Jurnal E-KOMTEK (Elektro-Komputer-Teknik)
Vol. 5, No. 1 (2021) pp. 110-122
https://jurnal.politeknik-kebumen.ac.id/index.php/E-KOMTEK
p-ISSN : 2580-3719 e-ISSN : 2622-3066

Effect of Accelerator Addition on the Drying Time, Thickness and Glossy Clear Coat in Vehicle's Body

M. Fajar Sidiq, **Sultanul Reza Islami**, **M. Agus Shidiq**
Department of Faculty of Mechanical Engineering, Universitas Panca Sakti Tegal, Indonesia, 52121

sultanulreza@gmail.com

https://doi.org/10.37339/e-komtek.v5i1.441

Published by Politeknik Dharma Patria Kebumen

Artikel Info
Submitted:
16-02-2021
Revised:
08-03-2021
Accepted:
12-03-2021
Online first :
30-06-2021

Abstract

Painting is the application of paint in liquid form onto the object, to create a thin layer which is then dried to form a hard layer or layers of paint. Many things are influential in the painting process, including the clear coat process which functions as a gloss effect and protects and maintains the paint color of the vehicle. In this research, it was expected to know the effect of the ratio between the thinner and accelerator on the clear coat on drying time, thickness, and glossiness of the clear coat. In this study, the mixture ratio variations of accelerator and thinner used were 0%: 100%, 25%: 75%, 50%: 50%, 75%: 25%. The speeds of drying with the aforementioned ratio of accelerator and thinner were 28 mins, 24 mins, 18 mins, and 16 mins respectively, while the values of the thickness of the ratio were 53, 4 µm, 55.6 µm, 54.03 µm, and 57.1 µm respectively, and the glossiness values of the accelerator and thinner with the ratio were 96.1 Gu, 95.4 Gu, 92.5 Gu, and 93.1 Gu respectively.

Keywords: *Accelerator, Thinner, Drying time, Thickness, Glossy*

Abstrak

Melukis adalah pengaplikasian cat dalam bentuk cair pada objek, untuk membuat lapisan tipis yang kemudian dikeringkan untuk membentuk lapisan atau lapisan cat yang keras. Banyak hal yang berpengaruh dalam proses pengecatan, diantaranya adalah proses clear coat yang berfungsi sebagai efek kilap dan melindungi serta mempertahankan warna cat kendaraan. Dalam penelitian ini diharapkan dapat diketahui pengaruh perbandingan thinner dan akselerator pada clear coat terhadap waktu pengeringan, ketebalan, dan kilap clear coat. Pada penelitian ini, variasi rasio campuran akselerator dan thinner yang digunakan adalah 0% : 100%, 25% : 75%, 50% : 50%, 75% : 25%. Kecepatan pengeringan dengan perbandingan akselerator dan pengencer tersebut masing-masing adalah 28 menit, 24 menit, 18 menit, dan 16 menit, sedangkan nilai ketebalan rasio adalah 53, 4 m, 55.6 m, 54.03 m, dan 57,1 m. m, dan nilai glossiness dari akselerator dan thinner dengan perbandingan masing-masing adalah 96,1 Gu, 95,4 Gu, 92,5 Gu, dan 93,1 Gu.

***Kata-kata kunci**: Akselerator, Tipis, Waktu pengeringan, Ketebalan, Glossy*

1. Introduction

Paint is a liquid that is used to coat the surface of objects to decorate, beautify, and protect the surface of objects [1]. Over time, the paint deteriorates in quality, such as discoloration, scratches, or peeling. The damaged part of the paint can cause a decrease in its aesthetic value and if left unchecked, corrosion will damage the metal surface due to the damage to the protective layer, so the paint also needs to be repaired [2].

To repair this damage, it could be done by repainting only the damaged part or the entire surface covered in paint. The painting process can be done in various ways, from the traditional process by ketok magic to the modern processes with robotic assistance [3].

One of the important factors affecting the quality of car paint is the work of a clear coat which functions as a glossy effect and protects and maintains the paint color of the vehicle [4]. Many industrial painting services try things that are considered better in terms of workmanship and economics, such as adding the accelerator to the clear coat process. An accelerator is a substance that accelerates the drying of a clear coat, aiming to speed up the working process so that productivity increases.

Even so, there are not many studies that discuss the use of accelerators in the painting process. Therefore, the authors researched the effect of variations in the comparison of accelerators with thinners in the painting process. Based on the aforementioned description, this study used an accelerator as additional materials in the clear coat process which was tested by testing methods of drying, quality (gloss), and thickness.

2. Method

2.1 Material

a. Paints

Paints are viscous liquids consisting of resins, pigments, solvents, and additive components that are mixed to form a uniform coating [5]. Pigment (dye) cannot mix with water, oil, and even solvents. Therefore, this pigment needs to be mixed with a binder (resin) so that it can stick to the object to be sprayed. The role of the solvent (thinner) is to dilute the properties of the paint mixture.

b. Solvent/ Thinner

Solvents are liquids that dissolve the pigment and resin so that the resin can be mixed in the paint. In the mixing, the ratio between the thinner and the paint becomes very important to

be taken into account. The mixture that is too thick or too thin will cause problems in the painting process and its results. When spraying the paint, if the mixture is too thick, the result is rough because the paint cannot flow properly. On contrary, if the mixture is too liquid, it flows too easily and results in a melting effect, and the paint dries quickly [6].

c. Clear Coat

A clear coat is the top layer of vehicle paint. The goal is to increase the resistance of base coat environmental and scratches and to give the desired finish, such as a high gloss appearance or matt effect (no shine).

Basically, in the process of painting, there is no standardized comparison between the varnish thinners, it depends on each operator to determine the ratio of paint, but the composition affects many things including the level of viscosity, the coating process, the consumption in terms of financing, and gloss of the paint.

d. Accelerators

Without raising the concentration or temperature of the reaction, the reaction rate can be accelerated by providing catalysts or other substances. This substance is called an accelerator. Accelerators can speed up the reaction, but no permanent chemical changes that will occur, so that the substance can be recovered at the end of the reaction [7].

Catalyst is added to paint to speed up the drying and hardening. They include drying agents (desiccants, siccative), which in the case of air-drying binders (including some unsaturated alkyd resins or oils), accelerate the decomposition of the peroxides and hydroperoxides formed during the drying process [8].

However, the previously done studies rarely used accelerators in the painting process; most of them only relied on drying of the thinner concentration, even though there is no definite mixture ratio based on its use [9] [10]. Therefore, the authors tested the use of an accelerator in the painting process with the ratios of the accelerator and the thinner mixture of 0%: 100%, 25%: 75%, 50%: 50%, 75%: 25% in the Clear Coat process.

2.2 Methods

This study was experimental research, where the researchers controlled the variables and observed their effects on the dependent variable. In this study, the independent variable was the variation of the addition of accelerator and thinner on the implementation of Clear Coat, i.e. 100%: 0%, 25%: 75%, 50%: 50%, and 75%: 25% of the total clear coat. The dependent variables in this study were gloss, thickness, and drying speed.

Control variables used in this study were Standard paint equipment condition, Spray angle was the angle of the standard work, i.e. ± 90 ° with respect to the position of the working field, and Spraying using an automatic compressor with a pressure of 5-8 bar while the air pressure of the spray gun was 2-4 bar.

a. Research Flow Chart

The research process followed a schematic diagram as shown by **Figure 1**.

