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Detrmination of Wear Resistance of Neem, Mango and Cork Wood Polyacrylonitrile Composites

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Abstract - Wood has long been used by the plastics industry as in expensive filler to increase strength and stiffness of the thermo plastic or to reduce raw materials cost. Wood Polymer composites consist primarily of wood and thermoplastic polymers. The commercial successes of these materials have been primarily by the promise of improved moisture performance, recycled and waste material utilization and efficiency in product and process design. Wood polyacrylonitrile composite (WPC) from neem, mango and cork wood was synthesized. The process was carried out through benzoyl peroxide(0.05mol/l)catalyzed impregnation polymerization of acrylonitrile,4mol/l,6mol/l into neem wood cork wood and mango wood in benzene medium at 75+-10c. The properties of WPCs over untreated woods were evaluated in terms of wear resistance test of wood was improved with impregnation of polyacrylonitrile .Impregnation of polyacyrlonitrile (PAN) into neem, mango and cork woods were was confirmed through scanning electron microscope.

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I. 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,fire board products as well as source of energy and as raw materials for various industrially important chemicals. Considerable work has been done on the modification of wood [10].Meyer(1981)[11] reported that wood treated with vinyl type monomer followed by curing(radiation or catalyst)significantly improves the moisture resistance, hardness etc. 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]. Thermo gravimetric analysis (TGA) is one of the major thermal analysis techniques used to study the thermal behavior of carbonaceous materials. The rate of weight loss of the sample as a function of temperature and time is measured to predict thermal behavior of the materials. Thermal analysis as TG has become the polymer characterization method the most frequently used.The TGA is particularly more adopted for mass variation study.In this work,we studied the process of degradation of wood poly acrylonitrle composites.compressive streangth of imprenated eucalyptus wood specimens is greater than that of non impregnated ones indicating that monocomponent polyurethane resin can be considered for impregnated impregnating wood[12].In thermo gravimetric list thermal decompositions of rice husk floor from room temperature to 3500 was similar to that of wood floor.Thus rice husk floor was thought to be a substitute for wood floor in agricultural lignocellulosic fiber-thermoplastic polymer composites in the aspect of thermal decomposition[13].Physical and mechanical grown A auriculiformis of three different ages(8,12,13 years)from sirsi,Karnataka indicate that the wood can be used for tool handles in work shops and factories and agricultural sectors ,light packing cases[14].The mechanical stability of cedar wood samples were

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increased by using P(AGE/AN),P(AGE/MMA) copolymers.[15].Polymerization of polymethyl methacrylate and acrylonitite into Block Berry Wood has also been reported and composites indicated excellent wear stability and thermo oxidation stability[16].Polymerization of acrlonitrile into Indian Cork wood has also been reported and composites indicated excellent compressive resistence and thermal stability[17]. The effect of moisture content on mechanical properties of wood polystyrene composites in relation to their mechanical properties was studied[18].. A number of composites have shown improved dimensional stability and mechanical properties and proposed that they could replace the quality woods in high grade products[19]. Better tensile properties were observed in poly methyl vinyl methacrylate impregnated kadom and mango woods in presence of N-vinyl pyrrolidone tripropylene glycol diacrylale, trimethyloyl propane triacrylale, copper sulphate and urea [20]. Poly methymethacrylate was impregnated into low-grade woods in ligand paraffin, the composites so formed have shown increased hardness, impact strength dimensional stability and were proposed to be useful for tools and roofing [21].

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II. Experimental Methods

a) Materials

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 78^{0}C was used for the impregnation polymerization reaction. Other chemicals and solvents were used without further purification.

b) 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%.

c) Impregnation Procedure

The Benzene solution of acrylonitrile at concentration of 4M, 6 Moles and Benzene solution of benzoylperoxide at 0.05M 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 95^0 C for 2H to induce the impregnation polymerization reaction. Impregnation of polyacrylonitrile into neem,mango and cork woods were confirmed through scanning electron microscopy.

Fig.1 : Polymerization Process

III. Measurement

a) Wear Resistence

ASTMD10044 Model is used.The Vacuum control should be set high enough to remove abrading and abrasive particulars but not high enough to lift flexible specimens.

Fig. 2 : Experimental setup for Wear Resistence test.

