Wattle Tannin Adhesives for Radio-Frequency Curing

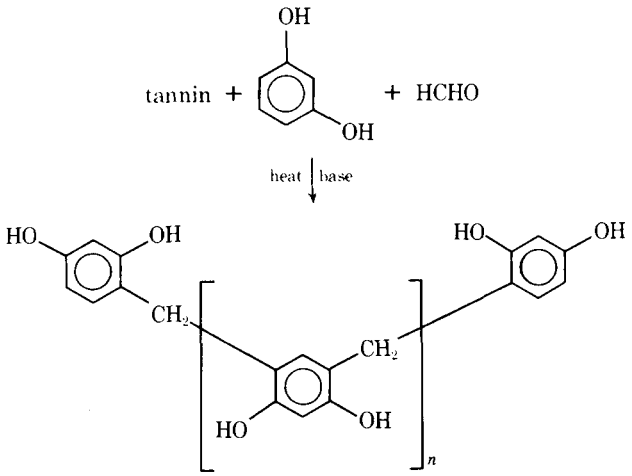
INTRODUCTION

A few of the wattle tannin adhesives previously reported[1,2] can be used for the production of laminated wood products by radio-frequency curing. Modifications to the adhesives glue mixes are, though, necessary to avoid arching between the electrodes used.

Two types of wattle-based adhesives already reported[1,2] can be successfully used for this type of application:

(1) Adhesives prepared by simultaneous synthesis of resorcinol/formaldehyde and flavonoid/formaldehyde condensates:

(1)



with $n \geq 0$ and —CH_2— flavonoid polymer —CH_2—
and uncombined resorcinol and uncombined flavonoid polymers

(2) Adhesives prepared by synthesizing stable phenol/resorcinol/formaldehyde resins and their subsequent addition to flavonoid polymers.

Industrial finger joints were prepared and cured by radio frequency using these two adhesives. The extract of the bark of the black wattle tree (*Acacia mearnsii*, formerly *mollissima*), commercially available, was used for this study.

EXPERIMENTAL

Resin Preparation

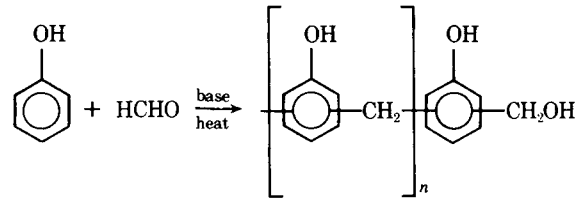
Adhesive 1. A mixture of 285 parts of a 52.5% aqueous solution of commercial powder wattle extract (containing 6% moisture), *no methanol*, 0.8 parts of a commercial defoamer, and 74.9 parts of 99% resorcinol was prepared at ambient temperature. To this mixture 24.5 parts of a 38% formalin solution and 20 parts of a 45% aqueous sodium hydroxide solution were added at ambient temperature. The mixture was then brought to 70°C, held there for 1 hr, then cooled, and stored.

Adhesive 2. To a mixture of 40.3 parts of 100% phenol and 34.5 parts of a 38% formaldehyde solution were slowly added 2.75 parts of a 40% aqueous sodium hydroxide solution and the mix brought to reflux (91°C) and held refluxing for 60 min. Then 18.8 parts of 99% resorcinol and 24.2

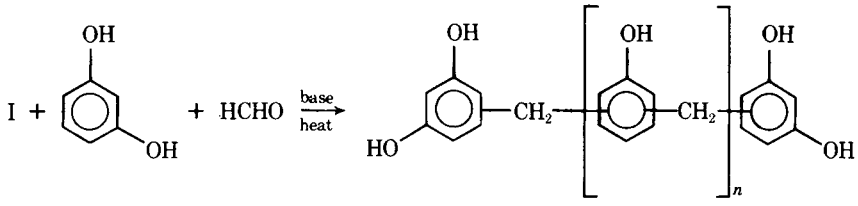
Journal of Applied Polymer Science, Vol. 22, 3603–3606 (1978)

0021-8995/78/0022-3603$01.00

(2)



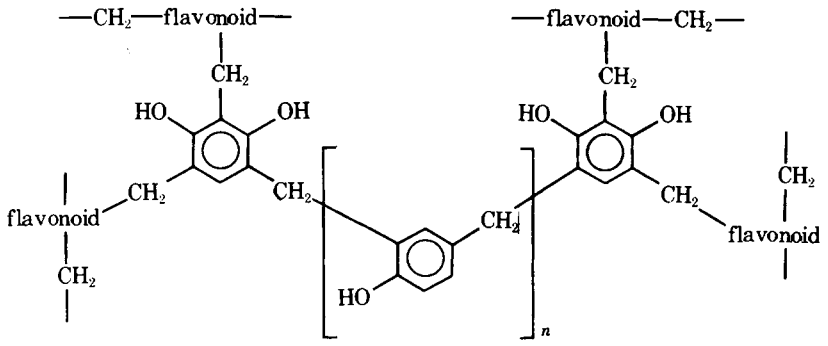
I with $n > 0$



II with $n > 0$

II + tannin + HCHO

heat | base



parts of 100% phenol were added. The mixture was again brought to reflux for 10 min, then cooled, and stored. Five parts of this liquid phenol/resorcinol/formaldehyde resin prepared were added to 200 parts of a 50% aqueous solution of commercial powder wattle extract. No methanol was added.

