## LAMPIRAN 1 DATA PENELITIAN

1. **Data Analisa pada Produk Bio - Pelumas**

**Tabel L1.1** Data Analisa Produk Bio Pelumas

## Rasio Katalis

|  |  |  |  |
| --- | --- | --- | --- |
| **Laurat (Mol) Reaksi** |  | **(mm2/s)** |  |
| **1** 0,50% 1:2 1 Jam dan | 0,7382 | 24,1 | 9 | 95 |
| 1 Jam dan120 0C | 0,7422 | 24,3 | 9 | 100 |
| 1 Jam dan140 0C | 0,7648 | 23,9 | 8 | 100 |
| 1 Jam dan160 0C | 0,7662 | 26,2 | 6,7 | 100 |
| **2** 1% 1:4 1 Jam dan | 0,75 | 26,2 | 6,7 | 98 |
| 1 Jam dan120 0C | 0,7527 | 27,2 | 6,3 | 100 |
| 1 Jam dan140 0C | 0,7566 | 28,5 | 6 | 100 |
| 1 Jam dan160 0C | 0,7776 | 28,5 | 6 | 100 |
| **3** 1,50% 1:6 1 Jam dan | 0,742 | 26,7 | 6,5 | 96 |
| 1 Jam dan120 0C | 0,7526 | 28,6 | 5,8 | 97 |
| 1 Jam dan140 0C | 0,7569 | 28,6 | 5,6 | 100 |
| 1 Jam dan160 0C | 0,7625 | 29 | 5,2 | 100 |

**Rasio EGDE:Asam**

## Waktu dan Suhu

**Densitas (gr/ cm3)**

## Viskositas Kinematik

***Pour Point***

## Volume (ml)

100 0C

100 0C

100 0C

39

40

40

## Tabel Hasil Analisa Anova

**Tabel L1.2** Data Analisa Anova dengan jumlah katalis 0,5%

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Source of Variation*** | ***SS*** | ***Df*** | ***MS*** | ***F*** | ***P - Value*** | ***F crit*** |
| **Between Groups** | 4405,556 | 2 | 2202,778 | 991,25 | 3,41E -30- | 6,247847 |
| **Within Groups** | 73,33333 | 33 | 2,222222 | - | - | - |
| **Total** | ***4478,889*** | ***35*** |  |  |  |  |
| **Tabel L1.3** Data Analisa Anova dengan jumlah katalis 1% |
| ***Source of*** | ***SS*** | ***Df*** | ***MS*** | ***F*** | ***P - Value*** | ***F crit*** |
| ***Variation*** |  |  |  |  |  |  |
| **Between Groups** | 4405,556 | 2 | 2202,778 991,25 | 3,41E-30 | 5,312029 |
| **Within Groups** | 73,33333 | 33 | 2,222222 - - - |
| **Total** | 4478,889 | 35 |  |  |
| **Tabel L1.4** Data Analisa Anova dengan jumlah katalis 1,5% |
| ***Source of*** | ***SS*** | ***Df*** | ***MS*** | ***F*** | ***P - Value*** | ***F crit*** |
| ***Variation*** |  |  |  |  |  |  |
| **Between Groups** | 4405,556 | 2 | 2202,778 | 991,25 | 3,41E-30 | 5,312029 |
| **Within Groups** | 73,33333 | 33 | 2,222222 | - | - | - |
| **Total** | 4478,889 | 35 |  |  |  |  |
| **Tabel L1.5** Data Analisa Anova dengan Rasio Perbandingan 1:2 |
| ***Source of*** | ***SS*** | ***Df*** | ***MS*** | ***F*** | ***P - Value*** | ***F crit*** |
| ***Variation*** |  |  |  |  |  |  |
| **Between Groups** | 4405,556 | 2 | 2202,778 | 991,25 | 3,41E-30 | 0,707912 |
| **Within Groups** | 73,33333 | 33 | 2,2222222 | - | - | - |
| **Total** | 4478,889 | 35 |  |  |  |  |
| **Tabel LI.6** Data Analisa Anova dengan Rasio Perbandingan 1:4 |
| ***Source of*** | ***SS*** | ***df*** | ***MS*** | ***F*** | ***P - Value*** | ***F - crit*** |
| ***Variation*** |  |  |  |  |  |  |
| **Between Groups** | 4405,556 | 2 | 2202,778 | 991,25 | 3,41E-30 | 1,446197 |
| **Within Groups** | 73,33333 | 33 | 2,222222 | - | - | - |
| **Total** | 4478,889 | 35 |  |  |  |  |
| **Tabel L1.7** Data Analisa Anova dengan Rasio Perbandingan 1:6 |
| ***Source of*** | ***SS*** | ***Df*** | ***MS*** | ***F*** | ***P - Value*** | ***F - crit*** |
| ***Variation*** |  |  |  |  |  |  |
| **Between Groups** | **4405,556** | **2** | **2202,778** | **991,25** | **3,41E-30** | **1,897132** |
| **Within Groups** | **73,33333** | **33** | **2,222222** | **-** | **-** | **-** |
| **Total** | **4478,889** | **35** |  |  |  |  |

