



A. INTRODUCTION

Surface characteristics of wood such as surface roughness, surface free energy (SFE) and wettability are important properties influencing further manufacturing processes such as gluing and coating. The woods tested in this study were fast-growing teak (FG-teak), afrika, sungkai, mindi, merbau, durian, lamtoro, pulai, acacia and kempas woods

The aim of this research was to determine the influence of surface roughness of ten tropical woods on their SFE, wettability and bonding quality for water based acrylic and solvent based alkyd varnishes

B. RESEARCH METHODOLOGY

Wood surfaces were prepared in unsanded and sanded using abrasive paper of 120 grits. Surface Free Energy (SFE) values were calculated based on the Rabel method. Wettability values were measured based on the contact angle between varnish liquids and wood surfaces using sessile drop method and the S/G model was used to evaluate the wettability of the varnishes on the woods surface. Bonding quality of the varnishes was measured using cross-cut test based on the ASTM 3359-02 standard.

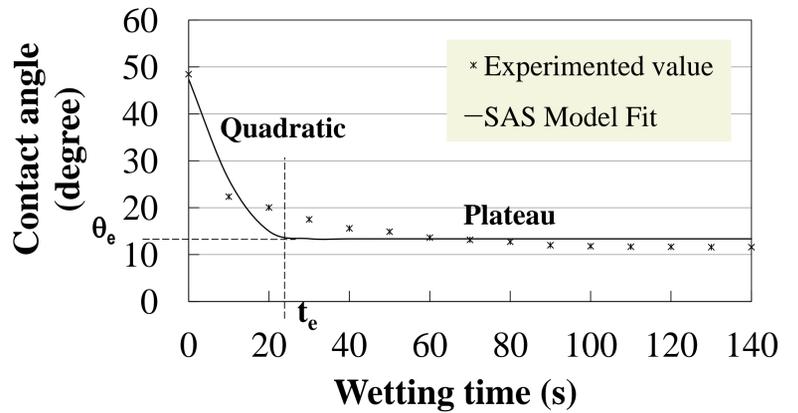


Figure 1. Determination of equilibrium contact angle (θ_e) from a plot of the contact angle as a function of time (t), by segmented regression model

C. RESULTS and DISCUSSION

Table 1. The values of equilibrium contact angle for 10 tropical wood species

Wood	Water-based acrylic paint		Oil-based alkyd paint	
	θ_e (Unsanded)	θ_e (Sanded)	θ_e (Unsanded)	θ_e (Sanded)
Afrika	20.6	25.2	6.1	7.1
Acacia	29.0	29.2	8.9	9.8
Kempas	26.9	28.2	9.7	12.7
Lamtoro	29.4	29.7	6.3	6.8
Durian	28.3	30.0	7.3	7.5
Sungkai	29.6	31.7	11.3	12.1
Pulai	31.7	31.8	8.2	10.1
Mindi	30.1	34.3	8.9	10.3
FG-Teak	33.7	37.9	10.8	11.4
Merbau	39.8	41.8	14.2	15.9

The water-based acrylic varnish generated higher values of θ_e . Its higher viscosity 1.5 poise compared to the solvent based alkyd varnish 0.3 poise could be the reason. The lower θ_e of the solvent based alkyd varnish indicated the varnish liquid easier to spread and lead to beneficial substrate wetting and penetration in wood. The lower θ_e of the solvent based alkyd also indicates that it should create more intimate contact on the wood surface than the water-based acrylic.