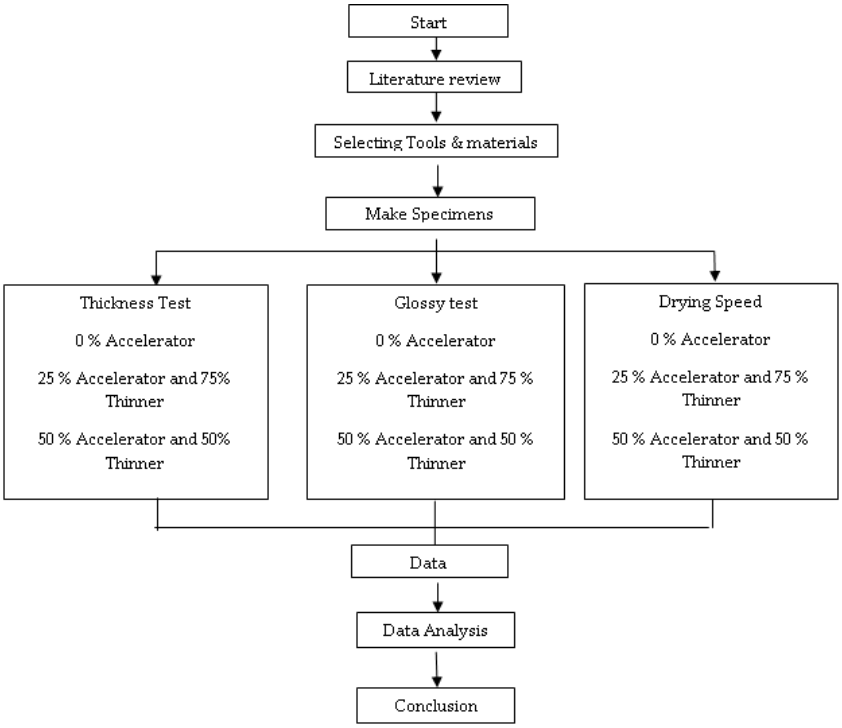

Figure 1. Flowchart Research

b. Preparation of Test Specimens

The material used in this painting process was aluminum plate. Material preparation was done by making the test specimens according to the dimensions specified by the specimen as follows: Length = 20 cm; Width = 20 cm; Height = 0.7 cm.

c. Thickness Testing

The purpose of the test was to determine the thickness of the coating on the vehicle body, using CEM Coating Thickness Gauge DT-156. It took a few minutes for the tool to adjust the correct material values to get the thickness values. After the thickness value was correct, then the researchers recorded and analyzed it through experiments 2 to 3 at each point that had been marked for measurement on the same specimen material (1 specimen). Then, the researchers recorded the value and took the average of the 5-result test. In this way, from the obtained average values, the researchers got the thickness of the layer covering the tested material by the

formula:

$$\text{Thickness of clearcoat} = \text{total thickness of base paint and clearcoat} - \text{thickness of paint (basecoat)} \quad \ldots (1)$$

In the thickness testing process, each board was divided into 5 test points, then the average value of each board was taken to plot the test points on each board as **Figure 2**.

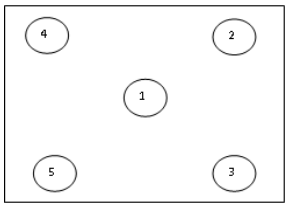

Figure 2. Thickness Testing Area

Coating thickness gauge presented in the **Figure 3**.

Figure 3. Coating Thickness Gauge

1) Glossy Test

Gloss test was conducted to find out the results of a quality value of gloss clearcoat layer, this test used a measuring instrument Glossmeter. The researchers divided the result of painting each board into a 3-point gloss test, then took the average value of each test points on the board so that each board painting results are as **Figure 4**.

Point Measurement 1	Point Measurement 2	Point Measurement 3

Figure 4. Test Point on The Plate Gloss Paintwork

The researchers used Glossmeter YG60S 600 models presented in the **Figure 5**.

Figure 5. Glossmeter

2) Drying Speed Test

In the drying proceeds from the painting process to adjust on the type of paint used, the method of drying itself was divided into [11]:

a) Drying Oven

The researchers used special paint booths equipped with a heater (oven) to accelerate the paint dries. The heat source provided by the oven were obtained from heating from electricity or from combustion [12].

b) Non-oven drying

It is a drying process without the use of an oven or for drying paint: the paint dried itself in normal air conditions (normal air). To do this, dry the paint on the outside air temperature of ±25°C-30°C. Drying without tools is usually carried out in a well-ventilated area.

The drying time of the paint varies from one brand to another and it is usually up to the paint manufacturer to consider the factors involved in achieving the perfect drying condition. For example, if dust is no longer stuck to the surface that is sprayed (dust-free), then it is a dust-free drying time which usually takes 0.5 hours, track-free (no trace), no stickiness even when pressed is achieved within 3 hours, dry if dry enough for hand-fitting is achieved within 12 hours, and hard dry if it is hard enough for some other operations it takes 20 hours [13]. For the drying time of the paint, many factors influence it, such as the quality of the paint, room temperature, thinner, and the paint layer used. Drying paint indicator can be seen in the **Figure 6.**

Figure 6. Drying Paint Indicator [14]

The researchers used the adhesion-free category in this test.

Drying speed = End Time - Initial Time …. (2)

The clear coat is not dry but adhesion-free can be seen in the **Figure 7.**

Figure 7. The Clear Coat is not Dry but Adhesion-Free

The clear coat has dried adhesion free can be seen in the **Figure 8.**

Figure 8. The Clear Coat Has Dried Adhesion

3. Results and Discussion

The research process was carried out in a painting room with a room temperature of 36^{0}C. This research was conducted to obtain the results of testing the effect of adding an accelerator in the clear coat process with a mixture variation between the accelerator and the thinner, following the variation of the mixture 0%: 100%, 25%: 75%, 50%: 50%, 75%: 25%, then comparing the mixture variation results with the best specimens that can be used as a reference or accelerator mixing formula.

a. Drying Speed Test Results

The following are the results of the clear coat drying speed test with variations in the addition of an accelerator. Data of clear coat drying time presented in the **Table 1.**

Table 1. Data of Clear Coat Drying Time

No	Specimen	Finish Time Process Clear coat T1 (minute)	Sticky Free Dry time T2 (minute)	Total Drying Time ΔT (minutes)	Average Drying Time (minutes)
1	A1	13:48	14:16	28	28
	A2	13:48	14:16	28	
	A3	13:48	14:16	28	
2	B1	14:32	14:56	24	24
	B2	14:32	14:56	24	
	B3	14:32	14:56	24	
3	C1	15:18	15:36	18	18
	C2	15:18	15:36	18	
	C3	15:18	15:36	18	
4	D1	16:00	16:16	16	16
	D2	16:00	16:16	16	
	D3	16:00	16:16	16	

Note : A= Full Thinner 100 %
B=Thinner 75 % Accelerator 25 %
C=Thinner 50 % Accelerator 50 %
D=Thinner 25 % Accelerator 75 %

Drying speed test results on additional accelerator clear coat with a variation of a mixture of 100%: 0% thinner and accelerator resulted in the average value of the speed of drying time of 28 minutes. And variations in the mixture 75%: 25% thinner and accelerator resulted in the average value of the speed of drying time of 24 minutes. Meanwhile, variations mixture of 50%: 50% thinner and accelerator resulted in the average value of the speed of drying time of 18 minutes. Then, variations mixture of 25%: 75% thinner and accelerator resulted in the average value of the speed of drying time of 16 minutes. Graph of drying speed test results presented in the **Figure 9.**

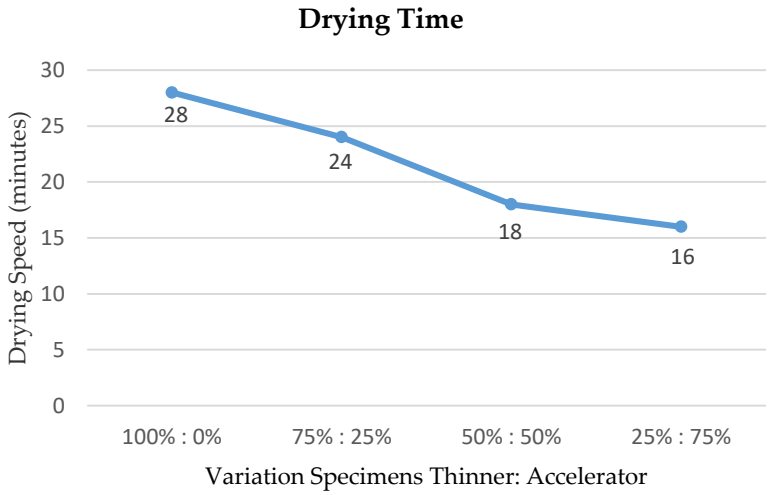

Figure 9. Graph of Drying Speed Test Results

On the data above, it can be seen that the variation of the thinner and accelerator mixture with the longest clear coat drying speed is 100%: 0% with the required time of 28 minutes, while with the variation of the thinner and accelerator mixture 25%: 75% the fastest clear coat drying speed namely with a drying time of 16 minutes, in this case in accordance with the purpose of adding an accelerator that the more accelerators, the faster the drying speed.

a. Clear Coat Thickness Testing Results

The thickness test itself was carried out in order to find out whether the variation of the mixture with the addition of the accelerator affects the thickness value of the clear coat. The following is the measurement result of clear coat thickness from the variation of accelerator additions. Base paint thickness data presented in the **Table 2**.

