Automotive Textile

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Abstract:-

Textile industry began with the need of protecting human being from the changing climatic conditions. Man first covered his body with leaves, plant fibers till he discovered the fabrics. Textiles are now an essential part of every body's life, to provide for fashion requirement and comforts rather than just to cover the skin. Textiles are mainly applied in three fields they are

• Apparel uses

• Home textiles and

• Technical textiles

Among which technical textiles are an expanding area of textile industries. New yarn and fiber development is one of the driving forces of the modern technical textile industry. The 1980s was a particular period, which saw the commercial introduction of a wide range of new materials, with liberalization and globalization as the slogan written on the wall... Technical textiles are the textile applications in medical, civil engineering and automotive fields. Technical textiles are gaining fast recognition to be one of the most dynamic and promising areas for the future of the textile industry in India for hiperformance applications. Automotive textiles happens to be the rewarding sector finding extensive use of technical textiles in the product categories viz. interior trims, safety devices like seat belts and airbags, carpets, filters, battery separators, hood liners, hoses & belt reinforcement. The potential for the growth of automotive textile business may be gauged from the explosive expansion projected for car production, with Asia- Pacific as the growth driver. Globally 65.1 million cars are produced. It will grow to 75.7 million by 2011 at a CAGR of 3.6 per cent. The market size for automotive textiles will double from Rs1,614 crore to over Rs 3,200 crore by 2011-12, according to Mrs. Shashi Singh, Joint Textile Commissioner. A Part of discusses issues such as automotive textile requirements, constructions and its applications will be dealt with this paper.

AUTOMOTIVE TEXTILE

Technical textile:

Textile materials and products manufactured primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics.

Automotive textile:

The Indian Automobile industry is flourishing like never before in the recent years. The production sales of the automobiles are growing strongly at a CAGR of around 16% with 11 million units produced in 2006-07 reaching to 19 million units by 2010. Presently, automotive textile industry has a share of 7% in the total domestic technical textile market, which is worth US$ 590 millions and is forecasted to reach approximately US$ 987 million by 2010. . It account for 20% consumption of global textile production. An automotive textile is a single largest consumer of technical textile with over 1 million tons/annum.

Textiles, which constitute approximately 20-25 Kgs. (Approximately 80-90 square yard) in a car, are not only used for enhanced aesthetic of automotives but also for sensual comfort & safety. Additionally, few textile products found their applications as design solutions to engineering problems in the form of composites, tyre reinforcement, sound insulation & vibration control. Apart from woven & knitted constructions, Nonwovens also find applications in transport textiles due to certain advantages served by them.

Table 1 shows various applications of textile fiber and their share in kgs. in average car.

