Reprinted from : Journal Institute of Wood Science (U.K.) 8(3), 127, June 79

PROPERTIES OF CATALYTICALLY POLYMERIZED WOOD-PLASTIC COMPOSITES

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Summary

Styrene monomer and styrene monomer mixed with Polyethylene glycol (20 per cent w/w) were impregnated in *Pinus roxburghii* (chir wood) and in-situ polymerised using catalyst heat technique. The comparison of the composites with controlled wood revealed marked improvement in engineering properties. Thus, the composites were comparable with conventional high-class timbers.

Kenaga and co-workers (1962) were the first to prepare wood-plastic composites by filling the pores of woods with monomeric materials. They polymerised vinyl monomers in the voids of woods with monomeric materials, and by means of radiations. The work of other workers worth mentioning in this respect is of Kent *et. al.*, (1963 a, 1963 b & 1967), Meyer *et. al.* (1965) and Mani *et. al.* (1969). In 1965, Meyer tried catalyst-heat technique for this purpose and compared it with radiation technique (1965, 1966). The results revealed that the composites prepared by both the techniques were comparable in the properties. The advantages of catalyst-heat technique (1973) such as ease in preparation with low capital investment and no fear of health hazards have attracted a number of investigators in recent years (1970, 1972). Work is being carried out in this Institute to improve the properties of various softwoods by preparing their wood-plastic composites with a view to using them in buildings. The present communication describes the studies on wood-plastic composites obtained from in-situ polymerisation of monomers using catalyst – heat technique in *Pinus roxburghii* (chirwood).

Experimental

Commercial grade styrene was treated with 10 per cent alkaline solution to neutralise the inhibitor. It was then washed, dried and distilled (specific gravity 0·9034). Polyethylene glycol (specific gravity 1·04) used was of laboratory grade. Benzoyl Peroxide (E. Merck) was used as free radical catalyst.

The engineering properties were determined according to IS-1708 (1969) whilst anti-shrink efficiency was calculated by the method of Stamm (1964). To determine static bending strengths, wooden samples of the size 45 × 2·5 × 2·5 cm. were prepared from flat grained chir wood while 5 cm. cubes were used to determine compressive strength. They were dried to a constant weight at 50°C and dimensions were measured.

The samples were dipped separately in styrene monomer and styrene mixed P.E.G. (20 per cent w/w) having 0·2 per cent benzoyl peroxide. In this way, the impregnation was carried out by capillary action in the wood. After keeping the samples in the monomer systems for 24 hours, they were wrapped in polyethylene sheeting and cured for 12 hours in an oven at 80°C.

Discussion

The results tabulated in Table 1 showed that in the test specimens the loading of styrene monomer was 25 per cent while loading of styrene mixed with Polyethylene glycol (P.E.G.) was 21 per cent. During curing some amount of styrene was also evaporated and therefore the rise in density of the wood was only 17 and 11 per cent respectively in the two composite systems. The better antishrink efficiency in the composite having P.E.G. might be due to the fact that P.E.G., having a polar solvent, facilitated partial grafting of the monomer into the cellulose which was available in the cell walls of the wood (1972).

The significant improvement in the properties of the chir wood (*Pinus roxburghii*) may be due to formation of copolymers which filled the cell cavities. The presence of the copolymer retards the movement of water from cell to cell through the cell cavities of the wood. In this way, it is considered that in wood consisting of closely packed parallel tubes, the presence of polymer prevents the collapse of these tubes under stress.

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TABLE 1 Properties of Chirwood – Plastic Composites

Properties	Controlled Wood	Styrene	Increase Per cent	Styrene + PEG (20% w/w)	Increase Per cent
Monomer Loading	—	25%	—	21%	
Density after Curing	0·58	0·68	17	0·65	11
Anti-shrink efficiency	—	22	—	40	
Static bending along the grain					
Fibre stress at limit of proportionality. (kg²./cm².)	443·0	818·0	84	680·0	53
Modulus of elasticity. (kg²./cm².)	65918	101556·0	54	80463·0	22
Horizontal shear stress at limit of prop (kg²./cm².)	14·2	30·0	114	22·0	56
Modulus of rupture (kg²./cm².)	585·0	974·0	66	870·0	48
Horizontal shear stress at neutral plane and	22·0				
maximum load (kg²./cm².)	22·0	32·2	45	26·0	27
Compression along the grain					
Compressive strength	400·0	648·0	62	630·0	56

Conclusions

The study was undertaken to compare the properties of *Pinus roxburghii* with its catalytically processed plastic composites. The results indicate that there was marked improvement in the properties of wood in both the systems under study. However, except anti-shrink efficiency the improvement in the rest of the properties was greater in styrene monomer systems.

Acknowledgement

The paper forms part of normal research work of the institute and is published with the permission of the Director.

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