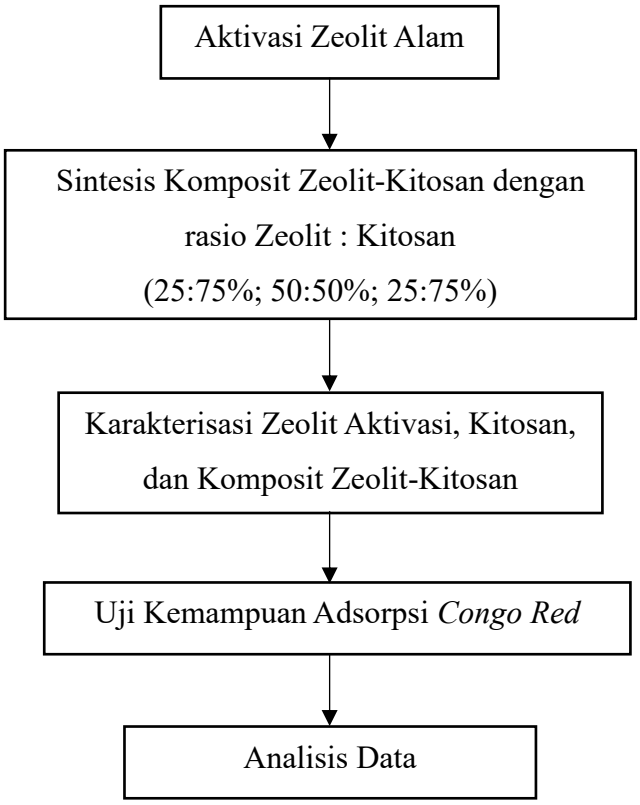
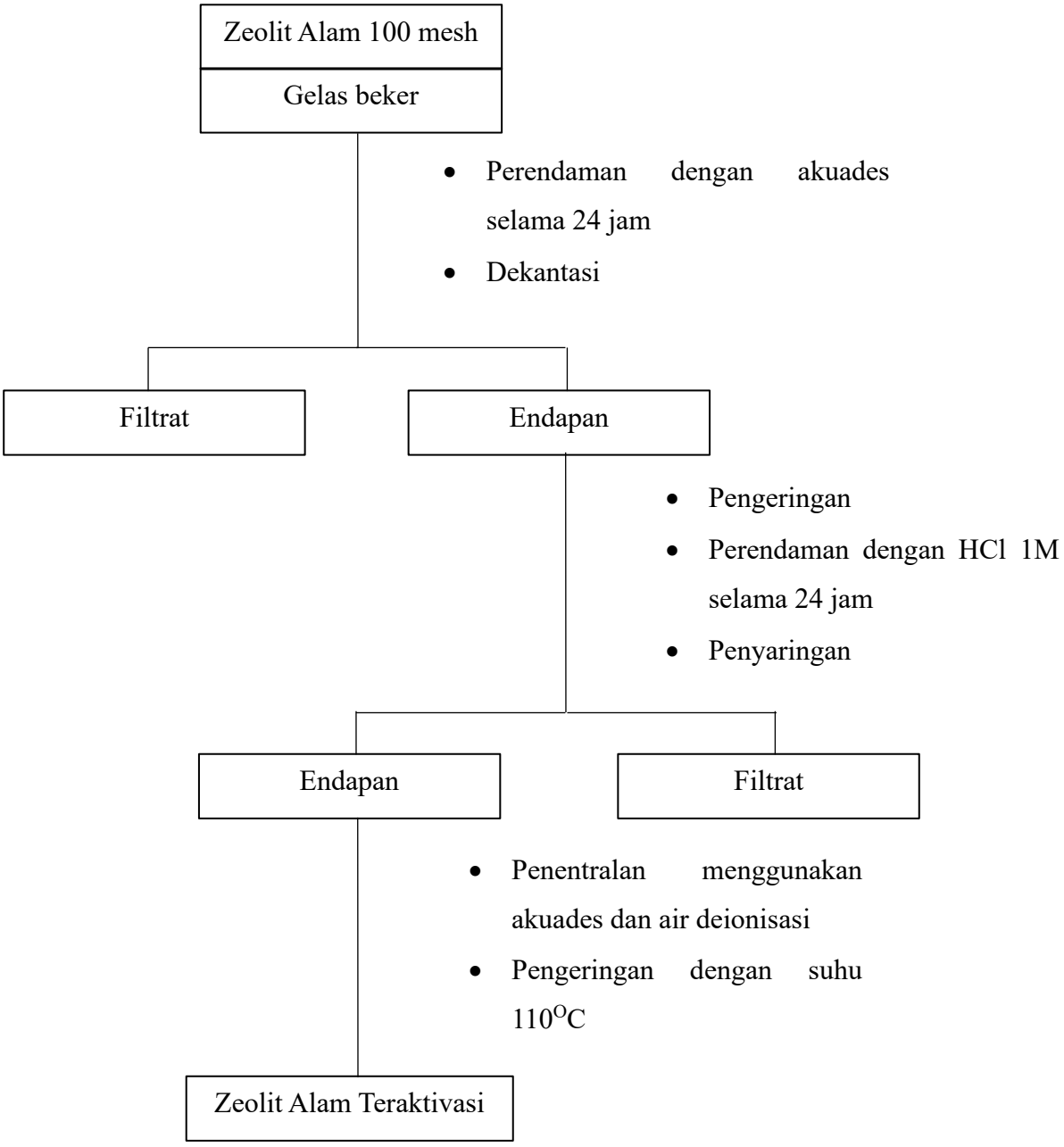
LAMPIRAN

