

Textiles in the Aerospace Industry for Making Aerospace Equipment

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Abstract

Textiles are used in many areas in the aerospace right from the G-suit to space shuttle. Aerospace comprises of the full spectrum of flight and the aerospace industry manufactures of the components and equipment for things that fly. Many textile developments are associated with the inside of aircraft and spacecraft components used for the different purposes. An increasing demand for textile reinforced composite structures have been noticed in the aviation industry and the reason is for the high strength/weight ratio of the products compared to other materials. The aerospace industry and manufacturer unrelenting passion enhance the performance of commercial and military aircraft is constantly driving the development of improved high performance structural materials. Highly developed speciality textiles have been developed to use in the construction of aircrafts, spacecraft, cars and ships. Nowadays tremendous growth in aerospace textiles is observed by the use of composite materials which are based on ultra strong aramid fibres.

Keywords: - *space textiles, aerospace industry, spacecraft, flight suits, balloon envelope, layered structures.*

INTRODUCTION

The present day textile industry is getting the benefits of aerospace products as the development of textile products through the research and technological

development. In textile industry the most important area is the application of technical textiles and aerospace industry are considered to be the most beneficial sector of the textile industry. The two

related areas are aircraft textiles and space textiles. The application of textile composites in aerospace has improved properties like strength, specific modulus, resistance to heat, chemicals and harmful radiations, etc. Phase change materials are also used in aerospace textile products. Some of the textile items produced by aerospace industry are wings, body parts, fuel tanks, rotor blades, nylon tyres, etc. Different fibres used for the aerospace products are glass fibres, poly fibres, etc [1].

Technical textiles are primarily used for technical performance and functional properties rather than aesthetic purposes. In the category of aerospace textiles two types of products related to aircraft and space activities are manufactured. Aerospace means the atmosphere of earth and surrounding space. It is a compression of aeronautics and space flights. Apart from the essential properties in textile composites other required properties are like washable, abrasion resistance, tear resistance, moisture resistance, material standardization, etc [2].

The important role played by the high performance textiles are increasing efficiency and flexibility while reducing cost. In the recent past, highly developed

speciality textiles have been innovated for using in the building of aircrafts, spacecrafts, cars and ships. High-performance textiles are an essential component of the manufacturing process that has no other alternatives. The application areas of textiles in aircrafts are related to safety and weight saving. The use of carbon fibres is related to their important properties like excellent tensile strength, heat resistance, chemical resistance, etc. These fibres are used in reinforcing moulds and heat insulating materials. Many different types of textiles products are used in the inside of aircrafts and spacecrafts. Therefore, textile industry is constantly developing more sophisticated and even more rugged cables that unlike rubber or plastics coated in hard wearing textiles. They have higher degree of durability and resilience. Drive belts are used in engines in the automobiles sectors as well as aircrafts, spacecrafts and on board ships [3].

Arville has a long established history in the design and supply of high-specification fabrics for defence through aerospace industry. They also have defence contracts for pre-fabricated textiles components used in a variety of complications in military aircrafts and helicopters. The components they supply are ejectors seat

covers, parachute release bags, troop seating, screens, partitions, breathers masks, reinforcements, fuel cell reinforcements, anti-G trousers and suits, survival inflatable's, flight suits, aircrafts flotation bags, etc. Apart from these they also produce fabrics which are specified for use in high-performance, high-integrity, light weight buoyancy devices and survival equipment [4].

In the early days, hot air balloons, air ships, bi-planes aircrafts of all kinds had to use silk or canvas for balloons envelop and panels for wings and fuses. After that wood, aluminium and artificial textiles became more widespread. Later on, for last few years, highly developed speciality textiles those were rediscovered for use in building of aircrafts, spacecrafts, cars and ships. The early days, demand for light weight aircrafts had the priority in aviation. Therefore, the automatic choice was textile fabrics. New materials like carbon fibres and other plastics made increasing inroads in the construction of aircrafts since the new millennium came. Special clothing had been designed for use in the weightless environment to capture sweat, and associated odours on the space stations and in the spacecrafts. Pilots also need special clothing such as anti-G-suits to prevent the blood from sinking into the

lower extremities or fire proof underwear to cool liquid in some specific applications and these are supposed to be very important for space and aviation sectors [6].

The modern world has advanced in aerospace textiles due to the development in composite textiles, which are produced by the ultra strong aramid fibres. The advantages of aramid fibres are low density, high specific strength with high specific modulus. The aramid fibres have resistance to flame at high temperatures, organic solvents and lubricants. Moreover, aramid fibres are pliable and can easily be woven by conventional methods. PBI is non-flammable high-performance fibre and space suits are made from these fibres. There are different requirements in space suits. They are applied with purifying and cooling systems. The suit is very expensive and is made with various fabrics. The fabric circular woven with layered structured from polyester, urethane and other materials. Ortho-fabrics are used on the outer layer of the suit because it is exposed to radiations and is made of blend of Gore-Tex, Kevlar and Nomex fibres. AS the temperature of the environment in the space is a hindrance, the fabric should be thermal insulated and thermal resistance

and the suit can be able to maintain comfortable temperatures in the space. Ability of the space suits should be of such that the astronaut should be capable of having impact resistance and stability to withstand major stresses caused by the meteoroids through small bits of rocks and metals [7].

