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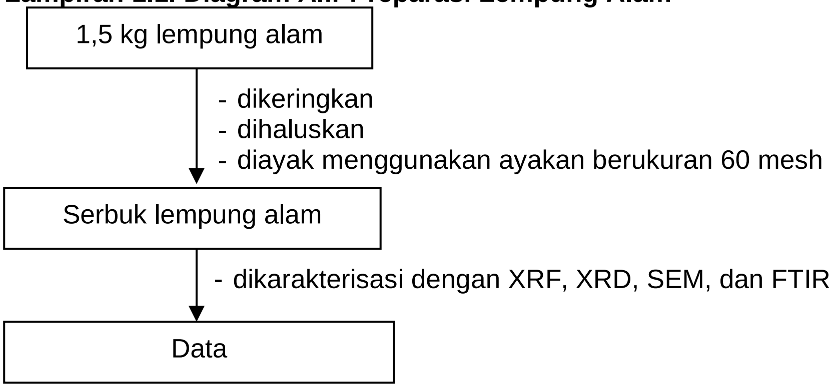
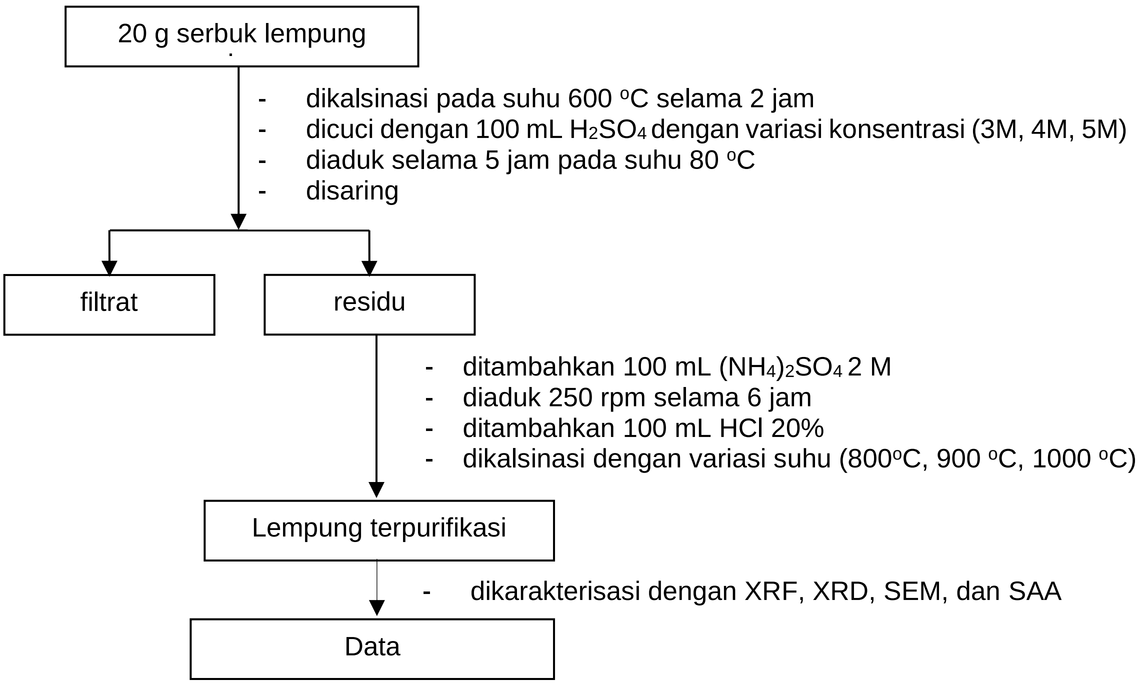
LAMPIRAN

Lampiran 1. Diagram Alir

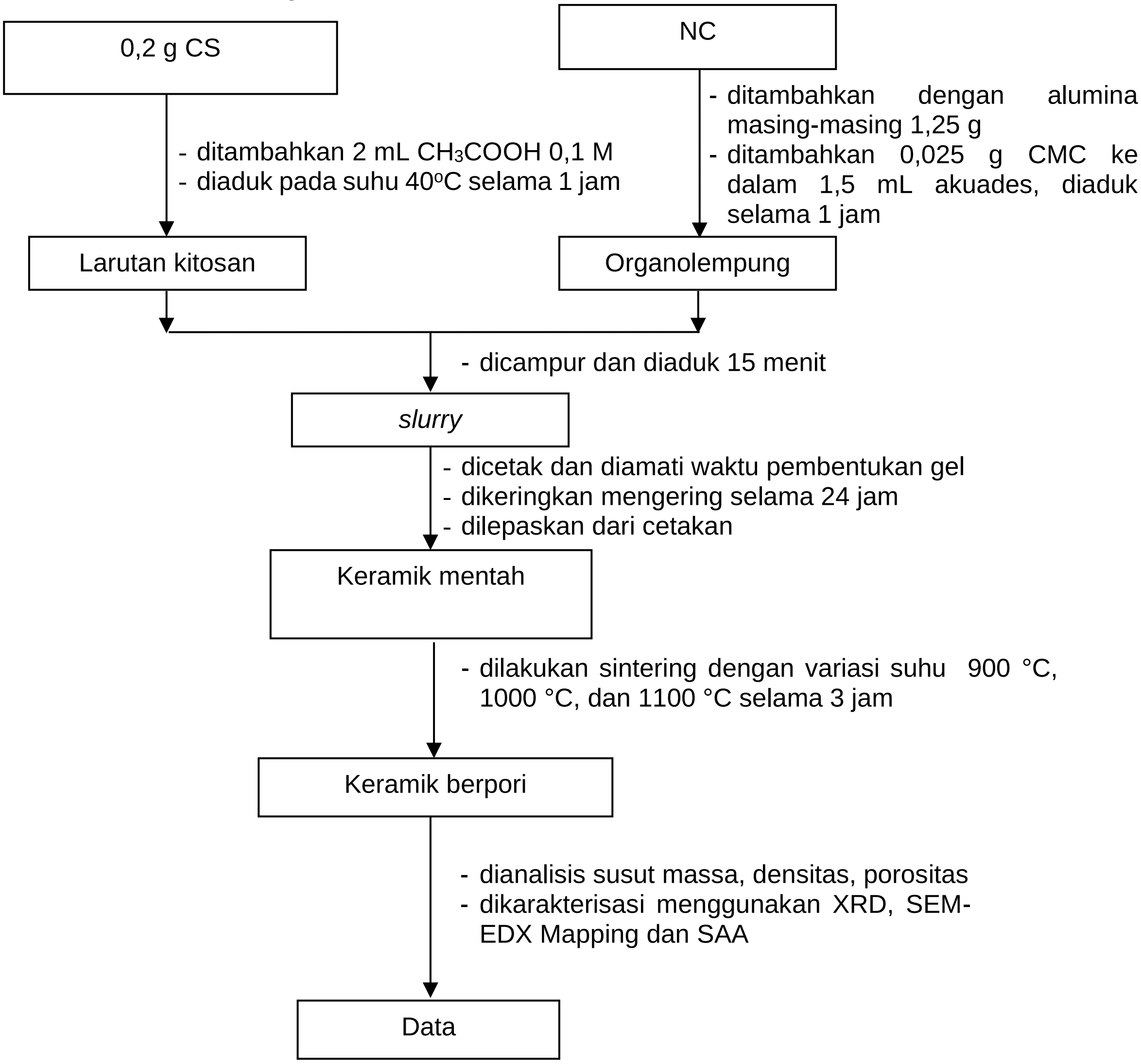
Lampiran 1.1. Diagram Alir Preparasi Lempung Alam



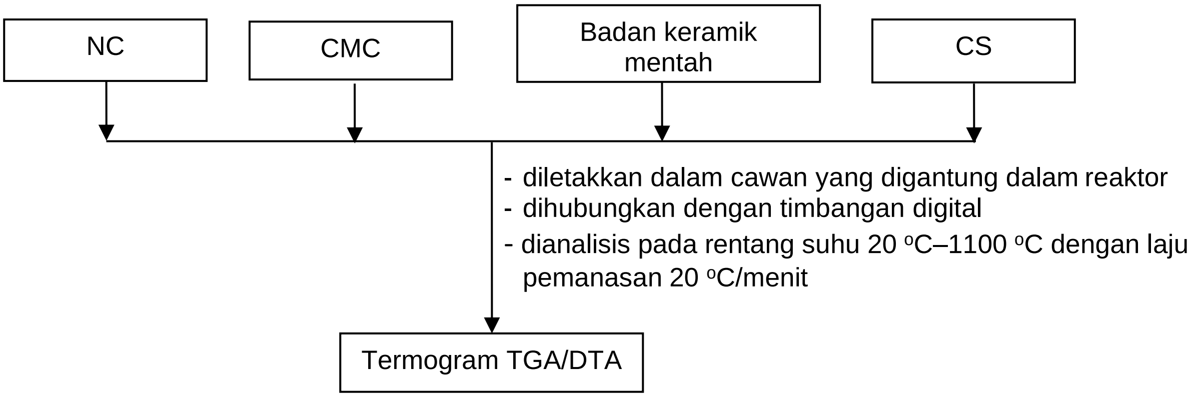
Lampiran 1.2. Diagram alir purifikasi lempung alam



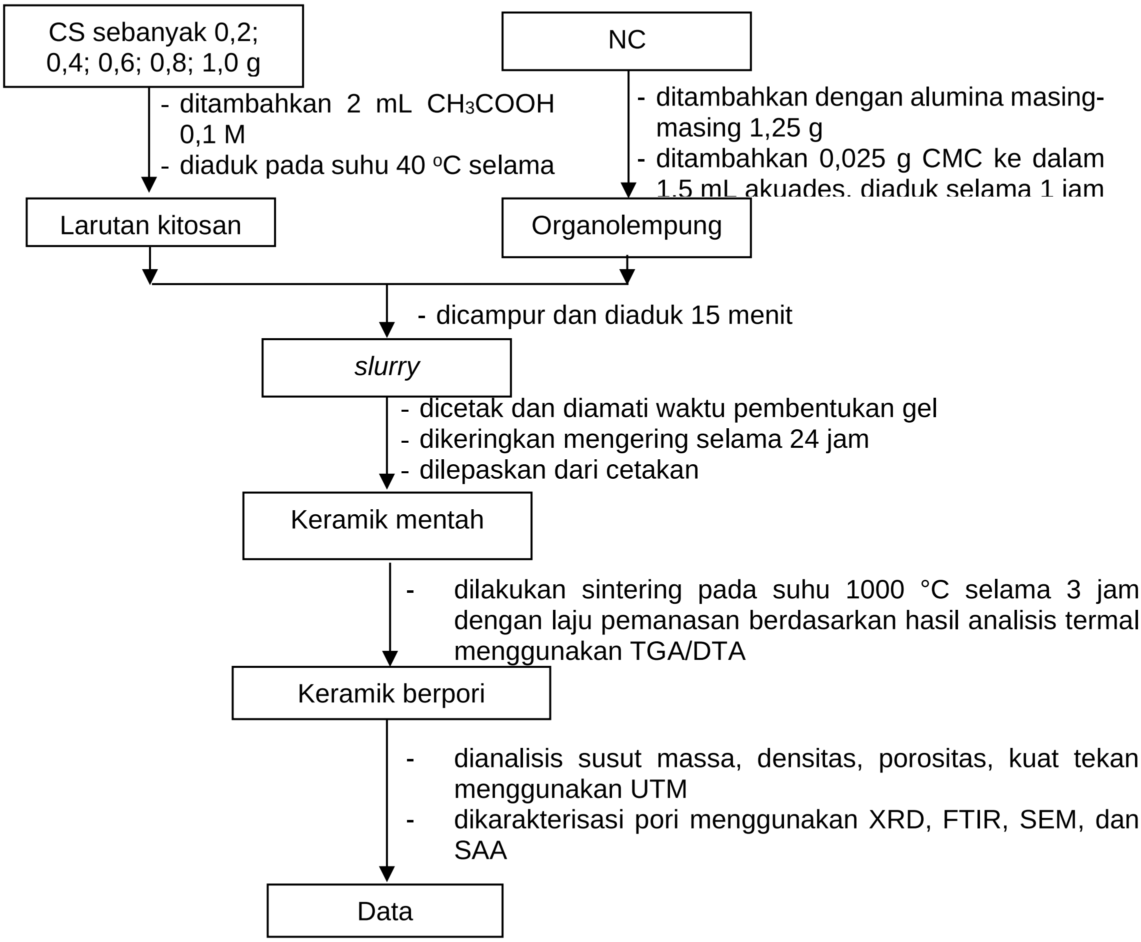
Lampiran 1.3. Diagram Alir Sintesis Keramik Berpori Untuk Penentuan Suhu Sintering



Lampiran 1.4. Diagram Alir Penentuan Suhu Sintering Menggunakan TGA/DTA



Lampiran 1.5. Diagram Alir Sintesis Keramik Berpori Secara *Gelcasting* Dengan Variasi Konsentrasi CS



Lampiran 1.6. Diagram Alir Impregnasi Katalis Kedalam Keramik Berpori

$Ca(NO_3)_2.4H_2O$ dan $Zn(NO_3)_2.6H_2O$

- dicampurkan masing-masing sebanyak 25 mL dengan perbandingan molar 1:1
- ditambahkan dengan 5 mL glikol dan diaduk selama 1 jam pada suhu kamar
- dimasukkan keramik berpori (dengan variasi konsentrasi CS) ke dalam larutan yang dihasilkan
- diimpregnasi pada kondisi vakum selama 1 jam
- dilakukan kalsinasi pada suhu 450 ^oC selama 2 jam

CaO-ZnO/KB-CS(10,20,30,40,50%)

- dikarakterisasi menggunakan XRF, XRD, FTIR, SEM dan SAA

Data

Lampiran 1.7. Diagram Alir Uji Aktivitas Katalitik Melalui Reaksi Transesterifikasi Pada Produksi Biodiesel

Minyak sawit

- dimasukkan kedalam labu leher tiga
- dipanaskan hingga suhu 70 ^oC
- ditambahkan metanol dengan perbandingan mol 1:3
- ditambahkan 1 pellet katalis bifungsional CaO-ZnO/KB
- dilakukan refluks pada suhu 60 ^oC selama 6 jam
- produk yang dihasilkan didiamkan selama 24 jam dan

Metil ester (lapisan atas) | Gliserol (lapisan bawah)

- didiamkan selama 24 jam dan dipisahkan
- dipanaskan pada suhu 100^oC selama 30 menit

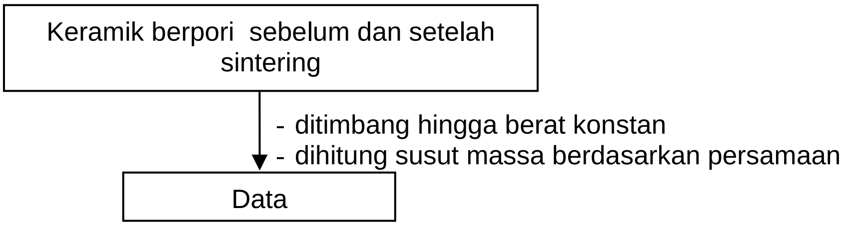
Biodiesel

- dilakukan analisis kuantitatif biodiesel mengacu pada SNI 7182:2015 parameter yang diuji meliputi pengukuran densitas, bilangan asam, bilangan penyabunan, bilangan iodin, dan angka setana.
- dikarakterisasi menggunakan GC/MS pada biodiesel dengan persen konversi terbesar

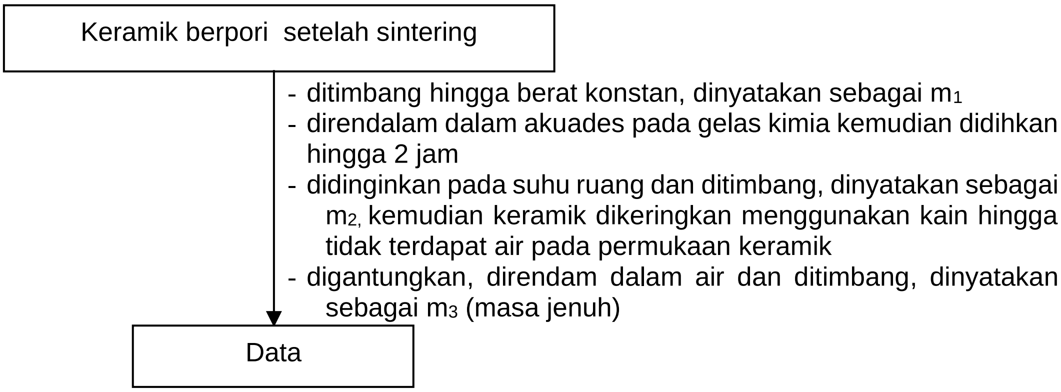
Data

Lampiran 1.8 Diagram Alir Analisis Susut Massa, Densitas, dan Porositas Keramik Berpori

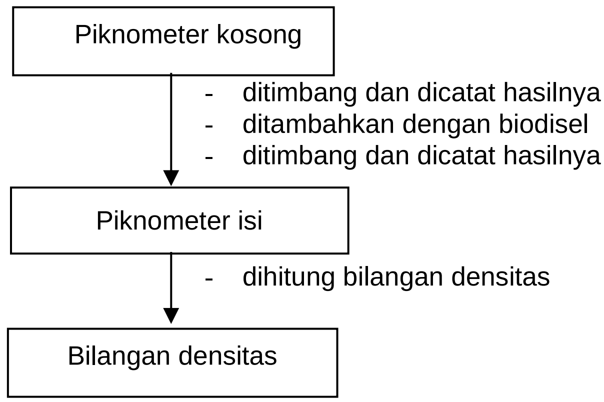
Lampiran 1.8.1 Diagram alir analisis susut massa keramik berpori



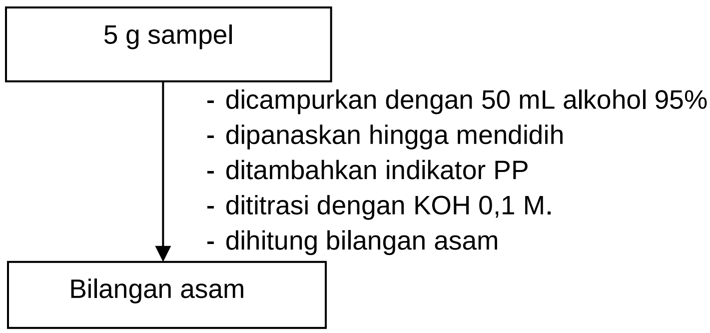
Lampiran 1.8.2 Diagram alir analisis porositas dan densitas keramik berpori



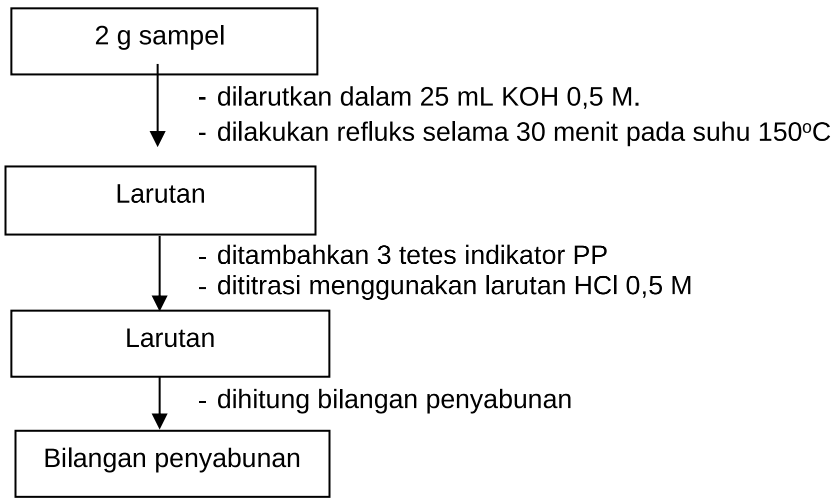
Lampiran 1.9 Diagram Alir Analisis Kuantitatif Biodiesel
Lampiran 1.9.1 Diagram alir analisis densitas biodiesel



Lampiran 1.9.2 Diagram alir analisis bilangan asam biodiesel



Lampiran 1.9.3 Diagram alir analisis bilangan penyabunan biodiesel



Lampiran 1.9.4 Diagram alir analisis bilangan iodin biodiesel

0,5 g sampel

- dimasukkan ke dalam Erlenmeyer 250 mL
- ditambahkan 10 mL kloroform dan 25 mL reagen Hanus
- disimpan pada tempat gelap selama 10 menit
- ditambahkan 10 mL KI 15% dan 100 mL akuades

Larutan

- dititrasi dengan $Na_2S_2O_3$ 0,1 N dengan indikator pati 1%
- dihitung bilangan iodin

Bilangan Iodin

Lampiran 1.10 Diagram alir uji penggunaan kembali (reusabilitas) katalis bifungsioanl CaO-ZnO/KB

Katalis bekas

- dicuci dengan 100 mL metanol
- diaduk selama 1 jam
- dikeringkan pada suhu 100 ^{o}C selama 12 jam

Katalis siap digunakan kembali

- diuji aktivitas katalitik hingga terjadi penurunan persen konversi secara signifikan

Data

Lampiran 2. Perhitungan

Lampiran 2.1 Perhitungan %LOI dan Persen Pengurangan Pengotor Lempung Terpurifikasi

Lampiran 2.1.1 Perhitungan %LOI lempung alam Ma'rang

Massa lempung sebelum dipanaskan (m_i) = 50,1446 g
Massa lempung setelah dipanaskan 1000°C (m_f) = 44,985 g

$$\text{LOI (\%)} = \frac{m_i - m_f}{m_i} \times 100\%$$

$$= \frac{(50{,}1446 - 44{,}985)\ g}{50{,}1446\ g} \times 100\%$$

$$= 10{,}29\ \%$$

Lampiran 2.1.2 Perhitungan persen pengurangan pengotor lempung terpurifikasi

Tabel 2.1.2 Hasil pengukuran massa lempung setelah purifikasi

$[H_2SO_4]$ (M)	Suhu (°C)	m_c (g)	m_t (g)	%PP	Rata - rata %PP	SD	Rendemen (%)	Rata- rata rendemen (%)	SD
3M	800	20,1201	18,8712	6,2072	6,10	0,27	93,7928	93,99	0,26
	800	20,0231	18,8801	5,7084			94,2915		
	800	20,1209	18,8911	6,1120			93,8879		
	900	20,0981	17,892	10,9766	10,64	0,29	89,0233	89,36	0,29
	900	20,0112	17,9112	10,4941			89,5059		
	900	20,1001	17,9981	10,4577			89,5423		
	1000	20,1014	17,4231	13,3239	13,05	0,26	86,6760	86,95	0,26
	1000	20,0012	17,3987	13,0117			86,9882		
	1000	20,0213	17,4553	12,8163			87,1836		
4M	800	20,0209	18,4005	8,0935	8,15	0,23	91,9064	91,85	0,23
	800	20,0821	18,3953	8,3995			91,6005		
	800	20,0012	18,4101	7,9550			92,0450		
	900	20,1101	17,9895	10,5449	11,10	0,48	89,4550	88,90	0,48
	900	20,1004	17,8112	11,3888			88,6111		
	900	20,0901	17,8081	11,3588			88,6411		
	1000	20,1112	17,3031	13,9628	13,35	0,53	86,0371	86,65	0,53
	1000	20,0021	17,3987	13,0156			86,9844		
	1000	20,0103	17,3955	13,0673			86,9327		
5M	800	20,0119	18,3035	8,5369	8,73	0,20	91,4631	91,27	0,19
	800	20,0513	18,2995	8,7366			91,2634		
	800	20,1051	18,3101	8,9281			91,0719		
	900	20,1004	17,6035	12,4221	11,90	0,57	87,5778	88,10	0,58
	900	20,0041	17,6012	12,0120			87,9880		
	900	20,0143	17,7593	11,2669			88,7330		
	1000	20,0259	17,3001	13,6113	13,49	0,14	86,3886	86,50	0,14
	1000	20,0078	17,3009	13,5292			86,4708		
	1000	20,0224	17,3505	13,3445			86,6554		

Dimana %PP adalah persen pengurangan pengotor

$$\%\text{pengurangan pengotor} = \frac{mc - mt}{mc} \times 100\%$$

$$\text{Rendemen (\%)} = \frac{mt}{mc} \times 100\%$$

Dimana : m_c adalah massa lempung pemanggangan 600°C (g)
: m_t adalah massa lempung terpurifikasi (g)

Lampiran 2.2 Analisis Porositas, Densitas, dan Susut Massa Keramik dengan Variasi Suhu Sintering

Lampiran 2.2.1 Analisis porositas

Tabel 2.1.1. Hasil pengukuran porositas keramik berpori

Suhu Sintering (°C)	m_1 (g)	m_2 (g)	m_3 (g)	Porositas	Rata-rata	SD
900	2,8125	2,8501	2,7298	31,2552	30,03	1,79
	2,9321	2,9890	2,7856	27,9744		
	2,9221	2,9830	2,7856	30,8511		
1000	1,9189	2,8699	1,5932	69,5837	70,79	1,04
	1,9199	2,8679	1,4989	71,3533		
	1,9201	2,8697	1,5153	71,4253		
1100	2,8197	2,8502	2,7479	35,7981	38,32	1,11
	2,9298	2,9530	2,8775	41,8018		
	2,7209	2,7954	2,6081	37,3808		

Dimana m_1 = massa kering keramik (g), m_2 = massa keramik yang direndam di air mendidih selama 2 jam (g), m_3 = keramik yang telah dikeringkan permukaannya kemudian digantungkan di dalam air (masa jenuh) (g).

Contoh perhitungan porositas pada suhu sintering 900 °C

I. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %

Porositas = $\frac{2,8501 - 2,8125}{2,8501 - 2,7298}$ x 100 %

Porositas = $\frac{0,0376}{0,1203}$ x 100 %

Porositas = 31,2552%

II. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %

Porositas = $\frac{2,9890 - 2,9321}{2,9890 - 2,7856}$ x 100 %

Porositas = $\frac{0,0569}{0,2034}$ x 100 %

Porositas = 27,9744%

III. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %

Porositas = $\frac{2,9830 - 2,9221}{2,9830 - 2,7856}$ x 100 %

Porositas = $\frac{0,0609}{0,1974}$ x 100 %

Porositas = 30,8511%

Porositas rata-rata = $\frac{\text{Porositas I} + \text{Porositas II} + \text{Porositas III}}{3}$

= $\frac{31,2552\% + 27,9744\% + 30,8511\%}{3}$

= 30,03%

Lampiran 2.2.2 Analisis densitas

Tabel 2.2.2. Hasil pengukuran densitas keramik berpori

Suhu Sintering (°C)	m_1 (g)	V (mL)	Densitas (g/mL)	Densitas Rata-rata	SD
900	2,8125	0,1203	14,6235	14,61	0,19
	2,9321	0,2034	14,4154		
	2,9221	0,1974	14,8029		
1000	1,9189	1,2767	1,50302	1,62	0,05
	1,9199	1,3690	1,60241		
	1,9201	1,3544	1,61768		
1100	2,8197	0,1023	27,5630	22,59	1,05
	2,9298	0,0755	25,6872		
	2,7209	0,1873	14,5270		

Dimana m_1= massa keramik kering (g), V_t= volume setelah disinterring, dan nilai V diperoleh dari m_2-m_3 pada Tabel 2.1.1

Contoh perhitungan densitas pada suhu sintering 900 °C

I. $\rho = \frac{m_1}{V}$

$\rho = \frac{2,8125}{0,1203}$

$\rho =$ 14,6235 g/mL

II. $\rho = \frac{m_1}{V}$

$\rho = \frac{2,9321}{0,2034}$

$\rho =$ 14,4154 g/Ml

III. $\rho = \frac{m_1}{V}$

$\rho = \frac{2,9221}{0,1974}$

$\rho =$ 14,6235 g/mL

Densitas rata-rata $= \frac{\rho 1+\rho 2+\rho 3}{3}$

$= \frac{14,6235 + 14,4154 + 14,6235}{3}$

= 14,61 g/mL

Lampiran 2.2.3 Analisis susut massa

Tabel 2.2.3. Hasil pengukuran susut massa keramik berpori

Suhu Sintering (^oC)	mo (g)	mt (g)	mo-mt (g)	(mo-mt)/mo (g)	Susut massa (%)	Rata-rata	SD
900	2,89	2,82	0,05	0,02	2,43	4,18	0,03
	2,98	2,93	0,05	0,02	1,70		
	2,98	2,73	0,26	0,09	8,40		
1000	2,39	2,02	0,37	0,16	15,52	14,97	0,02
	2,28	1,93	0,35	0,16	15,48		
	2,39	2,02	0,37	0,16	15,48		
1100	2,94	2,82	0,12	0,04	3,97	4,01	0,05
	3,05	2,93	0,12	0,04	4,06		
	2,83	2,72	0,11	0,04	4,00		

Dimana mo= massa keramik sebelum disintering, mt= massa keramik setelah disintering

Contoh Perhitungan susut massa pada suhu sintering 900 ^oC

I. Susut massa = $\frac{2,89-2,82}{2,89}$ x 100 %
   Susut massa = $\frac{0,07}{2,89}$ x 100 %
   Susut massa = 2,43%
II. Susut massa = $\frac{2,98-2,93}{2,98}$ x 100 %
   Susut massa = $\frac{0,05}{2,98}$ x 100 %
   Susut massa = 1,70%
III. Susut massa = $\frac{2,98-2,73}{2,98}$ x 100 %
   Susut massa = $\frac{0,25}{2,98}$ x 100 %
   Susut massa = 8,39%

Sudut massa rata-rata $= \frac{\text{Susut massa I + Susut massa II + Susut massa III}}{3}$

$= \frac{2,43\% + 1,70\% + 8,39\%}{3}$

= 4,18%

Lampiran 2.3 Analisis Porositas, Densitas, Susut Bakar dan Kuat Tekan Keramik Berpori Gelcasting dengan Bahan Dasar Lempung

Lampiran 2.3.1 Analisis porositas

Tabel 2.2.1. Hasil pengukuran porositas keramik berpori gelcasting

Konsentrasi CS	m_1 (g)	m_2 (g)	m_3 (g)	Porositas	Rata-rata	SD
10%	1,9189	2,8699	1,5032	69.5837	70,62	0,84
	1,9199	2,8679	1,5393	71.3533		
	1,9201	2,8697	1,5402	71.4253		
	1,9213	2,8779	1,5095	69.9065		
	1,9203	2,8789	1,5253	70.8186		
20%	2,0935	2,9881	1,7186	70.4687	71,38	1,12
	2,0931	2,9859	1,7153	70.2660		
	2,0932	2,8453	1,7935	71.5060		
	2,0944	2,8154	1,8081	71.5775		
	2,0961	2,9053	1,7981	73.0853		
30%	2,0021	2,9785	1,7132	77.1675	77,56	1,33
	2,0021	3,0113	1,7189	78.0873		
	1,9913	3,0041	1,7192	78.8233		
	2,0012	3,0132	1,7202	78.2676		
	1,9121	2,9011	1,5901	75.4386		
40%	2,1079	2,9823	1,8035	74.1771	75,77	1,95
	2,1011	2,9987	1,8501	78.1473		
	2,2600	3,2301	1,9801	77.6080		
	2,1089	2,9753	1,8062	74.1083		
	2,1079	2,9689	1,8182	74.8240		
50%	2,0991	2,9881	1,7632	72.5774	72,17	1,22
	2,1112	2,8454	1,8090	70.8414		
	2,0953	2,8453	1,7985	71.6469		
	2,0944	2,8454	1,7983	71.7219		
	2,0961	2,9053	1,8126	74.0551		

Dimana m_1= massa kering keramik (g), m_2= massa keramik yang direndam selama 2 jam (g), m_3= massa keramik yang telah dikeringkan permukaannya digantungkan dalam air (masa jenuh) (g)

Contoh perhitungan porositas keramik berpori gelcasting dengan bahan dasar lempung 10%

I. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %

Porositas = $\frac{2,8699-1,9189}{2,8699-1,5032}$ x 100 %

Porositas = $\frac{0,951}{1,3667}$ x 100 %

Porositas = 69,5837,%

II. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %

Porositas = $\frac{2,8679-1,9199}{2,8679-1,5393}$ x 100 %

Porositas = $\frac{0,948}{1,3286}$ x 100 %

Porositas = 71,3533%

III. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %

Porositas = $\frac{2{,}8697 - 1{,}9201}{2{,}8697 - 1{,}5402}$ x 100 %

Porositas = $\frac{0{,}9496}{1{,}3295}$ x 100 %

Porositas = 71.4253%

IV. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %

Porositas = $\frac{2{,}8779 - 1{,}9213}{2{,}8779 - 1{,}5095}$ x 100 %

Porositas = $\frac{0{,}9566}{1{,}3684}$ x 100 %

Porositas = 69.9065%

V. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %

Porositas = $\frac{2{,}8789 - 1{,}9203}{2{,}8789 - 1{,}5253}$ x 100 %

Porositas = $\frac{0{,}9586}{1{,}3536}$ x 100 %

Porositas = 70.8186%

Porositas rata-rata $= \frac{\text{Porositas I} + \text{Porositas II} + \text{Porositas III} + \text{Porositas IV} + \text{Porositas V}}{5}$

$= \frac{69{,}5837\% + 71{,}3533\% + 71{,}4253\% + 69{,}9065\% + 70{,}8186\%}{5}$

= 70,62%

Lampiran 2.3.2 Analisis densitas

Tabel 2.3.2. Hasil pengukuran densitas keramik berpori gelcasting

Konsentrasi CS	m_1 (g)	V (mL)	Densitas	Rata-rata	SD
10%	1,9189	1,3667	1,6040	1,62	0,02
	1,9199	1,3286	1,6451		
	1,9201	1,3295	1,6442		
	1,9213	1,3684	1,6040		
	1,9203	1,3536	1,6187		
20%	2,0935	1,2695	1,6491	1,85	0,2
	2,0931	1,2706	1,6473		
	2,0932	1,0518	1,9901		
	2,0944	1,0073	2,0792		
	2,0961	1,1072	1,8932		
30%	2,0021	1,2653	1,5823	1,54	0,05
	2,0021	1,2924	1,5491		
	1,9913	1,2849	1,5498		
	2,0012	1,2930	1,5477		
	1,9121	1,3110	1,4585		
40%	2,1079	1,1788	1,7882	1,81	0,02
	2,1011	1,1486	1,8293		
	2,2600	1,2500	1,8080		
	2,1089	1,1691	1,8039		
	2,1079	1,1507	1,8318		
50%	2,0991	1,2249	1,7137	1,93	0,13
	2,1112	1,0364	2,0371		
	2,0953	1,0468	2,0016		
	2,0944	1,0471	2,0002		
	2,0961	1,0927	1,9183		

Dimana m_1= massa keramik kering (g), V = volume yang diperoleh dari m_2-m_3 pada Tabel 2.3.1.