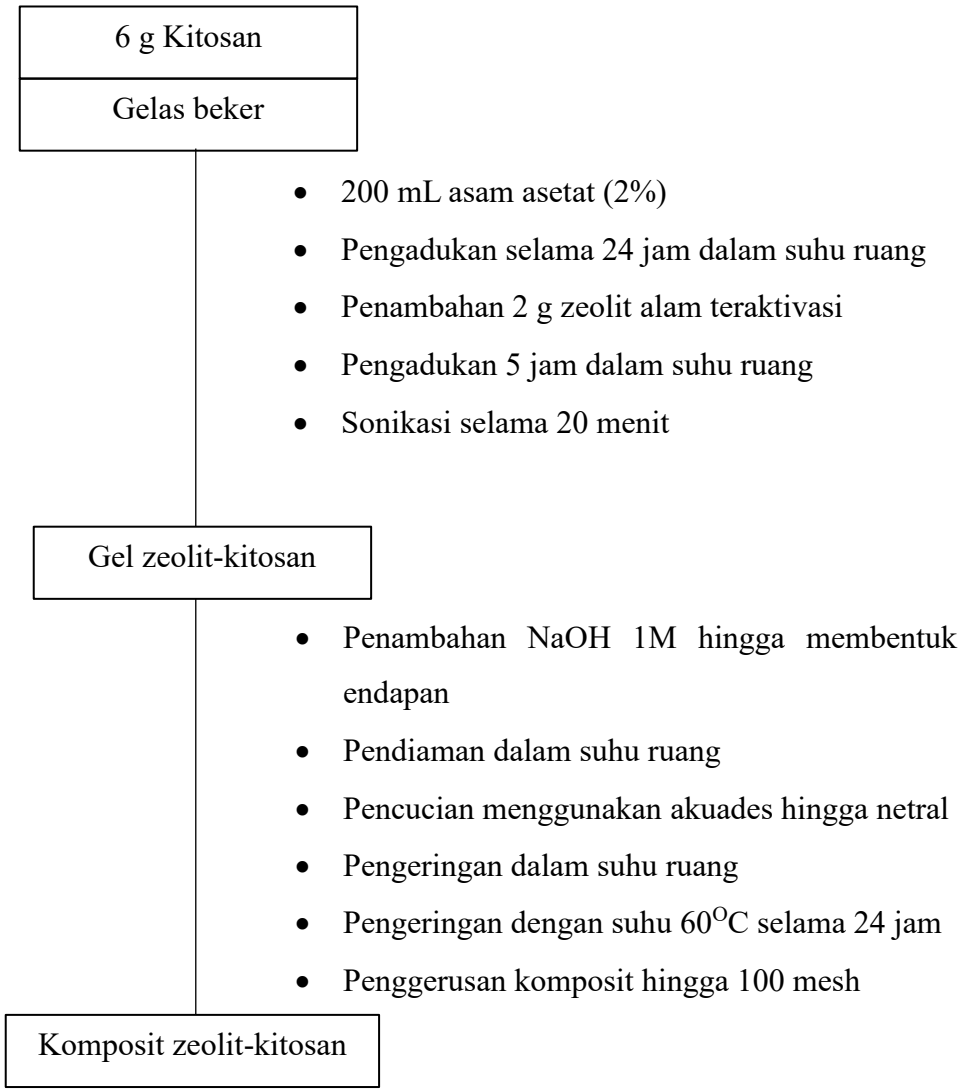
Lampiran 1. Diagram alur penelitian



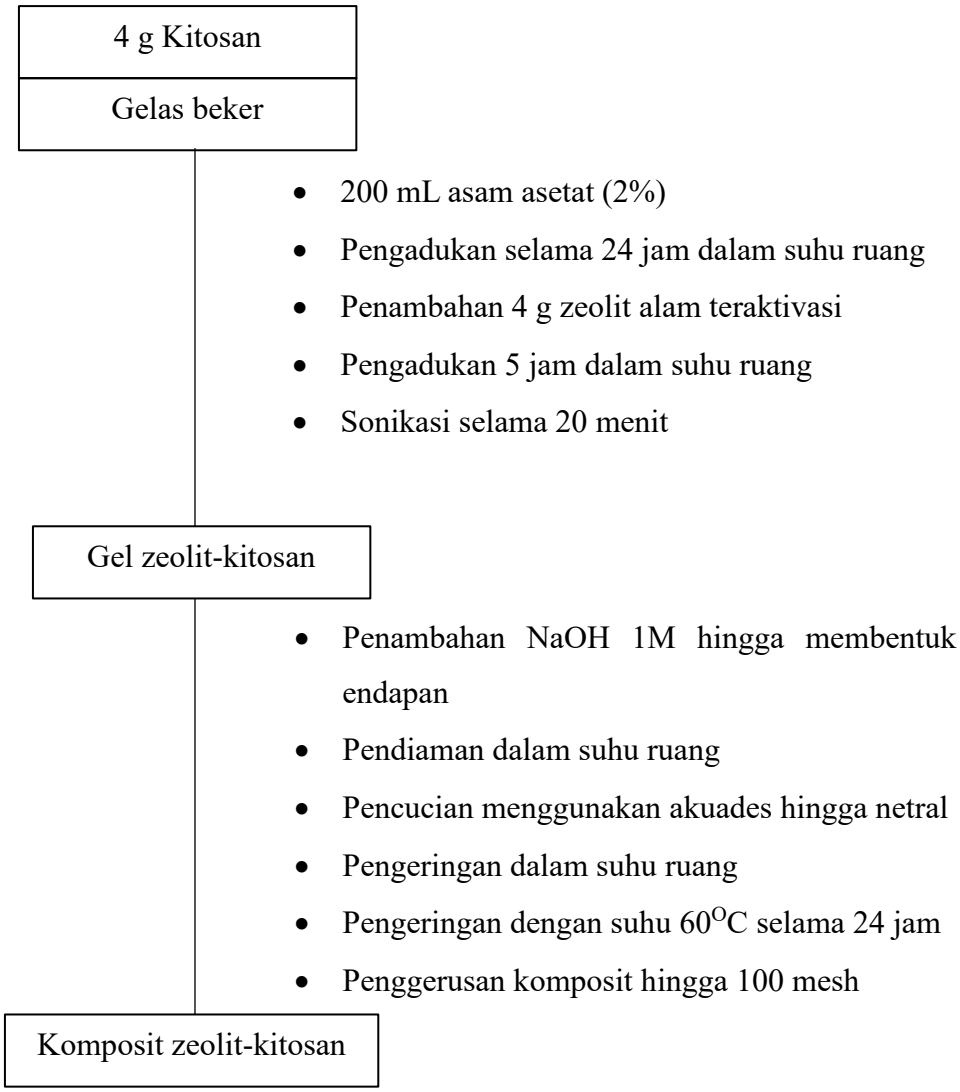
1.1 Aktivasi zeolit alam



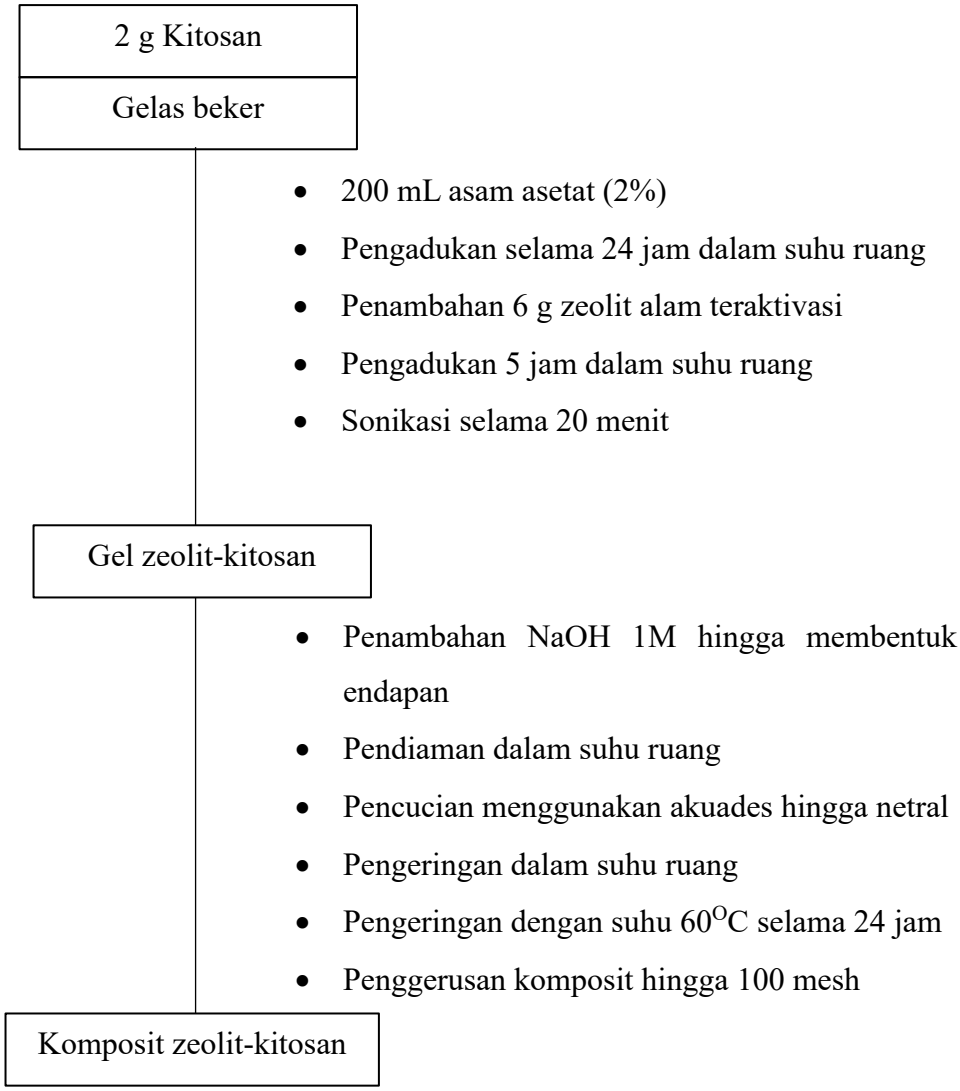
1.2 Sintesis komposit zeolit-kitosan (Z-Cs) 25%:75%



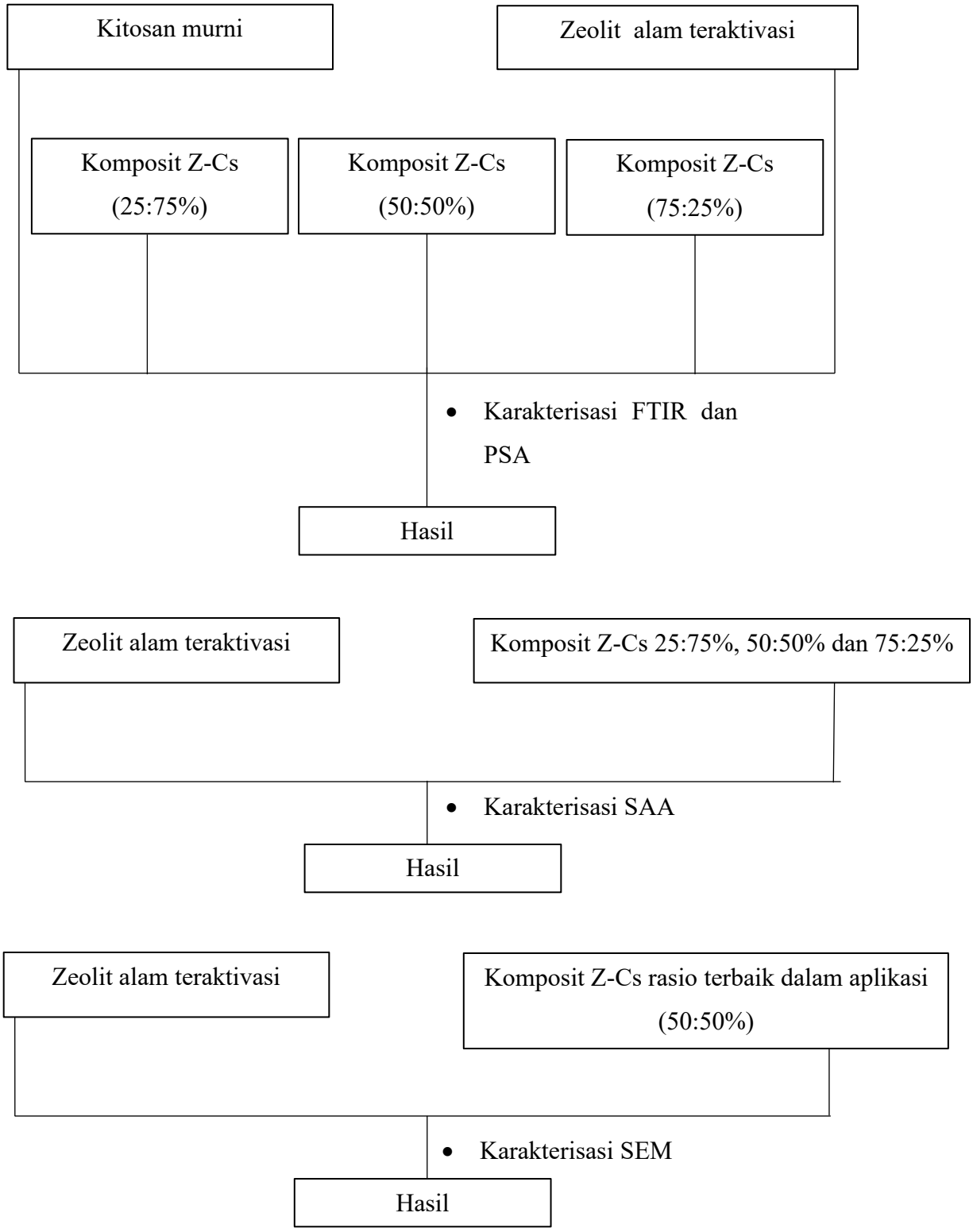
1.3 Sintesis komposit zeolit-kitosan (Z-Cs) 50%:50%



