**LAMPIRAN A**

**DATA BAHAN BAKU**

**LA.1 KOMPOSISI ASAM LEMAK BAHAN BAKU ASAM LEMAK SAWIT DISTILAT (ALSD) HASIL ANALISIS GCMS**

Tabel LA.1 Komposisi Asam Lemak Bahan Baku Asam Lemak Sawit Distilat

<table>
<thead>
<tr>
<th>Asam Lemak</th>
<th>Komposisi (%)</th>
<th>Berat Molekul (gr/mol)</th>
<th>% x BM (gr/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asam Laurat (C12:0)</td>
<td>0,3140</td>
<td>200,32</td>
<td>0,6290</td>
</tr>
<tr>
<td>Asam Miristat (C14:0)</td>
<td>1,2518</td>
<td>228,37</td>
<td>2,8587</td>
</tr>
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<td>Asam Palmitat (C16:0)</td>
<td>48,5401</td>
<td>256,42</td>
<td>124,4665</td>
</tr>
<tr>
<td>Asam Palmitoleinat (C16:1)</td>
<td>0,1492</td>
<td>254,41</td>
<td>0,3796</td>
</tr>
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<td>Asam Stearat (C18:0)</td>
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<td>284,48</td>
<td>11,1479</td>
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<td>282,46</td>
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<td>280,45</td>
<td>23,0334</td>
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<tr>
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<tr>
<td><strong>Jumlah</strong></td>
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Dari perhitungan maka diperoleh berat molekul rata-rata FFA asam lemak sawit distilat sebesar 268,8779 gr/mol.
### LAMPIRAN B

**DATA PENELITIAN**

**LB.1 DATA YIELD BIODIESEL**

Tabel LB.1 Hasil Analisis Yield Biodiesel

<table>
<thead>
<tr>
<th>Run</th>
<th>Level Kode</th>
<th>Rasio Molar DMC/ALSD (mol/mol)</th>
<th>Suhu Reaksi (°C)</th>
<th>Waktu Reaksi (jam)</th>
<th>Jumlah Biokatalis (%-b)</th>
<th>% Yield</th>
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<tbody>
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<td>10</td>
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</tr>
<tr>
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<tr>
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<td>6,0:1</td>
<td>60</td>
<td>3,0</td>
<td>10</td>
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<tr>
<td>23</td>
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<td>6,0:1</td>
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<tr>
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<tr>
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<td>10</td>
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<tr>
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<td>2,0</td>
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<td>77,6837</td>
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</table>
## LB.2 DATA VALIDASI MODEL

Tabel LB.2 Nilai Observasi dan Nilai Prediksi Yield Biodiesel

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<tr>
<th>Run</th>
<th>Nilai Observasi</th>
<th>Nilai Prediksi</th>
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</thead>
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<td>67,6577</td>
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<td>49,5617</td>
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<td>79,8159</td>
<td>79,7866</td>
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<td>81,8601</td>
<td>79,7866</td>
</tr>
<tr>
<td>27</td>
<td>77,6837</td>
<td>79,7866</td>
</tr>
</tbody>
</table>
LAMPIRAN C
CONTOH PERHITUNGAN

LC.1 PERHITUNGAN KADAR FFA ASAM LEMAK SAWIT DISTILAT (ALSD)

Kadar asam lemak = \( \frac{N \times V \times M}{\text{Massa Sampel} \times 1000} \times 100\% \)

Keterangan :
- \( N \) = Normalitas larutan NaOH (mol/l)
- \( V \) = Volume larutan NaOH terpakai (ml)
- \( M \) = Berat molekul FFA PFAD (BM = 268,8779 gr/mol)

Normalitas larutan NaOH = 0,1 N
Volume larutan NaOH terpakai = 36,8 ml
BM asam lemak = 268,8779 gr/mol
Berat PFAD = 1 gram

Kadar asam lemak = \( \frac{0,1 \times 36,8 \times 268,8779}{1 \times 1000} \times 100\% = 98,95\% \)

LC.2 PERHITUNGAN KEBUTUHAN DIMETHYL CARBONATE (DMC)

Gambar C.1 Reaksi Esterifikasi Enzimatik

Massa PFAD = 1 gr
PFAD : DMC = 1 : 6 (mol/mol)
BM asam lemak = 268,8779 gr/mol
Mol PFAD = \( \frac{\text{Massa}}{\text{BM asam lemak}} \)
\[
\begin{align*}
\text{Mol DMC} &= \frac{6}{1} \times (3,7192 \times 10^{-3}) = 0,0223 \text{ mol} \\
\text{Maka massa DMC} &= \text{mol DMC} \times \text{BM DMC} \\
&= 0,0223 \text{ mol} \times 90,08 \text{ gr/mol} \\
&= 2,009 \text{ gram} \\
\text{Volume DMC} &= \frac{m}{\rho} \\
&= \frac{2,009 \text{ gr}}{1,07 \text{ gr/ml}} \\
&= 1,8776 \text{ ml} \\
\end{align*}
\]

Untuk kebutuhan DMC yang lainnya sama dengan perhitungan di atas.

