CHAPTER-II

LITERATURE REVIEW

This chapter presents the works published in literature on the area of natural fibre, modification of natural fibres, sonochemical treatment of solvent and solution, treatment of compatible solutions and natural fibre reinforced composite.

2.1 Literature review on natural fibres

Increasing environmental awareness throughout the world has greatly impacted materials engineering and design. Renewed interest in the utilization of natural materials addresses ecological issues such as renewability, recyclability and environmental safety. Currently, synthetic fibres like glass, carbon and aramid are being widely used in polymer-based composites because of their high strength and stiffness properties [1]. However, these fibres have serious drawbacks in terms of their biodegradability, initial processing costs, recyclability, energy consumption, machine abrasion, health hazards, etc.[2]. Most significantly, adverse environmental impact alters the attention from synthetic fibres to natural/renewable fibres. In recent years, the introduction of natural fibres as reinforcements in the polymer matrix is receiving great attention. The interest of scientists and engineers has turned over on utilizing plant fibres as effectively and economically as possible to produce good quality fibre-reinforced polymer composites for structural, building, and other needs. It is because of the high availability and has led to the development of alternative materials instead of conventional or man-made ones. Many types of natural fibres have been investigated for their use in polymer such as wood fibre, sisal, kenaf pineapple, jute, banana and straw [3-8].

The influence of lignin content on the mechanical behavior of jute was studied[9], found a gradual decrease in both the strength and stiffness of the fibre with lignin removal. Similar experiments were carried out on sugarcane fibre by Collier et al. [10] and provided additional evidence of the significant contribution of lignin to fibre strength. However, Joseph et al. [11] studied the physical properties of natural fibre and concluded the physical property of natural fibres depend mainly on the nature of the plant, locality in which it is grown, age of the plant, and the extraction method used.
Lilholt et al. [12] reported on the different natural organic fibre and provides the informations about the composition and physical properties of natural fibre. Roger et al. [13] discussed the factors affecting the agrofibres and found that the chemical composition and physical properties of them depends on part from which fibre is extracted; the age of plant and the extraction methods.

Idicula et al.[14] studied the physical properties of natural fibres were mainly determined by their chemical and physical composition such as structure of fibres, cellulose content, angle of fibrils, cross section and the degree of polymerization.

Salit [15] studied the background of the importance of natural fibres. The advantages and disadvantages of tropical natural fibres are listed. The information about fibre extraction process, the application of fibres and other important topics are discussed.

2.2 Literature review on chemical treatment of natural fibres

Knowledge of the physio-chemical properties as well as mechanical behavior of natural fibres is required in order to optimize the composite performance. Most of the work has been done to clarify the influence of the vegetable fibre composition and the effect of the treatment process on their mechanical characteristics. The properties of composites depend on the matrix, fibres, and on their interfacial bonding. The adhesion between the reinforcing fibres and the matrix in composite materials plays an important role in the final mechanical properties of the material since the stress transfer between matrix and fibres determines reinforcement efficiency. The surface of synthetic fibres is usually modified using various types of processes in order to improve the fibre surface wettability with the matrix and to create a strong bond at the fibre–matrix interface which, in turn, provides an effective stress transfer between the matrix and the reinforcement fibres Mallick [16]. When natural fibre used as reinforcement in composite materials, many problems occur at the interface due to (incompatibility). Therefore, surface modification of the natural fibres by means treatment is one of the largest areas of current research to improve compatibility and interfacial bond strength. It is worth to mention that the chemical treatment of the fibres can either increase or decrease the strength of the fibres, and hence good understanding of what occurs structurally is required Kandachar [17]. On the other hand, poor interfacial interaction leads to internal
strains, porosity, environmental degradation, moisture absorption, poor mechanical properties of composite parts, and de-bonding over time [18-19].

