IJFEAT
INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

HIGH PERFORMANCE FIBERS

Kunal Jotwani[1], Ashwini Aware[2], Rashmi Moundekar[3]

[1]*Student, Textile Engineering Department, J.D.I.E.T, Yavatmal, Maharashtra, India,* ***kunajotwani7@gmail.com***
[2]*Student, Textile Engineering Department, J.D.I.E.T, Yavatmal, Maharashtra, India,* ***awareash21@gmail.com***
[3]*Student, Textile Engineering Department, J.D.I.E.T, Yavatmal, Maharashtra, India,*
rashmi14moundekar@gmail.com

ABSTRACT

Faster, stronger, lighter, safe etc these demands are constantly being pushed upon in today's Global world. High performance fibres aid enormously in allowing products to meet these challenges. Generally speaking, fibres are said to be either commodity or high performance. Commodity fibres are typically used in a highly competitive price environment which translates into large scale, high volume programs in order to compensate for the low margins. High performance fibres are driven by special technical functions that requirespecific physical properties unique to these fibres. Some of the most prominent of these properties is, tensile strength, operating temperature, Flame retardancys, dimensional stability, limiting oxygen index and chemical resistance etc. Each fibre has a unique combination of the above properties which allows it to fill a niche in the high performance fibre spectrum. This paper intends to provide a solid overview of the definitions, properties, products and end uses associated with some of the most common high performance fibres used today.

Keywords: *high performance fibres, commodity fibres, Properties.*

1. INTRODUCTION

The high performance fibres concept came into textile industries during 1950 – 1970 .There was continuing interest in technical textiles around the world, and this is one of the fastest growing sectors of the textile manufacturing industry. Many of these products use specialty fibers and the search for new and improved fibers is continuing in the field of high performance fibers.

High-performance fibers are those that are engineered for specific uses. It offers special properties due to the demands of the respective applications. These demands cover properties like high tenacity, high elongation% and high resistance to heat and fire and other environmental attacks.

They are generally nice products, but some of them are produced in large quantities. The main difference between high performance fibres and commodity fibres is as such, commodity fibres or general purpose fibres are typically used in a highly competitive price environment which translates into large scale high volume programs in order to compensate for the low margins. Conversely, high performance and specialty fibres are driven by special technical function that requires specific performance properties unique to these fibres. In earlier days, silk filament was mostly. However, with the introduction of manufactured fibres, higher ranking strength and modulus are achieved.

Most luxurious performance fibres have high tensile modulus and strength. Many of them are also known for their thermal resistance; they do not catch fire and provide protection against heat. Therefore, fabrics constructed from these fibres can be used for many applications where protection is required.

Examples of some high performance fibres are carbon, Kevlar, aramids, glass etc this aromatic polyamide fibres can have very high strength and modulus, and these properties persist at elevated temperature. Because of low density, aromatic polyamides have higher specific strength and modulus than steel or glass, in recent years design engineers have been able to utilize these unique properties to create products which protect personnel from fire, bullets and cuts reduce the weight of aircraft and auto mobiles and hold oil drilling platforms in place. This paper intends to provide a solid overview of the definitions, properties, products and end uses associated with some of the most common high performance fibres used today.

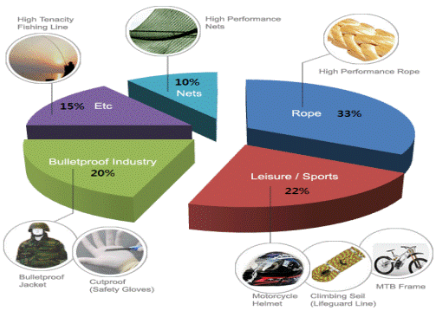

Fig-1

2. MARKET DYNAMICS:

This market is ditermined by factors, such as the increasing demand for lightweight and fuel-efficient materials, growing usage of high-performance fibers in the renewable energy market, and rising demand for greater safety & security. However, this market faces certain drawbacks; the premium pricing andprocessing constraints of these fibers may act as a roadblock to the **High - Performance Fibers Market growth.** The high performance fiber market is projected to grow from USD 10.73 Billion in 2016 to USD 16.46 Billion by 2021, at a CAGR of 8.9% between 2016 and 2021.

2.1 SEGMENTATION:

In the recent years, high-performance fibers have become an integral part of variousapplications in major industrial and commercial sectors. In the global **high-performance fibers**market report, we have taken the followingmajor end-usersectors into account: aerospace & defense, medical, automotive, sporting goods, alternative energy, electronics, construction & infrastructure, nonwoven, and filtration. The aerospace & defense end-user segment accounted for the maximum consumption share in the global high-performance fibers market, in 2015.

