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EVALUATION OF MATERIAL COMPATIBILITY, THERMAL DEGRADATION AND MECHANICAL PROPERTIES STUDY OF THE PLY BOARD BY USING WOOD PROTECTOR SCAPO[R].

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ABSTRACT
The study was aimed to evaluate the chemically compatibility, thermal degradation of Wood Protector **SCAPO[R]** (An eco- friendly) as glue line preservatives (GLP) as well as the mechanical properties of the plywood made by using Wood Protector **SCAPO[R]** as a glue line preservative. 12mm Plywood samples at different concentration (0.5% to 5%) preservative were manufactured randomly by using Wood Protector **SCAPO[R]** as a glue line preservative with combination of different wood veneer species and taken for mechanical properties study like MoR,MoE,GSS,Tensile strength etc. To assess the chemically compatibility Wood Protector **SCAPO[R]** was added with both phenolic and amino resin at different concentration (0.5% to 5%) and adhesive properties was studied .The test results shows that there was no adverse effect of the GLP on the adhesive properties like PH, bonding, rheological properties and shelf life for manufacturing of wood composites. To carry out the thermal degradation study of the glue line poison Wood Protector **SCAPO[R]** of 1% was mixed with resin and DSC – TGA study carried. The mass loss (%) Vs. temperature graph was plotted to assess the degradation study of the Wood Protector **SCAPO[R]** .The analysis data shows the material was not degraded before the temperature 240 to 250^{0}C which is appx. 100^{0}C more than the normal operating temperature to manufacturing of wood composites .The result of MoE, MoR, Glueshear strength test at 1.5% to 3% concentrations also show satisfactory limit of acceptance as per Indian standards.
Key words: - Wood Protector **SCAPO[R]**, MoE, MoR, Glueshear strength. Thermal degradation, DSC – TGA, chemically compatibility

INTRODUCTION
Wood is a lignocellulosic material and liable to degradation due to wood destroying organisms. The improved utility of wood has been the sole purpose of wood preservation. Wood preservation can increase greatly the serviceability of wood and with the supply of wood being limited, it has become necessary to protect wood from biological deterioration. Many workers have made numerous attempts to impart durability to wood by treating it with natural and synthetic chemicals.(Purushotham, 1970) The conventional wood preservative found to be very effective against wood destroying organisms, but they are said to cause environment pollution and are

hazardous to animals and human being (Fisher,1968).Over the past few decades there is much global awareness to develop eco friendly wood preservatives which does not impose any kind of health hazards to mammals. Green plants act as reservoirs of natural preservatives which are environment friendly and easily degradable than synthetic chemicals. To develop eco-friendly wood preservatives, many studies have been conducted. Work has been reported on extractives from heartwood (Onurah, 2000; Soni, 1975; Gupta and I.Dev, 1999), work has also been reported on extractives from leaves of *Ipomeacarnea* (Saxena et al. 2002), bulb and leaves of *Sternbergiacandidum* (Goktas*et al.* 2007), leaves of Neem (Swathi et al. 2004). These extracts possess a number of toxic constituents exhibiting high toxicity against wood destroying microbes. Efforts have been made by many workers to use these plant products with toxic metals and tested for durability against termites and fungi (Jain and Virendra Narayan, 1991; Jain et al. 1989 & 1997; Purushotham & Tewari, 1961; Indra Dev & Nautiyal, 2004)

Cashew nut shell liquid (CNSL) is a by-product of cashew industry. It is obtained either by extraction in hot oil or in solvents or by mechanical expulsion from the shells. Cashew nut shell liquid is chiefly used in the preparation of synthetic resins. In addition to its main application in brake lining of motor vehicles, it is used for manufacturing heat and waterproof paints, corrosion-resistant varnishes, insulating enamels and different types of surface coatings. CNSL consists chiefly of naturally produced phenolic compounds-Anacardic acid (about 90%) and Cardanol (about 10%). Anacardic acid is a derivative of salicycylic acid, which readily decarboxylates on heating, to obtain anacardol or cardanol. The cardanol is a resorcinol derivative having a long unsaturated hydrocarbon chain (Cornelius, 1996). In its natural form, CNSL is reported to accord protection against termites and has water repellency (Lepage and Delelis, 1980). The fishermen are also reported to be using this for protection of boat and fishing nets (Anon, 1948). Such protection is however temporary, as CNSL as such, has not been found effective for the purpose of wood preservation (Purushotham and Tewari 1961). Bagchee (1950) in his toxicity studies of CNSL against wood rotters reported that the activity of fungus and also weight loss was less in CNSL-treated blocks than in untreated ones. Activity of the fungus was decreased with the increase of concentrations of CNSL. Due to its phenolic nature, this product can be used directly as an outstanding preservative for timber and textile against insect and fungus attack (Ohler, 1979).