Chemical modification of cellulose fibres is usually applied to correct for deficiencies of the fibres. Modification may result in improved performance of the composites produced. This can be done through several approaches, including plasma activation and graft polymerization with vinyl monomers. These, however, will increase the fibre cost. The primary drawback of using cellulose fibres is their limited thermal stability with noticeable degradation occurring as the melt processing temperature approaches 200°C Araújo et al. [20]. Higher processing temperatures that reduce melt viscosity and facilitate good mixing, however, are possible, but only for short periods. If degradation occurs, cellulose fibres can be responsible for the formation of tar-like products and pyrolysis acids that may have various damaging effects both on the processing equipment and the composite properties. There are some physical fibre treatments like Plasma, but nowadays when we speak about surface treatments we almost mean chemical ones. These treatments can clean the fibre surface, modify the chemistry on the surface, lower the moisture uptake and increase the surface roughness. The contribution of fibres to the final properties of the composite depends on: fibre-matrix interface, nature of interface, mechanical properties of fibres, type (continuous/discontinuous) and orientation of fibres in the composite (anisotropy), volume fraction of fibres and processing technique used for composite manufacturing as studied by Liu et al. [21], Bledzki et al.[22], Gassan et al.[23] and Torres et al. [24]. Thus to meet all these fundamentals steps for synthesis of composite, the surface of fibres are to be properly bleached or cleaned so that the new sites may developed for interlocking of the fibres and matrix. Many works has been performed to treat the surface of the fibre by different chemical so that the surface of the fibre may modified by Maldas et al. [25]. But before modification, the surface bleaching of fibre may introduce and shortcomings associated with natural fibres have to be overcome before using them in polymer composites. The most serious concern with natural fibres is their hydrophilic nature due to the presence of pendant hydroxyl and polar groups in various constituents, which can lead poor adhesion between fibres and hydrophobic matrix polymers [26]. As the natural fibres bear hydroxyl groups from cellulose and lignin they are amenable to chemical modification. The hydroxyl groups
may be involved in the hydrogen bonding within the cellulose molecules thereby reducing the activity towards the matrix. Chemical modifications may activate these groups or can introduce new moieties that can effectively lead to chemical interlock with the matrix. Mercerization, isocyanate treatment, acrylation, permanganate treatment, acetylation, silane treatment and peroxide treatment with various coupling agents and other pretreatments of natural fibres have achieved various levels of success for improving fibre strength, fibre fitness and fibre-matrix adhesion. In the following section we report a review of the main pretreatments techniques.

Stamm et al. [27] studied the effect of acetylation on jute fibres at different reaction times and reaction temperatures. The modified fibres were characterized by FTIR, DSC, TGA and SEM studies. The extent of moisture regains and thermal stability was reported. From the study, the authors found that the thermal stability of acetylated jute is higher than that of untreated jute. Another major drawback of using cellulose fibres as reinforcing agent is the high moisture absorption of the fibres due to hydrogen bonding of water molecules to the hydroxyl groups within the fibre cell wall. This leads to a moisture build-up in the fibre cell wall (fibre swelling) and also in the fibre-matrix interface Methacanon et al. [28].

Mohanty et al. [29] have studied the surface modifications of natural fibres and performance of the resulting biocomposites. The result shows that the most important factors which determine the final performance of the composite materials is the quality of the fibre-matrix interface. A sufficient degree of adhesion between the surface of hydrophilic ligno-cellulosic natural fibres and the polymer matrix resin is usually desired to achieve optimum performance of the biocomposite. The hydrophilic nature of the fibre surface leads to high moisture take up for the natural fibres, for which the mechanical properties is reduced. The natural fibres are inherently incompatible with nonpolar-hydrophobic thermoplastics, such as polyolefins. Moreover, difficulty in mixing because of poor wetting of the fibres with the matrix is another problem that leads to composites with weak interface [30].

Yuhazri et al. [31] investigated the effect of NaOH on kenaf fibre reinforced polyester composite. It shows that the mechanical properties of the composite increases with
increasing the concentration of the alkali. Jonoobi et al. [32] characterized the kenaf (Hibiscus cannabinus) nano fibres by environmental scanning electron microscopy (ESEM) and transmission electron microscopy (TEM), were isolated from unbleached and bleached pulp by a combination of chemical and mechanical treatments. Tajvidi et al. [33] investigated the effect of modification on visco elastic properties of kenaf fibre-reinforced polypropylene (PP) composites. An increase in storage and loss moduli and a decrease in the mechanical loss factor were observed for all treated composites, indicating more elastic behavior of the composites when compared with the pure PP.

