

## RESEARCH ON EFFECTS OF RATE OF BECKOSOL 6501-80 AND SOLID POWDER TO PROPERTIES OF ALKYD PAINT SURFACE FILM OF WOOD

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### SUMMARY

The alkyde paint has high gloss, hardness, and flexibility, good color retention of coating film. It is good for adhesion with wood, metal and others. However, there have been very few researches on alkyde paints in Vietnam recently. This paper is aimed at studying the influence of rate of Beckosol 6501-80 binder and solids powder as titanium oxide R, Lithopone, CaCO<sub>3</sub> to quality of surface film of Alkyde paint. The result was showed as follows: when the rate of 6501-80 alkyd binder changed from 35% to 45%, and the rate of solids powder changed from 15% to 20% , the surface adhesion of paint reached level 1,2 and 3, depending on the composition ratio; hardness reached level 1H and 2H; Bending strength reached level 1; Dry surface time reached 2.5 to 2.8 hours, the complete drying time reached from 19 to 21 hours; The gloss of alkyd paint reached range from 72 to 75; The acid bases resistance reached level 70 to 84%. The mechanical and physical properties of alkyde paint film reached the highest quality when the rate of binder is at 45% of total input volume, but quality of paint film of 15% solid powder is better than that of 20%. However, this difference is not very significant, so the rate of binder and solid using for wood reached the most suitable level is 45% and, solids powder is 20% of total input volume.

**Keywords:** Alkyd paint, Beckosol 6501-80, mechanical properties, physical properties, quality of surface film.

### I. INTRODUCTION

The alkyde paint has high gloss, hardness, and flexibility, good color retention of coating film. The ability adhesion of paint with wood, metal and other materials is good, so it is commonly used for wood and steel. In the processing of making alkyd paint, the main raw materials as binder, solvents, and solids played an important role to quality of the paint film, determined to the type and scope of use of them.

Nowadays, the kinds of alkyde paints used for wood in Vietnam are commonly imported from other countries around the world; they are very diverse in color, components and their origin. Hence, it is difficult to manage the quality and the price. It is necessary to carry out a study on creating paints with good quality for furniture from available raw materials in Vietnamese markets. However, researches on paints for wood in general and alkyde paints in particular are very limited.

This paper expressed the influence of rate of

Beckosol 6501-80 binder and the solids powder as titanium oxide R, Lithopone, CaCO<sub>3</sub> to quality of surface film of Alkyde paint.

### II. MATERIALS AND METHODS

#### 2.1. The research materials

The raw materials to create the coating paints of Alkyde mainly consist of the following components: binder, solids, solvent and additives.

##### *(1) The binder component*

Oil-based Alkyde resin 6501-80 was used for creating alkyde paint. The trade name is Beckosol 6501-80.

Technical information of binder: Soybean oil; Oil length 64%; Phthalic anhydride: 25%; Color (Gardner): 6 max; Acid number: 3.9 – 9.0; Viscosity: (Gardner-Holdt, 25 deg C): Z6-Z8 (30% White spirit). Compatibility: Long oil alkyd resin: complete; Medium oil alkyd resin: limited; Short oil alkyd resin: incompatible; Melamine formaldehyde resin: limited; Rosin modified maleic resin: limited; Phenolic modified alkyd resin: incompatible.

Solubility: White spirit: complete; Xylene Butyl acetate: complete; Methyl ethyl ketone: complete;

n-butano: insoluble. Ester: complete; Aromatic: complete; Aliphatic: complete.

*(2) Solid powder component:*

Titanium oxide Rutile, Lithopone,  $\text{CaCO}_3$  powder was used to create paint.

Titanium oxide Rutile powder:

Purity of 97.8%, volatile content of 0.26%; Water-soluble matter of 0.3%; the amount of loss when heated to  $100^\circ\text{C}$  0.46%; Primary particle fineness  $< 0.063$  mm. Density  $4.03 \text{ g/cm}^3$ .

Lithopone powder:

Molecular formula:  $\text{ZnS.BaSO}_4$ . Molecular weight:  $330.80 \text{ g/mol}$ . Density of lithopone  $4.06 \text{ g/cm}^3$ , volatile content of 0.36% at  $105^\circ\text{C}$ , The amount of lost when baked  $0.5\%$  at  $100^\circ\text{C}$ , the coverage of the powder is  $98 \text{ g/cm}^2$ , the fineness of the powder is  $0.045$  mm.

The  $\text{CaCO}_3$  powder:

Purity of 97.53%, volatile content of 0.06% at  $105^\circ\text{C}$ , water-soluble substances of 0.06%, The amount of lost when baked at  $100^\circ\text{C}$  is  $0.02\%$ , Fineness of the powder is  $0.125$  mm.

