Preliminary

Moulded Products from Radiata Pine Bark

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(Received May 31, 2001)

Keywords: bark, tannin, moulding products, mechanical properties, radiata pine, *Pinus radiata*

Introduction

Radiata pine (*Pinus radiata* D. Don) is a fast growing tree species cultivated extensively throughout the world, and its bark contains a significant amount of condensed tannin, more than 30% by weight[1]. Radiata pine bark tannin is well known to react with formaldehyde to form condensation and polymerization products. In a previous study[2] we investigated the possibility of utilizing radiata pine bark tannin as a substitute for synthetic thermosetting resins for the production of moulded products. Radiata pine tannin powder extracted from bark when mixed with wood flour and moulded at 190°C and 100 MPa for 10 minutes produced plastic-like moulded products with a modulus of elasticity (MOE) of 9 to 10 GPa and a modulus of rupture (MOR) of 70 to 80 MPa without the addition of formaldehyde. Moreover, these moulded products showed good water resistance.

On the basis of these results, in this study, we studied the possibility of the direct conversion of bark into moulded products.

Materials and Methods

Radiata pine (*Pinus radiata* D. Don) bark samples were collected from the debarker of a plywood and laminated veneer lumber mill using logs from 35 year-old radiata pine trees at Mt. Gambier in South Australia. The bark samples were dried to 12% moisture content and then ground to pass a 0.5 mm screen in a Wiley mill. The resulting particle size distribution was : 0.250 mm to 0.500 mm (37.0%), 0.125 mm to 0.250 mm (23.5%), 0.090 mm to 0.125 mm (8.0%), 0.063 mm to 0.090 mm (5.0%), 0.045 mm to 0.063 mm (13.5%), and less than 0.045 mm (13.0%). The particles were classified into three groups, such as Coarse : more than 0.250 mm, Medium : 0.063 mm to 0.250 mm and Fine : less than 0.063 mm, and then vacuum-dried at 70°C for 24 hours.

Oven-dried radiata pine wood flour (particle sizes less than 0.090 mm) were added in a ratio of 1 to 1 (wood flour : bark, w/w) and mixed well using a mortar and pestle. Approximately 12 g of the bark mixture which made 2.2 mm thickness of moulded product was put into a stainless steel cylindrical die (70 mm inside diameter) and hot-pressed for 10 minutes. The die temperature at the beginning of hot-pressing was approximately 20°C, pressure was 30 MPa, and pressing temperatures were 190°C and 210°C. The samples were removed from the die after cooling to 20°C within 8 minutes. Under the same combination of these conditions two samples of moulded products were prepared.

From each sample four testing specimens were obtained for the determination of mechanical properties and water resistance. The mechanical properties were evaluated using three-point bending test at cross-head speed of 5 mm/min and test span of 40 mm before and after soaking in cold water at 20°C for one day. Thickness swelling (TS) due to soaking in water was evaluated based on oven-dry thickness.

Results and Discussion

The mechanical properties and thickness swelling due to soaking in cold water are shown in Fig 1. At any element size and pressing temperature, a density of 1.4 g/cm^3 were obtained. As shown in figure, the MOE and MOR of the samples compressed at 190°C reached around 7 GPa and

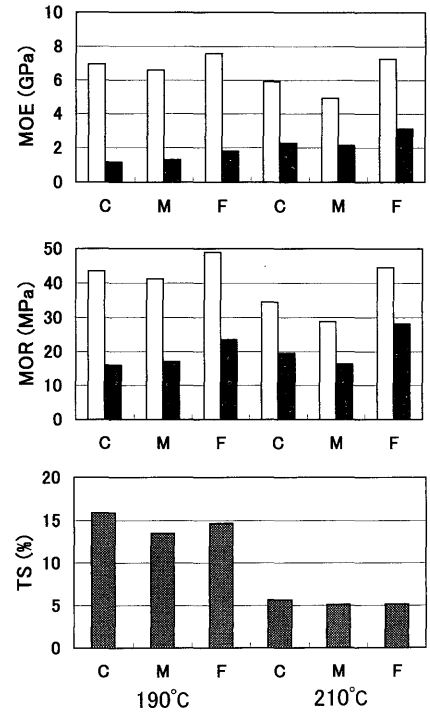

Fig. 1. Mechanical properties and thickness swelling (TS) of bark moulded product. Pressing pressure and time: 30 MPa and 10 minutes. Bark to wood ratio: 1 to 1. C: Coarse, M: Medium, F: Fine. Open bar: over-dried, Solid bar: after soaking in cold water.

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30 to 50 MPa, respectively, regardless of element sizes. These values are about 70% of those obtained for tannin moulded products in the previous work[2]. This may be due to the low fiber strength of the bark. In addition, it seems that the tannin located inside of the bark particles did not work as a binder.

With increases of pressing temperature from 190°C to 210°C, the mechanical properties decreased by 10 to 20%. On the other hand, the reduction in MOE and MOR due to the soaking in cold water were lower in the samples compressed at 210°C at any element size, and consequently after soaking in cold water the samples compressed at 210°C showed higher or same mechanical properties of the samples compressed at 190°C. As the thickness swelling due to the soaking in cold water was one-third at the higher pressing temperature, indicating that the water resistance was improved by increase of pressing temperature from 190°C to 210°C.

However, considering the fact that the reduction in MOR due to soaking in the hot water at 70°C for two hours was 30% for the tannin moulded product[2], and that the bark moulded products almost disintegrated during the hot water soaking, it can be said that the water resistance of bark moulded products are not sufficient. Therefore, a method to redistribute tannin on the surface of particles and act as a binder must be developed.

References

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