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TEXTILE APPLICATION IN TECHNICAL FIELDS

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Textile is generally referred as spinning and weaving and the layman does not have the idea of textiles in transportation, filtration, protective clothing, military application and in the medical field. The use of textiles for clothing was known to mankind from primitive age and was extended to household and domestic applications with progressive civilization. Amit Dayal (1999) states that the technological advancement of textile science has been to such an extent that no area seem to be untouched by textiles. David Rigby (1997) defined Technical Textiles as textile materials and products manufactured primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics.

Nowadays the textile scenario is fastly changing from conventional fields to the hi-tech areas of industrial application, where the products have been developed with defined engineering properties for their relative specific application. In this article, a review is attempted on the importance of textiles application in various technical fields.

Messe Frankfurt Gimb H (1999) classified and grouped technical textiles on the basis of application as under:

Agrotech	Textiles used for agriculture, horticulture and forestry
Buildtech	Textiles used for building and construction

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Clothtech	Textiles used for components of shoes and clothing
Geotech	Textiles used for geotechnical and civil engineering
Hometech	Textiles used for components of furniture, household textiles and floor coverings
Indutech	Textiles used for filtration, cleaning and industrial applications
Medtech	Textiles used for medical and hygiene
Mobiltech	Textiles used for automobiles, shipping, railways and aerospace
Oekotech	Textiles used for environment protection
Packtech	Textiles used for packing
Protech	Textiles used for personal and property protection
Sportech	Textiles used for sports and leisure

In many developed countries, technical textiles account for 40% of textile industry output and end uses, says Byrne (1997).

Rigby (1997) estimates that global production and consumption of technical textiles stand at 10 million tons in volume by 2005. A Mobitech textile is the largest sector accounting for about 20% of total technical textiles. Geo textiles and protective clothing have developed rapidly and their growth rates are projected between 5% to 9% by 2005, says Hoechst (1997). Non-woven textiles are projected as the largest single product group for technical textiles. Asia is recognized as the powerhouse and the real engine for world-growth in end-use and consumption of technical textiles. Most technical textiles are made from everyday polymers and materials with which we are all familiar.

Kusumgar and Talukdar (1999) highlighted the following as the basic fundamental considerations involved in the production of technical textiles:

- To understand the needs of the end-consumers and translate their requirements into textile parameters
- To select suitable polymeric material
- To select the appropriate form of polymeric material
- To adopt the most suitable converting process and the form of textile substrate such as woven, non woven, knitted, braided, tuffed etc

- To impart desired finishing to the textiles substrate and subject it to coating or lamination.

- To convert the textiles into final products through right fabrication techniques.

The latest developments and future trends of technical textiles are dealt under following heads.

- Protective Clothing

- Medical textiles

- Geo textiles

- Environment friendly technical textiles

Protective Clothing

The world technical textile industry has defined protective clothing as covering those garments intented to protect people against the elements, dangerous materials, processes or events encountered either in the course of their working or during leisure activities. Rigby (1997) states that textiles that are used to protect against fire and extreme heat protection, hazardous dust, gas and chemical protection, nuclear and biological substances. Protective clothing is classified based on their use into various categories like public utilities, military applications, medical applications, others like construction and agriculture industries, automation, safety devices, etc. Volumes used in public utilities and the military are considerably smaller but these sectors use fabrics with generally far higher level of performance and unit value.

Public utilities, including the emergency services, and transport/power generators and distributors are the major users of protective clothing. Rigby estimates that this sector accounts for around 10% of the protective clothing made in the European Union (EU), in terms of the volume of fabric, and rather more in terms of value, since a high proportion of the garments are based on heavier woven fabrics, many using expensive fibres or other materials.

In the case of Fire Retardant (FR) clothing, Europe has been much slower than the USA in moving away from heavy, traditional materials (including wool and leather) to newer, high performing fibres (such as the meta-aramids). Developments have resulted in a wide range of different fabrics and garment types, often in conjunction with fibre companies such as DuPont and Rhone Poulenc. As a result, there is now a steady move towards sophisticated multi-layer combinations of aramids and breathable waterproof membranes designed to improve comfort. Park (1997) describes that military applications of protective clothing are small in volume, but the unit values tend to be high. FR garments, often using the most sophisticated and modern raw materials, are mostly restricted to flight suits and specialist clothing for tank crews and submarines. Complicated blends of fibres, such as polybenzimidazole (PBI), Panox and meta-aramids, are increasingly found in this high performing garments. Larger volumes of military protective clothing are accounted for by NBC (nuclear-biological-chemical) suits. Apart from some impermeable (butyl) fabrics used for gloves, masks and some decontamination duties, most NBC fabrics are based on composite multilayer textile structures involving high-density woven fabrics and activated carbon nonwovens or foams. The fabrics are also required to provide some protection against fire, nuclear flash, and water and liquid penetration, while the remaining lightweight and breathable are enough for use during strenuous activity.

