LAMPIRAN

Lampiran 1 Pembuatan Larutan

1. Pembuatan Larutan NaOH 0,025M

Dilarutkan sebanyak 1,403 gram NaOH (BM= 40 g/mol, valensi = 1) dalam akuades dan diencerkan hingga tepat 250 mL.

$$M = \frac{massa}{BM} \times \frac{1000}{Volume}$$

$$0,025\ M = \frac{massa}{40\ g/mol} \times \frac{1000}{250\ mL}$$

Massa = 0,250

2. Pembuatan Larutan $C_2H_2O_4.2H_2O$ 0,025M

Mr. $C_2H_2O_4.2H_2O$

$$M = \frac{massa}{BM} \times \frac{1000}{Volume} \times valensi$$

$$0,025\ M = \frac{massa}{126,03} \times \frac{1000}{25mL} \times 2$$

Massa = 0,039 g

3. Standarisasi Larutan NaOH 0,025 M dengan larutan $C_2H_2O_4.2H_2O$ 0,025M

Larutan $C_2H_2O_4.2H_2O$ sebanyak 10 mL dititrasi dengan larutan NaOH menggunakan indikator *phenolftalein* (indikator pp) dan diulang sebanyak 2 kali.

Volume $C_2H_2O_4.2H_2O$ 0,025N (mL)	Volume NaOH (mL)
10	12,0
10	11,8
10	11,7
V rata-rata	11,83

M_1 x V_1 = M_2 x V_2

10mL x 0,025 M = M x 11,9 mL

$$M = \frac{10\ mL \times 0,025\ M}{11,83\ mL}$$

M = 0,022 M

Lampiran 2 Perhitungan Karakterisasi Sampel CPO Off Grade

1) Bilangan Asam dan ALB CPO *off grade*

massa$_1$　　　$= 1{,}141$ g

volume$_1$　　　$= 44{,}2$ mL

$$\text{Bilangan asam} = \frac{\text{mL NaOH x M NaOH x BM NaOH}}{\text{berat sampel (gram)}}$$

$$= \frac{44{,}2\text{mL x } 0{,}021 \text{ M x } 40}{1{,}141 \; gram}$$

$$= 32{,}539$$

$$\%\text{ALB} = \frac{\text{mL NaOH x N NaOH x BM palmitat CPO}}{\text{berat sampel (gram)} x \; 1000} \; x \; 100\%$$

$$= \frac{44{,}2\text{mL x } 0{,}021 \text{ N x } 256{,}16}{1{,}141 \; gram \; x \; 1000} \; x \; 100\%$$

$$= 20{,}838\%$$

Pengulangan	Massa sampel	V NaOH (mL)	M NaOH (M)	Bilangan Asam (g/mol)	%ALB
1	1,141	44,2	0,021	32,539	20,838
2	1,090	42,0	0,021	32,366	20,727
3	1,103	43,1	0,021	32,823	21,019
Rata-rata				32,576	20,861

2) Kadar Air

　　　Kadar air sampel minyak kelapa sawit dihitung sebagai berat yang hilang setelah ±5 gram sampel uji dipanaskan di dalam oven pada suhu 105°C ± 5°C selama 3 jam, dimasukan desikator selama 15 menit dan ditimbang. Pemanasan diulangi selama 30 menit, dimasukkan desikator dan ditimbang sampai selisih berat antara 2 penimbangan berturut-turut tidak melebihi 0,02% dari berat sampel uji. Kadar air ditentukan melalui persamaan berikut:

$$\text{Kadar air} = \frac{(\text{Wsampel} - \text{Wresidu})}{\text{Wsampel}} x \; 100\%$$

$$= \frac{(\text{gram} - \text{gram})}{\text{gram}} x \; 100\%$$

$$= \%$$

Sampel	W sampel (gram)	W residu (gram)	Kadar air (%)
1	5,159	5,138	0,407
2	5,067	5,041	0,513

3	5,104	5,087	0,333
		Rata-rata	0,417

$$\text{Kadar air} = \frac{(5{,}159 \text{ g} - 5{,}138 \text{ g})}{5{,}159 \text{ g}} x \ 100\%$$

$$= 0{,}407\%$$

$$\text{Kadar air} = \frac{(5{,}067 \text{ g} - 5{,}041 \text{ g})}{5{,}067 \text{ g}} x \ 100\%$$

$$= 0{,}513\%$$

$$\text{Kadar air} = \frac{(5{,}104 \text{ g} - 5{,}087 \text{ g})}{5{,}104 \text{ g}} x \ 100\%$$

$$= 0{,}333\%$$

$$\text{Rata} - \text{rata kadar air} = \frac{0{,}407 \ \% + 0{,}513 \ \% + 0{,}333 \ \%}{3}$$

$$= 0{,}417 \ \%$$

Lampiran 3 Perhitungan Sintesis Metil Ester

1) Penentuan perbandingan penggunaan katalis Sn-zeolit dan *red mud*

Parameter = katalis 5%, perbandingan metanol 1:15, waktu 4 jam

Dik.

