ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 2, Issue 1, January 2015 |

Application and Future of Composite Materials: A Review

Ankur Kumar[1], Rahul Tyagi[2], Sachin Kumar[3]

Department of Mechanical Engineering, K.S.V.C.E.M., Bijnor, Uttar Pradesh, India [1, 2,3]

ABSTRACT: Materials play a significant role in the blooming of human civilization and country's infrastructure. Composite materials have boundless engineering application where strength to weight ratio, low cost and ease of fabrication are required. For certain applications, the use of composite materials as compare to metals has in fact resulted in savings of both weight and cost. Some examples are cascades for engines, leaf spring, curved fairing and fillets, replacements for welded metallic parts, tubes, cylinders, ducts, blade containment bands, medical devices, electronic devices, sports goods etc. In aerospace approximately 50% of the airframe is made from composites due to their high specific strength, light weight and stiffness. The aim of this paper is to present the current scenario of application composites in industries and go towards the approach of composite material in future direction with its advantages, disadvantages and applications in industrial machinery. This paper also shows the Properties, Characteristics, Challenges, Opportunities and Future demand of Composite material towards industrial environment.

KEYWORDS: Composite materials, Aerospace, Medical devices, High specific strength.

I. INTRODUCTION

Composite materials have been using for thousands of years, e.g. they have manufactured bricks with the help of mud which is thousand-year-old technology. Now days, we all depend on composite materials at some aspects of our lives. Composite material defined as a mixture of two or more than two materials (reinforcement, fillers and binder) different in composition. Composite materials also called composition materials or shortened to composites. Composite materials are materials made from two or more than two materials with considerably differ in physical and chemical properties, that when combined, make a material with appearances different from the individual components. Composites comprise strong load carrying material is known as reinforcement and weaker materials is known as matrix. Reinforcement provides stiffness and strength which helps to support structural load. Composite materials do not lose their respective identities but still relate their properties to the product causing from their mixture. The benefits of composite materials have their great stiffness and strength. There are in many cases, the reinforcement is stronger, tougher, harder and stiffer than the matrix. It finds application in automotive, aerospace, electronic equipment, sport goods, furniture, medical equipment & packaging Industry. Composite materials used as an industrial material for their outstanding resistance to chemicals and most forms of corrosion. This property of composite material conventionally important is hardly the only useful property. There are many important and useful properties are, low mass, low weight unequalled manufacturing and processing possibilities, complex material body are easily produced, appropriate to very small products and very large product, tooling cost is very low, satisfactory surface finish can be an integral feature[1,2]. Composites have four to six times tensile strength as compare to steel or aluminium (depending on the reinforcements). Composites have less noise and lower vibration transmission than metals at the time of operations. Composite materials have torsional stiffness and impact properties. Composites have high fatigue strength, impact, environmental resistance and reduce maintenance, higher fatigue endurance limit (up to 60% of ultimate tensile strength. Composites exhibit fire retardancy and good corrosion resistance. Composites have improved surfaces properties and readily incorporable integral decorative melamine is other characteristics of composites, low electrical conductivity and thermal expansion. Composite parts can eliminate joints and providing simplification and assembly design compared to non composite metallic parts. Composite materials have high cost of material, long development time, manufacturing difficulties, low ductility, temperature limits, solvent or moister attack, hidden damages and damage susceptibility. Matrix used in composite materials is subject to environmental degradation and analysis is difficult, hot curing is necessary in many cases requiring special tooling, hot or cold curing takes time. Materials require refrigerated transport and storage and have limited shelf life.

ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 2, Issue 1, January 2015 |

II. APPLICATION OF COMPOSITE MATERIAL

1. In Aerospace- Approximately 50% component of the airspace is made from composites. The primary benefits that composite components are reduced weight and assembly simplification. The large scale use of composites in current program of development of helicopters, military fighter aircraft, small and big civil transport aircraft, satellites, launch vehicles and missiles. Various components of aircraft are fabricated by composites, e.g. rudder, spoilers, airbrakes, elevators, LG doors, engine cowlings, keel beam, rear bulkhead, wing ribs, main wings, turbine engine fan blades, propellers, Interior components etc[3-5].
2. In Automotive - Composites are being considered to make low weight, safer and more fuel-efficient vehicles. A composite is composed of a high strength fiber (carbon or glass) in a matrix material (epoxy polymer) that when combined provides magnify properties compared with the individual materials by themselves. Many components like steering wheel, dashboard, seat, roof, hatch, mats, energy absorber, instrument cluster, interior and exterior panel, leaf spring, wheels, engine cover etc. fabricated by composite materials [6-8].
3. In Medical- A composite is a nonviable material used in a medical device and intended to interact with biological system. Over the centuries, advancement in synthetic materials, surgical technique and sterilization methods have permitted the use of composite material in many ways. Medical practice today utilizes a large number of devices and implants. Composites in the form of sutures, bone and joint replacements, vascular grafts, heart valves, intraocular lenses, dental implants, pacemakers, biosensors, artificial hearts etc. widely used to replace and/or restore the function of disturbed or degenerated tissues or organs, to improve function, to assist in healing, to correct abnormalities and thus improve the quality of life of the patients [23-24].
4. In Electrical field- Composite materials have strength, high modulus; electronic composites emphasize high thermal conductivity, low thermal expansion, low dielectric constant and high/low electrical conductivity depending on the particular electronic applications. Electronics composites can use expensive fillers, such as silver particles, which serve to provide high electrical conductivity. The application of composites in electronics include interconnections, printed circuit boards, interlayer dielectrics, die attach, lids, thermal interface materials, electrical contacts, connectors, heat sinks, housings etc[9,20-21].
5. In Sports- Composite materials are used in sports equipment because they offer ease of transport, resistance, low weight, low maintenance and durability. Initially, natural materials, like wood, were used due to its good shock absorption, but these materials had some drawbacks. The anisotropic nature resulted in low resistance and the variation in properties and high moisture absorption allocate various deformations. The composite material has characteristics of fatigue resistance break resistance, superior thermo stability, friction resistance, abrasion resistance and vibration attenuation, and it has light weight, high strength and high design freedom, and can be processed and shaped easily, so it is widely used in sports equipment. There are various goods made of composite materials, including the planning boats, sailing boats, sailboards tennis rackets, badminton rackets, softball bats, ice hockey sticks, bows and arrows etc [25, 26].
6. In Chemical Industry- Advantages of composites of fire resistance properties, lightweight, mold ability, and resistance to chemicals has made the material used in the chemical industry. Composites are extensively used in industrial gratings, scrubbers, ducting, piping, exhaust stacks, pumps & blowers, structural supports, storage tanks, columns, reactors etc. for alkaline & acidic environments. Some applications are drive shaft, fan blades, ducts, stacks, underground storage tanks, casings, composite vessels etc. Internationally, composites applications in chemical industry are a relatively small segment in relation to the total usage of composites [27].
7. Other- Composites have long been used in the construction for industrial supports, buildings, long span roof structures, tanks, bridge components and complete bridge systems. With composites exhibiting excellent resistance to the marine environment. With the help of composite we make light weight doors, window, furniture, building, bridge etc. for domestic and construction purpose [28].

III. LITERATURE REVIEW

D. Pathania et al. [10] study and showed that dielectric constant and dielectric dissipation decreased with frequency and increased with temperature but dielectric loss factor decreased with the increase of frequency at fixed temperature and increased with temperature at lower frequencies. It is also concluded that the dielectric loss factor decrease with chemical treatment. It is also observed that with systematic and persistent research there will be good scope and bright future for polymer reinforced composites for various electrical applications such as terminals, connectors, switches, circuit boards etc.