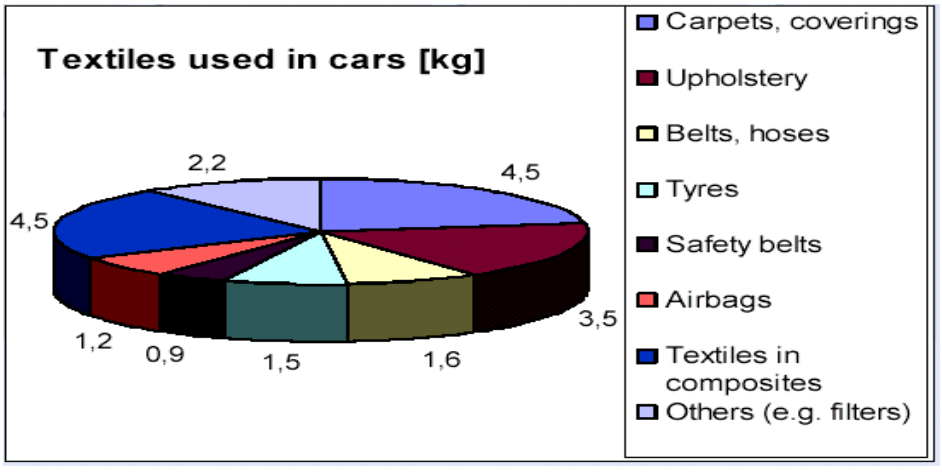


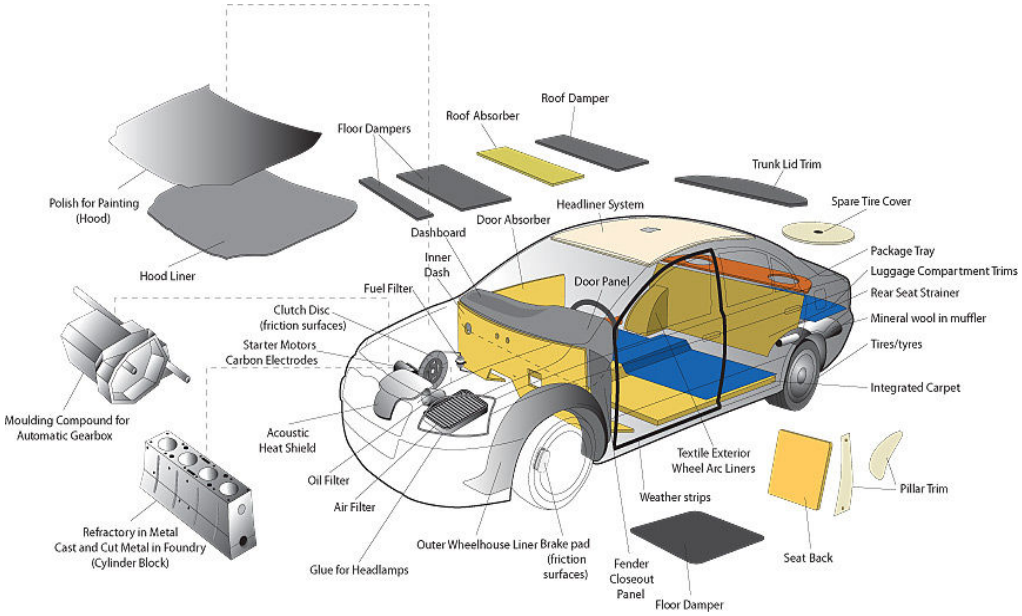
Table 2 shows various applications of textile fiber & their share in percentage in average car.

Application area	% share
Carpet (Including car mats)	33.3
Upholstery(seating fabric)	18.0
Preassembled interior component	14.0
Tire	12.8
Safety belt	8.8
Air bag	3.7
Other	9.4
Total	**100.0**

Need of Automobile textile:

The consumers look for aesthetically pleasing interior, great comfort and fuel economy. The textile product can satisfy both requirement and these are constructed to light weight. Textiles offer other are significant weight reduction which gives fuel economy. Approximately 75% of vehicles fuel consumption is directly related to weight of vehicles and 25% related to air drag. Improvement in std of leaving resulting in greater demand for personal vehicles. Ecological reforms for recycling of used cars have increased the amount of textile in an automobile. Apart from safety & interior textile come to engineering problems such as tire reinforcement, acoustic protection, and gas and air filtration.

Principle application of textile in automobile industry and the fiber used



Use	Main property requirements	Fiber used
Seat covers	Abrasion, UV resistance, Attractive design & Texture.	Nylon, polyester, Wool, polypropylene.
Seat belt	Tensile Strength, Extension(25%-30%),abrasion & UV resistance	Polyester.
Carpet	Light fastness ,mould ability	Nylon,polyester,polypropylene
Air bag	Resistance to high temp inflation gases, durability to storage over many year, tear strength	Nylon6,6 and Nylon4,6
Tire cord	High strength, less extensibility, compatibility with rubber	Viscose rayon ,polyester, Kevlar
Composites	Light weight, high stiffness, high strength, less elasticity	Carbon(SMC),glass, aramid

The general classification and description of automotive textiles can be summarized as:

Upholstery-

The volume of upholstery varies by region since manufacturers from different regions may prefer different styles of vehicle interiors. Both woven manufacture of automotive upholstery. An average of 5-6 m2 of fabric is used in cars for upholstery. Modern designers are trying to give sporty or elegant look to the car interiors.

Carpets-

Carpet is an important part of the automotive interior. Carpets must withstand temperature extremes. Needle-felt carpets, tufted cut-pile carpets are generally used. Major car producers are using tufted cut-pile carpets in their cars. Carpets usually have a rubberized backing.

