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Sustainable Non Woven Fabric Composites for Automotive Textiles Using Reclaimed FIBRES

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Abstract: More eco- friendly composite materials for automotive manufacturing have been made by substituting reclaimed fibre for a widely used cotton fibre to make non- woven fabric composites of reclaimed fibres and recycled polyester fibres. This more eco-friendly composites that can be compression molded into a wide range of parts has a greater bending stiffness, is more resistant to fire, less expensive and without the odor problems that accompany many natural fibre.

I. INTRODUCTION:

The use of reclaimed fibres has the advantages of consuming less water and chemical products, does not contaminate the subsoil, water or air, consumes less energy, recycles textile garments or fabrics which would otherwise become waste, provides economic benefits to developing countries which have been seriously damaged in recent years due to excessive mass production of cotton, and above all, production costs are lower than when using conventional or fully certified organic cotton. Recycling in the context of solid waste may be defined as the reclamation of material and its reuse which could include repair, remanufacture and conversion of materials, parts and products. In developed countries recovery of material from solid wastes is affected more scientifically at central collection and processing stations.

II. Material Preparation

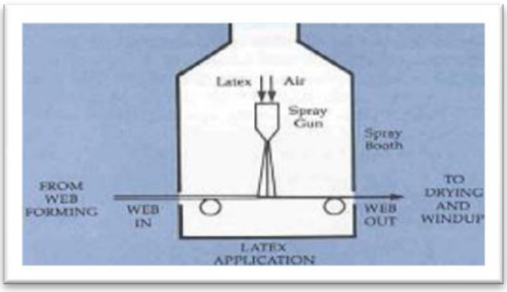
The most widely accepted preparatory method is 'mechanical re-fiberisation'. This involves passing cut fabric pieces through two nipped feed rollers that grip the textile while a rapidly rotating cylinder covered in sharp metallic pins mechanically opens the fabric into smaller fractions. The product of mechanical pulling typically consists of a mixture of individual fibres, yarn segments and smaller fabric pieces. Further separation stages are employed to increase the reduction of the segments and pieces into fibre form. The fibre is then collected on a vacuum assisted drum and fed out of the machine. The structure of the textile being refiberised influences the dimensions, degree of separation and homogeneity of the fibrous product.

Web Formation

The most common form of dry laid web formation is carding, but heavier weight webs containing waste fibres are also commonly formed into webs using Garnett machines. The mechanically recovered fibres were processed on the NIRI non-woven carding system and good compatibility was observed in terms of web weight uniformity and the degree of fibre separation. Immediately after carding, the webs were parallel lapped, which involves laying the webs over one another in the machine direction to improve final web uniformity further without changing the predominant fibre orientation. The resulting web is anisotropic in nature, in that fibres are preferentially aligned in the longitudinal direction. After subsequent bonding, the final fabric tensile strength will tend to be higher in the longitudinal direction. Whilst most air laying techniques designed for waste fibre recycling have traditionally utilized revolving pinned roller to transport fibres, a second method of web formation involves converting very short fibres (less than 10mm) using an adapted air laying technique of the sifting type. This system has been modified to handle mixed waste particles and fibres without the need for pre-sorting or separation. Such materials are not compatible with carding and therefore their commercial value in textile recycling is limited. Much work has been completed to verify the uniformity of the webs produced using this technique. The short fibres and particles that are recovered from the clothing waste which are incompatible with both carding and garneting were found to be particularly suited to conversion using the adapted air lay method. The fibres were separated efficiently during processing and formed a uniform web with isotropic properties. The addition of a proportion of homo-fil thermoplastic fibres, powders or bi-component thermoplastic fibres provided a convenient means of bonding the webs by through air bonding.

Spray Bonding

In spray bonding, binders are sprayed onto moving webs. Spray bonding is used for fabric applications which require the maintenance of high loft or bulk, such as fiberfill and air-laid pulp wipes. The binder is atomized by air pressure, hydraulic pressure, or centrifugal force and is applied to the upper surfaces of the web in fine droplet form through a system of nozzles. Lower-web-surface binder addition is accomplished by reversing web direction on a second conveyor and passing the web under a second spray station. After each spraying, the web is passed through a heating zone to remove water, and the binder is cured (set/cross-linked) in a third heating zone (Refer illustration). For uniform binder distribution, spray nozzles are carefully engineered.



Schematic illustration of spray bonding process

III. Concept Of Automotive Textiles

After a brief introduction to the Mobil-tech segment of technical textiles, it is essential to identify what products this segment includes. Automotive textile means all types of textile components e.g. fibres, filaments, yarns and fabrics used in automobiles. Some of these components are visible while the others are concealed. They are as follows:

A. VISIBLE Components:

Upholstery, Carpets Seat belts, Roof liners, etc.

B. CONCEALED Components:

Tyre cords, Composites (bumpers, side panels etc.) and rubber reinforced components (hose and filters), Airbags, etc.

It is estimated that approximately 45 square meters of textile material is used in an average car for interior trim (seating area, headliners, side panels, carpets, and trunk). This faster growing market in Asia gains opportunities for new developments in the area of technology and processing. According to a survey, the percentage of textile in a motor car amounts to 2% of overall weight of a car. Of this, visible textile component (excluding hidden components such as in tyres and composites, hoses, and filters) amount to 10-11 kg per vehicle in absolute terms. This data is mainly for the European cars and it is expected that these figures can vary from region to region.

