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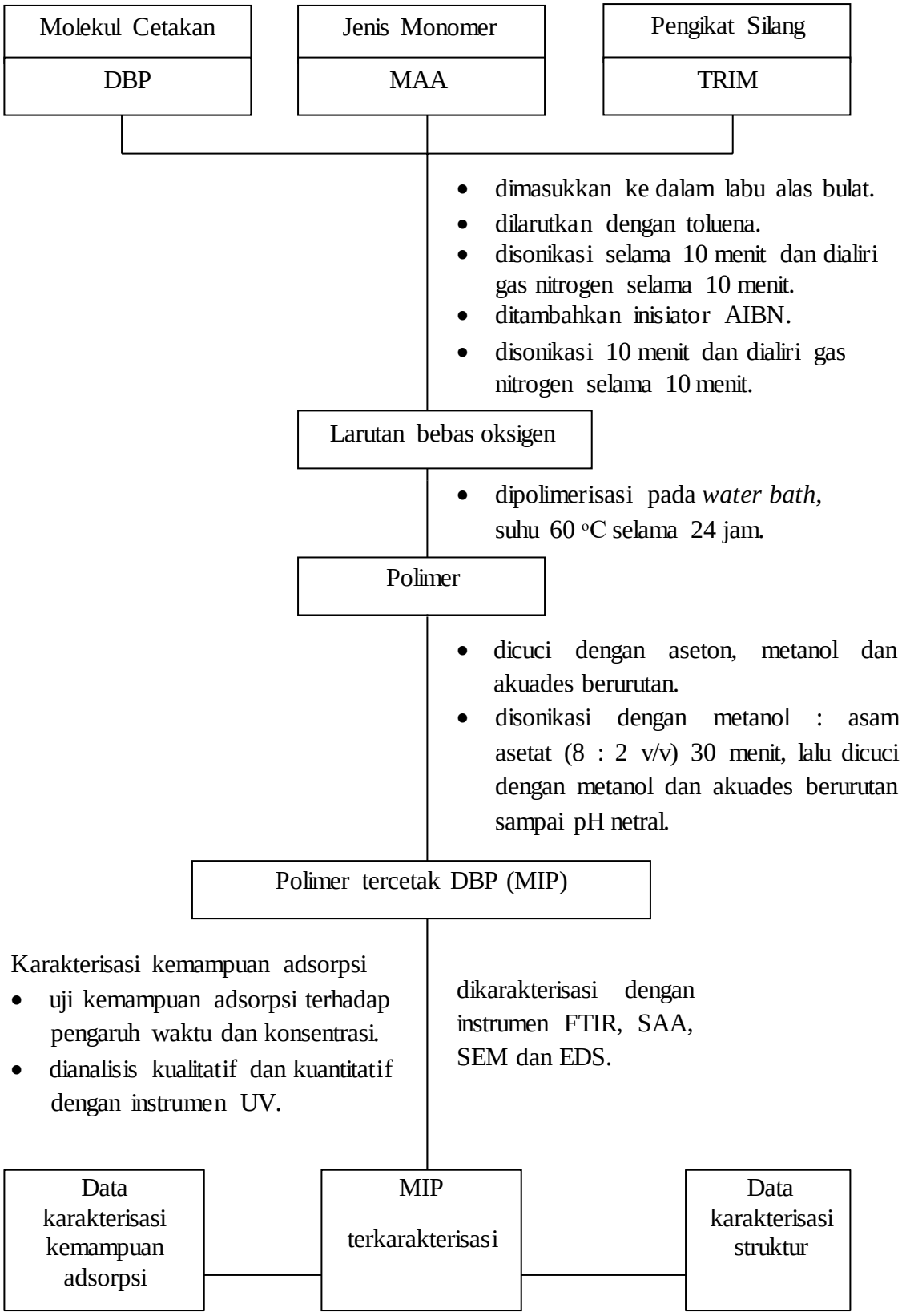
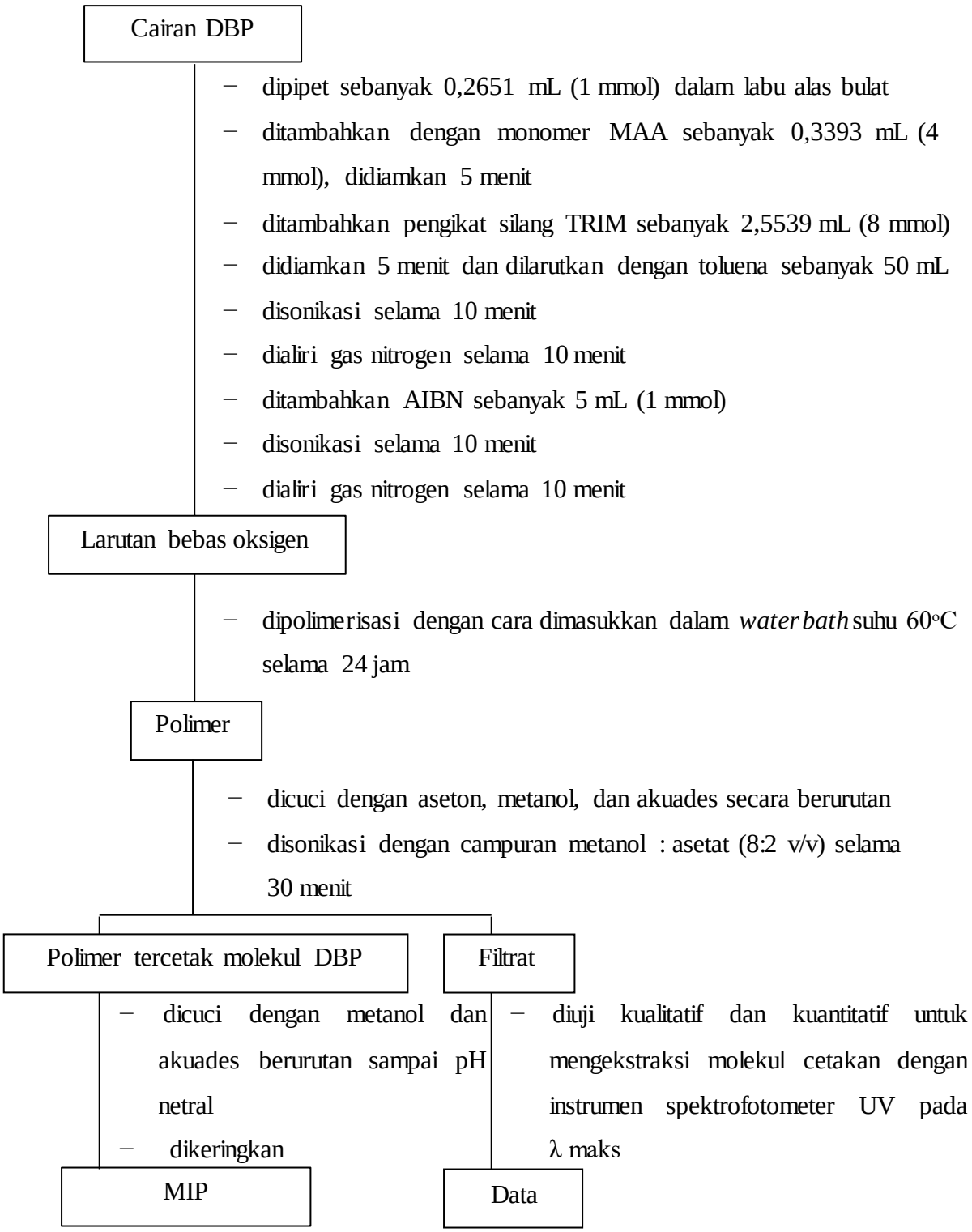
Lampiran 1. Skema Sintesis Polimer Bercetakan Molekul DBP menggunakan Metode Polimerisasi Presipitasi



Catatan: Sintesis NIP dibuat dengan metode yang sama dengan MIP, tapi tanpa DBP dan proses ekstraksi.

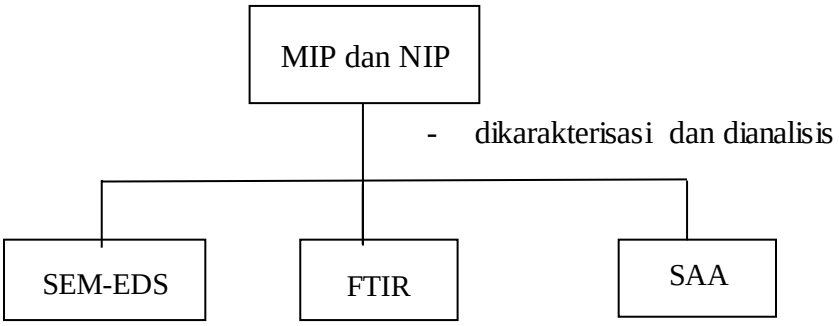
Lampiran 2. Bagan Alir Prosedur Penelitian

1. Sintesis MIP dan NIP

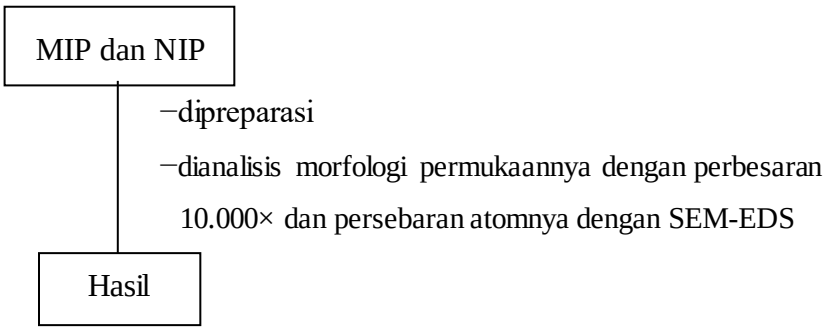


Catatan : Sintesis NIP dibuat dengan metode yang sama, tetapi tanpa menggunakan molekul cetakan (DBP).