Table 3. The constant contact angle change rates (K-values) of water-based acrylic paint and oil-based alkyd paint for ten wood species

Wood	Water-based acrylic paint		Oil-based alkyd paint	
	K-value (Unsanded)	K-value (Sanded)	K-value (Unsanded)	K-value (Sanded)
Merbau	0.027	0.022	5.600	4.249
Lamtoro	0.032	0.028	7.452	6.898
Pulai	0.033	0.029	4.506	3.627
Kempas	0.036	0.034	5.148	4.619
Mindi	0.037	0.034	7.447	6.310
Acacia	0.038	0.033	7.260	5.389
FG-Teak	0.038	0.032	5.730	5.038
Durian	0.041	0.035	6.637	6.531
Sungkai	0.052	0.038	5.557	3.485
Afrika	0.055	0.051	9.253	8.202

The solvent based alkyd generated larger K values compared to water-based acrylic because the solvent based alkyd was lower in viscosity (0.3 poise) than water-based acrylic varnish (1.5 poise). The greater K-values, the faster the time needed for the liquid to spread and penetrate on the wood surfaces. By considering the fact that the acrylic and alkyd varnishes in this study were prepared and applied at the manufacturer's recommended use, it can be concluded that the alkyd varnish produced better wettability than the acrylic varnish for all ten wood surfaces.

D. CONCLUSIONS

The equilibrium contact angles increase as the roughness of the planed surface of the woods decrease. The SFE values decrease as the equilibrium contact angles of the wood increase. The higher SFE values generate the higher K-values. The higher K-value indicates higher wettability and bonding quality of varnishes. Solvent based alkyd varnish is more wettable and generates better bonding quality compared to the water-based acrylic varnish. The K-values of all woods tested in this work larger than 0 give an indication that the acrylic and alkyd paints can spread and penetrate on the surface of the woods tested. Improving the quality of especially fast-growing wood from plantation by painting could be considered to spread their utilization for higher value wood products

Table 2. The values of SFE (polar component γ_s^p , dispersive component γ_s^d , the total value γ_s) for ten wood species (in mJ/m^2)

Wood	Unsanded			Sanded		
	γ_s^d	γ_s^p	γ_s	γ_s^d	γ_s^p	γ_s
FG-Teak	23.60	15.00	38.60	26.55	9.62	36.17
Merbau	40.29	6.96	47.26	43.35	3.57	46.92
Acacia	41.69	7.31	49.00	36.60	7.16	43.76
Sungkai	42.16	7.64	49.80	35.52	7.85	43.37
Pulai	40.78	9.65	50.43	30.61	12.12	42.72
Durian	35.63	14.91	50.54	32.03	14.12	46.15
Mindi	35.53	15.52	51.05	27.91	17.69	45.60
Lamtoro	34.25	16.87	51.12	22.24	19.11	41.35
Kempas	46.49	6.85	53.34	41.46	7.10	48.55
Afrika	44.48	9.13	53.61	36.02	9.44	45.46

The solvent based alkyd varnish had lower surface tension of 66.32 (mJ/m^2) compared to water based acrylic varnish of 80.52 (mJ/m^2). The higher SFE value of the wood indicated the higher the energy on the surfaces of the wood to be used for breakdown the liquid to spread and penetrate on their surfaces. A rougher wood surface tended to produce a higher SFE. This could due to the contact area on the rougher surfaces higher than on smoother surfaces.

Table 4. Bonding quality of water-based acrylic paint and oil-based alkyd paint for ten wood species.

Wood	Water-based acrylic Paint		Oil-based alkyd Paint	
	Unsanded	Sanded	Unsanded	Sanded
Afrika	5B	5B	5B	4B
Lamtoro	4B	3B	3B	3B
Durian	3B	3B	5B	4B
Acacia	4B	3B	4B	3B
Pulai	3B	3B	3B	3B
Mindi	3B	3B	5B	4B
FG-Teak	5B	4B	5B	4B
Sungkai	5B	4B	5B	5B
Kempas	3B	2B	5B	2B
Merbau	5B	3B	3B	3B

Oil-based alkyd produced higher bonding quality than water-based acrylic for most of ten wood species. Better wettability of the alkyd varnish (higher K values) contributed to better bonding quality. Oil-based alkyd varnish completed its polymerization reaction on the wood surfaces which allow for chemical bonding on wood surfaces. Lower bonding quality of water-based acrylic varnish is considered because the water used as a solvent causes swelling of wood fibres and decrease penetration near the wood surfaces which lead to a weakening of the interface of wood and coating material.