Table 2. Base Paint Thickness Data

No	Specimens	Measuring point					The average point Measurement (µm)	Average Thickness of Base Paint (µm)
		1 (µm)	2 (µm)	3 (µm)	4 (µm)	5 (µm)		
1	A1	25,1	26,4	26,3	21,4	26,4	25,1	26,8
	A2	22,1	20	22	22,2	27,1	22,7	
	A3	29,4	35,9	29,4	34,3	34,3	32,7	
2	B1	31,6	24,3	24,2	31,4	29,2	28,1	28,8
	B2	27,7	22,1	33,7	38,1	32,3	31,1	
	B3	27	22,1	24,5	29,3	32,3	27,2	
3	C1	26,5	24,1	34,3	33,8	32	30,1	30,5
	C2	35,5	34,3	27	33,8	34,4	33	
	C3	27,4	25,8	30,3	28,8	29,7	28,4	
4	D1	25,1	15,2	17,7	27,3	27,2	22,5	26,8
	D2	32,5	22,3	27,5	39,8	27,7	29,9	
	D3	34,8	22,5	22,6	32,5	27,7	28	

Thickness measurement data of base paint and clear coat presented in the **Table 3.**

Table 3. Thickness Measurement Data of Base Paint & Clear Coat

No	Spesimen	Measuring point					The average point Measurement (µm)	Average Thickness of Base Paint & Clear coat (µm)
		1 (µm)	2 (µm)	3 (µm)	4 (µm)	5 (µm)		
1	A1	73	85	76	76	75	77	80,2
	A2	70	63	76	79	82	74	
	A3	84	85	86	95	98	89,6	
2	B1	85	90	63	91	80	81,8	84,4
	B2	94	85	91	90	81	88,2	
	B3	85	73	91	76	91	83,2	
3	C1	88	79	85	83	91	85,2	91,3
	C2	88	79	85	83	91	85,2	
	C3	82	82	76	85	91	83,2	
4	D1	76	65	83	72	87	76,6	87,5
	D2	91	74	85	94	86	86	
	D3	94	81	87	85	98	89	

Total clear coat thickness data presented in the **Table 4.**

Table 4. Total Clear Coat Thickness Data

No	Specimens	Base Paint & Clear coat thickness (t2) (μm)	Base Paint Thickness (t1) (μm)	Clear Coat Thickness (t2 – t1) (μm)	Total average Clear coat Thickness (Δt) (μm)
1	A1	77	25,1	51,9	53,4
	A2	74	22,7	51,3	
	A3	89,6	32,7	56,9	
2	B1	81,8	28,1	53,7	55,6
	B2	88,2	31,1	57,1	
	B3	83,2	27,2	56	
3	C1	85,2	30,1	55,1	54,03
	C2	85,2	33	52,2	
	C3	83,2	28,4	54,8	
4	D1	76,6	22,5	54,1	57,1
	D2	86	29,9	56,1	
	D3	89	28	61	

Note : A= Full *Thinner* 100 %
B=*Thinner* 75 % *Accelerator* 25 %
C=*Thinner* 50 % *Accelerator* 50 %
D=*Thinner* 25 % *Accelerator* 75 %

Table 2, **Table 3**, and **Table 4** above show the measurement results of the thickness of the base paint layer and the total layer of the base coat with clear coat and the thickness of the clear coat. This is done to make it easier to find the value of the thickness of the clear coat.

The results of the clear coat thickness test with the addition of an accelerator with a mixture variation of 100%: 0% thinner and accelerator resulted in an average thickness value of 53.4 μm, a mixture variation of 75%: 25% thinner and accelerator resulted in an average thickness value of 55.6 μm., the variation of the 50%: 50% thinner and accelerator mixture produces an average thickness value of 54.03 μm. And the variation of the mixture 25%: 75% thinner and accelerator produces an average thickness value of 57.1 μm. Diagram of clear coat thickness test results presented in the **Figure 10**.

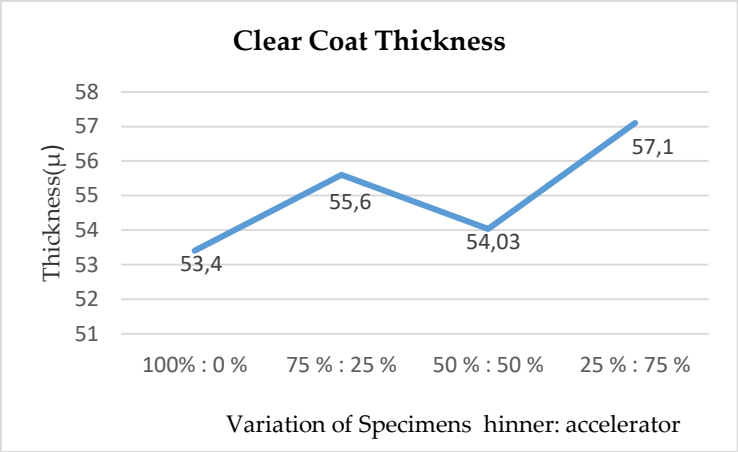

Figure 10. Diagram of Clear Coat Thickness Test Results

Based on the data, the variation of the thinner and accelerator mixture with the lowest clear coat thickness value is 100%: 0% with a thickness value of 53.4 µm, while with the variation of the thinner and accelerator mixture 25%:75% the thickness value is the thickest clear coat. 57.1 µm, in this case the addition of an accelerator to the clear coat process greatly affects the thickness of the clear coat. The more accelerators are added, the thicker the clear coat is, because the amount of thinner is less and affects the viscosity of the clear coat.

b. Glossy test results

The test was carried out to determine the variation of the mixture of accelerator additions which affected the glossy value of the clear coat. The testing used a Glossmeter (Gu) measuring instrument. Below are the results of measurement variation shimmer clear coat with the addition of accelerator. Data On the Glossy Test Results of Clear Coat presented in the **Table 5**.