The Additives supporting for dry speeds of surface: combination of 3 types of additives as follows:

10% Co- Naphthenate

30% Pb- Naphthenate

5% than- Naphthenate

*(3) Solvents component:*

The mixture of 3 solvents as ethylene acetate solvent, toluene and Kentone was used.

*(4) Other additives:*

Other additives are included:

Anti-foaming additives additives PolyglycolBYK 0.24.

Film-forming support additives Disper BYK 2150.

Surface smoothing Additives BYK 333.

Anti-settling additives CERATIX 8466.

When mixing materials for Alkyde paints, the total ingredients are 100%.

Inside:

The percentage of binder change  $40\%$  and  $45\%$  of the total input volume.

The percentage of solid powder change  $15\%$  and  $20\%$  of total input volume.

The solid powders include filler powder, pigments and ingredient for supporting dry speeds.

The pigment content  $50\%$  of solids powder.

Inside:

Lithopone: ratio of  $25\%$  of solids powder.

R - Titaniumdi  $\text{TiO}_2$  oxide: ratio of  $25\%$  of solids powder.

Powder fillers:  $\text{CaCO}_3$  powder ratio of  $49\%$  solids powder.

The Additives supporting for dry surface speeds:  $1\%$  rate of solids powder.

Inside:

$10\%$  Co - Naphthenate:  $0.25\%$  rate of solids powder.

$30\%$  Pb - Naphthenate:  $0.5\%$  ratio of solids powder.

$5\%$  - Naphthenate:  $0.25\%$  rate of solids powder.

The ratio of other additives is constant of  $3\%$  of the total input volume.

Inside:

Anti-foaming additives BYK 0.24 polyglycol of  $0.4\%$ : the rate  $1\%$  of the total input.

Film-forming support additives Disper BYK 2150 of  $0.4\%$ : the rate  $0.5\%$  of the total input volume.

Surface smoothing Additives BYK 333 of  $0.2\%$ : the rate  $0.5\%$  of the total input volume.

Anti-settling additives CERATIX 8466 of  $0.5\%$ : the rate  $1\%$  of the total input volume.

The solvent ratio: Changes according to the change of binder ingredient and solid powder, but the total input volume was  $100\%$ .

Solvent ingredient:

Ethylene acetate: 35% of the total volume of solvent.

Toluene: 25% of the total volume of solvent.

Methyl Ethyl Ketone (MEK): 40% of the total volume of solvent.

## 2.2. Research methods

### Documental methods

Inherit the previous theories on wood paints, especially Alkyde paint.

### Experimental method

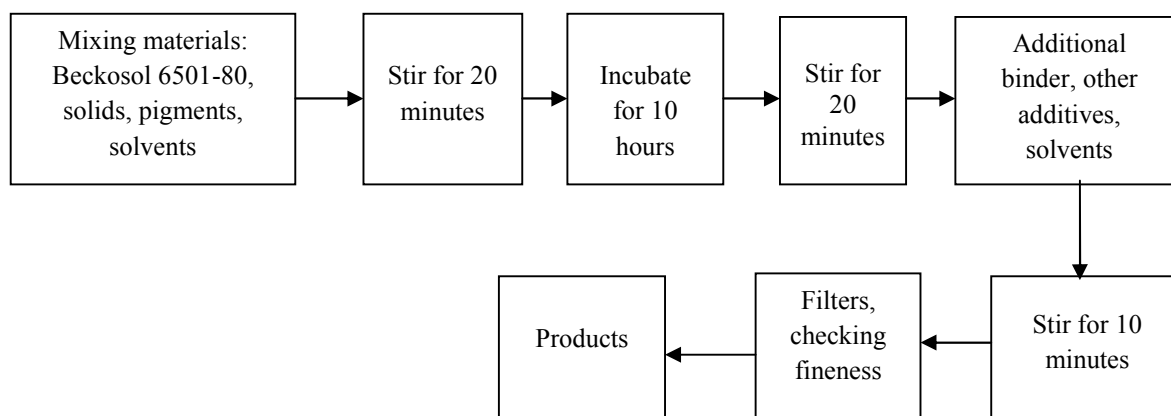
Multifactorial experimentation was used to determine the effect of the rate of main components such as binder and solid components to the mechanics, physics and chemistry properties of the surface film, including surface adhesion, hardness, bending strength, dry surface time, gloss, acid bases resistance.

The experimental design is as follows tab 2.1.