Contoh perhitungan densitas keramik berpori gelcasting dengan bahan dasar lempung 10%

I. $\rho = \frac{m_1}{V}$

$\rho = \frac{1,9189}{1,3667}$

$\rho =$ 1,6040 g/mL

II. $\rho = \frac{m_1}{V}$

$\rho = \frac{1,9199}{1,3286}$

$\rho =$ 1,6451 g/mL

III. $\rho = \frac{m_1}{V}$

$\rho = \frac{1,9201}{1,3295}$

$\rho =$ 1,4442 g/mL

IV. $\rho = \frac{m_1}{V}$

$\rho = \frac{1,9213}{1,3684}$

$\rho =$ 1,6040 g/mL

V. $\rho = \frac{m_1}{V}$

$\rho = \frac{1,9203}{1,3536}$

$\rho =$ 1,6187 g/mL

Densitas rata-rata $= \frac{\rho 1+\rho 2+\rho 3+\rho 4+\rho 5}{5}$

$= \frac{1,6040 + 1,6451 + 1,6442 + 1,6040 + 1,6187}{5}$

= 1,42 g/mL

Lampiran 2.3.3 Analisis susut massa

Tabel 2.3.3. Hasil pengukuran susut massa keramik berpori *gelcasting*

Konsentrasi CS	mo (g)	mt (g)	susut massa (%)	Rata-rata	SD
10%	2,4765	2,0785	16,07	14,97	0,99
	2,5053	2,1512	14,13		
	2,4567	2,0952	14,71		
20%	2,8429	2,2259	21,7	21,18	0,46
	2,8256	2,2312	21,04		
	2,8302	2,2412	20,81		
30%	2,9702	1,9165	35,48	35,74	0,25
	3,0122	1,9285	35,98		
	3,0859	1,9822	35,77		
40%	3,1982	2,2098	30,9	30,79	0,68
	3,2569	2,2780	30,06		
	3,0791	2,1119	31,41		
50%	3,1978	2,2945	28,25	28,66	0,55
	3,2718	2,3411	28,45		
	3,4129	2,4132	29,29		

Dimana mo= massa keramik sebelum disintering, mt= massa keramik setelah disintering

Contoh Perhitungan susut massa keramik berpori gelcasting dengan bahan dasar lempung 10%

I. Susut massa = $\frac{mo-mt}{mo}$ x 100 %

Susut massa = $\frac{2,4765-2,0785}{2,4765}$ x 100 %

Susut massa = $\frac{0,3980}{2,4765}$ x 100 %
Susut massa = 16,07%

II. Susut massa = $\frac{mo-mt}{mo}$ x 100 %
Susut massa = $\frac{2,5053-2,1512}{2,5053}$ x 100 %
Susut massa = $\frac{0,3541}{2,5053}$ x 100 %
Susut massa = 14,13%

III. Susut massa = $\frac{mo-mt}{mo}$ x 100 %
Susut massa = $\frac{2,4567-2,0952}{2,4567}$ x 100 %
Susut massa = $\frac{0,3615}{2,4567}$ x 100 %
Susut massa = 14,71%

Sudut massa rata-rata = $\frac{\text{Sudut massa I + Sudut massa II + Sudut massa III}}{3}$
= $\frac{16,07\% + 14,13\% + 14,71\%}{3}$
= 14,97%

Lampiran 2.3.4 Analisis kuat tekan

Tabel 2.3.4. Hasil pengukuran kuat tekan keramik berpori gelcasting

Perlakuan		Dimensi Spesimen					Kekuatan Kompresi	Rata-rata	SD
No	Variasi CS	dx (mm)	dy (mm)	D (mm)	A (mm)	F_{uc} (N)	σ_c (MPa)		
1	10%	19,40	19,51	19,45	297,12	3940	13,26	13,28	0,023
		19,38	19,51	19,44	296,81	3942	13,28		
		19,41	19,51	19,46	297,27	3956	13,31		
2	20%	19,40	19,52	19,46	297,27	3720	12,51	12,79	0,24
		19,39	19,52	19,45	297,12	3820	12,86		
		19,40	19,52	19,46	297,27	3860	12,98		
3	30%	19,20	19,40	19,30	292,40	3140	10,74	10,88	0,37
		19,22	19,40	19,31	292,71	3104	10,60		
		19,19	19,40	19,29	292,25	3304	11,31		
4	40%	18,90	19,42	19,16	288,18	3240	11,24	11,77	0,77
		18,88	19,42	19,15	287,88	3286	11,41		
		18,89	19,42	19,15	288,03	3646	12,66		
5	50%	18,69	18,39	18,54	269,83	3360	12,45	12,97	0,89
		18,71	18,39	18,55	270,12	3364	12,45		
		18,62	18,39	18,51	268,81	3762	13,99		

Contoh Perhitungan kuat tekan keramik berpori gelcasting dengan bahan dasar lempung 10%

I. Kekuatan kompresi = $\frac{F}{A}$
Kekuatan kompresi = $\frac{3940}{297,12}$
Kekuatan kompresi = 13,26 Mpa

II. Kekuatan kompresi = $\frac{F}{A}$

Kekuatan kompresi = $\frac{3942}{296,81}$

Kekuatan kompresi = 13,28 MPa

III. Kekuatan kompresi = $\frac{F}{A}$

Kekuatan kompresi = $\frac{3956}{297,27}$

Kekuatan kompresi = 13,31 MPa

Kekuatan kompresi rata-rata

$$= \frac{\text{Kekuatan kompresi I+Kekuatan kompresi II+Kekuatan kompresi III}}{3}$$

$$= \frac{13{,}26\ \text{MPa} + 13{,}28\ \text{MPa} + 13{,}31\ \text{MPa}}{3}$$

= 13,28 MPa

Lampiran 2.4 Analisis Porositas, Densitas, Susut Bakar dan Kuat Tekan Keramik Berpori Gelcasting dengan Bahan Silika Murni (Kontrol)

Lampiran 2.4.1 Analisis porositas

Tabel 2.4.1. Hasil pengukuran porositas keramik berpori gelcasting

Konsentrasi CS	m_1 (g)	m_2 (g)	m_3 (g)	Porositas	Rata-rata	SD
10%	1,6204	2,6951	1,5321	70,1455	71,24	1,72
	1,6213	2,6895	1,5243	70,0781		
	1,6214	2,6952	1,5234	70,4871		
	1,6102	2,7246	1,5021	74,1895		
	1,6201	2,6902	1,5012	71,2830		
20%	1,7982	2,9454	1,5320	74,8830	75,04	1,80
	1,7980	2,9191	1,5213	73,6940		
	1,7983	2,8946	1,5015	73,0137		
	1,6981	2,8562	1,5203	7,1757		
	1,7983	2,9753	1,5201	77,4291		
30%	1,4222	2,5398	1,3908	80,3566	81,71	1,34
	1,4220	2,6086	1,4298	82,9906		
	1,4223	2,5537	1,4111	80,1786		
	1,4223	2,5916	1,4219	82,2350		
	1,4223	2,5071	1,3105	82,7775		
40%	1,5424	2,7222	1,4610	80,7529	82,29	1,20
	1,5342	2,6981	1,4201	81,9590		
	1,5421	2,7193	1,4111	83,4243		
	1,5480	2,7021	1,4121	81,7293		
	1,5391	2,7182	1,4105	83,5945		
50%	1,6317	2,9127	1,5101	84,8288	84,52	1,04
	1,6267	2,8844	1,5211	82,6836		
	1,5915	2,7894	1,4121	84,8311		
	1,6302	2,9031	1,4987	84,9334		
	1,5925	2,8068	1,4231	85,3278		

Dimana m_1 = massa kering keramik (g), m_2 = massa keramik yang direndam di air mendidih selama 2 jam (g), m_3 = keramik yang telah dikeringkan permukaannya kemudian digantungkan di dalam air (masa jenuh) (g).
Contoh perhitungan porositas keramik berpori gelcasting dengan bahan silika murni (kontrol) 10%

I. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %
   Porositas = $\frac{2{,}6951 - 1{,}6204}{2{,}6951 - 1{,}5321}$ x 100 %
   Porositas = $\frac{1{,}0747}{1{,}163}$ x 100 %
   Porositas = 70,1456%
II. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %
   Porositas = $\frac{2{,}6895 - 1{,}6213}{2{,}6895 - 1{,}5243}$ x 100 %
   Porositas = $\frac{1{,}0682}{1{,}1652}$ x 100 %
   Porositas = 70,0781%
III. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %
   Porositas = $\frac{2{,}6952 - 1{,}6214}{2{,}6952 - 1{,}5234}$ x 100 %
   Porositas = $\frac{1{,}0738}{1{,}1718}$ x 100 %
   Porositas = 70,4871%
IV. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %
   Porositas = $\frac{2{,}7246 - 1{,}6102}{2{,}7246 - 1{,}5021}$ x 100 %
   Porositas = $\frac{1{,}1144}{1{,}2225}$ x 100 %
   Porositas = 74,1895%
V. Porositas = $\frac{m_2 - m_1}{m_2 - m_3}$ x 100 %
   Porositas = $\frac{2{,}6902 - 1{,}6201}{2{,}6902 - 1{,}5012}$ x 100 %
   Porositas = $\frac{1{,}0701}{1{,}189}$ x 100 %
   Porositas = 71,283%

Porositas rata-rata $= \frac{\text{Porositas I+Porositas II+Porositas III+ Porositas IV+ Porositas V}}{5}$

$= \frac{70{,}1456\%+70{,}0781\%+70{,}4871\%+74{,}1895+71{,}283\%}{5}$

= 71,24%

Lampiran 2.4.2 Analisis densitas

Tabel 2.4.2. Hasil pengukuran densitas keramik berpori gelcasting

Konsentrasi CS	m_1 (g)	V (mL)	Densitas (g/mL)	Densitas Rata-rata	SD
10%	1,6204	1,1630	1,3933	1,37	0,03
	1,6213	1,1652	1,3914		
	1,6214	1,1718	1,3837		
	1,6102	1,2225	1,3171		
	1,6201	1,1890	1,3626		
20%	1,7982	1,4134	1,2723	1,27	0,02
	1,7980	1,3978	1,2863		
	1,7983	1,3931	1,2909		
	1,6981	1,3359	1,2711		
	1,7983	1,4552	1,2358		
30%	1,4222	1,1490	1,2378	1,22	0,02
	1,4220	1,1788	1,2063		
	1,4223	1,1426	1,2448		
	1,4223	1,1697	1,2159		
	1,4223	1,1966	1,1886		
40%	1,5424	1,2612	1,2230	1,20	0,02
	1,5342	1,2780	1,2005		
	1,5421	1,3082	1,1788		
	1,5480	1,2900	1,2000		
	1,5391	1,3077	1,1770		
50%	1,6317	1,4026	1,1633	1,16	0,02
	1,6267	1,3633	1,1932		
	1,5915	1,3773	1,1555		
	1,6302	1,4044	1,1608		
	1,5925	1,3837	1,1509		

Dimana m_1= massa keramik kering keramik (g), V= volume, yang diperoleh dari m_2-m_3 pada Tabel 2.4.1.

Contoh perhitungan densitas keramik berpori gelcasting dengan bahan silika murni (kontrol) 10%

I. $\rho = \frac{m_1}{V}$

$\rho = \frac{1,6204}{1,1630}$

$\rho =$ 1,3933 g/mL

II. $\rho = \frac{m_1}{V}$

$\rho = \frac{1,6213}{1,1652}$

$\rho =$ 1,3914 g/mL

III. $\rho = \frac{m_1}{V}$

$\rho = \frac{1,6214}{1,1718}$

$\rho =$ 1,3837 g/mL

IV. $\rho = \frac{m_1}{V}$

$\rho = \frac{1,6102}{1,2225}$

$\rho =$ 1,3171 g/mL

V. $\rho = \frac{m_1}{V}$

$\rho = \frac{1,6201}{1,1890}$

$\rho =$ 1,3626 g/mL

Densitas rata-rata $= \frac{\rho 1+\rho 2+\rho 3+\rho 4+\rho 5}{5}$

$= \frac{1,3933 + 1,3914 + 1,3837+1,3171+1,3626}{5}$

= 1,37 g/mL

Lampiran 2.4.3 Analisis susut massa

Tabel 2.4.3. Hasil pengukuran susut massa keramik berpori gelcasting

Konsentrasi CS	mo (g)	mt (g)	Susut massa (%)	Rata-rata	SD
10%	2,7175	2,2098	18,68	17,67	0,87
	2,6535	2,1981	17,16		
	2,5397	2,1039	17,16		
20%	2,3796	1,9964	17,28	17,54	0,34
	2,2847	1,8750	17,93		
	2,2028	1,8190	17,42		
30%	2,3796	1,7975	26,46	26,81	0,52
	2,2847	1,6775	26,58		
	2,2028	1,5991	27,41		
40%	2,4505	1,6790	31,48	32,55	0,82
	2,3930	1,6198	32,31		
	2,4009	1,5880	33,86		
50%	3,3070	2,1617	34,63	35,08	0,68
	3,3124	2,1239	35,88		
	3,2208	2,1014	34,76		

Dimana mo= massa keramik sebelum disintering, mt= massa keramik setelah disintering

Contoh Perhitungan susut massa keramik berpori gelcasting dengan bahan silika murni (kontrol) 10%

I. Susut massa = $\frac{mo-mt}{mo}$ x 100 %

Susut massa = $\frac{2,7175-2,2098}{2,7175}$ x 100 %

Susut massa = $\frac{0,5077}{2,7175}$ x 100 %

Susut massa = 18,68%

II. Susut massa = $\frac{mo-mt}{mo}$ x 100 %

Susut massa = $\frac{2,6535-2,1981}{2,6535}$ x 100 %

Susut massa = $\frac{0,4554}{2,6535}$ x 100 %

Susut massa = 17,16%

III. Susut massa = $\frac{mo-mt}{mo}$ x 100 %

Susut massa = $\frac{2,5397-2,1039}{2,5397}$ x 100 %

Susut massa = $\frac{0,4358}{2,5397}$ x 100 %

Susut massa = 17,16%

Sudut massa rata-rata = $\frac{\text{Sudut massa I} + \text{Sudut massa II} + \text{Sudut massa III}}{3}$

= $\frac{18,68\% + 17,16\% + 17,16\%}{3}$

= 17,67%

Lampiran 2.4.4 Analisis kuat tekan

Tabel 2.4.4. Hasil pengukuran kuat tekan keramik berpori gelcasting

Perlakuan				Dimensi Spesimen			Kekuatan Kompresi	Rata -rata	SD
No	Variasi CS	dx (mm)	dy (mm)	D (mm)	A (mm)	F_{uc} (N)	σ_c (MPa)		
1	10%	18,53	18,47	18,5	268,67	2300	8,56	8,60	0,039
		18,51	18,47	18,49	268,38	2308	8,60		
		18,49	18,47	18,48	268,09	2316	8,64		
2	20%	18,62	18,51	18,565	270,56	2096	7,75	8,29	0,48
		18,60	18,51	18,555	270,27	2296	8,50		
		18,61	18,51	18,56	270,41	2336	8,64		
3	30%	18,67	18,5	18,585	271,14	1960	7,23	7,19	0,04
		18,6	18,5	18,55	270,12	1930	7,14		
		18,61	18,5	18,555	270,27	1942	7,19		
4	40%	18,74	18,51	18,625	272,31	1240	4,55	4,85	0,26
		18,70	18,51	18,605	271,72	1340	4,93		
		18,72	18,51	18,615	272,02	1374	5,05		
5	50%	18,15	17,89	18,02	254,91	1340	5,26	5,35	0,08
		18,30	17,89	18,095	257,03	1378	5,36		
		18,21	17,89	18,05	255,75	1390	5,43		

Contoh Perhitungan kuat tekan keramik berpori gelcasting dengan bahan silika murni (kontrol) 10%

I. Kekuatan kompresi = $\frac{F}{A}$

Kekuatan kompresi = $\frac{2300}{268,67}$

Kekuatan kompresi = 8,56 MPa

II. Kekuatan kompresi = $\frac{F}{A}$

Kekuatan kompresi = $\frac{2308}{268,38}$

Kekuatan kompresi = 8,60 MPa

III. Kekuatan kompresi = $\frac{F}{A}$

Kekuatan kompresi = $\frac{2316}{268,09}$

Kekuatan kompresi = 8,64 MPa

Kekuatan kompresi rata-rata

$= \frac{\text{Kekuatan kompresi I} + \text{Kekuatan kompresi II} + \text{Kekuatan kompresi III}}{3}$

$= \frac{8{,}56\ \text{Mpa} + 8{,}60\ \text{MPa} + 8{,}64\ \text{MPa}}{3}$

= 8,60 MPa

Lampiran 2.5 Pengatamam Waktu Gelasi Keramik Berpori

Keramik berpori dengan bahan dasar NC

Konsentrasi kitosan (%)	Waktu Gelasi I (menit)	Waktu Gelasi II (menit)	Waktu Gelasi III (menit)	Rata-rata
10	8	8,5	8	8,17
20	6	6	6	6
30	5	5	4	4,67
40	4	4	4	4
50	3	2,5	3	2,83

Keramik berpori dengan bahan dasar SiO_2

Konsentrasi kitosan (%)	Waktu Gelasi I (menit)	Waktu Gelasi II (menit)	Waktu Gelasi III (menit)	Rata-rata
10	9	8,5	9	8,83
20	8,5	8	8	8,17
30	7	7	6,5	6,83
40	8	8	8	8
50	5	6	5,5	5,5

Lampiran 2.6 Perhitungan Massa Minyak Sawit dan Metanol

Perbandingan mol metanol : minyak sebesar 3:1

Perhitungan massa metanol:

mol : $\frac{\text{m}}{\text{Mr}}$

3 mol : $\frac{\text{m}}{32\ \text{g}/\text{mol}}$

m : 96 g

Perhitungan massa minyak sawit, Mr yang digunakan dari asam palmitat:

mol : $\frac{\text{m}}{\text{Mr}}$

1 mol : $\frac{\text{m}}{256{,}50\ \text{g}/\text{mol}}$

m : 256,450 g

Lampiran 2.7 Standarisasi Larutan Standar NaOH 0,1 N dengan Menggunakan Asam Oksalat

Perhitungan standarisasi larutan standar NaOH 0,1 N dengan menggunakan Asam Oksalat.

$N = \frac{\text{m asam oksalat} \times 2}{\text{BM asam oksalat} \times \text{V NaOH}}$

$$N = \frac{0{,}1 \times 2}{126 \times 0{,}0176}$$

$$N = \frac{0{,}2}{2{,}2176}$$

N = 0,09 N

Lampiran 2.8 Standarisasi Larutan Standar $Na_2S_2O_3$ 0,1 N dengan Menggunakan $K_2Cr_2O_7$ 0,1 N

Perhitungan standarisasi larutan standar $Na_2S_2O_3$ 0,1 N dengan menggunakan $K_2Cr_2O_7$ 0,1 N.

$$V_1.N_1 = V_2.\ N_2$$

$$V_{Na2S2O3}.N_{Na2S2O3} = V_{K2Cr2O7}.N_{K2Cr2O7}$$

$$N_1 = \frac{V2.N2}{V1}$$

$$N_1 = \frac{8{,}33\ mL \times 0{,}1\ N}{7{,}9\ mL}$$

N_1 = 0,1 N

Lampiran 2.9 Standarisasi Larutan Standar HCl 0,5 N dengan Menggunakan $Na_2S_2O_3$ 0,1 N

Perhitungan standarisasi larutan standar HCl 0,5 N dengan menggunakan $Na_2S_2O_3$ 0,1 N.

$$V_1.N_1 = V_2.\ N_2$$

$$V_{HCl}.N_{HCl} = V_{Na2S2O3}.N_{Na2S2O3}$$

$$N_1 = \frac{V2.N2}{V1}$$

$$N_1 = \frac{50\ mL \times 0{,}1\ N}{9{,}43\ mL}$$

N_1 = 0,5 N

Lampiran 2.10 Standarisasi Larutan Standar KOH 0,1 N dengan Menggunakan Asam Oksalat

Perhitungan standarisasi larutan standar KOH 0,1 N dengan menggunakan Asam Oksalat

$$N = \frac{\text{massa asam oksalat} \times 2}{126 \times \text{V NaOH}}$$

$$N = \frac{0{,}1\ g \times 2}{126 \times 0{,}017}$$

$$N = \frac{0{,}2}{2{,}142}$$

N = 0,09 N

Lampiran 2.11 Perhitungan Densitas, Persen FFA, Bilangan Asam, Bilangan Penyabunan dan Bilangan Iodine Minyak Sawit

Lampiran 2.11.1 Perhitungan massa jenis minyak sawit

Tabel 2.11.1 Hasil pengukuran massa jenis minyak sawit

No.	Sampel	m_0 (g)	m_1 (g)	massa minyak (g)	massa jenis (g/mL)	Rata-rata	SD
1	Minyak sawit	13,0500	22,7600	9,7100	0,971	0,98	0,002
		13,0400	22,7100	9,6700	0,967		
		13,0500	22,7600	9,7100	0,971		

Rumus Perhitungan Massa Jenis Biodiesel

$$\rho = \frac{m_1 - m_0}{Vp}$$

Dengan ρ adalah densitas minyak (g/mL), m_0 adalah berat piknometer kosong (g), m_1 adalah berat piknometer dengan minyak (g) dan V_p adalah volume piknometer (mL).
Volume piknometer (Vp) = 10 mL

Lampiran 2.11.2 Perhitungan persen FFA minyak sawit

Tabel 2.11.2 Hasil titrasi minyak sawit menggunakan larutan NaOH 0,09 M

V NaOH (mL)	m (g)	%FFA	Rata-rata	SD
9,8	5,0012	4,5226	4,4768	0,0461
9,7	5,0001	4,4775		
9,6	5,0011	4,4304		

Mr yang digunakan adalah asam palmitat:
BM yang digunakan adalah BM Asam palmitat

I. %FFA $= \frac{VNaOH \times N \times BM}{M} \times 100\%$

$= \frac{9,8\ mL \times 0,09\ mol/L \times 256,45\ g/mol}{5,0012\ g} \times 100\%$

$= \frac{9,8\ .\ 10^{-3}\ L \times 0,09\ mol/L \times 256,45\ g/mol}{5,0012\ g} \times 100\%$

= 4,52%

II. %FFA $= \frac{VNaOH \times N \times BM}{M} \times 100\%$

$= \frac{9,7\ mL \times 0,09\ mol/L \times 256,45\ g/mol}{5,0001\ g} \times 100\%$

$= \frac{9,7\ .\ 10^{-3}\ L \times 0,09\ mol/L \times 256,45\ g/mol}{5,0001\ g} \times 100\%$

= 4,47%

III. %FFA $= \frac{VNaOH \times N \times BM}{M} \times 100\%$

$= \frac{9,6\ mL \times 0,09\ mol/L \times 256,45\ g/mol}{5,0011\ g} \times 100\%$

$= \frac{9,6\ .\ 10^{-3}\ L \times 0,09\ mol/L \times 256,45\ g/mol}{5,0011\ g} \times 100\%$

= 4,43%

%FFA rata-rata = $\frac{\%FFA\ I + \%FFA\ II + \%FFA\ III}{3}$

%FFA rata-rata = $\frac{4{,}52\% + 4{,}47\% + 4{,}43\%}{3}$

%FFA rata-rata = $\frac{13{,}42}{3}$

%FFA rata-rata = 4,47

Lampiran 2.11.3 Perhitungan bilangan asam minyak sawit

Tabel 2.11.3 Hasil pengukuran bilangan asam minyak sawit

Sampel	V KOH (mL)	m sampel (gr)	Bilangan asam (mg KOH/g)	Rata-rata	SD
Minyak sawit	9,8	5,0012	9,8941	9,8937	0,10
	9,9	5,0013	9,9944		
	9,7	5,0012	9,7927		

Perhitungan Bilangan Asam Minyak Sawit

Bilangan Asam = $\frac{56{,}1 \times V \times M}{m\ sampel}$

V adalah volume KOH yang dibutuhkan untuk titrasi (mL), M adalah Molaritas KOH (0,09 mol/L), m sampel adalah massa sampel (g) dan 56,1 adalah berat molekul KOH (g/mL)

Lampiran 2.11.4 Perhitungan bilangan penyabunan minyak sawit

Tabel 2.11.4 Hasil pengukuran bilangan penyabunan minyak sawit

No	Sampel	V HCl (mL)	m sampel (g)	Bilangan Penyabunan (mg/g)	Bil Penyabunan rata-rata	SD
1	Minyak sawit	16,4	2,0113	228,7177	227,74	1,42
		16,3	2,0012	228,4704		
		16,2	2,0105	226,0184		

Rumus Perhitungan Bilangan Penyabunan

Bilangan Penyabunan = $\frac{V\ HCl \times M\ HCl \times BM\ KOH}{m\ sampel}$

V adalah volume HCl (mL); M HCl adalah moralitas HCl (0,5 mmol/mL); BM KOH adalah berat molekul KOH (56,1 mg/mmol) dan m sampel adalah massa sampel minyak sawit (g)

Lampiran 2.11.5 Perhitungan bilangan iodine minyak sawit

Tabel 2.11.5 Hasil pengukuran bilangan iodine minyak sawit

No	Sampel	V $Na_2S_2O_3$ (mL)	m sampel (g)	M $Na_2S_2O_3$	Bilangan iodine (mg/g)	Bilangan iodine rata-rata	SD
1	Minyak sawit	5,1	0,5115	0,1	126,6276	127,71	3,87
		5,2	0,5003	0,1	132,0008		
		5,0	0,5101	0,1	124,4854		

Rumus Perhitungan Bilangan Iodine

Bilangan Iodine = $\frac{V \times M \times Mr\ I2}{m\ sampel}$

V_b volume tiosulfat yang dibutuhkan untuk menitrasi minyak sawit (mL), M adalah molaritas tiosulfat sebesar 0,1 M, Mr I_2 adalah massa molekul relatif I_2 (mg/mmol) dan m sampel adalah massa biodiesel (g).

Lampiran 2.12 Penentuan Massa Jenis, Bilangan Asam, Persen Konversi, Bilangan Iodine, Bilangan Penyabunan dan Angka Setana Biodiesel Menggunakan Keramik Berpori dengan Variasi Konsentrasi Kitosan (Kondisi reaksi selama 6 jam dengan perbandingan metanol : minyak (3:1) dengan perbandingan Ca:Zn (1:1))

Lampiran 2.12.1 Penentuan massa jenis

Tabel 2.12.1 Hasil pengukuran massa jenis biodiesel

No.	Sampel	m_0 (massa pikno)	m_1 (massa pikno + biodiesel	massa biodiesel (g)	massa jenis (g/mL)	Rata-rata	SD
1	CaO-ZnO/KB-CS10%	12,7022	21,1972	8,4950	0,8495	0,85	0,0008
		12,7122	21,2072	8,4950	0,8495		
		12,976	21,4856	8,5096	0,85096		
2	CaO-ZnO/KB-CS 20%	13,0497	21,4661	8,4164	0,84164	0,84	0,004
		12,5651	21,0129	8,4478	0,84478		
		12,6663	21,1578	8,4915	0,84915		
3	CaO-ZnO/KB-CS 30%	12,6232	21,1987	8,5755	0,85755	0,86	0,0005
		12,5132	21,0987	8,5855	0,85855		
		12,9732	21,5556	8,5824	0,85824		
4	CaO-ZnO/KB-CS 40%	12,667	21,0376	8,3706	0,83706	0,84	0,001
		13,0251	21,4189	8,3938	0,83938		
		13,0475	21,4289	8,3814	0,83814		
5	CaO-ZnO/KB-CS 50%	12,699	21,2833	8,5843	0,85843	0,85	0,006
		12,581	21,0833	8,5023	0,85023		
		13,0764	21,5413	8,4649	0,84649		

Rumus Perhitungan Massa Jenis Biodiesel

$$\rho = \frac{m_1 - m_0}{Vp}$$

Dengan ρ adalah densitas (g/mL), m_0 adalah berat piknometer kosong (g), m_1 adalah berat piknometer dengan sampel (g) dan V_p adalah volume piknometer (mL).

Volume piknometer (Vp) = 10 mL

Contoh Perhitungan Massa Jenis Biodiesel Menggunakan Keramik Berpori dengan Variasi Konsentrasi Kitosan 10%

$$\rho_1 = \frac{m1-m0}{Vp}$$

Volume piknometer (Vp) = 10 mL

$$\rho_1 = \frac{21{,}1972\ g-12{,}7022\ g}{10\ mL}$$

$\rho_1 = \frac{8{,}495\ g}{10\ mL}$

ρ_1 = 0,8495 g/mL

$\rho_2 = \frac{m1 - m0}{Vp}$

$\rho_2 = \frac{21{,}4856 - 12{,}7122\ g}{10\ mL}$

$\rho_2 = \frac{8{,}495\ g}{10\ mL}$

ρ_2 = 0,8495 g/mL

$\rho_3 = \frac{m1 - m0}{Vp}$

$\rho_3 = \frac{21{,}4856\ g - 12{,}9760\ g}{10\ mL}$

$\rho_3 = \frac{8{,}5096\ g}{10\ mL}$

ρ_3 = 0,85096 g/mL

ρ rata-rata $= \frac{\rho 1 + \rho 2 + \rho 3}{3}$

ρ rata-rata $= \frac{0{,}8495 \frac{g}{mL} + 0{,}8495 \frac{g}{mL} + 0{,}85096 \frac{g}{mL}}{3}$

$\rho\ rata - rata$ = 0,849987 g/mL

Lampiran 2.12.2 Pengujian bilangan asam dan persen konversi

Tabel 2.11.2 Hasil pengukuran bilangan asam dan persen konversi

No	Sampel	V KOH (mL)	m sampel (g)	Bilangan asam (mg KOH/g)	Persen konversi (%)	Rata-rata	SD
1	CaO-ZnO/KB-CS 10%	0,2	5,001	0,2019	97,9591	97,67	0,53
		0,2	5,1021	0,1979	97,9995		
		0,3	5,2187	0,2902	97,0663		
2	CaO-ZnO/KB-CS 20%	0,2	5,1546	0,1959	98,0199	97,69	0,52
		0,3	5,2701	0,2874	97,0949		
		0,2	5,0248	0,2009	97,9752		
3	CaO-ZnO/KB-CS 30%	0,2	5,0421	0,2225	98,4784	98,14	0,09
		0,15	5,0321	0,1673	97,9725		
		0,2	5,0355	0,2228	97,9730		
4	CaO-ZnO/KB-CS 40%	0,2	5,0050	0,2017	97,9607	97,63	0,59
		0,3	5,0119	0,3022	96,9453		
		0,2	5,0527	0,1998	97,9799		
5	CaO-ZnO/KB-CS 50%	0,2	5,0697	0,1991	97,9867	97,64	0,59
		0,2	5,0355	0,2005	97,9730		
		0,3	5,0292	0,3011	96,9558		

Rumus Perhitungan Bilangan Asam

Bilangan Asam = $\frac{56{,}1 \times V \times M}{m \text{ sampel}}$

V adalah volume KOH yang dibutuhkan untuk titrasi (mL), M adalah Molaritas KOH, m sampel adalah massa sampel (g) dan 56,1 adalah berat molekul KOH (g/mL).

Diketahui:

V KOH = 9,80 mL

m sampel = 5,0012 g

BM KOH = 56,1 g

N KOH = 0,09 N ≈ 0,09 M

Bilangan Asam = $\frac{56{,}1 \times V \times M}{m \text{ sampel}}$

Bilangan Asam = $\frac{56{,}1 \frac{mg}{mmol} \times 9{,}80 \text{ mL} \times 0{,}09 \frac{mmol}{mL}}{5{,}0012 \text{ g}}$

Bilangan Asam = $\frac{49{,}4802 \text{ mg}}{5{,}0012 \text{ g}}$

Bilangan Asam = 9,8937 mg/g

Contoh Perhitungan Bilangan Asam pada Biodiesel Menggunakan Keramik Berpori dengan Variasi Konsentrasi Kitosan 10%

I. Bilangan Asam = $\frac{56{,}1 \times V \times M}{m \text{ sampel}}$

Bilangan Asam = $\frac{56{,}1 \frac{mg}{mmol} \times 0{,}2 \text{ mL} \times 0{,}09 \frac{mmol}{mL}}{5{,}0010 \text{ g}}$

Bilangan Asam = $\frac{1{,}0098 \text{ mg}}{5{,}0010 \text{ g}}$

Bilangan Asam = 0,20192 mg/g

II. Bilangan Asam = $\frac{56{,}1 \times V \times M}{m \text{ sampel}}$

Bilangan Asam = $\frac{56{,}1 \frac{mg}{mmol} \times 0{,}2 \text{ mL} \times 0{,}09 \frac{mmol}{mL}}{5{,}1021 \text{ g}}$

Bilangan Asam = $\frac{1{,}0098 \text{ mg}}{5{,}1021 \text{ g}}$

Bilangan Asam = 0,19792 mg/g

III. Bilangan Asam = $\frac{56{,}1 \times V \times M}{m \text{ sampel}}$

Bilangan Asam = $\frac{56{,}1 \frac{mg}{mmol} \times 0{,}3 \text{ mL} \times 0{,}09 \frac{mmol}{mL}}{5{,}2187 \text{ g}}$

Bilangan Asam = $\frac{1{,}5147 \text{ mg}}{5{,}2187 \text{ g}}$

Bilangan Asam = 0,29025 mg/g

Rumus Perhitungan Persen Konversi

%Konversi = $\frac{C0 - C1}{C0}$ × 100%

C_0 adalah bilangan asam pada blanko (ditunjukkan pada Tabel 2.11.3 sebesar 9,8937 mg/g), C_1 adalah bilangan asam biodiesel.

