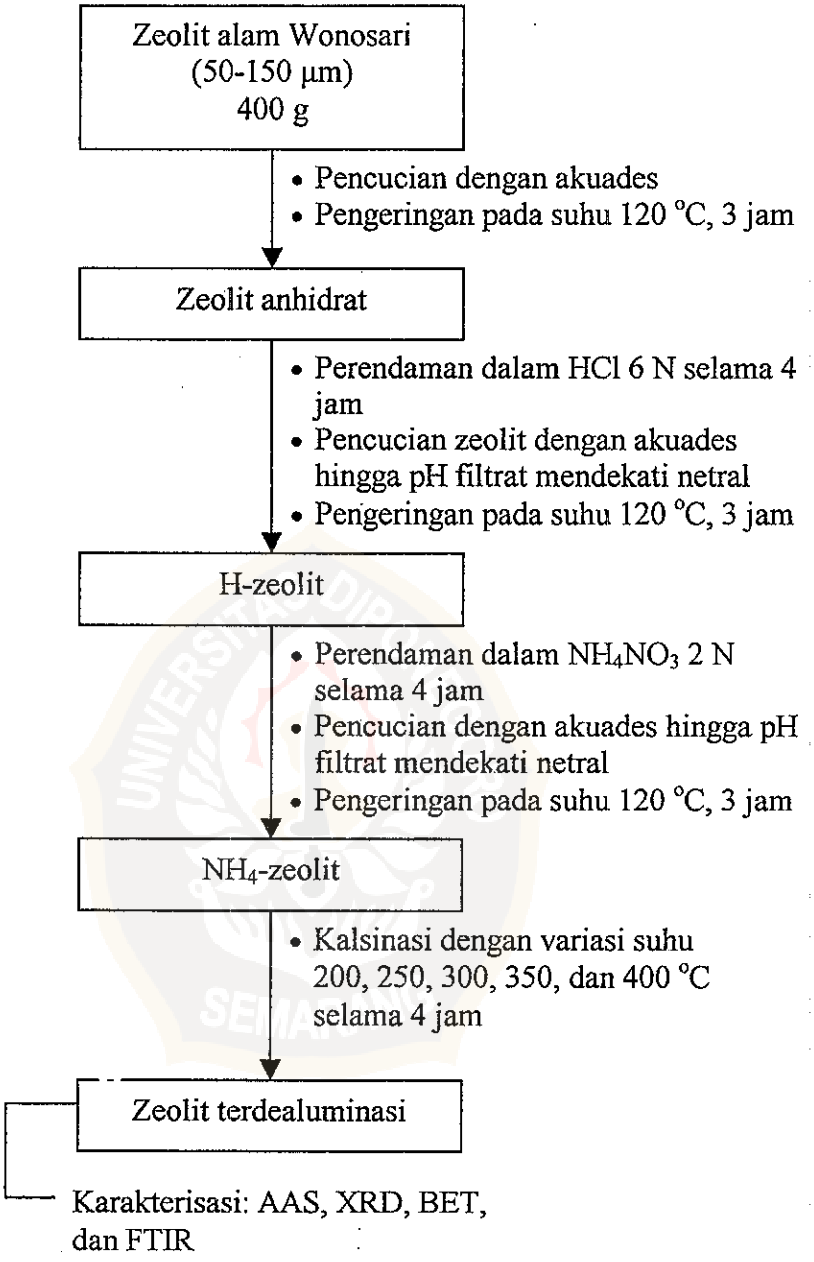
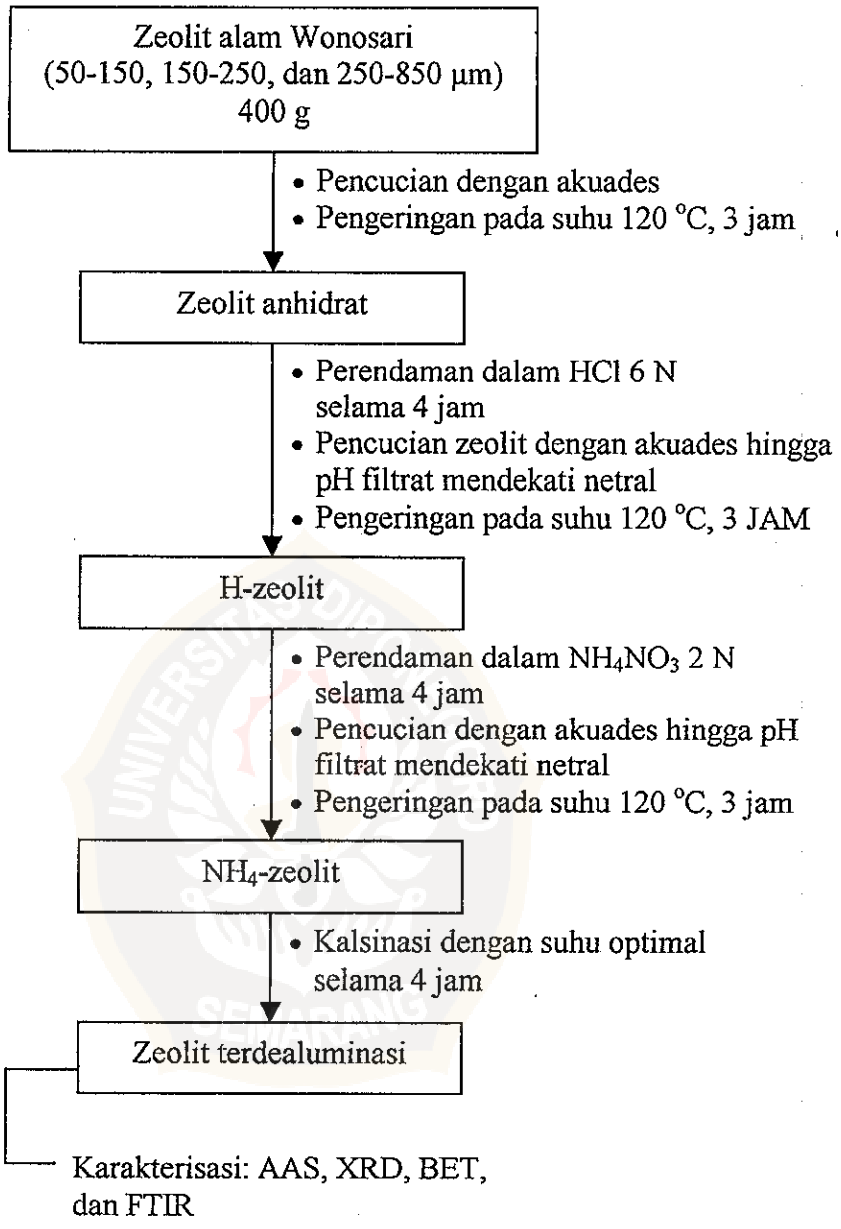
Lampiran 1. Diagram kerja

A. Variasi suhu kalsinasi



B. Variasi diameter Partikel



Lampiran 2. Perhitungan pembuatan larutan HCl 6 N dan NH_4NO_3 2 N.

