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Manufacture of Sole from Leather and Rubber Wastes blends

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ABSTRACT
The aim of this Study was to manufacture sole from buffing leather waste and buffing rubber waste. Through tanning process a large amount of solid waste produced from leather manufacturing. Leather buffing dust is a waste from buffing operations and constitutes an important part of solid wastes. The leather and rubber buffing wastes resulted from buffing machine were blended and mixed with Polyurethane adhesive in different formulations. Mechanical properties of experimental footwear sole, such as tensile strength, elongations and hardness. Density test was determined as a physical test. The leather and rubber buffing wastes were blended successfully and the result showed that, tensile strength was 28.8 (kg/cm^2), elongation 50 (%), hardness 81 (shore A) and density 0.91 (gm/cc). It is concluded the optimum different composition of leather and rubber buffing wastes blends (leather\rubber 50:50) provided good mechanical and physical properties of sole.

INTRODUCTION:

The environmental and economic need to increase recycling rates is one of the principal driving forces behind technological innovation in the 21st century. Solid wastes from the tanning industry are unavoidable. This is because leather processing primarily associated with purification of a muti-component skin to obtain a single protein, collagen. The intrinsic nature of the leather processing steps and the nature of chemicals employed are also responsible for the generation of certain quantum of solid wastes starts at the first operation namely, desalting the raw hides/skis and prolongs through almost all unit processes and operations till end of the process sequence , namely shaving and buffing operations based on the nature of solid waste generated from the leather processing, they can be categorized into chemical and protein based solid waste.(Ponsubbiah, Suryanarayana, Sanjeev Gupta, 2018).

The leather processing industry produces large amounts of solid organic wastes in the form of un-tanned (trimmings, fleshings, splits) and tanned (trimmings, splits and shavings) waste from raw hides and skins, semi processed leather as well as sludge as a result of wastewater treatment. If this solid waste are not properly treated and disposed of, they can cause environmental damage to soil and groundwater as well as emissions of odour and poisonous greenhouse gases into the atmosphere. (UNIDO, 2000).

Moreover, the leather manufacturing process generates a variety of solid wastes which are well described in a UNIDO (2000). They report, the selected the wastes having a chemical composition comparable to finished leather:

- wet blue (WB) splits, trimmings and shavings,
- leather trimmings,
- leather dust.

The main waste production ratios used by UNIDO (2000) is summarised in the Table (1).

Table (1) Waste ratios regarding the leather manufacturing process (UNIDO 2000)

	ratio for heavy bovine leather (t / t finished leather)	ratio for light bovine leather (t / million m² finished leather)	ratio for sheep and goat leather (t / million m² finished leather)
Unusable WB splits, WB shavings and WB trimmings	171.0	513.0	180.0
Dry leather wastes (trimmings, dust ..)	27.7	83.2	151.3

According to the process of leather manufacturing, out of 1000 kg of raw hide, nearly 850 kg is generated as solid wastes in leather processing. Only 150 kg of the raw material is converted into leather. Tannery generates huge amount of solid waste as follows: fleshing, 50-60%; chrome shaving, chrome splits and buffing dust, 35-40%; skin trimmings, 5-7%; and hair, 2-5%. Solid wastes in the leather processing operation constitute: beam house, 80%; tanning, 19%; finishing, 1%. The solid wastes can be hydrolyzed and used as a useful byproduct Kanagaraj, et al, 2006).

Although the characterization of solid wastes from the tanning industry is well documented, the properties of the solid wastes generated from buffing leather (Table 2). Ponsubbiah, et al, 2018).

Table (2) Characteristics properties of waste leather (Ponsubbiah 2018)

Tests	Values
Humidity (wt %)	7.92 ± 0.22
Greases and Oils (wt %)	1.97 ± 0.36
Ash (wt %)	12.86 ± 0.20
Chrome Oxide (wt %)	3.41 ± 0.10
pH in water Extract (wt %)	4.15 ± 0.20
Nitrogen (wt %)	9.71 ± 1.41
Protein (wt %)	54.58 ± 3.80
Decomposition Temperature (°C)	323.0 ± 10.0
Diameter Average (μm)	4.52 ± 0.03
Length Average (μm)	258.5 ± 2.50

The current practice of disposing of buffing dust consists of: (i.) incineration in incinerators, (ii.) land co-disposal. Incineration causes serious air pollution problems because of release of toxic So_x and No_x gases, and it has been observed that at 800°C, about 40% of Cr(III) is converted into Cr(VI) during the incineration of Cr laden solid waste. Land co-disposal method poses a threat to groundwater resources. Reports indicate that groundwater sources were contaminated with Cr(III) and organic residues when leachates from land co-disposal mass enter the aquifers. Cr(III) in the groundwater is converted into Cr(VI) when it is chlorinated prior to disposal. (Sekaran, et al, 1998).