1.4 Sintesis komposit zeolit-kitosan (Z-Cs) 75%:25%

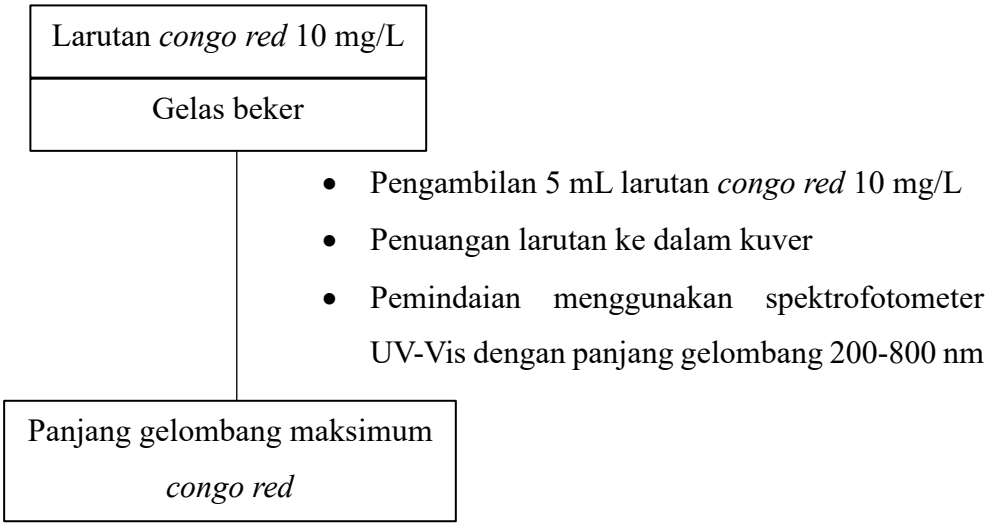


1.5 Karakterisasi material

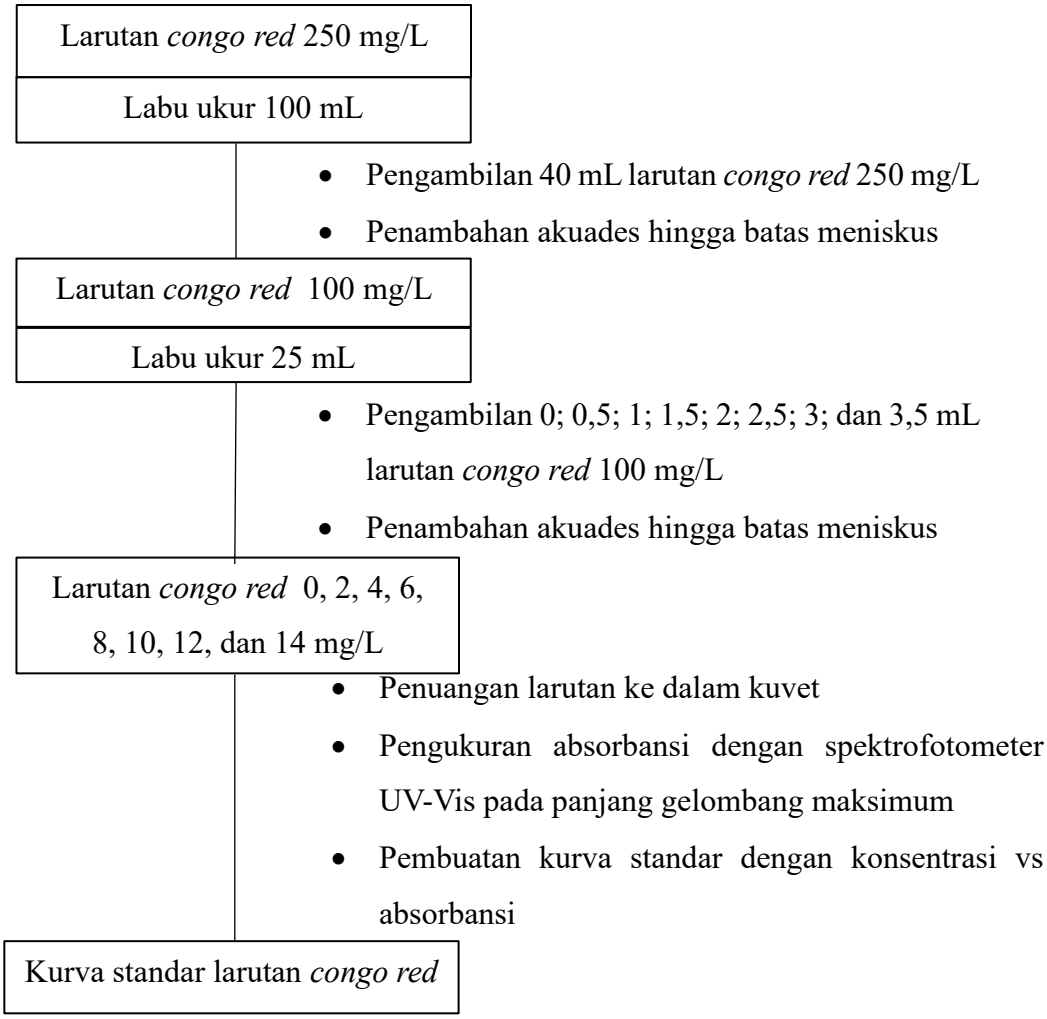


1.6 Penentuan panjang gelombang maksimum dan kurva standar *congo red*

a. Penentuan Panjang Gelombang Maksimum *Congo Red*



b. Kurva Standar *Congo Red*



1.7 Pengujian adsorben pengaruh konsentrasi awal *congo red*

a. Zeolit alam teraktivasi

25 mL larutan *congo red* 60; 75; 90; 105; 120; 135; dan 150 mg/L

Gelas beker 250 mL

- Penambahan 0,05 g zeolit alam teraktivasi
- Penggojogan selama 60 menit menggunakan shaker
- Pengambilan filtrat
- Pengukuran absorbansi menggunakan spektrofotometer UV-Vis pada panjang gelombang maksimum
- Perhitungan konsentrasi

Hasil Data

b. Z-Cs rasio 25:75%

25 mL larutan *congo red* 60; 75; 90; 105; 120; 135; dan 150 mg/L

Gelas beker 250 mL

- Penambahan 0,05 g Z-Cs 25:75%
- Penggojogan selama 60 menit menggunakan shaker
- Pengambilan filtrat
- Pengukuran absorbansi menggunakan spektrofotometer UV-Vis pada panjang gelombang maksimum
- Perhitungan konsentrasi

Hasil Data

c. Z-Cs rasio 50:50%

25 mL larutan *congo red* 60; 75; 90; 105; 120; 135; dan 150 mg/L

Gelas beker 250 mL

- Penambahan 0,05 g Z-Cs 50:50%
- Penggojogan selama 60 menit menggunakan shaker
- Pengambilan filtrat
- Pengukuran absorbansi menggunakan spektrofotometer UV-Vis pada panjang gelombang maksimum
- Perhitungan konsentrasi

Hasil Data

d. Z-Cs rasio 75:25%

25 mL larutan *congo red* 60; 75; 90; 105; 120; 135; dan 150 mg/L

Gelas beker 250 mL

- Penambahan 0,05 g Z-Cs 75:25%
- Penggojogan selama 60 menit menggunakan shaker
- Pengambilan filtrat
- Pengukuran absorbansi menggunakan spektrofotometer UV-Vis pada panjang gelombang maksimum
- Perhitungan konsentrasi

Hasil Data

Lampiran 2. Perhitungan

2.1 Perhitungan aktivasi zeolit

Pembuatan HCl 1 M

$$M_{HCl} = \frac{\% \times \rho \times 1000}{Mr}$$

$$M_{HCl} = \frac{37\ \% \times 1{,}19\ g/mL \times 1000}{36{,}5\ g/mol}$$

M_{HCl}= 12,06 mol/mL

Untuk membuat HCl 1M 500 mL

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 12{,}06\ M = 500\ mL \times 1M$

V_1= 41,459 mL

2.2 Perhitungan sintesis komposit zeolit-kitosan

a. Pembuatan 100 mL asam asetat 2% dari asam asetat 100%

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 100\% = 100\ mL \times 2\%$

V_1= 2 mL

b. Pembuatan 100 mL NaOH 1M

$$M_{NaOH} = \frac{mol}{L}$$

$$mol = \frac{M_{NaOH}}{L} = \frac{1M}{0{,}1\ L} = 1\ mol$$

$$mol = \frac{Massa}{Mr}$$

$$1\ mol = \frac{Massa}{40\ g/mol}$$

Massa =1 mol × 40 g/mol

Massa = 4 g

2.3 Perhitungan pembuatan larutan standar *congo red*

a. Pembuatan larutan induk 100 mL 250 mg/L *congo red*

250 mg/L = 250 mg/L

250 mg/L = 250 mg/1000 mL =0,25 mg/mL

0,25 mg/mL= x/100 mL

x=25 mg=0,025 gram

b. Untuk 100 mL 100 mg/L *congo red* dari larutan induk

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times$ 250 mg/L= 100 mL$\times$100 mg/L

V_1= 40 mL

c. Larutan standar 25 mL 0 mg/L *congo red* dari larutan 100 mg/L

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times$100 mg/L= 25 mL $\times$0 mg/L