## 2. Analisa Alat GC-MC

|  |  |  |
| --- | --- | --- |
|  | **Tabel L1.8** Data Analisa Alat GC-MS |  |
| **No** | **Real Time** | **Hit 1** | **Hit 2** | **Hit 3** | **Komposisi (%)** |
| 1 | 3.201 | 3 – Hexanol | 3 - Hexanol | 3 - Hexanol | 1.57 |
| 2 | 3.520 | Cyclotrisilovane, hovamethyl- | Cyclotrisilovane, hovamethyl- | Cyclotrisilovane, hovamethyl- | 0.85 |
| 3 | 3.703 | Arsenous acid, tris (tri ester lsilyl) ester | Cyclotrisilovane, hexamethyl- | Tris (tert-butyldimethylsilyloxy)arsane | 0.14 |
| 4 | 3.902 | trimethyl[4-[1-[(trimethyl silyl)oxyJethenyl] phenoxy-2,6-d2]- | Dimethylsilyloxy-dimethyl-trimethy | 1,4-Bis (trimethylsilyl) benzene | 0.18 |
| 5 | 4.167 | trimethyl[4-[1-[(trimethyl silyl)oxyJethenyl] phenoxy-2,6-d2]- | Dimethylsilyloxy-dimethyl-trimethy | isiiyioxy-siiane | 0.10 |
| 6 | 4.301 | 3-Cyano-2-ethyl-9-methyl-4-(methy thio)pyrido | Dentasilovane, dodecamethyl- | 1,4-Bis (trimethylsilyl) benzene | 1.16 |
| 7 | 4.505 | 2,4-Dihydroxyacetophenone | 3,5-Diester-2,6-bis | 4-tert-Butylphenol | 0.46 |
| 8 | 4.652 | Tri – Ester | trimethylsiloxy trisiloxane | Cyclotetrasiloxane, octamethyl | 0.47 |
| 9 | 4.728 | 3-Ethoxy-1,1,1,5,5,5-hexamethy | Cyclotetrasiloxane, octamethyl- | 2-(Acetovymethyl)-3-(methoxycarbon) | 0.57 |
| 10 | 4.869 | Di Ester | 1 - ethly 1-4- phosphorinanone thiosemi | Ethly tri - Methyl | 6.28 |
| 11 | 4.970 | ethenyl tri Ester | 3-Buten-2-01, 2,3-dimethyl- | 1-Propoxypropan-2-yl 2-methylbutan | 5.75 |
| 12 | 5.080 | 2H-Pyran, 2-(butyl1thio)tetrahydro- | Isobuty1 4-methylpentan-2-yl carbo | Sulfurous acid,butyl hexyl ester | 0.81 |
| 13 | 5.136 | 6-((E)-2-Methylbut-2-enamido)hexy | 2-methylbut-2-enoate 1-Butene, 2,3,3-trimethy | Cyclohexanecarbonyl chloride | 1.63 |
| 14 | 5.315 | -4-Acetoxy-1-pheny1-2- | Cyclotetrasiloxane, octamethyl- | Cyclotetrasiloxane, octamethy1- | 2.04 |
| 15 | 5.399 | Cyclotetrasiloxane, octamethyl- | Cyciotetrasiioxane, octametnyi- | Cyclotetrasiloxane, octamethyl- | 0.09 |
| 1617 | 5.8026.194 | 1,5-PentanediamineHeptasiloxane, 1,1,3,3,5,5,7,7,9,9 | 2,2,9a-trimethy1-3,9-dihydro-1H-p tetradecamethy1-2' ,4' - Dimethyloxanilic acid | 3,3-bis(Ethylthio)-2-(phenylthio) atrylidenehydrazide 3,5-Dimethy1-2,6- bis(trimethyls) | 0.150.09 |
| 18 | 6.596 | Methyl ester | 2- Hydrazino -4,6-diMethyl | 4- Ethly 1-3 Methyl -9H-Carbazone -2- | 0.11 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No** | **Real Time** | **Hit 1** | **Hit 2** | **Hit 3** | **Komposisi (%)** |
| 19 | 7.049 | 4-Chlorophenly -2-6 dimet | Cyclotrisilovane, hovamethyl- | Cyclotrisilovane, hovamethyl- | 1.15 |