Massa CPO = 10 gram

BM palmitat = 256,16 g/mol

ρ metanol = 0,792 g/mL

BM metanol = 3,042 g/mol

$$\text{Mol CPO} = \frac{\text{massa CPO}}{\text{BM asam palmitat}}$$

$$= \frac{\text{l0 gram}}{256,16 \text{ g/mol}}$$

$$= 0,0390 \text{ mol}$$

Mol metanol = 15 x mol CPO

$\quad\quad\quad\quad$ = 15 x 0,0390 = 0,585 mol

Massa metanol = BM Metanol x mol metanol

$\quad\quad\quad\quad$ = 32,042 g/mol x 0,585 mol

$\quad\quad\quad\quad$ = 18,744 gram

$$\text{Volume metanol} = \frac{\text{massa metanol}}{\rho \text{ metanol}}$$

$$= \frac{18,744 \text{ gram}}{0,792 \text{ g/mL}}$$

$$= 23,667 \text{ mL}$$

5% Katalis = 5% x (10 gram + 18,744 gram)

$\quad\quad\quad\quad$ = 5% x 28,744 gram

$\quad\quad\quad\quad$ = 1,437 gram

Perbandingan katalis asam dan basa

Asam : basa = 2 : 1

Asam $= \dfrac{2}{3}$ x 1,437 gram = 0,958

Basa $= \dfrac{1}{3}$ x 1,437 gram = 0,479

2) Variasi konsentrasi (%) katalis

Parameter = perbandingan katalis asam : basa = 1,5 : 1, perbandingan metanol 1:15, waktu 4 jam

Massa CPO = 10 gram

Mol metanol = 15 x 0,0390 = 0,585 mol

Massa metanol = BM Metanol x mol metanol

$\qquad$ = 32,042 g/mol x 0,585 mol

$\qquad$ = 18,744 gram

Volume metanol $= \dfrac{\text{massa metanol}}{\rho\ metanol}$

$\qquad\qquad = \dfrac{18,744\ \text{gram}}{0,792\ \text{g/mL}}$

$\qquad\qquad$ = 23,667 mL

3% Katalis = 3% x (10 gram + 18,744 gram)

$\qquad\qquad$ = 3% x 28,744 gram

$\qquad\qquad$ = 0,862 gram

Asam : basa = 1,5 : 1

Asam $= \dfrac{1,5}{2,5}$ x 0,862 gram = 0,517

Basa $= \dfrac{1}{2,5}$ x 0,862 gram = 0,344

3) Penentuan perbandingan metanol

Parameter = perbandingan katalis asam : basa = 1,5:1, konsentrasi katalis 7%, waktu 4 jam.

Perbandingan metanol = 1:10

Massa CPO = 10 gram

Mol metanol = 10 x 0,0390 = 0,390 mol

Massa metanol = BM Metanol x mol metanol

$\qquad$ = 32,042 g/mol x 0,390 mol

$\qquad$ = 12,496 gram

Volume metanol $= \dfrac{\text{massa metanol}}{\rho\ metanol}$

$$= \frac{12{,}496 \text{ gram}}{0{,}792 \text{ g/mL}}$$

$$= 15{,}773 \text{ mL}$$

7% Katalis   = 7% x (10 gram + 12,496 gram)

               = 7% x 22,496 gram

               = 1,573 gram

Perbandingan katalis asam dan basa

Asam : basa = 1,5 : 1

Asam $= \dfrac{1{,}5}{2{,}5}$ x 1,573 gram = 0,943 gram

Basa $= \dfrac{1}{2{,}5}$ x 1,573 gram = 0,629 gram

Karakterisasi Metil Ester Hasil Sintesis

1) Sintesis Metil ester dalam penentuan perbandingan katalis asam dan basa

Perbandingan asam : basa = 2 : 1

massa$_1$ = 0,515 g

volume$_1$ = 14.4 mL

%ALB$_1$ $= \dfrac{\text{mL NaOH x N NaOH x BM CPO}}{\text{berat sampel (gram)} x\ 1000}\ x\ 100\%$

               $= \dfrac{14{,}4\text{mL x } 0{,}022 \text{ N x } 256{,}16}{0{,}515 gram\ x\ 1000}\ x\ 100\%$

               = 15,758%

massa$_2$ = 0,509 g

volume$_2$ = 14,0 mL

%ALB$_2$ $= \dfrac{\text{mL NaOH x N NaOH x BM CPO}}{\text{berat sampel (gram)} x\ 1000}\ x\ 100\%$

               $= \dfrac{14{,}0\text{mL x } 0{,}022 \text{ N x } 256{,}16}{0{,}509\ gram\ x\ 1000}\ x\ 100\%$