V_1= 0 mL

d. Larutan standar 25 mL 2 mg/L *congo red* dari larutan 100 mg/L

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times$100 mg/L= 25 mL $\times$2 mg/L

V_1= 0,5 mL

e. Larutan standar 25 mL 4 mg/L *congo red* dari larutan 100 mg/L

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times$100 mg/L= 25 mL $\times$4 mg/L

V_1= 1 mL

f. Larutan standar 25 mL 6 mg/L *congo red* dari larutan 100 mg/L

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times$100 mg/L= 25 mL $\times$6 mg/L

V_1= 1,5 mL

g. Larutan standar 25 mL 8 mg/L *congo red* dari larutan 100 mg/L

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times$100 mg/L= 25 mL $\times$8 mg/L

V_1= 2 mL

h. Larutan standar 25 mL 10 mg/L *congo red* dari larutan 100 mg/L

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times$100 mg/L= 25 mL $\times$10 mg/L

V_1= 2,5 mL

i. Larutan standar 25 mL 12 mg/L *congo red* dari larutan 100 mg/L

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 100$ mg/L $= 25$ mL $\times 12$ mg/L

$V_1 = 3$ mL

j. Larutan standar 25 mL 14 mg/L *congo red* dari larutan 100 mg/L

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 100$ mg/L $= 25$ mL $\times 14$ mg/L

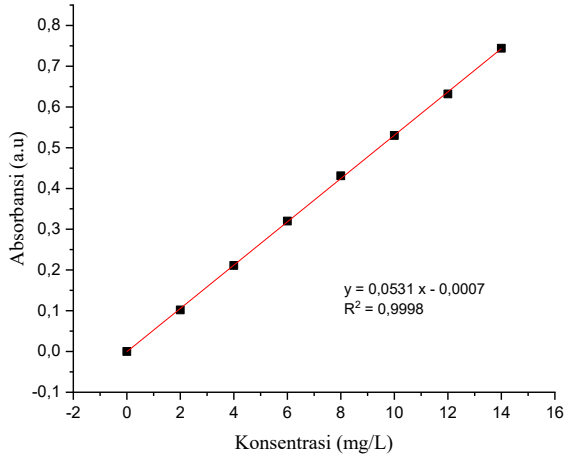
$V_1 = 3{,}5$ mL

2.4 Perhitungan kurva standar *congo red*

a. Tabel

Kode Sampel	Konsentrasi (x)	Absorbansi (y)	xy	x^2	y^2
0 mg/L	0	0	0	0	0
2 mg/L	2	0,102	0,204	4	0,010404
4 mg/L	4	0,211	0,844	16	0,044521
6 mg/L	6	0,320	1,920	36	0,1024
8 mg/L	8	0,431	3,448	64	0,185761
10 mg/L	10	0,530	5,300	100	0,2809
12 mg/L	12	0,632	7,584	144	0,399424
14 mg/L	14	0,744	10,416	196	0,553536
Jumlah	56	2,97	29,716	560	1,576946
Rata-rata	7	0,37125	3,7145	70	0,197118

b. Grafik



c. Persamaan Garis

1. Mencari *m*

$$m = \frac{n\,(\sum xy) - (\sum x)(\sum y)}{n\,(\sum x^2) - (\sum x)^2}$$

$$m = \frac{8\,(29{,}716) - (56)(2{,}97)}{8\,(560) - (\sum 56)^2}$$

$m = 0{,}0531$

Dengan $n = 8$

2. Mencari c

$\bar{y} = m\,\bar{x} + c$

$c = \bar{y} - m\,\bar{x}$

$c = 0{,}37125 - 0{,}05313 \times 7$

$c = -0{,}0007$

3. Mencari R^2

$$R^2 = \frac{[n\,(\sum xy) - (\sum x)(\sum y)]^2}{[n(\sum x^2) - (\sum x)^2]\,[n(\sum y^2) - (\sum y)^2]}$$

$$R^2 = \frac{[8\,(29{,}716) - (56)(2{,}97)]^2}{[8(560) - (56^2)][8(1{,}576946) - (2{,}97^2)]}$$

$R^2 = 0{,}9998$

Maka persamaan garis yang didapatkan

$\bar{y} = 0{,}0531\ \bar{x} + 0{,}0007$

$R^2 = 0{,}9998$

2.5 Pembuatan variasi konsentrasi larutan *congo red* sebagai adsorbat

a. Larutan *congo red* 100 mL 250 mg/L

250 mg/L = 250 mg/L

250 mg/L = 250 mg/1000 mL =0,25 mg/mL

0,25 mg/mL= x/100 mL

x=25 mg=0,025 gram

b. Variasi 60 mg/L dengan labu ukur 25 mL

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 250$ mg/L= 25 mL ×60 mg/L

V_1= 6 mL

c. Variasi 75 mg/L dengan labu ukur 25 mL

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 250$ mg/L= 25 mL ×75 mg/L

V_1= 7,5 mL

d. Variasi 90 mg/L dengan labu ukur 25 mL

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 250$ mg/L= 25 mL ×90 mg/L

V_1= 9 mL

e. Variasi 105 mg/L dengan labu ukur 25 mL

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 250$ mg/L= 25 mL ×105 mg/L

V_1= 10,5 mL

f. Variasi 120 mg/L dengan labu ukur 25 mL

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 250$ mg/L= 25 mL ×120 mg/L

V_1= 12 mL

g. Variasi 135 mg/L dengan labu ukur 25 mL

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 250$ mg/L= 25 mL ×135 mg/L

V_1= 13,5 mL

h. Variasi 150 mg/L dengan labu ukur 25 mL

$V_1 \times M_1 = V_2 \times M_2$

$V_1 \times 250$ mg/L= 25 mL ×150 mg/L

V_1= 15 mL

2.6 Perhitungan konsentrasi setelah adsorpsi (Ce) *congo red*

$y = mx + c$

$y = 0{,}0531\ x - 0{,}0007$

$$x = \frac{y - c}{m}$$

$Ce = x \times FP$

Keterangan :

y = absorbansi

x = konsentrasi akhir ($\frac{\text{mg}}{\text{L}}$)

Ce = konsentrasi setelah adsorpsi ($\frac{\text{mg}}{\text{L}}$)

FP = Faktor Pengenceran

c = -0,0007

m = 0,0531

a. Adsorben Zeolit Alam Teraktivasi

60 mg/L, y = 0,469

Dengan FP = 5

$Ce = \frac{y - c}{m} \times FP$

$Ce = \frac{0{,}469 - (-0{,}0007)}{0{,}0531} \times 5$

Ce = 44,2279 mg/L

75 mg/L, y = 0,609

Dengan FP = 5

$Ce = \frac{y - c}{m} \times FP$

$Ce = \frac{0{,}609 - (-0{,}0007)}{0{,}0531} \times 5$

Ce = 57,4105 mg/L

90 mg/L, y = 0,377

Dengan FP = 10

$Ce = \frac{y - c}{m} \times FP$

$Ce = \frac{0{,}377 - (-0{,}0007)}{0{,}0531} \times 10$

Ce = 71,1299 mg/L

105 mg/L, y = 0,444

Dengan FP = 10

$Ce = \frac{y - c}{m} \times FP$

$Ce = \frac{0{,}444 - (-0{,}0007)}{0{,}0531} \times 10$

Ce = 83,7476 mg/L

120 mg/L, y = 0,513

dengan FP = 10

$Ce = \frac{y - c}{m} \times FP$

$Ce = \frac{0{,}513 - (-0{,}0007)}{0{,}0531} \times 10$

Ce = 96,742 mg/L

135 mg/L, y= 0,569

dengan FP = 10

$Ce = \frac{y - c}{m} \times FP$

$Ce = \frac{0{,}569 - (-0{,}0007)}{0{,}0531} \times 10$

Ce =107,2881 mg/L

150 mg/L, y= 0,617

dengan FP = 10

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0{,}617-(-0{,}0007)}{0{,}0531} \times 10$$

Ce = 116,3277 mg/L

b. Adsorben Z-Cs 25:75%

60 mg/L, y = 0,054

$$Ce = \frac{y - c}{m}$$

$$Ce = \frac{0{,}054-(-0{,}0007)}{0{,}0531}$$

Ce = 1,0301 mg/L

75 mg/L, y = 0,107

$$Ce = \frac{y - c}{m}$$

$$Ce = \frac{0{,}107 - (-0{,}0007)}{0{,}0531}$$

$Ce = 2{,}0282\ mg/L$

90 mg/L, y = 0,394

$$Ce = \frac{y - c}{m}$$

$$Ce = \frac{0{,}394-(-0{,}0007)}{0{,}0531}$$

Ce = 7,4331 mg/L

105 mg/L, y = 0,769

$$Ce = \frac{y - c}{m}$$

$$Ce = \frac{0{,}769-(-0{,}0007)}{0{,}0531}$$

Ce = 14,4953 mg/L

120 mg/L, y = 0,278

dengan FP = 5

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0{,}278-(-0{,}0007)}{0{,}0531} \times 5$$

Ce =26,2429 mg/L

135 mg/L, y = 0,326

dengan FP = 5

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0{,}326-(-0{,}0007)}{0{,}0531} \times 5$$

Ce = 30,7627 mg/L

150 mg/L, y = 0,402

dengan FP = 5

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0{,}402-(-0{,}0007)}{0{,}0531} \times 5$$

