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Nonwovens in the Automobile Interior

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Abstract. Textile applications have a significant role in the automotive architecture. The structure of textiles, used fibres and textile producing technology depends on textile placement in the car. Sound absorption is a very important property of textiles because of the large number of noise sources in a car (engine and driving noise) and from the road. Nonwoven fabrics have the ability to reduce noise; other significant benefits of nonwovens are high productivity, low production costs, opportunity to blend natural fibres into them and possibility to use nonwovens as base component of composites.

Introduction

Modern car (economy class, middle-class, premium class) interior is not completed without using a variety and large amount of textile applications. Using a textile in a car interior plays a major role to absorb the noise, especially if the car textile has form of nonwoven.

The purpose of this research is to find out and show wide use of nonwovens applications in different parts and positions of the car, the most widely used fibres for these applications and the most widely used nonwovens manufacturing technologies.

1. The architecture of an automobile

This chapter outlines the structure of the passenger car (included in the research field about six car types: compact car, mid-size sedan, full size sedan, multi-purpose vehicle, sport utility vehicle and coupe [1]). In general, application areas of automotive interior parts in a car could be divided into three categories [2]: 1 - passenger compartment, 2 - trunk compartment and 3 - engine compartment. All those areas are separated from each other (Fig.1.). Although textile functions are slightly different in each of those compartments, good noise absorbing is very important for all.

Textiles can be visible or hidden from people's eyes. The hidden textiles are located inside of door panels, upholstery of seats, under the front dashboard, etc. locations. Textiles are also used for the car details that traditionally do not make any association with textiles, such as tires, heater hoses, battery separators, brake and clutch linings, air filters, parts of the suspension, gears, drive belts, gaskets.

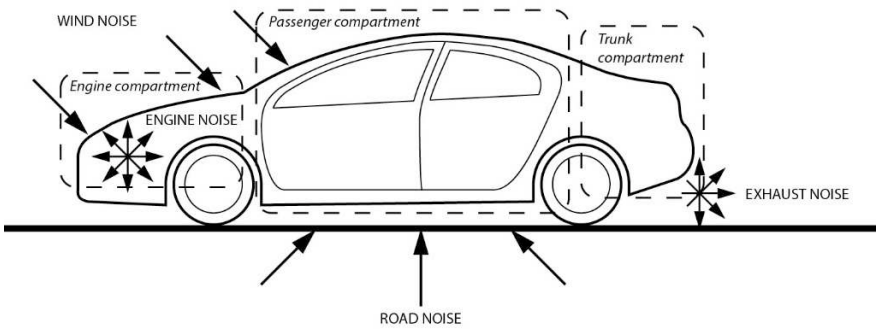

Fig. 1. Major areas of car interior and types of noises

An average car is made up approximately from 20-25 kg [3; 4] of textile. Until 2005 less than 21 kg of textile was used in a typical car. For furthermore using of textile will only increase. By the 2020 textile usage is predicted to reach 35 kg [3]. In some literature sources amount of car textile is indicated not only in kg but also in m². In the Table 1 data from the different sources regarding textile applications in a car are compared by volume (m²).

Table 1

Comparison of automotive textiles volume in a car from different sources (m²)

	Sources		
Textile applications	**1** [5]	**2** [6]	**3** [2]
Upholstery (seating)	10	6 – 8	
Seat squabs			1,96
Seat backs			2,8
Door panels	2	0,6 – 0,8	
Pillars (pillar cover)	2	0,4 – 0,5	
Carpet, floor	4	5 – 6	1,47
Footwell			1,05
Headlining	4-6	2	3,5
Side trim			3,0
Rear trim			0,84
Parcel shelf	1	0,7-0,8	
Luggage compartment, trunk	4-5		1,12
Boot/cargo		3-3,5	
Seat belts	0,5		
Airbags	3,5		
TOTAL:	**31-34**	**17,7-21,6**	**15,74**

The most popular automotive textiles are made from woven, knitted and warp knitted, tufted and laminated fabrics, and nonwoven, electrostatic flocked surfaces [5]. From all the above mentioned materials nonwovens are most popular, and their popularity is increasing.

2. Nonwovens in the car

EDANA (the international association for the nonwovens and related industries) published that there were more than 40 applications for nonwovens or over 35 square metres [7] of flat nonwovens inside a car. Nonwovens products weight is in wide range: between 100 g/m² and 1,400 g/m² [8].

EDANA also has made a forecast (Fig. 2.) of demand for nonwoven textiles for automotive applications; it shows that demand will increase significantly.