A. Pembuatan larutan I liter HCl 6 N

Diketahui: Larutan induk, 37 %, ρ = 1,19 g/mL

Dalam 1 mL terdapat HCl seberat: $\frac{37}{100} \times 1{,}19 g/mL \times 1mL = 0{,}4403 g$

Untuk membuat larutan HCl 6 N diperlukan HCl induk seberat:

$M = N/n_{eq}$

$= 6/1$

$= 6$

$$w = M \times v \times BM$$
$$w = 6 \times 1 \times 36{,}46$$
$$w = 219 g$$

Maka volume yang dibutuhkan sebesar:

$$v = \frac{219}{0{,}4403} = 498 mL$$

B. Pembuatan larutan 1 liter NH_4NO_3 2 N

Diketahui BM= 80,04 mol/g

$N = M \times n_{eq}$

Maka 2 N larutan NH_4NO_3 adalah 2 M.

Dengan demikian berat NH_4NO_3 yang dibutuhkan adalah:

$$w = M \times BM \times v$$
$$w = 2 \times 80{,}4 \times 2$$
$$w = 160 g$$

Lampiran 3. Perhitungan rasio Si/Al

Diketahui BM_{Si}= 28,0855 g/mol ; BM_{Al}= 26,9185 g/mol

$$Si/Al = \frac{beratSi / BM(Si)}{beratAl / BM(Al)}$$

A.Rasio Si/Al zeolit alam.

$$Si/Al = \frac{34,38 / 28,0855}{6,21 / 26,9185}$$

$$Si/Al = 5,31$$

B.Rasio Si/Al zeolit terdealuminasi pada berbagai diameter partikel

1.Diameter 50-150 μm

$$Si/Al = \frac{39,51 / 28,0855}{1,47 / 26,9185}$$

$$Si/Al = 26,857$$

2.Diameter 150-250 μm

$$Si/Al = \frac{33,70 / 28,0855}{5,51 / 26,9185}$$

$$Si/Al = 5,874$$

3.Diameter 250-850 μm

$$Si/Al = \frac{33,90 / 28,0855}{5,64 / 26,9185}$$

$$Si/Al = 5,792$$

B.Rasio Si/Al zeolit terdealuminasi pada berbagai suhu kalsinasi

1. Suhu 200 °C.

$$Si/Al = \frac{32,00/28,0855}{4,90/26,9185}$$

$$Si/Al = 6,022$$

2. Suhu 250 °C

$$Si/Al = \frac{39,51/28,0855}{1,41/26,9185}$$

$$Si/Al = 26,867$$

3. Suhu 300 °C

$$Si/Al = \frac{39,64/28,0855}{5,58/26,9185}$$

$$Si/Al = 6,808$$

4. Suhu 350 °C

$$Si/Al = \frac{39,63/28,0855}{5,14/26,9185}$$

$$Si/Al = 7,389$$

5. Suhu 400 °C

$$Si/Al = \frac{37,88/28,0855}{5,23/26,9185}$$

$$Si/Al = 6,889$$

Lampiran 4

4.1 Hasil Analisis XRD Zeolit Alam

Strongest 3 peaks

no.	peak no.	2Theta (deg)	d (A)	I/I1	FWHM (deg)	Intensity (Counts)	Integrated Int (Counts)
1	30	25.5794	3.47964	100	0.21870	1626	21355
2	22	22.1739	4.00575	62	0.28300	1009	16306
3	35	27.6577	3.22271	55	0.45040	893	19861