By treating the fibres with suitable chemicals, the reinforcing efficiency of the fibres in the composite and the interfacial adhesion between fibres and most polymers matrices was solved by Martins et al. [34]. Chemical treatment of the fibre cleaned the fibre surface, chemically modified the surface, delayed the moisture absorption process and increased the surface roughness. It has been found that the alkalization treatment improved the mechanical properties of the kenaf fibre significantly as compared to untreated kenaf fibre [35]. Li et al. [36] studied the surface modification method to improve the sisal fibre/matrix interaction with alkali treatment, \( \text{H}_2\text{SO}_4 \) treatment, conjoint \( \text{H}_2\text{SO}_4 \) and benzol/alcohol dewax treatment, acetylated treatment, thermal treatment, alkali-thermal treatment and thermal-alkali treatment.

Ray et al. [37] studied the changes occurring in jute fibres after 5 % NaOH solution treatment for different periods of 0, 2, 4, 6, and 8 hrs. A 9.63 % weight loss was measured during 2 hr of the treatment with a drop of hemicelluloses content from 22 to 12.90 %. The tenacity and modulus of treated fibres improved by 45 % and 79 %, respectively, and the breaking strain was reduced by 23 % after 8 hr of the treatment. The crystallinity of the fibres increased only after 6 hr of the treatment. Nishino et al. [38] investigated the influence of silane coupling agent on kenaf fibre-reinforced PLA. The stress on the fibres in the composite under transverse load was monitored in situ and non destructive methods using X-ray diffraction. Pothan et al. [39] reported the influence of chemical modification on dynamic mechanical properties of banana fibre-reinforced polyester composites. A number of silane coupling agents were used to modify the banana fibres.
Zulkifli et al. [40] studied the effect of chemical treatment on the interlaminar fracture toughness of woven silk composite. The results give the indication of the effect of the fibre surface treatment and number of layers because the thicknesses of all the specimens are the same. Rafah [41] investigation reveals that the chemical treatment improved the dielectric strength and thermal conductivity by about 29.37 % and 139 % respectively compared with untreated fibre composites. Finally, the dielectric constant value of the treated fibre composite was found to be lower than the untreated fibre composite and virgin unsaturated polyester.

Kalia et al. [42] have done a review work on pretreatment of natural fibre and suggests that the graft copolymer of natural fibre with vinyl monomers provide better adhesion between matrix and fibre. Maheswari et al. [43] have studied a comparison between modified and unmodified high density polyethene/borassus fibre composite. They found that fibre matrix interaction is strong in modified fibre as compare to pure one which is supported by enhanced mechanical properties of the natural fibre.

Liu et al. [44], reported to modify the surface of jute fibre mat by sodium hydroxide and maleic anhydride in propylene emulsion method and micromechanical properties of jute fibre mat. They have found that the surface of jute fibre mat have been very effective in improving fibre-matrix adhesion. The result has demonstrated a new approach to use natural materials to enhance the mechanical performance of composites.

Corderio et al. [45] investigated the surface properties of chemically modified natural fibre using inverse gas chromatography on natural fibre like eucalyptus, bagassee and wheat straw with 1% NaOH. The result shows that alkaline treatment achieves the overall improvement in the properties of natural fibre composite.

Ahad et al. [46] studied the chemical treatment on banana fibre with 5%, 10%, 15% NaOH and found that the treated fibres has good mechanical strength as the surface of the fibre is chemically bleached and modified with the alkaline treatment. Kundu et al. [47] treated natural fibre to synthesize the concrete composite from jute fibre which provides high mechanical performance to the natural fibre composites. Mohammed et al. [48] have studied the effect of surface treatment on some mechanical properties of sisal fibre using alkaline treatment method with NaOH at different
concentrations and time at a constant temperature of 65°C. The surface morphology and characteristics of the treated and untreated sisal fibre samples was studied using Scanning Electron Microscope (SEM). The result shows that, the extent of surface modification depends on the concentration of NaOH solution and time of treatment. The changed fibre surface properties observed from SEM images of the treated sisal fibres were responsible for better adhesion.

