GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

KENAF FIBER REINFORCED BIOCOMPOSITES:CRITICAL REVIEW

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ABSTRACT

The development of biodegradable polymers has been subjected to great interest in materials science for both ecological and biomedical perspectives. Among the many types of natural assets, Kenaf fiber have been widely used over the past few existence which is a mostly attractive alternative due to its rapid growth at different climatic conditions and its ensuing low cost, kenaf fiber has gained some attention in replacing the glass fiber composite and making it purely a eco friendly. Therefore, in this paper, it is presented as overview of the developments that are made in the area of kenaf reinforced composites in terms of their market, processing methods, fiber content, environmental effects, chemical treatments, mechanical properties. Several critical issues and suggestions which are helpful for further research are discussed, for the better future of this bio-based material through a value addition and for the enhancement of its uses.

Keywords- *Kenaf fiber; chemical treatment-methods; polymer matrix composites; fiber content; thermo-mechanical properties.*

I. INTRODUCTION

Jeffrey Sachs [1] aimed to work for eradication of excessive poverty; to ensure environmental sustainability. The improved utilization of plastics throughout the world has resulted in enhanced plastic waste. Shekeil YAE et al. [2] identified that the recent developments in recyclable polymers plays vital role as today there is an uncertainty in petroleum usage in the world. Natural fibers are environmentally superior substitute to synthetic fiber because they are cheaper, renewable, biodegradable, recyclable, corrosion resistive, abundant, permeable, non-toxicity and competitive mechanical properties, capable of non absorbing moisture. Khalil HPSA et al. [3] mentioned that, the major drawback of natural fiber composite is incompatibility between hydrophobic polymer matrix and hydrophilic natural fiber .Among these some amount of residues are used in household, remaining fuel will burn in fields, this causes air pollution in environment. Mohanty AK et al. [4] studied that, to solve this problem agriculture residue are used as reinforcement. Joshi SV et al. [5] found that, plant based fibers are used as reinforcement with polymers to enhance the mechanical properties. Aziz SH et al. [6] studied that among the different types of natural resources, kenaf plants have rapid development in past years. H.M.Akil et al. [7] developed kenaf fiber which is attractive due to their rapid growth with consequence of low cost under wide range of climatic conditions. Kenaf fiber have a potential medium alternate to replace the synthetic fibers as reinforcement composites and also reduces the waste, hence contributes to the healthier environment; It will thus create jobs in urban and rural areas.

II. BIO BASED NATURAL FIBER COMPOSITES

Netravali AN et al. [8] investigated that a synthetic fiber composite makes land useless after ending their life. To overcoming this problem, recent researches are going on biodegradable resin with natural fiber; biodegradable, environment-friendly, bio based composites that can easily be disposed at the end of their life. Bullions.T et al. [9] found that natural fiber reinforcement is environmentally superior in specific applications. The life cycles of bio composites are shown in fig.1.

Mohanty AK et al. [10] proposed that the use of natural fiber composites in automobile and aerospace industries is high because of cheaper cost and low weight; previously it got shifted from steel to aluminum composites, later from Aluminum to synthetic fiber composites, now from synthetic fiber to natural fiber composites for many applications. That leads to reduction in 15% of automobile weight. Natural fibers are classified based on their origins .i.e. they are derived from plants (vegetable), animals (proteins) and minerals; they are shown in fig. 2.

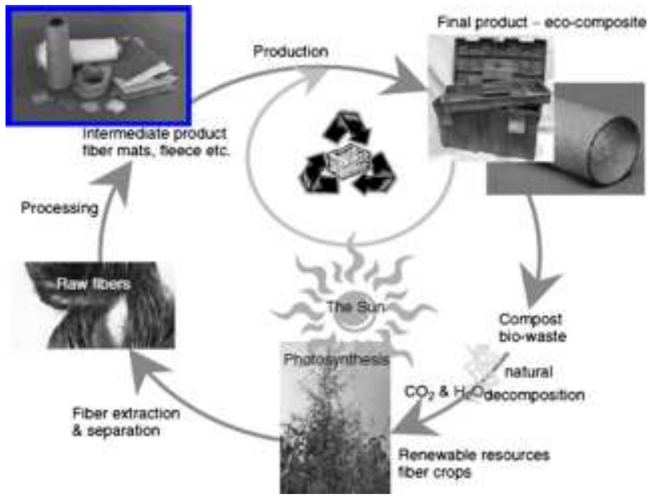

Fig.1.Life cycle of bio-composites [9]

