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Different Forms of Textile Materials in Transportation Applications

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Abstract

In transportation industrial textiles have wide applications in the areas such as trains, buses, marine transportation, airplanes, and cars. In the tire manufacturing about 75% fibres is used in rubber industry. In the manufacturing of airbags, the most widely used yarns are nylon 6, 6. Polyester is used in automobiles seat belts and nylon fibres are used in aircraft seat belts. For the purpose of automotive interior trims, woven and nonwoven fabrics are used having different properties. Polyvinyl chloride or rubber coated fabrics are used for the exterior trim of the cars. For hoses and belts for cars engines reinforced textile materials are used. In the airplane upholstery, ZIRPRO WOOL is used which is a chemically treated wool having flame retardant property.

Keywords*: - Buoyancy bags, Chopped glass, Poly urea resin, Hazardous waste, Sound insulator, Truck liners*

INTRODUCTION

Textile materials are mostly used in the cars for interior trim and the areas covered for reinforcement, underlay, tires, filters, hoses, sound dampening and insulation. Moreover, main application areas also cover body cloth, headliner and carpet. Mostly nonwoven products are used in automobiles. In the manufacturing of tire, the first used fibre was Irish flax and cotton replaced it till the time of Second World War. After this period viscose and nylon were introduced. Later on, for reinforcement fibres like polyester, fibre glass, aramid and steel were introduced. Betted, diagonal and radial are the three types of tire designs available in the industry **[1, 2].**

A cord used in the tire cord manufacturing is produced by the process of plying several twisted filament yarns together. The direction of twists of each constituent yarn and the cord structure are opposite to each other. Three different twisting methods namely ring twisting, direct twisting and two for one method are used. The cord fabric is manufactured from the cord yarn as warp and low filling count of one or two picks/inch. In the weaving of the fabrics, usually rapier looms, air jet looms and shuttle looms are used. Warp yarns are much coarser than the filling yarns **[3, 4].** As the warp yarns are securely placed in the rubber compound, the purpose of filling yarns becomes of no use and in the later stages of cord manufacturing the spacing changes took place as the tire is formed.

In the radial tire manufacturing, polyester or rayon and steel belts are widely used in passenger tires. In order to optimize adhesion and performance, different types of adhesives are heat treatments are applied to the synthetic cord fabrics. Steel, polyester and aramid fibres are extensively used in tire cord manufacturing replacing rayon and nylon fibres. The use of air bags has gained significant weight age as an automatic restraint system. These are built into the steering wheel and instrument panel. When any crash occurs, sensors set off as igniters in the centre of airbags to inflate. Pallets of sodium azides in the inflator act as igniters and release gases of nitrogen type. It then passes through a filter which removes ash or particles into the bag causing the bag to inflate **[5, 6].** In the year 1970, the first air bag was appeared in the market by General Motors. In U S Department of Transportation introduced FMVSS (Federal Motor Vehicle safety standard) in the year 1984**[7].** In any air bag system the major considerations in the assembly work are reliability in crash protection with reduced space and unit weight having low cost **[8].**

A seat belt is an effective device to prevent the forward movement of the user in a controlled manner when any sudden deceleration of the vehicle takes place. This device is easy to use, effective and inexpensive measure against an accident. Automobile seat belts are usually made from polyester and for aircraft it is made of nylon. Depending on the type of vehicle there are different types of seat belts are available. The static load carried by a seat belt is around 1500 kg with a maximum extension of 25% to 30% **[9].** The characteristics of any well designed seat belt must provide non-recoverable stretch at the time of any collision in order to

reduce the deceleration forces on the body. With the use of a controlled extension a typical seat belt must allow the passenger to move maximum of 12 inches during an accident **[10].**

PVC sheets are being replaced as car seats by textiles and leathers. The textile structures in fabrics to be used as seat belts materials are mostly from woven, pile warp, knit, circular knit and double needle bar raschel fabrics. These fabrics may be piece dyed or yarn dyed materials. Computer control on dyeing machines is used for colour and shade reproducibility. The yarns used in the structures are mostly flat continuous filament, false twist, air-jet and knit-de-knit types. The main requirements of seat belts facing fabrics are soft handle with colour designs and patterns, piece dyed with moulded ability during stretch. 3D knitted fabrics are also used as seat belts fabrics and it has the advantages to reduce need for cut and sew techniques. This technique is fully automated under CAD/CAM system **[11].**