2.3 Literature review on effect of solute-solvent and solvent-solvent interaction on natural fibres

To study the different physical properties of natural fibre, it is very fundamental concept for every composite designer is to study the nature of matrix-fibre interface as this interface has a vital role in binding of fibres. The presence of pendant and polar –OH group in cellulosic material and its activity can be well studied by analysis of different blended solution in light of their solute-solvent and solvent-solvent interaction. In survey of literature it was found that all most all chemical treatment on surface of natural fibre has been done on trial basis and studying their physical properties. Thus, to use particular set up blending chemical, it is an important step in synthesis of composite industry and composite engineering to study the pair of compatibility liquid mixture for surface modification/surface bleaching of chemicals. This compatibility can be well studied with the help of study of intermolecular interaction between the selected pair of liquids. This intermolecular interaction between the blended chemicals can be well studied with the help of different acoustic parameters.

Shukla et al. [49] reported the solvent-solvent interaction well explained inverse gas chromatography on the basis of study of different physical properties like surface tension, dielectric constant, refractive index isothermal compressibility and different thermodynamic parameters in dimethyl sulphoxide-water system. Pratt[50] has studied effects of solute-solvent attractive forces hydrophilic correlations and found that hydrophobic characteristics are sensitive to relatively long range slowly varying interactions. Souvignet et al.[51] established significant interaction between methanol and Carbon dioxide mixture which explains how solvent-solvent and solute-solvent interaction plays
vital role to analyze the different acoustic parameters. Rank and Baker [52] have studied the contribution of solvent-solvent hydrogen bonding and van der Waal interaction in mixture of methane and water and has concluded that the hydrogen bonding in a compatible solvent mixture has greater contribution to make the hydrophilic nature into hydrophobic one.

Kharat [53] has studied ultrasonic velocity and density in solution of maleic acid and tartaric acid with water and discussed the acoustic parameters in terms of intermolecular interaction. This provides the basis of solute-solvent interaction. Kim et al. [54] reported the sonochemical activities produced from sonoreacter and describes the effect of sono chemical reaction in liquid system when ultrasonic wave allowed passing through the sample contained in the container

2.4 Literature review on composites of natural fibres

The idea for composite material was coming to the technology begins in midway of 20\textsuperscript{th} century, particularly natural fibre-reinforced plastics which have gained increasing attention of researchers and manufacturers [55]. The increased interest in natural fibre-reinforced composites is due to the high performance in mechanical properties, significant processing advantages, excellent chemical resistance, low cost and low density. They have long served many useful purposes but the application of material technology for the utilization of natural fibres as reinforcement in polymer matrix has taken place in recent years. Biocomposite consists of a polymer as the matrix material and a natural fibre as the reinforcing element. The use of fibres derived from annually renewable resources, such as reinforcing fibres; provide positive environmental benefits with respect to ultimate disposability and raw material utilization. Recent studies indicate that plant-based natural fibres can be used as reinforcement in polymer composites, replacing the expensive and non-renewable synthetic fibres such as glass, because of their potential for recyclability [19]. Vegetable fibres can serve as excellent reinforcing agent for plastics because of their moderately high specific strength and stiffness which is used as reinforcing materials in polymeric resin matrices to make useful structural composite materials [55]. Cellulose based natural fibres are a potential resource for making low cost composite materials. Cellulosic fillers of a fibrous nature have been of greater interest,
because they would give composites with improved mechanical properties compared to those containing non-fibrous fillers. Lignocelluloses fibres like jute, sisal, coir, and pineapple have been reportedly used as reinforcements in polymer matrix [55].