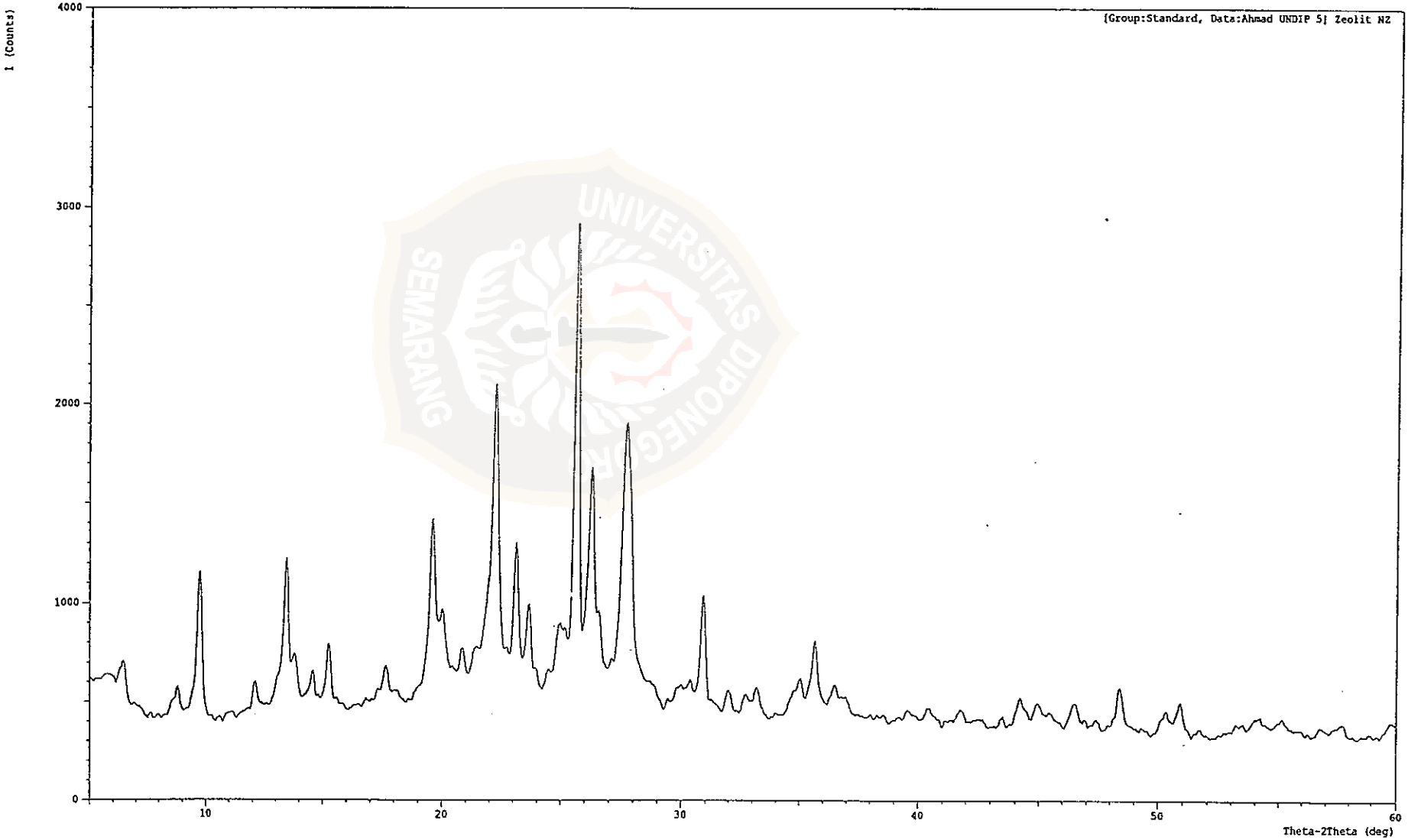
Peak Data List

peak no.	2Theta (deg)	d (A)	I/I1	FWHM (deg)	Intensity (Counts)	Integrated Int (Counts)
1	5.8800	15.01847	3	0.62860	54	1569
2	6.2600	14.10764	5	0.23000	86	810
3	6.4400	13.71372	8	0.22900	132	1454
4	8.5600	10.32150	3	0.18940	55	454
5	8.7300	10.12088	6	0.30000	102	1344
6	9.3600	9.44104	4	0.18000	71	1107
7	9.6923	9.11808	31	0.25050	503	6922
8	12.0818	7.31957	6	0.22090	102	1683
9	13.0400	6.78379	6	0.25200	105	1971
10	13.3928	6.60587	31	0.25380	500	5970
11	13.7600	6.43040	11	0.27820	174	3064
12	14.5261	6.09294	7	0.23620	115	1858
13	15.2195	5.81687	13	0.22900	214	3065
14	17.3200	5.11587	3	0.23560	55	947
15	17.6141	5.03111	8	0.27830	133	2601
16	19.2800	4.59999	7	0.17100	116	1859
17	19.5625	4.53419	36	0.27310	581	7431
18	19.9800	4.44038	16	0.28220	259	5214
19	20.8082	4.26547	6	0.22080	104	1348
20	21.4200	4.14501	6	0.38000	94	1725
21	21.7600	4.08100	12	0.31200	192	4038
22	22.1739	4.00575	62	0.28300	1009	16306
23	22.6800	3.91750	6	0.00000	97	0
24	23.0667	3.85269	30	0.23530	481	6939
25	23.5979	3.76715	17	0.24290	280	3866
26	23.9400	3.71409	4	0.14760	60	681
27	24.4600	3.63629	4	0.25720	62	893
28	24.9400	3.56739	12	0.45200	200	3938
29	25.1200	3.54223	11	0.00000	184	0
30	25.5794	3.47964	100	0.21870	1626	21355
31	26.1931	3.39949	45	0.27920	738	11079
32	26.5400	3.35584	15	0.21680	236	3290
33	27.0600	3.29252	5	0.24000	82	1134
34	27.3000	3.26412	11	0.17180	177	1707
35	27.6577	3.22271	55	0.45040	893	19861
36	28.2000	3.16196	6	0.00000	95	0
37	28.3000	3.15101	4	0.00000	70	0
38	28.5600	3.12291	3	0.00000	54	0
39	28.6800	3.11012	4	0.00000	61	0
40	28.8200	3.09533	4	0.22800	57	773
41	29.7600	2.99966	5	0.18660	74	1428
42	29.9600	2.98009	5	0.00000	82	0
43	30.3400	2.94363	6	0.21340	100	2248
44	30.8367	2.89734	25	0.22450	412	5627

peak no.	2Theta (deg)	d (A)	I/I1	FWHM (deg)	Intensity (Counts)	Integrated Int (Counts)
45	31.9387	2.79984	5	0.26750	80	1206
46	32.7000	2.73637	4	0.33000	70	1186
47	33.1327	2.70162	6	0.25890	99	1478
48	34.5400	2.59470	3	0.15120	54	931
49	34.7200	2.58165	5	0.00000	89	0
50	34.9600	2.56448	8	0.33780	127	2152
51	35.3200	2.53916	5	0.17000	87	934
52	35.5858	2.52080	17	0.24990	269	3697
53	36.2600	2.47546	4	0.20000	64	805
54	36.4400	2.46365	7	0.28440	110	1598
55	36.7600	2.44293	4	0.00000	66	0
56	36.9400	2.43144	4	0.16660	67	962
57	40.3700	2.23241	4	0.28000	62	1548
58	41.7125	2.16361	3	0.39500	56	1960
59	44.0000	2.05629	4	0.16000	64	515
60	44.1800	2.04833	6	0.20800	102	1010
61	44.4400	2.03695	3	0.16000	49	435
62	44.8923	2.01747	5	0.35260	81	2114
63	46.4280	1.95425	5	0.34400	87	2075
64	48.1200	1.88941	3	0.12920	53	642
65	48.3519	1.88089	12	0.19880	187	2295
66	50.1000	1.81928	4	0.21860	71	942
67	50.3000	1.81252	6	0.18580	96	933
68	50.8127	1.79542	8	0.31200	129	2524
69	53.1762	1.72106	3	0.18360	52	683
70	53.9600	1.69789	3	0.45820	55	1233
71	54.2000	1.69094	4	0.13540	58	444
72	55.0273	1.66746	3	0.40130	54	1750
73	59.7400	1.54668	4	0.33780	62	1431

