



RESEARCH PROGRAMME NO. 35
INDUSTRIAL EXTRACTION AND UTILIZATION OF TANNINS

RESEARCH PROJECT NO. 35/4
DEVELOPMENT OF WATER-RESISTANT GLUES FROM TANNIN

REPORT NO. 1
ECONOMIC EVALUATION OF
TANNIN-FORMALDEHYDE ADHESIVES FOR PLYWOOD

BY

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ASRCT, BANGKOK 1967

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APPLIED SCIENTIFIC RESEARCH CORPORATION OF THAILAND

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ECONOMIC EVALUATION OF TANNIN-FORMALDEHYDE ADHESIVES FOR PLYWOOD

By Bernard P. Esselink*

SUMMARY

A comparison is made between the costs of reinforced tannin-formaldehyde adhesives, phenol-formaldehyde and urea-formaldehyde adhesives.

The tannin-formaldehyde adhesives prove to be cheaper in the application as a weather-resistant plywood adhesive than the phenol-formaldehyde adhesives.

A warning has to be given that the processing of the tannin-formaldehyde adhesives is much more complicated than phenol-formaldehyde adhesives.

INTRODUCTION

According to information from CSIRO Australia (Plomley 1966) reinforced tannin-formaldehyde adhesives can compete favourably with phenol-formaldehyde adhesives. At present the glue is used economically in several plywood factories in Australia. The properties are the same or better than phenol-formaldehyde glue except in regard to the processing properties. The working life of the glue is short and the formulation of the glue solution needs accurate working methods.

This application of tannin-formaldehyde adhesives is a result of many years' research in several countries. Research in India claims to have succeeded in the formulation of water-resistant plywood glues with the cashew nut shell liquid and the tannins of the Acacia catechu (Narayanamurti et al 1958) and the tamarind-seed testa (Rao and Rajagopalan 1958). In Indonesia work has been done on the mangrove tannin (Brandt 1952). But only the research at CSIRO Australia starting with the work of Dalton (1950) resulted in the practical application of the adhesives (Plomley 1966). The use of a tannin of constant high quality such as the wattle tannin (imported from South Africa!) has been found necessary.

In the present situation in Thailand, it will not be possible to produce this high quality tannin from indigenous resources. Only the mangrove tannin

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is available but a good production is difficult and even then the performance of this tannin is poor in the application as an adhesive (Plomley et al 1964) in comparison with wattle tannin.

Therefore it will be more useful to investigate the possibilities of the application of reinforced tannin-formaldehyde adhesives in Thailand with imported tannin as the raw material.

COMPARISON OF THE COSTS ON THE DIFFERENT ADHESIVES

The costs of the glue solutions per kg were calculated from data obtained from the Thai Plywood Company in the case of phenol-formaldehyde and urea-formaldehyde adhesives. The costs of the reinforced tannin-formaldehyde glue solution were calculated from the details from CSIRO Australia (Plomley 1966) where the research on the development of this adhesive has been done. Finally the cost of the glues per square metre plywood has been calculated for each glue.

Cost of the fortifying resorcinol phenol resins

The fortifying resin can have different composition depending on the type of glue that is needed. In this formulation the maximum amount of resorcinol (50 % of the weight of the phenol) is taken to obtain the maximum cost of the resin.

Formulation:

	Parts by weight	Per cent	Fractional cost (baht)
Phenol	96	37	3.04
Formaldehyde	39	15	1.74
Resorcinol	48	19	8.22
Water	75	29	_____
Cost of the resin (baht/kg)			<u>13.00</u>

The minimum amount of resorcinol is 25 % of the weight of phenol. The price is then approximately 10 baht per kg resin. Another possibility is to buy the fortifying resin from Australia. The local price of the Australian resin is 11.80 baht per kg. The f.o.b price (in Australia) is estimated to be

20 % below this local price. With the transport costs (1000 baht/metric ton) and the import duty (27.5 %) the price of imported resin will be about 13 baht/kg.