Table 5. Data On the Glossy Test Results of Clear Coat

No	Specimens	Measuring point			The average point Measurement	Total Average glossy Clear Coat (Gu)
		1	2	3		
1	A1	92	94	95	93,7	96,1
	A2	97	97	95	96,3	
	A3	97	99	99	98,3	
2	B1	95	94	94	94,3	95,4
	B2	97	96	96	96,3	
	B3	95	95	97	95,7	
3	C1	86	94	86	88,7	92,5
	C2	92	95	94	93,7	
	C3	96	95	94	95	
4	D1	93	91	87	90,3	93,1
	D2	96	90	92	92,7	
	D3	96	96	97	96,3	

Note : A= Full *Thinner* 100%
B=*Thinner* 75% *Accelerator* 25%
C=*Thinner* 50% *Accelerator* 50%
D=*Thinner* 25% *Accelerator* 75%

The results of the clear coat glossy test with a mixture variation of 100%:0% thinner and accelerator produce an average glossy value of 96.1 Gu, a mixture variation of 75%:25% thinner and accelerator produces an average glossy value of 95.4 Gu, mixed variations 50%:50% thinner and accelerator get an average glossy value of 92.5 Gu. While the variation of the mixture 25%:75% thinner and accelerator produces an average glossy value of 93.1 Gu. Diagram of clear coat glossy test results presented in the **Figure 11.**

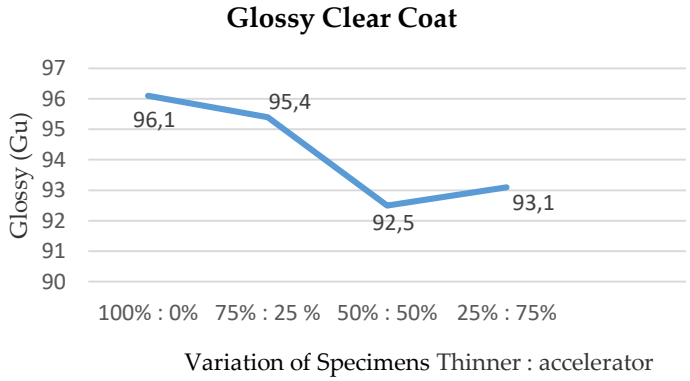

Figure 11. Diagram of Clear Coat glossy Test Results

In **Figure 1**1, it can be observed that the variation of thinner and accelerator mixture with the highest clear coat shine value is 100%:0% with a shine value of 96.1 Gu, while with a mixture of thinner and accelerator 25%:75% get the lowest clear coat gloss value of 93.1 Gu.

Thus, the addition of an accelerator to the clear coat process has an effect on the glossiness of the clear coat. The more accelerator is added, the clear coat decreases the gloss value, this is due to the faster drying process. However, this value is still within the standard luster limit for paint, which is above 70 Gu.

4. Conclusion

Based on the research's results, analysis, and discussion on the effect of adding an accelerator to the clear coat process on drying time, thickness, and gloss of the clear coat on the vehicle body, the following conclusions were drawn:

a. The comparison of the best thinner and accelerator mixture variations for the clear coat drying process was 25%:75% because it had the fastest drying speed of 16 minutes, the ratio of variations in the mixture was very suitable because the more accelerator is added, the faster the clear coat drying process.

b. The best thickness level obtained in the test was in the ratio of variations in the mixture of thinner and accelerator 25%:75% with a thickness value of 57.1 μm. So, it can be concluded

that the addition of an accelerator did not only increase the drying speed of the clear coat but also the thickness of the clear coat.

c. The addition of the accelerator to the glossy clear coat resulted in 93.1 Gu at a ratio of 100%:0% thinner and accelerator variations, where adding the accelerator blend caused a decrease in the gloss value. However, the decrease was still within the standard limit of the glossy value of the clear coat for paint, which was above 70 Gu.

d. The test results showed that the variation of the accelerator and thinner mixture ratio of 75%:25% can best be used in the vehicle body painting process.

References

[1] M. Cesyantikha and Wahyudi, "Analisis Pengaruh Perbandingan Campuran Thinner," *J. Kompetensi Tek. Vol.*, vol. 11, no. 2, pp. 28–33, 2019.

[2] A. KHASIB, "Pengaruh Variasi Penggunaan Thinner Pada Campuran Cat Terhadap Kualitas Hasil Pengecatan," *J. Pendidik. Tek. Mesin UNESA*, vol. 6, no. 01, p. 250865, 2017.

[3] F. Y. Utama, *Teknologi Pengecatan Kendaraan Bermotor*, 1st ed., no. September. Surabaya: Universitas Negri Surabaya, 2018.

[4] D. Setyawan and F. Utama, "Pengaruh Komposisi Mixing Clear Gloss (Vernish) Terhadap Kualitas Hasil Pengecatan Pada Komponen Bodi Kendaraan," *JPTM.*, vol. 6, no. 01, pp. 63–67, 2017.

[5] S. T. Dwiyati, "Pengaruh Kadar Hardener Terhadap Kualitas Produk Pengecatan Plastik," *J. Konversi Energi dan Manufaktur UNJ*, vol. II, pp. 65–72, 2015.

[6] F. I. Permana and S. Anwar, "Pengaruh Kualitas Thinner Pada Campuran Cat Terhadap Hasil Pengecatan," *JTM.*, vol. 03, no. 02, pp. 53–61, 2014.

[7] M. A. Ramdhoni, "Pengaruh variasi temperatur dan accelerator asam nitrit pada proses phospating di aplikasi powder coating mild steel ST 37," UNIVERSITAS JEMBER, 2015.

[8] D. Stoye and W. Freitag, *Paints, Coatings and Solvents*, 2nd ed. Germany: Weinheim, 1998.

[9] M. W. Ardyanto and F. Y. Utama, "Rekayasa Komposisi Mixing Solvent Dan Varnish Terhadap Kualitas Hasil Pengecatan Menggunakan Gloss Meter," vol. 07, pp. 26–33, 2018.

[10] N. J. Habibie and S. Anwar, "Pengaruh Perbandingan Campuran Cat Dengan Thinner Terhadap Kualitas Hasil Pengecataan," *Jtm*, vol. 2, no. 3, pp. 97–104, 2014.

[11] K. B. Hermianto and F. Y. Utama, "Pengaruh Drying Process Terhadap Finishing Top Coat Pada Pengecatan," *Pengaruh Dry. Process Terhadap Finish. Top Coat Pada Pengecatan*, vol. 06, pp. 215–224, 2018.

[12] S. Sukram and S. Sutikno, "Pengaruh Suhu Dan Waktu Tinggal Terhadap Kecenderungan Menguning Pada Proses Produksi Alumunium Fasad," *JATI UNIK J. Ilm. Tek. dan Manaj. Ind.*, vol. 2, no. 1, p. 64, 2019, doi: 10.30737/jatiunik.v2i2.330.

[13] F. PRANATA, "Perbaikan Bodi Dan Pengecetan Mobil Ford Telstar Tahun 1986 AB 1073 MA Bagian Setengah Atap Belakang Dan Belakang," UNIVERSITAS NEGERI YOGYAKARTA, 2012.

[14] Team B&P, *Pedoman Pelatihan Pengecatan*, 2nd ed. Jakarta: PT. Toyota - Astra Motor, 2015.

Effect of Accelerator Addition To The Drying Time, thickness, and Glossy Clear Coat In Vehicle Body

by M. Fajars Sidiq

Submission date: 04-Mar-2021 08:21AM (UTC+0700)
Submission ID: 1523641310
File name: cek_plagiat_ok..pdf (716.73K)
Word count: 4978
Character count: 22992

Pre Review Article Template

ORIGINAL RESEARCH PAPER & CASE STUDY

Effect of Accelerator Addition To The Drying Time, thickness, and Glossy Clear Coat In Vehicle Body

M. FAJAR SIDIQ [1], SULTANUL REZA ISLAMI [2*], M. AGUS SHIDIQ [3]

[1,2,3]Faculty of Mechanical Engineering, Pancasakti University Tegal, Indonesia, 52121

[2*]Email: sultanulreza@gmail.com

Abstract

Painting is the application of paint in liquid form onto the object, to create a thin layer which is then dried to form a hard layer or layers of paint. Many things are influential in the painting process, including the clear coat process which functions as a gloss effect and protects and maintains the paint color of the vehicle. In this research, it is expected to know the effect of the ratio between the thinner and accelerator on the clear coat on drying time, thickness, and glossiness of the clear coat. In this study, the accelerator mixture ratio variations and thinner used is 0%: 100%, 25%: 75%, 50%: 50%, 75%: 25%. The speed of drying with a ratio of accelerator and thinner 0%: 100% 28 min, 25%: 75% 24 min, 50%: 50% 18 min, 75%: 25% 16 minutes, while the value of the thickness ratio of 0%: 100% 53, 4 μm, 25%: 75% 55.6 μm, 50%: 50% 54.03 μm, 75%: 25% 57.1 μm, the glossiness value of the accelerator and thinner ratio 0%: 100% 96.1 Gu, 25%: 75% 95.4 Gu, 50%: 50% 92.5 Gu, 75%: 25% 93.1 Gu.