*** Multi Plot ***

File Name : Standard\Ahmad UNDIP 5
Sample Name : Zeolit NZ Comment : Zeolit NZ
Date & Time : 03-13-03 13:24:02
Condition
X-ray Tube : Cu(1.54060 A) Voltage : 40.0 kV Current : 30.0 mA
Scan Range : 5.0000 <-> 60.0000 deg Step Size : 0.0200 deg
Count Time : 0.24 sec Slit DS : 1.00 deg SS : 1.00 deg RS : 0.30 mm



4.2 Hasil Analisis XRD Zeolit Terdealuminasi

Strongest 3 peaks

no.	peak no.	2Theta (deg)	d (A)	I/I1	FWHM (deg)	Intensity (Counts)	Integrated Int (Counts)
1	28	25.5975	3.47723	100	0.22060	1907	22835
2	21	22.1897	4.00294	68	0.28210	1292	22506
3	32	27.5600	3.23391	58	0.28240	1102	16124

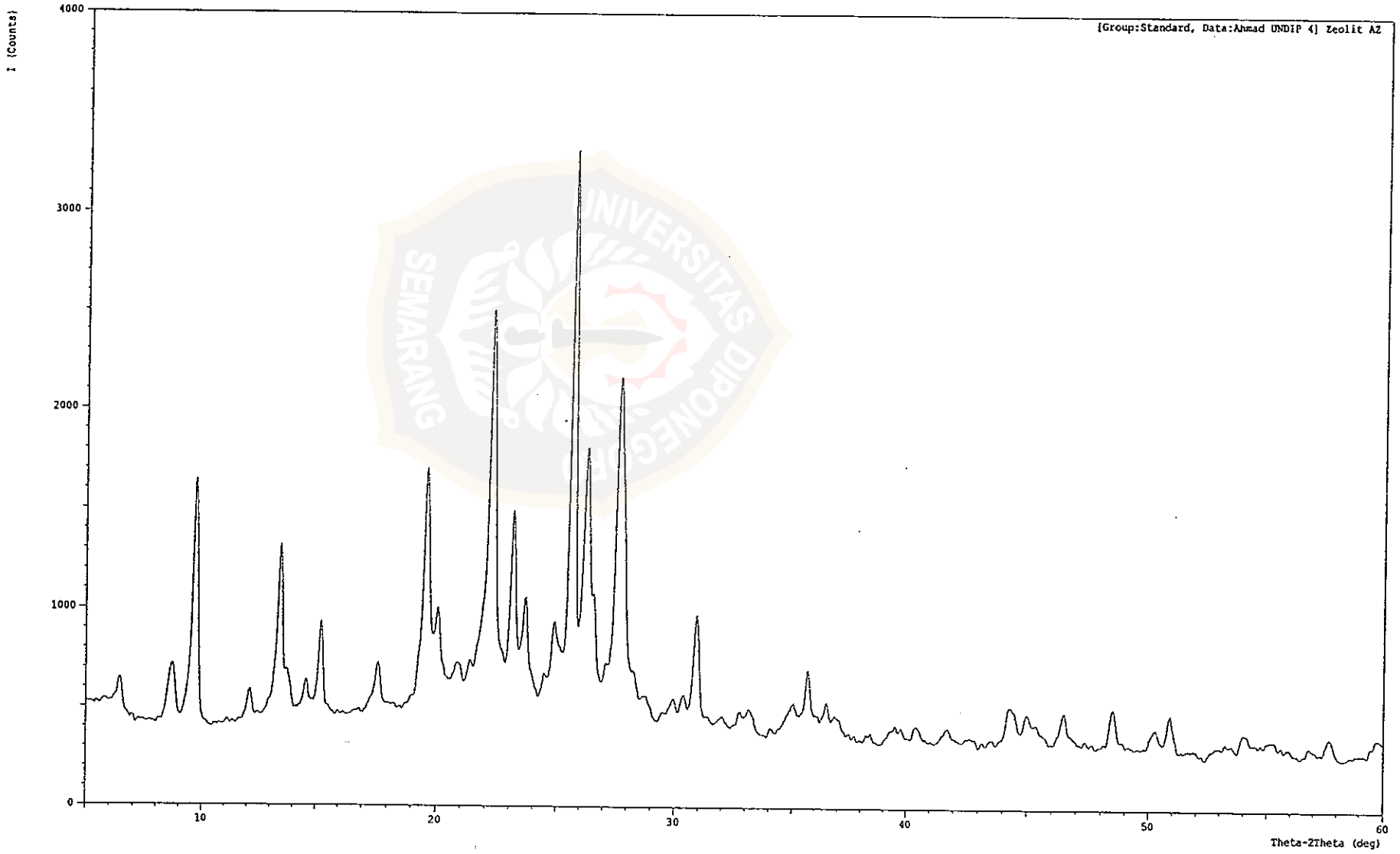
Peak Data List

peak no.	2Theta (deg)	d (A)	I/I1	FWHM (deg)	Intensity (Counts)	Integrated Int (Counts)
1	6.2000	14.24403	3	0.99560	58	1938
2	6.4002	13.79891	7	0.30050	133	1731
3	8.6490	10.21549	11	0.37800	203	4299
4	9.2000	9.60487	3	0.25140	64	1963
5	9.6677	9.14123	44	0.25410	834	11695
6	12.0777	7.32205	5	0.23040	97	1319
7	13.1600	6.72220	8	0.20400	152	2247
8	13.3850	6.60971	30	0.25730	572	6688
9	13.8000	6.41186	6	0.21720	115	2263
10	14.5443	6.08536	6	0.23530	115	1966
11	15.1850	5.83001	17	0.24240	318	4673
12	17.5885	5.03837	9	0.25710	164	2929
13	19.2200	4.61421	6	0.14000	117	1340
14	19.5421	4.53888	41	0.25730	786	10631
15	20.0000	4.43598	15	0.24940	292	4360
16	20.2400	4.38392	4	0.13720	77	687
17	20.7927	4.26862	4	0.38550	73	1435
18	21.3400	4.16036	4	0.19500	80	777
19	21.6400	4.10336	7	0.23000	129	2385
20	21.8200	4.06992	12	0.00000	231	0
21	22.1897	4.00294	68	0.28210	1292	22506
22	22.6600	3.92091	6	0.00000	112	0
23	23.0855	3.84959	32	0.23680	617	8873
24	23.5764	3.77054	17	0.29290	331	4943
25	23.9200	3.71715	3	0.17340	66	832
26	24.4400	3.63922	4	0.17720	81	803
27	24.9459	3.56656	12	0.44810	235	6375
28	25.5975	3.47723	100	0.22060	1907	22835
29	26.1978	3.39889	44	0.31850	833	14130
30	26.5400	3.35584	17	0.18520	324	3754
31	27.0400	3.29491	6	0.17540	106	1468
32	27.5600	3.23391	58	0.28240	1102	16124
33	27.8000	3.20654	33	0.19400	635	6795
34	28.2000	3.16196	7	0.33200	125	2852
35	28.6960	3.10842	3	0.36800	58	1122
36	29.8422	2.99159	4	0.33100	78	1529
37	30.3124	2.94625	5	0.28710	91	1405
38	30.8439	2.89668	20	0.25660	380	5651
39	32.7000	2.73637	4	0.15760	69	677
40	33.1078	2.70359	4	0.44220	84	1676
41	34.7800	2.57734	3	0.40000	66	1449
42	35.0200	2.56022	5	0.31200	102	1556
43	35.6153	2.51878	12	0.22130	238	3506
44	36.2800	2.47414	3	0.16340	63	942

peak no.	2Theta (deg)	d (A)	I/I1	FWHM (deg)	Intensity (Counts)	Integrated Int (Counts)
45	36.4400	2.46365	6	0.22000	120	878