The protective clothing industry plays a crucial role in the protection of firemen, police officers, military personnel, and industrial workers. Concerns for general worker safety, including protection from death and disabling injuries and illnesses, as well as protection from the specific threats of chemical agents and splashes, fire, and bullets, have resulted in an entire industry devoted to personal protective equipment. This equipment includes everything from chemical protective garments and suits to firefighters' turnout gear to industrial fire retardant garments to bullet-resistant vests to respirators. While the industry has not seen many new standards and regulations, there have been significant revisions and additions to many of the existing standards for worker protective clothing in the areas of chemical protection, fire protection, and bullet-resistant garments.

The protective clothing industry is undergoing significant growth in many areas as a direct result of the terrorist activities that occurred on September 11, 2001. In addition, the revisions that have been made to existing standards have forced manufacturers to change the materials used in the production of some forms of personal protection equipment. Also, while there is growth in many segments of the personal protective clothing market, the number of players in some segments of the industry is decreasing due to acquisitions. Kelvin Swift (1998) describe that the protective clothing market is a very fragmented industry. There are three significant segments of the industry. Within each of those segments lies a variety of players, including government organizations (that create, develop, and enforce regulations and standards), raw material suppliers, fiber manufacturers, mills and fabric producers, finished goods manufacturers, and suppliers and distributors.

This study of the protective clothing market focuses on the following major clothing types:

Chemical protective garments and equipment, including chemical-resistant clothing, chemical warfare and protective suits, and gloves, used in industrial applications. Heat and flame-resistant clothing, including firefighters' turnout gear for structural, proximity, and wildland fire service, as well as industrial fire-resistant garments for use in electric and gas utilities or industrial applications where electric arc and flash fire may be hazards.

Body armor, including bullet-resistant garments used in law-enforcement and military applications. The protective textile try to combine both the fabric characteristics such as flexibility, softness, drape, handle and breathability with critical protective characteristics mentioned above. This is a challenge because, applying any coating or modifying fibres for obtaining protective function tend to sacrifice that very fabric qualities which are dear to a textile technologist and a customer. Therefore, a balance where desirable textile attributes are preserved while achieving adequate protection is always a topic of intense research worldwide.

Inherently fire retardant polyester filaments materials are very important in creating protective clothing for use in chemical-nuclear-biological warfare, firefighting, and other heat intensive jobs. Many approaches have been used around the world in producing such fibres through modification during polymerization or melt spinning route. However, melt additive during spinning route is normally not commercially used as it tends to lower the mechanical properties of the resultant fibre. Our group has found an unique approach of adding phosphorous based compounds to PET upto 10% by weight loading in the fibres. These fibres can be easily drawn at high draw ratios to give high strength nearly equivalent to PET fibres without additive. The Limiting Oxygen Index (LOI) values for these fibres were as high as 27.5 in knitted filament form (i.e. open structure).

Body Armor Industry (2002) conducted research and found that breathable Coatings Textile that allow water vapours to pass but protect from rain or water find varied applications in many areas. Many commercial products are today available, however, creating breathable coating which can provide very high rates of water vapor transmission (WVTR) to allow comfortable feeling to the wearer is still a challenge. Microporous films or coatings with hydrophobic-hydrophilic segmented polymer are known methods of creating such structures. However, due to hydrophobic nature of the polymers used, WVTR values are normally restricted. Hydrophilic films are a better choice but they suffer from the limitation that they are soluble in water, and therefore, are not durable. Our group is working on integrating certain hydrophilic polymer systems based on substituted polyacrylamides with known textile surfaces that can provide durable protective coating while giving very high values of WVTR. Heat Managing Outer-layer Structures.

Textile structures for extreme winter clothing is normally composed of several layers. These layers provide insulation and at times manage the flow of winds so that they do not penetrate the textile structures. Use of fur inside and bird feathers in between are often used or providing insulation from low outside temperatures. However, very little attention has been given for optimizing the structure of outermost layer of such garments. Our group has investigated certain structures for outer most layer which allow better capturing of heat from the Sun while minimizing loss of captured heat from the surface under windy conditions. Use of these layers was found to raise the fabric temperature by several degrees compared to standard structures.

Medical Textiles

Textile materials are indispensable in the medical area and have proved to be life saving and boon to human life. At National level symposium on medical textiles, Dr. Subramaniam (2001) said that textiles are used in medical field in various forms like bandages, plasters, wound cleaning fibres and the like. The major requirements of medical textiles are absorbency, tenacity, flexibility, softness and biodegradable. However, the complexity and sophistication of applications have increased with new developments in the area of medical textiles. Textiles have crossed the boundaries of conventional applications and have reached the level of organ transplants.

Subhashini V (2001) has classified the textiles used in medical into the following categories as

- Non-implantable textiles — Wound dressing, Bandages, Plasters, Gauze
- Implantable textiles - Sutures, artificial tendons and ligament, orthopedic and cardiovascular implants
- Textile for extracorporeal devices — incorporating artificial kidney or lungs in the body
- Healthcare textiles — surgical clothing, covers bedding, wipes and incontinence products.