It is stated that textile companies have more opportunities for high-performance fabrics and products due to NASA sets a co-use for Mars and return to the Moon and provides companies engage in new space era. NASA, military organizations, airlines and aerospace companies, research institutions and universities, weather and science programs and Google and data companies are utilizing fabric technologies for their aerospace exploration industry, spurred by initiatives including Elion Musk's Space X, Jeff Bezos's Blue Origin and Richard Branson's Virgin Galactic, committed to make space travel accessible to individuals who are not trained astronauts. The objective is to take advantage of the opportunities of the speciality fabric industry that can meet the requirements of the extreme environments beyond the clouds. Robert Behnken the NASA astronaut installed ammonia line multi-layer insulation blankets which is manufactured by Aerospace Fabrication &

materials on the International Space Station during maintenance of extravehicular activities session [8].

APPLICATION OF TEXTILES IN AEROSPACE INDUSTRY

Strength, resistance to heat, chemicals and harmful radiations, specific modulus, etc are the important properties for which textile composites are used in aircrafts. Moreover, the main objects for using textile materials in aircrafts are safety and light weight characteristic. In aerospace textiles phase changing materials (PCM) are also used. The important areas where aerospace textiles used are like wings, body parts, fuel tanks, curtains, carpets, furnishing fabrics, technical fabrics, upholstery, aerodynamic fairings, wall covers, seat covers, fibre-reinforcement composites, tyre cords, rotor blades, circuit boards, webbing airbags, parachutes, etc. The following are the applications of textile composite fibres in the aerospace industry: Carbon/epoxy (primary structure and skin), Kevlar/epoxy (military applications), Glass fibres (structural and skin materials), Glass/Phenolic (GFRP in interior fittings, furnishings, etc), Poly fibres (rejuvenated of weathering), nylon (shelf panel cover), polyester (door trim panel padding), Nylon 6 (tire cord).

In pace shuttle mission, the ultimate protective clothing is known as astronauts' functional clothing. To protect from heat, cold, chemicals, micrometeoroids,, pressure fluctuations and temperature extremes of the astronauts who are subject to high levels of accelerations forces (g), for them G-suits are used. It is also worn by the fighter pilot, astronauts and aviators because to control the blood circulation at higher level of acceleration. G-suits are considered to be very interesting and significantly useful textile clothing in aerospace industry [1].

The definition of aerospace is the space comprising of earth and surrounding space. It is actually a compression of aeronautics and space flight. In other words aerospace covers the full spectrum of flight and the aerospace industry manufacturing the components and equipment for things to fly. Various types of fibres are used in the manufacturing of component parts such as carbon fibres, Kevlar fibres, aluminium-boron-silica fibres, e-glass, etc. Carbon fibres have excellent tensile strength, heat resistance and chemical resistance. Kevlar is suitable for its heat resistance, high-strength and modulus, good abrasion resistance, corrosion resistance and malleability. Nextel has a good retention of strength,

flexibility, thermal insulation, impact resistance, low flammability, etc [2].

Aerospace industry has a variety of complex applications in military aircrafts and helicopters. Arville an aerospace industry has a long history to work with defence contractors in supplying high-specification fabrics and pre-fabricated components, The following are areas for which military aircrafts and helicopters materials are supplied, ejectors seat covers, parachute release bags, troop seating, screens, partitions, breather masks, fuel cells reinforcements, anti-G-suits, survival inflatable's, flight suits and aircrafts flotation bags. Due to the high strength/weight ration textile reinforcement composite structures are increasingly being used by the aviation industry. Arville fabrics which are used in the aviation industry are integral reinforcement materials for a wide range of high-specification component. They also supply textiles to be used in the restoration and repair of both modern and vintage clad light aircrafts. They also have special fabrics designs for application to provide light airproof skin for lifting [3].

USE OF MODERN TEXTILES IN AEROSPACE MANUFACTURING

In aerospace industries it is clear that high-performance textiles are essential components of the manufacturing process that without which required components cannot be manufactured. New materials like carbon fibres and other plastics have made increasing inroads in aircraft constructions since the turn of the millennium. In the last two decades manufacturers have seen the benefits of innovations in the field of textile industry, which extended beyond the aerospace industry. Nowadays, it is possible to make use of specialist textiles that use nanotechnology to simulate sharkskin for the aviation and shipbuilding industry with a significant energy savings due to reduced air and water resistance. The use of nature's biological designs to create modern technology is known as bionics. The present standardized norm in the aviation industry is to wrap the outer skin of an aircraft's fuselage with special materials either entirely or at key points.