Contoh Perhitungan Persen Konversi pada Biodiesel Menggunakan Keramik Berpori dengan Variasi Konsentrasi Kitosan 10%

I. Persen Konversi

$$\%\text{Konversi} = \frac{\text{C0} - \text{C1}}{\text{C0}} \times 100\%$$

$$\%\text{Konversi} = \frac{9{,}8937\ \frac{\text{mg}}{\text{g}} - 0{,}20192\frac{\text{mg}}{\text{g}}}{9{,}8937\ \frac{\text{mg}}{\text{g}}} \times 100\%$$

$$\%\text{Konversi} = \frac{9{,}69178\frac{\text{mg}}{\text{g}}}{9{,}8937\ \frac{\text{mg}}{\text{g}}} \times 100\%$$

%Konversi = 97,9591%

II. Persen Konversi

$$\%\text{Konversi} = \frac{\text{C0} - \text{C1}}{\text{C0}} \times 100\%$$

$$\%\text{Konversi} = \frac{9{,}8937\ \frac{\text{mg}}{\text{g}} - 0{,}19792\ \frac{\text{mg}}{\text{g}}}{9{,}8937\ \frac{\text{mg}}{\text{g}}} \times 100\%$$

$$\%\text{Konversi} = \frac{9{,}69578\ \frac{\text{mg}}{\text{g}}}{9{,}8937\ \frac{\text{mg}}{\text{g}}} \times 100\%$$

%Konversi = 97,99954%

III. Persen Konversi

$$\%\text{Konversi} = \frac{C0 - C1}{C0} \times 100\%$$

$$\%\text{Konversi} = \frac{9{,}8937\ \frac{\text{mg}}{\text{g}} - 0{,}29025\ \frac{\text{mg}}{\text{g}}}{9{,}8937\ \frac{\text{mg}}{\text{g}}} \times 100\%$$

$$\%\text{Konversi} = \frac{9{,}60345\ \frac{\text{mg}}{\text{g}}}{9{,}8937\ \frac{\text{mg}}{\text{g}}} \times 100\%$$

%Konversi = 97,06636 %

$$\%\text{Konversi rata-rata} = \frac{\%\text{Konversi I} + \%\text{Konversi II} + \%\text{Konversi III}}{3}$$

$$\%\text{Konversi rata-rata} = \frac{97{,}9591\% + 97{,}99954\% + 97{,}06636\%}{3}$$

$$\%\text{Konversi rata-rata} = \frac{293{,}025\%}{3}$$

%Konversi rata-rata = 97,675%

Lampiran 2.12.3 pengujian bilangan iodine

Tabel 2.12.3 Hasil pengukuran bilangan iodine

No	Sampel	V $Na_2S_2O_3$ (mL)	m sampel (g)	N $Na_2S_2O_3$	Bilangan iodine (mg/g)	Rata-rata	SD
1	CaO-ZnO/KB-CS 10%	3,2	0,5226	0,1	92,3460	91,41	5,39
		3,2	0,5013	0,1	96,2697		
		3,3	0,5341	0,1	85,6019		
2	CaO-ZnO/KB-CS 20%	3,3	0,5843	0,1	78,2475	87,26	9,64
		3,2	0,5605	0,1	86,1017		
		3,1	0,5214	0,1	97,4301		
3	CaO-ZnO/KB-CS 30%	3,3	0,5605	0,1	81,5701	86,20	4,73
		3,3	0,5023	0,1	91,0213		
		3,2	0,5611	0,1	86,0096		
4	CaO-ZnO/KB-CS 40%	3,3	0,5473	0,1	83,5374	87,14	3,18
		3,3	0,5105	0,1	89,5593		
		3,2	0,5464	0,1	88,3236		
5	CaO-ZnO/KB-CS 50%	3,2	0,5387	0,1	89,5860	86,63	5,57
		3,3	0,5074	0,1	90,1064		
		3,4	0,5383	0,1	80,2155		

Rumus Perhitungan Bilangan Iodine

Bilangan Iodine = $\frac{(\text{Vb}-\text{Vs}) \times \text{M} \times \text{Mr I2}}{\text{m sampel}}$

V_b volume tiosulfat yang dibutuhkan untuk menitrasi blanko (mL), V_s adalah volume tiosulfat yang dibutuhkan untuk menitrasi sampel biodiesel (mL), M adalah molaritas tiosulfat, Mr I_2 adalah massa molekul relatif I_2 (mg/mmol) dan m sampel adalah massa biodiesel (g).

Diketahui :

Volume blanko = 5,1 mL

N $Na_2S_2O_3$= 0,1 N ≈ 0,1 M

Mr I_2 = 254 mg/mmol

Contoh Perhitungan Bilangan Iodine pada Biodiesel Menggunakan Keramik Berpori dengan Variasi Konsentrasi Kitosan 10%

I. Bilangan Iodine = $\frac{(\text{Vb}-\text{Vs}) \times \text{M} \times \text{Mr I2}}{\text{m sampel}}$

Bilangan Iodine = $\frac{(5{,}1 \text{ mL}-3{,}2 \text{ mL}) \times 0{,}1 \text{ M} \times 254 \frac{\text{g}}{\text{mol}}}{0{,}5226 \text{ g}}$

Bilangan Iodine = $\frac{1{,}9 \text{ mL} \times 0{,}1 \frac{\text{mmol}}{\text{mL}} \times 254 \frac{\text{mg}}{\text{mmol}}}{0{,}5226 \text{ g}}$

Bilangan Iodine = $\frac{48{,}26 \text{ mg}}{0{,}5226 \text{ g}}$

Bilangan Iodine = 92,346 mg/g

II. Bilangan Iodine = $\frac{(Vb-Vs)\times M \times Mr\ I2}{m\ sampel}$

Bilangan Iodine = $\frac{(5{,}1\ mL-3{,}2\ mL)\times 0{,}1\ M \times 254 \frac{g}{mol}}{0{,}5013\ g}$

Bilangan Iodine = $\frac{1{,}9\ mL \times 0{,}1 \frac{mmol}{mL} \times 254 \frac{mg}{mmol}}{0{,}5013\ g}$

Bilangan Iodine = $\frac{48{,}26\ mg}{0{,}5013\ g}$

Bilangan Iodine = 96,2697 mg/g

III. Bilangan Iodine = $\frac{(Vb-Vs)\times M \times Mr\ I2}{m\ sampel}$

Bilangan Iodine = $\frac{(5{,}1\ mL-3{,}3\ mL)\times 0{,}1\ M \times 254 \frac{g}{mol}}{0{,}5341\ g}$

Bilangan Iodine = $\frac{1{,}8\ mL \times 0{,}1 \frac{mmol}{mL} \times 254 \frac{mg}{mmol}}{0{,}5341\ g}$

Bilangan Iodine = $\frac{45{,}72\ mg}{0{,}5341\ g}$

Bilangan Iodine = 85,6019 mg/g

Bilangan Iodine rata-rata = $\frac{Bil.\ iodine\ I + Bil.\ iodine\ II + Bil.\ iodine\ III}{3}$

Bilangan Iodine rata-rata = $\frac{92{,}346 \frac{mg}{g} + 96{,}2697 \frac{mg}{g} + 85{,}6019 \frac{mg}{g}}{3}$

Bilangan Iodine rata-rata = $\frac{274{,}2176\ \frac{mg}{g}}{3}$

Bilangan Iodine rata-rata = 91,4059 mg/g

Lampiran 2.12.4 Pengujian bilangan penyabunan

Tabel 2.12.4 Hasil pengukuran bilangan penyabunan

No	Sampel	V HCl (mL)	m sampel (g)	Bilangan penyabunan (mg/g)	Bil Penyabunan rata-rata	SD
1	CaO-ZnO/KB-CS 10%	8,8	2,0325	103,5055	103,56	0,05
		8,8	2,0312	103,5718		
		8,8	2,0305	103,6075		
2	CaO-ZnO/KB-CS 20%	8,9	2,0329	102,1054	102,06	0,08
		8,9	2,0327	102,1154		
		8,9	2,0356	101,9699		
3	CaO-ZnO/KB-CS 30%	8,3	2,0543	109,2343	108,41	0,72
		8,4	2,0498	108,1057		
		8,4	2,0539	107,8899		
4	CaO-ZnO/KB-CS 40%	8,0	2,1540	108,0850	107,55	0,92
		8,1	2,1601	106,4812		
		8,0	2,1542	108,0749		
5	CaO-ZnO/KB-CS 50%	8,0	2,0138	115,6098	116,15	0,89
		8,0	2,0129	115,6615		
		7,9	2,0107	117,1831		

Rumus Perhitungan Bilangan Penyabunan

Bilangan Penyabunan = $\frac{(\mathrm{B}-\mathrm{A}) \times \mathrm{M\ HCl} \times \mathrm{BM\ KOH}}{\mathrm{m\ sampel}}$

B adalah banyaknya HCl pada titrasi KOH + alkohol (blanko) (mL), A adalah banyaknya HCl pada titrasi biodiesel + KOH dan alkohol (mL), M HCl adalah moralitas HCl, BM KOH adalah berat molekul KOH (56,1 mg/mmol) dan m sampel adalah massa sampel biodiesel.

Diketahui :

Volume blanko = 16,3 mL

N HCl = 0,5 N ≈ 0,5 M

BM KOH = 56,1 mg/mmol

Contoh Perhitungan Bilangan Penyabunan pada Biodiesel Menggunakan Keramik Berpori dengan Variasi Konsentrasi Kitosan 10%

I. Bilangan Penyabunan = $\frac{(\mathrm{B}-\mathrm{A}) \times \mathrm{M\ HCl} \times \mathrm{BM\ KOH}}{\mathrm{m\ sampel}}$

Bilangan Penyabunan = $\frac{(16{,}3\ \mathrm{mL}-8{,}8\ \mathrm{mL}) \times 0{,}5\ \mathrm{M} \times 56{,}1\frac{\mathrm{mg}}{\mathrm{mmol}}}{2{,}0325\ \mathrm{g}}$

Bilangan Penyabunan =$\frac{7{,}5\ \mathrm{mL} \times 0{,}5\frac{\mathrm{mmol}}{\mathrm{mL}} \times 56{,}1\frac{\mathrm{mg}}{\mathrm{mmol}}}{2{,}0325\ \mathrm{g}}$

Bilangan Penyabunan = $\frac{210{,}375\ \mathrm{mg}}{2{,}0325\ \mathrm{g}}$

Bilangan Penyabunan = 103,506 mg/g

II. Bilangan Penyabunan = $\frac{(\mathrm{B}-\mathrm{A}) \times \mathrm{M\ HCl} \times \mathrm{BM\ KOH}}{\mathrm{m\ sampel}}$

Bilangan Penyabunan = $\frac{(16{,}3\ \mathrm{mL}-8{,}8\ \mathrm{mL}) \times 0{,}5\ \mathrm{M} \times 56{,}1\frac{\mathrm{mg}}{\mathrm{mmol}}}{2{,}0312\ \mathrm{g}}$

Bilangan Penyabunan = $\frac{7{,}5\ \mathrm{mL} \times 0{,}5\frac{\mathrm{mmol}}{\mathrm{mL}} \times 56{,}1\frac{\mathrm{mg}}{\mathrm{mmol}}}{2{,}0312\ \mathrm{g}}$

Bilangan Penyabunan = $\frac{210{,}375\ \mathrm{mg}}{2{,}0312\ \mathrm{g}}$

Bilangan Penyabunan = 103,572 mg/g

III. Bilangan Penyabunan = $\frac{(\mathrm{B}-\mathrm{A}) \times \mathrm{M\ HCl} \times \mathrm{BM\ KOH}}{\mathrm{m\ sampel}}$

Bilangan Penyabunan = $\frac{(16{,}3\ \mathrm{mL}-8{,}8\ \mathrm{mL}) \times 0{,}5\ \mathrm{M} \times 56{,}1\frac{\mathrm{mg}}{\mathrm{mmol}}}{2{,}0305\ \mathrm{g}}$

Bilangan Penyabunan = $\frac{7{,}5\ \mathrm{mL} \times 0{,}5\frac{\mathrm{mmol}}{\mathrm{mL}} \times 56{,}1\frac{\mathrm{mg}}{\mathrm{mmol}}}{2{,}0305\ \mathrm{g}}$

Bilangan Penyabunan = $\frac{210{,}375\ \mathrm{mg}}{2{,}0305\ \mathrm{g}}$

Bilangan Penyabunan = 103,607 mg/g

Bilangan Penyabunan rata-rata = $\frac{\mathrm{Bil.\ penyabunan\ I+Bil.\ penyabunan\ II+Bil.\ penyabunan\ III}}{3}$

Bilangan Penyabunan rata-rata = $\frac{103{,}506\ \frac{mg}{g} + 103{,}572\frac{mg}{g} + 103{,}607\ \frac{mg}{g}}{3}$

Bilangan Penyabunan rata-rata = $\frac{310{,}685\ \frac{mg}{g}}{3}$

Bilangan Penyabunan rata-rata = 103,5616 mg/g

Lampiran 2.12.5 Pengukuran angka setana

Tabel 2.12.5 Hasil pengukuran angka setana

No	Sampel	Bilangan penyabunan	Bilangan Iodine	Angka Setana	Rata-rata	SD
1	CaO-ZnO/KB-CS 10%	103,506	92,34596	75,4833	75,03	0,53
		103,572	96,2697	74,4490		
		103,607	85,60195	75,1511		
2	CaO-ZnO/KB-CS 20%	102,105	78,24748	78,8012	78,24	0,51
		102,115	86,10169	77,7934		
		101,970	97,4300	78,1209		
3	CaO-ZnO/KB-CS 30%	109,234	81,57003	75,4656	74,67	0,98
		108,106	91,0213	73,5772		
		107,890	86,00962	74,9562		
4	CaO-ZnO/KB-CS 40%	108,085	83,53737	75,4953	74,83	0,61
		106,481	89,55926	74,7203		
		108,075	88,32357	74,2795		
5	CaO-ZnO/KB-CS 50%	115,610	89,58604	70,6661	70,53	0,12
		115,661	90,10642	70,5123		
		117,183	80,21549	70,0000		

Rumus Perhitungan Angka Setana

CN = 46,3 + $\frac{5458}{SV}$ – 0,255 × IV

CN adalah indeks setana, angka 46,3; 5458 dan -0,225 merupakan suatu konstanta. SV adalah bilangan penyabunan dan IV adalah bilangan iodine.

Contoh Perhitungan Angka Setana pada Biodiesel Menggunakan Keramik Berpori dengan Variasi Konsentrasi Kitosan 10%

I. CN = 46,3 + $\frac{5458}{SV}$ – 0,255 × IV

CN = 46,3 + $\frac{5458}{103{,}506}$ – 0,255 × 92,34596

CN = 46,3 + 52,7315 – 23,5482198

CN = 75,4833

II. CN = 46,3 + $\frac{5458}{SV}$ – 0,255 × IV

CN = 46,3 + $\frac{5458}{103{,}572}$ – 0,255 × 96,2697

CN = 46,3 + 52,6976 – 24,5487735

CN = 74,449

III. $CN = 46{,}3 + \frac{5458}{SV} - 0{,}255 \times IV$

$CN = 46{,}3 + \frac{5458}{103{,}607} - 0{,}255 \times 85{,}60195$

CN = 46,3 + 52,6798– 21,8284972

CN = 75,1511

$\text{Angka Setana rata-rata} = \frac{\text{Angka Setana I+Angka Setana II+Angka Setana III}}{3}$

$\text{Angka Setana rata-rata} = \frac{75{,}4833+74{,}449+75{,}1511}{3}$

$\text{Angka Setana rata-rata} = \frac{225{,}0834}{3}$

Angka Setana rata-rata = 75,0278

Lampiran 2.13 Hasil Perhitungan Persen Konversi pada Penentuan Kondisi Optimum

Tabel 2.13 Hasil pengukuran bilangan asam dan persen konversi pada variasi desain percobaan

Kode	Waktu reaksi (jam)	Rasio CaO: ZnO	Rasio minyak: metanol	V KOH (mL)	m sampel (g)	Bilangan asam (mg/g)	Persen konversi (%)	Rata - rata	SD
R1	5	1:2	2:1	2,5	5,4908	2,5542	76,76	76,89	1,09
				2,6	5,5017	2,6511	75,88		
				2,5	5,8113	2,4134	78,04		
R2	7	1:2	4:1	1,2	5,0851	1,3238	87,95	87,29	0,58
				1,3	5,0863	1,4338	86,95		
				1,3	5,0846	1,4343	86,95		
R3	7,6	1,25:1	3:1	0,3	5,0161	0,3355	96,95	96,95	0,0003
				0,3	5,0154	0,3356	96,95		
				0,3	5,0162	0,3355	96,95		
R4	4,3	1,35:1	3:1	0,3	5,0454	0,3336	96,96	96,63	0,58
				0,4	5,0453	0,4448	95,95		
				0,3	5,0438	0,3337	96,96		
R5	6	1,25:1	3:1	0,3	5,0094	0,3360	96,95	97.29	0,58
				0,3	5,0092	0,3360	97,94		
				0,2	5,0061	0,2241	97,96		
R6	6	1,25:1	3:1	0,3	5,0209	0,3352	96,95	97,29	0,59
				0,2	5,0224	0,2234	97,97		
				0,3	5,0215	0,3352	96,95		
R7	7	1:2	2:1	3,2	5,0484	3,5559	67,64	67,31	0,59
				3,3	5,0478	3,6675	66,63		
				3,2	5,0487	3,5558	67,64		
R8	6	2,4:1	3:1	0,2	5,0111	0,2239	97,96	97,28	0,59
				0,3	5,0124	0,3358	96,94		
				0,3	5,0097	0,3359	96,94		

R9	5	2:1	2:1	6,3	5,0166	7,0452	35,89	36,91	1,02
				6,1	5,0165	6,8217	37,93		
				6,2	5,0172	6,9325	36,92		
R10	6	1,25:1	3:1	0,3	5,1090	0,3294	97,01	97,33	0,57
				0,2	5,0987	0,2200	97,10		
				0,3	5,1087	0,3294	97,01		
R11	7	2:1	4:1	0,7	5,0203	0,7822	92,88	92,88	0,0020
				0,7	5,0211	0,7821	92,88		
				0,7	5,0183	0,7825	92,88		
R12	6	1,25:1	3:1	0,3	5,0513	0,3332	96,97	96,97	0,0012
				0,3	5,0481	0,3334	96,97		
				0,3	5,0519	0,3331	96,97		
R13	6	1,25:1	3:1	0,3	5,0554	0,3329	96,97	96,97	0,0038
				0,3	5,0432	0,3337	96,96		
				0,3	5,0524	0,3331	96,97		
R14	6	1,25	4,7:1	0,2	5,0884	0,2205	97,99	97,99	0,0025
				0,2	5,0789	0,2209	97,99		
				0,2	5,0912	0,2204	97,99		
R15	6	1,25:1	1,3:1	5	5,0182	5,5896	49,14	48,46	1,18
				5	5,0191	5,5886	49,15		
				5,2	5,0166	5,8151	47,09		
R16	5	2:1	3:1	0,2	5,1086	0,2196	98,00	98,33	0,58
				0,1	5,1086	0,1098	99,00		
				0,2	5,1095	0,2196	98,00		
R17	5	2:1	4:1	0,4	5,0238	0,4467	95,94	96,27	0,59
				0,4	5,0214	0,4469	95,93		
				0,3	5,0239	0,3350	96,95		
R18	6	0	3:1	6,8	5,0209	7,5979	30,87	31,92	1,08
				6,6	5,0301	7,3609	33,02		
				6,7	5,0204	7,4868	31,88		
R19	7	2:1	2:1	0,5	5,1399	0,5457	95,03	95,03	0,01
				0,5	5,1245	0,5474	95,02		
				0,5	5,1397	0,5457	95,03		
R20	5	1:2	4:1	1,4	5,0358	1,5596	85,81	85,79	0,02
				1,4	5,0219	1,5639	85,77		
				1,4	5,0317	1,5609	85,80		

Lampiran 2.14 Perhitungan Konstanta Laju Reaksi Transesterifikasi Minyak Sawit dan Metanol Menggunakan Katalis CaO-ZnO$_{2:1}$/KB

Tabel 2.14.1 Hasil pengukuran persen konversi dengan variasi waktu dan suhu reaksi

Suhu (K)	Waktu (jam)	V KOH	Massa (g)	Bilangan asam (mg KOH/g)	Persen Konversi (%)	Rata – rata persen konversi (X)	SD
323,15	3	3,6	5,0100	4,0311	63,3199	64,0222	1,2163
		3,4	5,0200	3,7996	65,4267		
		3,6	5,0100	4,0311	63,3199		
	4	1,0	5,0500	1,1109	89,8918	89,5058	0,6000
		1,0	5,0100	1,1198	89,8111		
		1,1	5,0200	1,2293	88,8145		
	5	0,9	5,0200	1,0058	90,8482	91,1817	0,5777
		0,8	5,0100	0,8958	91,8489		
		0,9	5,0200	1,0058	90,8482		
	6	0,7	5,0200	0,7823	92,8819	93,2161	0,5912
		0,6	5,0200	0,6705	93,8988		
		0,7	5,0100	0,7838	92,8678		
328,15	3	3,5	5,0100	3,9192	64,3388	64,3625	0,0410
		3,5	5,0200	3,9113	64,4099		
		3,5	5,0100	3,9192	64,3389		
	4	0,9	5,0200	1,0058	90,8482	91,1817	0,5777
		0,8	5,0100	0,8958	91,8489		
		0,9	5,0200	1,0058	90,8482		
	5	0,5	5,0200	0,5588	94,9157	94,9089	0,0058
		0,5	5,0100	0,5599	94,9055		
		0,5	5,0100	0,5599	94,9055		
	6	0,5	5,0200	0,5588	94,9157	95,5909	0,5847
		0,4	5,0100	0,4479	95,9244		
		0,4	5,0200	0,4470	95,9325		
333,15	3	3,2	5,0132	3,5809	67,4163	66,6857	0,6327
		3,3	5,0019	3,7012	66,3222		
		3,3	5,0014	3,7016	66,3188		
	4	0,9	5,0008	1,0096	90,8131	90,4739	0,5979
		1,0	5,0021	1,1215	89,7950		
		0,9	5,0010	1,0096	90,8135		
	5	0,2	5,1086	0,2196	98,0015	98,3347	0,5768
		0,1	5,1086	0,1098	99,0007		
		0,2	5,1095	0,2196	98,0019		
	6	0,1	5,0143	0,1119	98,9820	98,6406	0,5905
		0,2	5,0014	0,2243	97,9587		
		0,1	5,0101	0,1120	98,9811		

338,15	3	3,1	5,0200	3,4643	68,4773	68,7959	0,5519
		3,0	5,0100	3,3593	69,4333		
		3,1	5,0200	3,4643	68,4773		
	4	0,8	5,0200	0,8940	91,8651	91,1750	0,5076
		0,9	5,0100	1,0078	90,8300		
		0,9	5,0100	1,0078	90,8300		
	5	0,1	5,0200	0,1117	98,9831	98,6428	0,5894
		0,2	5,0100	0,2239	97,9622		
		0,1	5,0200	0,1117	98,9831		
	6	0,1	5,0100	0,1120	98,9811	98,6450	0,5865
		0,1	5,0200	0,1117	98,9831		
		0,2	5,0200	0,2235	97,9662		

Tabel 2.14.2 Hasil perhitungan konstanta laju (*k*)

Suhu (K)	Waktu (Jam)	1-X	-ln(1-X)	k(jam^{-1})	Rata – rata *k*	ln *k*
323,15	3	0,3598	1,0223	0,3408	0,4320	-0,8439
	4	0,1049	1,8127	0,4532		
	5	0,0882	2,4284	0,4857		
	6	0,0678	2,6906	0,4484		
328,15	3	0,3564	1,0318	0,3439	0,4659	-0,7637
	4	0,0882	1,9989	0,4997		
	5	0,0590	2,4988	0,4998		
	6	0,0441	3,1215	0,5202		
333,15	3	0,3331	1,1099	0,3664	0,5675	-0,5664
	4	0,0953	2,3511	0,5878		
	5	0,0167	2,9983	0,5997		
	6	0,0136	4,2981	0,7163		
338,15	3	0,3120	1,1646	0,3882	0,6145	-0,4869
	4	0,0882	2,4275	0,6069		
	5	0,0136	3,7315	0,7463		
	6	0,0135	4,3002	0,7167		

$$-\mathrm{r} = -\frac{\mathrm{d[TG]}}{\mathrm{dt}} = k[\mathrm{TG}][\mathrm{CH_3OH}]^3$$

Dimana, 'r' menunjukkan laju reaksi, dan '*k*' menunjukkan konstanta laju.

Karena konsentrasi metanol tinggi, maka kesetimbangan cenderung bergeser ke arah kanan. Oleh karena itu, persamaan yang dimodifikasi dinyatakan sebagai:

$$-\mathrm{r} = -\frac{\mathrm{d[TG]}}{\mathrm{dt}} = k[\mathrm{TG}]$$

Dengan memasukkan limit integral, waktu awal (t = 0) dan konsentrasi trigliserida [TG] pada bahan baku adalah $[\mathrm{TG}]_0$ dan ketika waktu t, ([TG] = $[\mathrm{TG}]_t$) persamaannya dinyatakan sebagai:

$$-\int_{[TG]_0}^{[TG]} \frac{d[TG]}{[TG]} = \int_{t=0}^{t=t} k\mathrm{dt}$$

$$\ln([\mathrm{TG}]_0 - [\mathrm{TG}]_t) = kt$$

Ketika waktu awal, $t = 0$, $\ln[\mathrm{TG}]_0$ sebagai $[\mathrm{TG}]_0 = \frac{1{,}0\ \mathrm{mol}}{\mathrm{dm}^3}$, $[\mathrm{TG}]_t$ = % konversi biodiesel pada waktu t, kesetimbangan untuk orde reaksi satu semu dinyatakan sebagai:

$$X = 1 - {[\mathrm{TG}]_t}/{[\mathrm{TG}]_0}$$

dimana X adalah persen konversi biodiesel.

$$\frac{dX}{dt} = k(1 - X),$$

$$\text{atau} \quad \frac{dX}{(1 - X)} = k\mathrm{dt}$$

$$\int \frac{dX}{(1 - X)} = \int k\mathrm{dt}$$

$$\text{atau}, -\ln(1 - X) = kt$$

Reaksi transesterifikasi dilakukan pada suhu yang berbeda, sehingga energi aktivasi (Ea) dapat dihitung melalui persamaan Arrhenius:

$$\ln k = -\frac{E_a}{R}\frac{1}{T} + \ln A$$

Dimana nilai Ea dapat dihitung dari slope kurva hubungan antara 1/T (K) dan ln *k*, slope kurva menunjukkan nilai dari $-\frac{E_a}{R}$ dan intersep menunjukkan ln A.

Lampiran 2.15 Perhitungan Konstanta Laju Reaksi Transesterifikasi Minyak Sawit dan Metanol Tanpa Menggunakan Katalis

Tabel 2.15.1 Hasil pengukuran persen konversi dengan variasi waktu dan suhu reaksi tanpa menggunakan katalis

Suhu (K)	Waktu (jam)	V KOH	Massa (g)	Bilangan asam (mg KOH/g)	Persen Konversi (%)	Rata - rata	SD
323,15	3	9,2	5,0500	10,2201	7,0045	7,5900	0,6565
		9,0	5,0100	10,0778	8,2999		
		9,1	5,0200	10,1695	7,4657		
	4	8,9	5,0500	9,8869	10,0370	9,4003	0,6916
		9,0	5,0300	10,0378	8,6645		
		8,9	5,0200	9,9460	9,4994		
	5	8,9	5,0100	9,9659	9,3188	9,7179	0,6914
		8,9	5,0100	9,9659	9,3188		
		8,8	5,0200	9,8342	10,5163		
	6	8,8	5,0200	9,8342	10,5163	10,4567	0,1031

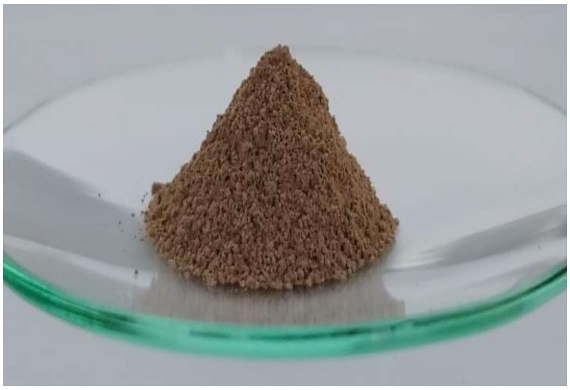
		8,8	5,0200	9,8342	10,5163		
		8,8	5,0100	9,8539	10,3376		
328,15	3	9,0	5,0400	10,0178	8,8457	8,3259	0,6132
		9,0	5,0200	10,0578	8,4825		
		9,1	5,0300	10,1493	7,6496		
	4	8,8	5,0200	9,8343	10,5162	9,7774	1,2796
		9,0	5,0100	10,0778	8,2997		
		8,8	5,0200	9,8343	10,5163		
	5	8,8	5,0200	9,8343	10,5163	10,7368	0,5441
		8,8	5,0100	9,8539	10,3376		
		8,7	5,0100	9,7419	11,3565		
	6	8,7	5,0200	9,7225	11,5331	11,8132	0,6441
		8,7	5,0100	9,7419	11,3565		
		8,6	5,0200	9,6107	12,5500		
333,15	3	8,9	5,0300	9,9262	9,6793	9,8388	0,4412
		8,9	5,0200	9,9460	9,4994		
		8,8	5,0100	9,8539	10,3376		
	4	8,7	5,0200	9,7225	11,5331	10,7957	0,6448
		8,8	5,0200	9,8343	10,5163		
		8,8	5,0100	9,8539	10,3376		
	5	8,7	5,0100	9,7419	11,3565	12,0940	0,6446
		8,6	5,0200	9,6107	12,5500		
		8,6	5,0100	9,6299	12,3754		
	6	8,5	5,0200	9,4990	13,5668	13,8583	0,6427
		8,4	5,0200	9,3872	14,5837		
		8,5	5,0100	9,5180	13,3943		
338,15	3	8,5	5,0200	9,4990	13,5668	13,8490	0,4887
		8,4	5,0100	9,4060	14,4132		
		8,5	5,0200	9,4990	13,5668		
	4	8,5	5,0200	9,4990	13,5668	14,4707	0,9339
		8,3	5,0100	9,2940	15,4321		
		8,4	5,0100	9,4060	14,4132		
	5	8,2	5,0200	9,1637	16,6174	16,5619	0,0961
		8,2	5,0100	9,1820	16,4510		
		8,2	5,0200	9,1637	16,6174		
	6	8,1	5,0100	9,0700	17,4699	16,9015	0,4922
		8,2	5,0200	9,1637	16,6174		
		8,2	5,0200	9,1637	16,6174		

Tabel 2.15.2 Hasil perhitungan konstanta laju (*k*)

Suhu (K)	Waktu (jam)	1-X	-ln(1-x)	*k* (jam^{-1})	Rata – rata *k*	ln *k*
323,15	3	0,9240	0,0789	0,0263	0,0224	-3,9120
	4	0,9060	0,0987	0,0247		
	5	0,9028	0,1022	0,0204		
	6	0,8954	0,1104	0,0184		
328,15	3	0,9167	0.0869	0,0289	0,0246	-3,6889
	4	0,9022	0,1028	0,0257		
	5	0,8926	0,1136	0,0227		
	6	0,8819	0,1257	0,0209		
333,15	3	0,9016	0,1035	0,0345	0,0284	-3,5065
	4	0,8920	0,1142	0,0286		
	5	0,8790	0,1289	0,0257		
	6	0,8615	0,1490	0,0248		
338,15	3	0,8615	0,1490	0,0497	0,0389	-3,3524
	4	0,8553	0,1563	0,391		
	5	0,8343	0,1811	0,362		
	6	0,8310	0,1851	0,0308		

Lampiran 3. Dokumentasi

Lampiran 3.1 Penampakan Fisik NC Sebelum dan Setelah Purifikasi

Gambar penampakan fisik NC sebelum proses purifikasi	
Gambar penampakan fisik NC setelah dilakukan pemanggangan pada suhu 600 ^oC	
Gambar penampakan fisik NC terpurifikasi H_2SO_4 3M dengan suhu kalsinasi 800 ^oC	

Gambar penampakan fisik NC terpurifikasi H_2SO_4 3M dengan suhu kalsinasi 900 ^oC	
Gambar penampakan fisik NC terpurifikasi H_2SO_4 3M dengan suhu kalsinasi 1000 ^oC	
Gambar penampakan fisik NC terpurifikasi H_2SO_4 4M dengan suhu kalsinasi 800 ^oC	

Gambar penampakan fisik NC terpurifikasi H_2SO_4 4M dengan suhu kalsinasi 900 ^oC	
Gambar penampakan fisik NC terpurifikasi H_2SO_4 4M dengan suhu kalsinasi 1000 ^oC	
Gambar penampakan fisik NC terpurifikasi H_2SO_4 5M dengan suhu kalsinasi 800 ^oC	

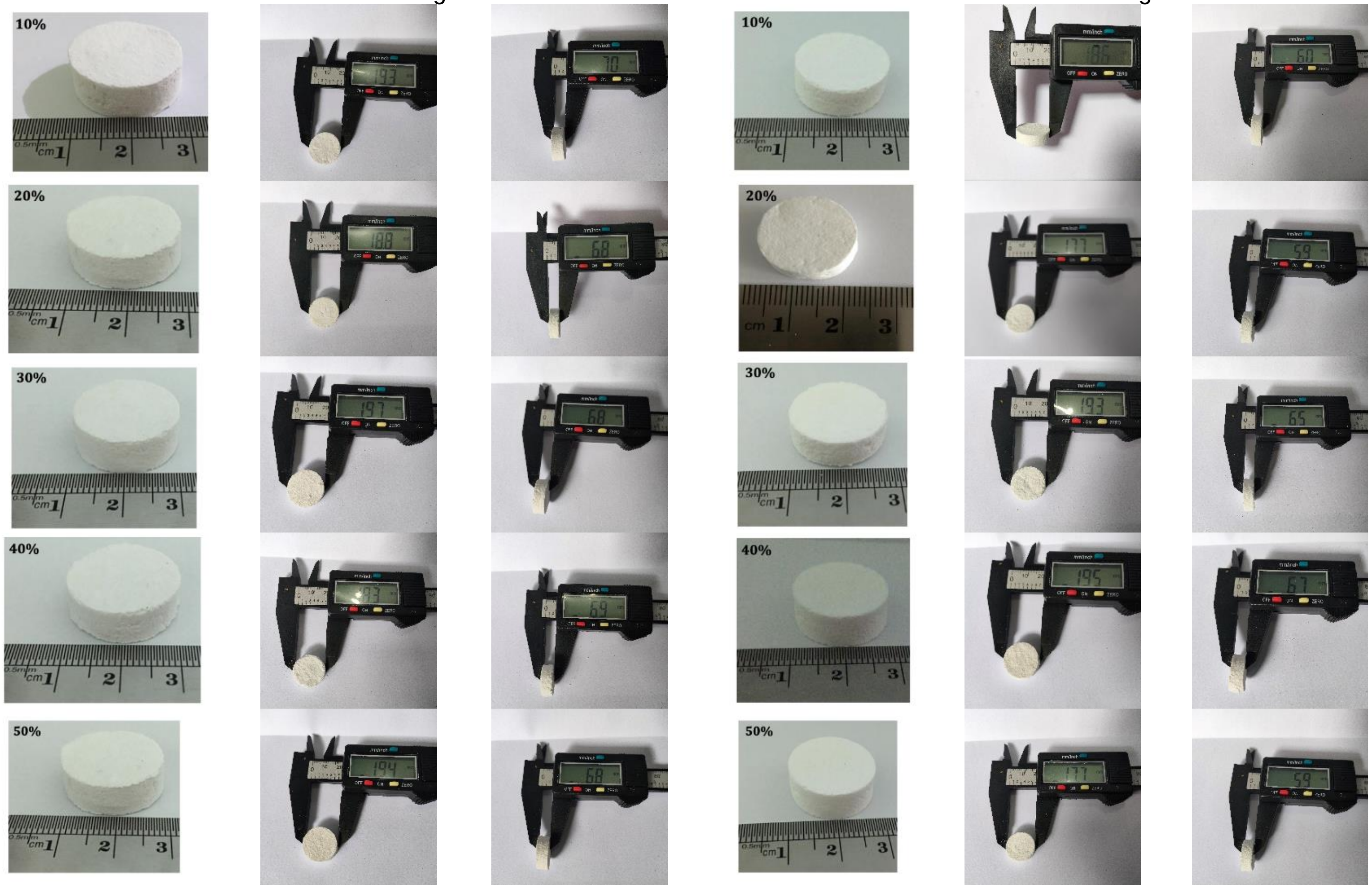
Gambar penampakan fisik NC terpurifikasi H_2SO_4 5M dengan suhu kalsinasi 900 ^oC	
Gambar penampakan fisik NC terpurifikasi H_2SO_4 5M dengan suhu kalsinasi 1000 ^oC	