46	36.8200	2.43909	4	0.56440	68	1935
47	39.3612	2.28727	4	0.38250	67	1467
48	39.7274	2.26703	3	0.15660	61	525
49	40.4002	2.23081	3	0.30450	62	1034
50	44.2000	2.04745	7	0.27500	140	2204
51	44.4600	2.03608	5	0.18660	104	1073
52	44.9556	2.01478	6	0.26480	116	1619
53	45.3000	2.00026	3	0.25500	64	1153
54	46.4291	1.95421	6	0.25380	113	1805
55	48.4283	1.87810	8	0.26330	150	2378
56	50.0200	1.82200	3	0.10800	58	454
57	50.2600	1.81386	4	0.20920	77	1105
58	50.8358	1.79466	8	0.23830	144	2192
59	53.9400	1.69848	4	0.27700	76	1412
60	54.1200	1.69325	3	0.19420	62	921
61	57.6509	1.59766	4	0.32940	76	1606
62	59.7590	1.54624	4	0.31400	78	1765

*** Multi Plot ***

File Name : Standard\Ahmad UNDIP 4
Sample Name : Zeolit AZ Comment : Zeolit AZ
Date & Time : 03-13-03 13:36:53
Condition
X-ray Tube : Cu(1.54060 A) Voltage : 40.0 kV Current : 30.0 mA
Scan Range : 5.0000 <-> 60.0000 deg Step Size : 0.0200 deg
Count Time : 0.24 sec Slit DS : 1.00 deg SS : 1.00 deg RS : 0.30 mm



Lampiran 5

5.1 Hasil Analisis Luas Permukaan Zeolit Alam

Quantachrome Corporation
NOVA Data Analysis Package Ver. 2.00
File Name = f.dat

User ID	=	User Setup	= 3
Sample ID	= F	Sample Cell Number	= 2
Sample Weight	= 0.1453 g	Sample Volume	= 0.1553 cc
Sample Density	= 1.0000 g/cc		
Po Type	= User	Po	= 749.71 mm Hg
Adsorbate	= N2	Bath Temperature	= 77.40 deg K
Adsorption Tolerance	= 0.1000 mm Hg	Desorption Tolerance	= 0.0000 mm Hg
Adsorption Equil Time	= 60 sec	Desorption Equil Time	= 0 sec
Adsorption Dwell Time	= 180 sec	Desorption Dwell Time	= 0 sec
Analysis Start Time	= Wed Mar 12 13:09:23 2003	Analysis End Time	= Wed Mar 12 14:12:59 2003

Multi BET (Adsorption)

P/Po	BET Transform (1/{W[Po/P - 1]})
0.094311	12.811575
0.146357	18.655964
0.198638	25.196825
0.249343	31.989679
0.296186	38.994054

Slope	=	129.512325
Intercept	=	0.019969
Correlation Coefficient	=	0.998589
BET C	=	6486.744331
Surface Area	=	3.905146 sq m
Specific Surface Area	=	26.885315 sq m/g

Quantachrome Corporation
NOVA Data Analysis Package Ver. 2.00
File Name = f.dat

User ID	=	User Setup	= 3
Sample ID	= F	Sample Cell Number	= 2
Sample Weight	= 0.1453 g	Sample Volume	= 0.1553 cc
Sample Density	= 1.0000 g/cc		
Po Type	= User	Po	= 749.71 mm Hg
Adsorbate	= N2	Bath Temperature	= 77.40 deg K
Adsorption Tolerance	= 0.1000 mm Hg	Desorption Tolerance	= 0.0000 mm Hg
Adsorption Equil Time	= 60 sec	Desorption Equil Time	= 0 sec
Adsorption Dwell Time	= 180 sec	Desorption Dwell Time	= 0 sec
Analysis Start Time	= Wed Mar 12 13:09:23 2003	Analysis End Time	= Wed Mar 12 14:12:59 2003

DVR (Adsorption)