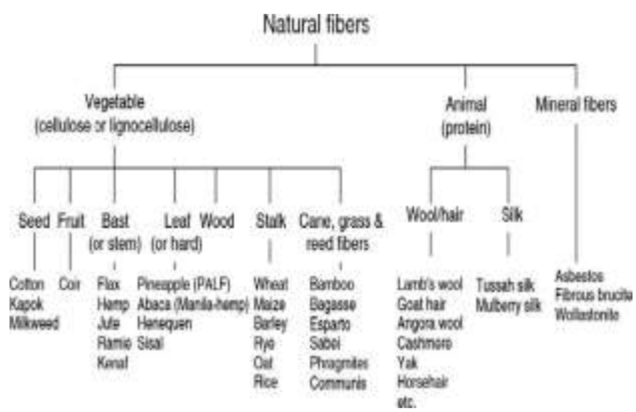

Fig.2. Classification of natural fibers [10]

III. KENAF FIBER

Karnani R et al. [11] proposed that in polymer matrix composites, kenaf fiber is one of the sources to use as reinforcement for composites in industrial applications (fig.3). H.M. Akil et al. [7] provided that the main advantages of using kenaf fiber as reinforcement in composites is to create jobs and also reduce the wastages; contributes healthier environment. Usage of kenaf fiber cellulose has both economic and ecological advantages; within 3 months it will grow up to 3m height with 3-5 cm base diameter under wide range of climatic conditions [12]. Edeerozey AMM et al. [13] mentioned that previous studies state that the growing speed of cellulose fiber may reach 10 cm/per day under ambient conditions. kenaf fiber requires very less water to grow because of its growing cycle 150-180-days [15]. Zaveri M et al. [14] provided that kenaf fiber grows effectively with minimal chemical treatment as it is adoptable to various types of soil. White GA et al. [16] studied that globally, kenaf fiber is consider as suitable biological resources ,substitute for fossil fuels and wood pulps due to its extensive adaptation, large biomass, strong resistance and rich cellulose. The physical properties of the fiber depends on the location of the plant, the changes will take place within 500mm from the ground. The first research began on kenaf fiber in the United States in 1957. Saba N et al. [17] presented that it produces biofuel feedstock due to its high cellulose and low lignin content; the kenaf can produce 61.4 gal of biofuels /ton biomass which is currently marketed in United States of America. Ashori A et al. [18] identified that kenaf is versatile plant due to their well adopted soil types when the selection of suitable site the important consideration is frost, it is commercially cultivated around more than twenty countries among these more than 95% of production is from India, Bangladesh, china, Thailand and its native plants are in India, Malaysia, Pakistan, Japan, Indonesia, Thailand, Vietnam.

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Fig.3. Kenaf plants [11].

Challenges for kenaf fiber used as reinforcement in polymer composites

Interphase

Tserki V et al. [19] studied that the main drawback of the natural fibers including kenaf fiber the lack of adhesion between the two components which is effects poor properties of the final product while using as reinforcement in polymer composites. Vilay V et al. [20] provided that chemical treatments are improves interfacial adhesion between the fiber and matrix; chemical modification requires to improves the properties of natural fiber, among the more number of modification treatments particularly one of the familiar type of chemical treatment applied for kenaf fiber is alkaline modification treatment based on sodium hydroxide(NaOH)[19,20]

Properties of kenaf fibers

M.Ramesh [21] investigated that the properties of composites are varied due to the place of origin, chemical treatment, manufacturing methods and fiber content. Mohanty AK et al. [22] studied that fiber properties are improved with chemical treatment.

Chemical treatments / surface modification of kenaf fiber

Mohanty AK et al. [22] proposed that the chemical treatment is well known method to increase the Bonding strength of the fiber and matrix. Different types of chemical treatments are improves their properties and adhesion between the matrix and natural fiber composite which is reported in previous literates. [15,22-24] explained that the various surface medication treatments are alkaline treatment, dewaxoy, isocyanite treatment, nirefgretty acetylating, cyanoethylation, bleaching, peroxide treatment, sizong with polymeric isocyanite, silane permanganate, acrylic acid maleated polymer, alknoxysilances and other coupling agents. Yousif B et al. [25] investigated that the chemical modification improves surface adhesion between the fiber and matrix.identified that Chemical treatments are increased the adhesion between the hydrophobic polymer matrix and hydrophilic natural fibers at the interface. [26-27]

IV. PROPERTIES OF KENAF FIBER REINFORCED POLYMER COMPOSITES

The kenaf fiber reinforced polymer composite properties are depend on the chemical treatment, manufacturing methods and fiber content, type of polymer used. [22]

Alkaline treatment effects on properties of kenaf fiber

L. Mwaikambo et al. [28] explained that the reaction of sodium hydroxide with natural fiber equation as below; this treatment is inexpensive and effective.

