PREPARATION AND CHARACTERIZATION OF LEATHER WASTE POLYMER COMPOSITES

A. Jacob Moses\textsuperscript{1*}, M. Sumathi\textsuperscript{2}, Renjin J Bright\textsuperscript{3}

\textsuperscript{1, 2, 3} Department of Mechanical Engineering, JEPPIAAR SRR Engineering College, Padur, Chennai, 603 103, Tamil Nadu, India.

Abstract: This study deals with the possible utilization of industrial wastes of leather industry and automotive glass industry as useful materials. For this study composite plates have been prepared with recycled Poly Vinyl Butyral (PVB) as matrix and wet blue leather trimming waste and buffing dust as reinforcement materials. PVB is the industrial waste from automotive glass industry. Buffing dust and wet blue leather trimming waste are the industrial wastes from leather industry. Weight fraction of matrix as well as reinforcement in the composite has been maintained as 50%. Both wastes were compounded using two roll mill at a temperature of 90°C. After milling, the composite plates were compression moulded at a temperature of 95°C to improve surface finishing and a final thickness of 3 mm has been obtained. Specimens for mechanical testing were punched out from the composite plates as per ASTM standard. Characterization result indicates that these composites could be used as a replacement of conventional O-ring and insulation materials. Proper utilization of these waste materials not only reduces the production costs but also drive down environmental pollution.

Keywords: Compounding; Trimming Waste; Buffing Dust; Weight Fraction; Compression Moulding.

I. INTRODUCTION

Generation of solid and liquid wastes during manufacturing processes is unavoidable in major industries. India alone yields more than 960 Mega tons of solid waste from various industries. Domestic operations and dumping of these wastes in wastelands causes severe environmental threats. Proper recycling of these wastes would indubitably save the energy and conserve the resources. Waste management has become a major problem in modern society, especially solid wastes with potential toxic effects. The search for innovative solutions for the reuse of solid waste increased in the late 20\textsuperscript{th} century and has intensified with growing urgency for environmental preservation [1-3]. Many waste management solutions aim to add value to wastes through the development of new materials and processes [4].

1. Materials

Leather is wasted during each and every operation while transforming it to final product. Each operation leads to the generation of different kind of wastes [5]. Tannery generates huge amount of solid wastes during each stage of processing. Leather wastes such as Buffing Dust (BD) and Trimming Waste (TW) have been potentially utilized for this study. Both wastes were collected from leather industry, Chrompet, Chennai. BD obtained from chrome tanned leather is impregnated with chromium and synthetic fat. The BD and TW were mixed with PVB under necessary temperature and pressure.
II. METHODOLOGY

Figure 1 depicts the methodology of this study in a step by step manner. Both type of leather wastes (BD and TW) were dried under direct sunlight for 5 hours. It has been found that initial weight got reduced by 62% for trimming waste and by 9% for buffing dust. The tworoll mill which is commonly used for rubber compounding has been used for mixing the components. The two rolls were turned towards each other with preset, adjustable nip or gap to allow the material to pass through it to achieve high- shear mixing at 95°C. The gap between the rollers has been maintained as 1 mm. The back roll usually turns at a faster speed than the front roll. Here the back roll has been made to rotate at a speed of 15 rpm and the front roll at 10 rpm.Dies have been prepared to fabricate the required flexible sheet of dimensions 270 mm X 130 mm X 3 mm. After compounding, materials were placed in the lower die. The dies were heated up to 95°C. The upper die is then compressed against lower die by applying a load of 20 tons and it has been allowed to cool in the die for a duration of 30 minutes. Using the ejector pin the required composite has been taken out of the die.

III. RESULTS AND DISCUSSION

Tensile Test for the new material has been conducted as per the ASTM D412 standard. Figure 2 depicts the tensile behaviour of Buffing dust composites (BDC) and Trimming waste composites (TWC).
The tensile strength of PVB and Leather has been found to be higher than that of flexible composite sheet. This tensile strength value is compatible with that of nitrile rubber and greater than that of concrete. The tensile strength of nitrile rubber and concrete are 14 MPa and 3 MPa respectively.

Figure 3 depicts the comparison of tear resistance of composites made of buffing dust and trimming waste. Study of tear resistance reveals that these composites may be appropriate in O-ring Applications. It could be observed that both these composite materials exhibit good tear resistance property. TWC and BDC possess a tear resistance of 91.3 N and 83 N respectively.

Table 1 explains the important mechanical properties of TWC and BDC. Both these composites display similar range for all the mechanical properties explained.

| S. No. | Properties            | Standard        | Unit | Sample 1 Trimming Waste | Sample 2 Buffering Dust |
|--------|-----------------------|-----------------|------|--------------------------|-------------------------|
| 1.     | Tensile Strength      | ASTM D412       | MPa  | 7.32                     | 8.0                     |
| 2.     | Tear Resistance       | ASTM D1004      | N    | 91.3                     | 83.0                    |
| 3.     | Hardness (Shore A)    | ASTM D2240      | -    | 87.5                     | 84.5                    |
| 4.     | Abrasion Resistance   | ASTM D1044      | mg   | 94.2                     | 172                     |
| 5.     | Moisture Content      | -                | %    | 6.07                     | 3.47                    |
| 6.     | Thermal Conductivity  | ASTM E1630      | W/mK | 0.232                    | 0.220                   |
From table 1, it could be observed that tensile strength of TWC is slightly higher than that of BDC. Also TWC possess more tear resistance, hardness, and abrasion resistance than BDC. Thermal conductivity of both the composites have been found to be less. Thermal conductivity of TWC is 0.232 W/mK and that of BDC is 0.220 W/mK. This very low thermal conductivity suits these composites for application of moderate temperature insulation, heat shields etc. Further, moisture content test reveals that both composites have less moisture content. Moisture content has been found to be more in TWC than BDC. As a result, drying time has to be extended for trimming waste or alternative drying method has to be chosen.

The SEM micrographs of the BDC and TWC are shown in figure 4(a) and 4(b) respectively. The SEM results explains that there is a good bondage between polymer and leather wastes. Also it shows the leather particles are well distributed in the PVB matrix.

![SEM micrographs of BDC and TWC](image)

**Figure 4. Scanning Electron Micrographs of PVB Leather Composites**

IV. CONCLUSION

In this work, leather wastes and PVB were converted into flexible composite sheets using two roll mill followed by compression moulding. It has been found that these composites possess good mechanical properties such as tensile strength (8 MPa), tear Resistance (91.3N), Hardness (shore- A 87.5) and Abrasion resistance (94.2 mg). The low thermal conductivity and moisture absorption properties signifies their possible application in insulation materials, fabrication of gasket and O-ring. Consequently, the current work offers a valuable solution for recycling and managing of industrial wastes like trimming wastes and buffing dust by efficiently converting it into useful composite materials.

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