Pore Radius (Ang)	Pore Area (sq m/Å/g e-03)	Pore Volume (cc/Å/g e-03)
651.097579	0.041957	0.001366
188.122280	1.112502	0.010464
113.332775	4.612666	0.026138
79.405124	12.580726	0.049949
62.830737	18.447173	0.057952
52.796817	35.757195	0.094393
44.067449	49.958148	0.110076
39.452501	62.854089	0.123988
35.511087	59.308570	0.105306
31.664749	129.547408	0.205104
28.550869	183.648251	0.262166
25.996813	267.521201	0.347735
23.812357	345.170081	0.410966
21.860492	438.770225	0.479587
19.965333	547.946974	0.546997
18.563840	683.472891	0.634394
17.480726	758.114762	0.662620
16.290898	858.456911	0.699252
15.187413	1028.976827	0.781375

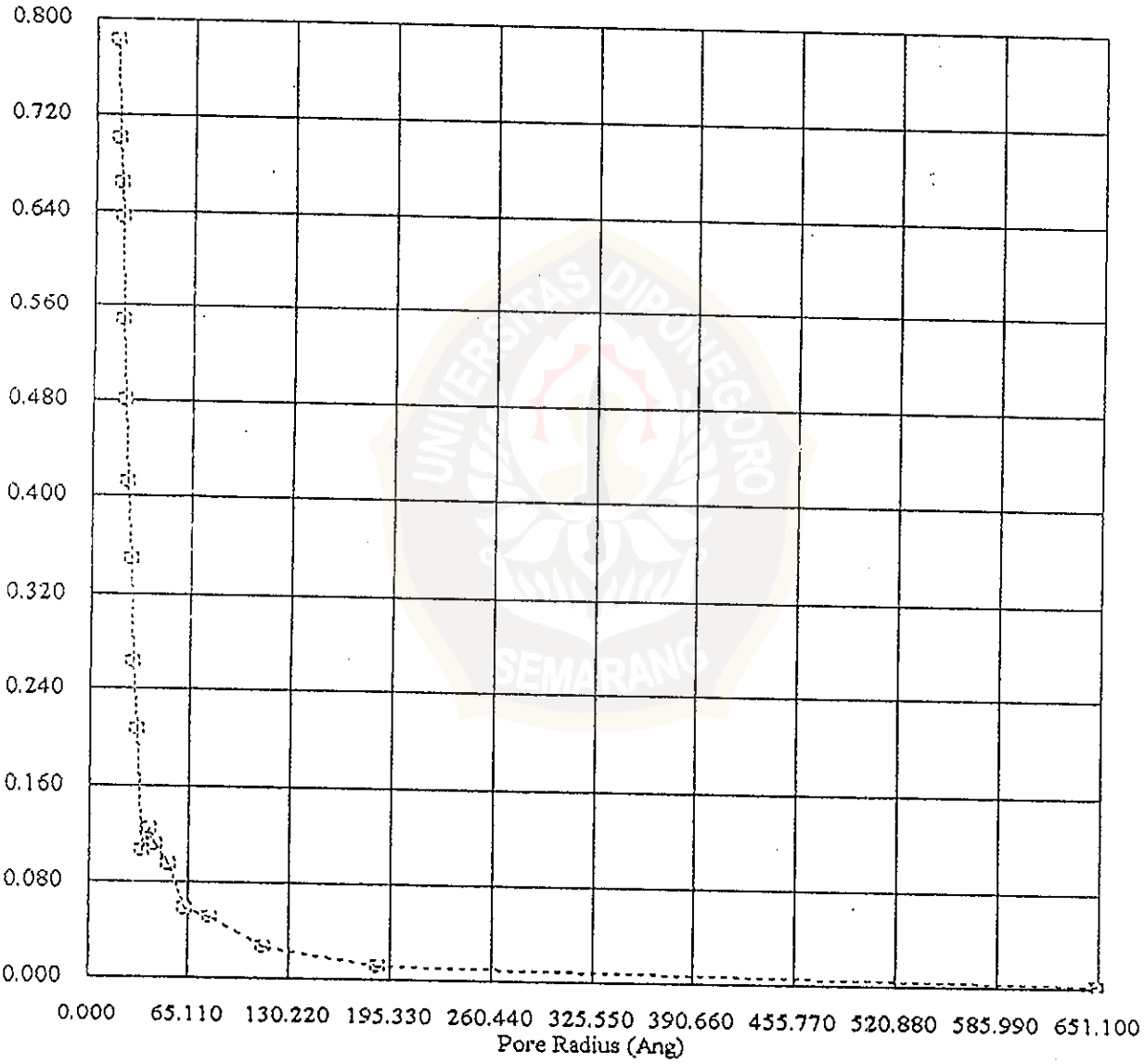
Total Pore Volume is 24.514343 e-03 cc/g for all pores less than 1031.887345 Angstrom.

Average pore radius is 18.236232 Angstrom.

Quantachrome Corporation
NOVA Data Analysis Package Ver. 2.00
File Name = f.dat

ser ID	=	User Setup	= 3
mple ID	= F	Sample Cell Number	= 2
mple Weight	= 0.1453 g	Sample Volume	= 0.1553 cc
mple Density	= 1.0000 g/cc		
Type	= User	Po	= 749.71 mm Hg
dsorbate	= N2	Bath Temperature	= 77.40 deg K
dsorption Tolerance	= 0.1000 mm Hg	Desorption Tolerance	= 0.0000 mm Hg
dsorption Equil Time	= 60 sec	Desorption Equil Time	= 0 sec
dsorption Dwell Time	= 180 sec	Desorption Dwell Time	= 0 sec
nalysis Start Time	= Wed Mar 12 13:09:23 2003	Analysis End Time	= Wed Mar 12 14:12:59 2003

DVR (Adsorption)



5.2 Hasil Analisis Luas Permukaan Zeolit Terdealuminasi

Quantachrome Corporation
NOVA Data Analysis Package Ver. 2.00
File Name = e.dat

User ID	=	User Setup	= 3
Sample ID	= E		
Sample Weight	= 0.1815 g	Sample Cell Number	= 4
Sample Density	= 1.0000 g/cc	Sample Volume	= 0.1915 cc
Po Type	= User		
Adsorbate	= N2	Po	= 749.91 mm Hg
		Bath Temperature	= 77.40 deg K
Adsorption Tolerance	= 0.1000 mm Hg	Desorption Tolerance	= 0.0000 mm Hg
Adsorption Equil Time	= 60 sec	Desorption Equil Time	= 0 sec
Adsorption Dwell Time	= 180 sec	Desorption Dwell Time	= 0 sec
Analysis Start Time	= Mon Mar 17 13:05:51 2003	Analysis End Time	= Mon Mar 17 14:08:28 2003