Lampiran 3.2 Penampakan Fisik Keramik Berpori Dengan Variasi Suhu Sintering

Gambar penampakan fisik keramik berpori sebelum sintering	
Gambar penampakan fisik keramik berpori pada suhu sintering 900 ^{o}C	
Gambar penampakan fisik keramik berpori pada suhu sintering 1000 ^{o}C	
Gambar penampakan fisik keramik berpori pada suhu sintering 1100 ^{o}C	

Lampiran 3.3 Penampakan Fisik Keramik Berpori *Gelcasting* Berbahan Dasar SiO_2 (Kontrol)

Sebelum Sintering Setelah Sintering

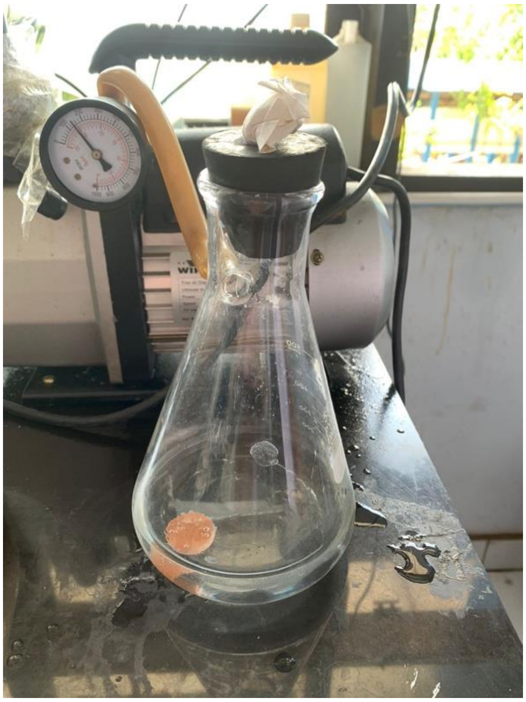


Lampiran 3.4 Penampakan Fisik Keramik Berpori *Gelcasting* Berbahan Dasar NC

Sebelum Sintering

Setelah Sintering

Lampiran 3.5 Dokumentasi Proses Impregnasi pada Kondisi Vakum



Lampiran 3.6 Penampakan Fisik Keramik Berpori *Gelcasting* Setelah Impregnasi dan Setelah Digunakan Hingga Sembilan Siklus

Penampakan fisik keramik berpori *gelcasting* setelah diimpregnasi katalis bifungsional CaO-ZnO

Penampakan fisik keramik berpori CaO-$ZnO_{2:1}$/KB-CS30% setelah digunakan pada proses produksi biodiesel

Siklus 1

Siklus 2

Siklus 3

Siklus 4

Siklus 5

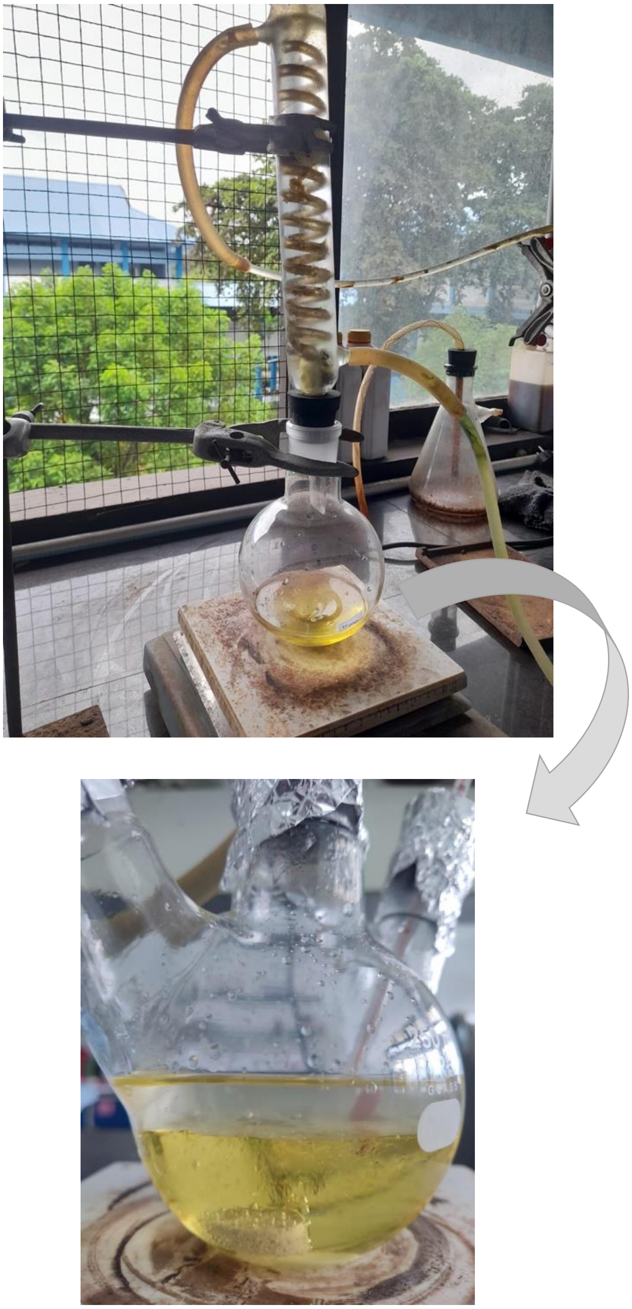
Siklus 6

Siklus 7

Siklus 8

Siklus 9

Lampiran 3.7 Rangkaian Alat pada Reaksi Transesterifikasi



Lampiran 3.8 Penampakan Fisik Biodiesel Hasil Reaksi Transesterifikasi Minyak Sawit dan Metanol Menggunakan CaO-ZnO/KB dengan Variasi Konsentrasi CS pada KB

Lampiran 3.9 Penampakan Fisik Biodiesel Hasil Reaksi Transesterifikasi Minyak Sawit dan Metanol pada Proses Optimasi

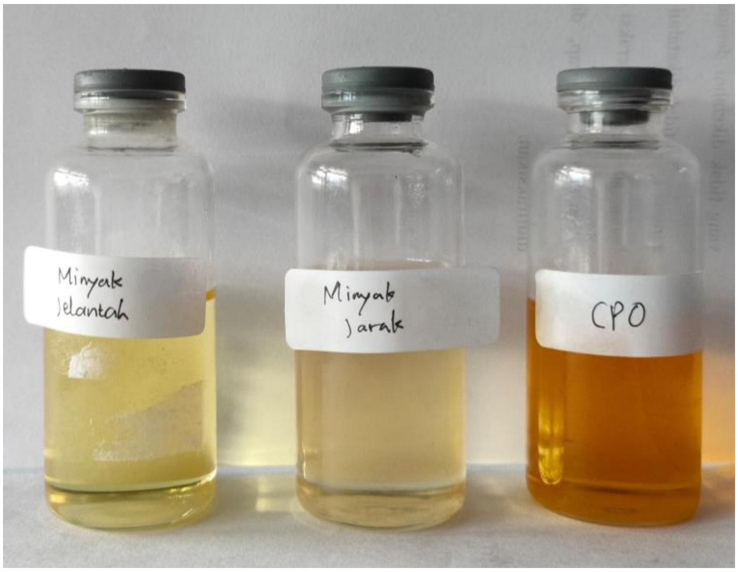

R10
R9
R8
R7
R6


R15
R14
R13
R12
R11

Lampiran 3.10 Penampakan Fisik Biodiesel Hasil Reaksi Transesterifikasi Minyak Sawit dan Metanol pada Proses Uji Efektivitas

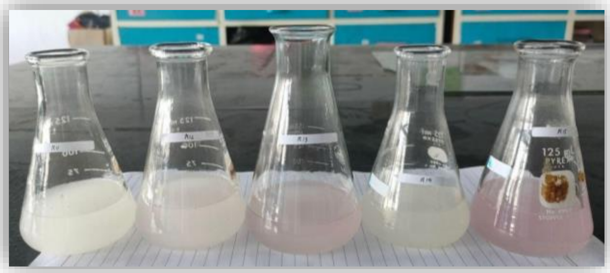
Lampiran 3.11 Penampakan Fisik Biodiesel Hasil Reaksi Transesterifikasi Minyak Sawit dan Metanol pada Proses Uji Efesiensi

Lampiran 3.12 Penampakan Fisik Biodiesel Menggunakan Berbagai Jenis Bahan Baku



Lampiran 3.13 Penampakan Fisik Hasil Analisis Kuantitatif Biodiesel
Lampiran 3.13.1 Analisis bilangan asam
Sebelum titrasi:

Setelah titrasi:



Lampiran 3.13.2 Analisis bilangan penyabunan
Sebelum titrasi:

Setelah titrasi:

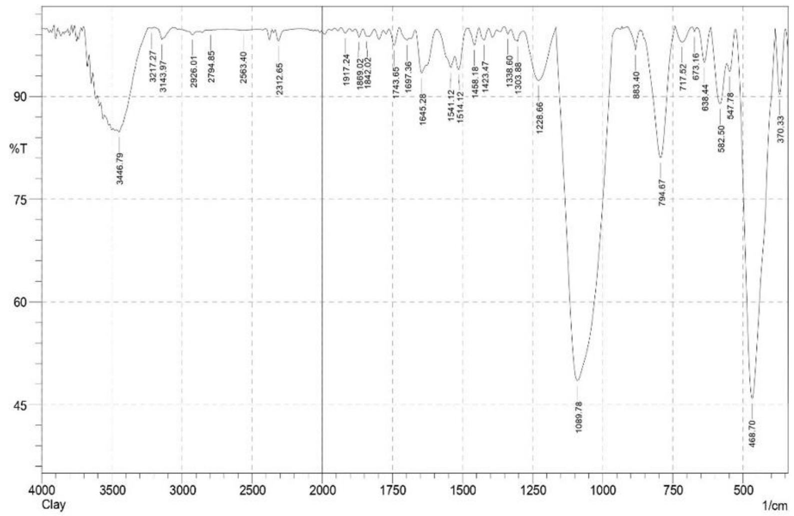
Lampiran 3.13.3 Analisis bilangan iodin

Sebelum titrasi:

Setelah titrasi:

Lampiran 3.14 Data Mentah Hasil Analisis
Lampiran 3.14.1 Beberapa data mentah pada tahap purifikasi NC

SHIMADZU



	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	370.33	90.31	9.563	385.76	349.12	0.854	0.833
2	468.7	45.89	53.941	526.57	385.76	22.255	22.158
3	547.78	93.639	2.7	557.43	526.57	0.559	0.185
4	582.5	88.901	8.047	615.29	559.36	1.847	1.177
5	638.44	94.953	5.048	659.66	615.29	0.478	0.478
6	673.16	99.421	0.676	682.8	665.44	0.01	0.018
7	717.52	97.937	2.264	742.59	682.8	0.283	0.333
8	794.67	81.031	18.318	850.61	742.59	4.756	4.44
9	883.4	96.787	3.076	910.4	867.97	0.235	0.222
10	1089.78	48.506	51.539	1166.93	948.98	36.839	36.859
11	1228.66	92.336	7.371	1282.66	1168.86	2.223	2.084
12	1303.88	98.024	1.628	1327.03	1282.66	0.213	0.147
13	1338.6	99.129	0.815	1350.17	1327.03	0.042	0.037
14	1423.47	98.256	1.71	1440.83	1406.11	0.149	0.144
15	1458.18	97.489	2.495	1479.4	1440.83	0.197	0.194
16	1514.12	93.937	3.15	1527.62	1483.26	0.671	0.258
17	1541.12	94.172	2.501	1591.27	1527.62	0.931	0.317
18	1645.28	93.416	3.189	1668.43	1629.85	0.768	0.273
19	1697.36	98.232	0.663	1726.29	1687.71	0.197	0.077
20	1743.65	97.459	2.504	1762.94	1726.29	0.202	0.195
21	1842.02	98.761	1.069	1855.52	1815.02	0.147	0.117
22	1869.02	98.66	1.171	1882.52	1855.52	0.082	0.062
23	1917.24	99.225	0.727	1932.67	1903.74	0.05	0.045
24	2312.65	98.119	1.586	2335.8	2262.5	0.305	0.208
25	2563.4	99.653	0.119	2652.12	2468.88	0.218	0.037
26	2794.85	99.701	0.005	2798.71	2742.78	0.066	0
27	2926.01	99.003	0.489	2953.02	2881.65	0.216	0.058
28	3143.97	98.31	1.768	3197.98	3064.89	0.366	0.412
29	3217.27	99.96	0.09	3240.41	3197.98	-0.001	0.007
30	3446.79	84.807	1.606	3466.08	3244.27	8.132	0.723

Comment;
Clay

Date/Time; 2/8/2023 3:54:02 PM
No. of Scans;
Resolution;
Apodization;

Quantachrome® ASiQwin™ - Automated Gas Sorption Data Acquisition and Reduction
© 1994-2012, Quantachrome Instruments
version 3.0

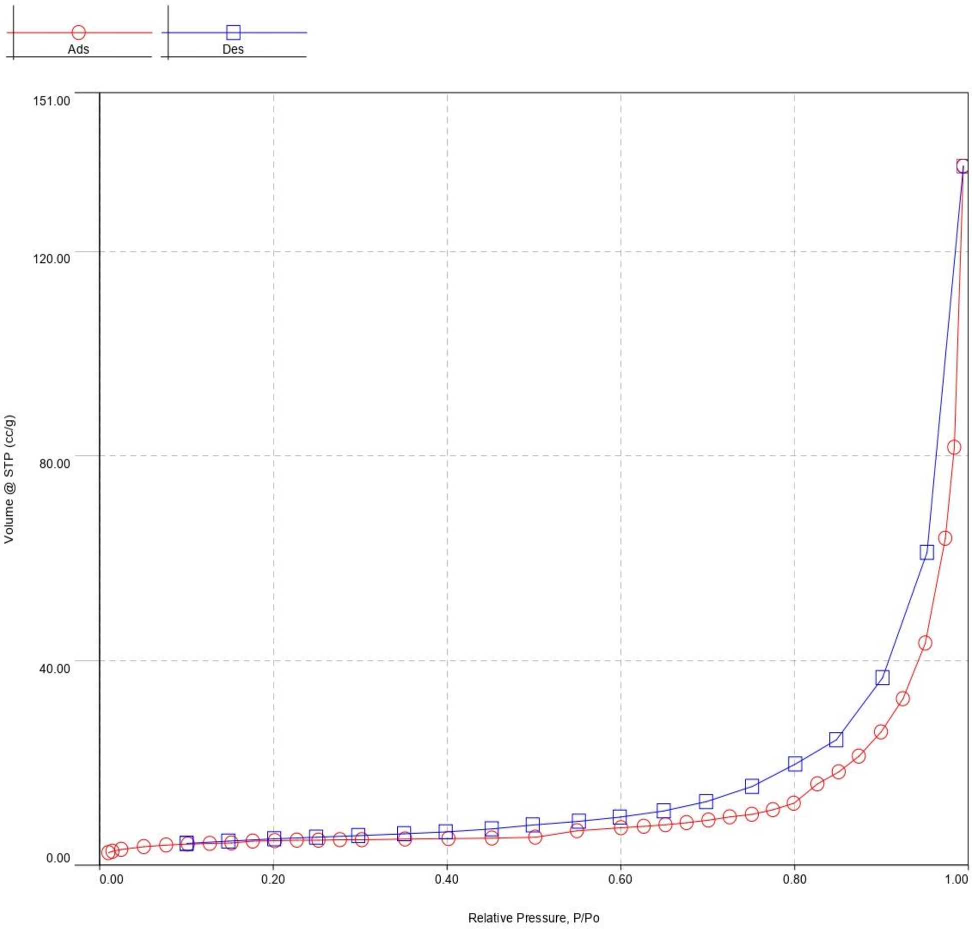
Quantachrome INSTRUMENTS

Analysis			**Report**		
Operator: Lab. Energi ITS	**Date:**2022/03/02		**Operator:** Lab. Energi ITS	**Date:**2022/03/04	
Sample ID: EL-70 SiO2 3M	**Filename:**	iq_phisy_st1_2022_03_02_10_28_20EL-70 SiO2 3M.qps			
Sample Desc:	**Comment:**				
Sample Weight: 0.0997 g	**Instrument:**	Autosorb iQ Station 1			
Approx. Outgas Time: 7.5 hrs	**Final Outgas Temp.:**	300 °C		**Extended info:**	Available
Analysis gas: Nitrogen	**Non-ideality:**	6.58e-05 1/Torr		**CellType:**	9mm w/o rod
Analysis Time: 5:34 hr:min	**Bath temp.:**	77.35 K			
Analysis Mode: Standard				**VoidVol Remeasure:**	off
VoidVol. Mode: He Measure	**Cold Zone V:**	3.09124 cc		**Warm Zone V:**	18.0946 cc

Isotherm : Linear

Data Reduction Parameters

Adsorbate			
	Thermal Transpiration: on	**Eff. mol. diameter (D):** 3.54 Å	**Eff. cell stem diam. (d):** 4.0000 mm
	Nitrogen	**Temperature** 77.350K	
	Molec. Wt.: 28.013	**Cross Section:** 16.200 Å²	**Liquid Density:** 0.808 g/cc



Analysis			**Report**		
Operator: Lab. Energi ITS	**Date:**2022/03/02		**Operator:** Lab. Energi ITS	**Date:**2022/03/04	
Sample ID:	EL-70 SiO2 3M	**Filename:**	iq_phisy_st1_2022_03_02_10_28_20EL-70 SiO2 3M.qps		
Sample Desc:		**Comment:**			
Sample Weight:	0.0997 g	**Instrument:**	Autosorb iQ Station 1		
Approx. Outgas Time:	7.5 hrs	**Final Outgas Temp.:**	300 °C	**Extended info:**	Available
Analysis gas:	Nitrogen	**Non-ideality:**	6.58e-05 1/Torr	**CellType:**	9mm w/o rod
Analysis Time:	5:34 hr:min	**Bath temp.:**	77.35 K		
Analysis Mode:	Standard			**VoidVol Remeasure:**	off
VoidVol. Mode:	He Measure	**Cold Zone V:**	3.09124 cc	**Warm Zone V:**	18.0946 cc

BJH Pore Size Distribution Adsorption

Data Reduction Parameters Data

	Thermal Transpiration: on	**Eff. mol. diameter (D):** 3.54 Å	**Eff. cell stem diam. (d):** 4.0000 mm
t-Method	**Calc. method:** de Boer		
BJH/DH method	**Moving pt. avg.:** off	**Ignoring P-tags below 0.35 P/Po**	
Adsorbate	**Nitrogen**	**Temperature** 77.350K	
	Molec. Wt.: 28.013	**Cross Section:** 16.200 Å²	**Liquid Density:** 0.808 g/cc

BJH Pore Size Distribution Adsorption Data

Radius [Å]	Pore Volume [cc/g]	Pore Surf Area [m²/g]	dV(r) [cc/Å/g]	dS(r) [m²/Å/g]	dV(logr) [cc/g]	dS(logr) [cc/g]
15.3304	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
17.1263	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
19.1917	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
21.5705	2.4993e-03	2.3173e+00	9.8499e-04	9.1327e-01	4.8866e-02	4.5308e+01
24.4659	2.5531e-03	2.3613e+00	1.6547e-05	1.3527e-02	9.3080e-04	7.6089e-01
27.0915	2.5531e-03	2.3613e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
29.1664	2.5531e-03	2.3613e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
31.4393	2.7171e-03	2.4656e+00	6.8487e-05	4.3568e-02	4.9555e-03	3.1524e+00
34.0567	3.1227e-03	2.7038e+00	1.4280e-04	8.3858e-02	1.1191e-02	6.5722e+00
37.0962	3.7424e-03	3.0379e+00	1.9136e-04	1.0317e-01	1.6335e-02	8.8070e+00
40.7163	3.9510e-03	3.1404e+00	5.2114e-05	2.5599e-02	4.8819e-03	2.3980e+00
45.0131	5.1039e-03	3.6526e+00	2.5111e-04	1.1157e-01	2.6004e-02	1.1554e+01
50.0923	6.8895e-03	4.3656e+00	3.2076e-04	1.2807e-01	3.6959e-02	1.4756e+01
56.9371	1.4474e-02	7.0296e+00	9.3369e-04	3.2797e-01	1.2220e-01	4.2925e+01
65.7984	1.8653e-02	8.2999e+00	4.3532e-04	1.3232e-01	6.5837e-02	2.0012e+01
76.9097	2.4196e-02	9.7413e+00	4.3913e-04	1.1419e-01	7.7592e-02	2.0177e+01
93.3439	3.2800e-02	1.1585e+01	4.2498e-04	9.1056e-02	9.0982e-02	1.9494e+01
119.8264	4.4520e-02	1.3541e+01	3.5821e-04	5.9788e-02	9.8216e-02	1.6393e+01
169.9343	6.3709e-02	1.5799e+01	2.8430e-04	3.3459e-02	1.0976e-01	1.2918e+01
288.0255	9.8634e-02	1.8225e+01	2.0704e-04	1.4377e-02	1.3329e-01	9.2557e+00
488.4072	1.2810e-01	1.9431e+01	1.2696e-04	5.1989e-03	1.4005e-01	5.7350e+00
1142.2619	2.1598e-01	2.0970e+01	8.1706e-05	1.4306e-03	1.9795e-01	3.4660e+00

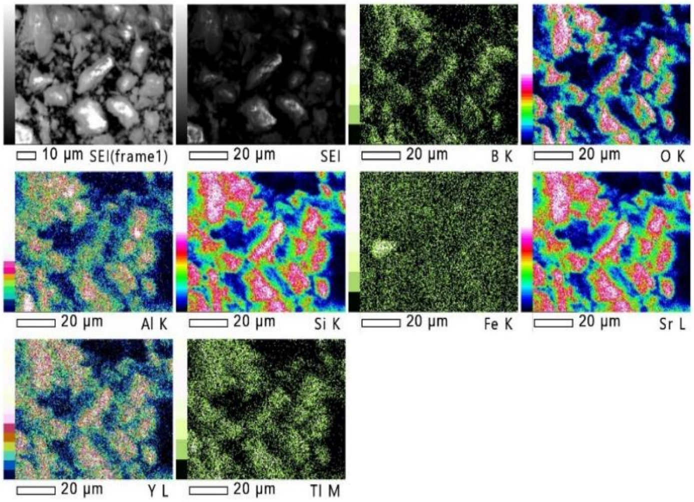
BJH adsorption summary

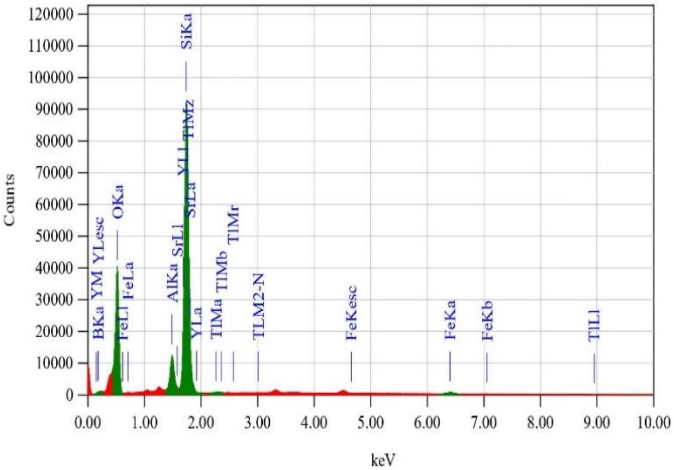
Surface Area =	20.970 m²/g
Pore Volume =	0.216 cc/g
Pore Radius Dv(r) =	21.571 Å

View004

JEOL 1/1

Date	:	2/14/2022
Resolution	:	256 x 192
Instrument	:	JCM-6000PL
Acc. Volt.	:	15 kV
Magnification	:	x 1,500
Dwell Time	:	0.20 msec.
Sweep Count	:	50

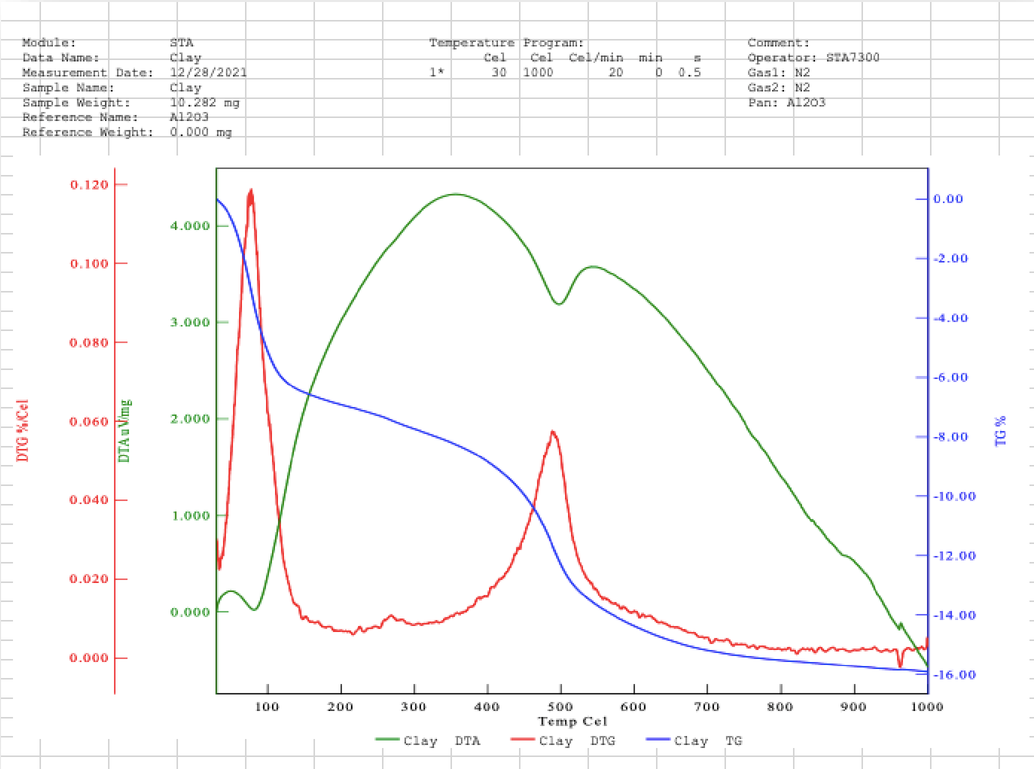




Acquisition Parameter

Instrument	:	JCM-6000PLUS
Acc. Voltage	:	15.0 kV
Probe Current	:	1.00000 nA
PHA mode	:	T3
Real Time	:	491.52 sec
Live Time	:	481.57 sec
Dead Time	:	2 %
Counting Rate	:	4032 cps
Energy Range	:	0 - 20 keV

JED-2300 AnalysisStation


Module: STA
Data Name: Clay
Measurement Date: 12/28/2021
Sample Name: Clay
Sample Weight: 10.282 mg
Reference Name: Al2O3
Reference Weight: 0.000 mg
Temperature Program:
Cel Cel Cel/min min s
1* 30 1000 20 0 0.5
Comment:
Operator: STA7300
Gas1: N2
Gas2: N2
Pan: Al2O3
DTG %/Cel
0.120
0.100
0.080
0.060
0.040
0.020
0.000
DTA uV/mg
4.000
3.000
2.000
1.000
0.000
TG %
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
100
200
300
400
500
600
700
800
900
1000
Temp Cel
Clay DTA
Clay DTG
Clay TG

Intensity Peak Statistics

v2.1

Malvern

Sample Details

Name: 0211 Suriati Eka Putri-UNM_Clay

Filename: Feb 2022.dts

Operator: Lambda 365

Date and Time: Wednesday, Feb 23, 2022 10:47:21 AM

SOP: mansettings.nano

Cumulant Results

Z-Avg (nm): 1190

Pd Index: 0.560

Pd (nm): 891.0

%Pd: 74.9

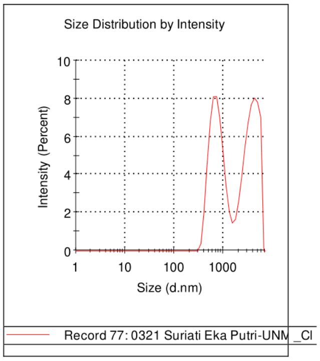
Derived kcps: 4155.4

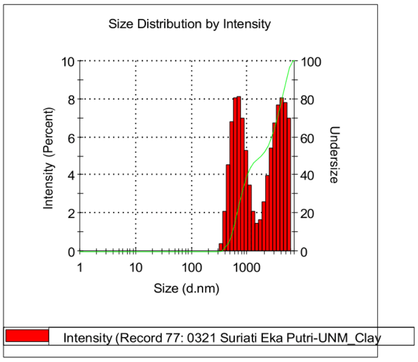
Distribution Results

	Size (d.nm):	% Int	s	%Pd
Peak 1:	3664	51.5	383.1	32.1
Peak 2:	748.7	48.5	257.6	34.4
Peak 3:	0.000	0.0	0.000	0

Undersize Results

Di (%)	Size (d.nm):
10	527
50	1720
90	4890
100	6440





Size d.nm	Mean Intensity Percent	Std Dev Intensity Percent
0.4000	0.0	
0.4632	0.0	
0.5365	0.0	
0.6213	0.0	
0.7195	0.0	
0.8332	0.0	
0.9649	0.0	
1.117	0.0	
1.294	0.0	
1.499	0.0	
1.736	0.0	
2.010	0.0	
2.328	0.0	
2.696	0.0	
3.122	0.0	
3.615	0.0	
4.187	0.0	
4.849	0.0	
5.615	0.0	
6.503	0.0	
7.531	0.0	
8.721	0.0	
10.10	0.0	
11.70	0.0	

Size d.nm	Mean Intensity Percent	Std Dev Intensity Percent
13.54	0.0	
15.69	0.0	
18.17	0.0	
21.04	0.0	
24.36	0.0	
28.21	0.0	
32.67	0.0	
37.84	0.0	
43.82	0.0	
50.75	0.0	
58.77	0.0	
68.06	0.0	
78.82	0.0	
91.28	0.0	
105.7	0.0	
122.4	0.0	
141.8	0.0	
164.2	0.0	
190.1	0.0	
220.2	0.0	
255.0	0.0	
295.3	0.0	
342.0	0.4	
396.1	2.1	

Size d.nm	Mean Intensity Percent	Std Dev Intensity Percent
458.7	4.5	
531.2	6.8	
615.1	8.1	
712.4	8.1	
825.0	7.0	
955.4	5.3	
1106	3.5	
1281	2.1	
1484	1.5	
1718	1.7	
1990	2.6	
2305	3.9	
2669	5.4	
3091	6.7	
3580	7.7	
4145	8.0	
4801	7.8	
5560	7.0	
6439	0.0	
7456	0.0	
8635	0.0	
1.000e4	0.0	

Lampiran 3.14.2 Beberapa data mentah pada tahap penentuan suhu sintering

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version 3.0

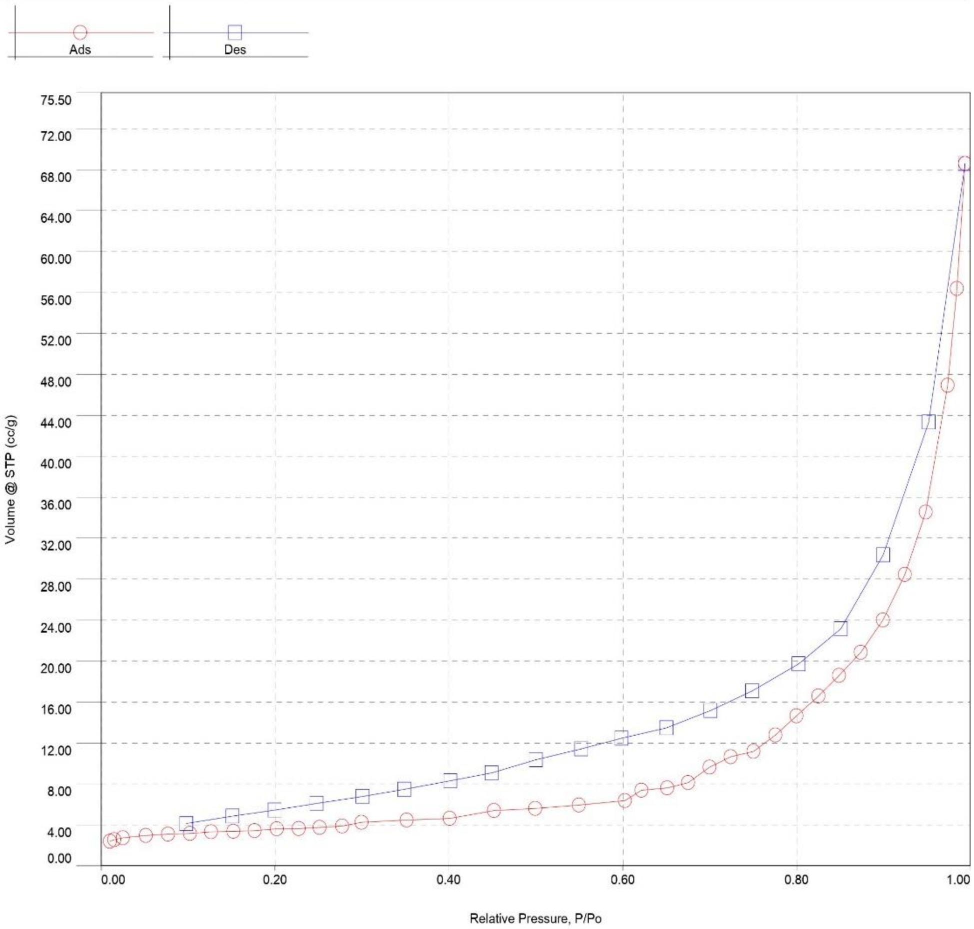
Quantachrome INSTRUMENTS

Analysis				**Report**			
Operator:	Lab. Energi ITS	**Date:**2022/07/16		**Operator:**	Lab. Energi ITS	**Date:**2022/07/17	
Sample ID:	EL-379 1000 C	**Filename:**		iq_phisy_st1_2022_07_16_21_13_22EL-379 1000 C.qps			
Sample Desc:		**Comment:**					
Sample Weight:	0.1514 g	**Instrument:**		Autosorb iQ Station 1			
Approx. Outgas Time:	12.6 hrs	**Final Outgas Temp.:**		200 °C		**Extended info:**	Available
Analysis gas:	Nitrogen	**Non-ideality:**		6.58e-05 1/Torr		**CellType:**	9mm
Analysis Time:	5:12 hr:min	**Bath temp.:**		77.35 K			
Analysis Mode:	Standard					**VoidVol Remeasure:**	off
VoidVol. Mode:	He Measure	**Cold Zone V:**		2.38293 cc		**Warm Zone V:**	18.5579 cc

Isotherm : Linear

Data Reduction Parameters

	Thermal Transpiration: on	**Eff. mol. diameter (D):** 3.54 Å	**Eff. cell stem diam. (d):** 4.0000 mm
Adsorbate	**Nitrogen**	**Temperature** 77.350K	
	Molec. Wt.: 28.013	**Cross Section:** 16.200 Å²	**Liquid Density:** 0.808 g/cc



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Report id:{1002779933:20220717 102155421} Page 1 of 1