Mwaikambo et al. [56] evaluated the physical and mechanical properties of the natural fibre composites to assess their serviceability. They concluded that the presence of lignin in the untreated hemp fibre offers additional cross linking sites and the untreated fibre surface is more compatible with Cashew Nut Shell Liquid resin) than alkali treated surface. Joshi et al. [57] studied comparative life cycle assessment of natural fibre and glass fibre composites where they concluded the superiority of natural fibre over the glass fibre. Ndazi et al [58] was also studied the plant based composites and suggest their advantages and superiority over other polymer based composite.

Bax et al. [59] investigated the mechanical properties of PLA reinforced with cordenka rayon fibres and flax fibres, respectively. A poor adhesion was observed using Scanning electron microscopy analysis. The highest impact strength and tensile strength were found for cordenko reinforced PLA at fibre proportion of 30%. Saw et al. [60] have studied thermo mechanical properties of jute /bagaasse hybrid reinforced composites modified by alkali and furfural alcohol and the result shows, the chemically treated fiber have better thermo mechanical properties due to fibre matrix interactions.

Lau et al. [61] have studied importance of different natural fibre and composites made from it. They also provide the information about mixing of different natural fibre with biodegradable and bio resorbable polymers and their application in different area. Alawar et al. [62] prepared the treated date palm tree fibre as composite reinforcement and find alternative reinforcements and resin systems that are environmentally friendly. This study investigates the effect of different treatment process on the date palm fibre (DPF). Raw DPF underwent different surface modification methods such as alkali treatment with concentrations 0.5%, 1%, 1.5%, 2.5% and 5%, and acid treatment with 0.3, 0.9 and 1.6 N. All treatments were performed at 100°C for 1 h. The surface morphology, thermal gravimetric analysis (TGA), Fourier transform infrared spectroscopy (FTIR), mechanical properties and chemical analysis, of treated DPF were
investigated. Specimen treated with 1% NaOH showed optimum mechanical properties. Hydrochloric acid treatment resulted in deterioration in mechanical properties

Sbiai et al. [63] prepared date palm tree composites in a resin transfer molding process and they can conclude that there is no enhanced fibre matrix interface observed in material during the processing. Favaro et al. [64] have performed chemical, morphological, and mechanical analysis on composites of sisal fibre with polyethylene. The sisal was mercerized with NaOH solution and acetylated and shows improved mechanical performance of treated fibre composites.

Santos et al.[65] have studied the surface morphology of sisal fibre treated with aqueous solution of NaOH at a concentration of 3% and the result shows an increase of 27% in flexion strength and 54% in maximum strain but there was a reduction of about 15% in its flexural modulus. Mantia et al.[66] have done a review paper on green composites prepared from different renewable sources which are biodegradable. The review results briefly illustrate the main path for processing of green composites, additives or chemical modification of fillers. López et al.[67] have prepared polypropylene-based composites reinforced with three types of randomly distributed short lignocelluloses fibres, namely mechanical pulp (MP), deinked pulp (DIP), and jute strands, were prepared and analyzed. Addition of 6% (wt/wt) of MAPP resulted in a significant enhancement in the tensile strength in line with the improvement of the fibre-matrix interfacial adhesion making more effective the transfer of stress from the matrix to the rigid reinforcement.

Kittikorn et al.[68]established the comparison of water uptake capacity of oil palm fibre of untreated and treated fibre with alkali. The results confirm that the fibre treated with alkali has less water content making fibre becomes hydrophobic from hydrophilic nature. They also demonstrated that surface morphology micrograph have increased surface roughness after treatment due to removal of lignin. Zhu et al. [69] described flax fibre reinforced composites with different fibre treatment such as mercerization, Silane treatment, acylation, peroxide treatment and coating for the enhancement of flax/matrix incompatibility. The review report provides the information
that anhydride treatment is very efficient way to improve the flax/PP adhesion and hence the mechanical properties.

Higondo et al.[70] have prepared natural rubber composites using maize stalk as reinforcement chemically modified with acetic anhydride. The results show that compatibility increases with the hydrophobic rubber polymer matrix. The treated fibre shows less moisture absorption and higher resistant to hydrothermal aging.