Multi BET (Adsorption)

P/Po	BET Transform (1/{W[Po/P - 1]})
0.091491	26.531117
0.149089	39.091168
0.201053	50.652880
0.251459	62.583878
0.301605	75.167714

Slope	=	230.914254
Intercept	=	4.867422
Correlation Coefficient	=	0.999557
BET C	=	48.440774
Surface Area	=	2.680240 sq m
Specific Surface Area	=	14.770090 sq m/g

Quantachrome Corporation
NOVA Data Analysis Package Ver. 2.00
File Name = e.dat

ser ID	=	User Setup	= 3
ample ID	= E	Sample Cell Number	= 4
ample Weight	= 0.1815 g	Sample Volume	= 0.1915 cc
ample Density	= 1.0000 g/cc		
o Type	= User	Po	= 749.91 mm Hg
dsorbate	= N2	Bath Temperature	= 77.40 deg K
dsorption Tolerance	= 0.1000 mm Hg	Desorption Tolerance	= 0.0000 mm Hg
dsorption Equil Time	= 60 sec	Desorption Equil Time	= 0 sec
dsorption Dwell Time	= 180 sec	Desorption Dwell Time	= 0 sec
nalysis Start Time	= Mon Mar 17 13:05:51 2003	Analysis End Time	= Mon Mar 17 14:08:28 2003

DVR (Adsorption)

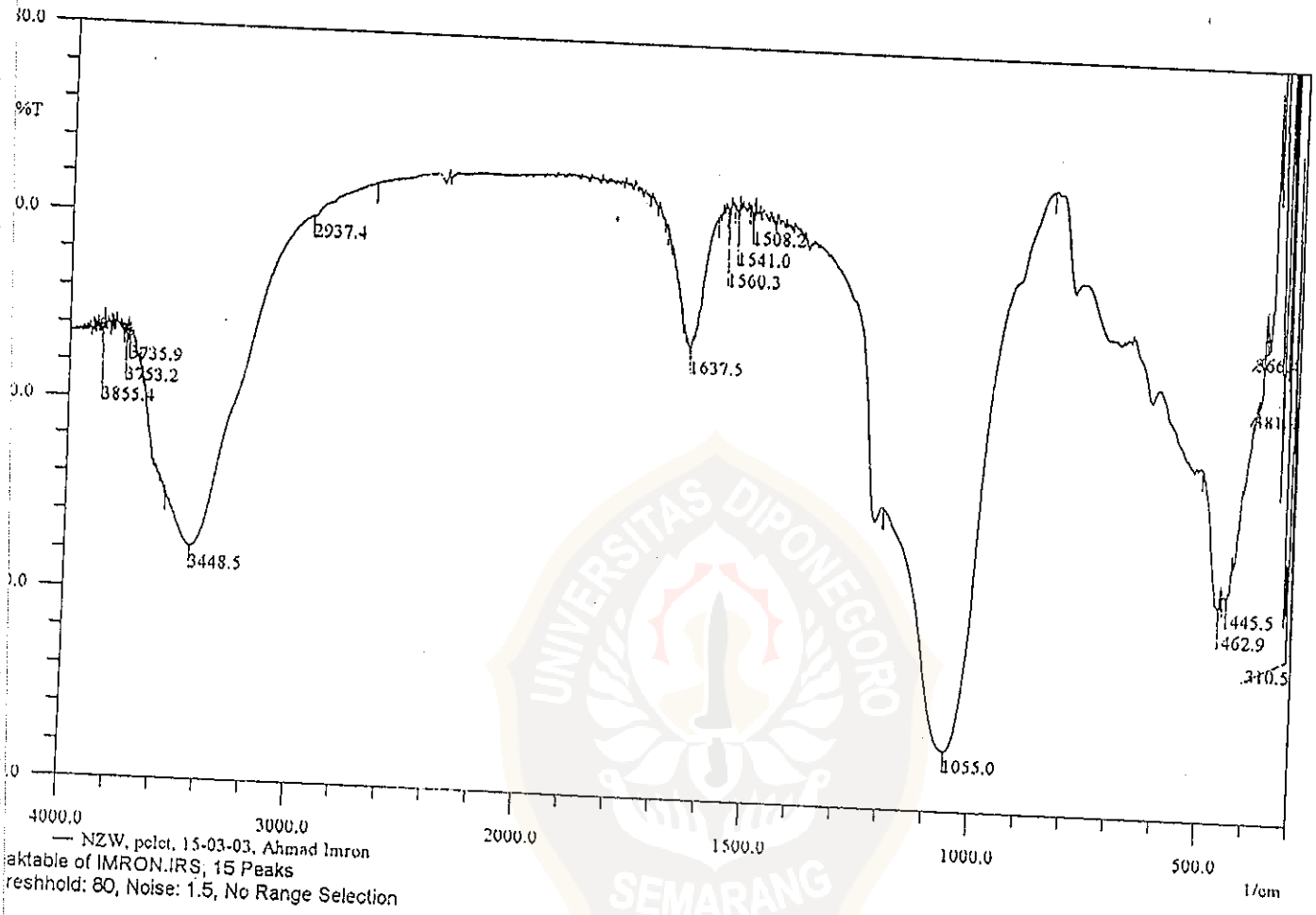
Pore Radius (Ang)	Pore Area (sq m/Å/g e-03)	Pore Volume (cc/Å/g e-03)
395.569675	0.029362	0.000581
181.325667	0.344075	0.003119
107.346890	1.267154	0.006801
81.491960	3.678489	0.014988
63.333155	6.352627	0.020117
52.920259	11.193578	0.029618
44.064798	21.470417	0.047304
38.582034	32.882554	0.063434
34.956286	43.066851	0.075273
31.784903	57.217488	0.090933
28.114071	81.984143	0.115245
25.645931	95.120825	0.121973
23.522736	140.268956	0.164975
21.603088	6.310209	0.006816
20.030398	22.150178	0.022184
18.599271	410.118451	0.381395
17.312448	530.839103	0.459506
16.115710	668.203039	0.538428
15.036253	759.004765	0.570629

Total Pore Volume is 11.098458 e-03 cc/g for all pores less than 525.062313 Angstrom.