| 20 | 8.709 | 4-Chloropheny1 | Cyclohevasilovane, dodecamethy1- | Cyclohevasilovane, dodecamethy1- | 0.65 |
| 21 | 10.231 | Cycloheptasiloxane,tetradecamethy | 1-Cycloheptasiloxane,tetradecamethy | 1-Cycloheptasiloxane,tetradecamethy | 0.57 |
| 2223 | 10.47911.583 | methyl esterBenzenedio1, 3,5-bis(1,1-dimet hylethy1)- Renzoic acid | 10-methyl-, methy trimethylsilyl ester Benzoic acid,2,3-bis[(trimethylsi) | 10-methyltri- ester | 1.600.24 |
| 24 | 12.808 | Methy1-5H-dibenz | 2-Napncnalenesuifonic acid | 4-Methy1pheny1)ethyny1 | 0.46 |
| 25 | 13.447 | Epoxy-15-nor-1abdane | Cyclotrisiloxane, hexamethyl- | 2-Methy1-5H | 0.09 |
| 26 | 13.796 | Thymol, TMS derivative | 5,8-Epoxy-15-nor-1abdane | Arsenous acid, tris(trimethylsi ester) | 0.05 |
| 27 | 14.283 | Cyclotrisiloxane, hexamethyl- | Cyclotrisiloxane, hexamethyl- | senous acid, tris(trimethylsilyl ester) | 0.04 |
| 2829 | 14.59418.911 | Cyclotrisilovane, hovamethyl-2,4,6-Cycloheptatrten-1-one-is- trimethylsilyl- | Cyclotrisilovane, hovamethyl-1-(3-Chloropheny1)-5-pheny1- 1,2,3- | Cyclotrisilovane, hovamethyl-hylpiperidin-1-methanimine | 0.0556.01 |
| 30 | 19,334 | 1-(3-Chloropheny1)-5-pheny1-1,2,3- | Triazol-4-amine 2-Naphthalenesulfonic acid | 2-Methy1-5H-dibenz[b,f]azep | 4.47 |
| 31 | 19.607 | 2,4,b-Cycioneptatrien-1-one, 3,5- | 5 62 is-trimethylsilyl-1-(3-Chloropheny1)-5-pheny1-1,2,3- | triazol-4-amine 1,4-Bis(trimethylsily1)benzene | 3.97 |
| 32 | 19.658 | 1-(3-Chloropheny1)-5-pheny1-1,2,3- | triazol-4-amine 1,2-Bis(trimethylsily1)benzene | 2-Methy1-5H-dibenz[b,f]azepine | 0.48 |
| 33 | 19.711 | 2,4,6-Cycloheptatrien-1-one, 3,5- | trimethylsilyl-1-(3-Chloropheny1)-5-pheny1-1,2,3- | triazol-4-amine | 1.93 |
| 34 | 19.884 | 1-(3-Chloropheny1)-5-pheny1- | triazol-4-amine 2- Naphthalenesulfonic acid | 2-(Acetoxymethy1)-3-(methoxycarbon) | 0.59 |
| 35 | 20.071 | 1-(3-Chioropneny1)-5-pneny1-1,2,3- | triazo1-4-amine | 2-Methy1-5H-dibenz[b,f]azepine | 1.71 |
| 36 | 20.226 | 1-(3-Chloropheny1)-5-pheny1-1,2,3 | triazo1-4-amine 1,2- | 5,8- Epoxy - 15 - nor - labdane | 0.51 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Bis(trimethylsily1)benzene |  |  |
| triazo1-4-amine 1,2- | 1-(3-Chloropheny1)-5-pheny1- | riazol-4-amine [4-(1-Ethy1-2-(4- |
| 37 | 21.494 | Bis(trimethylsily1)benzene | 1,2,3- | [(trimethy1sily1) | 0.28 |
|  |  |  | 1-(3-Chloropheny1)-5-pheny1- | triazo1-4-amine [4-(1-Ethy1-2-(4- |  |
| 38 | 22.073 | 5,8-Epoxy-15-nor-1abdane | 1,2,3- | [(trimethylsily1) | 0.69 |
|  |  |  | triazor-4-amine 1,4- |  |  |
| 39 | 23.386 | 1-(3-Chloropheny1)-5-pheny1-1,2,3- | Bis(trimethylsily1)benzene | ,4-Bis(trimethylsily1)benzene | 0.18 |