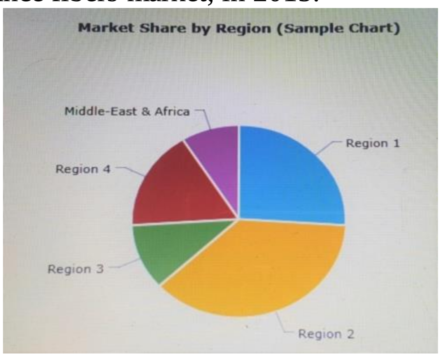

Fig-2:

The market has also been geographically segmented by consumption. The regional analysis includes Asia-Pacific, North America, Europe, South America, and the Middle-East and Africa. The North America region is the current global leader for high-performance fibers, which can be assign to the high-demand for these fibers from its established automotive and aerospace and defense sectors.

3. COMPARISION BETWEEN CONVENTIONAL FIBRES AND HIGH PERFORMANCE FIBRES:

Conventional fibers	High performance fibers
Volume Driven Price oriented Large scale, Line type production Examples-Synthetic and natural fibers.	Technically Driven Specially oriented Smaller batch-type production Examples-Manmade fibers.

4. HIGH PERFORMANCE FIBER PROPERTIES AND THEIR APPLICATION:

4.1 GLASS:

Glass is the oldest, and most familiar product for performance. Fibers have been manufactured from glass since the 1930s. Although early versions were strong, they were relatively inflexible and not suitable for many textile applications. Today glass fibers offer much wider range of properties such as insulation batting, fire resistant fabrics, and reinforcing materials for plastic composites. Items such as bathtub enclosures and boats, often referred to as "fiberglass" are, in reality, plastics (often cross-linked polyesters) with glass fiber reinforcement.And, of course, continuous filaments of optical quality glass have revolutionized the communications industry in recent years.

4.2 CARBON:

Carbon fiber may also be engineered for strength. Carbonfiber variants differ in flexibility, electrical conductivity, thermal and chemical resistance. Altering the production method allows carbon fiber to be made with the stiffness and high strength needed for reinforcement of plastic composites, or the softness and flexibility necessary for conversion into textile materials. The primary factors governing the physical properties are degree of carbonization (carbon content, usually greater than 92% by weight) and orientation of the layered carbon planes. Fibers are producedcommercially with a wide range of crystalline and amorphous contents.Because carbon cannot ready to be shaped into fiber form, commercial carbon fibers are made by extrusion of some precursor material into filaments, followed by a carbonization process to convert the filaments into carbon. Different precursors and carbonization processes are used, depending on the desired product properties. Since carbon fiber may be difficult to process, the herald fiber may be converted into fabric form, which is then carbonise to produce the end product. The following materials are common precursors for carbon fiber

4.3 MELAMINE:

Melamine fiber is primarily known for its inherent thermal resistance and outstanding heat blocking capability in direct flame applications. This high stability is due to the cross-joined nature of the polymer and the low thermal conductivity of melamine resin. In comparison to other performance fibers, melamine fiber offers an excellent value for products designed for direct flame contact and elevated temperature exposures.Moreover, the dielectric properties and cross section shape and distribution make it idealistic for high temperature filtration applications. It is sometimes blended with aramid or other performance fibers to increase final fabric strength.

4.4KEVLAR:

Kevlar is the register brand for a Para-aramid synthetic fiber, related to other aramids such as Nomex and Technora. Developed by Stephanie Kwolek at DuPont in 1965, this high-strength material was first commercially used in the early 1970s as a replacement for steel in racing tires. Typically it is oscillate into ropes or fabric sheets that can be used as an ingredient in composite material components.

Currently, Kevlar has many applications, ranging from bicycle tires and racing sails to body armor, because of itshigh tensile strength-to-weight ratio; by this measure it is 5 times stronger than steel. It is also used to make modern drumheads that withstand high impact. When used as a woven material, it is suitable for mooring lines and other underwater applications.