Neem (Azadirachta indica) the large tree of India, has been used in our country and all over the world as anti- fungal, insectcide and termiticide and for many other medicinal uses and it is also used as medicine in ayurveda. And very part of the tree has different types of uses (Chaturvedi et al., 2003).

About Wood Protector SCAPO^{R}

Wood Protector **SCAPO^{R}** is a **registered** brand of **Wood Cure Enterprise** ,Bandel, Hooghly ,West Bengal ,India - A leading and popular **Glue Line Preservative/Poison (GLP)** among Plywood Industries producing Termite/Borer/Beetles/Ants /Insects **resistan**t-Plywood ,Block Board & Flush Doors using **Plantation Timbers** like Eucalyptus /Poplar/Melia

Dubia ,Rubber wood etc . **SCAPO^{R}** is an Eco-friendly recipe of **CNSL, AZADIRACHTIN, KALMEGH, KARANJ,CREOSOTE and some other Organic Extract** - is a Reddish brown- low viscous, with No pungent smell, neutral PH and is compatible with any type of Synthetic resin at high Temp (180-220 degC) , High PH (<12) media for making Engineered Panel and is friendly with Doctor Roller ,Human & Environment.

MATERIALS AND METHODS

For the experimental work under this project following materials were used

1. Wood Protector **SCAPO^{R}** supplied by M/s-Wood Cure Enterprise.
2. Phenol.Urea,Formalin etc. purchased from local market for resin synthesis.
3. Veneers
   Gurjun face veneer (Dipterocarpus spp.)
   Semul (Bombax ceiba)
   Eucalyptus
   Poplar

Evaluation of compatibility of resin (Phenolic and amino) with preservative :-

The preservative was added at six different concentrations starting from 0.5%, 1.0%, 1.5%, 2.0%, 3.0%, 4.0%, and 5.0% to both conventional phenol formaldehyde and urea formaldehyde resin to assess the suitability in resin without any adverse effect. Color, odour, PH, Pot life of the glue was studied .Observations were made after every one hour to see the consistency of the resin quality.

Preparation of samples:-

The samples for efficacy test were prepared according to IS: 4833:1993 for **termite** resistance. Test samples or plywood with 12 mm thickness were prepared from defect free air dried veneers of Semul wood (Bombaxceiba). Samples were of size 100 x 25 x 12 mm and were prepared for field test.

The samples for efficacy test for **borer** were prepared according to IS: 4873 (Part-II); 2008 for **Borer** resistance. Test samples or plywood were of size 100 x 40 x 12.5 mm were prepared from defect free air dried veneers of Semul wood (Bombaxceiba).

The samples for evaluation of moisture content, density, water resistance, bond quality (glue shear strength), adhesion of plies and mechanical properties (Modulus of rupture and modulus of elasticity) were prepared according to IS: 1734:1986. Sample sizes were 150 x 75 mm, 150 x 75 mm, 250 x 250 mm, 150 x 25 mm, 250 x 250 mm and 338 x 50 x 12 mm respectively.

Physico-mechanical study:-

The plywood samples made with glue incorporated with different concentration of Wood Protector **SCAPO^{R}** were tested as per IS 1734: 1986.

Thermal Degradation Study:-

Thermal degradation of polymers is molecular deterioration as a result of overheating. Degradation of material is extensive loss of useful properties. To carry out the thermal degradation study of the Wood Protector **SCAPO^{R}** as glue line poison, 1% Wood Protector **SCAPO^{R}** was mixed with resin and DSC – TGA study carried . The mass loss (%) Vs temperature graph was plotted to assess the degradation study of the wood protector.