EXPERIMENTAL PLAN AND PROCEDURE:

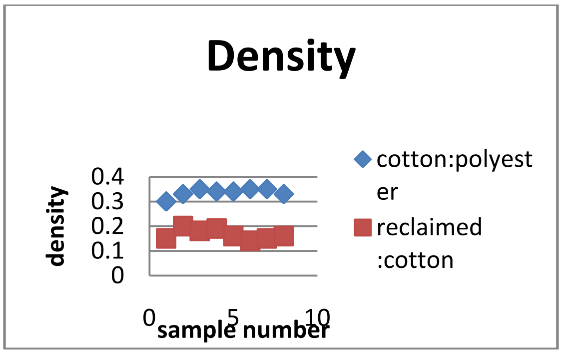
The experimental plan included the following steps:

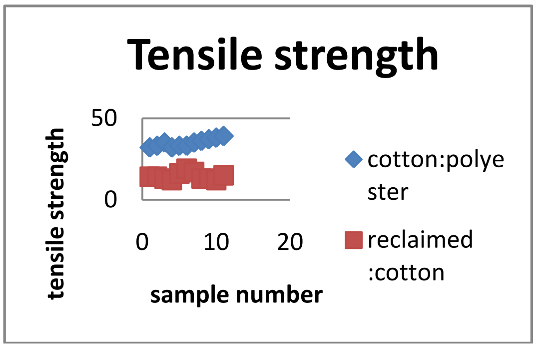
1. Secure from the cutting wastes of garment industry, carefully segregated them into a fibre
2. Mixed this fibre into recycled polyester fibre and make them into composites using spun laid.
3. Photograph in leica binocular micrographs before and after compression molding
4. Hot press 9” x 12” pieces of felt cut from the large rolls, using different combinations of temperature (170c -230c), pressure (0.33 – 1MPa) and time (15s -60s) to produce rigid plaques.
5. Measure the density and determine the flexural stiffness on table-top instron, tensile strength and elongation.
6. Repeat for 50:50 cotton: polyester non woven composites fiber mixture

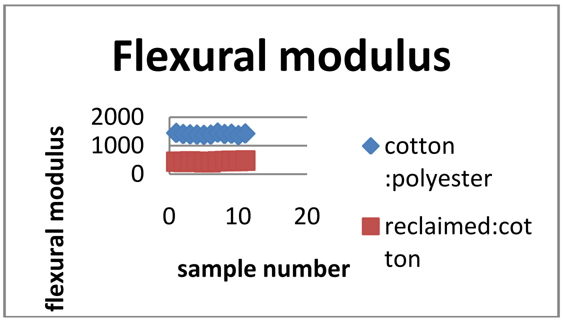
IV. Results And Discussion:

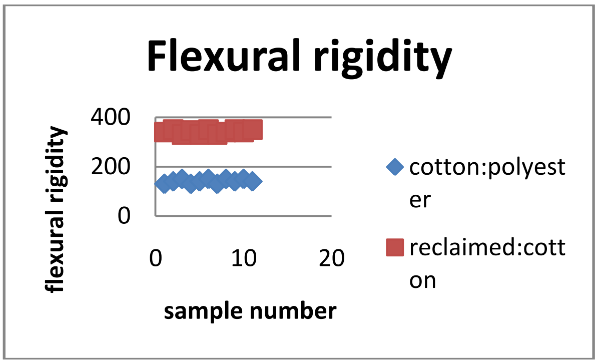
Mechanical test results are presented in the above table which shows the tensile strength, flexural modulus and flexural rigidity as a function of density for reclaimed: cotton and cotton: polyester composites. The cotton: polyester composites molded to a much higher density than the reclaimed: cotton at the polyester flow because the two small diameter fibers are much more flexible than the large diameter reclaimed fibre allow them to fill the nooks and cronies more efficiently. Since the polyester does the flowing in both non-woven fabric composites, the processing variable must be the difference in fiber stiffness.

PROPERTIES	Reclaimed :cotton	Cotton: polyester	Units
Areal density	**1000**	**1000**	**g/cmˆ2**
Unpressed bulk density	**0.14**	**0.30**	**g/cmˆ3**
Pressed thickness	**0.18**	**0.11**	**cm**
Pressed bulk density	**0.45**	**0.95**	**g/cmˆ3**
Tensile strength	**13**	**39**	**MPa**
Specific tensile strength	**26**	**39**	**MPa**
Tensile modulus	**680**	**2300**	**MPa**
Specific tensile modulus	**1250**	**2300**	**MPa**
Elongation	**23**	**30**	**%**
Flexural modulus	**450**	**1500**	**MPa**
Specific flexural modulus	**975**	**1500**	**MPa**
Flexural rigidity	**350**	**140**	**N-cmˆ2**
Specific flexural rigidity	**700**	**140**	**N-cmˆ2**
Burn testing for GM9070P	**1.00**	**1.25**	**Inch/min**









A comparison of the properties of the properties of the cotton: polyester to the reclaimed: cotton non woven fabric is presented. Since most applications are driven by compression strength and bending stiffness than tensile strength, the reclaimed: cotton looks very desirable in this comparison.

V. Conclusion:

The result of this study leads to the utility patent. Non –woven fabric composites made using reclaimed fibre and cotton fibre have been found to provide very attractive family physical and mechanical properties when compared with the widely used cotton: polyester non-woven fabric composites. The reclaimed fibres are an abundant, renewable resources that is currently under utilized they can provide a eco-friendly, non- non woven fabric composites materials at very competitive price points.

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