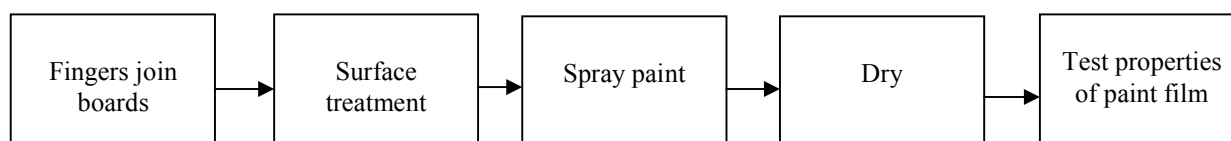
**Table 2.1. The experimental design**

		Kinds of First sample	Kinds of Second sample	Kinds of third sample	Kinds of forth sample
Rate of binder	%	40	40	45	45
Rate of solid powder	%	15	20	15	20
Additives	%	3	3	3	3
Rate of solvent	%	42	37	37	32
Total		100%	100%	100%	100%
Test of properties	Surface adhesion: 5 samples				
	Hardness: 5 samples				
	Bending strength: 5 samples				
	Dry surface time: 5 samples				
	Gloss: 5 samples				
	Acid resistance: 5 samples				

The experimental procedure is as follows fig. 2.1 and fig. 2.2.



**Figure 2.1. Preparing the base board**



**Figure 2.2. The experimental procedures**

Finger join boards: Finger join boards were made from Acacia wood and PVA glue at moisture content of  $12 \pm 2\%$ .

Treatment of surface of based boards: Using scrap paper (N0 100, 120, 150) sanding until achieve smoothness  $\nabla 8$  ( $R_{\max} \leq 60 \mu\text{m}$ ).

In the process, the ratio of binder changed to 40% and 45% of the total input volume. The ratio solid powder changed from 15% to 20% of the total input volume.

Standards used to test properties of paint films: Surface adhesion TCVN 2097 - 1993, hardness ISO 2098 - 1993, bending strength TCVN 2100 - 1993, drying surface time

TCVN 2094 - 1993, chemical resistance (acids, bases) TCVN 2099 - 1993, gloss TCVN 2101: 2008.

### III. RESULTS AND DISCUSSION

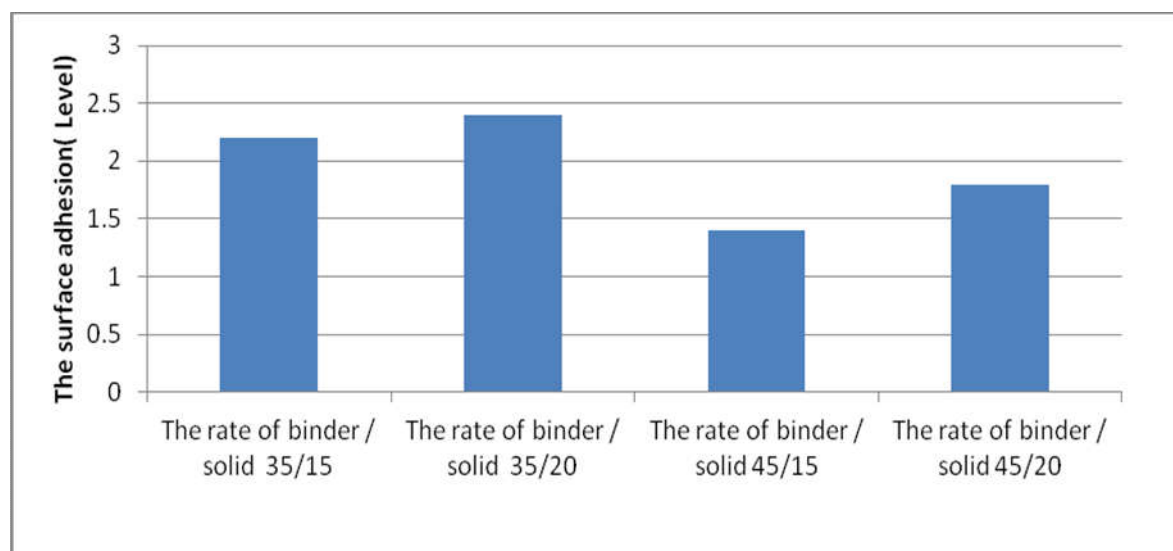
#### 3.1. The effect of composition ratio to the mechanical properties of Alkyde coating film

##### 3.1.1. The influence of composition ratio to the surface adhesion

The study was carried out to identify the effect of ingredient ratio of Alkyde Beckosol 6501-80 and the other ingredients to surface adhesion. The results were shown in the table 3.1 and figure 3.1:

**Table 3.1 The effect of component rate to surface adhesion**

Sample	The surface adhesion (Level)			
	The rate of binder (%) / solids (%)			
	35/15	35/20	45/15	45/20
	Solvent (%)			
	47	42	37	33
Sample 1	2	3	1	2
Sample 2	2	2	1	2
Sample 3	2	3	2	2
Sample 4	3	2	1	2
Sample 5	2	2	2	1
The average value	2.2	2.4	1.4	1.8
The standard deviation S	0.44	0.54	0.54	0.44