Ce = 37,9190 mg/L

c. Adsorben Z-Cs 50:50%

60 mg/L, y = 0,014

$$Ce = \frac{y - c}{m}$$

$$Ce = \frac{0{,}014-(-0{,}0007)}{0{,}0531}$$

Ce = 0,2768 mg/L

75 mg/L, y = 0,033

$$Ce = \frac{y - c}{m}$$

$$Ce = \frac{0{,}033-(-0{,}0007)}{0{,}0531}$$

Ce = 0,6347 mg/L

90 mg/L, y = 0,108

$$Ce = \frac{y - c}{m}$$

$$Ce = \frac{0{,}108-(-0{,}0007)}{0{,}0531}$$

Ce = 2,0471 mg/L

105 mg/L, y = 0,321

$$Ce = \frac{y - c}{m}$$

$$Ce = \frac{0{,}321-(-0{,}0007)}{0{,}0531}$$

Ce = 6,0584 mg/L

120 mg/L, y = 0,357

Dengan FP = 2

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0{,}357-(-0{,}0007)}{0{,}0531} \times 2$$

Ce = 13,4727 mg/L

135 mg/L, y = 0,222

Dengan FP = 5

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0{,}222-(-0{,}0007)}{0{,}0531} \times 5$$

Ce = 20,9699 mg/L

150 mg/L, y = 0,311

Dengan FP = 5

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0{,}311-(-0{,}0007)}{0{,}0531} \times 5$$

Ce = 29,3503 mg/L

d. Adsorben Z-Cs 75:25%

60 mg/L, y = 0,402

$$Ce = \frac{y - c}{m}$$

$$Ce = \frac{0,402-(-0,0007)}{0,0531}$$

Ce = 7,5838mg/L

75 mg/L, y = 0,755

$$Ce = \frac{y - c}{m}$$

$$Ce = \frac{0,609-(-0,0007)}{0,0531}$$

Ce = 14,2316 mg/L

90 mg/L, y = 0,519

Dengan FP = 2

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0,519-(-0,0007)}{0,0531} \times 2$$

Ce = 19,5744 mg/L

105 mg/L, y = 0,302

Dengan FP = 5

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0,302-(-0,0007)}{0,0531} \times 5$$

Ce = 28,5028 mg/L

120 mg/L, y = 0,428

dengan FP = 5

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0,428-(-0,0007)}{0,0531} \times 5$$

Ce = 40,3672 mg/L

135 mg/L, y = 0,243

dengan FP = 10

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0,243-(-0,0007)}{0,0531} \times 10$$

Ce = 45,8945 mg/L

150 mg/L, y = 0,277

dengan FP = 10

$$Ce = \frac{y - c}{m} \times FP$$

$$Ce = \frac{0,277-(-0,0007)}{0,0531} \times 10$$

Ce = 52,2976 mg/L

2.7 Perhitungan kemampuan adsorpsi *(qe)*

$$qe = \frac{(Ci - Ce) \times V}{W}$$

Keterangan :

Ci = konsentrasi awal ($\frac{mg}{L}$)

Ce =konsentrasi setelah adsorpsi ($\frac{mg}{L}$)