**LC.3 PERHITUNGAN YIELD BIODIESEL**

\[
Yield = \frac{\text{Massa Biodiesel Praktik}}{\text{Massa Bahan Baku}} \times \text{Kemurnian}
\]

\[
= \frac{0,8336 \text{ gr}}{1 \text{ gr}} \times 95,7484\%
\]

\[
= 79,8159\%
\]

Untuk data yang lainnya sama dengan perhitungan di atas.
Gambar LD.1 Hasil Analisis Kromatogram GC Biodiesel Run 1
Gambar LD.2 Hasil Analisis Kromatogram GC Biodiesel Run 2
Gambar LD.3 Hasil Analisis Kromatogram GC Biodiesel Run 3
Gambar LD.4 Hasil Analisis Kromatogram GC Biodiesel Run 4
Gambar LD.5 Hasil Analisis Kromatogram GC Biodiesel Run 5
Gambar LD.6 Hasil Analisis Kromatogram GC Biodiesel Run 6
Gambar LD.7 Hasil Analisis Kromatogram GC Biodiesel Run 7
Gambar LD.8 Hasil Analisis Kromatogram GC Biodiesel Run 8
Gambar LD.9 Hasil Analisis Kromatogram GC Biodiesel Run 9
Gambar LD.10 Hasil Analisis Kromatogram GC Biodiesel Run 10
Gambar LD.11 Hasil Analisis Kromatogram GC Biodiesel Run 11
Gambar LD.12 Hasil Analisis Kromatogram GC Biodiesel Run 12
Gambar LD.13 Hasil Analisis Kromatogram GC Biodiesel Run 13
Gambar LD.14 Hasil Analisis Kromatogram GC Biodiesel Run 14
Gambar LD.15 Hasil Analisis Kromatogram GC Biodiesel Run 15
Gambar LD.16 Hasil Analisis Kromatogram GC Biodiesel Run 16
Gambar LD.17 Hasil Analisis Kromatogram GC Biodiesel Run 17
Gambar LD.18 Hasil Analisis Kromatogram GC Biodiesel Run 18
Gambar LD.19 Hasil Analisis Kromatogram GC Biodiesel Run 19
Gambar LD.20 Hasil Analisis Kromatogram GC Biodiesel Run 20
Gambar LD.21 Hasil Analisis Kromatogram GC Biodiesel Run 21
Gambar LD.22 Hasil Analisis Kromatogram GC Biodiesel Run 22
Gambar LD.23 Hasil Analisis Kromatogram GC Biodiesel Run 23

<table>
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<tr>
<th>Peak</th>
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<th>Comp Name</th>
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Gambar LD.24 Hasil Analisis Kromatogram GC Biodiesel Run 24

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Gambar LD.25 Hasil Analisis Kromatogram GC Biodiesel Run 25
Gambar LD.26 Hasil Analisis Kromatogram GC Biodiesel Run 26

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Gambar LD.27 Hasil Analisis Kromatogram GC Biodiesel Run 27
LAMPIRAN E
DOKUMENTASI PENELITIAN

LE.1  FOTO BAHAN BAKU PENELITIAN

Gambar LE.1 Foto Asam Lemak Sawit Distilat (ALSD)

Gambar LE.2 Foto Dimethyl Carbonate (DMC)

Gambar LE.3 Foto Biokatalis Novozym®435
LE.2  FOTO PENGUJIAN KADAR ASAM LEMAK BEBAS

Gambar LE.4 Foto Pengujian Kadar Asam Lemak Bebas

LE.3  FOTO PROSES ESTERIFIKASI ENZIMATIS

Gambar LE.5 Foto Rangkaian Alat Esterifikasi (Carousel)

Gambar LE.6 Foto Penggunaan Syringe filter
Gambar LE.7 Foto Pemisahan Hasil Esterifikasi dengan Syringe filter

Gambar LE.8 Foto Evaporasi Hasil Esterifikasi dengan Rotary Vacuum Evaporator

Gambar LE.9 Foto Produk Akhir Biodiesel