**Figure 3.1. The effect of component rate to surface adhesion**

The surface adhesion strength of the paint film was ranked from level 1 of perfectly smooth cuts, the level 2 of less than 5% of bubble surface area of cuts, to level 5 of over 35% of bubble area accounts. The table 3.1 and figure 3.1 showed when the ratio of binder composition was changed from 35% to 45%, the solid powder was changed from 15% to 20%, and the surface adhesive was changed from level 1, 2 to 3. At the rate of binder/solid is 45/15 and 45/20, the surface adhesive reached the highest average values at the degree of 1.4 and 1.8. At the rate of binder/solid of 35/15 and 35/20, the surface adhesive was more inferior, reached at average value of 2.2 and 2.4 degree. This could be seen that in the film

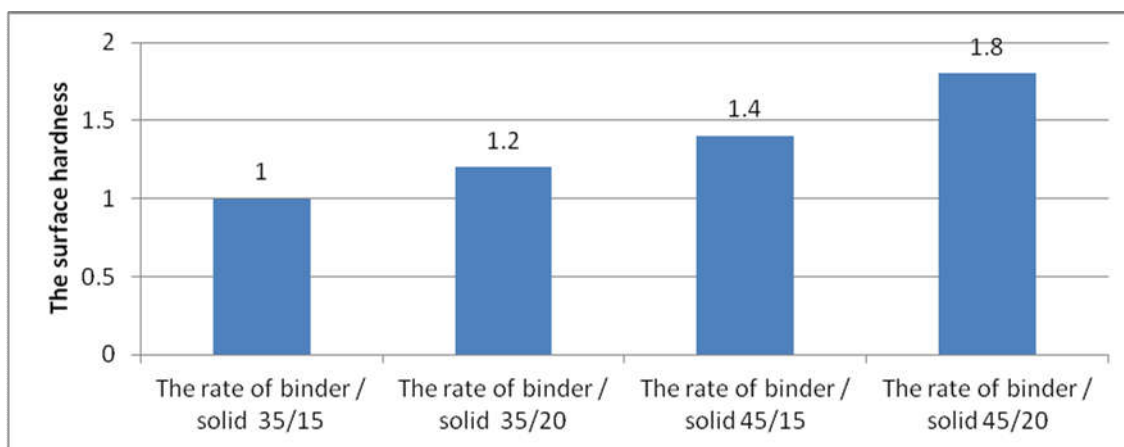
coating, the strength depends on the binder and the rate of the component. At the same kind of binder, the more binder has the more surface adhesive reaches because of good spreading and contact with the base board. On the other hand, the solid filler also influences on surface adhesion, if the amount of solid filler is too much, it may prevent the contact of binder with base surface, and reduce the surface adhesion.

### **3.1.2. The influence of composition ratio to the surface hardness**

The results of effect of the ratio of components to the surface hardness were clearly shown in the table 3.2 and figure 3.2:

**Table 3.2. Effect of rate components to surface hardness**

Sample	The surface hardness			
	The rate of binder/ solids (%)			
	Solvent (%) 47	Solvent (%)42	Solvent (%)37	Solvent (%)33
	35/15	35/20	45/15	45/20
Sample 1	1H	1H	2H	2H
Sample 2	1H	2H	1H	1H
Sample 3	1H	1H	1H	2H
Sample 4	1H	1H	2H	2H
Sample 5	1H	1H	1H	2H
The average value	1H	1.2H	1.4H	1.8H
The standard deviation S	0	0.44	0.543	0.44



**Figure 3.2. The impact of component rate to surface hardness**

The surface hardness was tested by pencil method, the hardness value increases from 6B to 6H. The data from the table 3.2 was showed that when rate of binder changed from 35% to 45% and the solid powder changed from 15% to 20 % , the surface hardneess reached high level at H and 2H. The highest value of surface hardness reached 1.8H at rate of binder/solid powder 45/20, and reached 1.4H at rate of binder/solid powder 45/15. The surface hardness reduced at the rate of 35/20 and 35/15. This was explained that the surface hardness depends on the binder and the total of solid powder in paint. If total of solid powder in paint increase than surface hardness of paint

will increase. When rate of binder /soilid powder of 45/20 and 45/15, which had higher binder, the surface spread was more equally, so that surface hardness was more incresed than that of 35/15 and 35/20. Comparing the same ratio of binder but defference solid powder, if paint has higher rate of solid than it will have higher hardness, so that surface hardneesn of samples of rate 35/20 and 45/20 had higher than that of 35/15 and 45/15.