RESULTS AND DISCUSSION

Physical and chemical Profile of Wood Protector SCAPO^{R} :-

The Appearance of the Wood Protector **SCAPO^{R}** is Deep Brown Viscous Liquid having some characteristic smell. It has been observed physically no etching or adverse effect on the human being during handling, however use of gloves /Specs during handling is advisable. When Wood Protector **SCAPO^{R}** was mixed with starting from the entire range from 0.5% to 5.0% it was observed that there was no adverse effect on the adhesiveness of the resin. It is fully compatible with both phenolic and amino resin.

Adhesive mix and pot life

Studies on pot life and pH of both UF and PF resin after addition of Wood Protector **SCAPO^{R}** from 0.5% to 5% based on the weight of liquid PF resin were studied. Addition of Wood Protector **SCAPO^{R}** was not changed the viscosity and pH of the resin up to 6 to 8 hours. From the study data reveals the incorporation of Wood Protector **SCAPO^{R}** in both amino and phenolic resin in glue lines shows no adverse effect on the pot life and pH.

Glue shear strength and resistance to microorganism

Results of the glue adhesion test are given in Table No. 1, which shows that the addition of Wood Protector **SCAPO^{R}** starting from concentration 0.5% to 5.0% in both amino and phenolic resin does not have significant adverse effect. Bond strength of plywood made by using UF resin and PF resin mixed with Wood Protector **SCAPO^{R}** at various concentrations were tested for glue shear strength in dry, wet and mycological conditions along with control samples. Average and minimum individual of the sample were tabulated in

Table No. 1. **Results of glue adhesion test for dry, wet and mycological state**

Preservative Concentration, %	**Glue Shear Strength, N**		
	Dry	**Wet**	**Mycological**
0.0	Avg: 1863 Min: 1573	Avg: 1532 Min: 1375	Avg: 1654 Min: 1438
0.5	Avg: 1642 Min: 1452	Avg: 1487 Min: 1285	Avg: 1508 Min: 1375
1.0	Avg: 1529 Min: 1377	Avg: 1353 Min: 1164	Avg: 1382 Min: 1244

2.0	Avg: 1464 Min: 1253	Avg: 1104 Min: 926	Avg: 1285 Min: 1106
3.0	Avg: 1372 Min: 1128	Avg: 1047 Min: 814	Avg: 1142 Min: 957
4.0	Avg: 1285 Min: 983	Avg: 946 Min: 763	Avg: 1032 Min: 861
5.0	Avg: 1114 Min: 939	Avg: 818 Min: 669	Avg: 894 Min: 639

The resistance of micro organisms tests of the plywood samples made by using UF and PF resin by addition with Wood Protector **SCAPO^R** for the entire range of doses starting from 0.5% to 5.0% were carried as per IS 1734:1983. From the study data reveals that there was no attack of microorganism on the surface or at the edges on the plywood samples. The details results were given in Table No. 2.

Effect on mechanical and bonding properties

Static Bending Strength i.e. modulus of rupture and modulus of elasticity both along and across the grain of the plywood samples made by using UF and PF resin by addition with wood protector plus for the entire range of doses starting from 0.5% to 5.0% were carried as per IS 1734:1983 along with control samples. From the study data shows the there was no adverse effect on the mechanical strength of the plywood sample were observed after using Wood Protector **SCAPO^R** samples in both amino and phenolic resins. The details of the results are in Table No. 4.

The knife test conducted on preservative concentrations 0.5%,1%,2%,3% shows pass standard whereas concentrations above 3% shows poor glue bonding in resistance to water test. Plywood sample shows pass standard results when tested for resistance to micro-organism for all concentrations of preservative. (Ref. Table 2).

Physico-mechanical properties were also studied as per IS: 1734-1986 and it was observed that as preservative concentration increases modulus of elasticity and modulus of rupture decreases. However all the results were within acceptable limit (Ref. Table 3).