Swain et al. [71] reported the effective mechanical properties of Polyvinyl alcohol biocomposites with reinforcement of date palm leaf fibres. Different chemical processes of modification were adopted and the tensile strengths of both treated and untreated fibres were compared. It was noticed that the tensile strength of acrylic acid treated fibre was optimum in comparison to other methods. Faruk et al .[72] has prepared the review paper which provides an overview of natural fibre reinforced composites focusing on natural fibre types and sources, processing methods, modification of fibres, matrices (petrochemical and renewable), and their mechanical performance.

Rosalan et al.[73] have studied the synthesis of resol type phenolic resin was synthesized from oil palm EFB fibres via liquefaction process using phenol and sulfuric acid, followed by resinification reaction with formaldehyde in alkaline condition. The result shows that the increase of the ratio of formaldehyde to liquefied EFB ($F/L_{EFB}$) increases the viscosity and molecular weight of the produced PF resin and the results confirms that the chemical treatment has a good impact on shear strength of resin.

Zainudin et al. [74] have fabricated the hybrid composites by compounding process with varying the relative weight fraction of oil palm empty fruit bunch (EFB) and coir fibres to assess the effect of hybridization of oil palm EFB with coir fibres in polypropylene (PP) matrix. The results show good results for the hybrid biocomposites material. Alomayri et al. [75] have studied cotton fabric (CF) reinforced geopolymer composites are with fibre loadings of 4.5, 6.2 and 8.3 wt%. Results show that flexural strength, flexural modulus, impact strength, hardness and fracture toughness are increased as the fibre content increased.

Sunija et al [76] have studied the Polyurethane composites prepared by reinforcing raw treated with silane .Results showed that composites had better mechanical properties compared to the non reinforced matrix. The paper suggests that
Thepesia populnea fibres have immense scope as reinforcement in the composite industry. Pappu et al.[77] summarized the banana residues and fibres as composites. The quality and quantity of biological macromolecules especially the cellulose, hemicellulose, lignin, wax, engineering and mechanical properties of banana biofibre resources are reported and discussed. Thakur et al.[78] comprehensively reviewed the potential efficacy of lignin in biopolymer based green hydrogels with particular emphasis on synthesis, characterization and applications.

Oqla et al. [79] have prepared a review paper on conductive polymer composites filled with natural fibres. The effects of fibre contents, fibre size, chemical treatment, temperature and moisture content on the dielectric properties of the conductive composites were reviewed. On the other hand, it was reported that relatively short natural fibres could modify the dielectric response of the polymeric matrix, but chemical treatment had negative effects on such composites and could decrease the dielectric loss factor.

The use of natural fibres as reinforcement in polymer composites is attracting much interest due to its potential mechanical properties, processing advantages and environmental benefits. However, the hydrophilic nature of the fibres lowers the compatibility with the matrix which results in poor mechanical properties of the composites. Chemical treatment is an essential processing parameter to reduce the hydrophilic nature of the fibres and thus improving adhesion with the matrix. Pre-treatments of fibre change its structure and surface morphology. Hydrophilic hydroxyl groups are removed from the fibre by the action of different blended chemicals. The quality and performance of plant based composites can further be improved by adopting appropriate engineering techniques. Research on natural fibre composite is still relatively new. It is clear that improvements must be made if natural fibres are to compete with synthetic fibres on the composite market. The adhesion between the fibre and the matrix, the processing of the fibres and the structure of the fibres are examples of areas that need to be studied in more detail. The adhesion between the fibres and the matrix is crucial to all fibre composite materials. If the adhesion is good, stress is transferred between the load carrying fibres over the matrix, which makes the material strong and stiff. Significant improvements in the mechanical properties of the composites are reported by using different chemical treatment processes on the reinforcing fibre. Most research
reviewed indicated the effect of alkali treatment, isocyanate treatment, acrylation, latex coating, permanganate treatment, acetylation on the fibre-reinforced composite. Only few studies in literature were related to study of compatibility of blended solutions which are having enough efficiency in converting hydrophilic to hydrophobic nature. Thus this thesis work presents a better understanding of the study of the property of blending solutions in terms of their intermolecular interactions present in the blended solution.