### ***3.1.3. The influence of composition ratio to the bending strength of paint film.***

The influence of composition ratio to the bending strength of paint film was shown in the table 3.3 and the figure 3.3:

**Table 3.3. The influence of composition ratio to the bending strength of paint film**

Sample	The bending strength of paint film			
	The rate of binder/ solids (%)			
	Solvent (%) 47	Solvent (%) 42	Solvent (%) 37	Solvent (%) 33
	35/15	35/20	45/15	45/20
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	1	1	1
5	1	1	1	1
The average value	1	1	1	1

The bending strength of paint film was detemined when using rollers of deference diameter that makes the surface broken or damaged. The rollers have diameter from 1mm to 32 mm. If the paint film is broken by the smaller of rollers diameter, they will have the higher of bending strength. The data from the table 3.3 showed that the bending strength of all samples reached high value atlevel 1 (roller diameter at 1mm). When rate of components of paint was changed as research scopts, the bending strength of paint film was not effected too much.

*In Conclusion:* From the research on the effects of composition ratio to the mechanical properties ofsurface film of the alkyd paint. It can be seen that the quality of surface film reached higher at the rate of binder/solid powder of 45/15 and 45/20.

### **3.2. The study on effect of ratio of components to the physical properties of paint Alkyd film**

#### ***3.2.1. The influence of composition ratio to surface and perfect dry time of paint film***

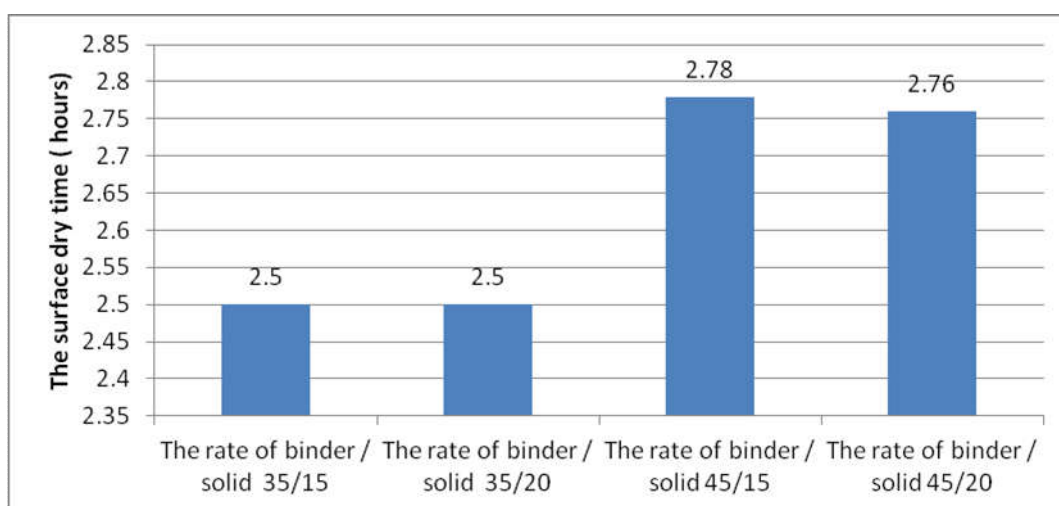
The effect of the composition ratio to dry time of paint film was studied, and the results were indicated in tables 3.4 and 3.5:

**Table 3.4. The influence of ratio of binder and solid powder to surface dry time of paint film**

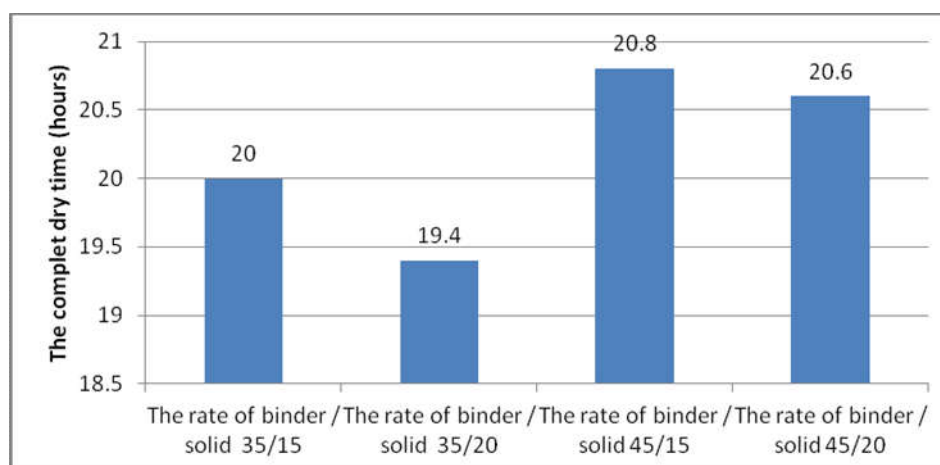
<b>The surface dry time (hours)</b>				
<b>Sample</b>	<b>The rate of binder/ solids (%)</b>			
	<b>Solvent (%) 47</b>	<b>Solvent (%) 42</b>	<b>Solvent (%) 37</b>	<b>Solvent (%) 33</b>
	<b>35/15</b>	<b>35/20</b>	<b>45/15</b>	<b>45/20</b>
	47	42	37	32
1	2.5	2.5	2.7	2.8
2	2.5	2.5	2.8	2.7
3	2.5	2.5	2.8	2.8
4	2.5	2.5	2.8	2.8
5	2.5	2.5	2.8	2.7
Average value	2.5	2.5	2.78	2.76
The standard deviation S	0	0	0.044721	0.054772