The specimen of Neem,Cork and Mango woods and their PAN composites of 2M, 4M and 6M of 4 inches Round with ¼ inch center hole and holded it in holder of testing machine E100-125, tighten with S-21 extension nut. The abrasive wheels H – 18 calibrade used. the evaluation of wear is based on Weight loss method. The Taber wear index (rate of wear) is the loss in weight in milligrams per thousand cycles of abrasion for a test performed under resistance quality of the material

$$\frac{100mg.\times 1000\,cycles}{500\,cycles\,test} = 200\ TABLE\ WAER\ INDEX\ (Weight\ Loss\ Method)$$

IV. Results and Discussions

a) Wear Strength

ASTMD1044 model wear tester is used. In the wear test for specific materials it is assumed that, when possible, test should be conducted in an atmosphere in controlled humidity and 70-74 degrees Fahrenheit temperature. The samples have been conditioned in the test atmosphere for at least 24 hours before testing. The Vacuum control should be set high enough to remove abrading and abrasive particulars but not high enough to lift flexible specimens. The specimen of Neem,Mango and Cork woods and their PAN composites of 2.0 M, 4.0M and 6.0M of 4 inches circle with ¼ inch center hole and hooded it in holder of testing machine E100-125, tighten with S-21 extension nut. The abrasive wheels H – 18 calibrate used. The evaluation of wear is based on Weight loss method.

i. *Conditioning*

Specimens of untreated wood are dried to a moisture content of 7% or 8%t. Specimens should be seasoned for 24 hours or longer in the conditioned atmosphere of the laboratory at 50 percent relative humidity and 70 – 74 F temperature. Wear resistance tests of natural and PAN Wood has been made on the Abraser. Panels has selected for flatness, uniform thickness, and freedom from warp. Prepared the surface by sanding it smooth and free of indentations or other surface defects that might occur in the path of the abrading wheels. A special extension nut, S-21 is available for holding material ¼ to ½ inch in thickness. This nut requires a 3/8 inch center hole in the specimen in place of the usual ¼ inch hole. The section is the outline all the elements of a typical test procedure from analysis of the testing problem to final evaluation of results and mechanics of testing, the preparation and mounting of specimens, and the setup and operation of the Abraser is presumed.The value of the Abraser in research and control programs depends to a considerable extent of the test problem, the service requirements and the desired wear characteristics of the material examined. Time and material may be saved by analyzing this problem and planning procedure before embarking the use of Polycrylonitrile wood.

An air-conditioned test room is strongly recommended where reproducible precision results are required. Both heat and moisture affect the abrasion resistance of most materials, and particularly organic materials. Abrasion research projects are usually carried out in an atmosphere maintained at 70-75^{0}F temperature and 50 percent relative humidity. Without exception, samples which were to be tested should be seasoned in the test atmosphere for at least 24 hours. When tests were to be conducted. Temperature and humidity conditions has specified kept constant in all tests.It was essential that record of every phase of test procedure be kept for purpose of comparison and in order that the test may be exactly duplicated at any future time.

ii. *Selecting the method of evaluating test results*

Test Results are expressed as a wear factor / numerical abrasion index of the test specimen.The wear factor arrived at by one of the method of calculating results is not directly comparable. The method of calculating results should be expressed with the wear factor. The tests have been performed by Weight loss method.

When the results are to be compared with those of similar materials having nearly the same specific gravity. The Taber wear index (rate of wear) is the loss in weight in milligrams per thousand cycles of abrasion for a test performed under resistance quality of the material.

$$\frac{100mg.\times 1000\,cycles}{500\,cycles\,test} = 200\ TABLE\ WAER\ INDEX\ (Weight\ Loss\ Method)$$

iii. *Weighing the specimen*

Before Testing, Immediately before these tested on the Abraser, the specimen has been weighed to the nearest tenth of a milligram in a sensitive laboratory balance and the weight entered in the record.Accuracy of results depends on correct weighing of the specimen. A high precision analytical balance should be used and its accuracy periodically checked. Sufficient time should be taken to assure maximum accuracy in the weight determination.

After Testing,at the end of the abrading operation, clean the specimen thoroughly by brushing it free of any loose particles Weight the specimen in the same balance and with the same care as before testing and entered the reading to the nearest tenth of a milligram in the test record for calculating the wear factor (table 1 to table.3).

Table 1 : Wear index Tests of Neem Wood and its PAN Composites

S.No	Concentration	Taber Wear resistence mg/1000 cycles
1	0M	70.5
2	2M	48.4
3	4M	34.9
4	6M	30.0

Table 2 : Wear index Tests of Mango Wood and its PAN Composites

S.No	Concentration	Taber Wear resistence mg/1000 cycles
1	0M	70.5
2	2M	338.5
3	4M	187.7
4	6M	111.8

Table 3 : Wear index Test of CorkWood and its PAN Composites

S.No	Concentration	Taber Wear resistence mg/1000 cycles
1	0M	347.3
2	2M	438.2
3	4M	94
4	6M	220.9

V. Conclusions

Results of these tests demonstrated that the Mechanical properties of impregnated wood specimens are greater than that non impregnated ones. .The wear resistance of the Polyacrylonitrile(PAN) reinforced wood composites is increased.Due to increase of Polyacrylontrile Concentration Weight loss decreases.

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