Cell + OH+ NaOH $\longrightarrow$ cell – O^- Na^+ + H2O + surface importing

Li X et al. [29] states that the alkaline treatment in very effective surface roughness and low cost treatment, NaOH solution increased surface roughness of the fiber which enhance the mechanical properties; chemical bonding with matrix. A.M. Mohd Edeerozey et al. [30] studied that kenaf fiber socked NaOH 3hr at room temperature, after allow to dry 48hr at 95^0C solution with different concentrations, when 3% NaOH solution not effectively removes the impurities and 6% NaOH yields the optimum solution for chemical treatment; 9% NaOH gives cleanest fiber its damages the fiber texture and reduce the tensile strength. Faseha Shukor et al. [31] mentioned that before fiber dried at 50^0 C for 24hr then 6% NaOH treated after washed at 60^0 C for 24hr .kenaf fiber reinforced biocomposite gives better mechanical properties than untreated biocomposite. Nor Azowa et al. [32] find out that whole stem kenaf fiber (WSK) treated with 4% NaOH for 3hr at room temperature. It increases Tensile strength and flexural proportion than untreated fiber. B.F. Yousif et al.[33] studied that the fiber socked 6% NaOH 24hr at room temperature, after dried at 70^0 C at constant wait reached; enhanced flexural property is 36% more than untreated fiber. Mohd Suhairil Meona et al.[34] it has been found that, the fiber socked 6%NaOH for 24hr,after dried at 100^0 C for 24 hr, which is enhanced the tensile properties. Y. A. El-Shekeil1M et al. [35] investigated that while treated kenaf fiber composites increases 2 NaOH + 4PMDI (Polymeric Methylene Diphe Discocyanate) 30% Tensile properties, (42%) Tensile modules, and also increases adhesion and wettability. A.M. Mohd Edeerozey et al. [30] investigated that kenaf fiber composite with and without NaOH treatment, reported that it gives higher Tensile strength value13% increased when compared to non treated fiber. Reza Mahjoub et al.[36] investigated that the surface modification of kenaf fiber reinforced composites with 5%,10% and 15%NaOH socked for 3hr and after dried for 24hr at room temperature, reported that fiber (10%,15%) texture damaged, more twisted and brittle. O.M.L. Asumani et al. [37] investigated that result 6%NaOH concentrate the optimum level of treatment for kenaf fiber. E Jayamania [38] investigated that 5%NaOH solution enhanced the mechanical properties of the kenaf fiber reinforced composite. A. K. Mohanty et al. [39] proposed lower cost chemical treatments are required to emphasized for biobased composites to replace the synthetic fibers in future applications.

Manufacturing methods

T.Nishino et al. [40] investigated that hand layup method is the oldest fabrication method to fabricate the composite because of its processing cost as low, very easiest and quality used one. k.deepak. [41] investigated handlay up method is used to prepare the composite it gives good mechanical properties to substitute to synthetic fiber. M.R.Kaiser et al. [42] investigated that bio based hybrid composite prepared by double extrusion method which is enhancing the mechanical and mechanical properties (impact strength is increased 50%). Iqbal mokhtar et al. [43] investigated kenaf based hybrid composite prepared by compression moulding process which enhance the mechanical properties. H.Anuar et al. [44] studied that kenaf based biocomposite was prepared by injection molding method, it increases the mechanical properties. M.A.A.Ghani et al. [45] investigated that the hybrid composites by using hand layup method. R.Yahaya et al. [46] studied that hand layup method are used to investigate the ballistic impact properties of the hybrid kenaf based composites. Ishag babaei et al. [47] investigated that injection molding method used to prepare the hybrid composites; it increases the mechanical and physical properties. Md.Saiful et al. [48] investigated that hot compression molding biobased hybrid kenaf fiber nanocomposite increases the mechanical and physical properties. I.S.Ajil et al. [49] investigated hybrid kenaf fiber reinforced composite prepared by compression molding method, it improves dynamic mechanical properties. Hyeok et al. [50] investigated the hybrid composite which is prepared by injection molding process it increases the tensile properties.