Car Interior Components-

Car interior becoming increasingly important with raised consumer expectations. Door kick panels, boot linings roof linings, parcel shelves and insulation (heat, sound, vibration etc.) materials are important examples for pre-assembled interior components. Coated laminated needle-punched non-woven and warp knits are the main materials used for the category.

Tire-

The textile material in a type is used mainly for reinforcement. Textile materials such as viscose, glass and steel cords provide dimensional stability as well as reinforcement. Dimensional

stability is an essential requirement for tires. Strength is provided to tires mainly by the web of fibers that lies with the body of the tire called as Carcass

Safety Device-

Due to governmental pressure and legislation, safety device have become a growing market for automotive textile. Seat belts and air begs are commonly used for safety in automotives. The seat belts control the forward movement of the wearers in the controlled manner during sudden stoppage of the vehicle. About 1 Kg of textile fiber per car is consumed in seat belts. An airbags is an automatic safety restraint system that has gained significance within the last decade. Airbag is not an alternative to seat belt but a supplement. Seat belt provides a protection regardless direction of collision but air begs provide protection against head on collision.

Filter and engine compartment item

Hoses, belts and linen are important components car engine which are reinforced with textile materials. Automotive filters are largely made of textiles. Some examples of the filter are air filter and oil filter. The function of these filters is to filter the fluid before it enters the engine because of delicate machine component may be destroyed if the dust particle enters into the engine.

Table 3: Fiber product and formation methods for automotive textile

Application	**Fiber**	**Manufacturing methods**
Transmission oil filter	Polyester	Needle, bonded
Dash insulator	Reprocessed	Dry laid, bonded
Slit cover slit sheet	Nylon	Spun bonded
Seam foam reinforcement	Polypropylene	Needled
Headlining substrate	Glass	Melt blown, air-laid
Shelf panel cover	Polypropylene	Needled
Landau vinyl backing	Polyester	Needled
Trunk liner floor covering	Polyester	Needled
Door trim panel padding	Polyester	Dry laid, bonded
Door trim panel carpet	Polypropylene	Needled
Floor carpet under pad	Reprocessed	Needled
Hood panel insulator	Glass	Melt blown, air-laid
Carpet tufting fabric	Polyester	spun bonded

UPHOLESTRY:-

- **Properties required:**

To overcome the two major tribulations of soiling and steam rupturing. The upholstery ones it fixed in place it must last the life time of car without being put in a washing machine.

Wear properties- abrasion and pilling resistance and seam strength.

Functional properties-wet ability, water repellency, oil and stain resistance and flammability.