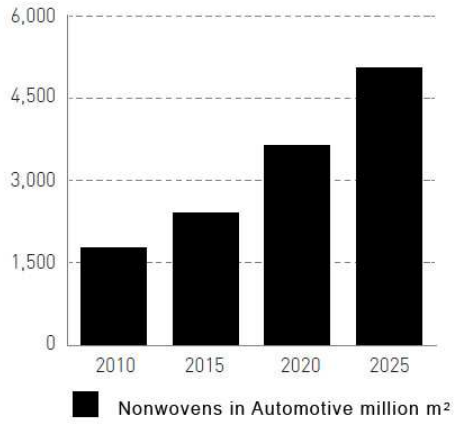

Fig. 2. Forecast of nonwoven in automotive industry (Source: Kellie Solutions Ltd, EDANA, Market Data)

Producing of nonwovens is fast (high productivity) and very economical. As a material nonwoven is very versatile and offers the opportunity to blend different fibres or fibre types with different binders [4]. This ability provides also including of natural fibres.

The nonwovens often use as base component of composite. Natural fibres have the potential to reduce vehicle weight (up to 40% comparing to glass fibre, which accounts for the majority of automotive composites) [9]. Environmental criteria rise, the usage of natural fibres for textile and composite materials helps to meet those requirements.

3. The most widely used nonwovens positions in the car

Any vehicle is a source of noise (engine and exhaust noises) as well as it is exposed to several types of noise (wind and road noises). This is a very important reason why car`s interior acoustical performance is an invisible but significant factor for the vehicle comfort characteristics. The efficiency of sound absorption usually is measured by ASTM C-384 "Impedance and Absorption of Acoustic Materials by the Impedance Tube Method".

Nonwovens in a car can take a variety of positions: filling, constructive and decorative surface layers. Nonwovens are used in passenger carpets, insulations, hoodliners, headliners, seats, door trims, trunk trims, parcel shelf, package trays, seating, seating and rear seat backs, pillar coverings [10; 11] etc. While the textiles used in the engine and trunk areas have a more functional value, the textiles in the passenger compartment require very good visual properties. Materials which are exposed to sunlight impact must be tested to light – fastness. Normally it is done by ISO 105-B02 "Colour fastness to artificial light: Xenon arc fading lamp" or ISO 105 B06 "Colour fastness and ageing to artificial light at the high temperatures: Xenon arc fading lamp test". Nonwovens in interior like other textiles are verifiable to abrasion - ISO 12947 (method of Martindale) or ISO 5470 (method of Taber).

Chapman [12] has studied the nonwovens distribution in the car. The largest amount is used for carpets - 43%, the second largest use is for insulation – 17%. Relatively significant amount of nonwovens is used for the trunk trim (13%), hoodliner (10%) and a headliner (6%).

4. The most widely used nonwovens fibres in the automotive industry

The most used fibre types of needled automotive nonwovens are polyester (PES), polyamide (PA) and PP polypropylene (PP) [8; 13]. PES is widely used for intermediate of seats, door panels, headliner, sunvisor, pillars and decorative surface of headliner, parcel shelf / package tray [4]. PP mostly is used as decorative layer (decorative surface) of needled fabrics in such kind of items as parcel shelf/package tray, hoodliner, headliners, door trims, seatbacks, bootliners, load floors etc. The same items are often made from polyethylene terephthalate (PET) fibres [11; 14]. PET is also popular fibre for the nonwoven carpets manufacturing [2], for this purpose recycled PET is used as well [15].

There are steadily increasing nonwovens in automotive that are made from mixture of different fibres, for example: 50:50 (natural fibre/ PP fibre), 50:50 (glassfiber/ PP fibre) [12]. In recent time, it is widespread to use natural fibres, so the automotive industry is currently taking a leading role in the processing of natural fibre reinforced composites [13].

5. The most widely used manufacturing technologies of nonwovens for the automotive industry

All nonwovens are manufactured by one or two general steps. The first is web formation, and the second is bonding the web fibres together [4]. Web formation can be done by carding or airlay technologies. There is a number of nonwoven manufacturing technologies but needlepunching, spunbond and spunlacing are the most commonly used in automotive applications.

Needlepunching technology is economical and fast. Producing speed could be over 20 m/min (opposite tufting: 3 to 4 m/min) [16]. One of the most important technical parameters of

needlepunching is a punch density. It defines the number of needle penetrations per unit area (punches/cm²), directly affects fabric properties, and dimensions [14].

Summary

The modern car is unthinkable without the use of textiles, including nonwovens. Depending on textile position (according to noise type) in the car, layered structure (filling, constructive layer and decorative layer) may belong to nonwovens. From all items made by nonwovens, the largest amount is used for cover textile as carpets (43%), trunk trim (13%), hoodliner (10%) and a headliner (6%). PES, PA and PP fibres were traditionally used for needled automotive nonwovens. Needlepunching technology offers to bond together natural fibres (including plant fibres) and produce lightweight textile from them. Needlepunching production costs are lower than to other methods.
Nonwovens are in continuing development process - there is a growing demand for weight-reduced textile which performance is not sacrificed. In addition, there is a demand for textiles with good visual properties of the surface in the automotive industry.

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