Quantachrome® ASiQwin™- Automated Gas Sorption Data Acquisition and Reduction

version 3.0

Analysis				**Report**			
Operator:	Lab. Energi ITS	**Date:**	2022/07/16	**Operator:**	Lab. Energi ITS	**Date:**	2022/07/17
Sample ID:	EL-379 1000 C	**Filename:**	iq_phisy_st1_2022_07_16_21_13_22EL-379 1000 C.qps				
Sample Desc:		**Comment:**					
Sample Weight:	0.1514 g	**Instrument:**	Autosorb iQ Station 1				
Approx. Outgas Time:	12.6 hrs	**Final Outgas Temp.:**	200 °C	**Extended info:**	Available		
Analysis gas:	Nitrogen	**Non-ideality:**	6.58e-05 1/Torr	**CellType:**	9mm		
Analysis Time:	5:12 hr:min	**Bath temp.:**	77.35 K				
Analysis Mode:	Standard			**VoidVol Remeasure:**	off		
VoidVol. Mode:	He Measure	**Cold Zone V:**	2.38293 cc	**Warm Zone V:**	18.5579 cc		

BJH Pore Size Distribution Adsorption

Data Reduction Parameters Data

	Thermal Transpiration: on	**Eff. mol. diameter (D):** 3.54 Å	**Eff. cell stem diam. (d):** 4.0000 mm
t-Method	**Calc. method:** de Boer		
BJH/DH method	**Moving pt. avg.:** off	**Ignoring P-tags below 0.35 P/Po**	
Adsorbate	**Nitrogen**	**Temperature** 77.350K	
	Molec. Wt.: 28.013	**Cross Section:** 16.200 Å²	**Liquid Density:** 0.808 g/cc

BJH Pore Size Distribution Adsorption Data

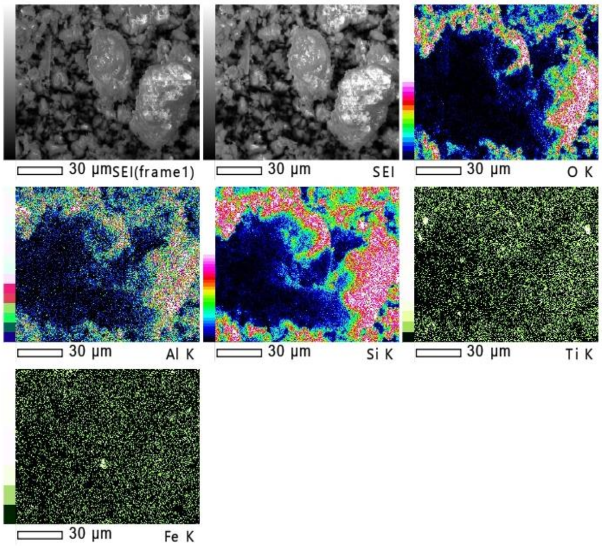
Radius [Å]	Pore Volume [cc/g]	Pore Surf Area [m²/g]	dV(r) [cc/Å/g]	dS(r) [m²/Å/g]	dV(logr) [cc/g]	dS(logr) [cc/g]
15.3095	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
17.1146	1.2587e-03	1.4709e+00	6.4655e-04	7.5555e-01	2.5452e-02	2.9742e+01
19.1423	1.2587e-03	1.4709e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
21.5222	1.2587e-03	1.4709e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
24.5537	1.2587e-03	1.4709e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
26.9793	3.6907e-03	3.2738e+00	1.6895e-03	1.2525e+00	1.0493e-01	7.7787e+01
28.9581	3.6907e-03	3.2738e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
31.4000	4.3467e-03	3.6916e+00	2.7730e-04	1.7662e-01	2.0039e-02	1.2764e+01
33.9761	7.7466e-03	5.6929e+00	1.2202e-03	7.1824e-01	9.5403e-02	5.6159e+01
36.9488	9.6604e-03	6.7289e+00	6.0584e-04	3.2793e-01	5.1512e-02	2.7883e+01
40.5800	1.0207e-02	6.9982e+00	1.3319e-04	6.5645e-02	1.2435e-02	6.1286e+00
45.0078	1.3391e-02	8.4132e+00	6.7006e-04	2.9775e-01	6.9377e-02	3.0829e+01
50.2305	1.7203e-02	9.9310e+00	6.6958e-04	2.6660e-01	7.7360e-02	3.0802e+01
56.8180	2.0966e-02	1.1256e+01	5.0297e-04	1.7704e-01	6.5707e-02	2.3129e+01
65.1816	2.4855e-02	1.2449e+01	4.2064e-04	1.2907e-01	6.3026e-02	1.9339e+01
76.4020	2.9037e-02	1.3544e+01	3.1689e-04	8.2955e-02	5.5610e-02	1.4557e+01
93.0835	3.4942e-02	1.4812e+01	2.9282e-04	6.2916e-02	6.2515e-02	1.3432e+01
119.4808	4.3123e-02	1.6182e+01	2.5073e-04	4.1970e-02	6.8548e-02	1.1474e+01
165.9482	5.4050e-02	1.7499e+01	1.8119e-04	2.1837e-02	6.8466e-02	8.2515e+00
285.8897	7.5267e-02	1.8983e+01	1.1815e-04	8.2656e-03	7.5150e-02	5.2573e+00
501.8078	9.0924e-02	1.9607e+01	6.2064e-05	2.4736e-03	7.0176e-02	2.7969e+00
1066.9564	1.1051e-01	1.9974e+01	2.2308e-05	4.1816e-04	5.1559e-02	9.6647e-01

BJH adsorption summary

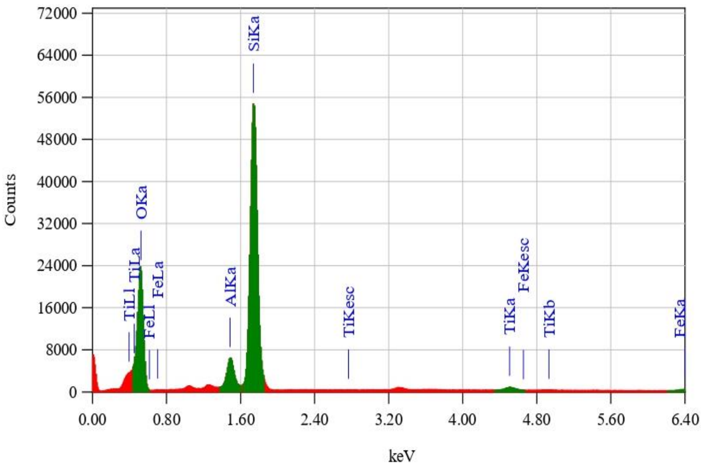
Surface Area = 19.974 m²/g
Pore Volume = 0.111 cc/g
Pore Radius Dv(r) = 26.979 Å

View000

JEOL 1/1

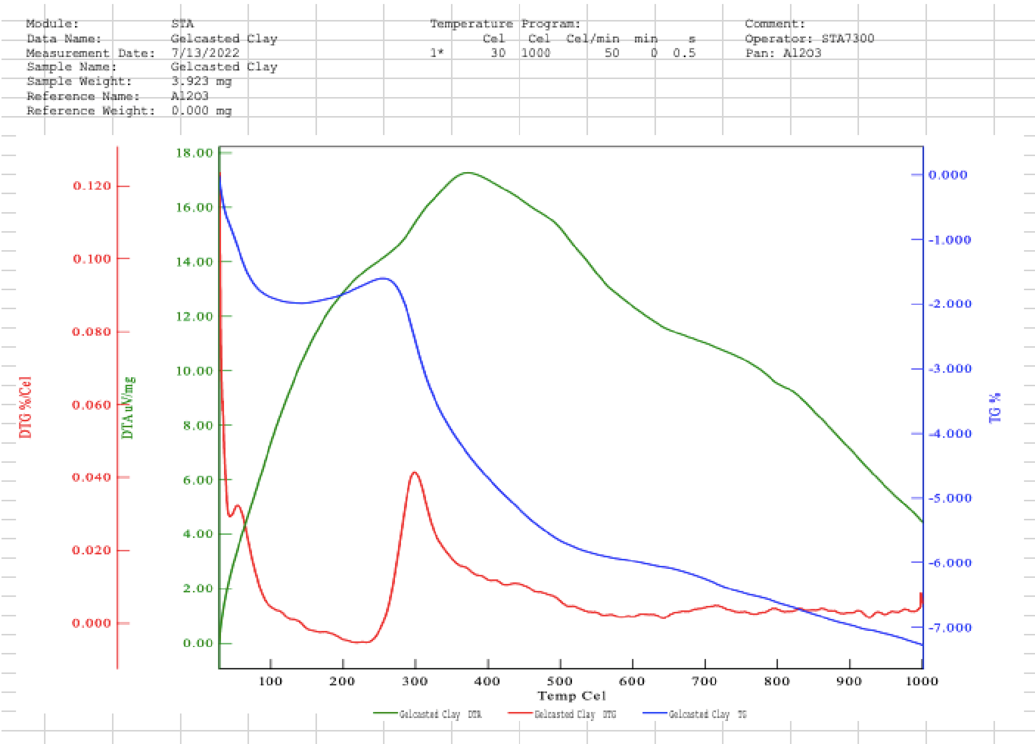


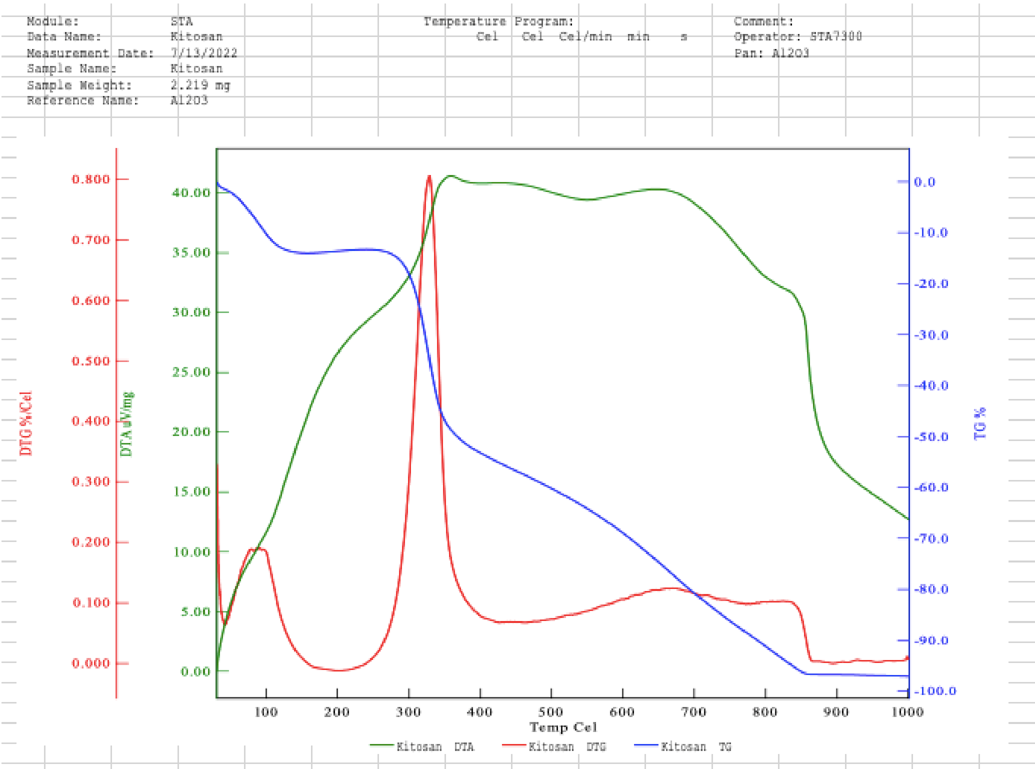
Date	: 7/20/2022
Resolution	: 256 x 192
Instrument	: JCM-6000PL
Acc. Volt.	: 15 kV
Magnification	: x 1,000
Dwell Time	: 0.20 msec.
Sweep Count	: 50



Acquisition Parameter

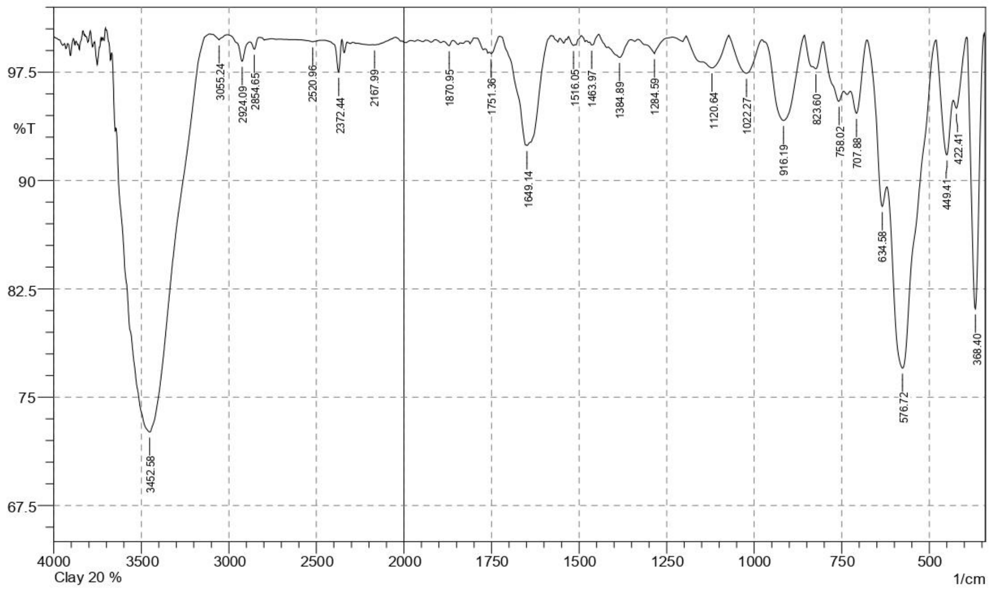
Instrument	: JCM-6000PLUS
Acc. Voltage	: 15.0 kV
Probe Current	: 1.00000 nA
PHA mode	: T3
Real Time	: 491.52 sec
Live Time	: 481.59 sec
Dead Time	: 1 %
Counting Rate	: 2419 cps
Energy Range	: 0 - 20 keV


Module: STA
Data Name: Gelcasted Clay
Measurement Date: 7/13/2022
Sample Name: Gelcasted Clay
Sample Weight: 3.923 mg
Reference Name: Al2O3
Reference Weight: 0.000 mg
Temperature Program:
Cel Cel Cel/min min s
1* 30 1000 50 0 0.5
Comment:
Operator: STA7300
Pan: Al2O3
DTG %/Cel
DTA uV/mg
TG %
Temp Cel
Gelcasted Clay DTA
Gelcasted Clay DTG
Gelcasted Clay TG


Module: STA
Data Name: Kitosan
Measurement Date: 7/13/2022
Sample Name: Kitosan
Sample Weight: 2.219 mg
Reference Name: Al2O3
Temperature Program:
Cel Cel Cel/min min s
Comment:
Operator: STA7300
Pan: Al2O3
DTG %/Cel
DTA uV/mg
TG %
Temp Cel
Kitosan DTA
Kitosan DTG
Kitosan TG

Lampiran 3.14.3 Beberapa data mentah pada tahap sintesis keramik berpori *gelcasting*

SHIMADZU

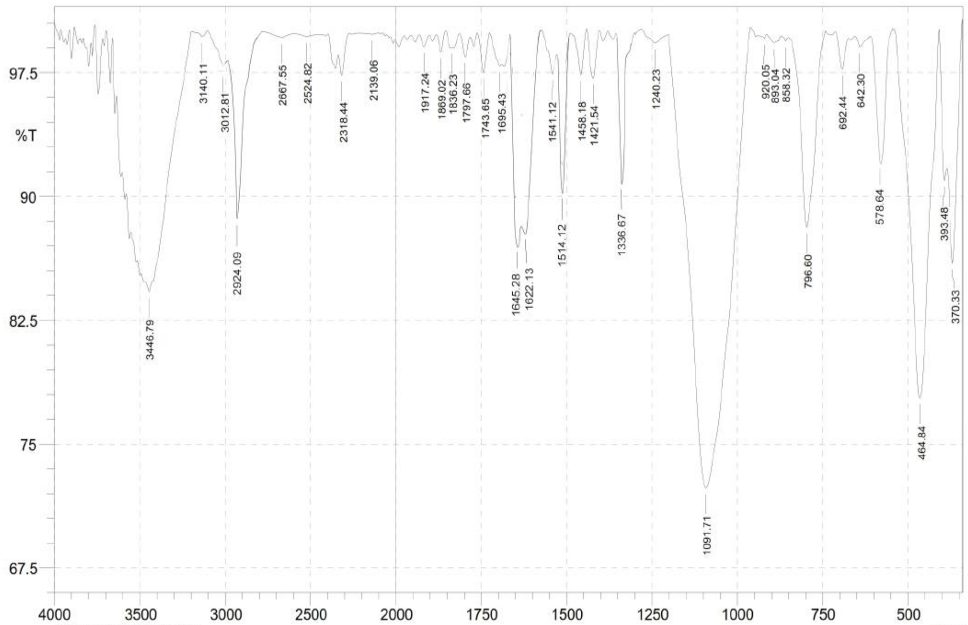


	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	368.4	81.115	18.888	391.55	343.33	2.165	2.168
2	422.41	95.001	1.642	432.05	393.48	0.525	0.137
3	449.41	91.782	5.271	480.28	432.05	1.179	0.656
4	576.72	77.009	15.791	621.08	482.2	8.726	5.357
5	634.58	88.201	3.512	677.01	623.01	1.636	0.319
6	707.88	94.653	2.813	725.23	677.01	0.725	0.29
7	758.02	95.482	1.502	802.39	744.52	0.809	0.271
8	823.6	97.744	2.041	856.39	802.39	0.351	0.312
9	916.19	94.159	5.627	968.27	858.32	1.671	1.576
10	1022.27	97.428	2.462	1072.42	977.91	0.629	0.588
11	1120.64	97.802	1.108	1149.57	1072.42	0.528	0.237
12	1284.59	98.791	0.794	1309.67	1234.44	0.177	0.07
13	1384.89	98.532	0.962	1417.68	1352.1	0.279	0.135
14	1463.97	99.376	0.335	1469.76	1444.68	0.037	0.021
15	1516.05	99.345	0.188	1529.55	1512.19	0.034	0.011
16	1649.14	92.425	0.883	1726.29	1641.42	1.34	0.075
17	1751.36	98.791	0.247	1755.22	1728.22	0.086	0.02
18	1870.95	99.332	0.347	1886.38	1859.38	0.056	0.018
19	2167.99	99.399	0.051	2179.56	2046.47	0.228	0.035
20	2372.44	97.507	2.239	2470.81	2355.08	0.38	0.246
21	2520.96	99.606	0.123	2601.97	2470.81	0.178	0.026
22	2854.65	99.09	0.657	2879.72	2827.64	0.118	0.062
23	2924.09	98.255	1.508	3008.95	2879.72	0.328	0.239
24	3055.24	99.736	0.375	3093.82	3008.95	0.015	0.055
25	3452.58	72.584	23.349	3643.53	3111.18	39.95	32.485

Comment;
Clay 20 %

Date/Time; 2/9/2023 10:43:03 AM
No. of Scans;
Resolution;
Apodization;

SHIMADZU



Clay sebelum sintering

No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	370.33	85.969	8.751	385.76	343.33	1.681	0.923
2	393.48	90.966	3.002	408.91	387.69	0.578	0.182
3	464.84	77.794	22.121	543.93	410.84	6.782	6.752
4	578.64	91.342	10.532	607.58	559.36	0.095	0.059
5	642.3	99.052	0.63	655.8	607.58	0.121	0.053
6	692.44	97.728	2.029	713.66	673.16	0.2	0.159
7	796.6	88.133	11.678	850.61	742.59	2.477	2.389
8	858.32	99.401	0.208	864.11	850.61	0.027	0.004
9	893.04	99.316	0.233	914.26	881.47	0.073	0.017
10	920.05	99.568	0.224	939.33	914.26	0.034	0.009
11	1091.71	72.345	27.677	1201.65	962.48	17.692	17.733
12	1240.23	99.302	0.681	1282.66	1201.65	0.131	0.128
13	1336.67	91.450	9.121	1355.96	1321.24	0.219	0.106
14	1421.54	97.182	2.922	1440.83	1404.18	0.238	0.255
15	1458.18	97.364	2.621	1479.4	1440.83	0.212	0.206
16	1514.12	91.165	10.035	1527.62	1487.12	0.391	0.256
17	1541.12	97.4	1.652	1573.91	1527.62	0.267	0.141
18	1622.13	88.614	11.435	1631.78	1573.91	0.796	0.167
19	1645.28	88.51	11.476	1664.57	1631.78	0.634	0.254
20	1695.43	97.905	0.311	1726.29	1691.57	0.193	0.035
21	1743.65	97.51	2.4	1762.94	1726.29	0.198	0.184
22	1797.66	98.465	1.283	1813.09	1782.23	0.116	0.083
23	1836.23	99.031	0.002	1838.16	1832.38	0.024	0
24	1869.02	98.742	1.17	1882.52	1853.59	0.073	0.063
25	1917.24	99.068	0.706	1930.74	1901.81	0.072	0.043
26	2139.06	99.82	0.033	2154.49	2119.77	0.024	0.002
27	2318.44	97.34	1.634	2337.72	2274.07	0.412	0.198
28	2524.82	99.673	0.152	2598.12	2457.31	0.142	0.035
29	2667.55	99.607	0.294	2785.21	2598.12	0.166	0.102
30	2924.09	88.689	11.873	2987.74	2785.21	1.769	0.961
31	3012.81	97.885	0.677	3101.54	2989.66	0.566	0.134
32	3140.11	99.667	0.318	3167.12	3101.54	0.047	0.046
33	3446.79	84.201	0.657	3469.94	3425.58	3.229	0.065

Date/Time; 2/8/2023 3:59:07 PM
No. of Scans;

POLITEKNIK NEGERI UJUNG PANDANG

JURUSAN TEKNIK KIMIA

Quantachrome TouchWin v1.2 2

Report date: Fri Dec 23 2022 **Operator:** Rifai
Filename: kontrol30%g.qcuPhysIso

Analysis Information

Sample

ID	kontrol30%g	**Weight**	0.2175g		
Description					

Analysis

Data ID	{0a8fc61a-d4d9-4af7-a11f-9803ffe4fea1}				
Operator	Rifai	**Date**	2022.12.19	**Duration**	164.0min
Instrument	St 2 on NOVA touch 2LX [s/n:1050025524]			**Firmware**	1.07
Comments					
Ambient Temp.	29.82°C	**Void Volume Mode**	NOVA mode	**Cell ID**	5_A
Cell Type	9mm with rod	**Thermal Delay**	600sec	**Po Mode**	Measure

Adsorbate

Name	Nitrogen	**Molecular Weight**	28.013g/mol	**Cross Section Area**	16.2Å²/mol
Non-ideality	6.580000e-05 1/torr	**Bath Temperature**	77.35K		

Degas information

Type	Vacuum Degassing
Operator	Rifai
Description	
Heating	Heat to 125.0 °C at 10.0 °C/min then hold for 60 min Heat to 300.0 °C at 10.0 °C/min then hold for 30 min

Data Reduction Parameters

Thermal Transpiration no

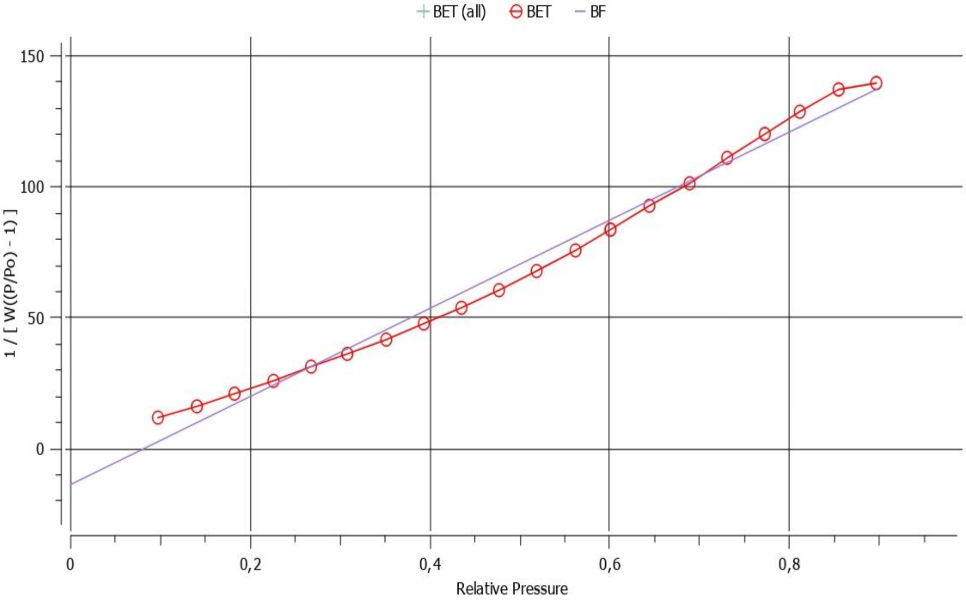
Adsorbate Model

Name	Nitrogen	**Molecular Weight**	28.0134g	**Cross Section Area**	16.2Å²/molec
Bath Temperature	77.35K				

BET Multi-point BET results

Isotherm Branch	Adsorption
Slope	168.198
Intercept	-13.5727
Correlation coeff., r	0.993443
C constant	-11.3924
Surface area	22.522 m²/g

Graph - BET Multi-point BET



POLITEKNIK NEGERI UJUNG PANDANG

JURUSAN TEKNIK KIMIA
Quantachrome TouchWin v1.22

Report date: Fri Dec 23 2022 **Operator:** Rifai
Filename: kontrol30%g.qcuPhysIso

Analysis Data

Sample

ID	kontrol30%g	**Weight**	0.2175g		
Description					

Analysis

Data ID	{0a8fc61a-d4d9-4af7-a11f-9803ffe4fea1}				
Operator	Rifai	**Date**	2022.12.19	**Duration**	164.0min
Instrument	St 2 on NOVA touch 2LX [s/n:1050025524]			**Firmware**	1.07
Comments					
Ambient Temp.	29.82°C	**Void Volume Mode**	NOVA mode	**Cell ID**	5_A
Cell Type	9mm with rod	**Thermal Delay**	600sec	**Po Mode**	Measure

Adsorbate

Name	Nitrogen	**Molecular Weight**	28.013g/mol	**Cross Section Area**	16.2Å²/mol
Non-ideality	6.580000e-05 1/torr	**Bath Temperature**	77.35K		

Degas information

Type	Vacuum Degassing
Operator	Rifai
Description	
Heating	Heat to 125.0 °C at 10.0 °C/min then hold for 60 min Heat to 300.0 °C at 10.0 °C/min then hold for 30 min

Data Reduction Parameters

Data Reduction Parameters

Thermal Transpiration	no		
Temp. Comp	no		
Thickness Method	deBoer		
P-tags below 0.35	included	**Moving Pt. Average**	off

Adsorbate Model

Name	Nitrogen	**Molecular Weight**	28.0134g	**Cross Section Area**	16.2Å²/molec
Bath Temperature	77.35K				

Multipoint BET Summary/Results

Isotherm Branch	Adsorption	**Slope**	168.198	**Intercept**	-13.5727
Correlation coeff., r	0.993443	**C constant**	-11.3924	**Surface area**	22.522 m²/g

BET-Multi-point BET

Relative Pressure	Volume Adsorbed @STP cc/g	1 / [W((P/Po) - 1)]
0.0975881	7.39290	11.7038
0.140256	8.04692	16.2208
0.181946	8.51048	20.9102
0.225343	8.97719	25.9266
0.268140	9.42569	31.1008
0.307943	9.83958	36.1828
0.351403	10.3764	41.7766
0.393683	10.8975	47.6725
0.434941	11.4470	53.8017
0.477388	12.0807	60.4993
0.519067	12.7712	67.6172
0.561904	13.5363	75.8128
0.601304	14.4565	83.4716
0.644689	15.6208	92.9370
0.688460	17.4459	101.3498
0.730576	19.5130	111.1875
0.772045	22.5666	120.0819
0.811478	26.7096	128.9430
0.854901	34.4149	136.9793
0.896732	49.7728	139.5897

Average Pore Size Summary/Results

Average Pore radius 1.7586e+00nm

Lampiran 1:

LAPORAN HASIL UJI TEKAN ULANGAN 1

Material	: Keramik
Jumlah sampel	: 20 sampel
Tanggal diterima	: 31 Januari 2023
Tanggal pengujian	: 31 Januari 2023
Nama Pengirim	: **Mahasiswa S3 UNHAS**
	Jurusan Kimia
Mesin Pengujian	: Universal Testing Machine (UTM)
	Type PM 100 Galdabini
	Skala Pembacaan 20 KN

Perlakuan Serat				Dimensi Spesimen			Kekuatan Kompressi
No.	Kode Sampel	dx (mm)	dy (mm)	D (mm)	A (mm)	F_{uc} (N)	σ_c (MPa)
1	Clay 10%	19,4	19,5	19,455	297,12	3940	13,26
2	Clay 20%	19,4	19,5	19,46	297,27	3720	12,51
3	Clay 30%	19,2	19,4	19,3	292,40	3140	10,74
4	Clay 40%	18,9	19,4	19,16	288,18	3240	11,24
5	Clay 50%	18,69	18,4	18,54	269,83	3360	12,45
6	Kontrol 10% ('C)	18,53	18,5	18,5	268,67	2300	8,56
7	Kontrol 20% ('C)	18,62	18,5	18,565	270,56	2096	7,75
8	Kontrol 30% ('C)	18,67	18,5	18,585	271,14	1960	7,23
9	Kontrol 40% ('C)	18,74	18,5	18,625	272,31	1240	4,55
10	Kontrol 50% ('C)	18,15	17,9	18,02	254,91	1340	5,26

Konversi Pembacaan dari 100 KN ke 20 KN (1/5)

Fu-100 N	Fu-20 N
19700	3940
18600	3720
15700	3140
16200	3240
16800	3360
11500	2300
10480	2096
9800	1960
6200	1240
6700	1340

INPUT DATA

Keterangan :

D = Diameter Penampang

A = Luas penampang

Fuc = Gaya maksimum kompressi

σc = Kekuatan tekan/kompressi

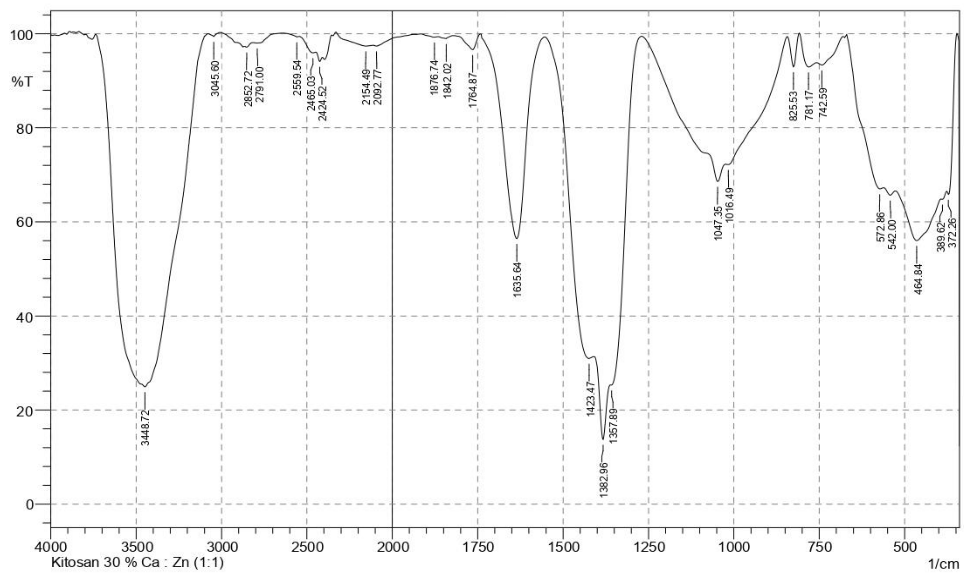
Hasil uji menggunakan alat Digital Force Gauge

Kode sampel	F (N)	d	A	σc
clay 10%	2751,7	19,64	303	9,0876
clay 30%	3037,6	19,46	297	10,223
kontrol 20%	500	18,65	273	1,8312
kontrol 30%	420	18,05	256	1,6422

Kompesi Keramik Ulangan 1 | Kuat Tekan Keramik Ulangan 2 | Kompresi Keramik Ulangan 3 | Kesimpulan

Lampiran 3.14.4 Beberapa data mentah pada tahap impregnasi katalis bifungsional CaO-ZnO ke dalam keramik berpori

SHIMADZU



No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	372.26	65.864	5.085	376.12	347.19	2.901	0.596
2	389.62	64.805	0.461	393.48	378.05	2.843	0.035
3	464.84	56.023	9.725	526.57	395.41	28.813	4.866
4	542	65.685	1.157	561.29	528.5	5.853	0.125
5	572.86	67.019	3.192	669.3	563.21	11.369	2.022
6	742.59	93.342	1.481	756.1	680.87	1.515	0.4
7	781.17	92.94	3.796	808.17	758.02	1.232	0.526
8	825.53	92.987	6.774	844.82	808.17	0.552	0.511
9	1016.49	72.171	1.265	1024.2	844.82	15.116	2.353
10	1047.35	68.575	6.053	1269.16	1026.13	20.849	3.391
11	1357.89	25.297	3.187	1361.74	1271.09	22.346	1.049
12	1382.96	13.778	14.317	1408.04	1361.74	31.032	5.491
13	1423.47	30.988	6.801	1552.7	1409.96	34.384	3.14
14	1635.64	56.462	43.11	1739.79	1554.63	17.026	16.709
15	1764.87	96.6	3.255	1820.8	1741.72	0.54	0.464
16	1842.02	98.967	0.528	1867.09	1820.8	0.15	0.046
17	1876.74	99.261	0.227	1917.24	1867.09	0.1	0.027
18	2092.77	97.375	0.401	2110.12	1938.46	1.074	0.112
19	2154.49	97.388	0.7	2330.01	2112.05	1.726	0.697
20	2424.52	94.106	1.306	2447.67	2409.09	0.869	0.101
21	2465.03	95.944	0.722	2546.04	2447.67	1.131	0.167
22	2559.54	99.312	0.207	2644.41	2546.04	0.088	-0.009
23	2791	98.02	0.379	2816.07	2644.41	0.66	-0.007
24	2852.72	97.169	0.345	2866.22	2816.07	0.532	0.026
25	3045.6	99.41	0.727	3078.39	3010.88	0.044	0.085
26	3448.72	24.95	74.967	3736.12	3078.39	197.142	196.933

Comment;

Kitosan 30 % Ca : Zn (1:1)

Date/Time; 9/1/2023 4:32:13 PM

No. of Scans;

Resolution;

Apodization;

POLITEKNIK NEGERI UJUNG PANDANG

JURUSAN TEKNIK KIMIA
Quantachrome TouchWin v1.22

Report date:	Tue Aug 8 2023	**Operator:**	Rifai
Filename:	x_20%.qcuPhysIso		

Analysis Information

Sample

ID	x20%	**Weight**	0.2334 g		
Description					

Analysis

Data ID	{9ce4bb1f-61dd-4eae-81d2-469b429191ba}				
Operator	Rifai	**Date**	2023.08.01	**Duration**	189.1 min
Instrument	St 1 on NOVA touch 2LX [s/n:1050025524]			**Firmware**	1.07
Comments					
Ambient Temp.	30.37 °C	**Void Volume Mode**	NOVA mode	**Cell ID**	6_B
Cell Type	9mm with rod	**Thermal Delay**	600 sec	**Po Mode**	Measure