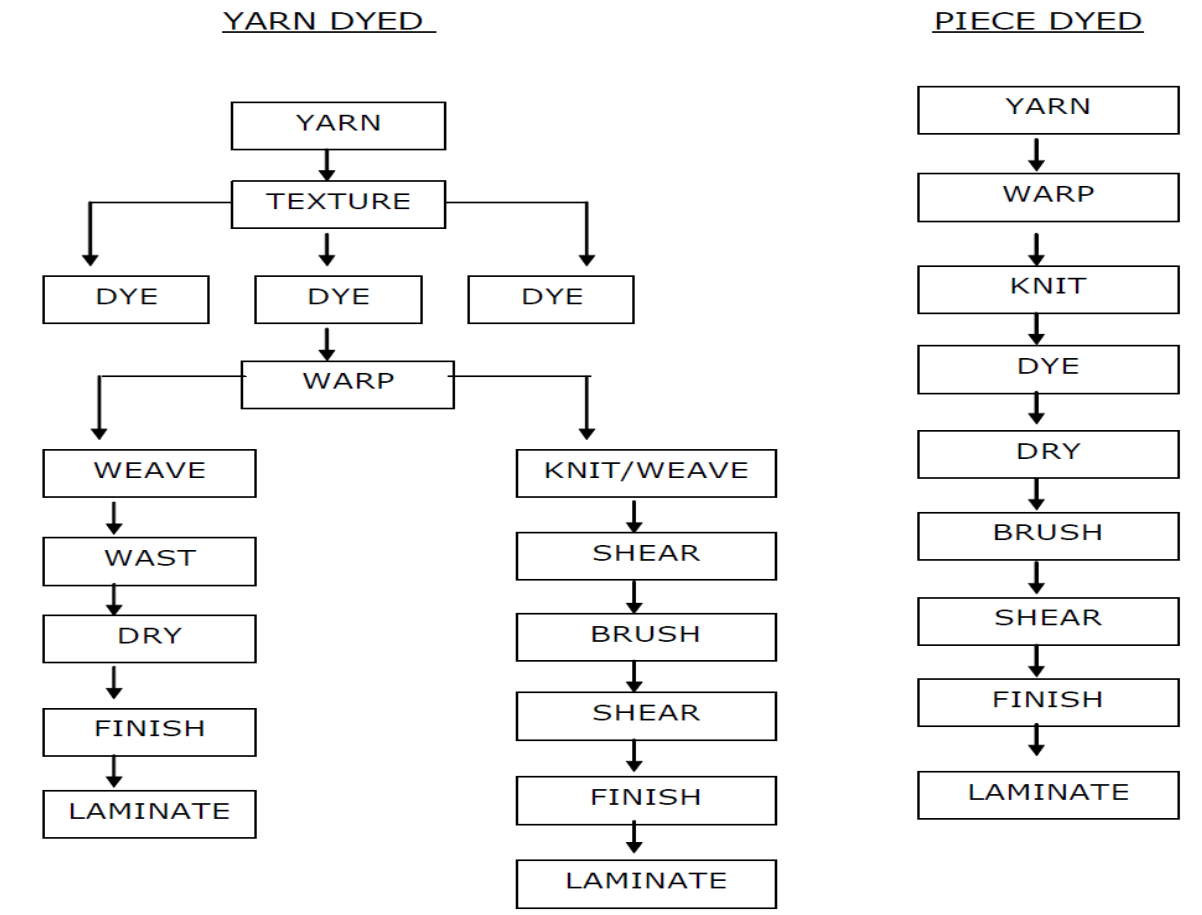
- **Manufacturing process:**

Textile fabrics and leather have replaced PVC for car seats. However vinyl is still used with either a polyester/cotton knit or a polyester non woven substrate as trim on the back and in the skirt of seat.

Major Upholstery fabric structure:

- flat woven fabric
- pile woven fabrics
- Warp knits
- Circular knits
- Double needle bar Rachel

One of the most traditional forms of automobile upholstery is plain woven cloth manufactured from air-jet textured and spun polyester. The textured yarns have good abrasion resistance because of their tight loop structure. The yarns contrived from core and effect components can produce fabric cover of very good quality. These types of yarns are based on a central yarn called the core which gives strength and stability to yarn. In case of yarn dye route, the dyeing is carried out prior to weaving and in case of piece dye route, the dyeing is carried out at a later stage. The manufacturing rote for automobile upholstery is as shown in fig.

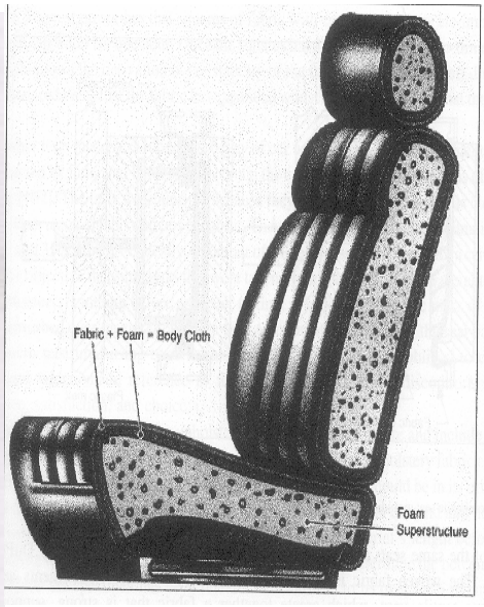


Different ways of manufacturing upholstery:

Car makers are increasingly favoring the usage of weft knitted fabrics for upholstery. These fabrics are generally manufactured on circular knitting machines and process sequence follows yarn dye route. Flat woven fabric is finished according to the yarn dye route. Finishing sequence for woven velvet upholstery is heat setting, brushing and then cropping. The ranges of finishing operations carried out are wide and varied but the objective is to produce fabrics with functional qualities and good aesthetic appeal. The formation of automotive upholstery involves the amalgamation of three layers i.e. face fabric, foam and backing material. The conventional method used for this purpose is Flame laminate on. But this process is environmentally unfriendly and some times the laminates lack porosity which affect the sound absorption and comfort. Hence, new technologies such as hot melt adhesive application are being introduced.