Keywords: Accelerator; Thinner; Drying Time; Thickness; Glossy

Effect of Accelerator Addition To The Drying Time, thickness, and Glossy Clear Coat In Vehicle Body

1. Introduction

A vehicle will look more attractive with a well-painted exterior. Paint itself is a liquid that is used to coat the surface of objects to decorate, beautify, and protect surface objects[1]. Over time, the paint itself deteriorates in quality, such as discoloration, scratches or peeling, which is usually caused by bumps or old paint. The damaged part of the paint can cause a decrease in its aesthetic value and if left unchecked, corrosion will damage the metal surface due to the damage to the protective layer, so the paint also needs to be repaired [2].

To repair this damage then repair the paint itself could do with repainting just the damaged part only or the process of repainting the entire surface covered in paint. The painting process can be done in various ways, from the traditional process by ketok magic to the modern processes with robotic assistance[3].

During the spraying process, several factors will affect the results of the spraying, including the angle formed by the spray equipment and the workpiece surface, the distance sprayer during spraying, and the repetition of spraying (over lapping) and that should not be overlooked is the ability of the person doing the painting itself[4].

One of the important factors affecting the quality of car paint is the work of a clear coat which functions as a glossy effect and protects and maintains the paint color of the vehicle [5]. Along with the development of renewable technology, the industry is required to be better in terms of processing time, cost efficiency and be more environmentally friendly. Relative to the many industrial painting services that try things that are considered better in terms of workmanship and economical, such as adding the accelerator to the clear coat process. Accelerator itself is a substance that accelerates the drying of clear coat, aiming to speed up the working process so that productivity increases.

Even so, there are not many studies that discuss the use of accelerators in the painting process. Therefore, the authors want to make research on the effect of variations in the comparison of accelerators with thinners in the painting process. From the description above in this study using an

accelerator for additional materials in the clear coat process which will be tested by testing methods of drying, quality (gloss), and thickness.

2. Materials and methods

2.1. Material

2.1.1. Cat

Paints are viscous liquids, consisting of resins, pigments, solvents and additive components that are mixed together to form a uniform coating [6]. Pigment (dye) itself cannot mix with water, oil and even solvents. Therefore, this pigment needs to be mixed with a binder (resin) so that it can stick to the object to be sprayed. The role of the solvent (thinner) is to dilute the properties of the paint mixture.

Types of paint can be divided into several types depending on their function [3], namely:

a) Base Paint, serves to provide a base coat for the final paint, namely color paint

b) Final Paint, paint type is the final polish that gives a colored coating on the surface and when done perfectly then a final layer will dry and form a layer that is very shiny and attractive.

c) Top Coat, commonly referred to as vernish or clear which is overlaid over the final paint. Its use in layered painting to get a glossy or matte effect as well as scratch resistance for metal primers

2.1.2. Zat Diluent(*Solvent*/ Thinner)

Solvents are liquids that dissolve the pigment and resin so that the resin can be mixed in the paint. Although the same function as solvents, there are differences between them. The difference is the use of solvent during the production process of a paint and thinner is used when the painting process to obtain the desired viscosity of the paint

In the mixing, the ratio between the thinner the paint becomes very important to note. The mixture that is too thick or too thin will cause problems in the painting process and the results of the painting process. When spraying paint, if the mixture is too thick then the result will be rough, because the paint cannot flow properly, otherwise if the mixture is too liquid it will flow too easily and will result in a melting effect and the paint dries quickly [7].

2.1.3. Clear Coat

Clear coat is the top layer of vehicle paint. The goal is to increase the resistance of base coat environmental and scratches and to give you a desired finish, such as a high gloss appearance or

effect matt (no shine).

In the vehicle body painting process used Clear coat or more popularly called varnish. This is a final varnish coating on car paint colorless. The vernish function, the first is to bring out the original color of the paint so that it is more shiny and the second, to protect the car paint color so that it is more shiny and does not fade easily. Just below the clear coat or Vernish there is a top coat layer. This is a paint that contains the color of choice, but the surface of this paint is not glossy and is less resistant to UV rays emitted by the sun. Therefore to be given clear coat or varnish coating the top coat will be shiny and not easily fade.

Basically in the process of painting a comparison between the varnish thinners can not be standardized, depending on each operator to determine the ratio of paint, but the composition will affect many things including the level of viscosity, the coating process, the consumption, in terms of financing and gloss of the paint.

2.1.4. Accelerators

Without raising the concentration or temperature of the reaction, the reaction rate can be accelerated by providing catalysts / other substances. This substance is called an accelerator. Accelerators can speed up the reaction, but no permanent chemical changes that will occur, so that the substance can be recovered at the end of the reaction [8].

Catalyst is added to paint to speed up drying and hardening. They include drying agents (desiccants, siccatives), which in the case of air drying binders (including some unsaturated alkyd resins or oils), accelerate the decomposition of the peroxides and hydroperoxides formed during the drying process. Dryer is used mostly metallic soaps such as cobalt naphthenate; manganese, calcium, zinc, and barium salts; and zirconium compounds. [9]

However, it is rare for studies to use accelerators in the painting process, mostly only relying on drying of the thiner concentration, even though there is no definite mixture ratio based on its use [10]. Therefore, the author himself will test the use of an accelerator in the painting process with the ratio of the accelarator and thinner mixture is 0%: 100%, 25%: 75%, 50%: 50%, 75%: 25% in the Clear Coat process.

2.2 Method

In this study, the applied method is experimental research, where the researcher controls the other

related variables and observes their effects on the dependent variable.

a. Independent Variable

In this study, the independent variable is the variation of the addition of accelerator and thinner on the implementation of Clear Coat, ie 100%: 0%, 25%: 75%, 50%: 50%, 75%: 25% of the total clear coat.

b. Dependent variable

The dependent variables in this study were gloss, thickness and drying speed.

c. Control variables

Control variables used in this study are: • standard paint equipment condition • spray angle is the angle of the standard work, ie ± 90 ° with respect to the position of the working field. • Spraying using an automatic compressor with a pressure of 5-8 bar while the air pressure of the spraygun is 2-4 bar.

2.2.1. Research Flow Chart The

The following schematic diagram will do the research process, as Fig.2 below:

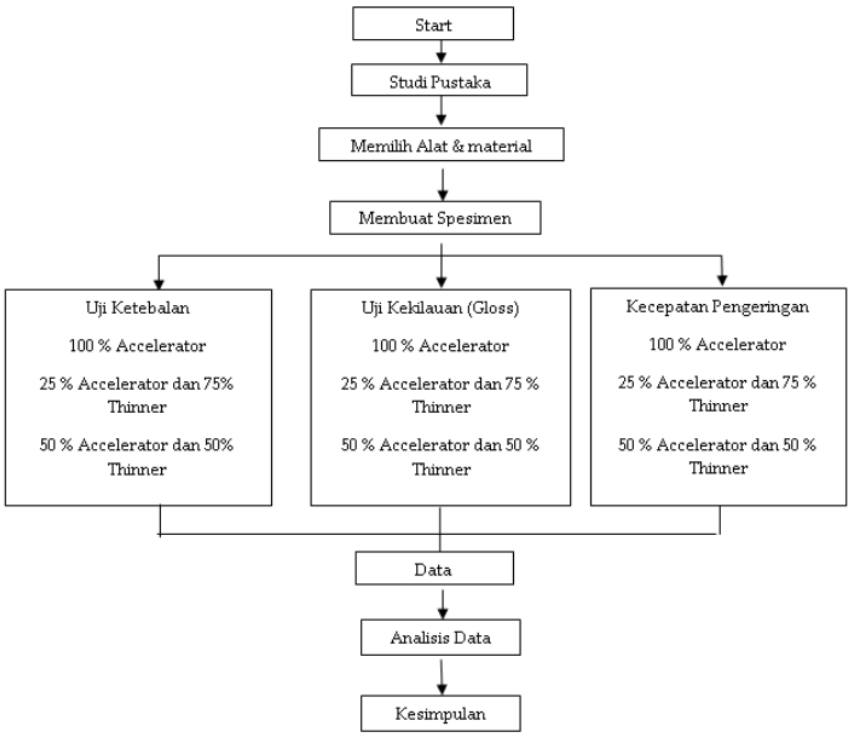

Fig.2 Flowchart Research

2.2.2. Preparation of Test Specimens

The material used in this painting process is aluminum plate. Material preparation is done by making the test specimens according to the dimensions specified by the specimen as follows:

Length = 20 cm; Width = 20 cm; Height = 0.7 cm

The formation of the test specimen is done by cutting the material using a cutting saw, then filing it on the side to get the desired flatness of size.