V = Volume adsorbat (L) = 0,025 L

W = massa adsorben (g) = 0,05 g

a. Adsorben Zeolit Alam Teraktivasi

$Ci = 60 \frac{mg}{L}$

$Ce = 44,2279 \frac{mg}{L}$

$qe = \frac{\frac{(60 - 44,2279)mg}{L} \times 0,025\ L}{0,05\ g}$

qe = 7,8861 mg/g

$Ci = 75 \frac{mg}{L}$

$Ce = 57,4105 \frac{mg}{L}$

$qe = \frac{\frac{(75-57,4105)mg}{L} \times 0,025\ L}{0,05\ g}$

qe = 8,7947 mg/g

$Ci = 90 \frac{mg}{L}$

$Ce = 71,1299 \frac{mg}{L}$

$qe = \frac{\frac{(90-71,1299)mg}{L} \times 0,025\ L}{0,05\ g}$

qe = 9,4350 mg/g

$Ci = 105 \frac{mg}{L}$

$Ce = 83,7476 \frac{mg}{L}$

$qe = \frac{\frac{(105-83,7476)mg}{L} \times 0,025\ L}{0,05\ g}$

qe = 10,6262 mg/g

$Ci = 120 \frac{mg}{L}$

$Ce = 96,7420 \frac{mg}{L}$

$qe = \frac{\frac{(120-96,7420)\ mg}{L} \times 0,025\ L}{0,05\ g}$

qe =11,6290 mg/g

$Ci = 135 \frac{mg}{L}$

Ce = 107,2881 $\frac{mg}{L}$

$qe = \frac{\frac{(135-107,2881)mg}{L} \times 0,025\ L}{0,05\ g}$

qe = 13,8559 mg/g

$Ci = 150 \frac{mg}{L}$

$Ce = 116{,}3277 \frac{mg}{L}$

$qe = \frac{\frac{(150\text{-}116{,}3277)mg}{L} \times 0{,}025\ L}{0{,}05\ g}$

$qe = 16{,}8362$ mg/g

b. Adsorben Z-Cs 25:75%

$Ci = 60 \frac{mg}{L}$

$Ce = 1{,}0301 \frac{mg}{L}$

$qe = \frac{\frac{(60\text{-}1{,}0301)mg}{L} \times 0{,}025\ L}{0{,}05\ g}$

$qe = 29{,}4849$ mg/g

$Ci = 75 \frac{mg}{L}$

$Ce = 2{,}0282 \frac{mg}{L}$

$qe = \frac{\frac{(75\text{-}2{,}0282)mg}{L} \times 0{,}025\ L}{0{,}05\ g}$

$qe = 36{,}4859$ mg/g

$Ci = 90 \frac{mg}{L}$

$Ce = 7{,}4331 \frac{mg}{L}$

$qe = \frac{\frac{(90 - 7{,}4331)mg}{L} \times 0{,}025\ L}{0{,}05\ g}$

$qe = 41{,}2834$ mg/g

$Ci = 105 \frac{mg}{L}$

$Ce = 14{,}4953 \frac{mg}{L}$

$qe = \frac{\frac{(105\text{-}14{,}4953)mg}{L} \times 0{,}025\ L}{0{,}05\ g}$

$qe = 45{,}2524$ mg/g

$Ci = 120 \frac{mg}{L}$

$Ce = 26{,}2429 \frac{mg}{L}$

$qe = \frac{\frac{(120\text{-}26{,}2429)mg}{L} . 0{,}025\ L}{0{,}05\ g}$

$qe = 46{,}8785$ mg/g

$Ci = 135 \frac{mg}{L}$

$Ce = 30{,}7627 \frac{mg}{L}$

$qe = \frac{\frac{(135\text{-}30{,}7627)mg}{L} .0{,}025\ L}{0{,}05\ g}$

$qe = 52{,}1186$ mg/g

$Ci = 150 \frac{mg}{L}$

$Ce = 37{,}9190 \frac{mg}{L}$

$$qe = \frac{\frac{(150\text{-}37{,}9190)mg}{L}.0{,}025\ L}{0{,}05\ g}$$

$qe = 56{,}0405$ mg/g

c. Adsorben Z-Cs 50:50%

$Ci = 60 \frac{mg}{L}$

$Ce = 0{,}2768 \frac{mg}{L}$

$$qe = \frac{\frac{(60\text{-}0{,}2768)mg}{L} \times 0{,}025\ L}{0{,}05\ g}$$

$qe = 29{,}8616$ mg/g

$Ci = 75 \frac{mg}{L}$

$Ce = 0{,}6347 \frac{mg}{L}$

$$qe = \frac{\frac{(75\text{-}0{,}6347)mg}{L} \times 0{,}025\ L}{0{,}05\ g}$$

$qe = 37{,}1827$ mg/g

$Ci = 90 \frac{mg}{L}$

$Ce = 2{,}0471 \frac{mg}{L}$

$$qe = \frac{\frac{(90\text{-}2{,}0471)mg}{L} \times 0{,}025\ L}{0{,}05\ g}$$

$qe = 43{,}9765$ mg/g

$Ci = 105 \frac{mg}{L}$

$Ce = 6{,}0584 \frac{mg}{L}$

$$qe = \frac{\frac{(105\text{-}6{,}0584)mg}{L} \times 0{,}025\ L}{0{,}05\ g}$$

$qe = 49{,}4708$ mg/g

$Ci = 120 \frac{mg}{L}$

$Ce = 13{,}4727 \frac{mg}{L}$

$$qe = \frac{\frac{(120\text{-}13{,}4727)mg}{L}.0{,}025\ L}{0{,}05\ g}$$

$qe = 53{,}2637$/g

$Ci = 135 \frac{mg}{L}$

$Ce = 20{,}9699 \frac{mg}{L}$

$$qe = \frac{\frac{(135\text{-}20{,}9699)mg}{L}.0{,}025\ L}{0{,}05\ g}$$

$qe = 57{,}0151$ mg/g

$Ci = 150 \frac{mg}{L}$

$Ce = 29{,}3503 \frac{mg}{L}$

$$qe = \frac{(120\text{-}29{,}3503)\frac{mg}{L}.0{,}025\ L}{0{,}05\ g}$$

$qe = 60{,}3249$ mg/g

d. Adsorben Z-Cs 75:25%

$Ci = 60\frac{mg}{L}$

$Ce = 7{,}5838\frac{mg}{L}$

$$qe = \frac{(60\text{-}7{,}5838)\frac{mg}{L}\times 0{,}025\ L}{0{,}05\ g}$$

$qe = 26{,}2081$ mg/g

$Ci = 75\frac{mg}{L}$

$Ce = 14{,}2316\frac{mg}{L}$

$$qe = \frac{(75\text{-}14{,}2316)\frac{mg}{L}\times 0{,}025\ L}{0{,}05\ g}$$

$qe = 30{,}3842$ mg/g

$Ci = 90\frac{mg}{L}$

$Ce = 19{,}5744\frac{mg}{L}$

$$qe = \frac{(90\text{-}19{,}5744)\frac{mg}{L}\times 0{,}025\ L}{0{,}05\ g}$$

$qe = 35{,}2128$ mg/g

$Ci = 105\frac{mg}{L}$

$Ce = 28{,}5028\frac{mg}{L}$

$$qe = \frac{(105\text{-}28{,}5028)\frac{mg}{L}\times 0{,}025\ L}{0{,}05\ g}$$

$qe = 38{,}2486$ mg/g

$Ci = 120\frac{mg}{L}$

$Ce = 40{,}3672\frac{mg}{L}$

$$qe = \frac{(120\text{-}40{,}3672)\frac{mg}{L}.0{,}025\ L}{0{,}05\ g}$$

$qe = 39{,}8164$ mg/g

$Ci = 135\frac{mg}{L}$

$Ce = 45{,}8945\frac{mg}{L}$

$$qe = \frac{(135\text{-}45{,}8945)\frac{mg}{L}.0{,}025\ L}{0{,}05\ g}$$

$qe = 44{,}5527$ mg/g

$Ci = 150\frac{mg}{L}$

$Ce = 52{,}2976\frac{mg}{L}$

$$qe = \frac{\frac{(150\text{-}52{,}2976)\text{mg}}{\text{L}}.0{,}025\ \text{L}}{0{,}05\ \text{g}}$$

$qe = 48{,}8512\text{mg/g}$

Lampiran 3. Tabel dan Grafik

3.1 Tabel kemampuan dan efisiensi adsorpsi

a. Adsorben Zeolit Alam Teraktivasi

Ci (mg/L)	y	m	c	FP	Ce (mg/L)	C teradsorpsi (mg/L)	qe (mg/g)	%Efisiensi
60	0,469	0,0531	-0,0007	5	44,2279	15,7721	7,8861	26,2869
75	0,609	0,0531	-0,0007	5	57,4105	17,5895	8,7947	23,4526
90	0,377	0,0531	-0,0007	10	71,1299	18,8701	9,4350	20,9667
105	0,444	0,0531	-0,0007	10	83,7476	21,2524	10,6262	20,2403
120	0,513	0,0531	-0,0007	10	96,7420	23,2580	11,6290	19,3817
135	0,569	0,0531	-0,0007	10	107,2881	27,7119	13,8559	20,5273
150	0,617	0,0531	-0,0007	10	116,3277	33,6723	16,8362	22,4482

b. Adsorben Z-Cs 25:75%

Ci (mg/L)	y	m	c	FP	Ce (mg/L)	C teradsorpsi (mg/L)	qe (mg/g)	%Efisiensi
60	0,054	0,0531	-0,0007	1	1,0301	58,9699	29,4849	98,2831
75	0,107	0,0531	-0,0007	1	2,0282	72,9718	36,4859	97,2957
90	0,394	0,0531	-0,0007	1	7,4331	82,5669	41,2834	91,7409
105	0,769	0,0531	-0,0007	1	14,4953	90,5047	45,2524	86,1950
120	0,278	0,0531	-0,0007	5	26,2429	93,7571	46,8785	78,1309
135	0,326	0,0531	-0,0007	5	30,7627	104,2373	52,1186	77,2128
150	0,402	0,0531	-0,0007	5	37,9190	112,0810	56,0405	74,7207

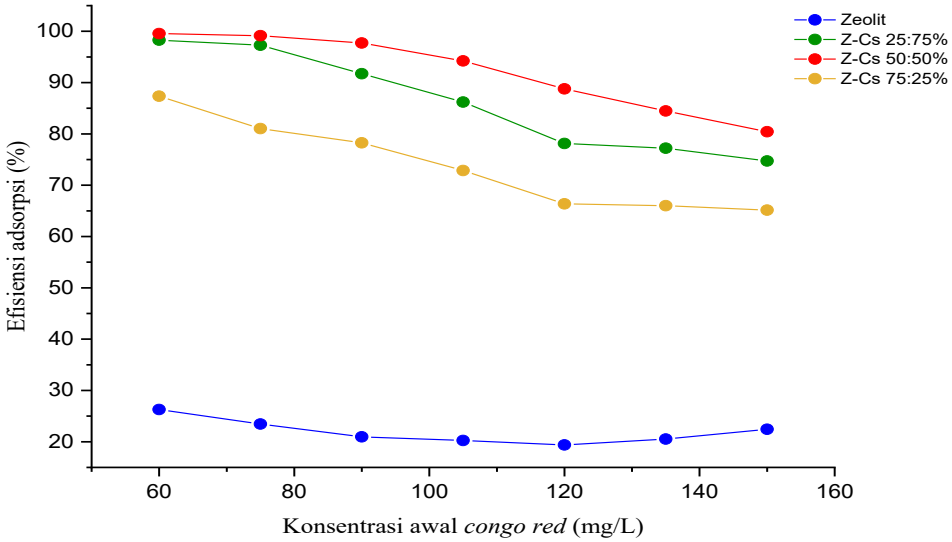
c. Adsorben Z-Cs 50:50%

Ci (mg/L)	y	m	c	FP	Ce (mg/L)	C teradsorpsi (mg/L)	qe (mg/g)	%Efisiensi
60	0,014	0,0531	-0,0007	1	0,2768	59,7232	29,8616	99,5386
75	0,033	0,0531	-0,0007	1	0,6347	74,3653	37,1827	99,1538
90	0,108	0,0531	-0,0007	1	2,0471	87,9529	43,9765	97,7255
105	0,321	0,0531	-0,0007	1	6,0584	98,9416	49,4708	94,2301
120	0,357	0,0531	-0,0007	2	13,4727	106,5273	53,2637	88,7728
135	0,222	0,0531	-0,0007	5	20,9699	114,0301	57,0151	84,4668
150	0,311	0,0531	-0,0007	5	29,3503	120,6497	60,3249	80,4331

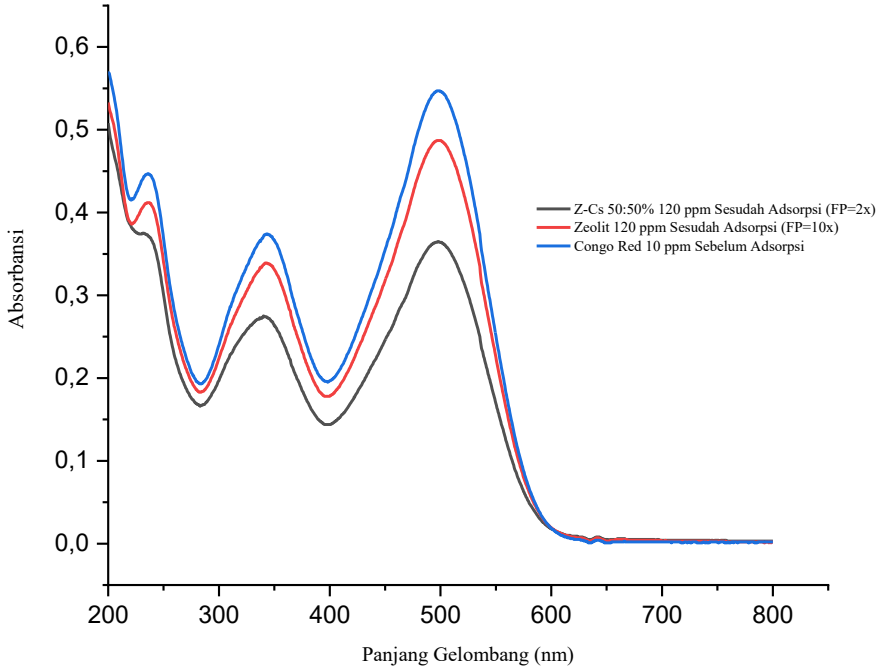
d. Adsorben Z-Cs 75:25%

Ci (mg/L)	y	m	c	FP	Ce (mg/L)	C teradsorpsi (mg/L)	qe (mg/g)	%Efisiensi
60	0,402	0,0531	-0,0007	1	7,5838	52,4162	26,2081	87,3603
75	0,755	0,0531	-0,0007	1	14,2316	60,7684	30,3842	81,0245
90	0,519	0,0531	-0,0007	2	19,5744	70,4256	35,2128	78,2507
105	0,302	0,0531	-0,0007	5	28,5028	76,4972	38,2486	72,8545
120	0,428	0,0531	-0,0007	5	40,3672	79,6328	39,8164	66,3606
135	0,243	0,0531	-0,0007	10	45,8945	89,1055	44,5527	66,0040
150	0,277	0,0531	-0,0007	10	52,2976	97,7024	48,8512	65,1350