Hot melt adhesives are solvent-free adhesives that are characteristically solid at temperatures below 180 degrees F, are low viscosity fluids above 180F, and rapidly set upon cooling. The development of hot melt adhesive technology stemmed from the previous use of molten wax for

bonding. When this method no longer satisfied performance needs, 100 percent thermoplastic systems were introduced. Today, hot melt adhesives are used in a variety of manufacturing processes, including bookbinding, product assembly, and box and carton heat sealing.



Testing:

1) Abrasion pilling resistance
2) Seam strength
3) Water repellency
4) Oil and stain resistance
5) Perspiration resistance.
6) flammability

2) SEAT BELT:-

Properties required:

Abrasion resistance, UV resistance, heat light resistance, high tensile strength, light weight flexibility, Extension (25%-30%) and carry static load of 1500 Kg

Manufacturing process:

Seat belts are made up of polyester. To get high strength polyester or nylon continuous filament yarn

are used in warp and weft direction (A typical yarn for seat belt is made up of 320 ends of 110 dtex each). Warp direction in the belt is more critical since the load applied mostly in that direction during accident. Twill or Satin types of weaves are used for seat belt. In this type of design, long warp knuckle on both sides of the belt provide the direction. This configuration also provides lightweight, slim and flexible fabric with smooth surface that is comfortable to wear and easy to use. The woven fabric is shrunk during finishing improving the energy-absorption properties. As a result of the shrinkage, the weight would increase typically from 50 g/m to 60 g/m. power dyestuff should be used to provide fastness to light, rubbing and perspiration. No dye should be transferred from seat belt to garment by rubbing even in wet conditions.

About 1 kg of textile fiber per car consumed in seat belt. Seat belts need to be soft and flexible as possible along the length direction but as rigid as possible in width direction so they can slide easily through buckles and to retract smoothly into housing. Now days, the seat belt are being woven on shuttle less needle looms which can deliver up to 1000 picks per minute. The 2 up 2 down twill is preferred because warp threads lie in parallel to the face and back of webbing and as a result, the material has a high warp ways strength and low elongation.

A typical seat belt should allow the passenger to move forward around 12 inches during an accident by controlled extension of the belt. In serious accident, a well-designed seat belt provides a deceleration of 20g (g-gravitational acceleration) or more, which means that there is a considerable amount of force exerted on the body by the seat belt. Although this force may cause some damage to body, this damage is far less compared to the damage without seat belt.

FIGURE 15.10 Two/two twill seat belt design [10].

Testing : The important testing to performed are

1) Abrasion performance

2) Dynamic test

AIRBAG:

Properties required: High material strength in warp and weft direction, High propagation tear strength, Heat stability, good ageing characteristics , energy absorption, coating adhesion and function at extremities, hot and cold condition, toughness, fog resistance, package ability, High anti slip properties of the seams, defined dimensional stability , defined air permeability 101/dm sq/ min at 500 Pascal, product liability 15 years.

WORKING: An airbag is an automatic safety restraint system importance within the last decade. Airbag is built into the steering wheel and instrument panel. they are not alternative but supplement to seat belts because air bag provides protection only against head collisions while seat belts provide protection regardless of crash direction.

Working sequence of airbag:-

FIGURE 15.6 Deployment of an airbag (courtesy of Sulzer Ruti).

Above figure shows, the operation sequence of an airbag. Since almost all collision occur within .125 second, the airbag is designed to inflate in less than .04 second or 40 milliseconds. In a collision, the air bag begins to fill within .03 second; the airbag is fully inflated and cushions the occupant from impact. The airbag then deflates .12 sec. and after absorbing the forward force. The entire event, from initial impart to fully development, takes about 55 milliseconds-about half the time to blink an eye.

Data shows that more than half of all serve injuries and death in automotive accidents are the result of frontal collisions.

