Original Research Paper

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Engineering

Impact strength of Neem,Mango and,Cork Wood polyacrylonitrile composites.

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ABSTRACT Wood polyacrolonitrile composite (WPC) from neem,mago,cork woods weresynthesized. The process was carried out through benzoylperoxide(0.05mol\l)catalyzed impregnation polymerization of acrylonitrile,4mol/l,6mol/l into neem,mago and cork woods in benzene medium at 75+-1^{0}c.The properties of WPC over untreated wood was evaluated in terms of impact strength. Impregnation of polyacrlonitrile (PAN) into neem,magoand cork woods were confirmed through scanning electron microscope.

KEYWORDS : benzoyl peroxide, Polyacronitrile, impregnation

1. INTRODUCTION:

Wood polymer composites (WPCs) results from the polymerization of liquid monomers already impregnated in wood. In principle WPCs should display super mechanical properties; dimensional stability to chemical degradation and less moisture absorb temperature than non-impregnated wood. A number of wood preservatives developed during those wood treatment processes and are under continuous demands which can develop the modified wood materials with improved mechanical strength, thermo-oxidative stability and resistance biodegradation for the better outdoor applications

Polymerization of polyacrylonitrile into poplar wood has also been reported and the composites indicated excellent moisture resistance and thermo oxidative stability [1,2]. Temperature affects physical, structural properties of wood. Several affects have been made to establish the relationship between temperature and thermal stability of wood [3,4,5,6].The physical and mechanical properties of wood may be improved by preparing composites of wood with vinyl monomers [7]. Reinforcement of several monomers like styrene, methyl methacrylate has provided substantial thermal stabilities to different types of woods[8,9].However, since most vinyl monomers are non-polar; there is little interaction between these monomers and hydroxyl groups of the cellulose fibers. Wood, a renewable resource and naturally occurring material abundantly available has a wide range of applications as construction material ,pulp,paper,fireboard products as well as source of energy and as raw materials for various industrially important chemicals. The advantage of impregnation at normal conditions is the large quantities of samples of various sizes and shapes can be conveniently impregnated compared to vacuum impregnation [8].

2.Experimental

2.1Materials

All the chemicals and solvents (AR) were purchased from M/S SDFCL Chemicals Ltd; Mumbai. The monomer acrylonitrile was purified by extracting it with aqueous NAOH (10%) to remove inhibitor contents fallowed by repeated washings with distilled water. The fraction at 780C was used for the impregnation polymerization reaction. Other chemicals and solvents were used without further purification.

2.2 Sample Preparation :

Wood specimens were prepared as per IS:1708-1986.The moisture content of wood was deduced according to ASTMD1037-72a and was found to be 12.75%.

2.2b Impregnation Procedure:

the Benzene solution of acrylonitrile at concentration of 4M ,6Moles and Benzene solution of benzoylperoxide at0.05M have also been prepared. Samples were then placed into an impregnation chamber. Some loads were applied on the samples before impregnation so that no flotation occurs. The appropriate monomer system was then introduced through a dropping funnel and the specimens were left immersed while atmospheric pressure was reached and allowed to stand for up to 24H(ASTMD-1413-61).Treated wood specimens were then wrapped in commercially available Al foil and cured in oven at 950 C for 2H to induce the impregnation polymerization reaction. Impregnation of polyacrylonitrile into cork wood was confirmed through scanning electron microscopy.

Figure 1. Polymerization Process

3. Measurement

3.1Impact Test

The impact strength tests have performed according to the dimensions of specimen as per IS: 1708-1986 .Specifications of the equipment are Impact energy is 0-21.68 Joules. Release angle of pendulum is 150°. Minimum resolutions on scale are 0.02 Joules, 0.05 Joules, 0.1 Joules &0.2 Joules respectively. Hammers are 2 numbers of hard chrome plated hammers one each for Izod & Charpy tests. Hard chrome plated vise for Izod & Charpy tests. Impact strength Test is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given materials toughness.

Fig.1Experimental setup for impact strength test

3.2SCANNING ELECTRON MICROSCOPE (SEM)

Electron micrographs of Neem, Mango and Cork woods &their Polyacrylonitrile (PAN) reinforced wood composites are scanned on HITACHI 3400N SEM The morphologies of composites are studied in view to get a clear understanding about the affinity of polyacrylonitrile (PAN) with their respective woods.(Viz.Cork,Neem&Mango).

Details of SEM Equipment are 3.0nm High Vacuum Mode, F4.0

Variable Mode Resolution. Solid state, TV rate observation Detectors. Fully eccentric 5 axis computer controlled moralized stage. Hitachi's Quad variable gun bias and SE accelerator plate ensures high currents for low voltage applications .S-3400 offers advances in automation including full filament saturation and "no touch" objective aperture alignment.