**LAMPPIRAN II PERHITUNGAN**

## Perhitungan Jumlah Reaktan yang diperlukan dalam reaksi

* 1. Menghitung Massa Asam Laurat Rasio 1:2 Volume EGDE : 110 ml

-. Mencari Massa EGDE

𝑚𝑎𝑠𝑠𝑎 = (𝐸𝐺𝐷𝐸 + 𝑝𝑖𝑘𝑜𝑛𝑜) − 𝑚𝑎𝑠𝑠𝑎 𝑝𝑖𝑘𝑜𝑛𝑜 𝑘𝑜𝑠𝑜𝑛𝑔

= 125, 2 gr – 15,25 = 110 gr

-. Mol EGDE = 𝑀𝑎𝑠𝑠𝑎

𝑀𝑟

= 110 𝑔𝑟

66 𝑔𝑟/𝑚𝑜𝑙

# = 1,6 𝑚𝑜𝑙

-. BM Asam Laurat = 𝑀𝑎𝑠𝑠𝑎 = 110 𝑔𝑟

# = 68,75 𝑔𝑟/𝑚𝑜𝑙

𝑚𝑜𝑙 1,6 𝑚𝑜𝑙

-. Mol Asam Laurat = 1 2

# 𝑥 1,6 𝑚𝑜𝑙 = 0,8 𝑚𝑜𝑙

-. Massa Asam Laurat = BM Asam Laurat x mol

= 68,75 gr x 0,8 mol

# = 55 gr/mol

= 5,5 gr

* 1. Menghitung Massa Asam Laurat Rasio 1:4 Volume EGDE : 110 ml

*P* FAME : 0,857 g/ml

-. Mencari Massa EGDE

𝑚𝑎𝑠𝑠𝑎 = (𝐸𝐺𝐷𝐸 + 𝑝𝑖𝑘𝑜𝑛𝑜) − 𝑚𝑎𝑠𝑠𝑎 𝑝𝑖𝑘𝑜𝑛𝑜 𝑘𝑜𝑠𝑜𝑛𝑔

= 125, 2 gr – 15,25 = 110 gr

44

-. Mol EGDE = 𝑀𝑎𝑠𝑠𝑎

𝑀𝑟

= 110 𝑔𝑟

66 𝑔𝑟/𝑚𝑜𝑙

# = 1,6 𝑚𝑜𝑙

-. BM Asam Laurat = 𝑀𝑎𝑠𝑠𝑎 = 110 𝑔𝑟

# = 68,75 𝑔𝑟/𝑚𝑜𝑙

𝑚𝑜𝑙 1,6 𝑚𝑜𝑙

-. Mol Asam Laurat = 1 4

# 𝑥 1,6 𝑚𝑜𝑙 = 0,4𝑚𝑜𝑙

-. Massa Asam Laurat = BM Asam Laurat x mol

= 68,75 gr x 0,4 mol

# = 27,5 gr/mol

= 2,75 gr

* 1. Menghitung Massa Asam Laurat Rasio 1:6 Volume EGDE : 110 ml

*P* FAME : 0,857 g/ml

-. Mencari Massa EGDE

𝑚𝑎𝑠𝑠𝑎 = (𝐸𝐺𝐷𝐸 + 𝑝𝑖𝑘𝑜𝑛𝑜) − 𝑚𝑎𝑠𝑠𝑎 𝑝𝑖𝑘𝑜𝑛𝑜 𝑘𝑜𝑠𝑜𝑛𝑔

= 125, 2 gr – 15,25 = 110 gr

-. Mol EGDE = 𝑀𝑎𝑠𝑠𝑎

𝑀𝑟

= 110 𝑔𝑟

66 𝑔𝑟/𝑚𝑜𝑙

# = 1,6 𝑚𝑜𝑙

-. BM Asam Laurat = 𝑀𝑎𝑠𝑠𝑎 = 110 𝑔𝑟

# = 68,75 𝑔𝑟/𝑚𝑜𝑙

𝑚𝑜𝑙 1,6 𝑚𝑜𝑙

-. Mol Asam Laurat = 1 6

# 𝑥 1,6 𝑚𝑜𝑙 = 0,26 𝑚𝑜𝑙

-. Massa Asam Laurat = BM Asam Laurat x mol

= 68,75 gr x 0,26 mol

# = 17,8 gr/mol

= 1,78 gr

## Menghitung Jumlah katalis yang dibutuhkan

* 1. Menghitung jumlah katalis 0,5%

-. Katalis CaO Diketahui:

* + - Volume FAME : 150 ml