Adsorbate

Name	Nitrogen	**Molecular Weight**	28.013 g/mol	**Cross Section Area**	16.2 Å²/mol
Non-ideality	6.580000e-05 1/torr	**Bath Temperature**	77.35 K		

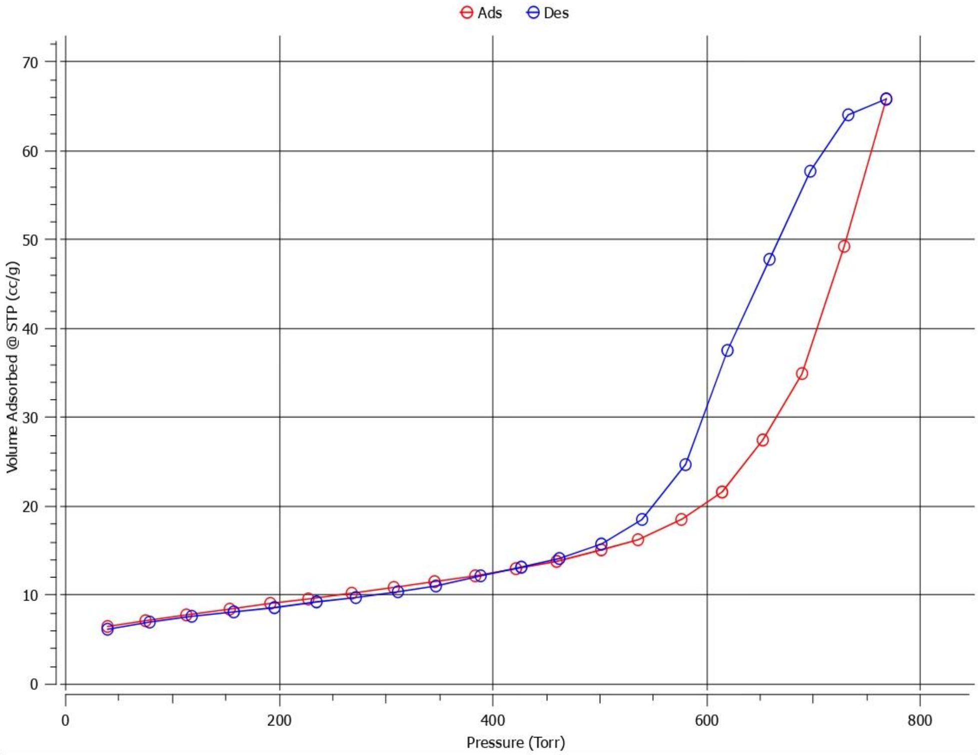
Degas information

Type	Vacuum Degassing
Operator	Rifai
Description	
Heating	Heat to 125.0 °C at 10.0 °C/min then hold for 60 min Heat to 300.0 °C at 10.0 °C/min then hold for 30 min

Data Reduction Parameters

Thermal Transpiration no

Graph - Isotherm Absolute Isotherm



POLITEKNIK NEGERI UJUNG PANDANG

JURUSAN TEKNIK KIMIA
Quantachrome TouchWin v1.22

Report date: Tue Aug 8 2023 **Operator:** Rifai
Filename: x_20%.qcuPhysIso

Analysis Data

Sample

ID	x20%	**Weight**	0.2334g		
Description					

Analysis

Data ID	{9ce4bb1f-61dd-4eae-81d2-469b429191ba}				
Operator	Rifai	**Date**	2023.08.01	**Duration**	189.1min
Instrument	St 1 on NOVA touch 2LX [s/n:1050025524]			**Firmware**	1.07
Comments					
Ambient Temp.	30.37°C	**Void Volume Mode**	NOVA mode	**Cell ID**	6_B
Cell Type	9mm with rod	**Thermal Delay**	600sec	**Po Mode**	Measure

Adsorbate

Name	Nitrogen	**Molecular Weight**	28.013g/mol	**Cross Section Area**	16.2Å²/mol
Non-ideality	6.580000e-05 1/torr	**Bath Temperature**	77.35K		

Degas information

Type	Vacuum Degassing
Operator	Rifai
Description	
Heating	Heat to 125.0 °C at 10.0 °C/min then hold for 60 min Heat to 300.0 °C at 10.0 °C/min then hold for 30 min

Data Reduction Parameters

Data Reduction Parameters

Thermal Transpiration	no		
Temp. Comp	no		
Thickness Method	deBoer		
P-tags below 0.35	included	**Moving Pt. Average**	off

Adsorbate Model

Name	Nitrogen	**Molecular Weight**	28.0134g	**Cross Section Area**	16.2Å²/molec
Bath Temperature	77.35K				

Multipoint BET Summary/Results

Isotherm Branch	Adsorption	**Slope**	457.398	**Intercept**	-109.485
Correlation coeff., r	0.611983	**C constant**	-3.17771	**Surface area**	10.010 m²/g

BET-Multi-point BET

Relative Pressure	Volume Adsorbed @STP cc/g	1 / [W((P/Po) - 1)]
0.050364	6.43213	6.5972
0.0954959	7.18023	11.7648
0.145687	7.86049	17.3582
0.196692	8.43548	23.2245
0.246385	9.04887	28.9082
0.292855	9.59741	34.5255
0.344217	10.2182	41.1007
0.395233	10.8741	48.0862
0.444682	11.5276	55.5802
0.492585	12.1916	63.7100
0.541760	12.9570	73.0063
0.591123	13.8293	83.6444
0.645207	15.1569	95.9984
0.688637	16.2332	109.0103
0.740775	18.5182	123.4698
0.789349	21.5609	139.0558
0.838208	27.4072	151.2451
0.886458	34.9210	178.8809
0.937107	49.2485	242.0731
0.988185	65.7648	1017.5838

Average Pore Size Summary/Results

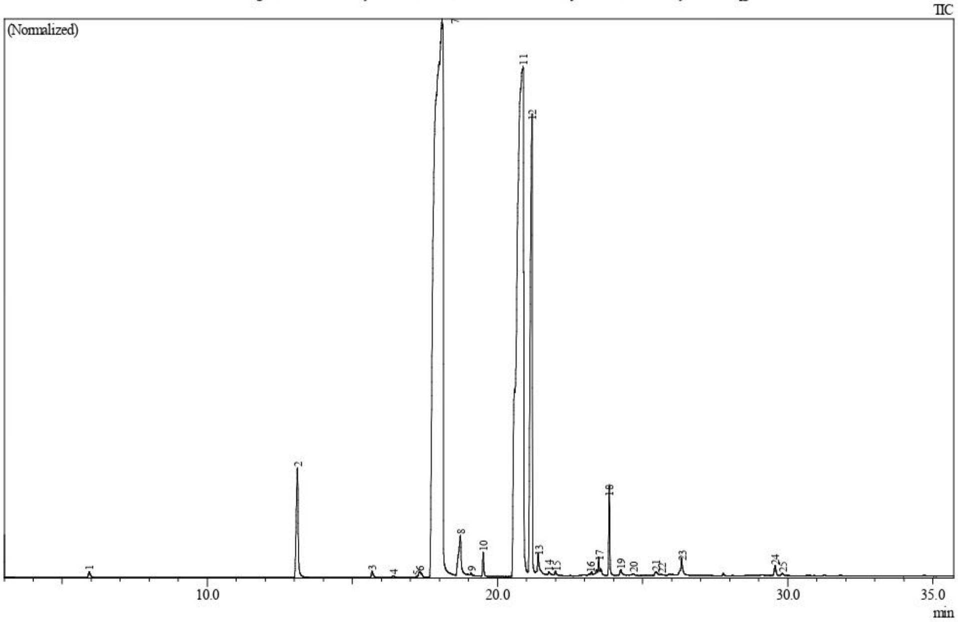
Average Pore radius 1.5259e+01nm

DATA REPORT GCMS-QP2010 ULTRA SHIMADZU

Sample Information

Analyzed by	: Admin
Analyzed	: 30/11/2023 11:50:31 AM
Sample Type	: Unknown
Level #	: 1
Sample Name	: Biodiesel Minyak Sawit
Sample ID	: Biodiesel Minyak Sawit
IS Amount	: [1]=1
Sample Amount	: 1

Chromatogram Biodiesel Minyak Sawit C:\GCMSsolution\Data\Project1\Biodiesel Minyak Sawit.qgd



Peak Report TIC

Peak#	R.Time	Area	Area%	A/H	Name
1	5.930	1307189	0.11	4.63	DODECANOIC ACID, METHYL ESTER
2	13.104	25638804	2.12	4.66	Tetradecanoic acid, methyl ester (CAS)
3	15.677	1424845	0.12	4.55	Pentadecanoic acid, methyl ester
4	16.407	480135	0.04	5.72	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester
5	17.207	173247	0.01	3.80	9-Hexadecenoic acid, methyl ester, (Z)- (CAS)
6	17.310	2048756	0.17	7.75	9-Hexadecenoic acid, methyl ester, (Z)- (CAS)
7	18.090	588850662	48.71	21.03	Hexadecanoic acid, methyl ester
8	18.721	15736002	1.30	7.68	n-Hexadecanoic acid
9	19.089	1392001	0.12	7.11	CIS-10-HEPTADECENOIC ACID ME
10	19.508	3707192	0.31	3.06	Heptadecanoic acid, methyl ester (CAS)
11	20.874	411695720	34.05	16.06	9-OCTADECENOIC ACID, METHYL ESTER
12	21.179	115607148	9.56	5.16	Methyl stearate
13	21.409	7511296	0.62	7.61	Oleic Acid
14	21.773	1537707	0.13	7.24	Octadecanoic acid
15	22.013	1598817	0.13	7.29	9,12-Octadecadienoic acid (Z,Z)-, methyl ester (CAS)
16	23.187	856848	0.07	10.68	Dichloroacetic acid, undec-2-enyl ester
17	23.498	4963813	0.41	7.14	cis-Methyl 11-eicosenoate
18	23.856	11725131	0.97	3.01	Eicosanoic acid, methyl ester (CAS)
19	24.256	1756696	0.15	6.16	2-Butyl-3-methyl-5-(2-methylprop-2-enyl)cyclohexanone
20	24.680	929721	0.08	9.40	7-Hexadecenal, (Z)-
21	25.463	1272026	0.11	7.17	1H-Benzocyclohepten-7-ol, 2,3,4,4a,5,6,7,8-octahydro-1,1,4a,7-tetramethyl-, cis-
22	25.667	531659	0.04	9.02	1H-Indole-3-ethanamine (CAS)
23	26.354	5350222	0.44	7.23	Docosanoic acid, methyl ester (CAS)
24	29.569	2216754	0.18	4.89	Tetracosanoic acid, methyl ester
25	29.827	638810	0.05	5.79	1,4-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
		1208951201	100.00		

PT. KILANG PERTAMINA INTERNASIONAL
LABORATORY - REFINERY UNIT V BALIKPAPAN

PERTAMINA KILANG PERTAMINA INTERNASIONAL

Jalan Yos Sudarso No.1 pintu IV, Balikpapan - 76111
Telp. (0542) 511000 - 5096, Email : Adm Eng & Dev RU V - Laboratory (mk.djuraidah@pertamina.com)

LABORATORY TEST REPORT

Test. Report No.	: 054/MH/IX/2023	Sample Number	: 1903 / 2023
Sample Type	: BIOSOLAR B100	Sampling Method	: None
Date/Time Received	: 11/09/2023 / 10.00 wita	Sampling by	: Customer
Reference	: VisKin, Density, Sulfur, Flash, Water	Sample Identity	: UN. Makassar
Sample Status	: Ekstra	Date Tested	: 11-Sep-23

No	Properties	Units	Limits*	Methods	Results
1	Angka Setana	-	Min 51	ASTM D613	-
2	Density at 15 °C	kg/m^3	850 - 890	ASTM D1298-12b(17)	877.0
3	Kinematic Viscosity at 40 °C	mm^2/sec	2.3 - 6.0	ASTM D445-21e1	4,4404
4	Sulfur Content (a)	mg/kg	Max 10	ASTM D2622-21	8,0
5	Distillation (90%vol Recovery)	°C	Max 360	ASTM D86-20b	
6	Flash Point PMcc	°C	Min 130	ASTM D93-20	158
7	Micro Carbon Residue	% m/m	Max 0.05	ASTM D4530-20	
8	Water Content	mg/kg	Max 350	ASTM D6304-20	673
9	Copper Strip Corrosion	Class	Max Class 1	ASTM D130-19	
10	Ash Content	% m/m	Max 0.02	ASTM D482-19	
11	Strong Acid Number	mgKOH/g	0	ASTM D664-18e2	
12	Total Acid Number	mgKOH/g	Max 0.4	ASTM D664-18e2	
13	Appearance	-	Clear & Bright	Visual	Clear & Bright
14	Color ASTM	ASTM No.	Max 3	ASTM D1500-17	
15	Oxidation Stability	Menit	Min 45	ASTM D7545-14(19)	

Remarks :

Refer to SK Dirjen EBTKE No. 189K/10/DJE/2019, tanggal 05 November 2019, Spesifikasi Bahan Bakar Nabati (Biofuel)

This commodity is not included in the scope of accreditation

Balikpapan, 12 September 2023
Pjs. Quality Supervisor

Arizzal FH

DEPUTI BIDANG INFRASTRUKTUR RISET DAN INOVASI
DIREKTORAT PENGELOLAAN LABORATORIUM, FASILITAS RISET, DAN KAWASAN SAINS TEKNOLOGI
Gedung B.J. Habibie, Jalan M.H. Thamrin Nomor 8
Jakarta Pusat 10340
Telepon/WA: 0811 8612 392
https://www.brin.go.id

No. ID ELSA :98740
Transaction Number

Metode : Carbon Dioxide-Temperature Programmed Desorption (CO_2-TPD)
Method Autochem II Micromeritics_

Nama Laboratorium : Laboratorium Karakterisasi Lanjut Serpong
Name of Laboratory Laboratorium Jasa Analisa Kimia - BRIN

Alamat Laboratorium : Gedung 452, Kawasan Puspiptek (Gedung Kimia)
Laboratory Address Muncul, Kec. Serpong, Tangerang Selatan, Banten 15314
Email : labkarserpong@brin.go.id ; Telp +62 811-1391-617

Kondisi Pengukuran/Parameter Pengujian *Measurement Conditions/Testing Parameters:*

a) *Pretreatment* sampel:
Sampel dipanaskan pada suhu 350°C selama 60 min dalam kondisi gas inert.
b) Adsorpsi CO_2:
Adsorsi CO_2 (5% dalam He, v/v) dilakukan pada suhu ruang selama 30 menit, kemudian di-*purging* dengan gas He (inert) pada suhu ruang, selama 30 menit.
c) Desorpsi CO_2:
Desorpsi CO_2 dilakukan pada suhu ruang s.d 800 °C dengan mengalirkan gas He dengan kecepatan penaikan suhu (heating rate) sebesar 10°C/menit. Seluruh flow rate gas adalah 50 mL/menit.

Hasil Pengujian *Testing Results* :
Link URL *Url link*
[https://data.brin.go.id/privateurl.xhtml?token=31dfb58b-48d9-4990-90f2-5ccd3b2c4d58]

No	Sampel	Bobot Sampel (g)	Area	mol CO_2 (mmol)	Basicity (mmol/g)
1	CaO-ZnO/SiO2	0.0577	0.19994	0.04238	0.7344

Catatan *Note:*
Data hasil pengujian yang autentik adalah data yang berada di Repositori Ilmiah Nasional (RIN) BRIN yang dapat diakses melalui *link url* yang tertera pada hasil pengujian pada lembar ini. *Link url* bersifat unik dan, hanya dibagikan untuk pengguna pada hasil uji transaksi pada Laporan Hasil Uji ini.

Daftar sampel yang dilakukan pengujian terdapat di lembar pengesahan.
Penamaan sampel sesuai dengan penamaan pada saat permohonan pengajuan layanan.

Terima kasih sudah melakukan pengujian/ penyewaan alat/ proses riset dengan fasilitas yang tersedia di Laboratorium Karakterisasi Lanjut Serpong- BRIN. Jika dikemudian hari, hasil pengujian atau analisis ini akan dipublikasikan, mohon kiranya bisa menambahkan dalam Ucapan Terima Kasih atau Acknowledgement di dalam publikasi Anda,

seperti dalam contoh format berikut:

Dalam bahasa Indonesia : "Penelitian ini didukung oleh fasilitas riset, dan dukungan ilmiah serta teknis dari Laboratorium Karakterisasi Lanjut Serpong di Badan Riset dan Inovasi Nasional".
Dalam bahasa Inggris : "The authors acknowledge the facilities, scientific and technical support from Advanced Characterization Laboratories Serpong, National Research and Innovation Institute through E- Layanan Sains, Badan Riset dan Inovasi Nasional.

BRIN
BADAN RISET DAN INOVASI NASIONAL

DEPUTI BIDANG INFRASTRUKTUR RISET DAN INOVASI
DIREKTORAT PENGELOLAAN LABORATORIUM, FASILITAS RISET, DAN KAWASAN SAINS TEKNOLOGI
Gedung B.J. Habibie, Jalan M.H. Thamrin Nomor 8
Jakarta Pusat 10340
Telepon/WA: 0811 8612 392
https://www.brin.go.id

No. ID ELSA **: 99692**
Transaction Number

Metode **: Ammonia-Temperature Programmed Desorption (NH_3-TPD)**
Method Micromeritics Chemisorb 2750

Nama Laboratorium : Laboratorium Karakterisasi Lanjut Serpong
Name of Laboratory Laboratorium Jasa Analisa Kimia - BRIN

Alamat Laboratorium : Gedung 452, Kawasan Puspiptek (Gedung Kimia)
Laboratory Address Muncul, Kec. Serpong, Tangerang Selatan, Banten 15314
Email : labkarserpong@brin.go.id ; Telp +62 811-1391-617

Kondisi Pengukuran/Parameter Pengujian *Measurement Conditions/Testing Parameters:*

a) *Pretreatment* sampel:
Sampel dipanaskan pada suhu 350°C selama 60 min dalam kondisi gas He (inert).
b) Adsorpsi NH_3:
Adsorsi NH_3 (5% dalam He, v/v) dilakukan pada suhu 100 °C selama 30 menit, kemudian dipurging dengan gas He (inert) pada suhu yang sama, selama 30 menit.
c) Desorpsi NH_3:
Desorpsi NH_3 dilakukan pada suhu 100–800 °C dengan kecepatan penaikan suhu 10 °C/menit.

Hasil Pengujian *Testing Results* :
Link URL *Url link*
[https://data.brin.go.id/privateurl.xhtml?token=6e07db64-2e6f-459d-ac6a-f64362f6685f]

No	Sampel	Bobot Sampel (g)	Area	mol NH_3 (mmol)	Acidity (mmol/g)
1	CaO-ZnO/SiO2	0.0558	0.12725	0.037457	0.6713

Catatan *Note:*
Data hasil pengujian yang autentik adalah data yang berada di Repositori Ilmiah Nasional (RIN) BRIN yang dapat diakses melalui *link url* yang tertera pada hasil pengujian pada lembar ini. *Link url* bersifat unik dan, hanya dibagikan untuk pengguna pada hasil uji transaksi pada Laporan Hasil Uji ini.

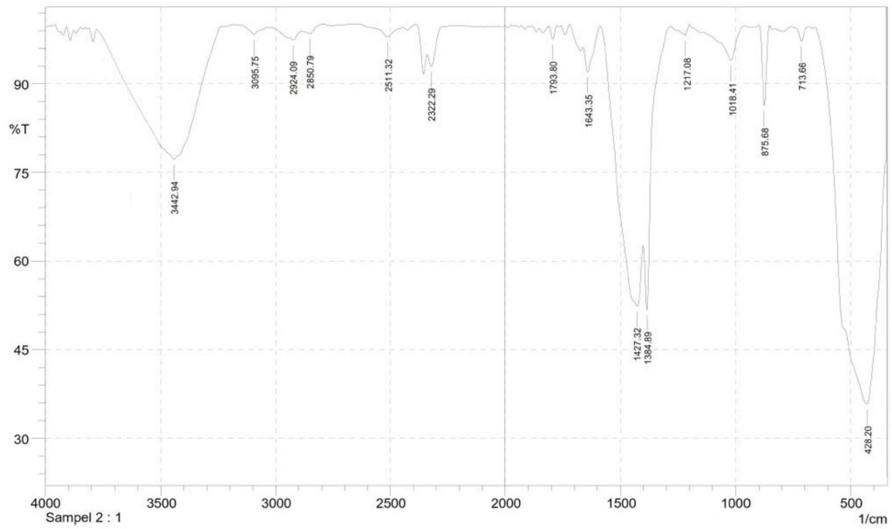
Daftar sampel yang dilakukan pengujian terdapat di lembar pengesahan.
Penamaan sampel sesuai dengan penamaan pada saat permohonan pengajuan layanan.

Terima kasih sudah melakukan pengujian/ penyewaan alat/ proses riset dengan fasilitas yang tersedia di Laboratorium Karakterisasi Lanjut Serpong- BRIN. Jika dikemudian hari, hasil pengujian atau analisis ini akan dipublikasikan, mohon kiranya bisa menambahkan dalam Ucapan Terima Kasih atau Acknowledgement di dalam publikasi Anda,
seperti dalam contoh format berikut:

Dalam bahasa Indonesia : "Penelitian ini didukung oleh fasilitas riset, dan dukungan ilmiah serta teknis dari Laboratorium Karakterisasi Lanjut Serpong di Badan Riset dan Inovasi Nasional".
Dalam bahasa Inggris : "The authors acknowledge the facilities, scientific and technical support from Advanced Characterization Laboratories Serpong, National Research and Innovation Institute through E- Layanan Sains, Badan Riset dan Inovasi Nasional.

Lampiran 3.14.5 Beberapa data mentah pada tahap optimasi kondisi reaksi transesterifikasi menggunakan katalis CaO-ZnO/KB

SHIMADZU



No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	428.2	35.786	46.91	651.94	349.12	76.161	58.347
2	713.66	97.24	2.432	758.02	682.8	0.361	0.255
3	875.68	86.294	13.613	898.83	854.47	1.267	1.249
4	1018.41	93.952	5.523	1141.86	962.48	2.242	1.68
5	1217.08	98.15	1.855	1282.66	1199.72	0.359	0.328
6	1384.89	51.76	15.731	1400.32	1282.66	9.72	1.694
7	1427.32	52.377	15.269	1587.42	1402.25	30.111	11.13
8	1643.35	92.005	5.101	1662.64	1589.34	1.487	0.841
9	1793.8	97.56	2.252	1813.09	1776.44	0.198	0.168
10	2322.29	92.942	3.201	2337.72	2274.07	1.092	0.388
11	2511.32	97.935	1.793	2646.34	2445.74	0.684	0.527
12	2850.79	98.478	0.945	2887.44	2796.78	0.327	0.146
13	2924.09	97.425	0.767	2943.37	2887.44	0.477	0.076
14	3095.75	98.294	1.492	3157.47	3037.89	0.412	0.304
15	3442.94	77.215	7.65	3512.37	3228.84	19.373	5.712
16	3641.6	45.531	41.099	3676.32	3614.6	9.345	5.561
17	3691.75	84.595	6.403	3714.9	3678.25	2.008	0.577
18	3734.19	90.187	4.946	3778.55	3716.83	1.552	0.539

Comment;

Sampel 2 : 1

Date/Time; 3/6/2024 4:04:47 PM

No. of Scans;

Resolution;

Apodization;

DATA REPORT GCMS-QP2010 ULTRA SHIMADZU

Sample Information

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Sample Type	: Unknown
Level #	: 1
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Sample ID	: Biodiesel CPO2
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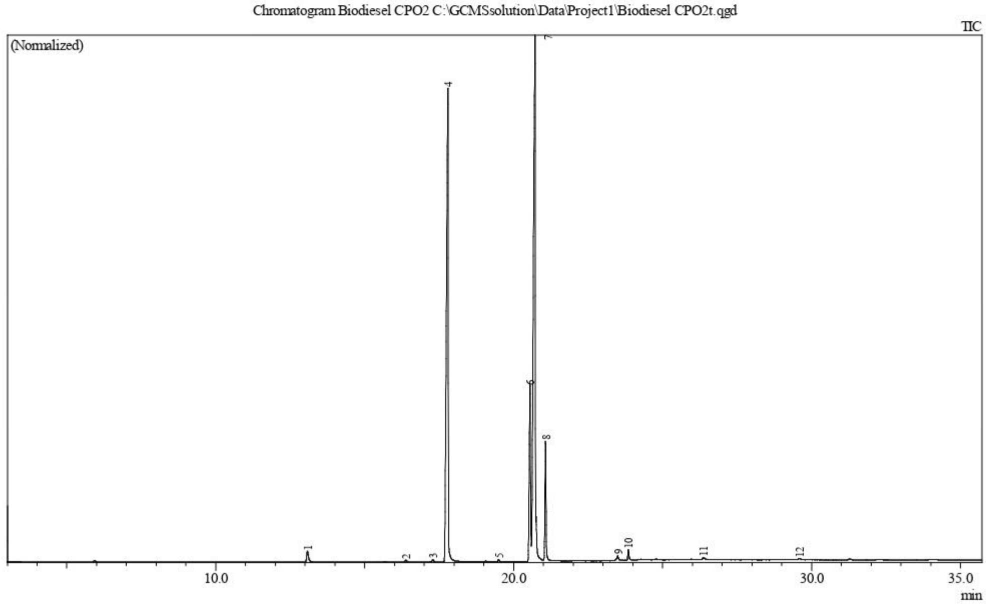

Peak Report TIC

Peak#	R.Time	Area	Area%	A/H	Name
1	13.077	1656400	0.78	4.08	Tetradecanoic acid, methyl ester (CAS)
2	16.374	213957	0.10	3.22	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester
3	17.282	296185	0.14	3.07	9-Hexadecenoic acid, methyl ester, (Z)- (CAS)
4	17.792	80363649	38.00	4.45	Hexadecanoic acid, methyl ester
5	19.493	259551	0.12	3.15	Heptadecanoic acid, methyl ester (CAS)
6	20.545	21324929	10.08	3.15	9,12-Octadecadienoic acid (Z,Z)-, methyl ester
7	20.714	93156960	44.05	4.61	9-OCTADECENOIC ACID, METHYL ESTER
8	21.068	11831909	5.59	2.60	Methyl stearate
9	23.491	685720	0.32	3.98	cis-Methyl 11-eicosenoate
10	23.847	1164461	0.55	2.84	Eicosanoic acid, methyl ester (CAS)
11	26.363	320001	0.15	4.37	DOCOSANOIC ACID, METHYL ESTER
12	29.592	220918	0.10	4.34	Tetracosanoic acid, methyl ester
		211494640	100.00		

DATA REPORT GCMS-QP2010 ULTRA SHIMADZU

Sample Information

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Level #	: 1
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Sample ID	: Biodiesel Minyak Jarak 4
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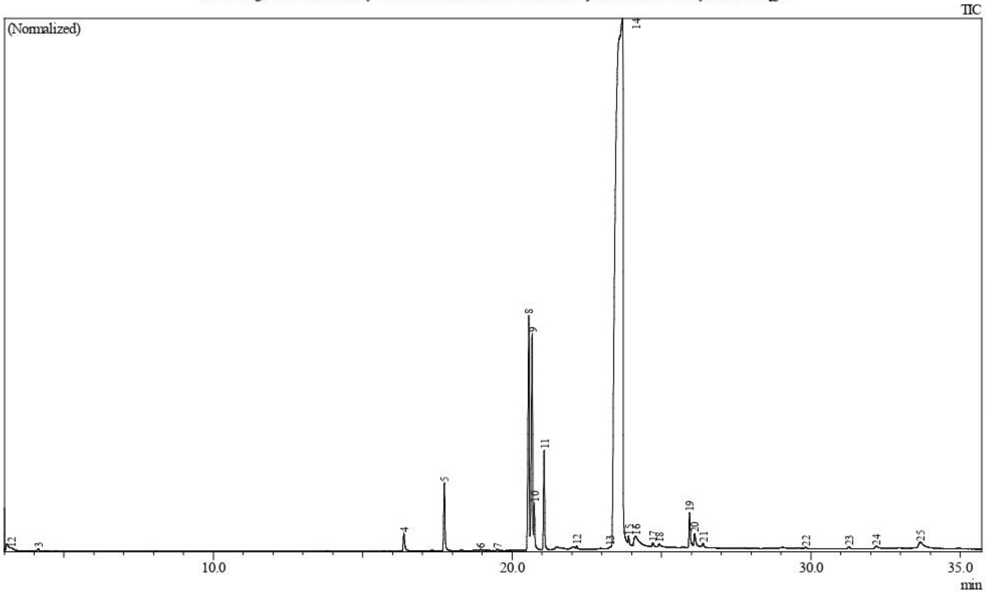

Peak Report TIC

Peak#	R.Time	Area	Area%	A/H	Name
1	3.013	78528	0.01	0.47	1-Methyldecylamine
2	3.087	1579163	0.28	5.28	1,3,5-TRIAZINE-2,4-DIAMINE, 6-CHLORO-N-ETHYL-
3	4.139	296180	0.05	2.90	Caryophyllene
4	16.371	2982171	0.52	3.45	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester
5	17.726	10083445	1.76	3.01	Hexadecanoic acid, methyl ester (CAS)
6	18.947	133927	0.02	2.46	Hexadecanoic acid, ethyl ester
7	19.497	188083	0.03	2.64	Heptadecanoic acid, methyl ester (CAS)
8	20.559	35951545	6.28	3.10	9,12-Octadecadienoic acid (Z,Z)-, methyl ester
9	20.668	32285372	5.64	3.02	9-Octadecenoic acid, methyl ester, (E)-
10	20.736	5980657	1.04	2.60	9-Octadecenoic acid (Z)-, methyl ester
11	21.069	12796805	2.24	2.61	Methyl stearate
12	22.158	290730	0.05	2.48	cis-10-Nonadecenoic acid, methyl ester
13	23.267	141263	0.02	3.35	8,11-Eicosadienoic acid, methyl ester (CAS)
14	23.693	447388332	78.15	17.09	9-Octadecenoic acid, 12-hydroxy-, methyl ester, (Z)-
15	23.896	769598	0.13	2.16	Methyl 18-methylnonadecanoate
16	24.132	5475648	0.96	11.72	Ricinoleic acid
17	24.709	632169	0.11	3.19	9-Octadecenoic acid, 12-hydroxy-, methyl ester, (Z)-
18	24.912	726825	0.13	4.99	Dicyclooctanopyridazine
19	25.937	5598709	0.98	3.23	9-Hexadecenoic acid, methyl ester, (Z)- (CAS)
20	26.104	3600509	0.63	5.21	Octadecanoic acid, 9,10-dihydroxy-, methyl ester
21	26.388	942859	0.16	4.25	Bis(2-ethylhexyl) phthalate
22	29.815	273483	0.05	4.50	1,4-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
23	31.265	463360	0.08	4.67	2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, (all-E)-
24	32.191	758219	0.13	7.08	1-Cyclohexyldimethylsilyloxybutane
25	33.660	3072055	0.54	10.93	13-Hexyloxacyclotridec-10-en-2-one
		572489635	100.00		

DATA REPORT GCMS-QP2010 ULTRA SHIMADZU

Sample Information

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Analyzed	: 30/11/2023 11:03:18 AM
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Level #	: 1
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Sample ID	: Biodiesel Minyak Jelantah
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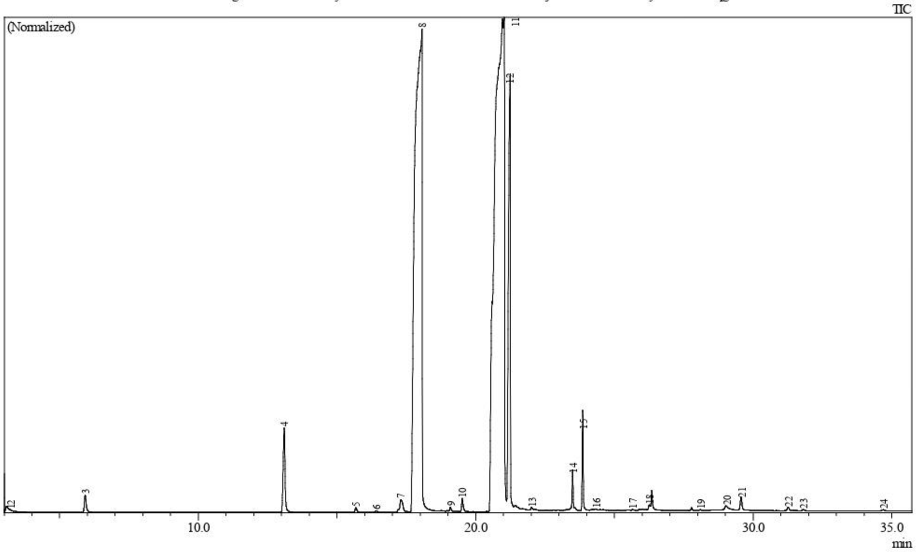
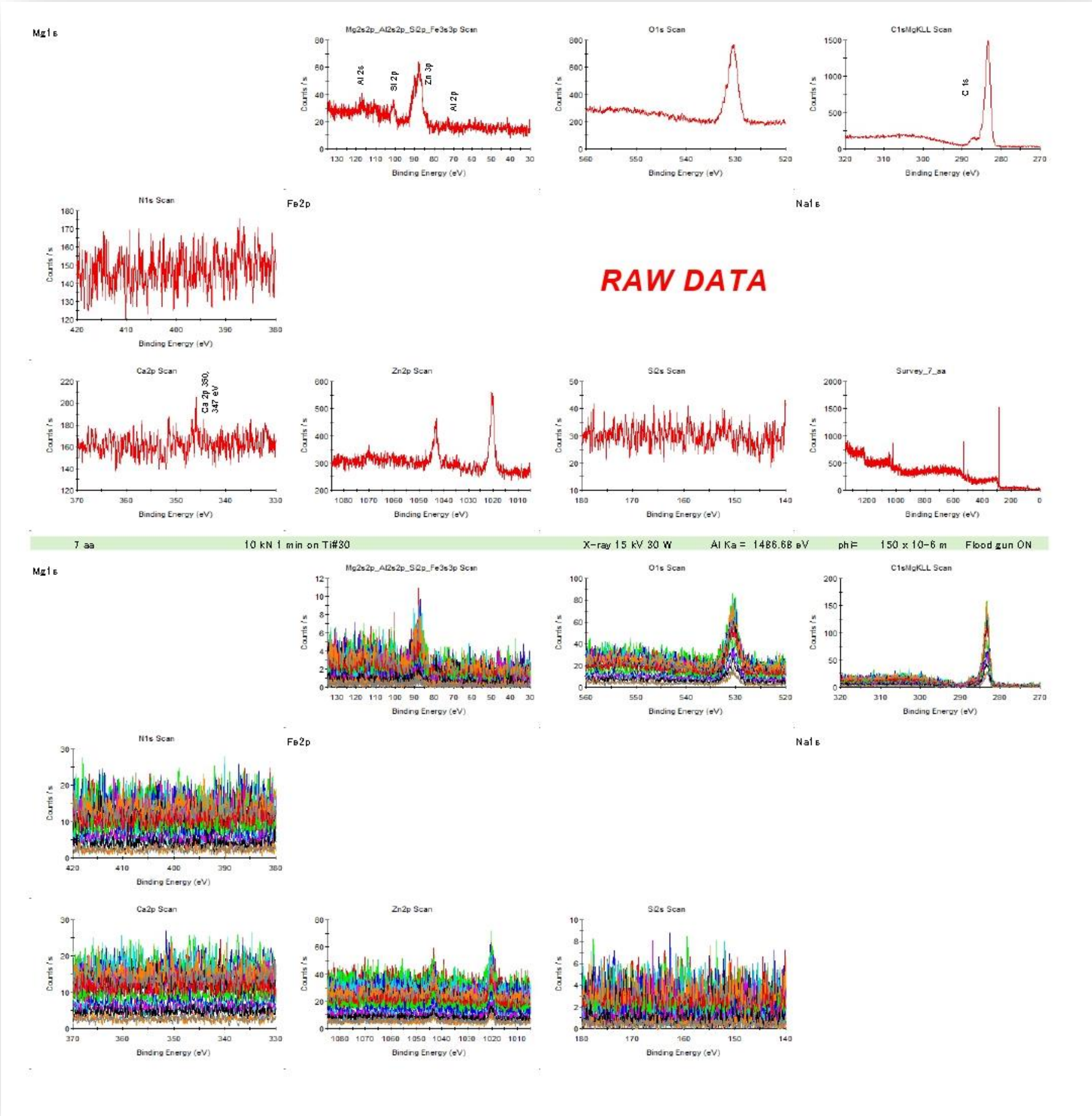