Kumar S. et al. [11] discussed industrial and domestic application of rice husk and rice husk ash. Due to fine insulating properties of rice husk like low thermal conductivity, low weight, high melting point, low bulk density high porosity, it used for the production of high quality steel. Blended cement is produced by using rice husk ash for fulfilling the increasing need for building material. Due to large silica content in rice husk ash, extraction of silica is economical.

ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 2, Issue 1, January 2015 |

Silica are used in rubber industries as a reinforcing agent, in cosmetics, in toothpastes, in food industries as an anti-caking agent.

A. Balaji et al [12] discussed about the future biocomposites material and their application. Natural fibers and biocomposites made from natural sources, eco-friendly and well designed industrial products which can be replace dominance of petroleum based products in future. The utilization of bagasse fibers for fabrication of biocomposites by using new technology transforms future of coming generation. It will be an alternative way to develop the biocomposites which can be widely used for daily requirements of common people whether it is house hold furniture, house, fencing, window, decking, designing, flooring, and light weight automobile components or sports equipments. Their low cost, easy availability and aesthetic designs will be the main advantages to transform the depended present to sustainable future.

T. Subash et al [13] discussed about bast fibers reinforced green composites for aircraft indoor structures applications. These materials provides the benefits in making of the body panels such as in seat cushions, cabin linings, parcel shelves etc., The natural fibers such as jute, kenaf, bagasse, bamboo, coir, sisal have proved to be a materials with the high strength in aerospace and automotive industry. These composites show a lower density as compared to traditional mineral composites and have a great potential to make lightweight sustainable finished products that can reduce tremendous amount of energy consumption in the aerospace industry.

Alen John et al. [14] give a review on the composite materials used for automotive bumper in passenger vehicles. Determining the right material during the selection process is very important. The material selected should meet the expectation of the engineer. The material should be mechanically feasible and should have low cost. Other than the manufacturing of bumpers, the composite materials have a wide range of other potential automotive applications such as body panels, suspension, steering, brakes and other parts of the automobile. Apart from body panels, the current, limited automotive application of composites include bumper systems, leaf springs, drive shafts, fuel tanks, instrument panels, cross wheel beam, intake manifold.

Gururaja M N et al. [15] give a review on recent applications and future scope of hybrid composites. This paper presents a review of the hybrid composite materials technology now a day, in terms of materials available and properties, and an outline of some of the obvious, trends and speculative, with emphasis on various applications including some details of smart hybrid composites. Author concluded the application of hybrid composite in automotive, aerospace, marine, wind power etc.

Prof. N.V. Hargude et al. [16] discussed about composite material mono leaf spring. In this paper we have understand it is possible to easy manufacturing a leaf spring using E glass epoxy glass fiber. As per the point of weight reduction it is possible by using composite material. Ride comfort and life of Composite Leaf Springs are also more when compared to steel leaf springs.

Obilade, I.O. et al. [17] study about use of rice husk ash as partial replacement for cement in concrete. Author concluded the replacement for cement is in the range 0-20% optimum addition of RHA as partially. The compacting factor values of the concrete decrease as the percentage of RHA increased. The Bulk Densities of concrete reduced as the percentage RHA replacement increased. The Compressive Strengths of concrete decrease as the percentage RHA replacement increased.

Md Iqbal Ahmad et al. [18] present scenario, future trends & its applications focusing on earthquake resistant building constructions present scenario, future trends & its applications focusing on earthquake resistant building constructions. It is concluded that composite material can be used as a viable alternative for conventional reinforced concrete frame in earthquake prone regions. Fiber reinforced cement composites are found effective in construction of masonry structure.

Piyoosh Thori et al. [19] give an approach of composite material in industrial machinery. Manufacturing process of hybrid laminates is provided as applicable to various industries such as civil constructions, transportation industry, marine, aeronautics, naval, automotive industries and components for the electronic industry. Considerable efforts have been focused on the applications of Hybrid composites for better understanding of the phenomena associated to the cutting edge technology.