Average pore radius is 15.028287 Angstrom.

Lampiran 6

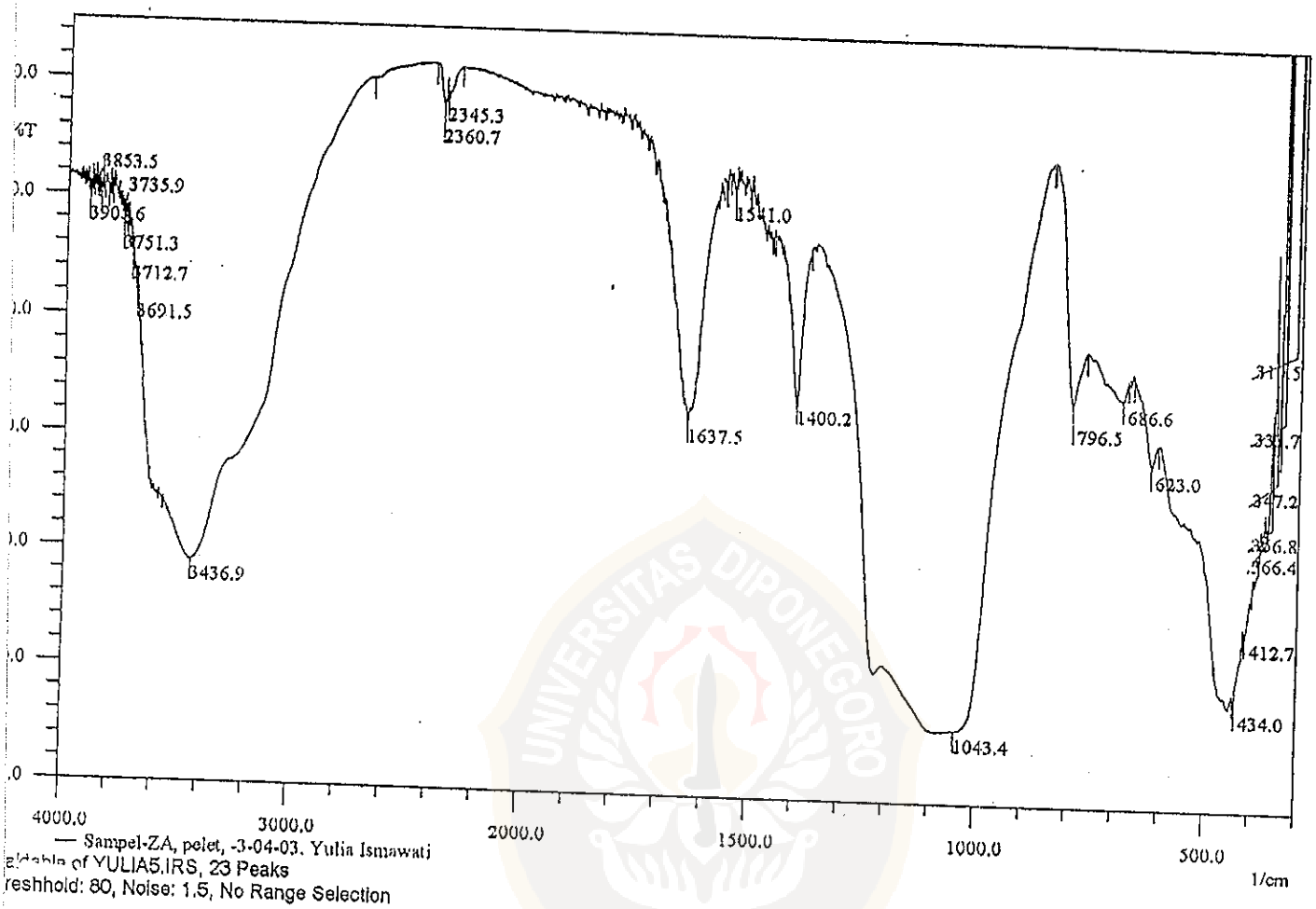
6.1 Hasil Analisis FTIR Zeolit Alam



— NZW, pelet, 15-03-03, Ahmad Imron
aktable of IMRON.IRS, 15 Peaks
reshhold: 80, Noise: 1.5, No Range Selection

Pos. (1/cm)	Inten. (%T)
310.5	17.486
366.4	50.697
381.9	44.467
445.5	23.192
462.9	22.698
1055.0	6.500
1508.2	61.475
1541.0	62.354
1560.3	61.076
1637.5	47.591
2937.4	60.077
3448.5	24.438
3735.9	46.273
3753.2	46.307
3855.4	46.197

6.2 Hasil Analisis FTIR Zeolit Terdealuminasi



— Sampel-ZA, pelet, -3-04-03. Yulia Ismawati
Editable of YULIA5.IRS, 23 Peaks
Threshhold: 80, Noise: 1.5, No Range Selection

Pos. (1/cm)	Inten. (%T)
310.5	39.696
333.7	33.739
347.2	28.382
356.8	24.496
366.4	23.472
412.7	15.246
434.0	9.120
623.0	29.535
686.6	35.257
796.5	34.915
1043.4	6.292
1400.2	34.284
1541.0	51.292
1637.5	32.385
2345.3	58.824
2360.7	58.285
3436.9	16.951
3691.5	41.464
3712.7	44.628
3735.9	46.410
3751.3	47.055
3853.5	48.368
3905.6	49.498

Lampiran 7. Perhitungan Kristalinitas

Kristalinitas zeolit terdealuminasi (Kzm)

$$Kzm = \frac{\Sigma Izm(counts)}{\Sigma Iza(counts)} \times 100\%$$

$$Kzm = \frac{19542}{16905} \times 100\%$$

Kzm= 113,425%

Peningkatan kristalinitas (ΔK)

ΔK= (Kzm-Kza)%

ΔK= (113,425-100)%

ΔK= 13,425%

Keterangan:

ΣIza: jumlah total intensitas (counts) zeolit alam

ΣIzm: jumlah total intensitas (counts) zeolit terdealuminasi