

# Effect of Sealant on Some Finishing Properties of Commercial Plywood

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## Abstract

Finishing is important to protect the surface and helps to enhance the attractiveness of the surface texture. These studies was obtained with 300mm x 100mm x 12mm of grade B plywood which used to evaluate the surface quality based on three type of sealer i.e Acid Catalyst (AC), Nitrocellulose (NC) and Polyurethane (PU) and finishing system (1) a sealer + a top coat, (2) two sealers + a top coat and (3) three sealers +a top coat. The coated plywood was assessing for surface roughness, surface hardness, adhesion and household test with accordance to the American Standard (ASTM). The results revealed that PU sealer gives good properties on adhesion, hardness and household reagent. While for surface roughness, AC gives better properties compared to other sealer. For finishing system, system 3 gives better properties on surface roughness, adhesion, hardness and household reagent. But for household and hardness properties, system 2 is enough to make the surface better.

**Keywords:** Plywood, Acid Catalyst (AC) Sealer, Nitrocellulose (NC) Sealer, Polyurethane (PU) Sealer.

## INTRODUCTION

There are many types of wood panel used for furniture manufacturing such as plywood. Plywood has their own characteristics which are flexible, workable and reusable (Anon 2012). Based on James E. Brumbough (1985), veneering has much stronger and more durable when produce furniture compared to furniture that made up from solid wood. In facts, plywood is resistance to cracking, shrinkage, twisting or warping. In other words, veneered plywood has their characteristic which is dimensional stability.

In the veneered furniture manufacturing, finishing is important in order to improve the surface of furniture product (Hosker, 2001). In order to improve the surface of furniture product, we have to ensure that the finishing system used is right. The selection of finishes also must be suitable to obtain the finishing problem. Therefore, to get the smooth surface and to ensure the defects are totally covered, the layers of sealer applied on the surface of wood veneer must be suitable before applying the topcoat.

In this study, grade B plywood was used to determine the best sealer layer should be applied on the plywood surface. Grade B plywood is used because this grade of plywood is widely used in furniture industry. AC sealer, NC sealer and PU sealer are used as important finishing material and coated with one topcoat to investigate the finishing performance towards surface roughness, adhesion, hardness and household test. This is because it was proven that finishing material is give different performance on certain type of performance properties (Shakri, 1991). Therefore, the main idea is to investigate how these three types of sealer and the finishing system perform on grade B plywood.

## MATERIALS AND METHODS

### Materials

Experimental grade B plywood panel with 12 mm thickness were used as a raw material. The plywood panels were cut into 300 mm in length and 100 mm in width. The total sample used is 81 samples. Then, the plywood samples were finished by using three types of sealer. The three types of sealer is nitrocellulose sealer (NC), acid catalyzed sealer (AC) and polyurethane sealer (PU).

Table 1: Experimental design of the surface treatment

Treatments	Types of layer	
	Basecoat	Topcoat
1	A Sealer	A Topcoat
2	2 Sealer	A Topcoat
3	3 Sealer	A Topcoat

Table 2: Formulation of three type of sealer used in this study

Type of Sealer	Sealer (ml)	:	Formulation Hardener (ml)	:	Thinner (ml)
NC Mixing Ratio (vol)	100		-		100
AC Mixing Ratio (vol)	100		10		40
PU Mixing Ratio (vol)	100		50		50

### Sanding and Surface Preparation

The samples were sanded with 150 and 180 grit number of sandpaper. 150 grit number of sandpaper were applied for the surface preparation. Since the smooth surface did not achieved by using 150 grit numbers, the samples were sanded back with sandpaper grit number of 180. After sanded the sample board, the sample were wipe to remove the dust.

### Finishing Application

The samples were applied with sealers and top coat (lacquer) by using spray gun. The samples were coated with the first sealers layer according to their type of sealer and treatment. Then, the coated samples were dried using air dry for about 30 minutes. This step was continued with the second and third sealer which is required to the second and third treatment. Finishing process is completed when topcoat which is lacquer was applied on the coated samples.

### Determination of Surface Roughness

The samples were placed on a stable horizontal surface. Surface roughness measurements were performed with a contact diamond stylus, 5  $\mu\text{m}$  tip radius, where the cut-off length is 2.5 mm. Considered to assess the surface characteristics of coated samples was the arithmetical mean deviation  $R_a$ . Three reading was taken for each sample.

### Determination of Adhesion

The 9 samples were cut into 300 mm x 100mm x 12 mm for each finishing material and finishing system. Then, select the area that free of blemishes. After that, a cutting knife was

used to cut the coating with the size of 1 mm apart. The total cutting were 12 cuts (6 horizontally and 6 vertically). The tape was placed at the centre of the intersection of the cuts. The tape was smoothed into placed by eraser and then pulled up within  $90 \pm 30$  seconds rapidly to an angle  $180^\circ$ . The total of removal coating from the substrate was examined.

#### *Determination of Hardness by Using Pencil*

The coated samples were placed on a stable horizontal surface. The test was started with the hardest lead. Then, the pencil was held on the holder firmly with the lead against the film at  $45^\circ$  angle and push forward. The process was repeated using down hardness scale pencil until found that there is no cut through the film.