2.2.3. Thickness Testing

Before testing, we first calibrate the measuring instrument in order to get maximum data. After the tool is calibrated, install the sensor and place it on the surface to be tested. It will take a few minutes for the tool to adjust the correct material values to get the thickness values. After the thickness value is correct, then we can record and analyze it through experiments 2 to 3, do this at each point that has been marked for measurement on the same specimen material (1 specimen) Then record the value and take the average of the 5 results test. In this way, from the obtained average values, we can get the thickness of the layer covering the tested material by the formula :

$$\text{Thickness of clearcoat} = \text{total thickness of base paint and clearcoat} - \text{thickness of paint (basecoat)} \quad \ldots (1)$$

In the thickness testing process, each board is divided into 5 test points, then the average value of each board is taken to plot the test points on each board as follows:

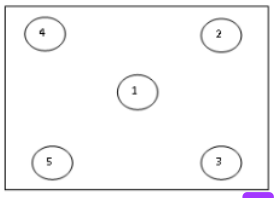

Fig. 3 Thickness Testing area

The purpose of test is to determine the thickness of the thickness of the coating on the vehicle body. Using Coating Thickness Gauge. The coating thickness gauge is a high precision measuring tool for the thickness of the paint layer. This tool has a special design for the measure so as not to damage the coating and able to perform testing quickly and accurately.

The author uses CEM Coating Thickness Gauge DT-156 Instrument with the specifications of measuring instruments as follows:

a. Measuring range 0-1250 μm

b. The guaranteed tolerance is ± 3% + 1 μm.

c. Low range precision of 0.1 μm.

d. Minimum radius of curvature F: 1.5 mm, FN: 3 mm.

e. Minimum area diameter F: 7 mm, FN: 5 mm.

f. Basic critical thickness F: 0.5 mm, FN: 3 mm.

g. Standardization GB / T 4956-1985, GB / T 4975-1985, JJG 889-95, JJG 813-93.

Fig. 4 Coating Thickness Gauge (source: documentation of research)

2.2.4. Glossy Test

Gloss test was conducted to find out the results of a quality value of gloss clearcoat layer, this test using a measuring instrument Glossmeter. Divide the result of painting each board into a 3-point gloss test, then take the average value of each test points on the board so that each board painting results are as follows:

Point Measurement 1	Point Measurement 2	Point Measurement 3

Fig.5 test point on the plate gloss paintwork.

The author uses Glossmeter YG60S 600 models with the specifications of measuring instruments as follows:

a. Measuring angle 60^0

b. Measurement limit 0-200 Gu

c. Measurement time 0.5 s

d. Repeatability: 0-100 *Gu* : ± 0.5 *Gu* ; 100-200 Gu: ± 0.5% *Gu*

e. Standardized JJG 696, meets ASTM D523, ISO 2813.

Fig. 6 Glossmeter (source: documentation of research)

2.2.5. Drying Speed Test

In the drying proceeds from the painting process to adjust on the type of paint used, the method of drying itself is divided into [11]:

a) Drying Oven

Use special paint booths equipped with a heater (oven) to accelerate the paint dries. The heat source provided by the oven can be obtained from heating from electricity or from combustion [12]. The temperature itself is relatively stable and can adjust the drying time as desired.

b) Non-oven drying

The drying process without the use of an oven or for drying paint but the paint will dry itself in normal air conditions (normal air), Dry the paint on the outside air temperature ± 25 ° C-30 ° C. For drying without tools, is usually carried out in a well ventilated area.

The drying time of the paint itself will vary from one brand to another and it is usually up to the paint manufacturer to consider the factors involved in achieving the perfect drying condition. For example, if dust is no longer stuck to the surface that is sprayed (dust-free), then it is a dust-free drying time which is usually achieved in 0.5 hours, track-free (No trace), no stickiness even when pressed is achieved within 3 hours, dry if dry enough for hand-fitting is achieved within 12 hours, and hard dry if it is hard enough for some other operations it takes 20 hours [13]. For the drying time of the paint, many factors influence it, such as the quality of the paint, room temperature, thinner, and the paint layer used.

Picture. 7 Drying Paint Indicator [14]

The author himself uses the adhesion-free category in this test.

Drying speed = End Time - Initial Time …… .. (2)

Figure 8. The *clear coat is* not dry but adhesion-free

Figure 9. The *clear coat* has dried adhesion-free (Source: documentation of research)

.

3. Results and Discussion

The research process was carried out in a painting room with a room temperature of 36^0C. This research was conducted to obtain the results of testing the effect of adding an accelerator in the clear coat process with a mixture variation between the accelerator and the thinner, following the variation of the mixture 0%: 100%, 25%: 75%, 50%: 50%, 75%: 25%, then comparing the mixture variation results with the best specimens that can be used as a reference or accelerator mixing formula.

3.1. Drying Speed Test Results

The following are the results of the clear coat drying speed test with variations in the addition of an accelerator

Table 1.Data of Clear Coat Drying Time

No	Specimen	Finish Time Process Clear coat T1 (minute)	Sticky Free Dry time T2 (minute)	Total Drying Time ΔT (minutes)	Average Drying Time (minutes)
1	A1	13:48	14:16	28	28
	A2	13:48	14:16	28	
	A3	13:48	14:16	28	
2	B1	14:32	14:56	24	24
	B2	14:32	14:56	24	
	B3	14:32	14:56	24	
3	C1	15:18	15:36	18	18
	C2	15:18	15:36	18	
	C3	15:18	15:36	18	
4	D1	16:00	16:16	16	16
	D2	16:00	16:16	16	
	D3	16:00	16:16	16	

Note :
A= Full Thinner 100 %
B=Thinner 75 % Accelerator 25 %
C=Thinner 50 % Accelerator 50 %
D=Thinner 25 % Accelerator 75 %

Drying speed test results on additional accelerator clear coat with a variation of a mixture of 100%: 0% thinner and accelerator resulted in the average value of the speed of drying time of 28 minutes. And variations in the mixture 75%: 25% thninerand accelerator resulted in the average value of the speed of drying time of 24 minutes. While variations mixture of 50%: 50% thinner and accelerator resulted in the average value of the speed of drying time of 18 minutes. And variations mixture of 25%: 75% thinner and accelerator resulted in the average value of the speed of drying time of 16 minutes.