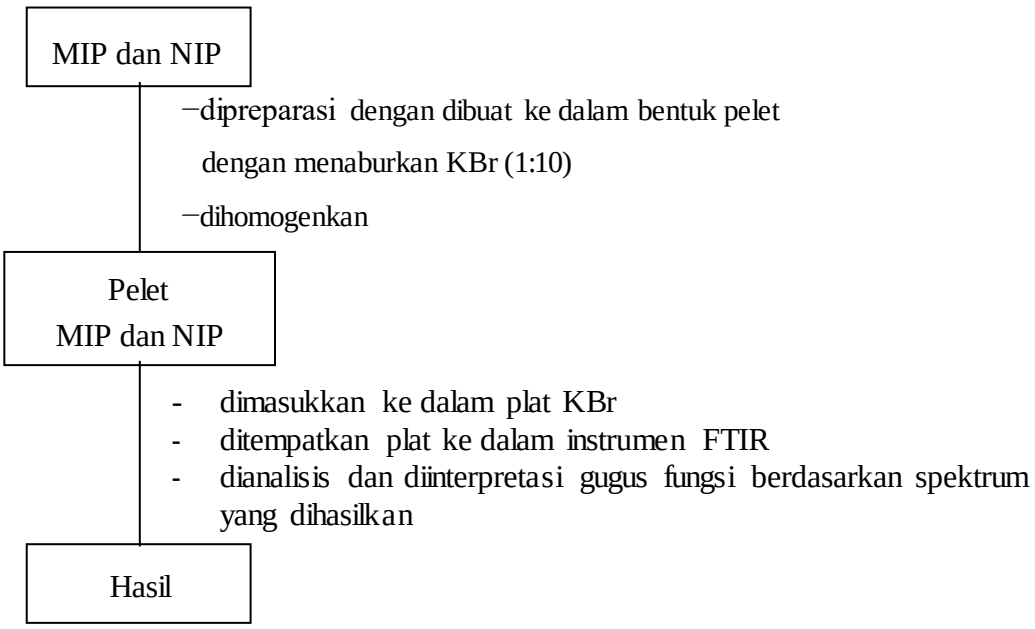
2. Karakterisasi MIP_DBP_MAA dan NIP_MAA



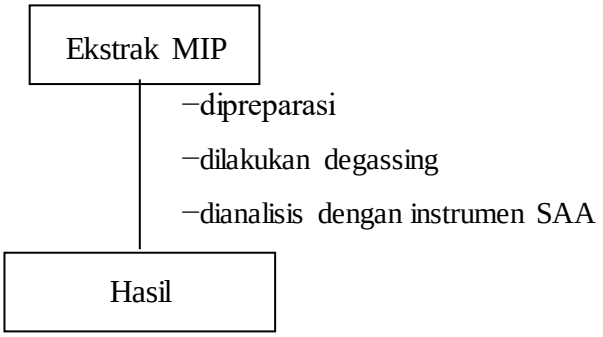
3. Karakterisasi MIP dan NIP menggunakan SEM-EDS



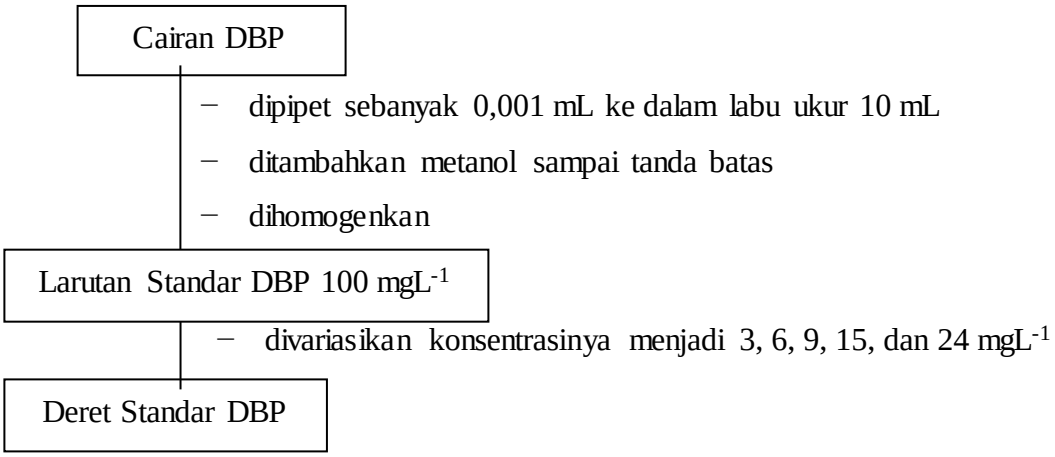
4. Karakterisasi MIP dan NIP menggunakan FTIR



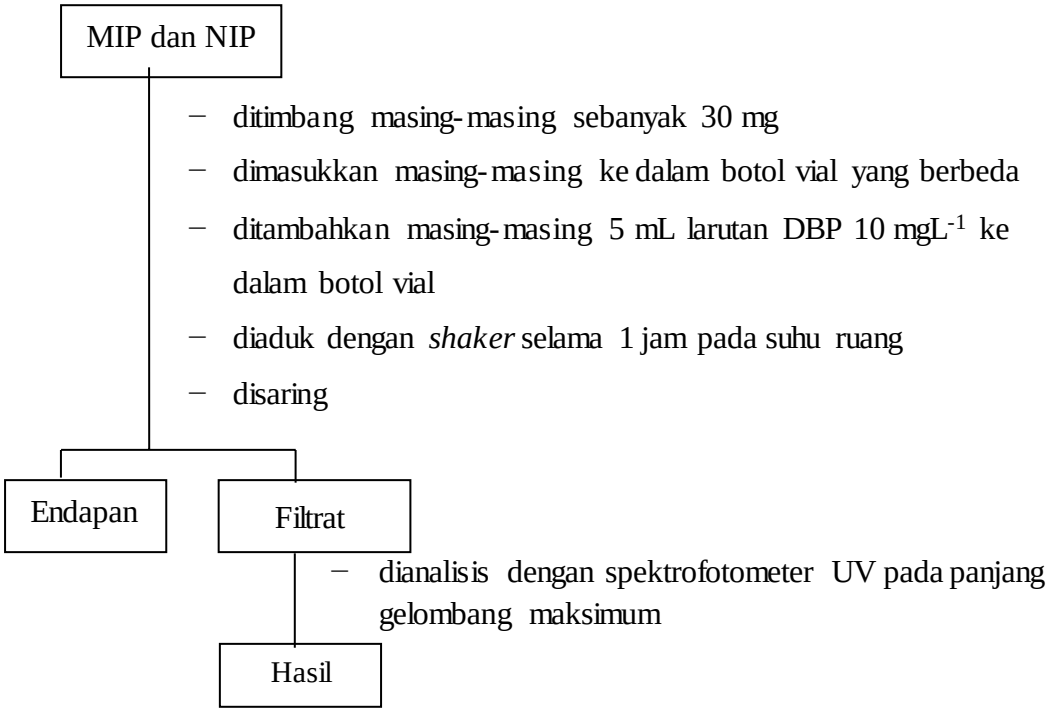
5. Karakterisasi MIP Menggunakan SAA



6. Pembuatan Larutan Standar DBP 100 mgL^{-1}



7. Uji Kemampuan Adsorpsi MIP dan NIP

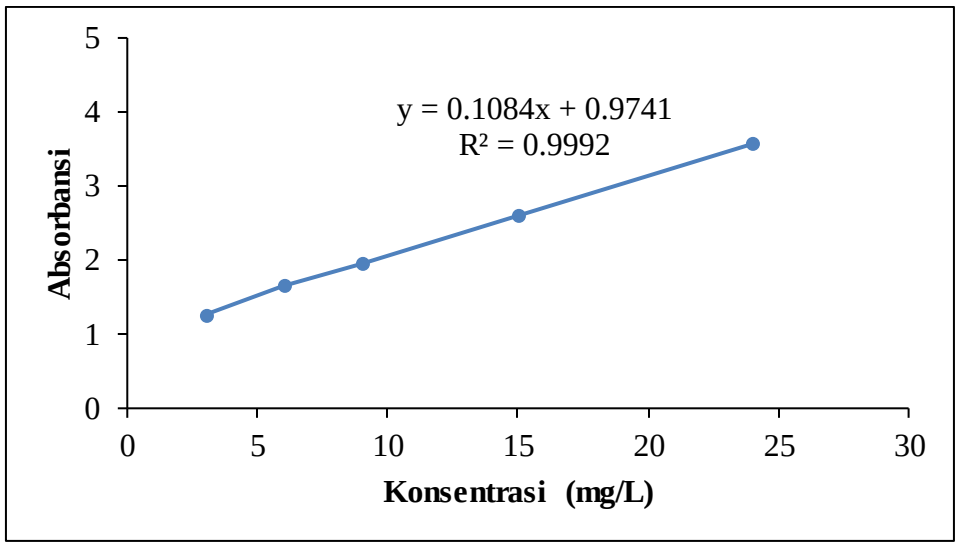


Lampiran 3. Data Spektrofotometer UV-Vis

1. Data absorbansi larutan standar DBP

No.	Sampel	Konsentrasi (mg/L)	Absorbansi
1.	DBP 1	3	1,265
2.	DBP 2	6	1,662
3.	DBP 3	9	1,952
4.	DBP 4	15	2,601
5.	DBP 5	24	3,569

2. Kurva hubungan antara absorbansi vs konsentrasi larutan standar DBP



3. Data absorbansi kemampuan adsorpsi MIP dan NIP

No.	Sampel	Absorbansi	q_e (mg/g)	Δq_e (mg/g)
1.	Adsorpsi DBP oleh MIP	1,304	1,16	0,4834
2.	Adsorpsi DBP oleh NIP	1,619	0,676	

4. Data absorbansi adsorpsi DBP oleh MIP terhadap pengaruh waktu

No.	Sampel	Waktu (menit)	Absorbansi
1	DBP	30	1,397
2	DBP	60	1,328
3	DBP	90	1,164
4	DBP	120	1,190
5	DBP	150	1,210

5. Data penentuan kinetika adsorpsi orde satu semu dan orde dua semu

No.	Waktu	C_e (mgL^{-1})	q_t (mg/g)	$q_e - q_t$	Log ($q_e - q_t$)	t/q_t
1.	0	0	0	1,3747	0,1382	0
2.	30	3,9012	1,0164	0,3583	-0,4457	29,5159
3.	60	3,2647	1,1225	0,2522	-0,5982	53,4521
4.	90	1,7518	**1,3747**	0	0	65,4688
5.	120	1,9916	1,3347	0,04	-1,3979	89,9078
6.	150	2,1761	1,3039	0,0708	-1,1499	115,0394

Catatan:

q_t adalah q_e pada waktu t

q_e adalah q_t pada waktu optimum

6. Data absorbansi adsorpsi DBP oleh MIP terhadap pengaruh konsentrasi

No.	Sampel	Konsentrasi (mg/L)	Absorbansi
1	DBP	9	1,256
2	DBP	12	1,519
3	DBP	15	1,785
4	DBP	18	2,069
5	DBP	21	2,438

7. Data persamaan isotermal adsorpsi Langmuir dan Freundlich

No.	Sampel	Konsen-trasi (mgL^{-1})	C_e (mgL^{-1})	q_e (mg/g)	Log C_e	Log q_e	$1/C_e$	$1/q_e$
1	MIP_DBP	9	2,6005	1,0666	0,4150	0,0280	0,3845	0,9375
2	MIP_DBP	12	5,0267	1,1633	0,7012	0,0657	0,1990	0,8597
3	MIP_DBP	15	7,4806	1,2534	0,8740	0,0980	0,1340	0,7979
4	MIP_DBP	18	10,1005	1,3166	1,0043	0,1194	0,0990	0,7595
5	MIP_DBP	21	12,821	1,4033	1,1080	0,1471	0,0780	0,7126