4.Resuts and discussions

4.1Impact Strength

ASTMD 256 the Izod striker and bushes of the hammer side plates in respective position. With the striking hammer in the safest position firmly hold the wood specimen in machine wise in such a way that the notch faces the hammer and is half inside and half above the top surface of the vice. Bringing the striking hammer to its striking position in also lock it at this position. Bringing the indicator of the machine to zero then released the hammer. It has felt down due to gravity and broken the specimen through its momentum. The notch strength ak is determined according to the relation $^{a}_{k} = \frac{A_k}{F_o}$ and is indicated in kg m/cm2. There is A_k the impact energy absorbed on rupture of the specimen in kgm. F_o the cross section of the spacemen below the notch before the test in cm2. The test were carried out as table .1 for impact strength of untreated and PolyAcrylonitrile PAN reinforced Cork, Mango and Neem wood composites at 0M, 2M, 4M & 6M. It has been observed from tables that there is marginal enhancement of the impact strength in all the said wood composites with their concentration

Table.1The impact strength Ak of Cork wood composite solution

S.No	Concentration	Cork(Impact strength x 10^{-5}) (Joule/m^2)	Mango(Impact strength x 10^{-5}) (Joule/m^2)	Neem(Impact strength x 10^{-5}) (Joule/m^2)
1	0M	10.8	20.73	21.54
2	2M	15.88	25.26	24.52
3	4M	20.35	30.85	30.68
4	6M	28.36	38.63	36.35

4.2Scanning electron microscope (SEM):

For SEM investigations, the raw wood sample in each case of Neem, Mango and Cork was considered as an untreated sample, while the polyacrylonitrile impregnated (in 2M, 4M and 6M concentrations) and polymerized (at 95-105 oC) wood-polymer composites (WPC) were considered as treated samples at their respective concentrations. The observed micrographs for each wood/WPC at different concentrations were compared and an attempt has been made to understand the possible interactions at the interfaces of the wood and polymer taking into account the wood surface structure and concentration of the impregnated polymer solution.

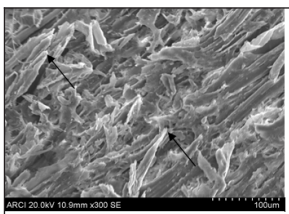

Fig. 2.1 Microscopic view of untreated Mango wood

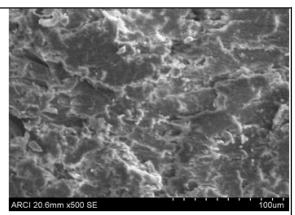

Fig. 2.2 Microscopic view poly acrylonitrile wood 2M concentration treated Mango wood

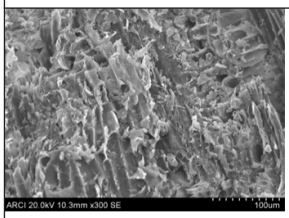

Fig. 2.3 Microscopic view poly acrylonitrile wood 4M concentration treated Mango wood

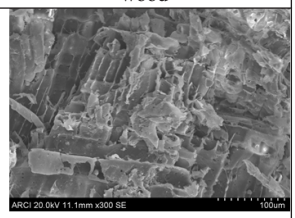

Fig. 2.4 Microscopic view poly acrylonitrile wood 6M concentration treated Mango wood

Mango

SEM micrographs of the untreated and treated mango wood/WPC samples are shown in Figs.2.1 to Fig.2.4. The surface structure of the untreated mango wood sample is characterized by cells that are tubular, elongated, pointed and closed at the ends. The cell walls appear to constitute wax like substances such as cellulose, hemicellulose and lignin and their interfaces seem to be ready for interaction with the impreganating polymer. Also, the interiors of the cell walls, which could be cellular lumen, are empty and can be easily filled with impregnating polymer provided the concentration and its degree of penetration ensures for such a compatibility[10]. That means, the impregnation capability is obviously more for low concentrations of polyacrylonitrile to fill the cellular lumen comprising voids, and this interpretation is well supported by the micrograph of mango WPC at 2M concentration. It can be clearly seen from the Fig.2.2 that the cellular lumen voids are completely filled and even the cell walls are also impregnated to a large extent leading perhaps to increased density and compression strength of the resulting treated wood polymer. It can be inferred from the above that the impregnation is uniform at low concentrations of polymer. Even though, the image contrasts however are clearly marked with dark and bright patches which indicate the unevenness at the surface and can be understood as regions of filled voids and cell walls, respectively.

As the concentration of the polyacrylonitrile increases, it naturally decreases the degree of penetration into the creeps or voids but at the same time increases the possibility to have a better interaction with the cell walls due to their wax like nature. This leads to a situation of non-uniform impregnation and is well demonstrated by the image at 4M concentration (Fig. 2.3) in which the contrasts are largely representative of cell walls while leaving most of the voids partially covered leading to increased roughness of the surface[11]. Further, the image at 6M concentration (Fig.2.4) appears well covered with impregnation all over the surface with a flake like cell wall structures. Perhaps, the voids which can not be seen in this sample might have left uncovered without any penetration of this high concentrated polymer. It would be interesting to examine the fractured surface of this sample to ensure that the observations are in commensurate with the arguments made above.