3.2 Grafik efisiensi adsorpsi (%)



3.3 Spektrum *congo red* sebelum dan sesudah adsorpsi



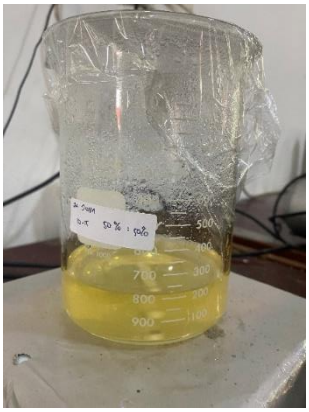
Lampiran 4. Dokumentasi penelitian

Zeolit Alam

Aktivasi Zeolit menggunakan HCl

Pencucian Zeolit Aktivasi menggunakan akuades hingga netral

Zeolit teraktivasi asam



Pelarutan Kitosan

Suspensi Zeolit-Kitosan

Sonikasi Suspensi Zeolit-Kitosan

Penambahan NaOH

Komposit Z-Cs 25:75%, 50:50%, dan 75:25%

Larutan *Congo Red* sebelum adsorpsi

Larutan *Congo Red* setelah di adsorpsi oleh Zeolit Teraktivasi asam

Larutan *Congo Red* setelah di adsorpsi oleh komposit Z-Cs 25:75%

Larutan *Congo Red* setelah di adsorpsi oleh komposit Z-Cs 50:50%

Larutan *Congo Red* setelah di adsorpsi oleh komposit Z-Cs 75:25%

Lampiran 5. Hasil Analisis dan Karakterisasi

5.1 Karakterisasi FTIR

a. FTIR Zeolit Alam Aktivasi

Lab. Terpadu UNDIP

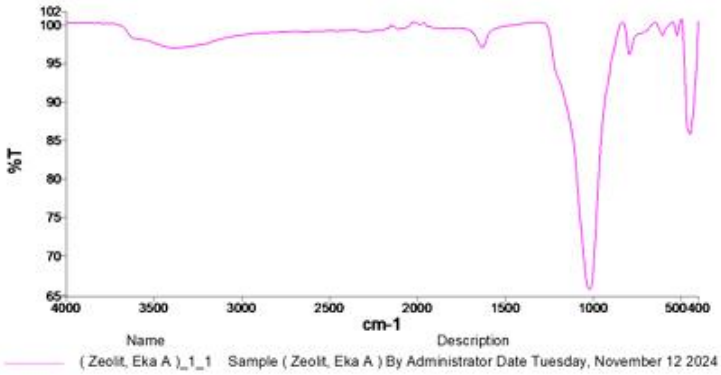
PerkinElmer Spectrum IR 10.6.1

November 13, 2024 4:46

Sample Details

Filename	E:\Report Hasil analisis FTIR\2024\November 2024\13 November 2024\SP24248014011\(Zeolit, Eka A)_1_1.sp
Creation Date	11/13/2024 4:37:01 PM
Analyst	Administrator
X-Axis Units	cm-1
X-Axis start value	4000
X-Axis end value	400
Data interval	-1
Number of points	3601
Y-Axis Units	%T
Description	Sample (Zeolit, Eka A) By Administrator Date Tuesday, November 12 2024

Spectrum



Summary

Sample Name	Description	Saved or unsaved State	Spectrum quality check summary
(Zeolit, Eka A)_1_1	Sample (Zeolit, Eka A) By Administrator Date Tuesday, November 12 2024	Saved	The Quality Checks do not report any warnings for the sample.

Search Results

Result Spectrum

PerkinElmer For the Better

Page 1 of 4

b. FTIR Kitosan

Lab. Terpadu UNDIP

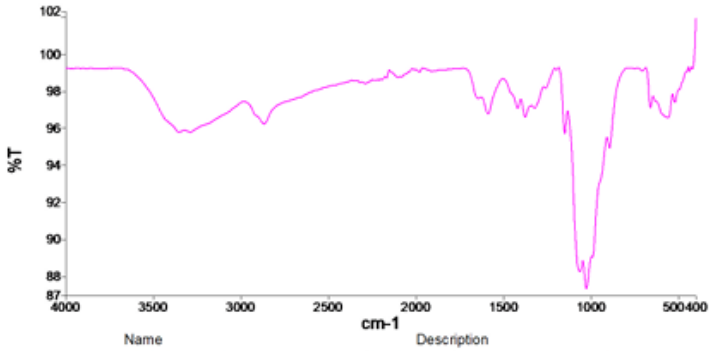
PerkinElmer Spectrum IR 10.6.1

December 11, 2024 23:52

Sample Details

Filename	E:\Report Hasil analisis FTIR\2024\Desember 2024\12 Desember 2024\SP24273514011\(kitosan)_016_1_1.sp
Creation Date	12/12/2024 11:18:41 AM
Analyst	Administrator
X-Axis Units	cm-1
X-Axis start value	4000
X-Axis end value	400
Data interval	-1
Number of points	3601
Y-Axis Units	%T
Description	Sample (kitosan) By Administrator Date Thursday, December 12 2024

Spectrum



Summary

Sample Name	Description	Saved or unsaved State	Spectrum quality check summary
(kitosan)_016_1_1	Sample (kitosan) By Administrator Date Thursday, December 12 2024	Saved	The Quality Checks give rise to a Weak Bands warning for the sample.

Search Results

Result Spectrum

PerkinElmer For the Better

c. FTIR Z-Cs 25:75%

Lab. Terpadu UNDIP

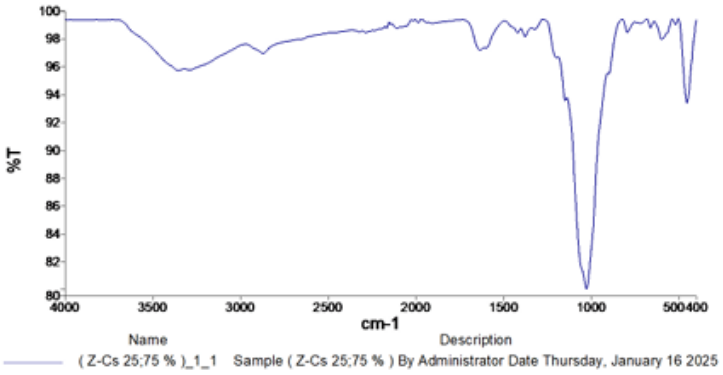
PerkinElmer Spectrum IR 10.6.1

January 20, 2025 0:39

Sample Details

Filename	E:\Report Hasil analisis FTIR\2025\Januari 2025\20 Januari 2025\SP25014914011\(Z-Cs 25;75 %)_1_1.sp
Creation Date	1/20/2025 11:11:50 AM
Analyst	Administrator
X-Axis Units	cm-1
X-Axis start value	4000
X-Axis end value	400
Data interval	-1
Number of points	3601
Y-Axis Units	%T
Description	Sample (Z-Cs 25;75 %) By Administrator Date Thursday, January 16 2025

Spectrum



Summary

Sample Name	Description	Saved or unsaved State	Spectrum quality check summary
(Z-Cs 25;75 %)_1_1	Sample (Z-Cs 25;75 %) By Administrator Date Thursday, January 16 2025	Saved	The Quality Checks give rise to a Weak Bands warning for the sample.

Search Results

Result Spectrum

PerkinElmer For the Better

d. FTIR Z-Cs 50:50%

Lab. Terpadu UNDIP

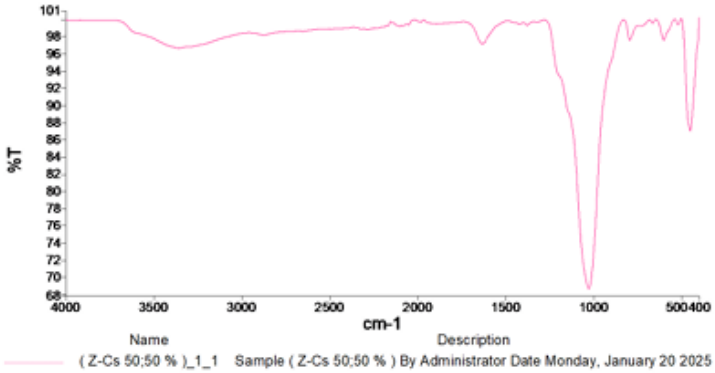
PerkinElmer Spectrum IR 10.6.1

January 20, 2025 0:39

Sample Details

Filename	E:\Report Hasil analisis FTIR\2025\Januari 2025\20 Januari 2025\SP25014914011\(Z-Cs 50;50 %)_1_1.sp
Creation Date	1/20/2025 11:36:48 AM
Analyst	Administrator
X-Axis Units	cm-1
X-Axis start value	4000
X-Axis end value	400
Data interval	-1
Number of points	3601
Y-Axis Units	%T
Description	Sample (Z-Cs 50;50 %) By Administrator Date Monday, January 20 2025

Spectrum



Summary

Sample Name	Description	Saved or unsaved State	Spectrum quality check summary
(Z-Cs 50;50 %)_1_1	Sample (Z-Cs 50;50 %) By Administrator Date Monday, January 20 2025	Saved	The Quality Checks give rise to a Weak Bands warning for the sample.

Search Results

Result Spectrum

PerkinElmer For the Better

e. FTIR Z-Cs 75:25%

Lab. Terpadu UNDIP

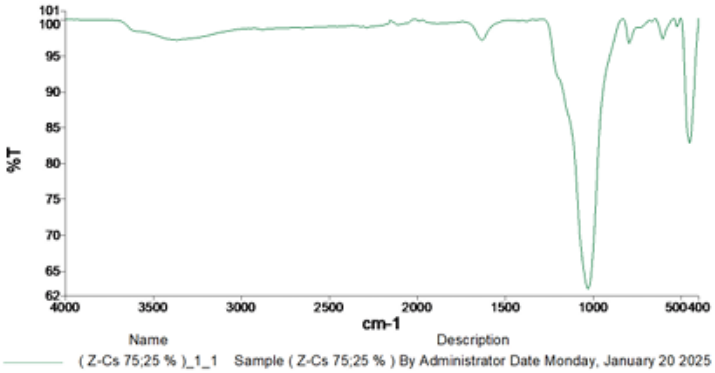
PerkinElmer Spectrum IR 10.6.1

January 20, 2025 0:39

Sample Details

Filename	E:\Report Hasil analisis FTIR\2025\Januari 2025\20 Januari 2025\SP25014914011\(Z-Cs 75;25 %)_1_1.sp
Creation Date	1/20/2025 11:40:00 AM
Analyst	Administrator
X-Axis Units	cm-1
X-Axis start value	4000
X-Axis end value	400
Data interval	-1
Number of points	3601
Y-Axis Units	%T
Description	Sample (Z-Cs 75;25 %) By Administrator Date Monday, January 20 2025

Spectrum



Summary

Sample Name	Description	Saved or unsaved State	Spectrum quality check summary
(Z-Cs 75;25 %)_1_1	Sample (Z-Cs 75;25 %) By Administrator Date Monday, January 20 2025	Saved	The Quality Checks do not report any warnings for the sample.