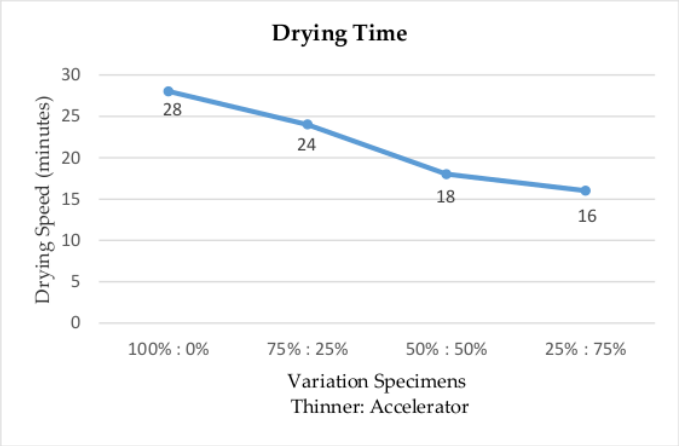

Figure 10. Graph of Drying Speed Test Results

From the data above, it can be seen that the variation of the thinner and accelerator mixture with the longest clear coat drying speed is 100%: 0% with the required time of 28 minutes, while with the variation of the thinner and accelerator mixture 25%: 75% the fastest clear coat drying speed namely with a drying time of 16 minutes, in this case in accordance with the purpose of adding an accelerator that the more accelerators, the faster the drying speed.

3.2. Clear Coat Thickness Testing Results

The thickness test itself is carried out in order to find out whether the variation of the mixture with the addition of the accelerator affects the thickness value of the clear coat, the thickness test itself uses a coating tickness gauge measurement. The following is the measurement result of clear coat thickness from the variation of accelerator additions.

Table 2. Base Paint Thickness Data

No	Specimens	Measuring point					The average point Measurement (µm)	Average Thickness of Base Paint (µm)
		1 (µm)	2 (µm)	3 (µm)	4 (µm)	5 (µm)		
1	A1	25,1	26,4	26,3	21,4	26,4	25,1	26,8
	A2	22,1	20	22	22,2	27,1	22,7	
	A3	29,4	35,9	29,4	34,3	34,3	32,7	
2	B1	31,6	24,3	24,2	31,4	29,2	28,1	28,8
	B2	27,7	22,1	33,7	38,1	32,3	31,1	
	B3	27	22,1	24,5	29,3	32,3	27,2	

3	C1	26,5	24,1	34,3	33,8	32	30,1	30,5
	C2	35,5	34,3	27	33,8	34,4	33	
	C3	27,4	25,8	30,3	28,8	29,7	28,4	
4	D1	25,1	15,2	17,7	27,3	27,2	22,5	26,8
	D2	32,5	22,3	27,5	39,8	27,7	29,9	
	D3	34,8	22,5	22,6	32,5	27,7	28	

Table 3. Thickness Measurement Data of Base Paint & Clear Coat

No	Spesimen	Measuring point					The average point Measurement (µm)	Average Thickness of Base Paint & *Clear coat* (µm)
		1 (µm)	2 (µm)	3 (µm)	4 (µm)	5 (µm)		
1	A1	73	85	76	76	75	77	80,2
	A2	70	63	76	79	82	74	
	A3	84	85	86	95	98	89,6	
2	B1	85	90	63	91	80	81,8	84,4
	B2	94	85	91	90	81	88,2	
	B3	85	73	91	76	91	83,2	
3	C1	88	79	85	83	91	85,2	91,3
	C2	88	79	85	83	91	85,2	
	C3	82	82	76	85	91	83,2	
4	D1	76	65	83	72	87	76,6	87,5
	D2	91	74	85	94	86	86	
	D3	94	81	87	85	98	89	

Table 4. Total Clear Coat thickness data

No	Specimens	Base Paint & Clear coat thickness (t2) (µm)	Base Paint Thickness (t1) (µm)	Clear Coat Thickness (t2 – t1) (µm)	Total average Clear coat Thickness (Δt) (µm)
1	A1	77	25,1	51,9	53,4
	A2	74	22,7	51,3	
	A3	89,6	32,7	56,9	

2	B1	81,8	28,1	53,7	55,6
	B2	88,2	31,1	57,1	
	B3	83,2	27,2	56	
3	C1	85,2	30,1	55,1	54,03
	C2	85,2	33	52,2	
	C3	83,2	28,4	54,8	
4	D1	76,6	22,5	54,1	57,1
	D2	86	29,9	56,1	
	D3	89	28	61	

Note :

A= Full *Thinner* 100 %

B=*Thinner* 75 % *Accelerator* 25 %

C=*Thinner* 50 % *Accelerator* 50 %

D=*Thinner* 25 % *Accelerator* 75 %

Based on tables 2, 3, and 4 above, it shows the measurement results of the thickness of the base paint layer and the total layer of the base coat with clear coat and the thickness of the clear coat, this is done to make it easier to find the value of the thickness of the clear coat.

The results of the clear coat thickness test with the addition of an accelerator with a mixture variation of 100%: 0% thinner and accelerator resulted in an average thickness value of 53.4 µm, a mixture variation of 75%: 25% thinner and accelerator resulted in an average thickness value of 55.6 µm. , the variation of the 50%: 50% thinner and accelerator mixture produces an average thickness value of 54.03 µm. And the variation of the mixture 25%: 75% thinner and accelerator produces an average thickness value of 57.1 µm.

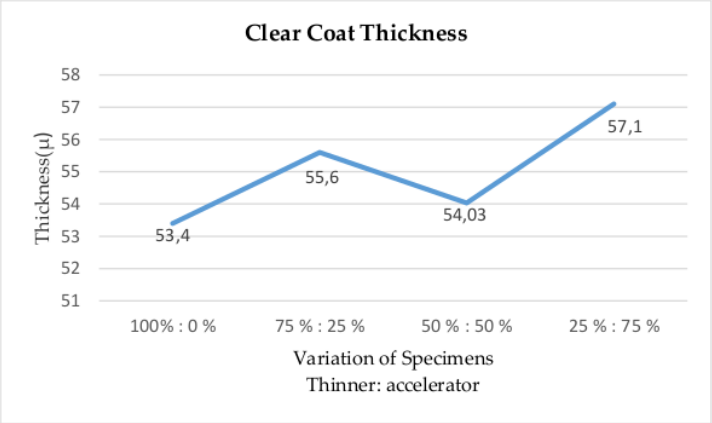

Figure 11. Diagram of Clear Coat Thickness Test Results

Judging from the data, the variation of the thinner and accelerator mixture with the lowest clear coat thickness value is 100%: 0% with a thickness value of 53.4 µm, while with the variation of the thinner and accelerator mixture 25% : 75% the thickness value is the thickest clear coat. 57.1 µm, in this case the addition of an accelerator to the clear coat process greatly affects the thickness of the clear coat. The more accelerators are added, the thicker the clear coat is, this is because the amount of thinner is less and affects the viscosity of the clear coat.

3.3. Glossy test results

The test was carried out to determine the variation of the mixture of accelerator additions which affected the glossy value of the clear coat. Testing using a Glossmeter (Gu) measuring instrument. Below are the results of measurement variation shimmer clear coat with the addition of accelerator.

Table 5. Data on the glossy test results of Clear Coat

No	Specimens	Measuring point			The average point Measurement	Total Average glossy Clear Coat (GU)
		1	2	3		
1	A1	92	94	95	93,7	96,1
	A2	97	97	95	96,3	
	A3	97	99	99	98,3	
2	B1	95	94	94	94,3	95,4
	B2	97	96	96	96,3	
	B3	95	95	97	95,7	
3	C1	86	94	86	88,7	92,5

	C2	92	95	94	93,7	
	C3	96	95	94	95	
4	D1	93	91	87	90,3	93,1
	D2	96	90	92	92,7	
	D3	96	96	97	96,3	

Note :

A= Full *Thinner* 100%

B=*Thinner* 75% *Accelerator* 25%

C=*Thinner* 50% *Accelerator* 50%

D=*Thinner* 25% *Accelerator* 75%

The results of the clear coat glossy test with a mixture variation of 100%: 0% thiner and accelerator produce an average glossy value of 96.1 Gu, a mixture variation of 75%: 25% thinner and accelerator produces an average glossy value of 95.4 Gu, mixed variations 50%: 50% thinner and accelerator get an average glossy value of 92.5 Gu. While the variation of the mixture 25%: 75% thinner and accelerator produces an average glossy value of 93.1 Gu.