S. Prabhakaran et al. [22] develop the glass fiber reinforced polymer composite ceiling fan blade. In this project the composite blade has been fabricated. Composite blade has more strength over existing fan blade. The existing fan blade weight about 295 grams where as the weight of composite fan blade is 215grams, which is 28% lesser than existing blade. Power consumed by the existing blade (0.052units) is more when compared to composite blade (0.037units). Cost of composite ceiling fan blade is Rs. 279/- which are 44% less than existing aluminium blade. Strength of the composite blade is also high when we compared with aluminium blade. From the study, it is concluded that fiber reinforced plastic material is a better material for manufacturing the composite ceiling fan blade.

IV. CONCLUSION AND FUTURE SCOPE

There is a wide scope of composite material in automotive, aerospace, wind energy, electrical, sports, domestic purpose, civil construction, medical chemical industries etc. Composite materials have a great potentiality of application in structures subjected primarily to compressive loads. Composite materials have attractive aspects like the relatively high

ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 2, Issue 1, January 2015 |

compressive strength, good adaptability in fabricating thick composite shells, low weight, low density and corrosion resistance. Composite materials have good mechanical, electrical, chemical properties, due to which we can use composite material in many various industries. Various parts of automobile and aerospace are manufactured by composite material due to good properties. Composite materials are used for domestic purpose like furniture, window, door, mating, civil construction etc. In the marine, chemical industries, sports, we can use composite material for better performance of the parts. With the help of review, we conclude that composite materials have wide advantages & application in various industries; we can make better life style with the help of composite material.

REFERENCES

[1] Satyanarayana, K.G., Sukumaran, K., Mukherjee, P.S., Pavithran, C. and Pillai, S.G.K., "International conference on low cost housing for developing countries", pp. 171-181, (Rookree, 1984).
[2] Satyanarayana, K.G., Pai, B.C., Sukumaran, K, and Pillai, S.G.K., "Lingocellulosic fiber reinforced polymer composites", (New York, Marcel Decker, Vol.1, pp.339.
[3] Hinrichsen, J, "The Material Down-selection Process for A3XX, CAES", 19th European Conference on Materials for Aerospace Applications, Munich, pp.6-8, 2000.
[4] Hinrichsen, J. & Pora, J., "Airbus A380: Requirements for the Selection of Materials and Manufacturing Technologies"; Aluminium Chair 2001: Aluminium in the Aerospace Industries, SONACA SA, Gosselies, Belgium, 8th March 2001.
[5] Pora, J. & Hinrichsen, J.: "Material and technology developments for the Airbus A380"; 22nd International SAMPE Europe Conference of the Society for the Advancement of Material and Process Engineering, La Défense, Paris, France, 27th – 29th March 2001.
[6] Blythe, A.R., "Electrical properties of polymer", Cambridge University Press Cambridge, London, (1979).
[7] Karthikeyan B., Ramanathan S., Ramakrishnan V., "Thermo physical property measurement of metalmatrix composites", Materials and Design, pp. 82-86, 2010.
[8] Georgios Koronis., Arlindo Silva and Mihail Fontul (2013), 'Green Composite: A review of adequate materials for automotive application', Composites: Part B., Vol.44, pp.120-127.
[9] Suddell B. "Industrial Fibres: Recent and Current Developments", In Proceedings of the Symposium on Natural Fibres, pp.7 – 82, 2009.
[10] D. Pathania , D. Singh., "A review on electrical properties of fiber reinforced polymer composites" International Journal of Theoretical & Applied Sciences, 1(2): 34-37(2009).
[11] Kumar S., Sangwan P., Dhankhar R. Mor V., and Bidra S., "Utilization of Rice Husk and Their Ash: A Review", Research Journal of Chemical and Environmental Sciences, Volume 1 Issue 5, pp. 126-129, December 2013.
[12] A.Balaji, B. Karthikeyan, and C. Sundar Raj, "Bagasse Fiber – The Future Biocomposite Material: A Review", International Journal of ChemTech Research, Vol.7, No.01, pp. 223-233, 2014-2015.
[13] T.Subash, S.Nadaraja Pillai, "Bast fibers reinforced green composites for aircraft indoor structures applications: Review", National Conference on Recent Trends And Developments In Sustainable Green Technologies, Journal of Chemical and Pharmaceutical Sciences, Issue 7, pp. 305-307, 2015.
[14] Alen John, Sanu Alex, "A review on the composite materials used for automotive bumper in passenger vehicles", Volume-4, Issue-4, pp. 98-101, August-2014.
[15] Gururaja M N, A N Hari Rao, "A review on recent applications and future prospectus of hybrid composites", International Journal of Soft Computing and Engineering, Volume-1, Issue-6, pp. 352-355, January 2012.
[16] Prof. N.V. Hargude, Prof. N.D.Patil, Prof. P.P. Awate, "Review of Composite Material Mono Leaf Spring", International Journal of Emerging Technology and Advanced Engineering, Volume 4, Issue 5, pp. 880-882, May 2014,.
[17] OBILADE, I.O.,"Use of rice husk ash as partial replacement for cement in concrete", International Journal of Engineering and Applied Sciences, Vol.5. No. 04, pp.11-16, 2014.
[18] Md Iqbal Ahmad, Rahul Mallick, Subhro Chakraborty, Aritra Guin, Anish Chakraborti, "Composite Materials: the present scenario, future trends & its applications focusing on earthquake resistant building constructions", Journal of Civil Engineering and Environmental Technology, Volume 2, Number 12, pp.65-69.
[19] Piyoosh Thori, Pawan Sharma, Manish Bhargava, "An approach of composite materials in industrial machinery: advantages, disadvantages and applications", International Journal of Research in Engineering and Technology, Volume 02, Issue 12, pp. 350-355 Dec-2013.
[20] T. Y. Kam, J. H. Jiang, H. H. Yang, R. R. Chang, F. M. Lai, and Y. C. Tseng "Fabrication and Testing of Composite Sandwich Blades for a Small Wind Power System", PEA-AIT International Conference on Energy and Sustainable Development, 2010.
[21] M A Drewry, and G A Georgiou "A review of NDT techniques for wind turbines", Wind turbine NDT, Vol.49, 2006.

ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 2, Issue 1, January 2015 |

[22] S.Prabhakaran, M.Senthil kumar, "Development of Glass Fiber Reinforced Polymer Composite Ceiling Fan Blade", International Journal of Engineering Research and Development, Volume 2, Issue 3, pp. 59-64, July 2012.
[23] S Ramakrishna, J Mayer, E Wintermantel, Kam W Leong, "Biomedical applications of polymer-composite materials: a review", Composites Science and Technology, Volume 61, Issue 9, pp.1189–1224, July 2001.
[24] E. Salernitano, C. Migliaresi, "Composite materials for biomedical applications: a review", Journal of Applied Biomaterials & Biomechanics, pp. 3-18, 2003.
[25] J. L. Wang, "Application of Composite Materials on Sports Equipments", Applied Mechanics and Materials, 2012, Vols. 155-156, pp. 903-906.
[26] Froes, F. H., "Is the Use of Advanced Materials in Sports Equipment Unethical?" JOM, pp. 15-19, February 1997.
[27] ZJ de Beer, "Applications for composite materials in the mining and metallurgy industry", present and future, pp. 1-10.
[28] M.K. Lila, Fanindra Kumar, Sanjay Sharma, "Composites from waste for civil engineering applications", i-manager's Journal on Material Science, Vol. 1 l, pp. 1-10, 3 l October - December 2013.
[29] Sukhwinder Singh Jolly, "Advancements in Composite Materials and Their Applications in Engineering and Technology", GRA - GLOBAL RESEARCH ANALYSIS, Volume 1, Issue 5, pp. 42-44, Nov 2012.
[30] Gururaja M N, A N HariRao, "A Review on Recent Applications and Future Prospectus of Hybrid Composites", International Journal of Soft Computing and Engineering Volume-1, Issue-6, pp. 352-355, January 2012.