Manufacturing process:

The most widely used yarns in air bag market are 315, 420, 630 and 840 denier Nylon 6,6 yarn. The yarn is sized by using a polycyclic coating through a one-dip process. Then it is passed between squeeze rollers and then through a cooling rod so that the size adheres to the yarn. for, drying a gas-fired dried is used. This process prevents the ends from rolling during drying and wind-up.

Table5: Typical properties of nylon6, 6 airbag yarns

Denier	420	480
filaments	68	140
Tenacity(g/d)	7.9	8.4
Elongation%	21	21
Free shrinkage(% at 177 degree C)˙	6.1	6.5
Melting temperature (degree C)	256	256

After weaving, the driver side airbag fabric is coated with black neoprene rubber or silicon rubber. major requirements for coating are good adhesion, anti blocking, long term flexibility, resistance to cyclic temperature change(from-40 degree F to 46250 degree F), ozone resistance, long term stability, low air permeability and low cost. Cutting and sewing of air bag fabrics demand careful attention. Dimensional tolerance is very small. Seaeing thread fiber type, weight, construction and coating need to be selected properly. Nylon 6, 6, polyester and Kevlar aramid fibers are used in for sewing threads. Sewing patterns and stitch type are critical to the performance of airbags. An airbag module consists of airbag, inflator, mounting hard wear and molded cover. Crash sensors and diagnostics are used as part of system.

Weaving machines for weaving air bag fabrics:

Rapier weaving machines are excellent for production of air bag fabrics. Water-jet and air-jet machines are also used .For weaving airbag fabrics double width on projectile weaving machines are also familiar. Modern weaving machine are shown in table 8:

Table8: Weaving machine for weaving air bag fabric

Style	Airbag	Picanol OMNIplus-2-p 280	SMIT fentile G 6300 230N4SP
Warp	Material Yarn count Density	Nylon 6,6 235 dtex f 68 (T749) 28 ends/cm	Unsized Nylon 6,6 NA 22 ends/cm

Weft	Material Yarn count Density	Nylon 6,6 235 dtex f68 (T749) 28 picks/cm	Unsized Nylon 6,6 NA 22.5 picks/cm
Width		270 cm	227 cm
Speed		780 rpm	600 rpm

Modern development in air bag fabrics is concentrated on 35*35 plain weave made of 650 denier nylon yarns for driver side and 41*41 plain weave made of 440 denier polyester yarns for passenger side.

TESTING:

1) Accelerated Ageing
2) Performance of airbag fabric
3) Physical properties of fabrics
4) Visual inspection and Grading

4)CARPET:-

Properties required:

Light fastness, mouldability, and soil and abrasion resistance.

Manufacturing process:

The carpets used in car are mainly three types

1) Tufted carpet
2) Tufted loop pile
3) Needle felt

The use of these types varies from country to country

Needle felt fabrics most popular in Western Europe & Japan. While tufted fabrics are popular in US market, they don't line needle felt fabrics. There are about 3-5 sq.meter carpet in each car mainly depends by location. Carpets are manufactured either by tufting or needle felting. Carpets made by tufting are based upon a supportive backing which is used as a base to accept the pile yarns which becomes the uppermost surface.

Carpet backing is usually spun bonded and is made by an integrated process in which polymer chips are melted and filaments are extracted through a die. Mainly polyester is used in Making this carpet backing whereas a blend of nylon and polyester is used in some occasions. But

during recent times polypropylene is assuming great importance considering the recyclability. The process of needling has got the advantages of more productivity at relatively low cost. But carpets produced by needling cannot be used to cover sharp counters especially foot areas and transmission tunnels. Superior needled material has a good filling which is determined by the amount of vertically oriented fibers at a given stitch density.