**Table 3.5. The influence of ratio of binder and solid powder to complete dry time of paint film**

<b>The perfect dry time (hours)</b>				
<b>Sample</b>	<b>The rate of binder/ solids (%)</b>			
	<b>Solvent (%) 47</b>	<b>Solvent (%) 47</b>	<b>Solvent (%) 47</b>	<b>Solvent (%) 47</b>
	<b>35/15</b>	<b>35/20</b>	<b>45/15</b>	<b>45/20</b>
1	20	20	21	21
2	20	19	20	20
3	20	19	21	21
4	20	19	21	20
5	20	20	21	21
The average value	20	19.4	20.8	20.6
The standard deviation S	0	0.547723	0.447214	0.547723



**Figure 3.3. The influence of ratio of binder and solid powder to surface dry time of paint film**



**Figure 3.4. Influence of ratio of binder and solid powder to complete dry time of paint film**

The data from tables 3.4 and 3.5 and figure 3.3, 3.4 was showed the surface dry time of the paint film reached from 2.5 to 2.8 hours, the complete dry time reached from 19 to 21 hours. It means that, the dry time of paint film has reached high value, it is necessary to have solution to reduce dry time of paint. The highest time of dry paint film at the sample of

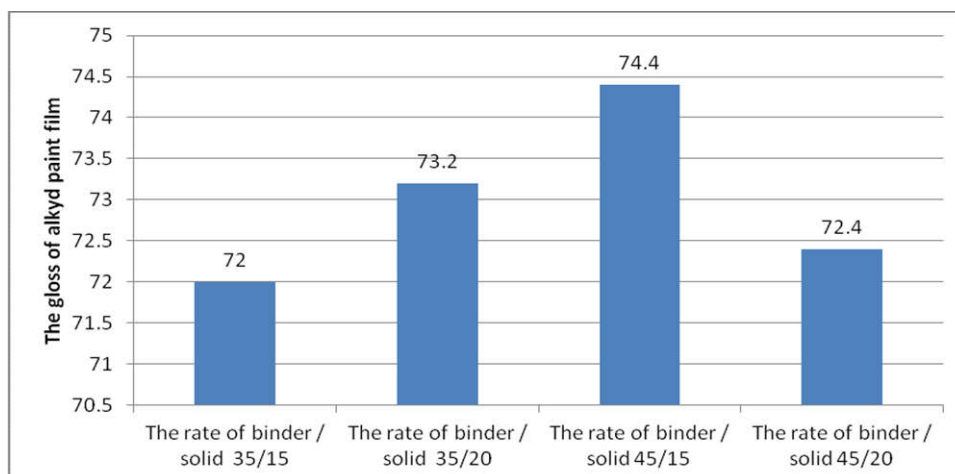
rate binder/solid is 45/15 and 45/20.

### 3.2.2. The influence of composition ratio to gloss of paint film

The effect of the composition ratio to gloss of Alkyd paint film was determined, and the results were indicated in the table 3.6, figure 3.5:

**Table 3.6. The effect of binderratio, solid to gloss of Alkyd paint film**

Sample	The gloss of Alkyd paint film			
	The rate of binder/ solids (%)			
	Solvent (%) 47 35/15	Solvent (%) 42 35/20	Solvent (%) 37 45/15	Solvent (%) 33 45/20
1	72	73	74	72
2	72	74	74	72
3	73	72	74	72
4	72	75	75	73
5	71	72	75	73
Average value	72	73.2	74.4	72.4
The standard deviation S	0.707107	1.30384	0.547723	0.547723



**Figure 3.5. The influence of ratio of binder and solid powder to gloss of Alkyd paint film**



The data from table 3.6 was showed that when the rate of binder changed from 35% to 45% and solid powder changed from 15% to 20% of total input volume, the gloss changed from 71 to 75. The equal spread of paint film was assessed by measuring the gloss of paint film, if the false of gloss of paint film is small, it means that the spread paint on the surface is equal. The sample of rate binder/solid is 35/15 and 35/20 gives high of the false of gloss of

paint film, so that the spread paint on the surface equally is small. The spread of paint film reached equally at the rate of binder/solid of 45/15 and 45/20.