Lampiran 4. Perhitungan

1. Nilai konsentrasi adsorpsi DBP oleh MIP dan NIP

$y = 0,1084x + 0,9741$

a. Adsorpsi DBP oleh MIP

$y = 1,304$

$y = 0,1084x + 0,9741$

$1,304 = 0,1084x + 0,9741$

$$x = \frac{1,304 - 0,9741}{0,1084}$$

$x = 3,043$ mg/L

b. Adsorpsi DBP oleh NIP

$y = 1,619$

$y = 0,1084x + 0,9741$

$1,619 = 0,1084x + 0,9741$

$$x = \frac{1,619 - 0,9741}{0,1084}$$

$x = 5,949$ mg/L

2. Nilai Kemampuan Adsorpsi DBP oleh MIP dan NIP

$$q_e = \frac{(C_o - C_e)V}{W}$$

Diketahui: $C_o = 10$ mg/L $W = 0,03$ g

$V = 0,005$ L C_e = Konsentrasi setelah adsorpsi

a. Kemampuan Adsorpsi DBP oleh MIP

$$q_e = \frac{(10 - 3,04)\ 0,005}{0,03}$$

$$q_e = \frac{0,0348}{0,03}$$

q_e = 1,16 mg/g

b. Kemampuan Adsorpsi DBP oleh NIP

$$q_e = \frac{(10 - 5,94)\ 0,005}{0,03}$$

$$q_e = \frac{0,0203}{0,03}$$

q_e = 0,67 mg/g

3. Nilai konsentrasi adsorpsi dan kemampuan adsorpsi DBP oleh MIP terhadap pengaruh waktu

Waktu (menit)	y (absorbansi)	x (konsentrasi)(mg/L)	q_e (mg/g)
30	1,397	3,9012	1,0170
60	1,328	3,2647	1,1225
90	1,164	1,7518	1,3747
120	1,190	1,9916	1,3347
150	1,210	2,1761	1,3039

Contoh perhitungan konsentrasi adsorpsi dan kemampuan adsorpsi DBP oleh MIP terhadap pengaruh waktu:

a. Konsentrasi Adsorpsi DBP oleh MIP 30 menit

y = 0,1084x + 0,9741

y = 1,397

y = 0,1084x + 0,9741

1,397 = 0,1084x + 0,9741

$$x = \frac{1,397 - 0,9741}{0,1084}$$

x = 3,90 mg/L

b. Kemampuan Adsorpsi DBP oleh MIP 30 menit

$$q_e = \frac{(C_o - C_e)V}{W}$$

Diketahui: C_o = 10 mg/L W = 0,03 g

C_e = Konsentrasi setelah adsorpsi V = 0,005 L

$$q_e = \frac{(10 - 3,90)\ 0,005}{0,03}$$

$$q_e = \frac{0,0305}{0,03}$$

q_e = 1,01 mg/g

4. Nilai konsentrasi adsorpsi dan kemampuan adsorpsi DBP oleh MIP terhadap pengaruh konsentrasi

Konsentrasi awal (mg/L)	**y (absorbansi)**	**x (konsentrasi) (mg/L)**	**q_e (mg/g)**
9	1,256	2,6005	1,0670
12	1,519	5,0267	1,1633
15	1,785	7,4806	1,2534
18	2,069	10,1005	1,3166
21	2,438	12,821	1,4033

Contoh perhitungan konsentrasi adsorpsi dan kemampuan adsorpsi DBP oleh MIP terhadap pengaruh konsentrasi:

a. Konsentrasi Adsorpsi DBP oleh MIP 9 mg/L

y = 0,1084x + 0,9741

y = 1,256

y = 0,1084x + 0,9741

1,256 = 0,1084x + 0,9741

$$x = \frac{1,256 - 0,9741}{0,1084}$$

$x = 2,60$ mg/L

b. Kemampuan Adsorpsi DBP oleh MIP 9 mg/L

$$q_e = \frac{(C_o - C_e)\ V}{W}$$

Diketahui: C_o = konsentrasi awal W = 0,03 g

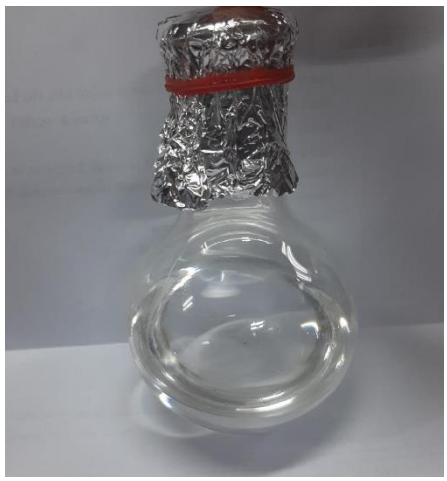
C_e = Konsentrasi setelah adsorpsi V = 0,005 L

$$q_e = \frac{(9 - 2,60)\ 0,005}{0,03}$$

$$q_e = \frac{0,032}{0,03}$$

$q_e = 1,06$ mg/g

Lampiran 5. Foto Hasil Penelitian



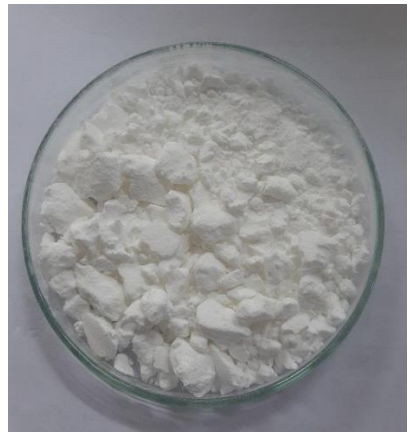
Tahap prapolimerisasi

Sonikasi

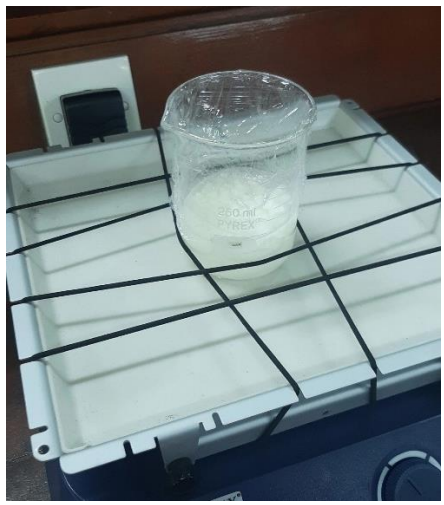
Pengaliran gas nitrogen untuk menghilangkan gas oksigen

Polimerisasi dalam *waterbath*

Polimer terbentuk berwarna putih



Polimer setelah dikeringkan

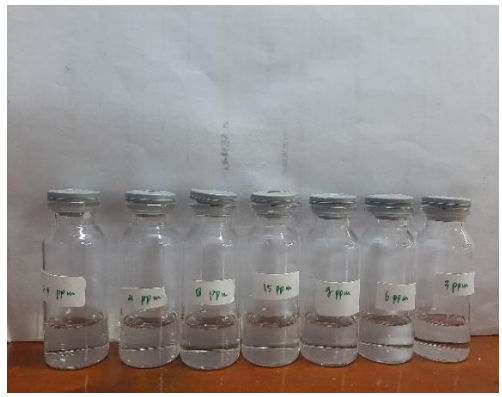


Proses pencucian polimer dengan aseton, metanol, dan akuades agar bersih dari pengotor

Proses ekstraksi (sonikasi)

Pencucian polimer dengan akuades

Penentuan pH



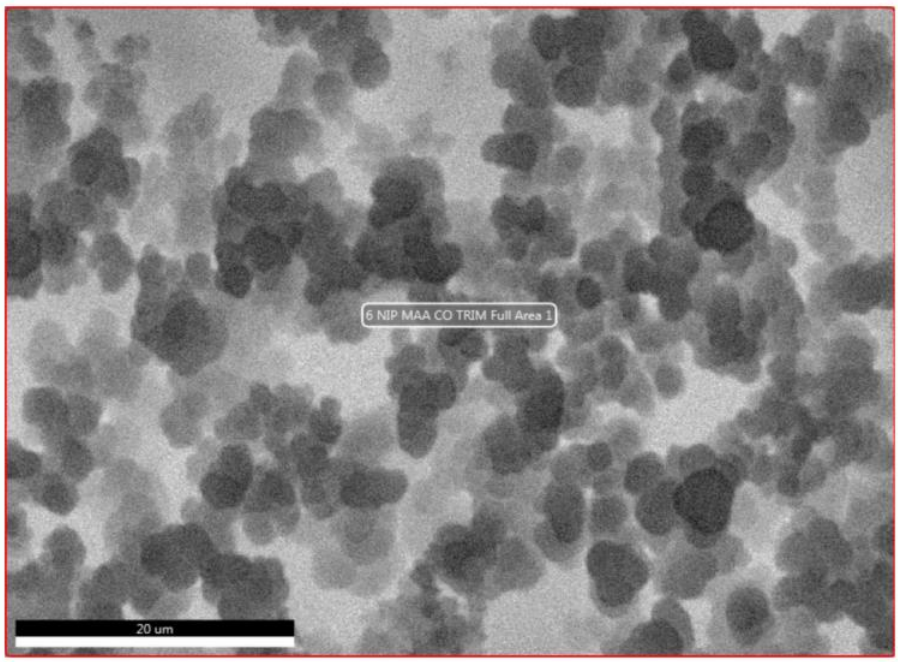
Pembuatan deret standar DBP

Pengocokan dengan alat *shaker* untuk pengaruh waktu dan konsentrasi terhadap adsorpsi DBP

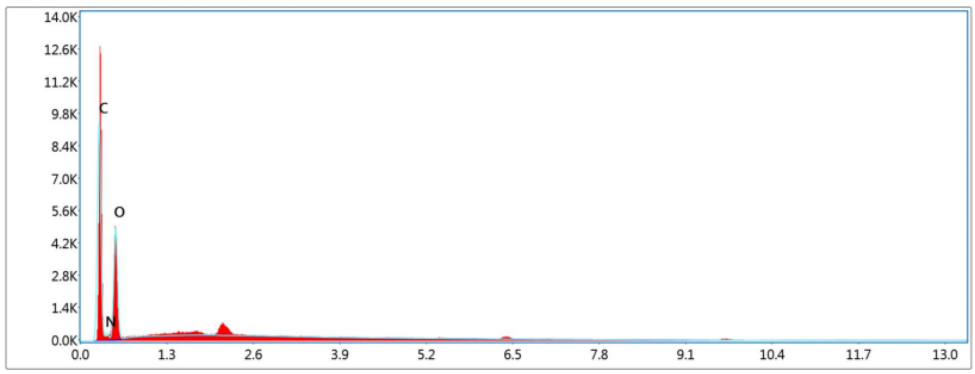
Polimer hasil sintesis MIP_DBP_MAA-co-TRIM dan NIP_MAA-co-TRIM disimpan