Peak Report TIC

Peak#	R.Time	Area	Area%	A/H	Name
1	3.013	80440	0.01	0.47	1-Methyldecylamine
2	3.084	1529850	0.11	5.55	CYCLODECANONE, 2-ACETYL-4-NITRO-
3	5.919	4283109	0.32	4.57	Dodecanoic acid, methyl ester (CAS)
4	13.095	21817365	1.63	4.65	Tetradecanoic acid, methyl ester (CAS)
5	15.675	1204860	0.09	4.42	Pentadecanoic acid, methyl ester
6	16.398	400010	0.03	4.98	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester
7	17.300	5289114	0.39	7.81	9-Hexadecenoic acid, methyl ester, (Z)-
8	18.058	478588007	35.69	18.05	Hexadecanoic acid, methyl ester
9	19.089	800222	0.06	3.63	CIS-10-HEPTADECENOIC ACID ME
10	19.514	2891338	0.22	4.10	Heptadecanoic acid, methyl ester (CAS)
11	20.978	662593035	49.41	24.42	9-Octadecenoic acid, methyl ester (CAS)
12	21.227	123406847	9.20	5.49	Methyl stearate
13	22.027	961646	0.07	6.74	9,12-Octadecadienoic acid, methyl ester, (E,E)- (CAS)
14	23.498	7089374	0.53	3.84	cis-Methyl 11-eicosenoate
15	23.865	14507694	1.08	2.91	Eicosanoic acid, methyl ester (CAS)
16	24.347	749543	0.06	11.09	9-Octadecene, 1-methoxy-, (E)- (CAS)
17	25.658	634525	0.05	9.32	1,3-Dipalmitin, TMS derivative
18	26.272	6423661	0.48	21.94	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester
19	28.106	276139	0.02	5.76	5,5-Dimethyl-1,3-dioxane-2-ethanol, TBDMS derivative
20	29.037	2366498	0.18	10.58	9-Octadecenoic acid (Z)-, 2,3-dihydroxypropyl ester
21	29.573	3142922	0.23	4.46	Tetracosanoic acid, methyl ester
22	31.269	1084007	0.08	5.92	2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, (all-E)-
23	31.813	441410	0.03	6.64	Pentacosanoic acid, methyl ester
24	34.698	479206	0.04	7.59	Hexacosanoic acid, methyl ester
		1341040822	100.00		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Mg2s2p_Al2s2p_Si2p_Fe3s3p Scan
Al 2s
Si 2p
Zn 3p
Al 2p
O1s Scan
C1sMgKLL Scan
C 1s
N1s Scan
Fe2p
Na1s
RAW DATA
Ca2p Scan
Ca 2p 350, 347 eV
Zn2p Scan
Si2s Scan
Survey_7_aa
7 aa
10 kN 1 min on Ti#30
X-ray 15 kV 30 W
Al Ka = 1486.68 eV
ph=
150 x 10-6 m
Flood gun ON
Mg1s
Mg2s2p_Al2s2p_Si2p_Fe3s3p Scan
O1s Scan
C1sMgKLL Scan
N1s Scan
Fe2p
Na1s
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Zn2p Scan
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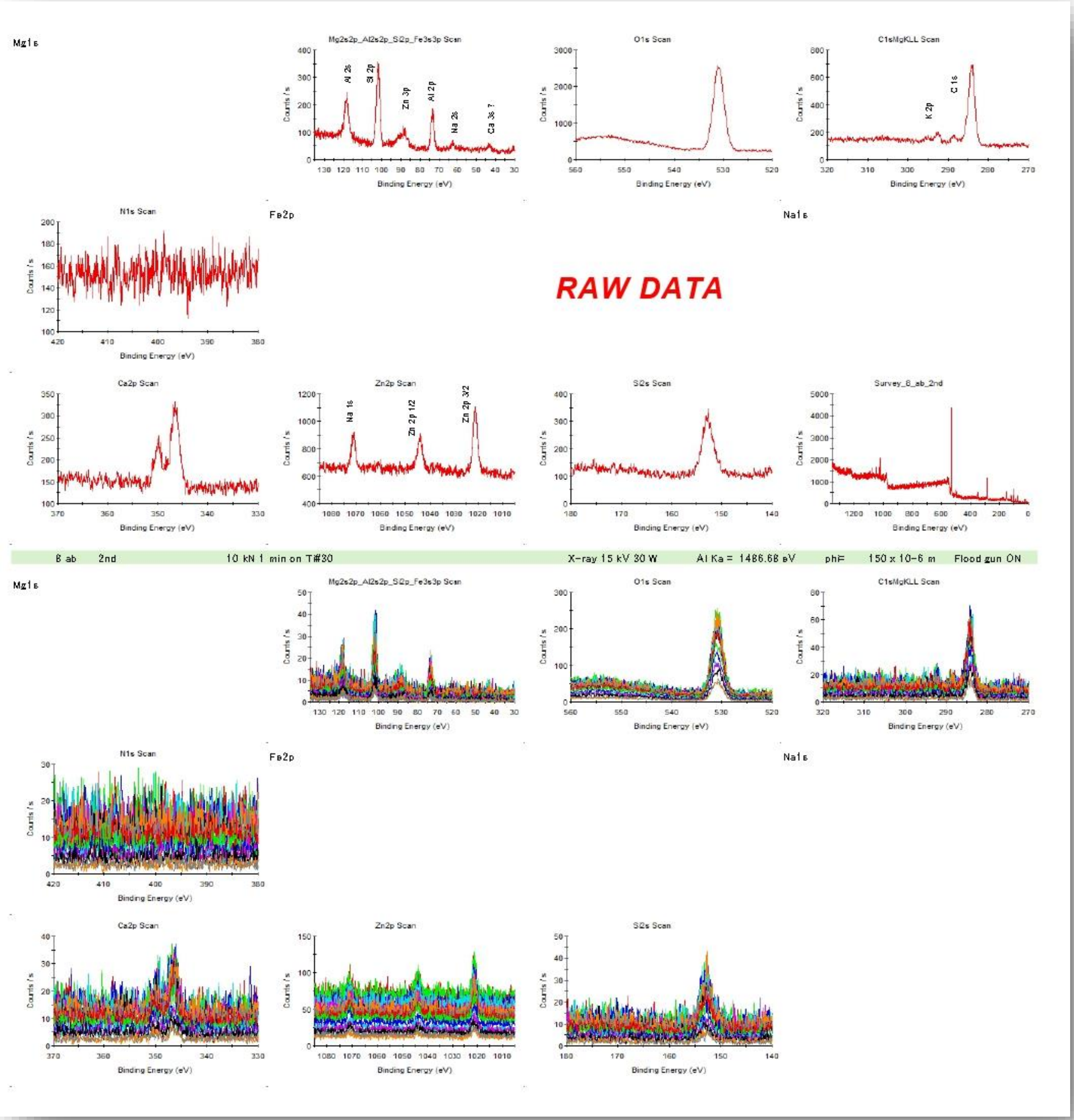
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Mg2s2p_Al2s2p_Si2p_Fe3s3p Scan
Al 2s
Si 2p
Zn 3p
Al 2p
Na 2s
Ca 3s ?
O1s Scan
C1sMgKLL Scan
K 2p
C 1s
N1s Scan
Fe2p
Na1s
RAW DATA
Ca2p Scan
Zn2p Scan
Na 1s
Zn 2p 1/2
Zn 2p 3/2
Si2s Scan
Survey_6_ab_2nd
Counts / s
Binding Energy (eV)
6 ab 2nd 10 kN 1 min on T#30 X-ray 15 kV 30 W Al Ka = 1486.68 eV phi= 150 x 10-6 m Flood gun ON

表7·2·3　Al Kα X線で励起される場合の各電子ピークの結合エネルギー値[71]

元素	原子番号	変動範囲 (eV)	1s	2s	$2p_1$	$2p_3$	3s	$3p_1$	$3p_3$	$3d_3$	$3d_5$	4s	$4p_1$	$4p_3$	変動範囲 (eV)	KL_1L_1	KL_1L_{23}	$KL_{23}L_{23}$
Li	3		56															
Be	4	4	113															
B	5	8	191															1 315
C	6	12	287															1 226
N	7	9	402												12			1 108
O	8	4	531	23											10	1 012	997	976
F	9	6	686	30											8	878	859	832
Ne	10	0	863	41	14										0	724	701	668
Na	11	2	1 072	64	31										4	565	536	497
Mg	12	2	1 305	90	51										8	384	350	305
Al	13	4		119	74													100
Si	14	6		153	103	102												
P	15	8		191	134	133	14											

元素	原子番号	変動範囲 (eV)	1s	2s	$2p_1$	$2p_3$	3s	$3p_1$	$3p_3$	$3d_3$	$3d_5$	4s	$4p_1$	$4p_3$	変動範囲 (eV)	$L_3M_{23}M_{23}$	$L_2M_{23}M_{23}$	$L_3M_{23}M_{45}$ ^1P	$L_3M_{23}M_{45}$ ^3P	$L_2M_{23}M_{45}$ ^1P	$L_3M_{45}M_{45}$	$L_2M_{45}M_{45}$
S	16	8		229	166	165	17								6	1 336						
Cl	17	11		270	201	199	17								4	1 304						
Ar	18	0		319	243	241	22								0	1 270	1 268					
K	19	1		378	296	293	33	17								1 238	1 236					
Ca	20	2		439	350	347	44	25								1 197	1 194					
Sc	21	6		501	407	402	53	31							8	1 153		1 125				
Ti	22	8		565	464	458	62	37							10	1 106		1 072				
V	23	6		630	523	515	69	40							6	1 055		1 017				
Cr	24	6		698	586	577	77	46	45							1 000		962				
Mn	25	4		770	652	641	83	49	48						6	948		903			853	
Fe	26	8		847	723	710	93	56	55						6	892		841			786	
Co	27	6		927	796	781	103	63	61						7	837	830	779	774		716	701
Ni	28	6		1 009	873	855	112	69	67						7	781	775	715	709		643	626
Cu	29	4		1 098	954	934	124	79	77						5	719	712	649	641	629	570	550
Zn	30	2		1 196	1 045	1 022	140	92	89	10					7	662	655	585	576	562	498	475
Ga	31	2		1 299	1 144	1 117	160	108	105	20					7	601	594	517	508	490	422	395
Ge	32	4			1 250	1 219	184	128	124	32	31				10	538	530	448	438	417	346	315
As	33	7				1 326	207	148	143	45	44				11			376	365	341	266	232
Se	34	8					232	169	163	58	57				8			300	288	259	184	143
Br	35	7					256	189	182	70	69											
Kr	36	0					287	216	208	89	88	22										
Rb	37	1					322	247	238	111	110	29		14								
Sr	38						358	280	269	135	133	37		20								
Y	39						395	313	301	160	158	45		25								
Zr	40	6					431	345	331	183	181	51		29								

元素	原子番号	変動範囲 (eV)	3s	$3p_1$	$3p_3$	$3d_3$	$3d_5$	4s	$4p_1$	$4p_3$	$4d_3$	$4d_5$	$4f_5$	$4f_7$	5s	$5p_1$	$5p_3$	$5d_3$	$5d_5$	6s	$6p_1$	$6p_3$	変動範囲 (eV)	$M_{45}N_{23}V$	$M_5N_{45}N_{45}$	$M_4N_{45}N_{45}$	$M_{45}N_{45}V$	M_5VV	M_4VV
Nb	41	8	470	379	364	209	206	59	35															1 321	1 289				
Mo	42	6	508	413	396	233	230	65	38															1 301	1 266				
Tc	43		544	445	425	257	253	68	39															1 280	1 241				
Ru	44	4	587	485	463	286	282	77		45													4	1 258	1 214				
Rh	45	4	629	522	498	314	309	83		49													5	1 235	1 187				
Pd	46	5	673	561	534	342	337	88		54													4	1 212	1 161				
Ag	47	2	718	604	573	374	368	97		58													4		1 136	1 130			
Cd	48	2	772	652	618	412	405	109		68	11												5		1 112	1 105			
In	49	3	828	704	666	453	445	123		79	19												7		1 086	1 079			
Sn	50	3	884	757	715	494	486	137		91	26	25											7		1 060	1 052			
Sb	51	4	946	814	768	539	530	155		105	35	34											10		1 036	1 027			
Te	52	5	1 009	873	822	585	575	171		114	44	43			14								6		1 008	998			
I	53	6	1 071	930	874	630	619	186		123	52	50			16								4		981	970			
Xe	54	4	1 144	997	936	685	672	209		141	65	63			19								4		957	944			
Cs	55	2	1 216	1 064	997	738	724	230	170	158	77	75			24										931	917			
Ba	56	2	1 292	1 137	1 062	795	780	254	192	179	92	90			23										904	890			
La	57			1 207	1 126	851	834	274	210	195	104	101			34	17									865				
Ce	58			1 271	1 184	900	882	290	222	207	112	108			37	18									827				
Pr	59			1 337	1 242	950	930	305	237	218	114				38	20									788				
Nd	60				1 299	1 001	980	318	248	227	120				38	23									752				
Pm	61					1 060	1 034	337	264	242	129				38	22									714				
Sm	62					1 110	1 083	349	283	250	132				41	20									673				
Eu	63					1 166	1 136	366	289	261	136				34	24									635				
Gd	64					1 219	1 186	380	301	270	141				36	21									595				
Tb	65					1 279	1 244	398	317	284	150				42	28									568		426	265	235
Dy	66					1 334	1 295	412	329	293	154				63	26									527		375	195	155
Ho	67							431	345	306	161				51	20									490		325	142	100
Er	68							451	362	320	169				61	25									454		273	99	58
Tm	69							470	378	333	180				54	32	26												
Yb	70							483	392	342	194	185			55	33	26												
Lu	71							507	412	359	207	197			58	34	27												
Hf	72	6						537	437	382	224	213	19	17	64	37	30												
Ta	73	8						566	464	403	241	229	27	25	71	45	37												
W	74	6						594	491	425	257	245	36	34	77	47	37												
Re	75	6						628	521	449	277	263	45	43	81	44	33												
Os	76	3						657	549	475	294	279	55	52	86	60	48												

元素	原子番号	変動範囲 (eV)	3s	$3p_1$	$3p_3$	$3d_3$	$3d_5$	4s	$4p_1$	$4p_3$	$4d_3$	$4d_5$	$4f_5$	$4f_7$	5s	$5p_1$	$5p_3$	$5d_3$	$5d_5$	6s	$6p_1$	$6p_3$	変動範囲 (eV)	$N_7O_{45}O_{45}$	$N_6O_{45}O_{45}$	$N_{67}O_{45}V$
Ir	77	4						692	579	497	313	297	65	62	98	65	53									
Pt	78	5						726	610	521	333	316	76	73	105	69	54							1 425		
Au	79	3						763	643	547	354	336	89	85	110	75	57							1 417		
Hg	80	2						803	681	577	379	359	104	100	127	84	65							1 409	1 406	
Tl	81	2						845	721	608	406	385	122	118	137	100	76	15	13					1 402		
Pb	82	3						893	762	645	435	413	143	138	148	107	84	22	19					1 395	1 392	
Bi	83	4						942	807	681	467	443	164	159	161	120	94	29	26					1 388	1 384	
Th	90	3						1 330	1 168	968	714	677	344	335	290	226	179	94	87	43	26	18		1 333		1 238
U	92	5							1 274	1 046	781	739	391	380	325	262	197	104	96	46	29	19		1 297		1 203
Np	93								1 327	1 088	816	771	414	402			206		101		29	18				
Pu	94									1 121	850	802	439	427			216		105		31	18				
Am	95										883	832	463	449	351		216	119	109		31	18				
Cm	96										919	865	487	473			232		113		32	18				
Bk	97										958	901	514	498			246		120		34	18				
Cf	98										994	933	541	523					124		35	19				

（注）　主線が枠で囲われている．

表7·2·5 Al Kα X線により励起される結合エネルギー値順の主だったピークの結合エネルギー値[21]

17 Hf $4f_7$ (2)	110 Rb $3d_5$ (1)	229 Ta $4d_5$ (12)	396 Mo $3p_3$ (17)	710 Fe $2p_3$ (13)	1 083 Sm $3d_5$ (27)
23 O 2s	113 Be 1s	230 Mo $3d_5$ (3)	402 N 1s	715 Sn $3p_3$ (42)	1 105 Cd (A)
25 Ta $4f_7$ (2)	114 Pr 4d	238 Rb $3p_3$ (9)	402 Sc $2p_3$ (5)	716 Co (A)	1 108 N (A)
30 F 2s	118 Tl $4f_7$ (4)	241 Ar $2p_3$ (2)	405 Cd $3d_5$ (7)	724 Cs $3d_5$ (14)	1 117 Ga $2p_3$ (27)
34 W $4f_7$ (2)	119 Al 2s	245 W $4d_5$ (12)	413 Pb $4d_5$ (22)	739 U $4d_5$ (42)	1 130 Ag (A)
40 V 3p	120 Nd 4d	263 Re $4d_5$ (14)	422 Ga (A)	752 Nd (A)	1 136 Eu $3d_5$ (30)
41 Ne 2s	124 Ge $3p_3$ (4)	265 Tb (A)	439 Ca 2s	768 Sb $3p_3$ (46)	1 153 Sc (A)
43 Re $4f_7$ (2)	132 Sm 4d	266 As (A)	443 Bi $4d_5$ (24)	780 Ba $3d_5$ (15)	1 161 Pd (A)
44 As $3d_5$ (1)	133 P $2p_3$ (1)	269 Sr $3p_3$ (11)	445 In $3d_5$ (8)	781 Co $2p_3$ (15)	1 186 Gd $3d_5$ (33)
45 Cr $3p_3$ (1)	133 Sr $3d_5$ (2)	270 Cl 2s	458 Ti $2p_3$ (6)	786 Fe (A)	1 187 Rh (A)
48 Mn $3p_3$ (1)	136 Eu 4d	279 Os $4d_5$ (15)	463 Ru $3p_3$ (22)	788 Pr (A)	1 194 Ca (A)
50 I $4d_5$ (2)	138 Pb $4f_7$ (5)	282 Ru $3d_5$ (4)	486 Sn $3d_5$ (8)	822 Te $3p_3$ (51)	1 205 U (A)
52 Os $4f_7$ (3)	141 Gd 4d	287 C 1s	497 Na (A)	827 Ce (A)	1 214 Ru (A)
55 Fe $3p_3$ (1)	142 Ho (A)	293 K $2p_3$ (3)	498 Zn (A)	832 F (A)	1 219 Ge $2p_3$ (31)
56 Li 1s	150 Tb 4d	297 Ir $4d_5$ (16)	498 Rh $3p_3$ (24)	834 La $3d_5$ (17)	1 226 C (A)
57 Se $3d_5$ (1)	153 Si 2s	301 Y $3p_3$ (12)	501 Sc 2s	855 Ni $2p_3$ (18)	1 230 Th (A)
61 Co $3p_3$ (2)	154 Dy 4d	305 Mg (A)	515 V $2p_3$ (8)	863 Ne 1s	1 236 K (A)
62 Ir $4f_7$ (3)	158 Y $3d_5$ (2)	306 Ho $4p_3$ (39)	530 Sb $3d_5$ (9)	865 La (A)	1 244 Tb $3d_5$ (35)
63 Xe $4d_5$ (2)	159 Bi $4f_7$ (5)	309 Rh $3d_5$ (5)	531 O 1s	882 Ce $3d_5$ (18)	1 268 Ar (A)
64 Na 2s	161 Ho 4d	316 Pt $4d_5$ (17)	534 Pd $3p_3$ (27)	890 Ba (A)	1 295 Dy $3d_5$ (39)
67 Ni $3p_3$ (2)	163 Se $3p_3$ (6)	319 Ar 2s	565 Ti 2s	903 Mn (A)	1 301 Mo (A)
69 Br $3d_5$ (1)	165 S $2p_3$ (1)	320 Er $4p_3$ (42)	570 Cu (A)	917 Cs (A)	1 304 Cl (A)
73 Pt $4f_7$ (3)	169 Er 4d	331 Zr $3p_3$ (14)	573 Ag $3p_3$ (31)	930 Pr $3d_5$ (20)	1 305 Mg 1s
74 Al 2p	180 Tm 4d	333 Tm $4p_3$ (45)	575 Te $3d_5$ (10)	934 Cu $2p_3$ (20)	1 315 B (A)
75 Cs $4d_5$ (2)	181 Zr $3d_5$ (2)	335 Th $4f_7$ (9)	577 Cr $2p_3$ (9)	944 Xe (A)	1 321 Nb (A)
77 Cu $3p_3$ (2)	182 Br $3p_3$ (7)	336 Au $4d_5$ (18)	595 Gd (A)	962 Cr (A)	1 326 As $2p_3$
85 Au $4f_7$ (4)	184 Se (A)	337 Pd $3d_5$ (5)	618 Cd $3p_3$ (34)	970 I (A)	1 336 S (A)
87 Zn $3p_3$ (3)	185 Yb $4d_5$ (9)	342 Yb $4p_3$ (50)	619 I $3d_5$ (11)	976 O (A)	1 388 Bi (A)
88 Kr $3d_5$ (1)	191 B 1s	346 Ge (A)	635 Eu (A)	980 Nd $3d_5$ (21)	1 395 Pb (A)
90 Ba $4d_5$ (2)	191 P 2s	347 Ca $2p_3$ (3)	641 Mn $2p_3$ (11)	998 Te (A)	1 402 Tl (A)
90 Mg 2s	195 Dy (A)	359 Lu $4p_3$ (53)	643 Ni (A)	1 017 V (A)	1 409 Hg (A)
99 Er (A)	197 Lu $4d_5$ (10)	359 Hg $4d_5$ (20)	666 In $3p_3$ (38)	1 022 Zn $2p_3$ (23)	1 417 Au (A)
100 Hg $4f_7$ (4)	199 Cl $2p_3$ (2)	364 Nb $3p_3$ (15)	668 Ne (A)	1 027 Sb (A)	1 425 Pt (A)
101 La $4d_5$ (3)	206 Nb $3d_5$ (3)	368 Ag $3d_5$ (6)	672 Xe $3d_5$ (13)	1 052 Sn (A)	
102 Si $2p_3$ (1)	208 Kr $3p_3$ (8)	378 K 2s	673 Sm (A)	1 072 Na 1s	
105 Ga $3p_3$ (3)	213 Hf $4d_5$ (9)	380 U $4f_7$ (11)	677 Th $4d_5$ (37)	1 072 Ti (A)	
108 Ce $4d_5$ (4)	229 S 2s	385 Tl $4d_5$ (21)	686 F 1s	1 079 In (A)	

注: ( ) 内のAはAuger線を示す。また, ( ) 内にある数字はスピン2重項の間隔 (eV)

出典 真空ハンドブック　日本真空技術株式会社編　オーム社(1992)

参考文献：C.D.Wagner: Practical Surface Analysis 2nd Ed ed.Vol.1 (Ed.D.Briggs and M.P.Seah), John Wiley & Sons, Inc., Chichester (1990) pp.595-634.

PT. KILANG PERTAMINA INTERNASIONAL
LABORATORY - REFINERY UNIT V BALIKPAPAN

Jalan Yos Sudarso No.1 pintu IV, Balikpapan - 76111
Telp. (0542) 511000 - 5096, Email : Adm Eng & Dev RU V - Laboratory (mk.djuraidah@pertamina.com)

PERTAMINA
KILANG PERTAMINA INTERNASIONAL

LABORATORY TEST REPORT

Test. Report No.	: 081/MH/IX/2023	Sample Number	: 1930 / 2023
Sample Type	: BIOSOLAR B100	Sampling Method	: None
Date/Time Received	: 11/09/2023 / 10.00 wita	Sampling by	: Customer
Reference	: VisKin, Density, Sulfur, Flash, Water	Sample Identity	: UNM Makassar
Sample Status	: Ekstra	Date Tested	: 18-Des-23

No	Properties	Units	Limits*	Methods	Results
1	Angka Setana	-	Min 51	ASTM D613	-
2	Density at 15 °C	kg/m^3	850 - 890	ASTM D1298-12b(17)	864.0
3	Kinematic Viscosity at 40 °C	mm ^{2}/sec	2.3 - 6.0	ASTM D445-21e1	4,0311
4	Sulfur Content (a)	mg/kg	Max 10	ASTM D2622-21	7,8
5	Distillation (90%vol Recovery)	°C	Max 360	ASTM D86-20b	
6	Flash Point PMcc	°C	Min 130	ASTM D93-20	165
7	Micro Carbon Residue	% m/m	Max 0.05	ASTM D4530-20	
8	Water Content	mg/kg	Max 350	ASTM D6304-20	340
9	Copper Strip Corrosion	Class	Max Class 1	ASTM D130-19	
10	Ash Content	% m/m	Max 0.02	ASTM D482-19	
11	Strong Acid Number	mgKOH/g	0	ASTM D664-18e2	
12	Total Acid Number	mgKOH/g	Max 0.4	ASTM D664-18e2	
13	Appearance	-	Clear & Bright	Visual	Clear & Bright
14	Color ASTM	ASTM No.	Max 3	ASTM D1500-17	
15	Oxidation Stability	Menit	Min 45	ASTM D7545-14(19)	

Remarks :

Refer to SK Dirjen EBTKE No. 189K/10/DJE/2019, tanggal 05 November 2019, Spesifikasi Bahan Bakar Nabati (Biofuel) This commodity is not included in the scope of accreditation

Balikpapan, 19 Desember 2023
Pjs. Quality Supervisor

Arizzal FH

BRIN
BADAN RISET DAN INOVASI NASIONAL

DEPUTI BIDANG INFRASTRUKTUR RISET DAN INOVASI
DIREKTORAT PENGELOLAAN LABORATORIUM, FASILITAS RISET, DAN KAWASAN SAINS TEKNOLOGI
Gedung B.J. Habibie, Jalan M.H. Thamrin Nomor 8
Jakarta Pusat 10340
Telepon/WA: 0811 8612 392

LAPORAN HASIL ANALISIS

ID ELSA : 108651
Jenis Pengujian : Analisa Chemisorption
JenisAnalisa : Kuantitatif
MetodeAnalisa :CO_2-TPD, menggunakan alat ChemiSorb 2750 Micromeritics

A. Metode Detail :

a) *Pretreatment* sampel:
Sampel dipanasi pada suhu 350 °C selama 60 min dalam kondisi gas He (inert).

b) Adsorpsi NH_3:
Adsorsi NH_3 (5% dalam He, v/v) dilakukan pada suhu ruang selama 30 menit, kemudian dipurging dengan gas He (inert) pada suhu yang sama, selama 30 menit.

c) Desorpsi NH_3:
Desorpsi NH_3 dilakukan pada suhu ruang–800 °C dengan kecepatan penaikan suhu 10 °C/menit.

Seluruh flow rate gas adalah 40mL/menit.

B. Kalibrasi gas :

Kalibrasi dilakukan pada 08 Agustus 2023 (Flowrate carrier : 40 mL/min)

No	Volume gas CO_2 (5%, dalam He v/v, dalam mL STP)	Luas Area Peak
2	0.2	0.0023
3	0.4	0.0050
4	0.6	0.0064
5	0.8	0.0094
	1	0.0116

C. Hasil Analisa:

- Area yang ditunjukkan pada hasil berikut adalah dihitung menggunakan software analisa data dan gambar.
- Data mentah dalam bentuk excel, gambar, file software analisa data/gambardandilampirkan terpisah, dengan nama file sesuai dengan sampelnya.

Code	Sample	Sample weight (g)	Area	mol CO2 (mmol)	Basicity (mmol/g)
001	Ca:Zn 1,25:1	0.0544	0.08291	0.016272233	0.2991
002	Ca:Zn 1:2	0.0565	0.0932	0.01829216	0.3238
003	Ca:Zn 2:1	0.0551	0.55924	0.109775812	1.9923
004	Ca:Zn 2.5:1	0,0561	0.57191	0.112262933	2.0011

DEPUTI BIDANG INFRASTRUKTUR RISET DAN INOVASI

DIREKTORAT PENGELOLAAN LABORATORIUM, FASILITAS RISET, DAN KAWASAN SAINS TEKNOLOGI

BRIN
BADAN RISET DAN INOVASI NASIONAL

Gedung B.J. Habibie, Jalan M.H. Thamrin Nomor 8

Jakarta Pusat 10340

Telepon/WA: 0811 8612 392

LAPORAN HASIL ANALISIS

ID ELSA	: 108650
Jenis Pengujian	: Analisa Chemisorption
JenisAnalisa	: Kuantitatif
MetodeAnalisa	: NH_3-TPD, menggunakan alat ChemiSorb 2750 Micromeritics

A. Metode Detail :

a) *Pretreatment* sampel:
Sampel dipanasi pada suhu 350 °C selama 60 min dalam kondisi gas He (inert).

b) Adsorpsi NH_3:
Adsorsi NH_3 (5% dalam He, v/v) dilakukan pada suhu 100 °C selama 30 menit, kemudian dipurging dengan gas He (inert) pada suhu yang sama, selama 30 menit.

c) Desorpsi NH_3:
Desorpsi NH_3 dilakukan pada suhu 100–800 °C dengan kecepatan penaikan suhu 10 °C/menit.

Seluruh flow rate gas adalah 40mL/menit.

B. Kalibrasi gas :

Kalibrasi dilakukan pada 22 Mei 2023 (Flowrate carrier : 40 mL/min)

No	Volume gas NH_3 (4.9%, dalam He v/v, dalam mL STP)	Luas Area Peak
2	0.4	0.0018
3	0.6	0.0034
4	0.8	0.0048
5	1.0	0.0063

C. Hasil Analisa:

- Area yang ditunjukkan pada hasil berikut adalah dihitung menggunakan software analisa data dan gambar.
- Data mentah dalam bentuk excel, gambar, file software analisa data/gambardandilampirkan terpisah, dengan nama file sesuai dengan sampelnya.

Code	Sample	Sample weight (g)	Area	mol NH3 (mmol)	Acidity (mmol/g)
001	Ca-Zn 2:1	0.0563	0.53358	0.15610536	2.7727
002	Ca-Zn 1,25:1	0.0559	0.06814	0.02019688	0.3613
003	Ca-Zn 1:2	0.0537	0.07798	0.02307016	0.4296
004	Ca-Zn 2,5:1	0.0562	0.51436	0.15049312	2.6778

Lampiran 4. Analisis Statistika

Lampiran 4.1. Hasil Analisis Statistika Porositas, Densitas, Susut Massa, dan Kuat Tekan Keramik Berpori *Gelcasting* dengan Variasi Konsentrasi Kitosan

Lampiran 4.1.1. Porositas dengan Bahan Dasar NC

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Sampel	Statistic	df	Sig.	Statistic	df	Sig.
Porositas	Lempung 10%	.371	3	.	.783	3	.076
	Lempung 20%	.310	3	.	.899	3	.383
	Lempung 30%	.360	3	.	.809	3	.137
	Lempung 40%	.351	3	.	.826	3	.179
	Lempung 50%	.385	3	.	.750	3	.000

a. Lilliefors Significance Correction

Dasar pengambilan keputusan dalam Uji Normalitas:

Jika nilai Sig. > 0,05 maka data berdistribusi normal

Jika nilai Sig. < 0,05 maka data tidak berdistribusi normal

Berdasarkan output SPSS pada Tabel Uji Normalitas, diperoleh nilai Shapiro-Wilk Sig. untuk ke-5 sampel data dimana terdapat 1 sampel yang < 0,05 atau tidak terdistribusi normal yaitu sampel Lempung 50%, sedangkan untuk sampel Lempung 10%, Lempung 20%, Lempung 30%, dan Lempung 40% > 0,05. Oleh karena terdapat sampel yang datanya tidak terdistribusi normal, maka digunakan alternatif uji statistik non parametrik yaitu Uji Kruskal Wallis.

Hasil Uji Kruskal Wallis

Test Statistics[a,b]

	Porositas
Chi-Square	13.524
df	4
Asymp. Sig.	.009

a. Kruskal Wallis Test

b. Grouping Variable: Sampel

Dasar pengambilan keputusan dalam Uji Kruskal Wallis:

Jika nilai Assymp. Sig. > 0,05 maka tidak terdapat perbedaan yang signifikan antara kelompok sampel

Jika nilai Assymp. Sig. < 0,05 maka terdapat perbedaan yang signifikan antara kelompok sampel

Berdasarkan output SPSS 2, diperoleh nilai Assymp. Sig. < 0,05 sehingga dapat disimpulkan bahwa terdapat perbedaan yang signifikan antara kelompok sampel tersebut.

Lampiran 4.1.2. Porositas dengan Bahan Dasar Silika

Tests of Normality							
		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Sampel	Statistic	df	Sig.	Statistic	df	Sig.
Porositas	Kontrol 10%	.236	3	.	.977	3	.711
	Kontrol 20%	.370	3	.	.785	3	.079
	Kontrol 30%	.338	3	.	.852	3	.246
	Kontrol 40%	.319	3	.	.885	3	.339
	Kontrol 50%	.351	3	.	.826	3	.179
a. Lilliefors Significance Correction							

Dasar pengambilan keputusan dalam Uji Normalitas:
Jika nilai Sig. > 0,05 maka data berdistribusi normal
Jika nilai Sig. < 0,05 maka data tidak berdistribusi normal

Berdasarkan output SPSS pada Tabel 1, diperoleh nilai Shapiro-Wilk Sig. untuk ke-5 sampel data dimana semua sampel memiliki nilai signifikan > 0,05 sehingga dapat disimpulkan bahwa semua sampel data terdistribusi normal.