Management of buffing dust from chrome-tanned leather is difficult, and current practice of its disposal includes its incineration and land co-disposal. However incineration causes serious air pollution problems because of the release of toxic gases, and on the other hand land disposal method poses a threat to groundwater resources. (Ponsubbiah, et al, 2018).

Therefore various attempts have been made for finding beneficial uses of this waste and numerous researchers reported alternative processes to recycle and utilize buffing dust. The objectives of this work, utilization of leather buffing waste mixed with rubber waste blended to produce composites for sole.

Material and Methods:

Buffing leather waste was collected from tannery leather industry. These buffing leather wastes were representing vegetable-tanned leather, chrome-tanned leather, synthetic-tanned leather, Buffing rubber waste was collected from buffing machine in footwear industry, Different amounts of leather and rubber buffing wastes were mixed one hand with Polyurethane (PU) adhesive. The leather and rubber wastes were used to manufacture footwear sole. The blend mixed prepared to the following compositions ratio: 90/10, 80/20, 70/30, 60/40, 50/50, 40/60, 30/70, 20/80 and 10/90 to make up a total of 150 g blend. The Compression moulding machine used to produce sole from the experimental blend. **Table 3** shows the different percentage of materials formulation used.

Table(3) Composition percentage of leather and rubber wastes blends

No	Materials	
	Leather waste (Wt %)	Rubber waste (Wt %)
A	90	10
B	80	20
C	70	30
D	60	40
E	50	50
F	40	60
G	30	70
H	20	80
I	10	90

Testing Methods:

Tensile strength test:

The tensile measurements were carried out by using a Tensile Tester Machine. In this analysis, tensile strength and elongation at break were carried out. The maximum force and the length of the specimen at break are recorded. Tensile strength in MPa and elongation at break as % are calculated. (Imran, 2010).

Density:

Density is one of the important parameter that must be analyzed. The sample was taken in any shape with a volume to find out mass and volume and then calculating density using the formula. (Imran, 2010)

Hardness:

The measured penetration is converted into International Rubber Hardness Degree (IRHD). The harder materials will give higher reading. Then the hardness sample is checked with the standard only by acceptance or rejection. (Somenath, 2005). The hardness of the samples was measured using Shore A.

Results and Discussion:

The mechanical studies of blend sheets are very important characteristics because the products made have to bear the mechanical stress exerted when used by the consumer, therefore the mechanical properties of the blend sheets prepared in this study were examined. The mechanical properties such as tensile strength, elongation at break and hardness were examined. Density as physical test was also determined.

The sample from each blend was tested and average was calculated. The mechanical and physical properties were evaluated. The results of these tests are shown in table 4.

Table (4) the mechanical and physical properties of different composites of blend

Composite / properties	Tensile strength (kg/cm2)	Percentage of Elongation %	Density (gm/cc)	Hardness (Shore A)
Rubber	**28**	**175**	**0.8**	**40**
A	**5.7**	**26**	**0.94**	**65**
B	**13.7**	**32**	**0.98**	**80**
C	**15.8**	**28**	**0.90**	**83**
D	**20.1**	**26**	**0.89**	**85**
E	**28.8**	**50**	**0.91**	**81**
F	**27**	**40**	**0.98**	**80**
G	**22**	**25**	**1**	**75**
H	**20**	**40**	**0.97**	**74**
I	**9.7**	**28**	**0.87**	**67**

All the tests had been carried out at room temperature. Figure 1 shows the tensile strength of different composites. The tensile strength was below the range of the rubber standard expect E in the normal.

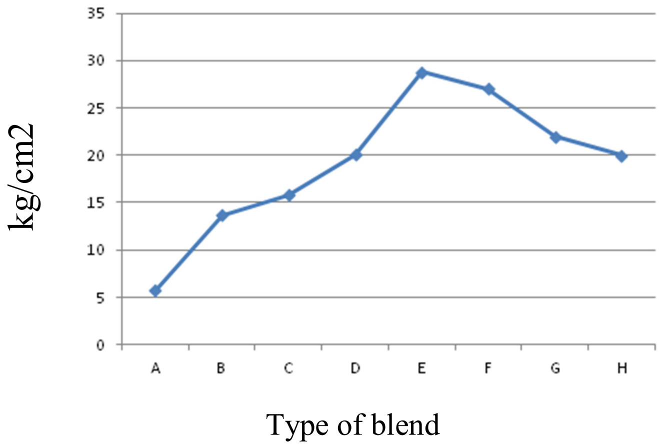

Figure (1): The Comparison of Tensile Strength in different composites of blend

As shown in **figure (2)** The Percentage of elongation of rubber materials 175 and the different composites of elongation were below the range that indicate to all the specimens has poor elasticity.