Testing:

1) Light fastness
2) Mouldability
3) Resistance for soil and abrasion resistance

5) TIRE:-

Properties required: High strength, less extensibility, Capability with rubber

MANUFACTURING OF TIRE :

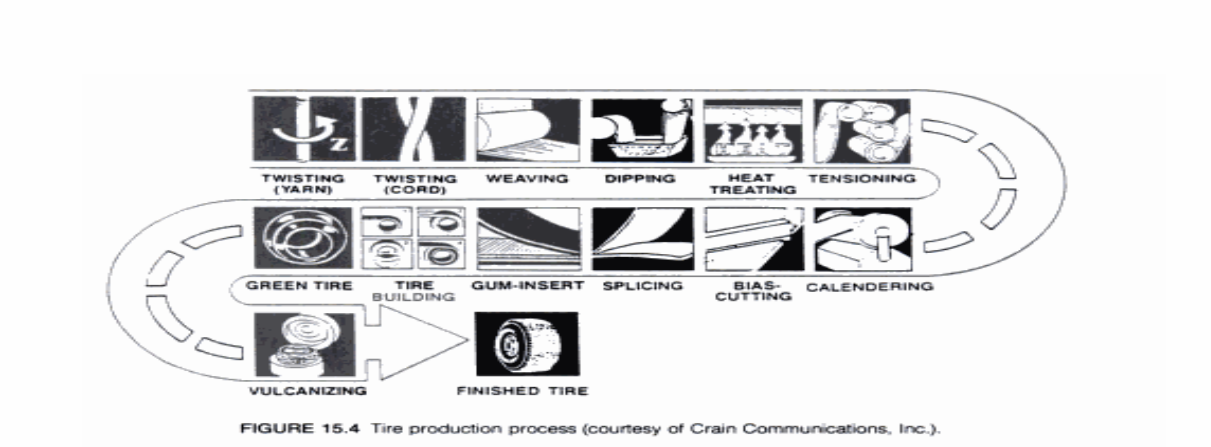


FIGURE 15.4 Tire production process (courtesy of Crain Communications, Inc.).

The above shown chart is steps for tire manufacturing. Carcass plies made of textile material are woven cord fabrics made of cords and light filling yarns. A cord is produced by plying several twisted filament yarns together. The twist direction for each constituent yarn and the cord are opposite. The three major system used to form tire cord are ring twisting, direct cabling and Two-for-one twisting. The twist level is usually high i.e. 10 TPI. The cord yarns are then woven as the warp of cord fabrics with a low filling count of one to two picks per inch. Usually rapier, air jet and shuttle looms are used for cord fabric weaving. Filling yarns are very fine compared to warp cords. The major function of filling yarn is to maintain the warp spacing during handling of fabric. The

filling yarns do not contribute to the performance of ply and therefore the tire. Relatively fine filling yarns are used to avoid misalignment of warp cords during treating and calendaring with rubber. The cord fabric is treated with adhesives and calendar coated with rubber to a thickness of approximately 1mm. treating the cord also sets for physical properties. Once the warp yarn are firmly placed in the rubber compound, the need for filling yarn ceases and in subsequent stages of tyre manufacturing the cord spacing changes as the tire is shaped. In fact, the very existence of filling yarns may adversely affect the uniform distribution of the tire forces and cord geometry. To avoid this, either the filling yarns are broken, or highly extensible filling yarns are used. Radial tire designs in particular need the elimination of filling influence.

Filter:-

Properties required: to balance filtration performance with desired cleanliness level & this level is depends on filter efficiency of particle removal, contamination capacity or pressure drop or resistance to flow through filter. Proper function of filter fabric is very important.

Material of filter: the filter media ranges from mesh screen to depth side media such as threads or chopped paper to 100% natural cellulose to 100% man made fiber or concessive combination.

Manufacturing process:

Air filter- Air is vital to vehicles and with the resulting controlled explosion provides power to vehicle, which is essential in removing contaminations such as dirt particles, dust and debris from air penetrating through engine.

The filter stationed here is normally non woven material. Commonly this medium is mixture of cellulose fibers that are derived from wood pulp, with small amount of synthetic fiber. Air filter can consist of 1-20 layer, which are normally pleated to increase the surface area. By dry laying technique also we can manufacture the air filter.

Oil filter-

dirt is one of the major causes of engine wear. Dirt particles are extremely abrasive and these particles are carried by oil into the precision clearance between in these parts. Once they work in between these parts, they grind and gouge surfaces, alternating clearances, and generating more abrasive debris. The earliest interactions of this filter were made from woven, mesh and paper media that caught dirt by surface phenomenon. Filter made from polyester needle were impregnated and are capable of trapping contaminations.