		- Volume Etilen Glikol : 50 ml
		- *P* FAME : 0,857 g/ml
		- Massa FAME = VFAME X *PFAME*

= 150 ml X 0,857 g/ml

= 128,55 gr

* + - Jumlah katalis = 0,5% X 128,55 gr

= 0,6 gr

-. Katalis H2SO4

* + - Volume Katalis = 0,5% X VFAME

= 0,5% X 110 ml

= 0,55 ml

* 1. Menghitung jumlah katalis 1%

-. Katalis CaO Diketahui:

* + - Volume FAME : 150 ml
		- Volume Etilen Glikol : 50 ml
		- *P* FAME : 0,857 g/ml
		- Massa FAME = VFAME X *PFAME*

= 150 ml X 0,857 g/ml

= 128,55 gr

* + - Jumlah Katalis = 1 % X 128,55 gr

= 1,28 gr

-. Katalis H2SO4

* + - Volume Katalis = 1% X VFAME

= 1% X 110 ml

= 1,1 ml

* 1. Menghitung jumlah katalis 1,5 %

-. Katalis CaO Diketahui:

* + - Volume FAME : 150 ml
		- Volume Etilen Glikol : 50 ml
		- *P* FAME : 0,857 g/ml
		- Massa FAME = VFAME X *PFAME*

= 150 ml X 0,857 g/ml

= 128,55 gr

* + - Jumlah Katalis = 1,5 % X 128,55 gr

= 1,92 gr

-. Katalis H2SO4

* + - Volume Katalis = 1,5% X VFAME

= 1,5% X 110 ml

= 1,65ml

## Menghitung Densitas Bio – Pelumas

* Piknometer kosong (a) = 33,79 gr
* Pikno + Bio – Pelumas (b) = 70,6 gr
* Suhu kosong = 27 0C
* Volume = 50 cm3
	1. Sampel 0,5% , Rasio 1:2 , 100 0C
		+ Massa Pelumas = b – a

**=** 70,7 gr – 33,79 gr

= 36, 9 gr

* + - *P*Bio – Pelumas = 𝑚 = 36,9 𝑔𝑟 = 0,738 gr/ cm3

𝑣 50 𝑚𝑙

* 1. Sampel 0,5% , Rasio 1:2 , 120 0C
		+ Pikno + Bio – Pelumas (b) = 70,9 gr
		+ Massa Pelumas = b – a

**=** 70,9 gr – 33,79 gr

= 37, 11 gr

* + - *P*Bio – Pelumas = 𝑚 = 37,11 𝑔𝑟 = 0,7422 gr/ cm3

𝑣 50 𝑚𝑙

* 1. Sampel 0,5% , Rasio 1:2 , 140 0C
		+ Pikno + Bio – Pelumas (b) = 71,9 gr
		+ Massa Pelumas = b – a