Lampiran 6. Karakterisasi EDS

1. NIP_MAA-co-TRIM



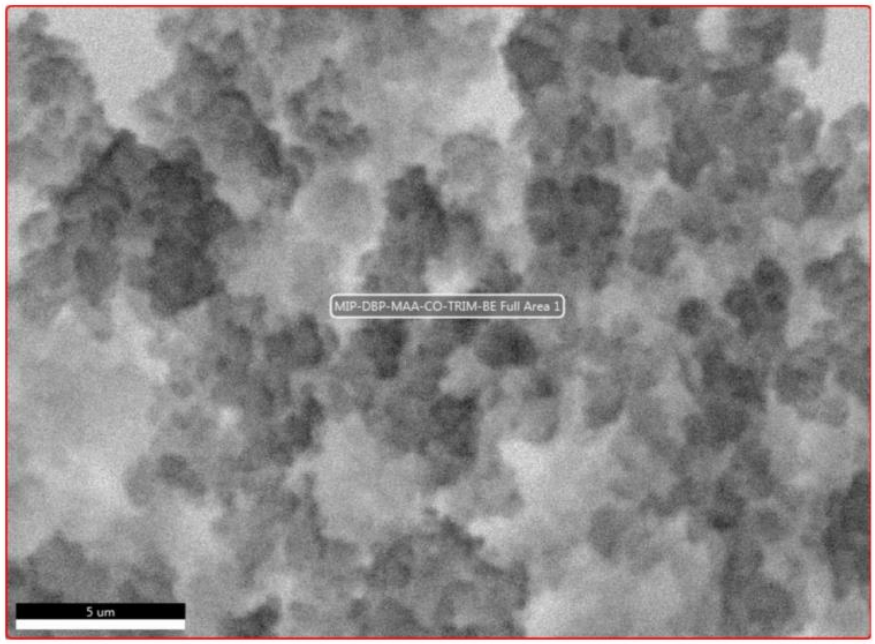
kV:20 Mag: 2000 Takeoff: 30 Live Time(s): 97.8 Amp Time(µs): 3.84 Resolution:(eV) 133.6



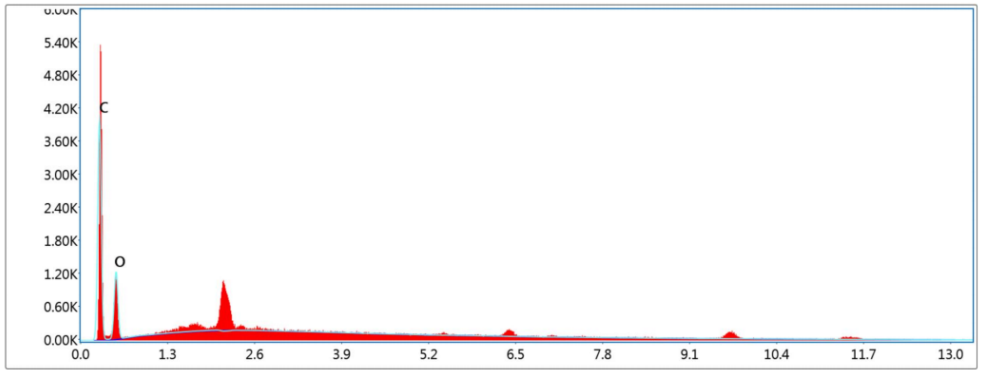
Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	A	F
C K	46.29	53.01	618.18	5.50	0.2759	1.0225	0.5828	1.0000
N K	6.65	6.53	21.36	13.00	0.0075	0.9981	0.1134	1.0000
O K	47.06	40.46	345.00	9.82	0.0786	0.9769	0.1709	1.0000

2. MIP_DBP_MAA-co-TRIM(BE)



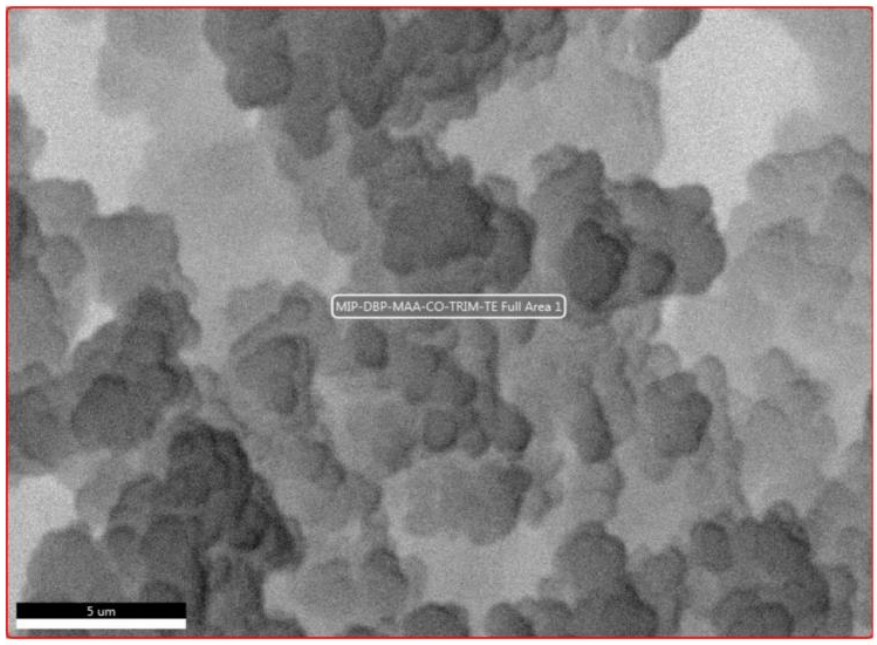
kV:20 Mag: 5000 Takeoff: 30 Live Time(s): 97 Amp Time(µs): 3.84 Resolution:(eV) 133.6



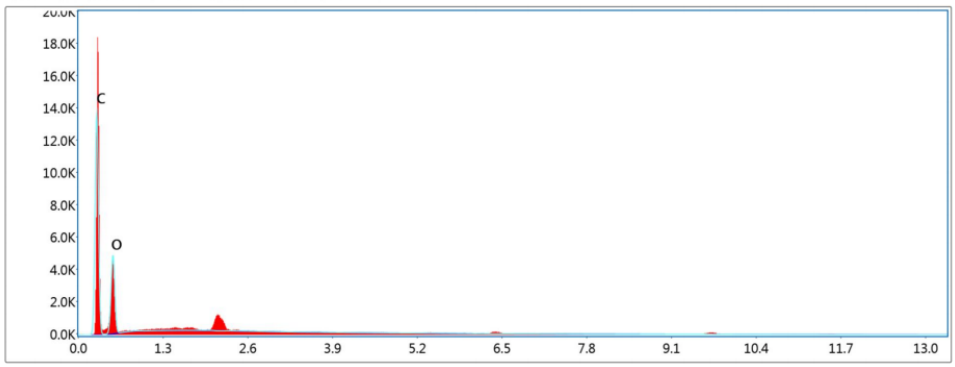
Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	A	F
C K	58.94	65.66	263.37	5.29	0.3788	1.0181	0.6311	1.0000
O K	41.06	34.34	87.95	10.71	0.0646	0.9726	0.1616	1.0000

3. MIP_DBP_MAA-co-TRIM(TE)



kV:20 Mag: 5000 Takeoff: 30 Live Time(s): 97.7 Amp Time(µs): 3.84 Resolution:(eV) 133.6

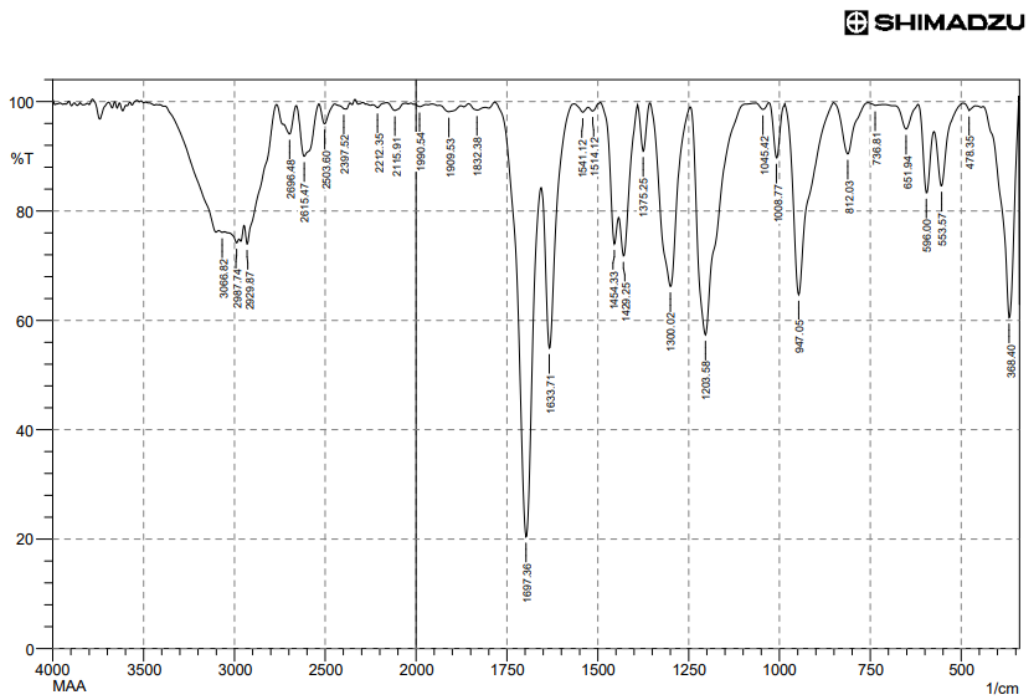


Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	A	F
C K	56.74	63.60	896.56	5.07	0.3572	1.0191	0.6179	1.0000
O K	43.26	36.40	347.76	9.84	0.0707	0.9736	0.1680	1.0000