The literature survey indicates that there no such basic study has been done in the composite technology to study the compatibility of the blending solution for surface treatment/bleaching of the natural fibre. The lack of idea of compatibility of blended solution in synthesis of composite material from natural fibre is a greater challenge for the composite technology.

Thus the work embedded in the thesis is based on the study of compatibility of different blended solution which can be well described in terms of intermolecular interaction occurs in blended solution due to propagation of ultrasonic wave. The different blended solution taken by the author into study of compatibility is

1. Acetone blended alcohols
2. Acrylic acid blended alcohols
3. Maleic acid blended alcohols
4. Tartaric acid blended alcohols
2.5 Scope and objective of the work

Natural fibres reinforced composite has special interest in academic & industrial point of view. The use of natural fibre with polymer, bio-polymer & other types of composites is to make the material biodegradable and eco-friendly. Natural fibres are more compatible with polymeric matrix when it will be free from lignin & other unwanted components otherwise lignin content in natural fibre may act as a scavenger during formation of composites. Further composite may be tough and brittle due to presence of these unwanted materials. Therefore chemical modification of natural fibres is high necessary for enabling the fibre as filler during the formation of composites. Chemical modification of natural fibre can be done by various traditional methods, however choosing of compatible blending of liquids is highly important to get better modification.

The series of blends of alcohols and organic carboxylic acids are important blending for modification; it is because most of the volatile substance and lignin are soluble in alcohols. Organic acids can be chosen for esterification of the hydroxyl group present in the surface. Hence compatibility of alcohols with various mono or di-carboxilic acids is important before choosing the blends for chemical modification of natural fibres. In literature review it is noticed that number of publications are reported regarding blending of organic inorganic solutions and study of their suitability for chemical modification. However the blending of alcohols with different chain length with various carboxylic acids for studying their compatibility is scanty in literature. Again the study of suitability of blend for natural fibre modification is an attempt in the literature.

In the present thesis we are motivated to study the blending of alcohols of different chain length with acetone and carboxylic acid. Among alcohol Methanol (Metha), Ethanol (Etha), Propanol (Propa) and Butanol (Buta) are chosen for our whole investigation. Acetone and carboxylic acids such as acrylic acid, maleic acid and tartaric acid are taken in four different chapters. The effect of different chain length of alcohols with acetone and carboxylic acid is studied. The ultrasonic wave being a high frequency wave it can interact with the matter directly. As the propagation of ultrasonic wave through a medium causes cavitations, nucleation, growth and violent collapse of
microscopic bubbles whose effects bring about the processes of sonochemistry. Owing to high sensitivity to very low population densities at high energy states, ultrasonic methods have been preferred, and are reported to be complementary to the other techniques like dielectric relaxation, infrared spectroscopy, nuclear magnetic resonance, etc. High reliability and scale ability as well as low maintenance costs and high energy efficiency make ultrasound a promising contender for established liquid processing equipment. Ultrasonic velocity and density are measured by standard techniques mentioned in other part of the thesis. The acoustic parameters such as adiabatic compressibility, acoustic impedance, intermolecular free length and bulk modulus are measured with their excess values. From plot of data & comparison the compatibility of various spare of organic liquids studied. The prediction of compatibility is proposed to be a suitable chemical for surface modification of natural fibre.

The main objective of the present investigation may be summarized as follows,

- Study of compatibility of blends of liquids.
- Study of effect of chain length of alcohol during their blending.
- Study of chemical interaction of various carboxylic acids with alcohols of different chain length.
- Calculation of different acoustic parameter such as adiabatic compressibility, acoustic impedance, intermolecular free length and bulk modulus are measured with their excess values.
- To determine solvent interaction solute-solvent interaction and solute-solute interaction during the formation of blends.
- Removal of lignin unwanted targeted materials through chemical modification with suitable blends.
- To modify some of the selected natural fibres such as date palm, sisal, flax.
- The comparison of surface morphology of natural fibre and after modification through electron microscope.
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