5. LEADING MANUFACTURES OF HIGH PERFORMANCE FIBERS:

Manufacturer	Country	Product	Applications
Honeywell International	United kingdom	Honeywell spectra, Spectra shield, Gold shield.	Aerospace & defense
Dupont	USA	Dupont nomex, Dupont Kevlar	Automobiles & aircrafts
Royal DSM	Europe	Dyneema	Sportstech & seat belts, ropes and slings
Teijin limited	Japan	High performance polyester, aramids, carbon	Sportstech, bullet-proof body armor, aircrafts

6.RECENT DEVELOPMENTS IN HIGH PERFORMANCE FIBERS:

6.1 MAGIC FIBER FOR AIDS DIAGNOSIS AND TREATMENT:

Ashai Chemical Industry Co. have developed a porous hollow fiber membrane BEMBERG MICROPOROUS MEMBRANE [BMM] to filter out and isolate AIDS virus [acquired immune deficiency syndrome virus] and hepatitis B in blood. BMM is made from cellulose fiber [BEMBERG] regenerated from cuprammonium solutions of cotton linters.

It is capable of removing virus from plasma and so suppresses its multiplication. AIDS virus immersed into lymphocytes, grows there, and then funoff into plasma. If the isolation rate of virus from plasma is fast, the clinical progress of AIDS can be suppressed. This suppression of the AIDS virus can allow the reactivation of the metabolic functions of the human body, so that treatment efficiency will improve when combined with other medical treatments.

6.2 SUPER ABSORBENT FIBERS:

In last few years, super absorbents in fiber from have become a commercial reality. The recent commercial grade of super absorbent fibers has spurred an enormous amount of development activity in many market applications including telecommunications, packaging, horticulture, electronics and disposable hygiene products. Most recently the potential to benefit from their outstanding properties in a wide range of medical products have been recognized. The product is based upon like polymer chemistry to that for powders that is a cross-linked copolymer of acrylic acid. The advantages that fiber offers compared to fibers are due to their physical form, or dimensions, rather than their chemical nature. The lubricant has also been selected to raise this wetting effect and results in a very high rate of moisture absorption. Typically the fiber will absorb 95% of its ultimate capacity in 15 sec.

6.3 SPIDER SILK:

It is a fibrous protein hidden as a fluid, which hardens as it oozes out of the spinnerets, which are mobile finger-like projections. As the fluid oozes out, the protein molecules are aligned in such a way that they form a solid; the process is not yet well understood. spidersilk is up to 5 times harder than steel of the same diameter. It is believed that the harderthe spider pulls on the silk as it is produced, the stronger the silk gets. Spider silk is so flexible that it doesn't break even if stretched 2-4 times its length. Spider silk is also waterproof, and doesn't break at temperatures as low as -40C. Spider silk is extremely strong -- it is about five times stronger than steel and twice as strong as Kevlar of the same weight. Spider silk alsohas the ability to extend about 30- percent longer than its original length without breaking, which makes it very resilient.

6.4 POWER FIBERS THAT STORE SOLAR ENERGY:

Heat regenerating fibers are produced from ceramic complex by applying heatinsulation processing technology, which utilizes the far infrared radiation effect of ceramic. These heat reradiating fibers are used for sportswear, bead-sheets, bed-cover materials, etc. A futuristic fiber material solar-α has been developed, which absorbs and preserves the optical energy of the sun. Oxygen consumption must be decreased to minimum to bring out power efficiently from muscle in severe climatic conditions. Zirconium carbide compounds are used is used for their excellent characteristics in absorbing and storing heat in a new type of solar system, including domestic water heaters and large-scale generators turbine. Zirconium carbide traps heat energy. It absorbs visible rays and reflects the light of long wavelength, which makes up 95% of sunlight, and converts it into stored heat energy.

7.CONCLUSION:

Natural fibers have good properties but have some limitations; to overcome those synthetic fibers are produced, Followed by high performance fiber because of their better properties and performance. These Fibres can replace even metals, so enormous developments are done in fiber field. This high performance fiber are used in technical textile they categories by its properties. We are looking forward for more and more eco-friendly, environment friendly fibers. Now there are endless innovations and researches are going on.

8. REFERENCES:

[1] https://www.slideshare.net/.../recent-developments-in-high-performance-fibres, Recent developments in high performance fibres- Jan 29, 2012.

[2] textilelearner.blogspot.com/2014/03/recent-developments-in-high-performance.

[3] https://www.nap.edu/read/11268/chapter/3 high performance fiber technology

[4] nptel.ac.in/courses/116102026/47Aug 25, 2014

[5] A.E. Naaman, H.W. Reinhardt ,ArchitectureHigh Performance Fiber Reinforced Cement Composites 2- 1996

[6] https://www.slideshare.net/kabirasm07/high-performance-fibres .Oct 2, 2013

[7] V Afroughsabet, High-performance fiber-reinforced concrete2016.

[8] Global High-Performance Fiber Market Sep 21, 2015 - 21, 2015.

[9] www.marketsandmarkets.com.