Influence of fiber content on properties

Y.A.El-Shekeil et al. [51] investigated that kenaf fiber composite were prepared with various fiber contents (20%, 30%, and 40%) with parameters 140ºC.11min.and 40 rpm process by compression molding. Observed that the mechanical properties (i.e.flexural properties ,tensile properties, impact strength properties) are decreases while increasing the fiber content 20% ,30 %, 40% respectively 34.9 kj/m2, 27.9 kj/m2, 20.2 kj/m2; they reported that impact strength, tensile strength and strain decreases with increasing the fiber content; when ever increasing fiber content tensile modulus increases. A morphology results indicates poor interfacial bonding, the Stress-Strain behavior of the composites are very high in 20% fiber content, by increasing fiber content 30%,40% standard deviation getting less. M,R.Kaiser et al.[42] investigated results that 20% kenaf fiber reinforced with 3% nano clay hybrid biocomposite gives optimum results glass transition temperature, damping property and storage modulus are increased; 20% kenaf fiber reinforcement enhance the good mechanical(increased 50% impact strength) more than and morphological properties of the hybrid biocomposite. Y.A.El-Shekeil et al.[52] investigated results that kenaf fiber reinforced composites prepared were 20%, 30%, 40%, 50% ,.Among this 30%fiber content is the optimum fiber content, because it enhanced the tensile strength, modulus and flexural strength; low impact strength , low tensile strain when compared to 20% fiber content. The addition of 30% fiber content increased hardness and abrasion resistance, thermal stability was decreased. A.A.Yussuf et al.[53] investigated that the comparison results of 20K(Kenaf) and 20RH (Rice husk) studied that 20% kenaf fiber reinforced biocomposite higher thermal and mechanical properties when compared to 20% Rice husk fiber biocomposite, the fiber content plays a vital role to enhance the properties of biocomposite. J.K.Sameni et al.[54] investigated report that the properties of the kenaf/TPNR composites 20%fiber improved tensile, young’s modulus, tensile strain and flexural modulus when compared to the other (10% and 30% loading composites),in addition of 30% fiber decreased tensile strain and impact strength. Bonnia N.N et al.[55] investigated report that kenaf fiber reinforced composite, the fiber loading compositions are increased from 5 to 25% ,higher fiber loading will disturbs the cross linking process and effects the strength of the composites due to fiber distribution percentage. H.Anuar et al. [44**]** investigated that kenaf fiber reinforced composite 20% fiber content improves tensile, flexural properties of the biocomposite and the tensile modulus is 15% higher than that of theoretical value. E.Jayamani et a.l[38] investigated that 10% fiber loading enhanced mechanical strength, sound absorption coefficient of the composite is increased with adding fiber content. O.M.L. Asumani et al. [37] investigated that 30% fiber content is the optimum for both kenaf fiber and glass fiber reinforcement.

V. CONCLUSIONS

Research on kenaf fiber reinforced composite is usually improved attention due to its outstanding properties and environmental considerations. A detailed discussion on chemical treatment, fiber contents effects on kenaf fiber reinforced composites is specified in this review from the earlier investigational studies as follows:

1. In water retting process for kenaf fiber, fresh water which contains chloride is not suggested.
2. From the literature study, alkaline treatment is the best suitable fiber treatment for kenaf fiber, because of their low cost and effective.
3. The alkaline treatment fiber about 6%NaOH solution gives the highest mechanical properties for kenaf fiber reinforced composite.
4. The alkaline treatment 8 % NaOH solution damages the texture of the kenaf fiber.
5. The kanaf fiber allows the 6% NaOH solution yields optimum for alkaline chemical treatment, it gives the best results.
6. The kanaf fiber reinforced composite mechanical properties are decreased by increasing the concentration rate and immersion time of NaOH solution.
7. The Fiber content influences the mechanical, thermal properties of kenaf fiber reinforced composite.
8. The fiber 30%content is the optimum for kenaf fiber reinforcement.
9. Sound absorption coefficient of the composite increased with fiber content.
10. Higher fiber loading disturbs the cross linking process and effects the strength of the composites due to fiber distribution percentage.
11. The fiber 20% content kenaf fiber reinforcement enhanced good mechanical and thermal properties.

From these literature reviews indicates that the treatments and fiber content influence on the properties of the kenaf fiber reinforced composite have been studied. Among these results, the fiber concentration of NaOH solution, immersion time and fiber content influences the thermal and mechanical properties of the composites. Very few researchers concentrate on these parameters. So, more research works are needed to investigate the properties based on solution concentration, immersion time and fiber content with different proportions for future applications. The parametric concentration is aimed at bringing scientists towards the potential of kenaf fiber substitute medium to replace synthetic fibers as reinforcement in composites. As a result of this review, in engineering field the kenaf fiber is found to have suitable properties to use as reinforcement fiber in polymer composite sectors. In general, the main advantage of using kenaf fiber as reinforcement in composites is to create jobs, reduce the wastages and contribute healthier environment. In future, however studies looking at demand rate, product commercialization, manufacturing processes for large scale end products.

VI. ACKNOWLEDGEMENTS

The authors would like to thank management Sri Venkateswara College Of Engineering and Technology (Autonomous), Chittoor for the financial support.

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