As floor coverings tufted cut piles is used in the passenger cabin floor. In the United States, finer tufted gauges, short nap heights and denser structures are being used. Pile fabrics having loop structures can also be used. Fibres like nylon, BCF and nylon staple are equally important to be used in tufted carpets **[12].**

The various classes of sound insulators in cars are such as spacer-type, barrier type and dampening type. Hood liners are used as part of the acoustical package design to make the cars quieter by preventing noise from reaching the passenger compartments. Bonded mat of glass fibres is used as sound absorbing element. By using a cross-linking thermosetting chemical binder fibres are bonded together. It is advised that thin spun bonded nonwoven fabric may replace fibre glass made hood liners in the future **[13].** Fabrics that are used for the exterior of a car need a coating reinforcement with PVC or rubber. Vinyl coated cotton sateen fabrics as conventional convertibles are made of dyed materials. This is in use for last 30 years. Solution dyed acrylics and acrylic polyester blends are being used as outer fabrics. Topping fabrics may be of the types like cotton, polyester, nylon or blend of any combination **[14].**

In truck covers tarpaulins as textiles materials are used to reduce the drag and therefore in aerodynamic conditions its fuel efficiency improves. This is observed specially in the cases of trucks carrying open cargoes. Tarpaulins are manufactured

as coated fabrics made of polyester and nylonfibres with high strength. These fabrics are highly weather proofing materials and it gives fuel savings up to 7%. Tarpaulins are all weather proof and impact absorbing padding **[15. 16].**

In commercial aircrafts, long time fuel and chemical resistance are offered by composite materials**.** Textile reinforced composites are extensively used. To increase the payload capability and improve ship stability, graphite composite can reduce structural weight. For covering aircraft flooring, honeycomb structures made of NOMEX and impregnated with PHONOLIC resin are used. In space shuttle boron reinforced aluminium was used **[17].** Polymeric materials are expected to replace steel in many automotive application areas. As the polymer composites are lighter, more flexible and better dent resistant, they can replace heavy steel bodies. In fender applications, polymer resists processed by RIM (Reaction Injection Moulding) are the best material to be used. In hoods, sheet moulding compound is used **[18].** Inflatable saving aids like life jackets, rafts, and aircraft emergency coated fabrics are used. KYLON laminates with inter ply butyl rubber, which is less permeable to carbon dioxide than natural rubber with linger use can be used in naval rafts **[19].**

PROCESSES OF TIRE CHORD MANUFACTURING

In tire manufacturing, several filament twisted in plied forms are used. The direction of twists in the plied form and the cord yarn are opposite to each other. The cord structure can be formed in three different ways, namely in the form of ring twisting, direct cabling form and two-for-one twisting form. Normally 10 tpi is used. In the fabric construction, cord yarns are used in warp way and low ppi is introduced in the weft way. Air-jet, rapier or shuttle looms are used to weave this fabric. Compared to warp yarns, filling yarns are finer. The space between warp is to control by filling yarns. Filling yarns have no part to play in the fabric performance. The cord fabric thickness of 1 mm is maintained by the use of rubber in presence of adhesives through calendaring process. The purpose of using radial tires is to avoid influence of filling yarns. Filling yarns are made of nylon or polyester as core and cotton as sheath materials to get 200% elongation. In radial tires, rayon or polyester cords with steel belts are widely used. Different types of adhesives and heat treatments are given to synthetic cord fabrics for the optimization

of performance. The use of steel, polyester and aramid fibres are preferred compared to nylon and rayon fibres at the expense of higher cost. The bundle form of bead wire are usually wrapped with treated nylon cords or or woven or warp knitted nylon fabrics to maintain the integrity of the wire bundle during cure. These fabrics are treated for adhesion and tack to uncured rubber and are slit to width by the textile supplier for direct application at the tire building machine **[5].**