               = 15,500%

Rerata %ALB $= \dfrac{ALB\ 1 + ALB\ 2}{2}$

$$= \frac{15{,}758 + 15{,}500}{2} \ \%$$

$$= 15{,}629 \ \%$$

2) Sintesis metil ester dalam penentuan konsentrasi katalis

Konsentrasi katalis 3%

massa$_1$ = 0,509 g

volume$_1$ = 12,7 mL

%ALB$_1$ $= \dfrac{\text{mL NaOH x N NaOH x BM CPO}}{\text{berat sampel (gram)} x\ 1000} \ x \ 100\%$

$= \dfrac{12{,}7\text{mL x } 0{,}022 \text{ N x } 256{,}16}{0{,}509\ gram\ x\ 1000} \ x \ 100\%$

$= 14{,}061\%$

massa$_2$ = 0,495 g

volume$_2$ = 12 mL

%ALB$_2$ $= \dfrac{\text{mL NaOH x N NaOH x BM CPO}}{\text{berat sampel (gram)} x\ 1000} \ x \ 100\%$

$= \dfrac{12\text{mL x } 0{,}022 \text{ N x } 256{,}16}{0{,}495\ gram\ x\ 1000} \ x \ 100\%$

$= 13{,}607\%$

Rerata %ALB $= \dfrac{ALB\ 1 + ALB\ 2}{2}$

$= \dfrac{14{,}061 + 13{,}607}{2} \ \%$

$= 13{,}834 \ \%$

3) Sintesis metil ester dalam penentuan perbandingan metanol

Perbandingan metanol 1:10

massa$_1$ = 0,497 g

volume$_1$ = 16,1 mL

%ALB$_1$ $= \dfrac{\text{mL NaOH x N NaOH x BM CPO}}{\text{berat sampel (gram)} x\ 1000} \ x \ 100\%$

$$= \frac{16,1\text{mL x }0,022\text{ N x }256,16}{0,497 \, gram \, x \, 1000} \; x \; 100\%$$

$$= 18,236\%$$

massa$_2$ $\quad = 0,495$ g

volume$_2$ $\quad = 16$ mL

%ALB$_2$ $\quad = \dfrac{\text{mL NaOH x N NaOH x BM CPO}}{\text{berat sampel (gram)} \, x \, 1000} \; x \; 100\%$

$$= \frac{16\text{mL x }0,022\text{ N x }256,16}{0,495 \, gram \, x \, 1000} \; x \; 100\%$$

$$= 18,216\%$$

Rerata %ALB $= \dfrac{ALB \; 1 + ALB \; 2}{2}$

$$= \frac{18,256 + 18,216}{2} \; \%$$

$$= 18,236 \; \%$$

Lampiran 4 Data Pengamatan

CPO: metanol	%katalis	Sn-zeolit/ Red mud	m.Sn-zeolit (g)	m.Redmud (g)	m.CPO (g)	m.titrasi (g) 1	m.titrasi (g) 2	V.titrasi (ml) 1	V.titrasi (ml) 2	ALB awal	%ALB1	%ALB 2	Rerata ALB
1:15	5%	2:1	0.933	0.483	10.212	0.515	0.509	14.4	14.0	20.861	15.758	15.500	15.629
		1.5:1	0.862	0.574	10.201	0.509	0.512	10.7	10.9	20.861	11.847	11.997	11.922
		1:1	0.733	0.756	10.189	0.506	0.507	13.0	12.9	20.861	14.479	14.339	14.409
		1:1.5	0.574	0.862	10.102	0.502	0.511	13.8	13.9	20.861	15.279	15.329	15.304

CPO: metanol	% katalis	Sn-zeolit/ Red mud	m.Sn-zeolit (g)	m.Redmud (g)	m.CPO (g)	m.titrasi (g) 1	m.titrasi (g) 2	V.titrasi (ml) 1	V.titrasi (ml) 2	ALB awal	%ALB1	%ALB 2	Rerata ALB
1:15	7%	3%	0.587	0.351	10,084	0.509	0.497	12.7	12	20.861	14.061	13.607	13.834
		5%	0.862	0.574	10.049	0.509	0.512	10.7	10.9	20.861	11.847	11.997	11.922
		7%	1.210	0.808	10.022	0.507	0.504	8.8	8.7	20.861	9.782	9.728	9.755
		10%	1.724	1.149	10.004	0.499	0.490	11.8	11.6	20.861	13.326	13.341	13.334

CPO: metanol	% katalis	Sn-zeolit/ Red mud	m.Sn-zeolit (g)	m.Redmud (g)	m.CPO (g)	m.titrasi (g) 1	m.titrasi (g) 2	V.titrasi (ml) 1	V.titrasi (ml) 2	ALB awal	%ALB1	%ALB 2	Rerata ALB
1:10	7%	1.5:1	0.950	0.632	10.073	0.497	0.495	16.1	16	20.861	18.256	18.216	18.236
1:12			1.048	0,702	10.210	0.501	0.510	12.4	12.5	20.861	13.948	13.813	13.880
1:15			1.210	0.808	10.020	0.507	0.504	8.8	8.7	20.861	9.782	9.728	9.755
1:20			1.467	0.981	10.212	0.514	0.503	7.6	7.4	20.861	8.333	8.291	8.312