Lampiran 7. Karakterisasi FTIR

1. Spektrum Monomer MAA

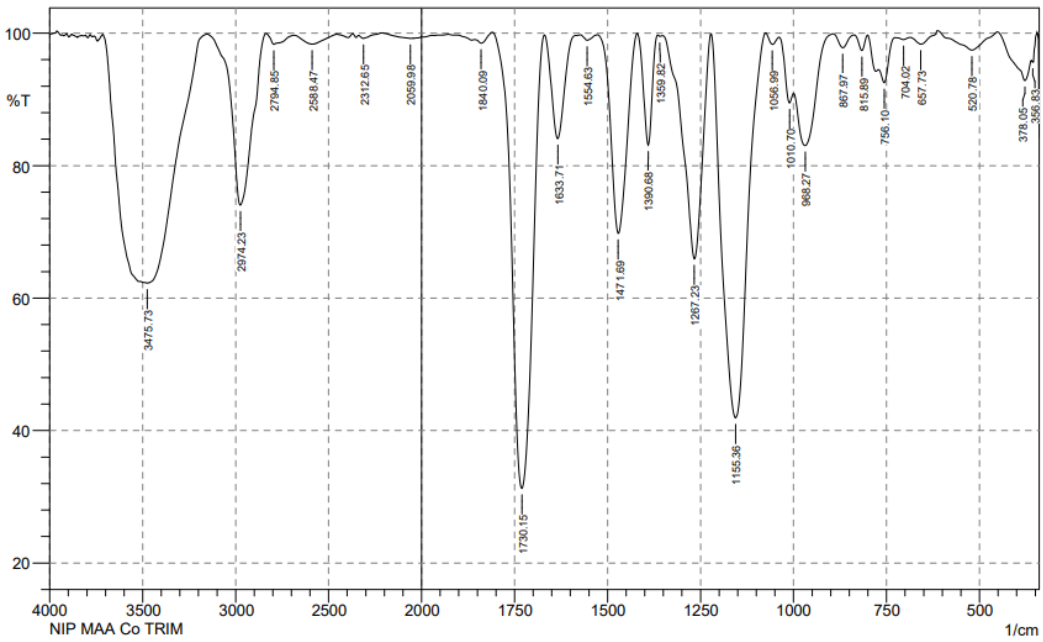


No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	368.4	60.49	37.684	437.84	343.33	7.841	7.199
2	478.35	98.319	1.157	493.78	460.99	0.14	0.063
3	553.57	84.571	11.346	574.79	495.71	2.271	1.286
4	596	83.307	13.463	617.22	576.72	1.823	1.239
5	651.94	94.989	4.365	684.73	619.15	0.711	0.526
6	736.81	99.274	0.361	758.02	711.73	0.104	0.028
7	812.03	90.419	9.351	850.61	758.02	1.637	1.545
8	947.05	64.653	34.72	983.7	852.54	8.797	8.516
9	1008.77	89.689	10.004	1028.06	985.62	0.933	0.874
10	1045.42	98.567	1.2	1064.71	1028.06	0.136	0.098
11	1203.58	57.354	41.758	1244.09	1072.42	13.592	13.078
12	1300.02	66.178	33.187	1355.96	1246.02	8.726	8.422
13	1375.25	90.945	8.609	1390.68	1355.96	0.709	0.645
14	1429.25	71.769	11.69	1440.83	1392.61	3.891	1.352
15	1454.33	73.947	9.714	1492.9	1442.75	3.082	0.701
16	1514.12	98.258	1.007	1525.69	1492.9	0.155	0.068
17	1541.12	98.037	1.153	1566.2	1525.69	0.215	0.085
18	1633.71	54.896	33.018	1654.92	1566.2	8.451	5.216
19	1697.36	20.431	68.838	1782.23	1656.85	25.453	20.698
20	1832.38	98.41	0.872	1855.52	1809.23	0.238	0.093
21	1909.53	98.142	1.135	1934.6	1876.74	0.348	0.164
22	1990.54	99.059	0.425	2007.9	1973.18	0.107	0.029
23	2115.91	98.381	1.358	2158.35	2056.12	0.414	0.295
24	2212.35	98.903	0.637	2237.43	2166.06	0.201	0.076
25	2397.52	98.671	0.041	2447.67	2395.59	0.186	-0.016
26	2503.6	95.933	3.634	2534.46	2447.67	0.805	0.64
27	2615.47	89.999	9.35	2659.84	2536.39	3.377	3.05
28	2696.48	94.074	5.223	2767.85	2661.77	1.731	1.425
29	2929.87	73.961	5.3	2945.3	2769.78	12.506	2.623
30	2987.74	74.168	0.868	3053.32	2976.16	9.462	0.079
31	3066.82	76.093	0.178	3084.18	3055.24	3.418	0.017

Date/Time; 4/18/2023 5:53:21 PM
No. of Scans;
Resolution;
Apodization;

2. Spektrum NIP_MAA-co-TRIM

SHIMADZU



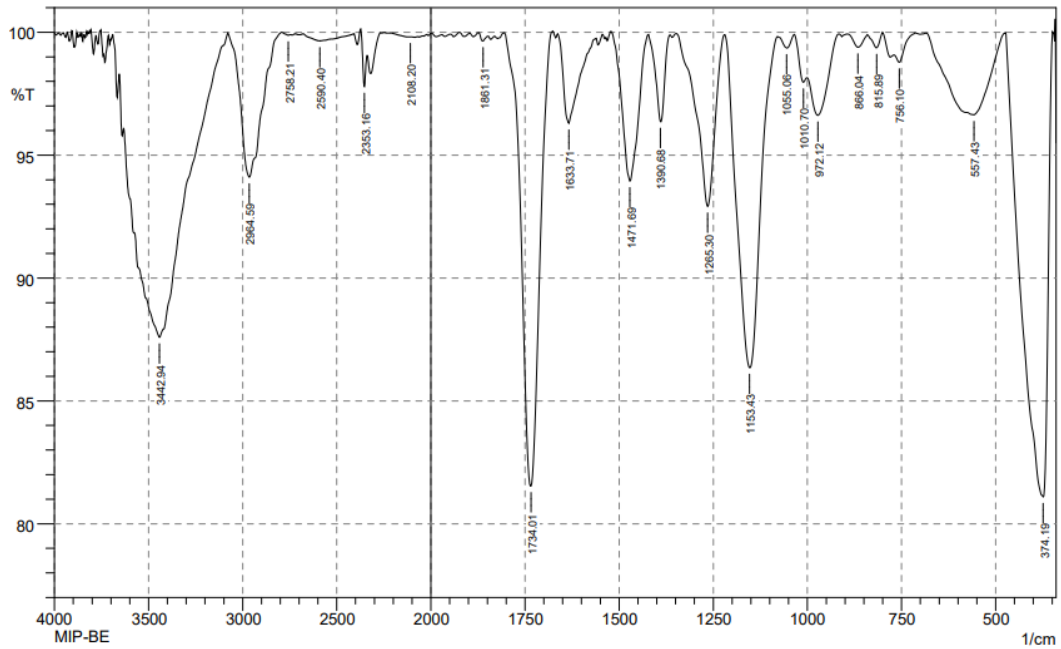
No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	356.83	95.634	1.316	360.69	345.26	0.171	0.035
2	378.05	92.843	3.681	451.34	362.62	1.589	0.772
3	520.78	97.444	2.823	611.43	451.34	0.845	1.038
4	657.73	98.342	1.401	686.66	611.43	0.288	0.242
5	704.02	99.042	0.307	725.23	686.66	0.134	0.024
6	756.1	92.534	3.579	771.53	725.23	0.901	0.266
7	815.89	97.365	2.373	837.11	800.46	0.216	0.175
8	867.97	97.797	2.037	894.97	837.11	0.274	0.231
9	968.27	83.023	10.555	999.13	894.97	4.385	2.315
10	1010.7	89.487	3.639	1037.7	1001.06	1.12	0.293
11	1056.99	98.309	1.406	1074.35	1039.63	0.16	0.117
12	1155.36	41.918	58.035	1220.94	1076.28	24.655	24.63
13	1267.23	65.938	33.859	1352.1	1222.87	9.526	9.391
14	1359.82	99.49	0.192	1365.6	1352.1	0.024	0.005
15	1390.68	83.108	16.721	1419.61	1365.6	1.926	1.886
16	1471.69	69.783	30.051	1527.62	1421.54	6.923	6.845
17	1554.63	98.942	0.815	1571.99	1527.62	0.128	0.081
18	1633.71	84.066	15.618	1668.43	1587.42	2.768	2.654
19	1730.15	31.265	68.64	1809.23	1670.35	25.919	25.878
20	1840.09	98.482	0.953	1857.45	1809.23	0.186	0.099
21	2059.98	99.224	0.073	2218.14	2046.47	0.33	0.062
22	2312.65	99.216	0.527	2339.65	2218.14	0.212	0.135
23	2588.47	98.351	1.41	2682.98	2459.24	0.969	0.75
24	2794.85	98.322	1.565	2835.36	2684.91	0.634	0.52
25	2974.23	74.059	25.858	3151.69	2837.29	15.187	15.066
26	3475.73	62.277	1.804	3491.16	3153.61	34.555	2.786

Comment;
NIP MAA Co TRIM

Date/Time; 3/27/2023 12:50:24 PM
No. of Scans;
Resolution;
Apodization;

3. Spektrum MIP_DBP_MAA-co-TRIM(BE)

SHIMADZU



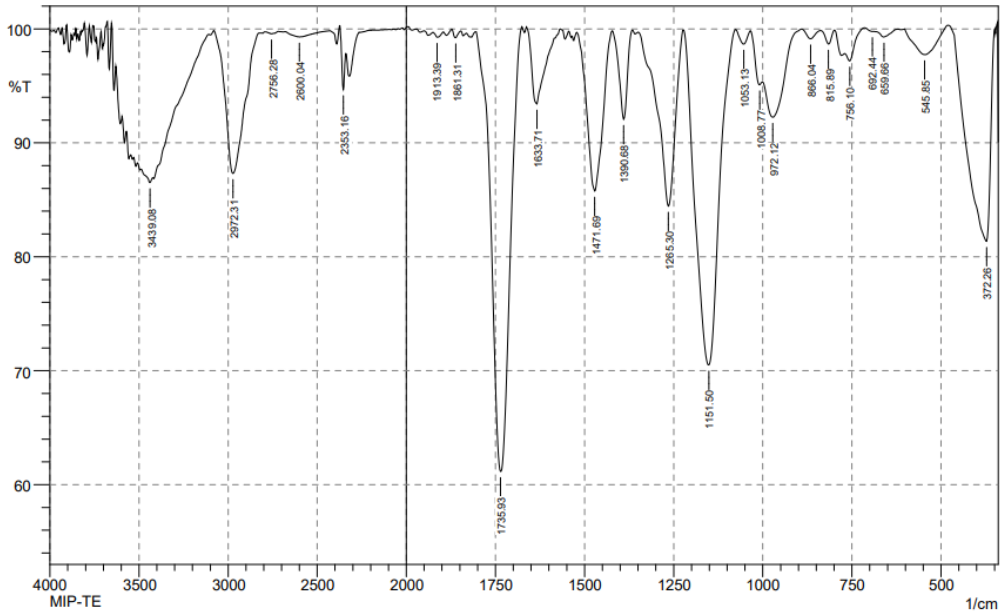
No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	374.19	81.094	18.905	472.56	349.12	6.65	6.634
2	557.43	96.642	0.71	576.72	474.49	0.937	0.198
3	756.1	98.78	0.512	769.6	713.66	0.149	0.033
4	815.89	99.368	0.593	840.96	800.46	0.063	0.054
5	866.04	99.391	0.523	893.04	840.96	0.08	0.061
6	972.12	96.622	2.135	1001.06	916.19	0.779	0.421
7	1010.7	97.969	0.702	1033.85	1001.06	0.196	0.057
8	1055.06	99.36	0.491	1074.35	1033.85	0.072	0.046
9	1153.43	86.352	13.507	1219.01	1080.14	4.188	4.102
10	1265.3	92.919	7.001	1348.24	1220.94	1.687	1.647
11	1390.68	96.363	3.534	1421.54	1365.6	0.414	0.389
12	1471.69	93.951	6.014	1521.84	1423.47	1.26	1.245
13	1633.71	96.292	3.593	1662.64	1560.41	0.781	0.713
14	1734.01	81.536	18.463	1805.37	1678.07	4.455	4.453
15	1861.31	99.647	0.273	1872.88	1847.81	0.025	0.016
16	2108.2	99.808	0.003	2218.14	2106.27	0.06	0.007
17	2353.16	97.789	1.746	2372.44	2337.72	0.189	0.128
18	2590.4	99.649	0.288	2677.2	2407.16	0.271	0.199
19	2758.21	99.881	0.045	2792.93	2746.63	0.015	0.005
20	2964.59	94.107	5.857	3076.46	2794.85	3.246	3.209
21	3442.94	87.587	6.429	3576.02	3078.39	15.862	6.669