Hasil Uji Homogenitas

Test of Homogeneity of Variances

Porositas

Levene Statistic	df1	df2	Sig.
9.331	4	10	.002

Dasar pengambilan keputusan dalam Uji Normalitas:
Jika nilai Sig. > 0,05 maka data homogen
Jika nilai Sig. < 0,05 maka data tidak homogen

Berdasarkan output SPSS pada Tabel Uji Homogenitas, diperoleh angka *Levene Statistic* sebesar 9,331 dengan signifikansi atau probabilitas (Sig) sebesar 0,002. Karena nilai signifikansi 0,002 < 0,05 maka dapat disimpulkan bahwa nilai porositas ke-5 sampel yang kita bandingkan tersebut adalah tidak homogen sehingga pada pemilihan Uji Lanjut (*Post Hoc Test*) menggunakan Uji Lanjut *Games-Howell.*

Hasil Uji Anova

ANOVA

Porositas

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	722.193	4	180.548	2942.006	.000
Within Groups	.614	10	.061		
Total	722.807	14			

Dasar pengambilan keputusan dalam Analisis Anova:
Jika nilai signifikansi (Sig) > 0,05 maka rata-rata sama.
Jika nilai signifikansi (Sig) < 0,05 maka rata-rata berbeda.

Berdasarkan output Anova pada Tabel 3, diketahui nilai Sig. yang diperoleh sebesar 0,000 < 0,05 sehingga dapat disimpulkan bahwa nilai porositas ke-5 sampel yang kita bandingkan tersebut "berbeda" secara signifikan.

Hasil Uji Lanjut (*Post Hoc Test*) Menggunakan Uji *Games-Howell*

Multiple Comparisons

Dependent Variable: Porositas

Games-Howell

(I) Sampel	(J) Sampel	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Kontrol 10%	Kontrol 20%	-.4137714070*	.014853527	.001	-.495372370	-.332170444
	Kontrol 30%	-8.3252139530*	.0318732224	.000	-8.549815105	-8.100612802
	Kontrol 40%	-12.4723325200*	.1712859070	.001	-13.786032640	-11.158632390
	Kontrol 50%	-17.9604201700*	.2680086440	.001	-20.019823470	-15.901016870
Kontrol 20%	Kontrol 10%	.4137714070*	.0148535279	.001	.332170444	.495372370
	Kontrol 30%	-7.9114425470*	.0339867575	.000	-8.106056179	-7.716828914
	Kontrol 40%	-12.0585611100*	.1716917570	.001	-13.361294860	-10.755827360
	Kontrol 50%	-17.5466487600*	.2682682060	.001	-19.598935890	-15.494361640
Kontrol 30%	Kontrol 10%	8.3252139530*	.0318732224	.000	8.100612802	8.549815105
	Kontrol 20%	7.9114425470*	.0339867575	.000	7.716828914	8.106056179
	Kontrol 40%	-4.1471185630*	.1739923400	.004	-5.393689031	-2.900548096
	Kontrol 50%	-9.6352062170*	.2697463730	.002	-11.648640580	-7.621771858
Kontrol 40%	Kontrol 10%	12.4723325200*	.1712859070	.001	11.158632390	13.786032640
	Kontrol 20%	12.0585611100*	.1716917570	.001	10.755827360	13.361294860
	Kontrol 30%	4.1471185630*	.1739923400	.004	2.900548096	5.393689031

	Kontrol 50%	-5.4880876530*	.3179403480	.001	-7.038972953	-3.937202354
Kontrol 50%	Kontrol 10%	17.9604201700*	.2680086440	.001	15.901016870	20.019823470
	Kontrol 20%	17.5466487600*	.2682682060	.001	15.494361640	19.598935890
	Kontrol 30%	9.6352062170*	.2697463730	.002	7.621771858	11.648640580
	Kontrol 40%	5.4880876530*	.3179403480	.001	3.937202354	7.038972953

*. The mean difference is significant at the 0.05 level.

Berdasarkan output SPSS pada Tabel di kolom *Mean Difference,* dapat dilihat perbedaan rata-rata nilai potensial sampel yang ditandai dengan tanda "*" dan dengan nilai signifikan < 0,05.

Lampiran 4.1.3. Densitas dengan Bahan Dasar NC

Tests of Normality

	Sampel		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
	Densitas	Lempung 10%	.384	3	.	.752	3	.004
		Lempung 20%	.363	3	.	.801	3	.117
		Lempung 30%	.175	3	.	1.000	3	.995
		Lempung 40%	.320	3	.	.884	3	.336
		Lempung 50%	.265	3	.	.953	3	.584

a. Lilliefors Significance Correction

Dasar pengambilan keputusan dalam Uji Normalitas:

Jika nilai Sig. > 0,05 maka data berdistribusi normal

Jika nilai Sig. < 0,05 maka data tidak berdistribusi normal

Berdasarkan output SPSS pada Tabel 1, diperoleh nilai Shapiro-Wilk Sig. untuk ke-5 sampel data dimana terdapat 1 sampel yang < 0,05 atau tidak terdistribusi normal yaitu sampel Lempung 10% sedangkan untuk sampel Lempung 20%, Lempung 30%, Lempung 40%, dan Lempung 50% > 0,05. Oleh karena terdapat sampel yang datanya tidak terdistribusi normal, maka digunakan alternatif uji statistik non parametrik yaitu Uji Kruskal Wallis.

Hasil Uji Kruskal Wallis

Test Statistics[a,b]

	Densitas
Chi-Square	10.978
df	4
Asymp. Sig.	.027

a. Kruskal Wallis Test

b. Grouping Variable: Sampel

Dasar pengambilan keputusan dalam Uji Kruskal Wallis:

Jika nilai Assymp. Sig. > 0,05 maka tidak terdapat perbedaan yang signifikan antara kelompok sampel

Jika nilai Assymp. Sig. < 0,05 maka terdapat perbedaan yang signifikan antara kelompok sampel

Berdasarkan output SPSS pada Tabel 2, diperoleh nilai Assymp. Sig. < 0,05 sehingga dapat disimpulkan bahwa terdapat perbedaan yang signifikan antara kelompok sampel tersebut. Namun untuk mengetahui sampel mana yang lebih baik dan hubungan antar kelompok sampel maka perlu dilakukan uji lanjut (*Post Hoc Test*).

Hasil Uji Lanjut (*Post Hoc Test*) Kruskal Wallis

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Densitas is the same across categories of Sampel.	Independent-Samples Kruskal-Wallis Test	.027	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Lampiran 4.1.4. Densitas dengan Bahan Dasar Silika

Tests of Normality

Sampel		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Densitas	Kontrol 10%	.300	3	.	.914	3	.430
	Kontrol 20%	.383	3	.	.754	3	.008
	Kontrol 30%	.385	3	.	.750	3	.000
	Kontrol 40%	.234	3	.	.978	3	.718
	Kontrol 50%	.332	3	.	.863	3	.276

a. Lilliefors Significance Correction

Dasar pengambilan keputusan dalam Uji Normalitas:

Jika nilai Sig. > 0,05 maka data berdistribusi normal

Jika nilai Sig. < 0,05 maka data tidak berdistribusi normal

Berdasarkan output SPSS pada Tabel 1, diperoleh nilai Shapiro-Wilk Sig. untuk ke-5 sampel data dimana terdapat 2 sampel yang < 0,05 atau tidak terdistribusi normal yaitu sampel Kontrol 20% dan Kontrol 30% sedangkan untuk sampel Kontrol 10%, Kontrol 40%, dan Kontrol 50% > 0,05. Oleh karena terdapat sampel yang datanya tidak terdistribusi normal, maka digunakan alternatif uji statistik non parametrik yaitu Uji Kruskal Wallis.

Hasil Uji Kruskal Wallis

Test Statistics[a,b]

	Densitas
Chi-Square	9.751
df	4
Asymp. Sig.	.045

a. Kruskal Wallis Test

b. Grouping Variable:Sample

Dasar pengambilan keputusan dalam Uji Kruskal Wallis:

Jika nilai Assymp. Sig. > 0,05 maka tidak terdapat perbedaan yang signifikan antara kelompok sampel

Jika nilai Assymp. Sig. < 0,05 maka terdapat perbedaan yang signifikan antara kelompok sampel

Berdasarkan output SPSS pada Tabel 2, diperoleh nilai Assymp. Sig. < 0,05 sehingga dapat disimpulkan bahwa terdapat perbedaan yang signifikan antara kelompok sampel tersebut. Namun untuk mengetahui sampel mana yang lebih baik dan hubungan antar kelompok sampel maka perlu dilakukan uji lanjut (*Post Hoc Test*).

Hasil Uji Lanjut (*Post Hoc Test*) Kruskal Wallis

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Densitas is the same across categories of Sampel.	Independent-Samples Kruskal-Wallis Test	.045	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Lampiran 4.1.5. Susut Massa dengan Bahan Dasar NC

Tests of Normality

	Sampel	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Susut Massa	Lempung 10%	.269	3	.	.949	3	.566
	Lempung 20%	.293	3	.	.922	3	.459
	Lempung 30%	.208	3	.	.992	3	.827
	Lempung 40%	.177	3	.	1.000	3	.974
	Lempung 50%	.318	3	.	.887	3	.344

a. Lilliefors Significance Correction

Dasar pengambilan keputusan dalam Uji Normalitas:
Jika nilai Sig. > 0,05 maka data berdistribusi normal
Jika nilai Sig. < 0,05 maka data tidak berdistribusi normal

Berdasarkan output SPSS pada Tabel 1, diperoleh nilai Shapiro-Wilk Sig. untuk ke-5 sampel data dimana semua sampel memiliki nilai signifikan > 0,05 sehingga dapat disimpulkan bahwa semua sampel data terdistribusi normal.

Hasil Uji Homogenitas

Test of Homogeneity of Variances

Persentase

Levene Statistic	df1	df2	Sig.
1.421	4	10	.296

Dasar pengambilan keputusan dalam Uji Normalitas:
Jika nilai Sig. > 0,05 maka data homogen
Jika nilai Sig. < 0,05 maka data tidak homogen

Berdasarkan output SPSS pada Tabel 2, diperoleh angka *Levene Statistic* sebesar 1,421 dengan signifikansi atau probabilitas (Sig) sebesar 0,296. Karena nilai signifikansi 0,296 > 0,05 maka dapat disimpulkan bahwa nilai ulangan ke-5 sampel yang kita bandingkan tersebut homogen sehingga pada pemilihan Uji Lanjut (*Post Hoc Test*) menggunakan Uji Lanjut *Bonferroni.*

Hasil Uji Anova

ANOVA

Persentase

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	806.317	4	201.579	492.446	.000
Within Groups	4.093	10	.409		
Total	810.410	14			

Dasar pengambilan keputusan dalam Analisis Anova:
Jika nilai signifikansi (Sig) > 0,05 maka rata-rata sama.

Jika nilai signifikansi (Sig) < 0,05 maka rata-rata berbeda.

Berdasarkan output Anova pada Tabel 3, diketahui nilai Sig. yang diperoleh sebesar 0,000 < 0,05 sehingga dapat disimpulkan bahwa nilai ulangan ke-5 sampel yang kita bandingkan tersebut "berbeda" secara signifikan.

Hasil Uji Lanjut (*Post Hoc Test*) Menggunakan Uji *Bonferroni*

Multiple Comparisons

Dependent Variable: Persentase

Bonferroni

(I) Sampel	(J) Sampel	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Lempung 10%	Lempung 20%	-6.2097849330*	.5223939680	.000	-8.080689932	-4.338879935
	Lempung 30%	-20.7662300000*	.5223939680	.000	-22.637135000	-18.895325000
	Lempung 40%	-15.7563218500*	.5223939680	.000	-17.627226850	-13.885416850
	Lempung 50%	-13.6884999400*	.5223939680	.000	-15.559404940	-11.817594940
Lempung 20%	Lempung 10%	6.2097849330*	.5223939680	.000	4.338879935	8.080689932
	Lempung 30%	-14.5564450700*	.5223939680	.000	-16.427350070	-12.685540070
	Lempung 40%	-9.5465369200*	.5223939680	.000	-11.417441920	-7.675631921
	Lempung 50%	-7.4787150070*	.5223939680	.000	-9.349620005	-5.607810008
Lempung 30%	Lempung 10%	20.7662300000*	.5223939680	.000	18.895325000	22.637135000
	Lempung 20%	14.5564450700*	.5223939680	.000	12.685540070	16.427350070
	Lempung 40%	5.0099081470*	.5223939680	.000	3.139003148	6.880813145
	Lempung 50%	7.0777300600*	.5223939680	.000	5.206825061	8.948635059
Lempung 40%	Lempung 10%	15.7563218500*	.5223939680	.000	13.885416850	17.627226850
	Lempung 20%	9.5465369200*	.5223939680	.000	7.675631921	11.417441920

	Lempung 30%	-5.0099081470*	.5223939680	.000	-6.880813145	-3.139003148
	Lempung 50%	2.0678219130*	.5223939680	.027	.196916915	3.938726912
Lempung 50%	Lempung 10%	13.6884999400*	.5223939680	.000	11.817594940	15.559404940
	Lempung 20%	7.4787150070*	.5223939680	.000	5.607810008	9.349620005
	Lempung 30%	-7.0777300600*	.5223939680	.000	-8.948635059	-5.206825061
	Lempung 40%	-2.0678219130*	.5223939680	.027	-3.938726912	-.196916915

*. The mean difference is significant at the 0.05 level.

Berdasarkan output SPSS pada Tabel 4 di kolom *Mean Difference,* dapat dilihat perbedaan rata-rata nilai persentase sampel yang ditandai dengan tanda “*” dan dengan nilai signifikan < 0,05.

Lampiran 4.1.6. Susut Massa dengan Bahan Dasar Silika

Tests of Normality

Sampel		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Susut Massa	Kontrol 10%	.384	3	.	.751	3	.003
	Kontrol 20%	.307	3	.	.903	3	.394
	Kontrol 30%	.344	3	.	.841	3	.217
	Kontrol 40%	.246	3	.	.970	3	.669
	Kontrol 50%	.353	3	.	.823	3	.171

a. Lilliefors Significance Correction

Dasar pengambilan keputusan dalam Uji Normalitas:
Jika nilai Sig. > 0,05 maka data berdistribusi normal
Jika nilai Sig. < 0,05 maka data tidak berdistribusi normal

Berdasarkan output SPSS pada Tabel 1, diperoleh nilai Shapiro-Wilk Sig. untuk ke-5 sampel data dimana terdapat 1 sampel yang < 0,05 atau tidak terdistribusi normal yaitu sampel Kontrol 10%, sedangkan untuk sampel Kontrol 20%, Kontrol 30%, Kontrol 40%, dan Kontrol 40% > 0,05. Oleh karena terdapat sampel yang datanya tidak terdistribusi normal, maka digunakan alternatif uji statistik non parametrik yaitu Uji Kruskal Wallis.

Hasil Uji Kruskal Wallis

Test Statistics[a,b]

	Persentase
Chi-Square	12.900
df	4
Asymp. Sig.	.012

a. Kruskal Wallis Test
b. Grouping Variable: Sampel

Dasar pengambilan keputusan dalam Uji Kruskal Wallis:
Jika nilai Assymp. Sig. > 0,05 maka tidak terdapat perbedaan yang signifikan antara kelompok sampel
Jika nilai Assymp. Sig. < 0,05 maka terdapat perbedaan yang signifikan antara kelompok sampel

Berdasarkan output SPSS pada Tabel 2, diperoleh nilai Assymp. Sig. < 0,05 sehingga dapat disimpulkan bahwa terdapat perbedaan yang signifikan antara kelompok sampel tersebut. Namun untuk mengetahui sampel mana yang lebih baik dan hubungan antar kelompok sampel maka perlu dilakukan uji lanjut (*Post Hoc Test*).

Hasil Uji Lanjut (*Post Hoc Test*) Kruskal Wallis

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Persentase is the same across categories of Sampel.	Independent-Samples Kruskal-Wallis Test	.012	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Lampiran 4.1.7. Kuat Tekan dengan Bahan Dasar NC

Hasil Uji Normalitas

Tests of Normality

Sampel		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Ulangan	Lempung 10%	.219	3	.	.987	3	.780
	Lempung 20%	.290	3	.	.926	3	.474
	Lempung 30%	.315	3	.	.891	3	.358
	Lempung 40%	.345	3	.	.838	3	.210
	Lempung 50%	.385	3	.	.750	3	.000

a. Lilliefors Significance Correction

Dasar pengambilan keputusan dalam Uji Normalitas:
Jika nilai Sig. > 0,05 maka data berdistribusi normal
Jika nilai Sig. < 0,05 maka data tidak berdistribusi normal

Berdasarkan output SPSS pada Tabel 1, diperoleh nilai Shapiro-Wilk Sig. untuk ke-5 sampel data dimana terdapat 1 sampel yang < 0,05 atau tidak terdistribusi normal yaitu sampel Lempung 50%, sedangkan untuk sampel Lempung 10%, Lempung 20%, Lempung 30%, dan Lempung 40% > 0,05. Oleh karena terdapat sampel yang datanya tidak terdistribusi normal, maka digunakan alternatif uji statistik non parametrik yaitu Uji Kruskal Wallis.

Hasil Uji Kruskal Wallis

Test Statistics[a,b]

	Ulangan
Chi-Square	10.085
df	4
Asymp. Sig.	.039

a. Kruskal Wallis Test
b. Grouping Variable:

Dasar pengambilan keputusan dalam Uji Kruskal Wallis:
Jika nilai Assymp. Sig. > 0,05 maka tidak terdapat perbedaan yang signifikan antara kelompok sampel
Jika nilai Assymp. Sig. < 0,05 maka terdapat perbedaan yang signifikan antara kelompok sampel

Berdasarkan output SPSS pada Tabel 2, diperoleh nilai Assymp. Sig. < 0,05 sehingga dapat disimpilkan bahwa terdapat perbedaan yang signifikan antara kelompok sampel tersebut. Namun untuk mengetahui sampel mana yang lebih baik dan hubungan antar kelompok sampel maka perlu dilakukan uji lanjut (*Post Hoc Test*).

Hasil Uji Lanjut (*Post Hoc Test*) Kruskal Wallis

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Ulangan is the same across categories of Sampel.	Independent-Samples Kruskal-Wallis Test	.039	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Lampiran 4.1.8. Kuat Tekan dengan Bahan Dasar Silika

Tests of Normality

Sampel		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Ulangan	Kontrol 10%	.175	3	.	1.000	3	1.000
	Kontrol 20%	.331	3	.	.865	3	.280
	Kontrol 30%	.196	3	.	.996	3	.878
	Kontrol 40%	.297	3	.	.917	3	.443
	Kontrol 50%	.213	3	.	.990	3	.806

a. Lilliefors Significance Correction

Dasar pengambilan keputusan dalam Uji Normalitas:
Jika nilai Sig. > 0,05 maka data berdistribusi normal
Jika nilai Sig. < 0,05 maka data tidak berdistribusi normal

Berdasarkan output SPSS pada Tabel 1, diperoleh nilai Shapiro-Wilk Sig. untuk ke-5 sampel data dimana semua sampel memiliki nilai signifikan > 0,05 sehingga dapat disimpulkan bahwa semua sampel data terdistribusi normal.

Hasil Uji Homogenitas

Test of Homogeneity of Variances

Ulangan

Levene Statistic	df1	df2	Sig.
7.267	4	10	.005

Dasar pengambilan keputusan dalam Uji Normalitas:
Jika nilai Sig. > 0,05 maka data homogen
Jika nilai Sig. < 0,05 maka data tidak homogen

Berdasarkan output SPSS pada Tabel 2, diperoleh angka *Levene Statistic* sebesar 7,267 dengan signifikansi atau probabilitas (Sig) sebesar 0,005. Karena nilai signifikansi 0,005 < 0,05 maka dapat disimpulkan bahwa nilai ulangan ke-5 sampel yang kita bandingkan tersebut adalah tidak homogen sehingga pada pemilihan Uji Lanjut (*Post Hoc Test*) menggunakan Uji Lanjut *Games-Howell.*

Hasil Uji Anova

ANOVA

Ulangan

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	34.636	4	8.659	140.52	.000
Within Groups	.616	10	.062		
Total	35.252	14			

Dasar pengambilan keputusan dalam Analisis Anova:
Jika nilai signifikansi (Sig) > 0,05 maka rata-rata sama.
Jika nilai signifikansi (Sig) < 0,05 maka rata-rata berbeda.

Berdasarkan output Anova pada Tabel 3, diketahui nilai Sig. yang diperoleh sebesar 0,000 < 0,05 sehingga dapat disimpulkan bahwa nilai ulangan ke-5 sampel yang kita bandingkan tersebut "berbeda" secara signifikan.

Hasil Uji Lanjut (*Post Hoc Test*) Menggunakan Uji *Games-Howell*

Multiple Comparisons

Dependent Variable: Ulangan
Games-Howell

(I) Sampel	(J) Sampel	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Kontrol 10%	Kontrol 20%	.30333	.27727	.804	-1.7965	2.4032
	Kontrol 30%	1.41333*	.03480	.000	1.2575	1.5692
	Kontrol 40%	3.75667*	.15246	.004	2.6423	4.8710
	Kontrol 50%	3.25000*	.05447	.000	2.9488	3.5512
Kontrol 20%	Kontrol 10%	-.30333	.27727	.804	-2.4032	1.7965
	Kontrol 30%	1.11000	.27753	.164	-.9830	3.2030
	Kontrol 40%	3.45333*	.31473	.006	1.8196	5.0871
	Kontrol 50%	2.94667*	.28067	.023	.9301	4.9632
Kontrol 30%	Kontrol 10%	-1.41333*	.03480	.000	-1.5692	-1.2575
	Kontrol 20%	-1.11000	.27753	.164	-3.2030	.9830
	Kontrol 40%	2.34333*	.15293	.011	1.2400	3.4466
	Kontrol 50%	1.83667*	.05578	.000	1.5432	2.1302
Kontrol 40%	Kontrol 10%	-3.75667*	.15246	.004	-4.8710	-2.6423
	Kontrol 20%	-3.45333*	.31473	.006	-5.0871	-1.8196
	Kontrol 30%	-2.34333*	.15293	.011	-3.4466	-1.2400
	Kontrol 50%	-.50667	.15857	.210	-1.5076	.4943
Kontrol 50%	Kontrol 10%	-3.25000*	.05447	.000	-3.5512	-2.9488
	Kontrol 20%	-2.94667*	.28067	.023	-4.9632	-.9301
	Kontrol 30%	-1.83667*	.05578	.000	-2.1302	-1.5432
	Kontrol 40%	.50667	.15857	.210	-.4943	1.5076

*. The mean difference is significant at the 0.05 level.

Berdasarkan output SPSS pada Tabel 4 di kolom *Mean Difference,* dapat dilihat perbedaan rata-rata nilai ulangan sampel yang ditandai dengan tanda "*" dan dengan nilai signifikan < 0,05.

Lampiran 4.2. Hasil Analisis Statistika Sifat Fisika Kimia Biodiesel
Lampiran 4.2.1. Densitas
ONEWAY Massajenis BY Konsentrasi/STATISTICS HOMOGENEITY/MISSING ANALYSIS /POSTHOC=TUKEY ALPHA(0.05).

Test of Homogeneity of Variances

Massa jenis

Levene Statistic	df1	df2	Sig.
3.968	4	10	.085

Nilai Sig >0,05 berarti tidak terdapat perbedaan yang signifikan untuk setiap perlakuan

ANOVA

Massa jenis

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.001	4	.000	15.465	.090
Within Groups	.000	10	.000		
Total	.001	14			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Massa jenis
Tukey HSD

(I) Konsentrasi	(J) Konsentrasi	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
10%	20%	.0047967	.0026794	.429	-.004022	.013615
	30%	-.0081267	.0026794	.075	-.016945	.000692
	40%	.0117933*	.0026794	.009	.002975	.020612
	50%	-.0017300	.0026794	.964	-.010548	.007088
20%	10%	-.0047967	.0026794	.429	-.013615	.004022
	30%	-.0129233*	.0026794	.005	-.021742	-.004105
	40%	.0069967	.0026794	.141	-.001822	.015815
	50%	-.0065267	.0026794	.183	-.015345	.002292
30%	10%	.0081267	.0026794	.075	-.000692	.016945
	20%	.0129233*	.0026794	.005	.004105	.021742
	40%	.0199200*	.0026794	.000	.011102	.028738
	50%	.0063967	.0026794	.196	-.002422	.015215
40%	10%	-.0117933*	.0026794	.009	-.020612	-.002975
	20%	-.0069967	.0026794	.141	-.015815	.001822
	30%	-.0199200*	.0026794	.000	-.028738	-.011102
	50%	-.0135233*	.0026794	.004	-.022342	-.004705
50%	10%	.0017300	.0026794	.964	-.007088	.010548
	20%	.0065267	.0026794	.183	-.002292	.015345
	30%	-.0063967	.0026794	.196	-.015215	.002422
	40%	.0135233*	.0026794	.004	.004705	.022342

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

Massa jenis

Tukey HSD[a]

Konsentrasi	N	Subset for alpha = 0.05 1	2	3
40%	3	.838193		
20%	3	.845190	.845190	
10%	3		.849987	.849987
50%	3		.851717	.851717
30%	3			.858113
Sig.		.141	.183	.075

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Lampiran 4.2.2. Bilangan Asam
ONEWAY Persen konversi BY Konsentrasi /STATISTICS HOMOGENEITY /MISSING ANALYSIS /POSTHOC=TUKEY ALPHA(0.05).
Oneway

Notes

Test of Homogeneity of Variances

Persen Konversi

Levene Statistic	df1	df2	Sig.
.067	4	10	.991

Nilai Sig >0,05 berarti tidak terdapat perbedaan yang signifikan untuk setiap perlakuan

ANOVA

Persen Konversi

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.361	4	.590	1.854	.195
Within Groups	3.184	10	.318		
Total	5.545	14			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Persen Konversi

Tukey HSD

(I) Konsentrasi	(J) Konsentrasi	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
10%	20%	-.0195565	.4607152	1.000	-1.535808	1.496695
	30%	-.9741985	.4607152	.286	-2.490450	.542053
	40%	.0463374	.4607152	1.000	-1.469914	1.562589
	50%	.0364569	.4607152	1.000	-1.479795	1.552708
20%	10%	.0195565	.4607152	1.000	-1.496695	1.535808
	30%	-.9546420	.4607152	.302	-2.470893	.561609
	40%	.0658939	.4607152	1.000	-1.450358	1.582145
	50%	.0560134	.4607152	1.000	-1.460238	1.572265
30%	10%	.9741985	.4607152	.286	-.542053	2.490450
	20%	.9546420	.4607152	.302	-.561609	2.470893

	40%	1.0205359	.4607152	.249	-.495716	2.536787
	50%	1.0106555	.4607152	.257	-.505596	2.526907
40%	10%	-.0463374	.4607152	1.000	-1.562589	1.469914
	20%	-.0658939	.4607152	1.000	-1.582145	1.450358
	30%	-1.0205359	.4607152	.249	-2.536787	.495716
	50%	-.0098804	.4607152	1.000	-1.526132	1.506371
50%	10%	-.0364569	.4607152	1.000	-1.552708	1.479795
	20%	-.0560134	.4607152	1.000	-1.572265	1.460238
	30%	-1.0106555	.4607152	.257	-2.526907	.505596
	40%	.0098804	.4607152	1.000	-1.506371	1.526132

Homogeneous Subsets

Persen Konversi

Tukey HSD[a]

Konsentrasi	N	Subset for alpha = 0.05
		1
40%	3	97.628037
50%	3	97.637918
10%	3	97.674375
20%	3	97.693931
30%	3	98.648573
Sig.		.249

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size =3.000.

Lampiran 4.2.3. Bilangan Iodin

ONEWAY Bilanganiodin BY Konsentrasi
/STATISTICS HOMOGENEITY
/MISSING ANALYSIS
/POSTHOC=TUKEY ALPHA(0.05).

Oneway

Test of Homogeneity of Variances

Bilangan iodin

Levene Statistic	df1	df2	Sig.
.964	4	10	.468

Nilai Sig >0,05 berarti tidak terdapat perbedaan yang signifikan untuk setiap perlakuan

ANOVA

Bilangan iodin

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	52.854	4	13.213	.356	.834
Within Groups	371.142	10	37.114		
Total	423.996	14			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Bilangan iodin

Tukey HSD

(I) Konsentrasi	(J) Konsentrasi	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
10%	20%	4.1461473	4.9742147	.914	-12.224402	20.516696
	30%	5.2055519	4.9742147	.829	-11.164997	21.576101
	40%	4.2658050	4.9742147	.906	-12.104744	20.636354
	50%	4.7698833	4.9742147	.867	-11.600666	21.140432
20%	10%	-4.1461473	4.9742147	.914	-20.516696	12.224402
	30%	1.0594047	4.9742147	.999	-15.311144	17.429954
	40%	.1196578	4.9742147	1.000	-16.250891	16.490207
	50%	.6237360	4.9742147	1.000	-15.746813	16.994285
30%	10%	-5.2055519	4.9742147	.829	-21.576101	11.164997
	20%	-1.0594047	4.9742147	.999	-17.429954	15.311144

	40%	-.9397469	4.9742147	1.000	-17.310296	15.430802
	50%	-.4356686	4.9742147	1.000	-16.806218	15.934880
40%	10%	-4.2658050	4.9742147	.906	-20.636354	12.104744
	20%	-.1196578	4.9742147	1.000	-16.490207	16.250891
	30%	.9397469	4.9742147	1.000	-15.430802	17.310296
	50%	.5040783	4.9742147	1.000	-15.866471	16.874627
50%	10%	-4.7698833	4.9742147	.867	-21.140432	11.600666
	20%	-.6237360	4.9742147	1.000	-16.994285	15.746813
	30%	.4356686	4.9742147	1.000	-15.934880	16.806218
	40%	-.5040783	4.9742147	1.000	-16.874627	15.866471

Homogeneous Subsets

Bilangan iodin

Tukey HSD[a]

Konsentrasi	N	Subset for alpha = 0.05
		1
30%	3	86.200318
50%	3	86.635986
40%	3	87.140064
20%	3	87.259722
10%	3	91.405869
Sig.		.829

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Lampiran 4.2.4. Bilangan Penyabunan

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ONEWAY Bilanganpenyabunan BY Konsentrasi
  /STATISTICS HOMOGENEITY
  /MISSING ANALYSIS
  /POSTHOC=TUKEY ALPHA(0.05).
```

Oneway

Test of Homogeneity of Variances

Bilangan penyabunan

Levene Statistic	df1	df2	Sig.
6.603	4	10	.107

Nilai Sig >0,05 berarti tidak terdapat perbedaan yang signifikan untuk setiap perlakuan

ANOVA

Bilangan penyabunan

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	362.198	4	90.549	207.543	.000
Within Groups	4.363	10	.436		
Total	366.561	14			

Multiple Comparisons

Dependent Variable: Bilangan penyabunan

Tukey HSD

(I) Konsentrasi	(J) Konsentrasi	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
10%	20%	1.4980287	.5393165	.110	-.276906	3.272964
	30%	-4.8483416*	.5393165	.000	-6.623277	-3.073407
	40%	-3.9854206*	.5393165	.000	-5.760356	-2.210486
	50%	-12.5898484*	.5393165	.000	-14.364783	-10.814914
20%	10%	-1.4980287	.5393165	.110	-3.272964	.276906
	30%	-6.3463704*	.5393165	.000	-8.121305	-4.571435
	40%	-5.4834494*	.5393165	.000	-7.258384	-3.708514
	50%	-14.0878772*	.5393165	.000	-15.862812	-12.312942
30%	10%	4.8483416*	.5393165	.000	3.073407	6.623277
	20%	6.3463704*	.5393165	.000	4.571435	8.121305

	40%	.8629210	.5393165	.529	-.912014	2.637856
	50%	-7.7415068*	.5393165	.000	-9.516442	-5.966572
40%	10%	3.9854206*	.5393165	.000	2.210486	5.760356
	20%	5.4834494*	.5393165	.000	3.708514	7.258384
	30%	-.8629210	.5393165	.529	-2.637856	.912014
	50%	-8.6044278*	.5393165	.000	-10.379363	-6.829493
50%	10%	12.5898484*	.5393165	.000	10.814914	14.364783
	20%	14.0878772*	.5393165	.000	12.312942	15.862812
	30%	7.7415068*	.5393165	.000	5.966572	9.516442
	40%	8.6044278*	.5393165	.000	6.829493	10.379363

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

Bilangan penyabunan

Tukey HSD[a]

Konsentrasi	N	Subset for alpha = 0.05 1	2	3
20%	3	102.063572		
10%	3	103.561600		
40%	3		107.547021	
30%	3		108.409942	
50%	3			116.151449
Sig.		.110	.529	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Lampiran 4.2.5. Angka Setana

```
ONEWAY Angkasetana BY Konsentrasi
  /STATISTICS HOMOGENEITY
  /MISSING ANALYSIS
  /POSTHOC=TUKEY ALPHA(0.05).
```

Notes

Test of Homogeneity of Variances

angka setana

Levene Statistic	df1	df2	Sig.
1.202	4	10	.368

Nilai Sig >0,05 berarti tidak terdapat perbedaan yang signifikan untuk setiap perlakuan

ANOVA

angka setana

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	93.526	4	23.381	58.508	.000
Within Groups	3.996	10	.400		
Total	97.522	14			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: angka setana

Tukey HSD

(I) Konsentrasi	(J) Konsentrasi	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
10%	20%	-3.2107106*	.5161597	.001	-4.909435	-1.511987
	30%	.3614406	.5161597	.952	-1.337283	2.060165
	40%	.1960961	.5161597	.995	-1.502628	1.894820
	50%	4.6349828*	.5161597	.000	2.936259	6.333707
20%	10%	3.2107106*	.5161597	.001	1.511987	4.909435
	30%	3.5721513*	.5161597	.000	1.873427	5.270875
	40%	3.4068067*	.5161597	.000	1.708083	5.105531
	50%	7.8456934*	.5161597	.000	6.146969	9.544417
30%	10%	-.3614406	.5161597	.952	-2.060165	1.337283
	20%	-3.5721513*	.5161597	.000	-5.270875	-1.873427
	40%	-.1653445	.5161597	.997	-1.864069	1.533379

	50%	4.2735422*	.5161597	.000	2.574818	5.972266
40%	10%	-.1960961	.5161597	.995	-1.894820	1.502628
	20%	-3.4068067*	.5161597	.000	-5.105531	-1.708083
	30%	.1653445	.5161597	.997	-1.533379	1.864069
	50%	4.4388867*	.5161597	.000	2.740163	6.137611
50%	10%	-4.6349828*	.5161597	.000	-6.333707	-2.936259
	20%	-7.8456934*	.5161597	.000	-9.544417	-6.146969
	30%	-4.2735422*	.5161597	.000	-5.972266	-2.574818
	40%	-4.4388867*	.5161597	.000	-6.137611	-2.740163

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

angka setana

Tukey HSD[a]

		Subset for alpha = 0.05		
Konsentrasi	N	1	2	3
50%	3	70.392797		
30%	3		74.666339	
40%	3		74.831683	
10%	3		75.027779	
20%	3			78.238490
Sig.		1.000	.952	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.