#### *Determination of Household*

The 9 coated samples were tested by using four types of household reagent which is salt, soy sauce, ketchup and detergent. Place a small portion of the reagent on a horizontal panel or surface. After 24 hours, the reagent were wipe and the effect were examined either there is a discoloration, change in gloss, blistering, swelling, loss of adhesion or other special phenomena on the tested surface.

#### *Statistical Analysis*

Data for each test were statistically analyzed. Analyses of variance (ANOVA) were used to test the significant difference between the types of sealer and the finishing system.

## RESULTS AND DISCUSSIONS

Table 3: The mean values of finishing performances between types of sealer and finishing system

Testing	Type of Sealer			Finishing System		
	NC	AC	PU	1	2	3
Surface Roughness Test	0.7788b <sup>1</sup>	0.4623a	0.5018ab	0.9316c	0.5138b	0.2976a
Hardness Test	12.7778a	14.000b	15.6667c	13.2222a	14.2222ab	15.0000b
Adhesion Test	0.5556a	3.7778b	4.4444b	2.7778a	2.8889a	3.1111a
<b>Household test:</b>						
Salt	0.6667a	0.2222a	0.2222a	0.6667b	0.3333ab	0.1111a
Soy sauce	2.6667b	1.0000a	0.0000a	1.6667a	1.3333a	0.6667a
Ketchup	0.2222a	0.2222a	0.0000a	0.4444a	0.0000a	0.0000a
Detergent	2.000b	1.5556b	0.4444a	1.7778a	1.1111a	1.1111a

<sup>1</sup>: Means followed by the same letter in each row are not significantly different at  $p < 0.05$  according to Duncan's Multiple Range Test Method

1: a Sealer + Top coat

2: a Sealer + a Sealer + Top coat

3: a Sealer + a Sealer + a Sealer + Top coat

## **Comparison between Wood Finish**

### *Surface Roughness*

Table 3 shows that there is significant different between NC and AC sealer. NC sealer gives highest mean value of roughness while AC sealer gives the lowest mean value. However, PU doesn't give any significant effect on the surface roughness. Therefore, AC sealer gives smooth surface compared to NC sealer because AC gives good filling for the plywood pores when sanding process of sealant applied (Anon, 2012, Dresdner, 2007). Besides, AC sealer also totally seals or covers the plywood surface.

### *Hardness by Using Pencil Test*

From the data obtained in Table 3, it was found that there is significant different between the three types of sealer used. From the result, we can see that PU shows the higher mean value which is 15.6667, follow by the AC which is 14.000 and NC have the lowest mean value which is 12.7778. It means that PU sealer is more durable for hardness compared to AC and NC sealer. This is due to the PU characteristics itself which gives good penetration into wood substrate when applied on the surfaces (Anon, 2006).

### *Adhesion Tape Test*

According to Table 3, there are significant different of adhesion test mean result between NC sealer and others sealer. NC sealer gives lowest adhesion result compared to AC and PU sealer. PU sealer gives better adhesion result compared to AC sealer. However, there are no significant different between these two type of sealer. Therefore, PU and AC sealer have good adhesion characteristics when applied on the plywood surface. This is because PU sealer has strong bending and tight seals where the adhesive contain in sealer acts as an initial bond between the plywood surfaces before fully cured (Anon, 2005).

### *Household Test*

According to Table 3, it shows that PU sealer gives better properties toward household reagent because PU has the characteristics of superior resistant towards chemical substance (Metcoat, 2012). Poor surfaces of coated sample were observed at NC sealer towards the entire household reagent.

## **Comparison between Systems**

### *Surface Roughness*

Table 3 shows that there are significant different on the roughness of the coated surface. System 1 indicates the highest value of roughness and system 3 gives the lowest value of roughness. The lowest value of system 3 indicates smoother surface than the higher value of system 1 because sealer will hardens the grain. When the grain become hard, it easy to sand away the grain and make the surface become more smooth (Anon, 2012).

### *Hardness by Using Pencil Test*

Based on the Table 3 above, it can be seen that type of system used has significant effect on the hardness of wood finish. System 1 gives the lowest mean value of hardness performance while system 3 gives the highest performance of surface hardness. This is may be cause of the

thickness of the sealant provide harder surface. The thicker the sealer, the harder the surface. Besides, based on the characteristics itself, sealer provide harder base coat for the surface (Anon, 2008 & Dresdner, 2007).

#### *Adhesion Tape Test*

From the data on Table 3, it was found that the adhesion ability of system 1 is the lowest where the mean value is 2.7778. It followed by the system 2, where the mean value is 2.8889 and last is system 3, where the mean value is 3.1111 which are considered to be good performance. But, finishing system used doesn't give significant effect on the adhesion ability plywood finish. This is because sealer acts as adhesion promoter (Anon, 2008 & Anon, 2006). Therefore, sealer has excellent adhesion ability.

#### *Household Test*

For finishing system, the best properties for household reagent were system 3 and the poor properties observed on system 1. This is due to the increasing the sealer layers on the surface that can decrease the household substance from penetrate to the substrate.

## CONCLUSIONS

The surface quality of wood finishing can be influenced by many factors such as finishing material and finishing system. From this study, PU sealer has been observed gives good properties on adhesion, hardness and household reagent. While for surface roughness, AC gives better properties compared to other sealer. However, NC sealers have poor properties towards all the testing done in this study.

For finishing system, system 3 gives better properties on surface roughness, adhesion, hardness and household reagent. But for household and hardness properties, system 2 gives better properties compared to other systems.

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