**=** 71,9 gr – 33,79 gr

= 38, 2 gr

* + - *P*Bio – Pelumas = 𝑚 = 37,11 𝑔𝑟 = 0,764 gr/ cm3

𝑣 50 𝑚𝑙

* 1. Sampel 0,5% , Rasio 1:2 , 160 0C
		+ Pikno + Bio – Pelumas (b) = 72,1 gr
		+ Massa Pelumas = b – a

**=** 72,1 gr – 33,79 gr

= 38, 4 gr

* + - *P*Bio – Pelumas = 𝑚 = 38,4 𝑔𝑟 = 0,766 gr/ cm3

𝑣 50 𝑚𝑙

* 1. Sampel 1% , Rasio 1:4 , 100 0C
		+ Pikno + Bio – Pelumas (b) = 71,2 gr
		+ Massa Pelumas = b – a

**=** 71,2 gr – 33,79 gr

= 37, 5 gr

* + - *P*Bio – Pelumas = 𝑚 = 37,5 𝑔𝑟 = 0,75 gr/ cm3

𝑣 50 𝑚𝑙

* 1. Sampel 1% , Rasio 1:4 , 120 0C
		+ Pikno + Bio – Pelumas (b) = 71,3 gr
		+ Massa Pelumas = b – a

**=** 71,3 gr – 33,79 gr

= 37, 6 gr

* + - *P*Bio – Pelumas = 𝑚 = 37,6 𝑔𝑟 = 0,752 gr/ cm3

𝑣 50 𝑚𝑙

* 1. Sampel 1% , Rasio 1:4 , 140 0C
		+ Pikno + Bio – Pelumas (b) = 72 gr
		+ Massa Pelumas = b – a

**=** 72 gr – 33,79 gr

= 38, 3 gr

* + - *P*Bio – Pelumas = 𝑚 = 38,3 𝑔𝑟 = 0,766 gr/ cm3

𝑣 50 𝑚𝑙

* 1. Sampel 1% , Rasio 1:4 , 160 0C
		+ Pikno + Bio – Pelumas (b) = 72,2 gr
		+ Massa Pelumas = b – a

**=** 72,2 gr – 33,79 gr

= 38, 5 gr

* + - *P*Bio – Pelumas = 𝑚 = 38,5 𝑔𝑟 = 0,77 gr/ cm3

𝑣 50 𝑚𝑙

* 1. Sampel 1,5 % , Rasio 1:6 , 100 0C
		+ Pikno + Bio – Pelumas (b) = 70,8 gr
		+ Massa Pelumas = b – a

**=** 70,8 gr – 33,79 gr

= 37, 1 gr

* + - *P*Bio – Pelumas = 𝑚 = 37,1 𝑔𝑟 = 0,742 gr/ cm3

𝑣 50 𝑚𝑙

* 1. Sampel 1,5% , Rasio 1:6 , 120 0C
		+ Pikno + Bio – Pelumas (b) = 71,2 gr
		+ Massa Pelumas = b – a

**=** 71,2 gr – 33,79 gr

= 37, 9 gr

* + - *P*Bio – Pelumas = 𝑚 = 37,9 𝑔𝑟 = 0,75 gr/ cm3

𝑣 50 𝑚𝑙

* 1. Sampel 1,5% , Rasio 1:6 , 140 0C
		+ Pikno + Bio – Pelumas (b) = 71,5 gr
		+ Massa Pelumas = b – a

**=** 71,5 gr – 33,79 gr

= 37, 8 gr

* + - *P*Bio – Pelumas = 𝑚 = 37,8 𝑔𝑟 = 0,756 𝑔𝑟/𝑐𝑚3

𝑣 50 𝑚𝑙

* 1. Sampel 1,5% , Rasio 1:6 , 160 0C
		+ Pikno + Bio – Pelumas (b) = 71,8 gr
		+ Massa Pelumas = b – a