MANUFACTURING PROCESS OF AIRBAGS AND PROPERTIES

Airbags are made of woven fabrics. After the manufacturing of bags, black neoprene rubber or silicon rubber is applied on the driver's side airbags. The purpose of coating is to have good adhesion, anti-blocking, long term flexibility, resistance to cyclic temperature change, ozone resistance, long term stability, low air permeability and low cost. Careful attention is required for cutting and sewing for airbag fabrics. Dimensional tolerances are very small. Fibres like nylon 6-6, polyester, Kevlar, etc., are used as sewing thread materials. To have good performance in the airbags, sewing patterns and stitch types are very important. Any airbag module consists of airbags, inflator, mounting hard wire and moulded cover. Crash sensors and diagnostics are used as part to certify and supply the car manufacturers with the complete unit to be installed in the car. Primarily inflators are made of sodium azoxide, which upon combustion produces hot nitrogen gas,. The functioning of the airbag takes place at a speed of about 100 mph and inflation starts at 40 milliseconds, which again depends on desire and size of the airbag at 5 to 10 psi. The important considerations for an airbag system are related to reliable crash protection, reduced space requirements, reduced unit weight and low cost. It is proposed that polyester will be mostly used in airbags manufacturing in the future. The future development in airbag manufacturing will be the use of side impact bags, rear seat bags, trucks, airplanes and buses.

SEAT BELTS AND THEIR FUNCTIONS

The object of seat belts is to prevent the forward movement of the wearer in a controlled manner during sudden deceleration of the vehicle. These are very easy to use with effective and inexpensive ways of protection during an accident. Different types of seat belts are available in the market. The seat belts in a passenger car fit across the lap and diagonally across the chest. In the passenger airplanes a simple lap strap is used that does not

restrain the upper part of the body. In the case of a racing driver, a full harness consisting of a strap over each shoulder and lap belt is used. Polyester for automobile seat belts and nylon for aircraft seat belts are used. The seat belts are able to carry a static load of about 3300 pound with the maximum extensibility of 25 to 30 %. The other major criteria for seat belts are abrasion, heat and light resistance, light weight and flexibility during use. In the fabric construction, polyester and nylon continuous filament yarns are used in warp and weft way respectively. The warp yarns particulars are 320 ends of 1100 dtex. Preferably twill or satin weave is used in the fabric construction. Properly designed seat belts should provide non-recoverable extension during collision to reduce the deceleration forces on the body. The extension and reduced recovery from stretch properties are given to seat belts by controlled heat relaxation during finishing.

INTERIOR TRIMS IN THE AUTOMOTIVES

Interior trim in the forms of seat facing, seat hotsters, head liners, doors and side panels are made from different types of woven and nonwoven fabrics. Fabrics give comfort and better appearance of the car interiors with the consistency in the requirements. This has an impact on the buyer's new cars. The majority of the seating fabrics are mostly from flat woven, pile, warp knitting, circular knit and double needle bar raschal. Presently, polypropylene is used successfully in accent colours and some bolster fabrics. The properties of such seating fabrics are soft handle, designed colours and patterns, pieced dyed and mould ability with stretch. For head liners, warp knit, flat woven, circular knit and nonwoven fabrics are used. For good hand and resilience, nylon is prevalent in the head liners. For using as door and side panels, normally a back coating is applied on the fabrics.

Needle punched fabrics are mostly used in seat backs and panels, trunk liners, lower door panels, package trays and kick panels. For primary and secondary backing substrate spun bonded polyester fabrics may be used. In the passenger cabin floor generally tufted cut pile carpets are used. Nylon BCF and nylon staple are used almost equally in all tufted carpets. Head liners are used as part of the acoustical package design to make cars quieter by preventing noise from reaching the passenger compartment.

EXTERIOR RIMS IN THE AUTOMOTIVES

Fabrics to be used as automotive exterior trims need to be coated reinforcement such as polyvinyl chloride or rubber. The most important consideration for exterior fabrics is the weather resistant. Modern convertible fabrics are made of PVC coated double texture butyl rubber. Materials like Orlon, rayon and nylon are also considered along with Hypalon exterior coatings. A newly developed design and body construction from Chrysler is used for safety requirement as well as to meet the market demand. For soft convertible topping fabrics solution dyed acrylics and acrylic/polyester blends are used as the outer fabric combined with plain drill or jacquard lining fabric. The lining fabrics may be of the type cotton polyester or rayon or a blend of a combination. Other classes of exterior fabrics include sports car front end covers, truck covers, rear window curtains for hatchbacks, blinding fabrics and tire covers. Front end covers are used are used to protect the body finish from gravel and insects. These exterior fabrics are made of vinyl on nonwoven polyester or expanded vinyl or polyester knit. To protect the cargo from light utility truck covers are used. The backing fabric is weft inserted loop sheeting or conventional sheeting made of polyester. The rear window curtains for hatch backs are used inside the vehicles and they are positioned directly beneath the rear window glass and subject to magnified ultraviolet rays. Vinyl coated polyester/cotton binder fabrics are used for vinyl products. A variety of fabrics are used as tire covers ranging from heavy cotton knitted fabrics to nonwoven or polyester coated with vinyl. Tarpaulins as textile fabrics are used as truck covers to reduce the drag and therefore improve truck aerodynamics. Tarpaulins are basically coated fabrics made of high strength polyester and nylon fibres. These are excellent to protect cargo from weather. Tarpaulins also protect cargo debris from flying. Textile fabric covers are used to protect cars from sun, rain, hail, snow, and other harsh environmental effects. All season car covers are made of polyester and impact absorbing padding.