Table 2**Results of adhesion of plies, resistance to water and resistance to micro-organism test**

Preservative Concentration, %	**Adhesion of plies**	**Resistance to water after 72 hrs**	**Resistance to micro-organism**
0.0	Excellent	Pass Stanard	Pass Standard
0.5	Pass Standard	Pass Standard	Pass Standard
1.0	Pass Standard	Pass Standard	Pass Standard
2.0	Pass Standard	Pass Standard	Pass Standard
3.0	Pass Standard	Pass Standard	Pass Standard
4.0	Pass Standard	Poor	Pass Standard

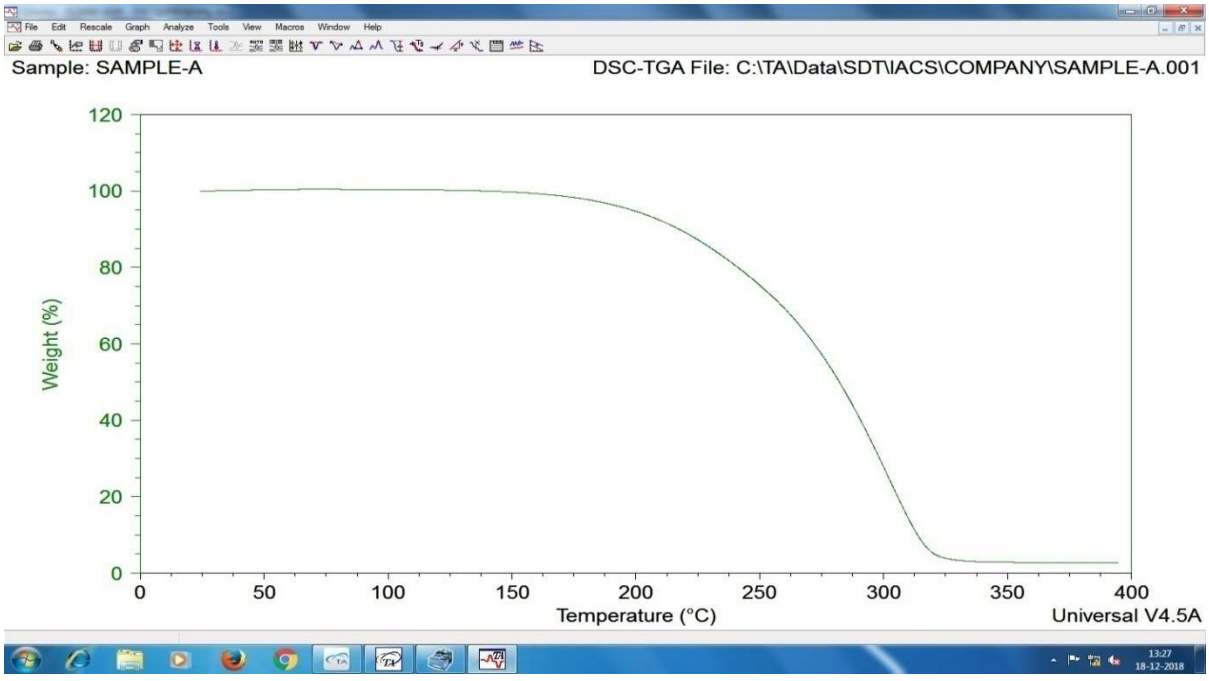
5.0	Pass Standard	Poor	Pass Standard

Table-3**Physico-mechanical properties of plywood prepared from Wood Protector SCAPO^R preservative concentrations**