**=** 71,8 gr – 33,79 gr

= 38, 1 gr

* + - *P*Bio – Pelumas = 𝑚 = 38,1 𝑔𝑟 = 0,762 𝑔𝑟/𝑐𝑚3

𝑣 50 𝑐𝑚3

## Menghitung Nilai Viskositas Kinematik Bio - Pelumas

* Densitas Bola = 8,1 gr/ cm3 *(nickel iron alloy)*
* k = 0,7 mpa.s. gr/ cm3.s
	1. Sampel 0,5% , Rasio 1:2 , 100 0C t = 3,47 s

*p* = 0,7382 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,7382 gr/cm3 ) 3,47 s

= 17,612 mpa.s

= 0,176 g/cm.s

* + - *v* = µ

𝑝

 𝑔𝑟

0,176 .𝑠

= 𝑐𝑚 = 0, 24,1 cm2/s =24,1 mm2/s

0,73 𝑔𝑟/𝑐𝑚3

* 1. Sampel 0,5% , Rasio 1:2 , 120 0C t = 3, 50 s

*p* = 0,74 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,74 gr/cm3 ) 3,50 s

= 18,03 mpa.s

= 0,180 g/cm.s

* + - *v* = µ

𝑝

 𝑔𝑟

0,180 .𝑠

= 𝑐𝑚 = 0,243 cm2/s = 24,3 mm2/s

0,74 𝑔𝑟/𝑐𝑚3

* 1. Sampel 0,5% , Rasio 1:2 , 140 0C t = 3, 55 s

*p* = 0,76 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,76 gr/cm3 ) 3,55 s

= 18,2 mpa.s

= 0,182 g/cm.s

* + - *v* = µ

𝑝

 𝑔

0,182 .𝑠

= 𝑐𝑚 = 0,239 cm2/s = 23,9 mm2/s

0,76 𝑔𝑟/𝑐𝑚3

* 1. Sampel 0,5% , Rasio 1:2 , 160 0C t = 4,6 s

*p* = 0,766 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,766 gr/cm3 ) 4,6 s

= 20,2 mpa.s

= 0,202 g/cm.s

* + - *v* = µ

𝑝

 𝑔𝑟

0,202 .𝑠

= 𝑐𝑚 = 0,2623 cm2/s = 26,23 mm2/s

0,766 𝑔𝑟/𝑐𝑚3

* 1. Sampel 1% , Rasio 1:4 , 100 0C t = 3,87 s

*p* = 0,75 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,75 gr/cm3 ) 3,87 s

= 19,9 mpa.s

= 0,199 gr/cm.s

* + - *v* = µ

𝑝

 𝑔𝑟

0,199 .𝑠

= 𝑐𝑚 = 0,272 cm2/s = 27,2 mm2/s

0,75 𝑔𝑟/𝑚𝑐3

* 1. Sampel 1% , Rasio 1:4 , 120 0C t = 3,98 s

*p* = 0,75 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,75 gr/cm3 ) 3,98 s

= 20,4 mpa.s

= 0,204 gr/cm.s

* + - *v* = µ = 0,204 𝑚𝑝𝑎.𝑠

= 0,272 cm3/s =27,2 mm2/s

𝑝 0,75 𝑔𝑟/𝑐𝑚3

* 1. Sampel 1% , Rasio 1:4 , 140 0C t = 4,24 s

*p* = 0,766 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,766 gr/cm3 ) 4,24 s

= 20,4 mpa.s

= 0,204 gr/cm.s

* + - *v* = µ

𝑝

0,204 𝑔𝑟 .𝑠

= 𝑐𝑚 = 0,285 cm3/s = 28,5 mm2/s

0,76 𝑔𝑟/𝑐𝑚3

* 1. Sampel 1% , Rasio 1:4 , 160 0C t = 4,29 s

*p* = 0,77 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,77 gr/cm3 ) 4,29 s

= 22,01 mpa.s

= 0,220 gr/cm.s

* + - *v* = µ

𝑝

0,220 𝑔𝑟 .𝑠

= 𝑐𝑚 = 0,285 cm3/s = 28,57 mm2/s

0,77 𝑔𝑟/𝑐𝑚3

* 1. Sampel 1,5% , Rasio 1:6 , 100 0C t = 3,90 s

*p* = 0,75 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,75 gr/cm3 ) 3,90 s