Fuel filter-

Water, fungus, bacteria, wax, asphaltines, sediment and other solids are major contaminations in the fuel, water is greatest concern because it is most common form of contaminant. The first petrol filter were made from wire mesh and although they were efficient. They unable to separate water from passing fuel. New filters based on vinyl chloride polymers. The filaments are made from melt spinning are starched. Some of their significant properties are resistance to water, fire, light and bacterial attack. Saran is prime material for petrol filter and are resistance to automotive fuel deliver high mechanical strength and recovery, flame retardant and do not absorb water. In addition, the saran filter is able to prevent the ingress of air into the fuel tank.

Cabin Air Filter -

There are about a dozen different kinds of filter used in cars but only about half use textile materials. Paper is used in many applications such as the oil filter and cabin air filter, although non-woven are used in some cars for the latter application. Dust diesel fumes and aromatic hydrocarbons can be even more damaging to health; hence filters are very much necessary.

The latest advanced filters combine both mechanical filtering through polypropylene non-woven electrets fabric with adsorption by activated carbon. Filter fabric is arranged in a pleated form to provide maximum surface area with minimum airflow resistance. The adsorption and retention capacity of the filter for odors in a given air flow rate is a measure of the filters performance. The non-woven filter fabric it self must be strong when wet is odor-free resistant to micro-organisms and resistant to extremes of temperature. Allied signal recently announced a filter for both particles and odors, which uses a system that is based on micro-fibers and a special liquid absorber.

7) Head liner:-

One time the headliner was simply a covering for the metal roof inside the car and consisted of a piece of fabric, PVC or same other material sometimes simply slung. i.e. held in place only at a few points. Some important requirements of headliners are light weight, thin profile but rigid without

any tendency to buckle, flex or vibrates, good dimensional stability, aesthetically pleasing and preferably with a soft touch.

The modern headliner is a multiple laminate of up to seven or more components all joined together. Each layer is there or a specific purpose either for aesthetics, to provides sound insulation, vibration clamping or to provide rigidity to the whole structure. The central layer is generally a layer of semi-rigid

Attached to the side facing inwards is the decorative material, a non-woven polyester scrim is usually attached to the other side. All layers are joined together by action of the hot-melt adhesives in a flat-bed laminator, taking care neither to damage the aesthetics of the decorative material nor to reduce the thickness of the centre core.

8) Noise Control:-

Sound is propagated through the air and by vibration of the car body and there are three basic mechanisms for reducing it, by absorption, by clamping and thirdly by isolation or insulation. In general thick piece of material will absorb more sound than a thinner piece of the same material. There are number of layers of material and permutations of layers of material used in noise and vibration damping. These layers are,

1. Top decorative layer: - Tufted BCF Nylon or needle punched polyester or polypropylene-Back, acrylic ladere.

2. Thermoforming layer: - Polyethylene powder, moldable fiber EVA or a further thick layer of compounded SBR (styrene-butadiene rubbers) later.

3. Caustic layers: - Heavy layers of EPDM, Shoddy fibers or polyurethane foam. These materials generally have to be fitted in small pieces, which is time consuming and produces an insulation performance which is interior to that of a continuous layer. In some vehicles this insulation layer is formed directly on the back of the pre-formed carpet it self by back injection molding using polyurethane foam.

CONCLUSION: -

Textile materials are used in automobiles for interior trim and for ensuring comfort (e.g. seat covers, carpets, roof liners, and door liners) as well as for reinforcement (e.g. tire) and filters. Textiles also offer weight reduction which in turn results in fuel economy.

Airbags help to save lives, but at times they can also be a source of serious injury. The search for a uniform smart airbag, which can perceive the size of the passenger or whether the seat is empty and react in that manner, is in progress. Such a 'smart' airbag will incorporate sensors to judge the weight, size and location of the car passengers and hence deploy more appropriately.

In addition, incorporated safety devices associated with the seat belt along with other safety items, particularly for child passengers, are under development. The trend towards uncoated fabrics is anticipated to continue and so is the improved trend towards more airbags per car and full-size bags. There is also a technical challenge of producing the bag by using more rational techniques and related specifications made by the automotive industry.