To 100 parts of the liquid adhesives 1 or 2 were added 7 parts of 96% paraformaldehyde powder, 10 parts of 200 mesh coconut shell flour, and enough water and 30% sodium hydroxide solution to have a viscosity of 2500 cps and a pH of 7.0–7.5.

TABLE I
SABS 096-1976 Specifications for Finger Joints

% Wood failure	Minimum tensile strength, N
10–29	2800
30–49	2500
50–69	2100
70–89	1700
90–100	1400

TABLE II
Tensile Strengths of Wood-Wattle Tannin Adhesive Joints

	Dry			24 hr cold soak			6 hr boil		
	Adhesive 1	Adhesive 2	Phenol/ resorcinol/ formal- dehyde control	Adhesive 1	Adhesive 2	Phenol/ resorcinol/ formal- dehyde control	Adhesive 1	Adhesive 2	Phenol/ resorcinol/ formal- dehyde control
Tensile strength, newtons	2959	1784	2589	3052	1592	2195	3501	1761	2313
% Wood failure	100	95	87	100	95	83	100	76	77

Manufacture and Testing of Finger Joints

Finger joints were made using five boards 14.5 cm × 3.5 cm in cross section of *Pinus radiata* having a 10–12% equilibrium moisture content. They were passed continuously between two parallel electrodes of a radio-frequency finger-jointing press, each 3.66 m long, at a speed of 7.5 m/min. Two radio-frequency generators, 6 kW maximum each, were connected to the two parallel electrodes, and the voltage per unit area was kept between 3.6 and 4 volts/cm^2. The finger joints produced could be handled without breakages immediately out of the radio-frequency press and were tested for tensile strength and percentage wood failure after five days of aging at ambient temperature according to the South African Bureau of Standards SABS 096-1976 specification for weather- and boil-proof finger joints. The SABS 096-1976 specification requirements are given in Table I, and the results obtained are shown in Table II.

DISCUSSION

The results obtained satisfy the requirements of the SABS 096-1976 specification for weather- and boil-proof finger joints. It is possible to observe that adhesive 1 gave better results than adhesive 2, this being due to the much higher proportion of resorcinol used. Adhesives 1 and 2 are, respectively, a wattle-based cold-setting adhesive[1] and a thermosetting wattle-based plywood adhesive.[2] The results obtained with these adhesives compare favorably with those obtained using a commercial phenol/resorcinol/formaldehyde adhesive expressely formulated for radio-frequency curing.

The compliance of the joints produced with the SABS 096-1976 accelerated test for weather- and boil-proof finger joints showed that no significant difference appeared to exist between commercial phenol/resorcinol/formaldehyde and tannin-based adhesives as for durability to exterior weather conditions.

Adhesive 1 is also a good cold-setting wood adhesive[1] and is able to give comparable results when the joints are cured for 16–24 hr under clamping at ambient temperature (±25°C). The radio-frequency curing accelerates the obtaining of such results. Adhesive 2, a good thermosetting adhesive for plywood,[2] is not able to give good joints if used in a heat chamber at 50°C for 4–6 hr, as required for heat treatment by the SABS 096-1976 specification, requiring instead 8 or 9 hr of curing or a much higher pH, increasing reactivity and consequently shortening its usable potlife, or a much higher curing temperature.

Adhesive 2 furthermore is considerably cheaper than comparable commercial phenol/resorcinol/formaldehyde adhesives for radio-frequency curing for finger joints of comparable performance. Adhesive 1 is also cheaper than commercial phenolic adhesives.

No substantial amounts of methanol, which is often used in similar adhesives previously reported[1,2] to lengthen potlives and improve wood wetting, can be used in radio-frequency curing as practically continuous arching between the electrodes is experienced with consequent charring of the wood. Considerably milder radio-frequency curing conditions could be used with acceptable, though lower, results.

It must be considered that these adhesives, in particular adhesive 2, are not extensions of a synthetic phenolic adhesive with tannin, but are mainly tannin adhesives with an amount of phenolic resin as low as 5%–10% of total resin solids.

References

1. A. Pizzi and D. G. Roux, *J. Appl. Polym. Sci.*, **22**, 6 (1978).
2. A. Pizzi and H. O. Scharfetter, *J. Appl. Polym. Sci.*, **22**, 7 (1978).

A. PIZZI*

Department of Chemistry
University of the Orange Free State
Bloemfontein, 9300 Republic of South Africa

Received September 9, 1977
Revised October 27, 1977

* Present address: National Timber Research Institute, Pretoria, CSIR, Republic of South Africa.