Comment;
MIP-BE

Date/Time; 4/18/2023 5:13:19 PM
No. of Scans;
Resolution;
Apodization;

4. Spektrum MIP_DBP_MAA-co-TRIM (TE)

SHIMADZU



No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	372.26	81.364	18.53	478.35	351.04	6.049	6.081
2	545.85	97.743	2.398	601.79	480.28	0.657	0.738
3	659.66	99.297	0.533	680.87	621.08	0.102	0.066
4	692.44	99.767	0.055	713.66	688.59	0.012	0.005
5	756.1	97.19	1.246	771.53	713.66	0.341	0.078
6	815.89	98.671	1.199	837.11	798.53	0.116	0.094
7	866.04	99.132	0.79	891.11	837.11	0.107	0.087
8	972.12	92.244	4.345	1001.06	893.04	2.024	0.954
9	1008.77	95.098	1.306	1033.85	1001.06	0.468	0.117
10	1053.13	98.666	1.221	1076.28	1033.85	0.142	0.121
11	1151.5	70.506	29.428	1222.87	1076.28	10.249	10.207
12	1265.3	84.45	15.364	1348.24	1224.8	3.846	3.73
13	1390.68	92.081	7.782	1421.54	1365.6	0.884	0.85
14	1471.69	85.777	13.974	1521.84	1423.47	3.155	3.049
15	1633.71	93.416	6.623	1660.71	1568.13	1.207	1.218
16	1735.93	61.156	38.817	1803.44	1676.14	11.168	11.147
17	1861.31	99.224	0.67	1872.88	1847.81	0.05	0.038
18	1913.39	99.265	0.451	1924.96	1896.03	0.066	0.031
19	2353.16	94.673	4.107	2374.37	2339.65	0.446	0.301
20	2600.04	99.3	0.478	2681.05	2426.45	0.492	0.264
21	2756.28	99.572	0.184	2791	2717.7	0.11	0.033
22	2972.31	87.316	12.446	3078.39	2823.79	6.833	6.548
23	3439.08	86.509	0.611	3487.3	3423.65	3.851	0.097

Comment;
MIP-TE

Date/Time; 4/18/2023 5:25:08 PM
No. of Scans;
Resolution;
Apodization;

Lampiran 8. Karakterisasi SAA

micromeritics®

Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		

Summary Report

Surface Area

Single point surface area at P/Po = 0,299670116:	23,9854 m²/g
BET Surface Area:	24,2362 m²/g

Pore Volume

Single point adsorption total pore volume of pores less than 384,1792 nm diameter at P/Po = 0,995000000:	0,039805 cm³/g

Pore Size

Adsorption average pore diameter (4V/A by BET):	6,5696 nm
Desorption average pore diameter (4V/A by BET):	4,6107 nm

Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		

Isotherm Tabular Report

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm³/g STP)	Elapsed Time (h:min)	Saturation Pressure (mmHg)
			00:48	721.245667
0.058928286	42.501602	5.9478	01:34	721.242798
0.075148432	54.202953	6.2150	01:37	721.278564
0.090272853	65.110497	6.3747	01:40	721.263306
0.110234967	79.506546	6.5687	01:42	721.246155
0.134985680	97.356148	6.7712	01:44	721.233154
0.150085897	108.248299	6.9236	01:46	721.242310
0.174856383	126.111687	7.1030	01:48	721.230103
0.199807140	144.103180	7.2733	01:51	721.211365
0.224790775	162.118561	7.4242	01:53	721.197571
0.249804961	180.150787	7.5775	01:55	721.165771
0.274660577	198.071884	7.7232	01:57	721.151489
0.299670116	216.099777	7.8686	01:59	721.125549
0.319698594	230.539429	8.0149	02:01	721.114929
0.339657514	244.932602	8.1535	02:03	721.116394
0.379224402	273.465118	8.2876	02:05	721.116882
0.439320804	316.789368	8.4133	02:08	721.088928
0.479632664	345.848114	8.5590	02:10	721.068726
0.499444533	360.118469	8.6968	02:12	721.037964
0.538845208	388.523346	8.8599	02:14	721.029602
0.578624713	417.204346	9.0118	02:16	721.027527
0.618589514	446.013611	9.1772	02:18	721.017090
0.658503649	474.779724	9.3684	02:20	720.997864
0.698433530	503.551605	9.5767	02:22	720.972839
0.738326302	532.295410	9.8127	02:24	720.948730
0.778235338	561.050964	10.0848	02:26	720.927124
0.818087197	589.780701	10.4696	02:29	720.926453
0.857961624	618.518433	10.9351	02:31	720.916199
0.888245901	640.343323	11.4767	02:33	720.907715
0.899308513	648.302856	11.8555	02:35	720.890381

Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		

Isotherm Tabular Report

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm³/g STP)	Elapsed Time (h:min)	Saturation Pressure (mmHg)
0.909579510	655.677307	12.2430	02:37	720.857605
0.919492850	662.797485	12.6475	02:39	720.829407
0.929294477	669.865906	13.1131	02:41	720.832764
0.939315724	677.082153	13.6491	02:43	720.824890
0.949286967	684.264343	14.2707	02:45	720.819275
0.954521094	688.005859	14.7868	02:47	720.786438
0.959698185	691.728943	15.3312	02:49	720.777588
0.964624198	695.258484	15.8732	02:51	720.755798
0.969517747	698.776306	16.5362	02:54	720.746277
0.974585576	702.395020	17.3752	02:56	720.711487
0.979619586	705.997498	18.3351	02:58	720.685364
0.982169946	707.831848	19.0094	03:00	720.681641
0.984717905	709.665771	19.8549	03:02	720.679260
0.987377487	711.550476	20.7336	03:04	720.646851
0.989560400	713.087891	21.7973	03:06	720.610779
0.991973621	714.801697	22.9853	03:08	720.585388
0.993564717	715.897217	24.1994	03:10	720.534058
0.994873921	716.834167	25.5323	03:13	720.527649
0.996757649	718.090881	28.5467	03:24	720.426758
0.980582183	706.404785	21.4547	03:27	720.393250
0.962509588	693.380005	18.8553	03:29	720.387634
0.941379581	678.130859	17.6517	03:31	720.358582
0.920885425	663.354004	17.0176	03:33	720.343689
0.900583842	648.714111	16.6869	03:35	720.326172
0.880439018	634.201172	16.4499	03:37	720.323792
0.861001077	620.177856	16.3364	03:39	720.298584
0.802208495	577.832581	16.0151	03:42	720.302246
0.780884818	562.478760	16.0240	03:44	720.309509
0.721701661	519.836060	16.0073	03:46	720.292175
0.700827274	504.775421	16.0378	03:48	720.256531

Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		

Isotherm Tabular Report

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm³/g STP)	Elapsed Time (h:min)	Saturation Pressure (mmHg)
0.641375895	461.930084	16.1191	03:50	720.217407
0.600544447	432.502258	16.1949	03:52	720.183594
0.560393070	403.573547	16.2875	03:54	720.161560
0.520291368	374.695526	16.3721	03:56	720.164795
0.480331450	345.898773	16.3561	03:58	720.125183
0.460512866	331.615753	16.3201	04:00	720.100952
0.421048713	303.193390	16.2280	04:03	720.091003
0.380807482	274.213531	16.1992	04:05	720.084412
0.320746085	230.957581	16.1423	04:07	720.063599
0.300360110	216.293304	16.0999	04:09	720.113281
0.251389134	181.026199	16.0427	04:11	720.103516
0.201408692	145.035980	15.9110	04:13	720.107849
0.152432222	109.768570	15.7223	04:15	720.113953
0.100995484	72.721939	15.3775	04:19	720.051392

Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
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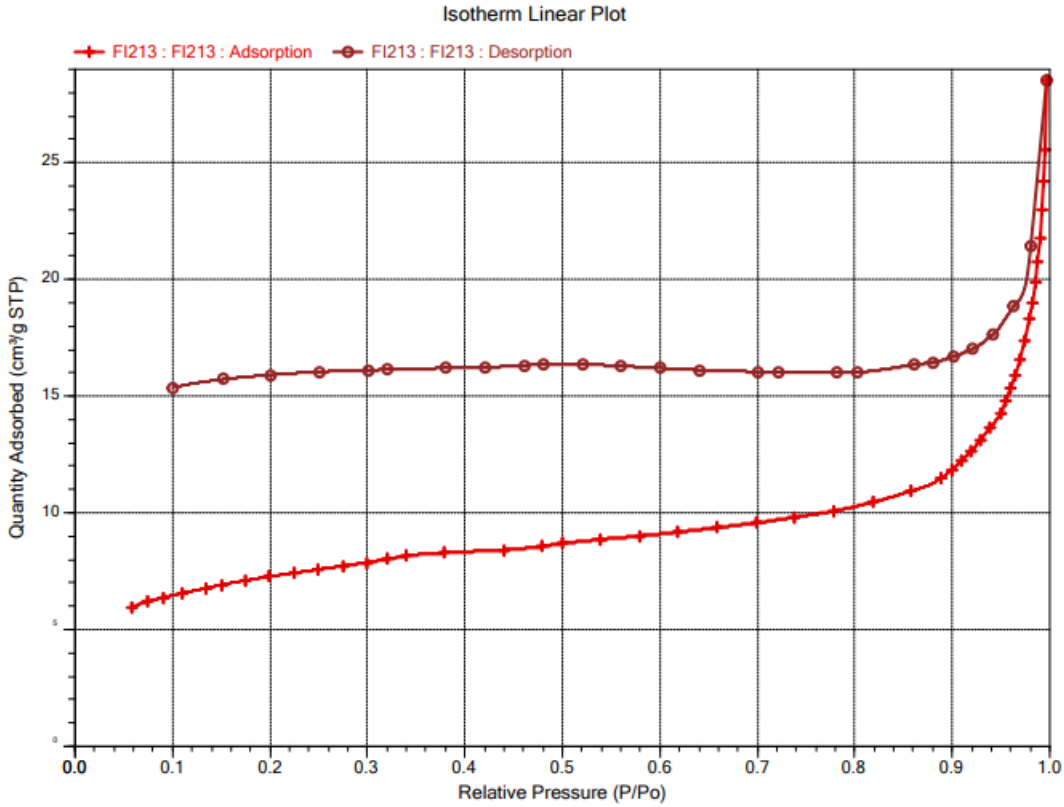
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		