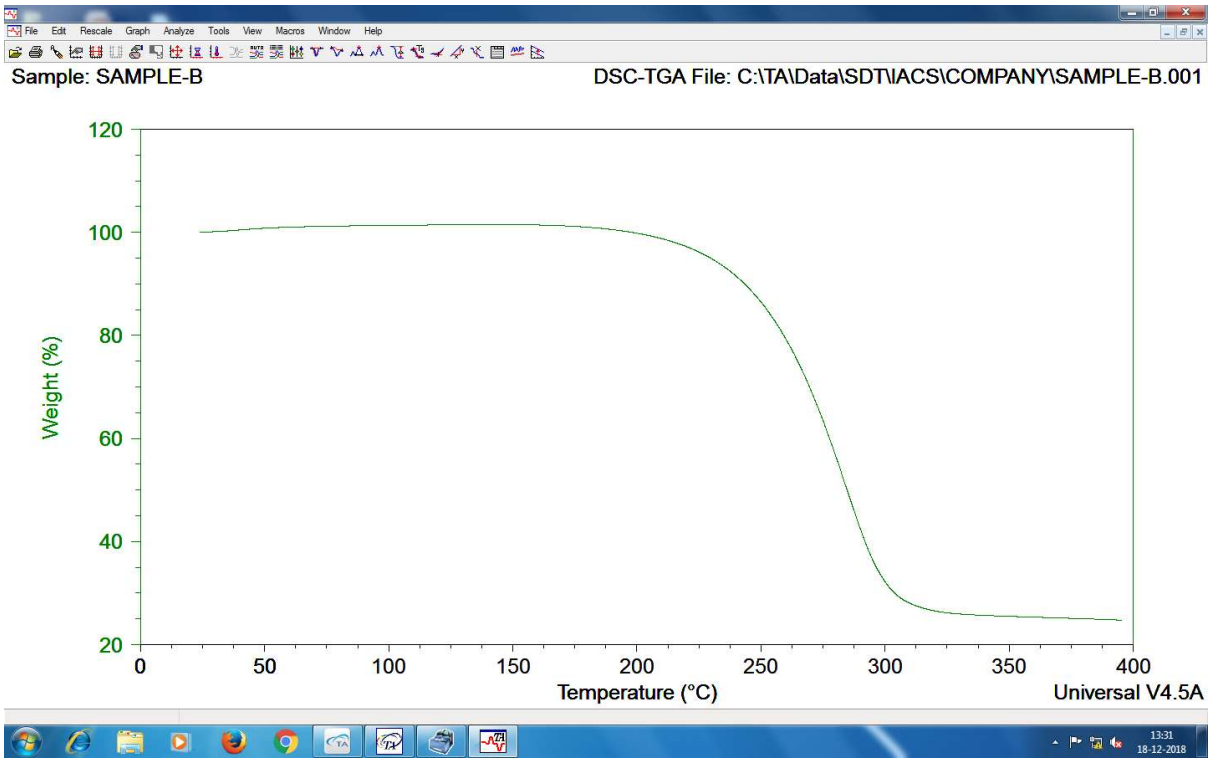
Preservative Concentration, %	Moisture Content, %	Density, kg/m^3	Modulus of Elasticity, N/mm^2 (Perpendicular to the grain)	Modulus of Rupture, N/mm^2 (Perpendicular to the grain)
0.0	8.91	916	6105	65.72
0.5	8.65	893	5406	61.38
1.0	8.50	872	5135	56.71
2.0	8.43	864	4904	51.83
3.0	8.30	847	4792	45.24
4.0	8.27	832	4368	39.71
5.0	8.16	815	4162	32.84

Thermal degradation study

From the DSC-TGA data plotted weight (%) Vs temperature (^{o}c) of the Wood Protector **SCAPO^R** sample added 1.5% in PF resin, shows that the loss of mass occurs about 300^{0}C. Hence, thermal degradation study of the preservative sample signifies that on heating the preservative molecule had not lost his original properties.



Thermal degradation study of wood protector sample



CONCLUSION

On the basis of the experimental studies and result & discussion it was concluded that:

The Wood Protector **SCAPO^{R}** GLP incorporated at in the glue line at different concentration have no imparted any change in the pot life and the bonding strength of the adhesive .It was compatible with both phenolic and amino based wood adhesive without having any adverse effect. Results from the water resistance test revealed that the chemical is suitable for use of BWP grade plywood without effecting any bonding quality and mechanical properties of the plyboard /Boards & Doors like MoE, MoR,Glueshear strength test at 1.5% to 3% concentrations also show satisfactory limit of acceptance as per Indian standards. From the DSC-TGA studies of the Wood Protector **SCAPO^{R}** sample added 1.5% in PF resin, shows that the loss of mass occurs about 300^{0}C. Hence, thermal degradation study of the preservative sample signifies that on heating the preservative molecule had not lost his original properties up to 300^{0}C.

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