= 20,06 mpa.s

= 0,20 gr/cm.s

* + - *v* = µ

𝑝

0,20 𝑔𝑟 .𝑠

= 𝑐𝑚 = 0,267 cm3/s =26,7 mm2/s

0,75 𝑔𝑟/𝑐𝑚3

* 1. Sampel 1,5 % , Rasio 1:6 , 120 0C t = 4,19 s

*p* = 0,756 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,756 gr/cm3 ) 4,19 s

= 21,5 mpa.s

= 0,215 gr/cm.s

* + - *v* = µ

𝑝

 𝑔𝑟

0,204 .𝑠

= 𝑐𝑚 = 0,286 cm2/s =28,6 mm2/s

0,75 𝑔𝑟/𝑐𝑚3

* 1. Sampel 1,5% , Rasio 1:6 , 140 0C t = 3,98 s

*p* = 0,70 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,70 gr/cm3 ) 4,25 s

= 21,8 mpa.s

= 0,218 gr/cm.s

* + - *v* = µ

𝑝

0,218 𝑔𝑟 .𝑠

= 𝑐𝑚 = 0,28 cm2 /s = 28,6 mm2/s

0,74 𝑔𝑟/𝑚𝑙3

* 1. Sampel 1,5% , Rasio 1:6 , 160 0C t = 4,30 s

*p* = 0,76 gr/ cm3

* + - µ = k ( *p1 – p2* ) t

= 0.7 mpa.s. gr/ cm3.s ( 8,1 gr/cm3 - 0,70 gr/cm3 ) 4,25 s

= 22,04 mpa.s

= 0,22 gr/cm.s

* + - *v* = µ

𝑝

 𝑔𝑟

0,22 .𝑠

= 𝑐𝑚 = 0,29 cm2/s = 29 mm2/s

0,76 𝑔𝑟/𝑚𝑙3

## LAMPIRAN III DOKUMENTASI

1. **Bahan – bahan Penelitian**



*Fatty Acid Methyl Ester* (FAME) Etilen Glikol



Karbon Oksida (CaO) Asam Laurat



Asam Sulfat ( H2SO4

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## Alat – alat yang digunakan dalam Penelitian



Gelas Kimia Kaca Arloji



Corong Timbangan Analitik



Erlenmeyer *Hot Plate*

## Proses Pembuatan Etilen Glikol Di - Ester

Saring FAME agar kotoran yang ada hilang dan siapkan 250 ml FAME yang sudah di saring.

Panaskan FAME hingga suhu 60 0C

Timbang katalis CaO sesuai dengan perhitungan yang ada pada Lampiran B

Siapkan Etilen Glikol 100 ml.

Setelah suhu FAME sudah mencapai 60 0C , tuangkan Etilen glikol dan CaO sambil diaduk menggunakan *magnetic Stirrel.*

Reaksikan hingga homogen dengan waktu reaksi 1 jam , dan pengadukan 160 rpm.

Setelah direaksikan 1 jam , diamkan hingga dingin sampai ada endapan dibawahnya. Setelah ada endapan ambil bagian atasnya dan saring , sehingga akan menghasilkan Etilen Glikol Di – Ester.

## Proses Pembuatan Etilen Glikol Tri – Ester

Panaskan EGDE sampai suhu 60 0C

Timbang katalis Asam Laurat sesuai dengan perhitungan yang ada pada Lampiran B

Setelah suhu sampai 60 0C, masukan H2SO4 dan Asam Laurat sambil diaduk dengan kecepatan 160 rpm dan waktu 1 Jam dengan suhu 100 – 160 0C.

Setelah itu diamkan hingga tidak terlalu panas da nada endapan diatas.

Setelah itu disaring , hingga terpisah dengan endapanya.

Setelah disaring , kemudian Tri – Ester dicuci dengan Hexana , NaCl dan NaOHCH3.

Dan ini adalah hasil dari pencucian tersebut , dan menghasilkan produk yaitu Bio – Pelumas.

## oses Pengujian produk Bio - Pelumas

Uji Densitas pada Bio - Pelumas

Uji Viskositas pada Bio – Pelumas.

Uji *Pour Point* pada Bio - Pelumas