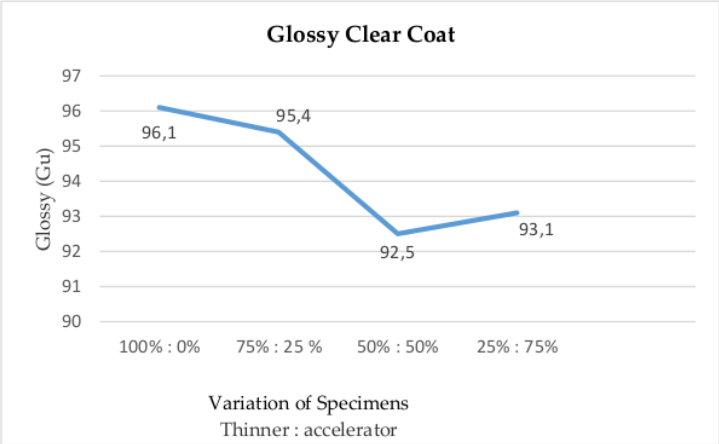

Figure 12. Diagram of Clear Coat glossy Test Results

From the data in Figure 12 you can see the variation of thinner and accelerator mixture with the highest clear coat shine value is 100%: 0% with a shine value of 96.1 Gu, while with a mixture of thinner and accelerator 25%: 75% get the lowest clear coat gloss value of 93.1 Gu.

Thus the addition of an accelerator to the clear coat process has an effect on the glossiness of the clear

coat. The more accelerator is added, the clear coat decreases the gloss value, this is due to the faster drying process. However, this value is still within the standard luster limit for paint, which is above 70 Gu.

4. Conclusion

Based on the resulting research, analysis and discussion of research on the effect of adding an accelerator to the clear coat process on drying time, thickness, and gloss of the clear coat on the vehicle body, in order to obtain the following conclusions from the researcher:

1. The comparison of the best thinner and accelerator mixture variations for the clear coat drying process is 25%: 75% because it has the fastest drying speed of 16 minutes, the ratio of variations in the mixture is very suitable because the more accelerator is added the faster the clear coat drying process.
2. The best thickness level obtained in the test is in the ratio of variations in the mixture of thinner and accelerator 25%: 75% with a thickness value of 57.1 µm. So it can be seen that the addition of an accelerator not only increases the drying speed of the clear coat but also increases the thickness of the clear coat.
3. Addition of accelerator to the glossy clear coat results in 93.1 Gu at a ratio of 100%: 0% thinner and accelerator variations. where adding the accelerator blend causes a decrease in the gloss value. However, the decrease is still within the standard limit of the glossy value of the clear coat for paint, which is above 70 Gu.
4. The test results showed that the variation of the accelerator and thinner mixture ratio 75%: 25% showed variation can best be used in the vehicle body painting process.

5. References

[1] M. Cesyantikha and Wahyudi, "Analisis Pengaruh Perbandingan Campuran Thinner," *J. Kompetensi Tek. Vol.*, vol. 11, no. 2, pp. 28–33, 2019.

[2] A. KHASIB, "Pengaruh Variasi Penggunaan Thinner Pada Campuran Cat Terhadap Kualitas Hasil Pengecatan," *J. Pendidik. Tek. Mesin UNESA*, vol. 6, no. 01, p. 250865, 2017.

[3] F. Y. Utama, *Teknologi Pengecatan Kendaraan Bermotor*, 1st ed., no. September. Surabaya: Universitas Negri Surabaya, 2018.

[4] M. W. Ardyanto and F. Y. Utama, "Rekayasa Komposisi Mixing Solvent Dan Varnish Terhadap Kualitas Hasil Pengecatan Menggunakan Gloss Meter," vol. 07, pp. 26–33, 2018.

[5] D. Setyawan and F. Utama, "Pengaruh Komposisi Mixing Clear Gloss (Vernish) Terhadap Kualitas Hasil Pengecatan Pada Komponen Bodi Kendaraan," *JPTM.*, vol. 6, no. 01, pp. 63–67, 2017.

[6] S. T. Dwiyati, "Pengaruh Kadar Hardener Terhadap Kualitas Produk Pengecatan Plastik," *J. Konversi Energi dan Manufaktur UNJ*, vol. II, pp. 65–72, 2015.

[7] F. I. Permana and S. Anwar, "Pengaruh Kualitas Thinner Pada Campuran Cat Terhadap Hasil Pengecatan," *JTM.*, vol. 03, no. 02, pp. 53–61, 2014.

[8] M. A. Ramdhoni, "Pengaruh variasi temperatur dan accelerator asam nitrit pada proses phospating di aplikasi powder coating mild steel ST 37," UNIVERSITAS JEMBER, 2015.

[9] D. Stoye and W. Freitag, *Paints, Coatings and Solvents*, 2nd ed. Germany: Weinheim, 1998.

[10] N. J. Habibie and S. Anwar, "Pengaruh Perbandingan Campuran Cat Dengan Thinner Terhadap Kualitas Hasil Pengecataan," *Jtm*, vol. 2, no. 3, pp. 97–104, 2014.

[11] K. B. Hermianto and F. Y. Utama, "Pengaruh Drying Process Terhadap Finishing Top Coat Pada Pengecatan," *Pengaruh Dry. Process Terhadap Finish. Top Coat Pada Pengecatan*, vol. 06, pp. 215–224, 2018.

[12] S. Sukram and S. Sutikno, "Pengaruh Suhu Dan Waktu Tinggal Terhadap Kecenderungan Menguning Pada Proses Produksi Alumunium Fasad," *JATI UNIK J. Ilm. Tek. dan Manaj. Ind.*, vol. 2, no. 1, p. 64, 2019, doi: 10.30737/jatiunik.v2i2.330.

[13] F. PRANATA, "Perbaikan Bodi Dan Pengecetan Mobil Ford Telstar Tahun 1986 AB 1073 MA Bagian Setengah Atap Belakang Dan Belakang," UNIVERSITAS NEGERI YOGYAKARTA, 2012.

[14] Team B&P, *Pedoman Pelatihan Pengecatan*, 2nd ed. Jakarta: PT. Toyota - Astra Motor, 2015.

Effect of Accelerator Addition To The Drying Time, thickness, and Glossy Clear Coat In Vehicle Body

ORIGINALITY REPORT

9%	8%	2%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	jurnal.politeknik-kebumen.ac.id Internet Source	3%
2	Dieter Stoye, Birgit Marwald, Wolfgang Plehn. "Paints and Coatings, 1. Introduction", Wiley, 2010 Publication	1%
3	lib.unnes.ac.id Internet Source	1%
4	ojs.unik-kediri.ac.id Internet Source	1%
5	jurnalmahasiswa.unesa.ac.id Internet Source	<1%
6	eprints.uny.ac.id Internet Source	<1%
7	jurnal.unmuhjember.ac.id Internet Source	<1%
8	www.neliti.com Internet Source	<1%

9	eprints.fri.uni-lj.si Internet Source	<1 %
10	eprints.soton.ac.uk Internet Source	<1 %
11	journal.unj.ac.id Internet Source	<1 %
12	journal.univpancasila.ac.id Internet Source	<1 %
13	uad.portalgaruda.org Internet Source	<1 %
14	d-nb.info Internet Source	<1 %
15	Wahyudi Wahyudi, Heribertus Budi Santoso, Ana Komari. "PENERAPAN MANAJEMEN RISIKO GUNA MENGETAHUI TINGKAT KECELAKAAN KERJA PADA PEKERJAAN PIGGING DI AREA SISI NUBI TOTAL E & P INDONESIE", JURMATIS : Jurnal Ilmiah Mahasiswa Teknik Industri, 2019 Publication	<1 %
16	www.design4rent.com Internet Source	<1 %
17	www.scribd.com Internet Source	<1 %

18 Felix A. Heinzler, Marc Piepenbrink, Torsten Doege. "Glanzmessung an verchromten Kunststoffbauteilen", JOT Journal für Oberflächentechnik, 2019 <1%
Publication

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		