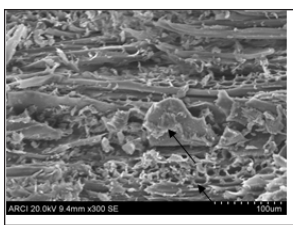

Fig. 3.1 Microscopic view of untreated Cork wood

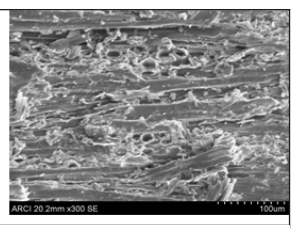

Fig. 3.2 Microscopic view poly acrylonitrile wood 2M concentration treated Cork wood

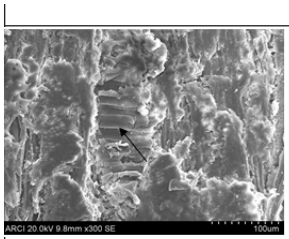

Fig. 3.3 Microscopic view poly acrylonitrile wood 4M concentration treated Cork wood

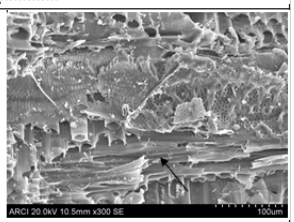

Fig. 3.4 Microscopic view poly acrylonitrile wood 6M concentration treated Cork wood

Cork

SEM micrographs of the untreated and treated cork wood/WPC samples are shown in Fig.3.1 to Fig.3.4. The microstructure of the untreated cork wood sample is characterized by round and needle like cells that are composed of more varying shapes and sizes. More over, the cell walls with cellulose, hemicellulose and lignin appear uneven thus leaving scope for better impregnation. The cellular lumen shows some round pores and they can of course be easily filled with impregnating polymer at low concentrations. Accordingly, the cork WPC sample at 2M concentration displays more or less uniform impregnation, as shown in Fig.3.2, by penetrating into the pores and cell walls equally well. In addition, it can also be inferred from the image that the surface roughness is much improved which is an indication of the level of impregnation. However, at higher concentrations of polyacrylonitrile cork WPC samples, the situation is altered for the reasons discussed above and the polymer will have an

increasing possibility to interact better with the cell walls rather than voids and pits[12]. This eventually leads to non-uniform impregnation and the cell walls are dominated with flake like structures as shown in Fig.3.3 and Fig.3.4 for 4M and 6M polyacrylonitrile concentrated cork WPC samples, respectively[13].

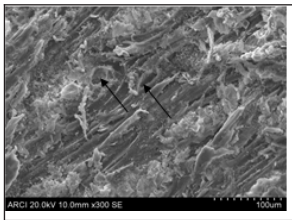

Fig.4.1 Microscopic view of untreated Neem wood

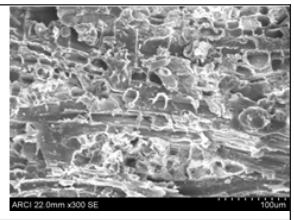

Fig.4.2 Microscopic view poly acrylonitrile wood 4M concentration treated Neem wood

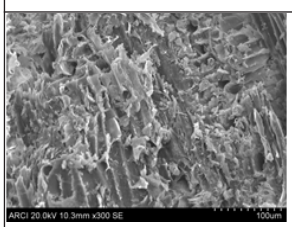

Fig. 4.3 Microscopic view poly acrylonitrile wood 4M concentration treated Neem wood

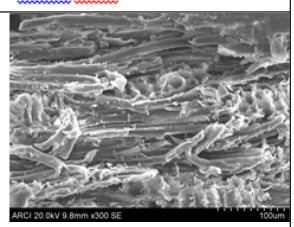

Fig. 4.4 Microscopic view poly acrylonitrile wood 6M concentration treated Neem wood

Neem

SEM micrographs of the untreated and treated neem wood/WPC samples are shown in Fig.4.1 to Fig.4.4. It can be seen from the images that the surface structure of the untreated neem wood sample is characterized by cell walls that are long and narrow, with pointed and closed ends reflecting the nature of fibres [11].Besides, in between the intercellular spaces there appears some regions of thin walled parenchyma occupying substantial part of the volume of the neem tissue. Inside the parenchyma, some small round parenchyma cells with varied dimensions and thin walls are also present. Interestingly, voids and pits are not much occupied in the surface structure of this sample. Under these conditions, impregnation in all the concentrations of polyacrylonitrile is uniform and the surfaces are dominantly characterized by parenchyma cells in the 2M concentration and thereby transforming towards the cell structure prominence in the 6M concentration[14].

CONCLUSIONS:

The Impact strength of Neem,Mango,Cork woods and their PolyAcrylonitrile PAN reinforced wood composites were tested as discussed. These tests indicate that the Impact strength of woods increased as the concentration of PolyAcrylonitrile PAN increased. Composites were improved in comparison to untreated neem,mango woods.Scanning microscope(SEM) indicated non-uniform distribution of polyacronitrile into wood lumens .

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