Cost of the reinforced tannin-formaldehyde adhesive

Formulation: (Plomley 1966)

	Parts by weight	Per cent	Fractional cost (baht)
Tannin extract (solid extract)	100	42	2.52
Fortifying resin	20	8	1.04
Paraformaldehyde	10	4	0.46
Filler etc.	10	4	-
Water	100	42	-
Cost of the glue solution (baht/kg)			<u>4.02</u>

In this formulation the maximum amount of fortifying resin is taken. Depending on the wood species this amount can be reduced to 10 % of the weight of the tannin extract.

The adhesive is applied in a quantity of 7-8 lb/100 ft² 350 grammes per m² double glue line. The cost becomes then 1.41 baht/m² plywood.

Comparison of the costs of the glues

Adhesive solution	Baht/kg	Baht/m ²	Properties
Urea-formaldehyde	3.01	1.03	Easy to apply; strong; not weather-resistant
Phenol-formaldehyde	4.95	1.96	Strong; weather-resistant
Reinforced Tannin-formaldehyde	4.02	1.41	Difficult to apply; strong; weather-resistant

CONCLUSIONS AND RECOMMENDATIONS

1. The application of reinforced tannin-formaldehyde adhesives will be economical in Thailand even when imported tannins are used as the raw material.

The advantages of the glue are:

- (a) Equal in properties to phenol-formaldehyde as a water resistant plywood adhesive in regard to strength and weather resistance.
- (b) Cheaper in price.

The disadvantages of the glue are:

- (a) Relatively short working life.
- (b) Complicated composition of the glue.

2. The application of locally extracted tannins is not recommended since a tannin of constant high quality is required.

3. Local manufacture of the fortifying resin is recommended as the shelf life of this resin is too short for transportation. (14 weeks at 70°F; 7 weeks at 90°F).

4. If industries in Thailand are interested in the application of the reinforced tannin-formaldehyde adhesives, experiments will have to be done to prove the technical feasibility of the glue in Thailand and to determine the quantity of reinforcement needed for local species of wood used in plywood manufacture.

REFERENCES

- BRANDT Th. G. (1952).—Mangrove tannin-formaldehyde resins as hot-press plywood adhesives. Textona 42: 137-150.
- DALTON, L.K. (1950).—Tannin-formaldehyde resins as adhesives for wood. Aust.J.appl.Sci. 1: 54-70.
- NARAYANAMURTI, D., RAO, P. Ramachandra, and RAM, Rulia (1958).—Adhesives from Acacia catechu Res. & Ind., New Delhi 3: 6-9.
- FLOMLEY, K.F. (1966).—Tannin-formaldehyde adhesives for wood. CSIRO Australia Division of Forest Products Technological Paper No. 39.

PLOMLEY, K.F., GOTTSTEIN, J.W., and HILLIS, W.E. (1964).—Tannin-formaldehyde adhesives for wood. Mangrove tannin adhesives. Aust.J.appl.Sci. 15: 171-182.

RAO, P. Ramachandra, and RAJAGOPALAN, T.K. (1958).—Adhesives from tamarind-seed testa. Res. & Ind., New Delhi. 3: 275-276.

APPENDIX

PRICE LIST OF CHEMICALS AND RAW MATERIALS

	baht/kg
Urea-formaldehyde	5.95
Hardener for urea-formaldehyde	5.95
Phenol-formaldehyde	9.30
Hardener for phenol-formaldehyde	5.96
Tapioca flour	2.00
Wattle tannin (solid extract)	6.00
Phenol	8.20
Resorcinol (technical grade)	43.20
Resorcinol (powdered U S P grade)	102.50
Paraformaldehyde	11.60

Data obtained from:

1. Thai Plywood Company Ltd.
2. Thai Tanning Organization
3. Oil, Paint & Drug Reporter 31 July 1967 (Freight 1500 baht/metric ton and import duty 27.5 % is added to get the price in Thailand)