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Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
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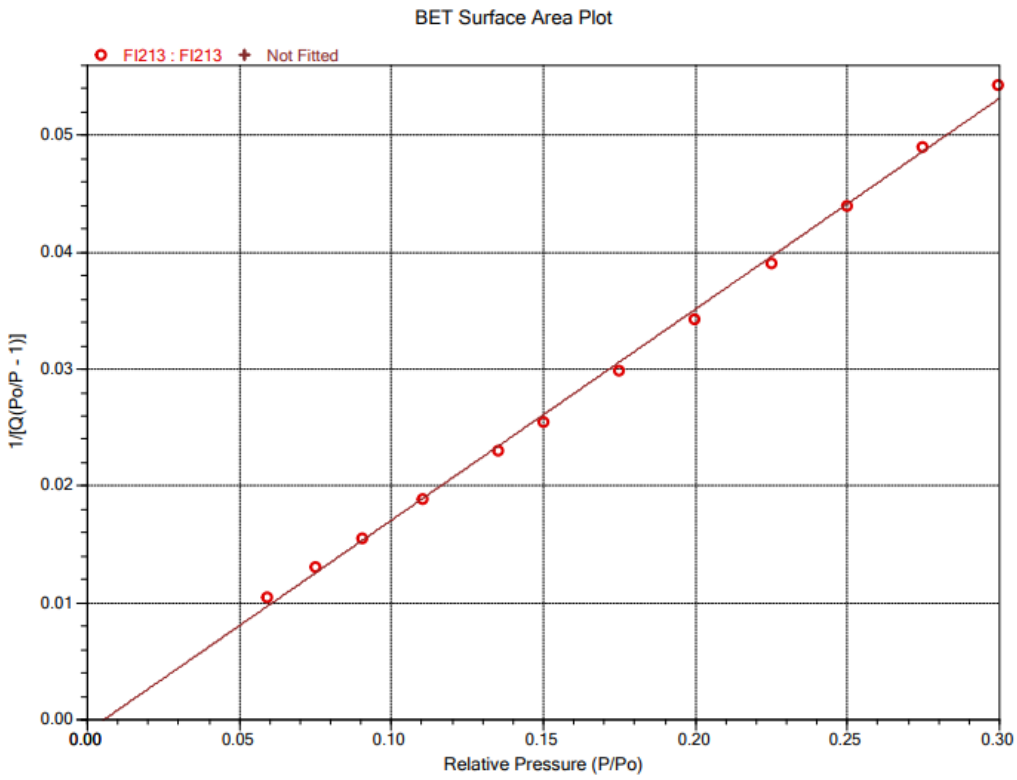
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		

BET Report

BET surface area:	24,2362 ± 0,3568 m²/g
Slope:	0,180573 ± 0,002599 g/cm³ STP
Y-intercept:	-0,000983 ± 0,000485 g/cm³ STP
C:	-182,661140
Qm:	5,5682 cm³/g STP
Correlation coefficient:	0,9989661
Molecular cross-sectional area:	0,1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.058928286	5.9478	0.010528
0.075148432	6.2150	0.013074
0.090272853	6.3747	0.015566
0.110234967	6.5687	0.018861
0.134985680	6.7712	0.023046
0.150085897	6.9236	0.025506
0.174856383	7.1030	0.029834
0.199807140	7.2733	0.034331
0.224790775	7.4242	0.039058
0.249804961	7.5775	0.043944
0.274660577	7.7232	0.049030
0.299670116	7.8686	0.054380

Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		



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Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		

BJH Adsorption Pore Distribution Report
Faas Correction
Harkins and Jura
t = [13.99 / (0.034 - log(P/Po))] ^ 0.5

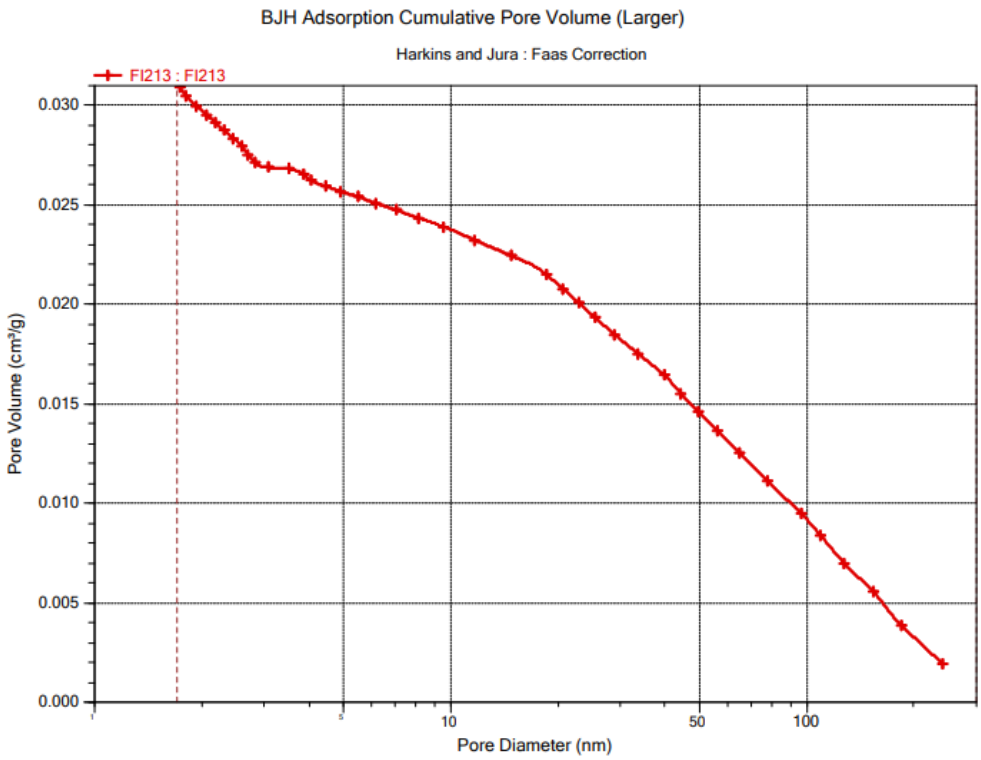
Diameter range:	1,7000 to 300,0000 nm
Adsorbate property factor:	0,95300 nm
Density conversion factor:	0,0015468
Fraction of pores open at both ends:	0,00

Pore Diameter Range (nm)	Average Diameter (nm)	Incremental Pore Volume (cm³/g)	Cumulative Pore Volume (cm³/g)	Incremental Pore Area (m²/g)	Cumulative Pore Area (m²/g)
299.1 - 240.4	263.3	0.001934	0.001934	0.029	0.029
240.4 - 185.4	205.8	0.001906	0.003840	0.037	0.066
185.4 - 153.8	166.6	0.001720	0.005560	0.041	0.108
153.8 - 127.5	138.1	0.001431	0.006991	0.041	0.149
127.5 - 109.6	117.2	0.001389	0.008380	0.047	0.197
109.6 - 96.2	102.0	0.001115	0.009495	0.044	0.240
96.2 - 77.6	84.8	0.001603	0.011099	0.076	0.316
77.6 - 65.0	70.1	0.001419	0.012518	0.081	0.397
65.0 - 56.3	60.0	0.001133	0.013651	0.076	0.472
56.3 - 49.6	52.5	0.000934	0.014585	0.071	0.544
49.6 - 44.2	46.6	0.000949	0.015534	0.082	0.625
44.2 - 39.8	41.7	0.000909	0.016443	0.087	0.712
39.8 - 33.5	36.0	0.001095	0.017538	0.122	0.834
33.5 - 28.9	30.8	0.000957	0.018495	0.124	0.958
28.9 - 25.5	27.0	0.000842	0.019336	0.125	1.083
25.5 - 22.8	24.0	0.000737	0.020073	0.123	1.205
22.8 - 20.6	21.6	0.000714	0.020787	0.132	1.337
20.6 - 18.6	19.5	0.000705	0.021491	0.144	1.482
18.6 - 14.8	16.2	0.000955	0.022446	0.235	1.717
14.8 - 11.6	12.8	0.000793	0.023240	0.248	1.965
11.6 - 9.6	10.4	0.000670	0.023910	0.258	2.223

Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		

Pore Diameter Range (nm)	Average Diameter (nm)	Incremental Pore Volume (cm³/g)	Cumulative Pore Volume (cm³/g)	Incremental Pore Area (m²/g)	Cumulative Pore Area (m²/g)
9.6 - 8.1	8.7	0.000442	0.024352	0.203	2.426
8.1 - 7.0	7.5	0.000388	0.024740	0.207	2.633
7.0 - 6.2	6.5	0.000345	0.025084	0.211	2.844
6.2 - 5.5	5.8	0.000323	0.025408	0.224	3.067
5.5 - 4.9	5.2	0.000269	0.025677	0.208	3.276
4.9 - 4.4	4.7	0.000248	0.025925	0.213	3.489
4.4 - 4.0	4.2	0.000303	0.026228	0.287	3.777
4.0 - 3.9	3.9	0.000344	0.026572	0.349	4.125
3.9 - 3.5	3.7	0.000249	0.026820	0.271	4.397
3.5 - 3.1	3.3	0.000066	0.026886	0.081	4.478
3.1 - 2.8	2.9	0.000249	0.027135	0.340	4.817
2.8 - 2.7	2.8	0.000405	0.027541	0.588	5.406
2.7 - 2.6	2.6	0.000434	0.027975	0.658	6.064
2.6 - 2.4	2.5	0.000384	0.028359	0.612	6.676
2.4 - 2.3	2.4	0.000381	0.028740	0.642	7.318
2.3 - 2.2	2.2	0.000405	0.029145	0.722	8.040
2.2 - 2.1	2.1	0.000383	0.029528	0.724	8.764
2.1 - 1.9	2.0	0.000458	0.029985	0.919	9.684
1.9 - 1.8	1.9	0.000480	0.030465	1.027	10.710
1.8 - 1.7	1.8	0.000489	0.030954	1.104	11.814

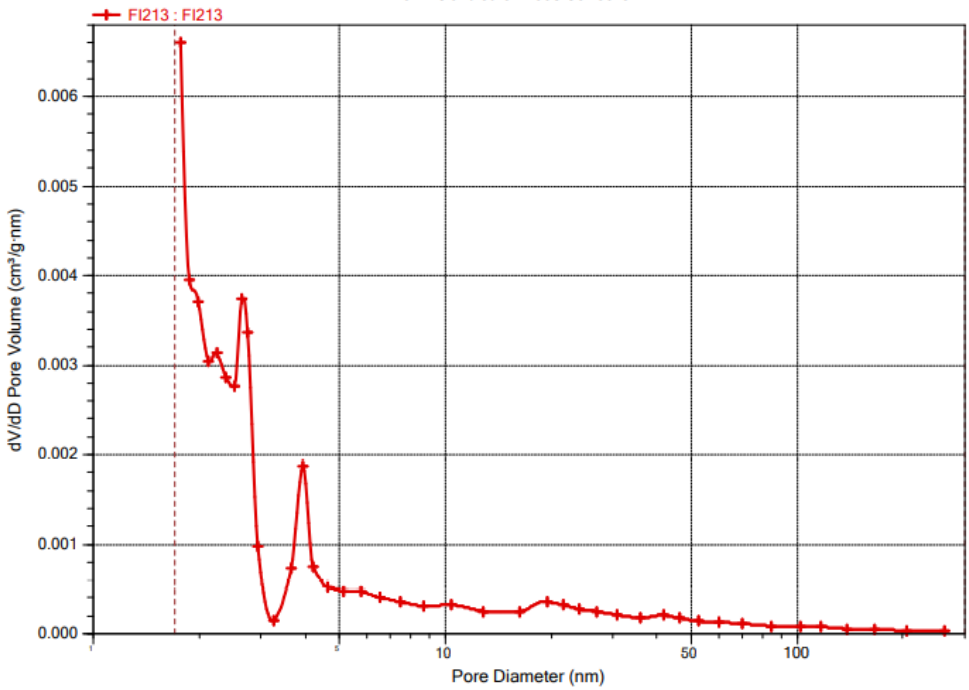
Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		



Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		

BJH Adsorption dV/dD Pore Volume

Harkins and Jura : Faas Correction



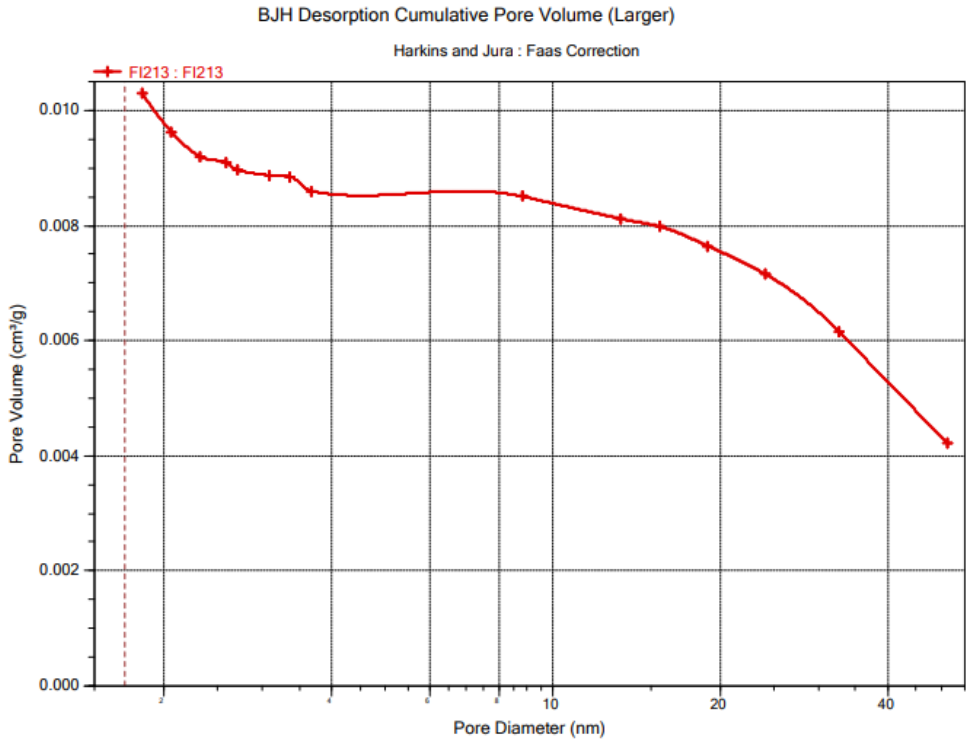
Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		

BJH Desorption Pore Distribution Report
Faas Correction
Harkins and Jura
t = [13.99 / (0.034 - log(P/Po))] ^ 0.5

Diameter range:	1,7000 to 300,0000 nm
Adsorbate property factor:	0,95300 nm
Density conversion factor:	0,0015468
Fraction of pores open at both ends:	0,00

Pore Diameter Range (nm)	Average Diameter (nm)	Incremental Pore Volume (cm³/g)	Cumulative Pore Volume (cm³/g)	Incremental Pore Area (m²/g)	Cumulative Pore Area (m²/g)
98.9 - 51.3	61.3	0.004216	0.004216	0.275	0.275
51.3 - 32.7	38.0	0.001941	0.006156	0.204	0.479
32.7 - 24.1	27.1	0.000998	0.007155	0.147	0.627
24.1 - 19.0	20.9	0.000492	0.007647	0.094	0.721
19.0 - 15.6	17.0	0.000338	0.007984	0.080	0.800
15.6 - 13.2	14.2	0.000135	0.008119	0.038	0.838
13.2 - 8.8	10.2	0.000386	0.008506	0.151	0.989
8.8 - 3.7	3.8	0.000090	0.008596	0.095	1.085
3.7 - 3.4	3.5	0.000253	0.008848	0.288	1.373
3.4 - 3.1	3.2	0.000023	0.008871	0.029	1.401
3.1 - 2.7	2.9	0.000092	0.008964	0.129	1.530
2.7 - 2.6	2.6	0.000124	0.009088	0.188	1.718
2.6 - 2.3	2.4	0.000113	0.009201	0.186	1.904
2.3 - 2.1	2.2	0.000428	0.009629	0.788	2.692
2.1 - 1.8	1.9	0.000669	0.010299	1.390	4.081

Started:	6/22/2023 7:29:41 AM	Analysis adsorptive:	N2
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		



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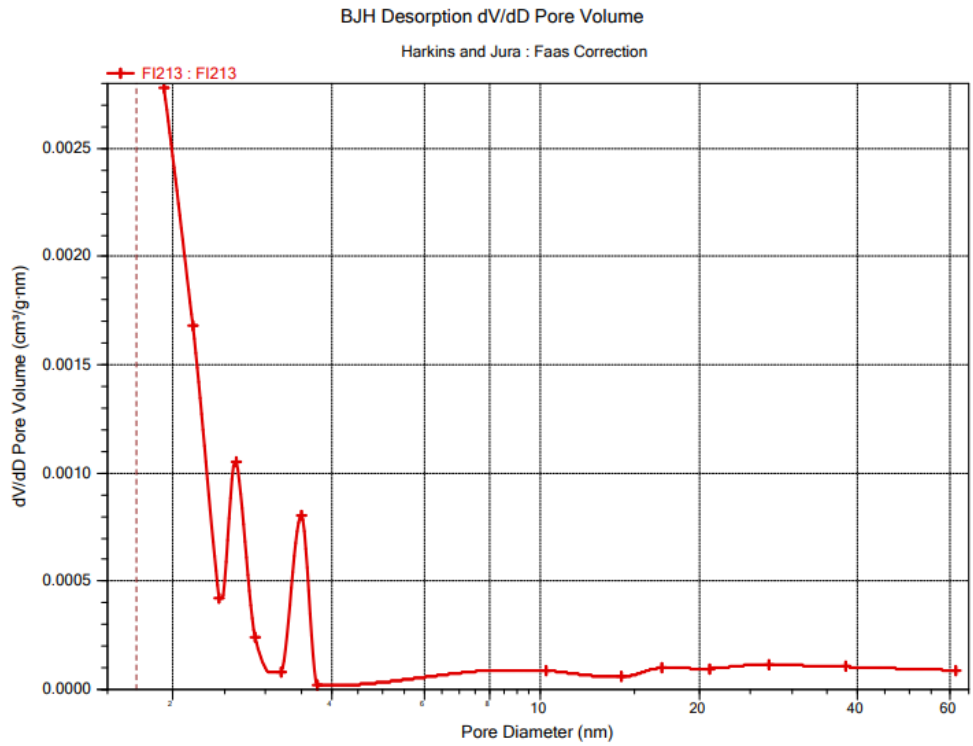
Completed:	6/22/2023 11:50:28 AM	Analysis bath temp.:	-195,850 °C
Report time:	6/22/2023 1:33:21 PM	Thermal correction:	No
Sample mass:	0,0318 g	Ambient free space:	10,9879 cm³ Measured
Analysis free space:	31,5746 cm³	Equilibration interval:	10 s
Low pressure dose:	None	Sample density:	1,000 g/cm³
Automatic degas:	No		



Lampiran 9. Contoh Perhitungan Nilai K_1 dan K_2 berdasarkan Persamaan Orde Satu Semu dan Orde Dua Semu

1. Penentuan K_1 dari persamaan orde satu semu

Persamaan orde satu semu:

$$\log (q_e - q_t) = \log q_e - K_1 \, t/2{,}303$$

- $\log q_e$ = Intercept
  q_e = Inv. log Intercept

  $\log q_e$ = 0,0411
  q_e = 1,0992

- $K_1/2{,}303$ = Slope
  K_1 = Slope x 2,303
  K_1 = -0,0083 x 2,303
  K_1 = -0,0191

2. Penentuan K_2 dari persamaan orde dua semu

Persamaan orde dua semu:

$$t/q_t = 1/K_2 \, q_e^2 + t/q_e$$

- $1/q_e$ = Slope
  q_e = 1/Slope

  q_e = 1/0,7318
  q_e = 1,3664

- $1/K_2 q_e^2$ = Intercept
  K_2 = 1/Intercept x q_e^2
  K_2 = 1/4,0119 x $(1{,}3664)^2$
  K_2 = 0,4653

Lampiran 10. Contoh Perhitungan Nilai Kapasitas Adsorpsi berdasarkan Model Persamaan Isotermal Adsorpsi Langmuir dan Isotermal Adsorpsi Freundlich

1. Isotermal Adsorpsi Langmuir

Persamaan:

$$\frac{1}{q_e} = \frac{1}{K_L q_m} \times \frac{1}{C_e} + \frac{1}{q_m}$$

Keterangan:

C_e = Konsentrasi saat kesetimbangan (mg/L)
q_e = Jumlah zat teradsorpsi saat kesetimbangan (mg/g)
q_m = Kapasitas adsorpsi maksimum monolayer (mg/g)
K_L = Konstanta afinitas adsorpsi atau konstanta kesetimbangan (L/mg)

Berdasarkan model isotermal Langmuir diperoleh persamaan garis:

$$y = 0{,}6794x + 0{,}692$$

$\frac{1}{q_m} = 0{,}6794$ maka, $q_m = \frac{1}{0{,}6794} = 1{,}4719$

$\frac{1}{q_m K_L} = 0{,}692$ maka, $K_L = \frac{1}{0{,}692 \times 1{,}4719} = 0{,}9819$

2. Isotermal Adsorpsi Freundlich

Persamaan:

$$\log q_e = \frac{1}{n} \log C_e + \log K_f$$

Keterangan:

C_e = Konsentrasi saat kesetimbangan (mg/L)
q_e = Jumlah zat teradsorpsi saat kesetimbangan (mg/g)
K_F = Kapasitas adsorpsi (mg/g)
$\frac{1}{n}$ = Konstanta Freundlich menyatakan faktor heterogenitas
n = Intensitas adsorpsi

Berdasarkan model isotermal Freundlich diperoleh persamaan garis:

$$y = 0{,}1688x - 0{,}0468$$

$\frac{1}{n} = 0{,}1688$ maka, $n = \frac{1}{0{,}1688} = 5{,}9241$

Log K_f = -0,0468
K_f = Inv. log (-0,0468)
K_f = 0,8978