The development in textiles is associated with the inside of aircrafts and spacecrafts. The textile industry continuously developing sophisticated and even more rugged cables used in the aerospace materials. They have higher level of durability and resilience. For aircrafts and

spacecrafts drive belts are used and textile mixtures instead of rubber or plastic have proved durability in many applications. Interior fittings fabrics have always been a part of the landscape and are hard-wearing but very comfortable and safe as coverings for aircrafts and automotives seats. Scientists are in the process of long research for the potential applications of artificially produced spider silk. Once again, bionics makes the decisive difference. Spider silk is a tough thread and significantly stronger than the steel fibres having equally same elasticity. As steel cables are also used in the aircrafts and ships and accordingly it may be possible to make use of bionics to achieve more efficient designs.

Normal functional clothing does not have the ability to absorb the sweat directly and it allows remaining sweat on the surface of the skin and does not allow to have necessary cooling effect. Therefore, some special clothing have been developed with proper designing with the idea of capturing sweat and the odour on the space stations and in the spacecrafts of the wearer. This reflects the importance of specialist textiles which will continue to play a major role not only in forming part of the structure of functional clothing and space

suits but also for the habitats that will need to be built [6].

Textile composites of the types both unidirectional and multi-directional show good properties in the in-plane and out-plane directions. In the formation of composites textile structures like woven, knit, braided and stitched are used. It is known to us that most of the failures take place due to fatigue. Investigations have proved that bi-axial braided carbon/epoxy composites with various braid angles have shown better impact resistance. The experiment conducted for the structures of small business jet applications with composites aerospace structural materials under various tension-compression fatigue loadings [7].

DIFFERENT COMPOSITES IN AEROSPACE STRUCTURES

The essential properties of textile composites used in the aerospace structures are summarized as follows: high specific modulus, good fatigue, impact and stress resistance, high specific strength, low flammability, resistant to chemicals and organic solvents, better dimensional stability and non-sensitive to harmful radiations. The recent development in new products with textile composites are associated with the use of fibres like

carbon fibres, Kevlar fibres, alumina-boric-silica fibres and nylon6 6 fibres aerospace structures. The carbon fibres are aligned parallel to the fibre axis as the carbon atoms are bonded together when observed under microscope. Superior to the other high-performance fibres, carbon fibres have properties of crystal alignment makes the fibres stronger. Kevlar fibres have very high molecular orientation which implies its high strength and modulus. Kevlar fibres are known for excellent endurance, corrosion resistance and malleability. The commercial name for the alumina-boric-silica fibres is Nextel. It is a woven ceramic fabric and one of the most widely used as the shielding materials. Silicon carbide fibres are similar to carbon fibres. It is very high resistant to heat and it has also excellent properties of resistance to corrosive chemicals and elasticity [7].

MARKET OPPORTUNITIES OF AEROSPACE TEXTILES

Organizations like NASA, military organizations, airlines and aerospace companies, universities and research organizations, weather and science programs and Google and data com companies utilize fabric technologies in their aerospace equipment. The growing exploration industries initiated by many

private organizations such as Elion Mask's Space X, Jeff Bezos's Blue Origin and Richard Branson's Virgin galactic are involved in making space travel accessible to individuals who are not trained as astronauts. It has opened the opportunities for many companies in the speciality fabrics industry which can meet the necessary requirements of extensive environment beyond the clouds.

Carbon fibres are very strong and durable. Although it is a textile fibre but when it is encapsulated in a resin and cured, it becomes very lightweight in a particular shape. It is an excellent material to be used by the aerospace industry. It has proved to perform well for space customers when fibres are woven into fabrics for high performance. From it fabrics are produced that have structural integrity to resist temperature with strong and durable properties and in addition these are lighter, stronger, and better fabrics. They also save fuel and deliver very high performance.

All aerospace textiles are used for outer space. Textile based items are suitable for stratosphere zone, which is having thin air, limited weather events, exposure to the ozone layer and high level of ultra violet radiation from the Sun. Raven Aero Star, Science Falls, S.D have been innovating

high altitude textiles and balloons for stratosphere since 1950's [8].

CONCLUSION

Optimization of aerospace industry is always an important consideration and this vital role has always been played by textile industry. There are many important properties of textile composites which are very essential and other properties are also there which are required to be maintained into the aerospace materials. To produce aerospace fabrics specified for use in high-performance, high integrity, lightweight buoyancy devices and survival equipment are supplied by Arville. The use of nature's biological designs to create modern technology is known as bionics. For a long time, scientists have been researching potential applications for artificially produced spider silk. It is expected that it may achieve extremely high take-up rates in the industry. The most prominent aspect of the present day textiles are the design, manufacture and applications of textile composites to be used by the aerospace industry. The aerospace textiles use the wide range of polymer composite materials with textile reinforcement from woven, non crimp fabrics to 3D textiles. The space economy with the help of speciality fabric industry

can meet the requirement of extreme environment beyond the cloud.

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