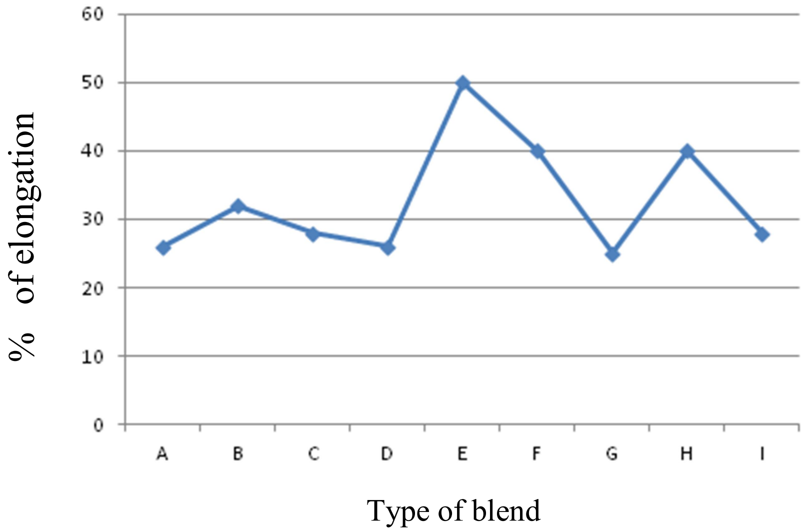

Figure (2): The Comparison of Elongation in the different composites of blend

The hardness values of different composites were above the rubber hardness range of blend sole as shown in **Figure (3).**

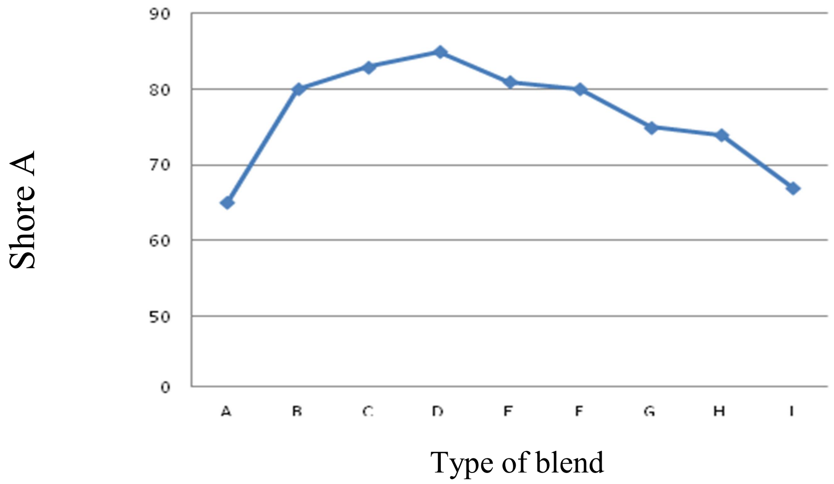

Figure (3): The Comparison of hardness in the different composites of blend

The density of different composites sole were evaluated all specimens were above the range compared with the rubber density 0.8 g/cm^3. **(Fig. 4).**

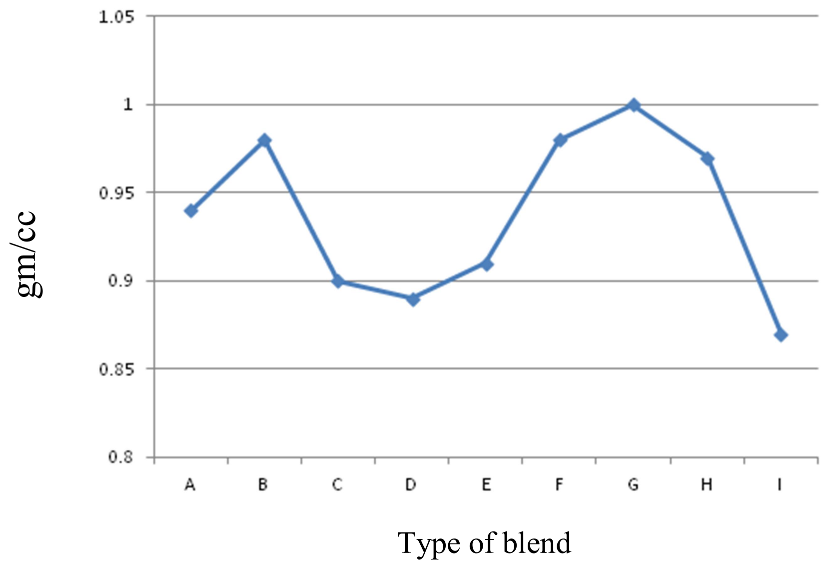

Figure (4): Comparison of density in the different composites of blend

It's concluded that, the different composites of leather and rubber buffing wastes blend were investigated. The composites successfully blended and the mechanical properties were evaluated with the rubber range. The leather waste improves the hardness of the composite of the mixture. The result showed that, tensile strength was 28.8 (kg/cm^2), elongation 50 (%), hardness 81 (shore A) and density 0.91 (gm/cc). the optimum different composition of leather and rubber buffing wastes blends (leather\rubber 50:50) provided good mechanical and physical properties of sole.

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