### **3.2.3. The effect of components rate to chemical durability of paint film**

The effect of the composition ratio to acids, bases resistant was identified, the results were indicated in the table 3.7, table 3.8, and the figure 3.6, 3.7:

**Table 3.7. The effect of composition ratio to acid resistant of Alkyd paint film**

<b>The effect of composition ratio to acid resistant</b>				
<b>Sample</b>	<b>The rate of binder/solids (%)</b>			
	<b>Solvent (%) 47</b>	<b>Solvent (%) 42</b>	<b>Solvent (%) 37</b>	<b>Solvent (%) 33</b>
	<b>35/15</b>	<b>35/20</b>	<b>45/15</b>	<b>45/20</b>
	GR	GR	GR	GR
1	75.7	70.2	82.4	81.3
2	70.4	74.6	82.1	83.1
3	72.2	73.6	82.4	78.9
4	69.4	71.2	82.6	81.3
5	73.2	67.5	82.1	78.6
The average value	72.1	71.4	82.3	80.6
The standard deviation S	2.4	2.8	0.2	1.8

**Table 3.8. The effect of composition ratio to bases resistant of Alkyd paint film**

<b>The effect of composition ratio to bases resistant</b>				
<b>Sample</b>	<b>The rate of binder/solids (%)</b>			
	<b>Solvent (%) 47</b>	<b>Solvent (%) 42</b>	<b>Solvent (%) 37</b>	<b>Solvent (%) 33</b>
	<b>35/15</b>	<b>35/20</b>	<b>45/15</b>	<b>45/20</b>
	GR	GR	GR	GR
1	75.3	70.8	81	81
2	73.2	72.6	83.5	82.8
3	72.8	72	82.6	78.9
4	73.6	72.6	84	80.5
5	74.6	73.6	83.7	82.6
The average value	73.9	72.32	82.96	81.16
The standard deviation S	1.029563	1.025671	1.213672	1.607171

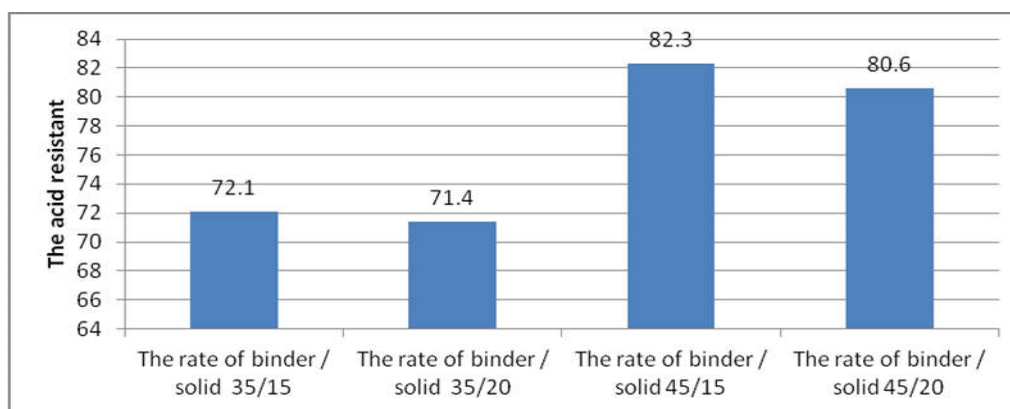


Figure 3.6. The effect of composition ratio to acid resistant of Alkyd paint film

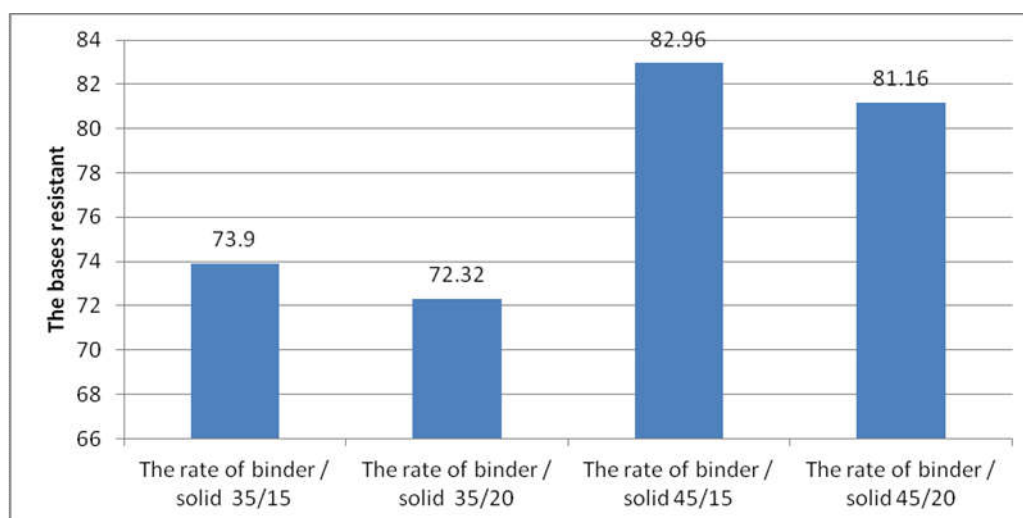


Figure 3.7. The effect of composition ratio to bases resistant of Alkyd paint film

