONS

The fatliquoring materials and system has an important effect on final properties of leathers like softness, physical & mechanical properties, touch properties, water-proofing, etc. [9]. Additionally fatliquoring materials also affect heating properties of leathers. From the findings of this study, it can be said that waterproofing fatliquors decrease the moisture and water absorption of leathers and they heat up less than standard fatliquors.

IR reflective dyes and pigments can be a solution for heating up problems of dark coloured leathers and leather products. This will ensure higher wearing and usage comfort of leather products without heat complaints of the customer. This technology can be used for car upholstery, steering-wheels, motorcycle upholstery, boots, military, horse-riding, sports & golf. From the test results it is found that leather samples dyed with IR reflective dyes and pigments heat up less than the standard coloured samples, and the leathers stay cooler. However the fatliquoring technology which determines the moisture content of leathers cannot be distinguished when IR reflective dyes and pigments are used. The authors will continue this study on IR reflectance characteristics of leathers, real-time in car tests and effects on aging.

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