OTHER TEXTILES FOR TRANSPORT VEHICLE

For cargo engines textile materials reinforcement forms are used in hoses and belts. Polyester and rayon reinforcements are used in radiator hoses, heater and air conditioning, hydraulic lines, power steering lines and vacuum brakes hoses. Heater and radiator hoses have to withstand the near-boiling temperature of

water and other chemicals and radiant heat from the engine itself. Recently, high temperature thermal barrier materials like fibre glass, ceramic and silica fibres, aramids, moulded mineral fibres, metalized fibres and silicon rubber coated fabrics are being used in modern cars for insulation of hydraulic, fuel, air-conditioning wires, engine mounts, wiring harnesses, exhaust gas, recirculation tubes and electronic components.

In airplane upholstery, a type of structure known as blocking layers is used to help pass flame resistance regulations. Zirpro wool is chemically treated flame resistant wool that has recently been developed. Seat covers with one of these kinds of layers help increase the chances of surviving a post crash fire. Using different layers in the seat covers, fire safety drastically increases. A new type of fabric known as Firotex has been developed which is placed around the cushions as an inner cover. Wool is another flame resistant material that is often used in aircraft furnishings. The other areas of the plane that require the use of textiles include seat belts and shoulder harnesses. Protective clothing plays a major role in the aeroplane industry. In order to maintain level of Cleanliness, workers must wear protective clothing. Textiles have also been used as actual components of the space shuttle.

The use of textile structural composites is increasing in the manufacturing of transport vehicles including automotives, trucks and aircrafts. In commercial aircrafts, composite materials provide long-term fuel and chemical resistance. In automotives many body components are made of textile reinforced composites. In ship building graphite composite can reduce structural weight to increase payload capability and improve ship stability. Textile fibres can be used in clutch and brake parts replacing asbestos. These parts require good abrasion and high temperature resistance. Automobiles account for approximately $2/3^{rd}$ of the gasoline consumption and $1/3^{rd}$ of total energy use in U S. Polymeric materials are expected to replace steel in many automotive applications. Steel is heavy and subject to corrosion. Polymer composites are lighter, more flexible and can offer batter dent resistance.

Coated fabrics are used in inflatable saving aids such as life jackets, rafts, and aircraft emergency chutes. Usually canopies are also included to protect against severe weather. Civilian rafts are generally made of woven nylon fabrics and coated on both

sides with natural rubber or rubber/SBR blend. Naval rafts are usually made of nylon laminates with an inter ply of butyl rubber, which is less permeable to carbon dioxide than natural rubber providing longer use. The coated fabric 'skirt' is filled around the hull and contains the cushion. Coated fabrics are also used to surround and contain oil slicks for marker buoys and in flotation equipment pipe lines and platform sections.

CONCLUSION

There are three major systems to produce tire cord, which are like ring twisting, direct cabling and two-for-one. In the radial passenger tires rayon, polyester and steel cords are mostly used. Nylon 6, 6 is widely used as yarns of airbags manufacturing. Careful attention is required in the process of cutting and sewing of airbag fabrics. He main purpose of wearing seat belts is to secure the forward movement of the passenger in a controlled way during any sudden deceleration of the vehicle. The3 functions of automotive interior trims are to provide comfort and good appearance along with better performance and consistency requirements. Yarns used in the making of seat belts are polyester and polypropylene. As sound dampening materials carpets, nonwoven and other fibrous materials are used. The soft topping of sports utility vehicle is a vinyl coated heavy duty polyester/cotton sateen fabrics. In order to protect cargo from weather tarpaulins are widely used and are excellent material. V-belts are used to drive the alternator and warp pump. Firotex is a new fabric has been developed which is placed around the cushion as an inner cover. Textiles are used as actual components of the space shuttle. Polymeric materials have start replacing steel in many automotive applications areas.

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