The effect of composition ratio to bases acid resistant of Alkyd paint film depends on the rate of binder and solid. The acids, bases resistant reached well when gloss of paint film changed not too much before and after using acid and bases to make test, after acids bases test, the gloss of paint film has to reach more than 90% of the previous gloss. When the rate of binder and solid changed as chosen, the bases acid resistant of Alkyd paint film reached medium level at the value from 70% to 83%. From the above data, it can be necessary to carry out the research to improve chemical resistant of alkyd paint. The bases acid resistant of Alkyd paint film reached better at rate of binder and solid of 45/15 and 45/20.

*Conclusion:* The data from the research has

showed that bases acid resistant of Alkyd paint film reached 45/15 and 45/20 and gave the good quality.

#### IV. CONCLUSION

The effects of ratio of binder 6501-80 alkyd and solids powder to coating layer quality of wood were studied, and the results were showed as follows:

When the rate of 6501-80 alkyd binder changed from 35% to 45%, and the rate of solids powder changed from 15% to 20%, the surface adhesion of paint reached level 1, 2 and 3, depending on the composition ratio; hardness reached level 1H and 2H; Bending strength reached level 1; Dry surface time reached from 2.5 to 2.8 hours, the complete drying time reached from 19 to 21 hours; The gloss of alkyd paint reached range from 72 to

75; The Acid bases resistance reached level from 70% to 84%.

The mechanical and physical properties of alkyde paint film reached the highest quality when the rate of binder at 45% of total input quality of paint film of 15% solid powder is better than it of 20%. However, this difference is not very significant, so the rate of binder and solid using for wood reached the most suitable level is when the binder is 45% and solids powder is 20 % of the total input volum.

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## NGHIÊN CỨU ẢNH HƯỞNG CỦA TỶ LỆ NHỰA BECKOSOL 6501-80 VÀ CHẤT RẮN ĐẾN TÍNH CHẤT MÀNG SƠN ALKYD LỚP NGOÀI DÙNG CHO ĐỒ GỖ

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<sup>1,2,3,4</sup>Trường Đại học Lâm nghiệp

#### TÓM TẮT

Sơn Alkyde là sơn có độ bóng cao, cứng, dẻo, bền với nước, ánh sáng và thời tiết, khả năng dán dính tốt với gỗ, kim loại và vật liệu khác, tuy nhiên những nghiên cứu về sơn alkyd ở Việt Nam chưa nhiều. Bài báo này nghiên cứu về ảnh hưởng của tỷ lệ nhựa Beckosol 6501-80 và chất rắn Oxit titan, Lithopone, CaCO<sub>3</sub> đến tính chất màng sơn alkyd lớp ngoài dùng cho đồ gỗ. Kết quả chỉ ra khi tỷ lệ nhựa alkyd 6501-80 thay đổi 35%, và 45%, tỷ lệ chất rắn thay đổi 15% và 20%, độ bền bám dính của màng sơn đạt cấp độ 1.2 và 3 tùy theo tỷ lệ thành phần, độ cứng màng sơn đạt ở mức độ 1H và 2H, độ bền uốn màng sơn đạt ở cấp độ 1, thời gian khô lớp mặt của màng sơn từ 2,5 đến 2,8 giờ, thời gian khô triệt để 19 đến 21 giờ, độ bóng của sơn nằm trong khoảng từ 72 đến 75, khả năng chịu axit bazơ của sơn đạt mức độ 70 đến 84%. Tính chất cơ học, vật lý của màng sơn tốt cao nhất khi tỷ lệ nhựa 45% nhưng ở tỷ lệ chất rắn 15% sẽ cao hơn tỷ lệ chất rắn 20%. Tuy nhiên sự chênh lệch này không đáng kể, vì vậy, tỷ lệ thành phần hợp lý nhất cho tạo sơn Alkyde lớp mặt cho đồ gỗ là tỷ lệ nhựa 45% và tỷ lệ chất rắn 20%.

**Từ khóa:** Beckosol 6501-80, chất lượng lớp phủ bề mặt, sơn Alkyd, tính chất cơ học, tính chất vật lý.

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