Textiles are used even in surgical transplants, vascular grafting structure, heart valve design and tissue engineering. In such transplants, it is very important to consider the biological, mechanical and geometrical to the physiological environment. The implant material may be expected to survive sterilization treatment such as radiation, chemicals and high temperatures. The materials must be compatible to avoid rejection by the body, which could lead to infection and failure of the implant. So far, polyester and Teflon fibres were found to be most biocompatible materials for surgical implants, according to Ko F.K (1997).

Anand and Horrocks (1997) have dealt with the textile materials that are used for medical and health care applications. Ramkumar (1998) has been quite successful in developing an artificial finger, which can be used as prosthesis in his research on the handle of knitted fabrics. Recently, Prescott, Anand, Richards and Halfpenny (2001) have dealt with cotton blend non-woven fabrics for medical use. Nonwoven fabrics containing cotton instead of viscose polypropylene and polyester have been found to possess more comfort and absorbency and are suitable for wound dressings for treatment of ulcers and as surgical gowns and drapes. Orthopedic implants are used for hard tissue applications to replace bones and joints. Recent technology has introduced 'embroidery technology' for the development of textile scaffold structures for tissue engineering and for medical applications. The use of medical textiles have proved to be life saving and boon to human life. Textile materials have been indispensable in the medical area and have helped the medical world in every form and shape.

Geotextiles

Geotextiles is a part of the broad spectrum of "Geosynthetics". Geosynthetics are being defined as civil engineering materials that are synthesized for use with geological materials like soil, rock or any other geotechnical engineering related materials to improve or modify the behavior of civil engineering works, as per the findings of Rao & co (1977). It includes geotextiles, geogrids, geomembranes, geocomposites, geonets and other products like, geomats, geomeshes, geowebs, etc.

Geotextiles are woven or non-woven textiles having applications in Civil engineering such as inter locking of the fabrics with soils to give reinforced structures or enhancing hydraulic properties for water transport. Development in geotextiles has been immense. The University of Illinois has developed a stress-absorbing composite for road repair. The composite consists of a low-stiffness geotextiles, a viscoelastic material over the geotextile and viscoelastic material, in terms of Dempsey et al (1997).

Nordon Enterprises Ltd. claims to develop an artificial turf carpet that includes a water permeable backing through, which are looped U-shaped tufts forming a pile. A water absorbent layer is located on the sides of the backing from which the tufts extend. Hoechst Celanese Corp. claims to have developed a geogrid composed of polyethylene terephthalate and polyolefin bicomponent fibres.

Transport applications is the largest single area for technical textiles. In 1996, manufacturers made 38 million automobiles with an average of 20 kg of textiles in each vehicle. Textiles are essential components of tyres, heater hoses, drive belts, brake and clutch linings, parts of the bodywork, and seat belts and airbags, to name a few of the functional technical applications. They also provide a means of decorating and ensuring comfort from surfaces (such as seating and interior furnishings) in automobiles, trains, aircraft, ships and boats. These decorative applications are also classified as technical because of the technology required to produce them and because of the high specifications demanded by the transportation industries.

Within the transportation sector, textile-reinforced composites are particularly expected to enjoy growth with some forecasters predicting as much as 6% a year. Composites offer high strength combined with low weights making them especially suited to transportation applications. They also allow several metal parts to be replaced by a single composite component, and are resistant to corrosion and dents. Diesel soot filters and fuel filtration tank will also find widespread market.

Airbags offer a big growth area for textiles. American safety standard FMVSS 208 requires that by 1999 all new automobiles have front airbags. By 2000, 25% of new automobiles will in addition need to have a head protection feature, which is also likely to be an airbag. The amount of fabric, principally nylon 66, used for airbags is likely to double or triple by the year 2000 opines Fung (1998).

Environment Friendly Technical Textiles

Technical textiles have also proved helpful in Gombating environmental issues like pollution. Lot of development work has been done towards arresting air pollution. Textiles can be used to arrest the dust particles and thereby minimise population. The British United Shoe Machinery Ltd. claims to have invented non-woven fabrics suitable for use in dust fabrics, the constructions allowing the passage of air but preventing the passage of dust and/or other debris carried by air. British United Shoe Machinery Ltd. and Greatorex (1997) say that the fabrics consist of blends of high temperature fabrics, for instance 50/50 aramid/nylon, glass fabrics, polytetrahydofuran fabrics can be used as eco textiles. Hoechst (1997) claims to have developed a particulate filter structure made of glass fibre can be used for air filtration medium, says Schuller International Inc.

David Rigby Associates provided a comprehensive overview of the technical textiles and by 2005, the market for technical textiles is expected to be around 72 billion US dollars. To conclude these textiles owe their significance to their functional and performance aspects. The conventional applications of textiles have been left behind new avenues and discoveries every day where textiles can be used reliably and efficiently. It is time to look into technoeconomics of technical textiles.

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