Search Results

Result Spectrum

PerkinElmer For the Better

f. FTIR Z-Cs setelah adsorpsi

Lab. Terpadu UNDIP

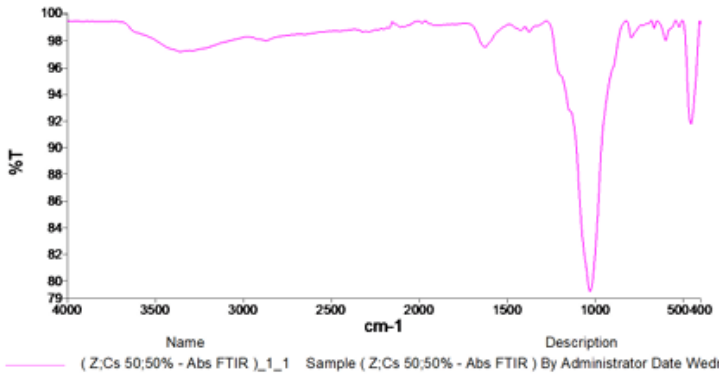
PerkinElmer Spectrum IR 10.6.1

April 22, 2025 23:20

Sample Details

Filename	E:\Report Hasil analisis FTIR\2025\April 2025\23 april 2025\SP25065714011\(Z;Cs 50;50% - Abs FTIR)_1_1.sp
Creation Date	4/23/2025 9:43:04 AM
Analyst	Administrator
X-Axis Units	cm-1
X-Axis start value	4000
X-Axis end value	400
Data interval	-1
Number of points	3601
Y-Axis Units	%T
Description	Sample (Z;Cs 50;50% - Abs FTIR) By Administrator Date Wednesday, April 23 2025

Spectrum



Summary

Sample Name	Description	Saved or unsaved State	Spectrum quality check summary
(Z;Cs 50;50% - Abs FTIR)_1_1	Sample (Z;Cs 50;50% - Abs FTIR) By Administrator Date Wednesday, April 23 2025	Saved	The Quality Checks give rise to a Weak Bands warning for the sample.

Search Results

Result Spectrum

PerkinElmer For the Better

Page 1 of 5

5. 2 Karakterisasi PSA

a. Zeolit alam teraktivasi

Bettersize

Bettersizer 2600(Wet) Particle Size Analysis Report

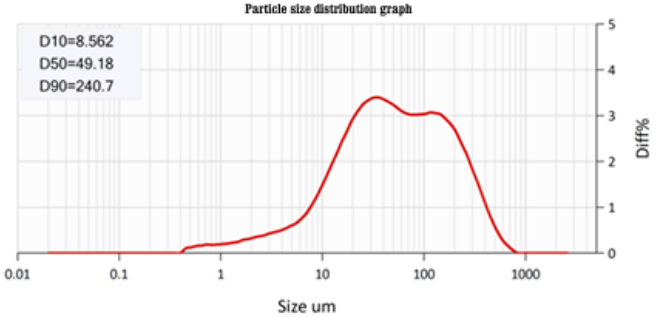
Range : 0.02um - 2600um

Sample :	Zeolit Alam	Number :	1	Sample Source :	UNDIP Kimia
Operator :	Fatih	Test Time :	2025-03-10 18:41:09	Measured By :	NEXUS Analytics Indonesia
Particle RI :	1.52	Particle AR :	0.05	Medium RI :	1.333
Optical :	Mie	Mode :	Adaptive	Distribution :	Volume
Sampling:		Speed (rpm):		Ultrasound:	
Medium :	Water	Dispersant :	Water	Remark :	

D[4,3] :	92.72 um	D[3,2] :	14.53 um	D[1,0] :	0.748 um	Peak Size :	33.47 um
SPAN :	4.720	SSA :	8257m^2/kg	Residual :	0.343 %	Obscuration :	10.71 %

D03 = 2.240 um	D06 = 4.846 um	D10 = 8.562 um	D16 = 13.21 um	D25 = 20.08 um
D75 = 128.5 um	D50 = 49.18 um	D84 = 183.4 um	D90 = 240.7 um	D97 = 380.1 um

Particle size distribution graph



Table

Diam um	Percent
45.00	47.57
75.00	61.15
100.0	68.50
200.0	86.06
300.0	93.92
400.0	97.50
500.0	99.04
600.0	99.69
700.0	99.93
800.0	100.00

Particle size distribution table

Diam um	Diff%	Cum%	Diam um	Diff%	Cum%	Diam um	Diff%	Cum%	Diam um	Diff%	Cum%
0.020-0.022	0.00	0.00	0.379-0.427	0.01	0.01	7.211-8.112	1.01	9.46	136.9-154.0	3.03	79.72
0.022-0.025	0.00	0.00	0.427-0.480	0.11	0.12	8.112-9.126	1.21	10.67	154.0-173.2	2.93	82.65
0.025-0.028	0.00	0.00	0.480-0.540	0.13	0.25	9.126-10.26	1.43	12.10	173.2-194.9	2.81	85.46
0.028-0.032	0.00	0.00	0.540-0.608	0.16	0.41	10.26-11.54	1.67	13.77	194.9-219.3	2.64	88.10
0.032-0.036	0.00	0.00	0.608-0.684	0.17	0.58	11.54-12.99	1.93	15.70	219.3-246.7	2.40	90.50
0.036-0.040	0.00	0.00	0.684-0.769	0.19	0.77	12.99-14.61	2.17	17.87	246.7-277.5	2.16	92.66
0.040-0.045	0.00	0.00	0.769-0.865	0.18	0.95	14.61-16.44	2.44	20.31	277.5-312.2	1.87	94.53
0.045-0.051	0.00	0.00	0.865-0.974	0.19	1.14	16.44-18.48	2.67	22.98	312.2-351.2	1.58	96.11
0.051-0.057	0.00	0.00	0.974-1.095	0.20	1.34	18.48-20.80	2.91	25.89	351.2-395.1	1.27	97.38
0.057-0.064	0.00	0.00	1.095-1.232	0.21	1.55	20.80-23.40	3.09	28.98	395.1-444.5	0.97	98.35
0.064-0.073	0.00	0.00	1.232-1.386	0.23	1.78	23.40-26.33	3.24	32.22	444.5-500.0	0.69	99.04
0.073-0.082	0.00	0.00	1.386-1.560	0.25	2.03	26.33-29.62	3.33	35.55	500.0-562.5	0.46	99.50
0.082-0.092	0.00	0.00	1.560-1.755	0.29	2.32	29.62-33.32	3.39	38.94	562.5-632.8	0.28	99.78
0.092-0.103	0.00	0.00	1.755-1.974	0.31	2.63	33.32-37.49	3.40	42.34	632.8-711.9	0.16	99.94
0.103-0.116	0.00	0.00	1.974-2.221	0.34	2.97	37.49-42.17	3.36	45.70	711.9-800.9	0.06	100.00
0.116-0.131	0.00	0.00	2.221-2.498	0.37	3.34	42.17-47.44	3.30	49.00	800.9-900.9	0.00	100.00
0.131-0.148	0.00	0.00	2.498-2.811	0.39	3.73	47.44-53.37	3.23	52.23	900.9-1013	0.00	100.00
0.148-0.166	0.00	0.00	2.811-3.162	0.43	4.16	53.37-60.04	3.14	55.37	1013-1140	0.00	100.00
0.166-0.187	0.00	0.00	3.162-3.557	0.46	4.62	60.04-67.55	3.07	58.44	1140-1282	0.00	100.00
0.187-0.210	0.00	0.00	3.557-4.002	0.49	5.11	67.55-75.98	3.03	61.47	1282-1443	0.00	100.00
0.210-0.237	0.00	0.00	4.002-4.502	0.53	5.64	75.98-85.49	3.02	64.49	1443-1623	0.00	100.00
0.237-0.266	0.00	0.00	4.502-5.065	0.59	6.23	85.49-96.17	3.03	67.52	1623-1826	0.00	100.00
0.266-0.300	0.00	0.00	5.065-5.698	0.64	6.87	96.17-108.1	3.04	70.56	1826-2054	0.00	100.00
0.300-0.337	0.00	0.00	5.698-6.410	0.73	7.60	108.1-121.7	3.07	73.63	2054-2311	0.00	100.00
0.337-0.379	0.00	0.00	6.410-7.211	0.85	8.45	121.7-136.9	3.06	76.69	2311-2600	0.00	100.00

Bettersize Instruments Ltd. www.bettersizeinstruments.com Email:services@bettersize.com Tel:+86 (415) 618 4440

System Status A:0-0-0-0-0-0-0-0-0-10-0-25-0-75-0-90 1-1 E:87-0-0-6-3 J:1-8-0-10-0-5 K:1-12-1-1-0-1 L:1-50-1-20000-0.1 M:0.3-1-1-0-7.5-1.1-2-1.03-1-30-16-0.025-0-0-65

SW.01.01.08204.00 01.10.BE.002540 Print Time: 2025-03-11 15:10:52 Project Name: Pak Pardoyo UNDIP Kimia Record No.: 7 PMT: Bettersizer 2600 BT-80N Pro General Test Method: Laser

b. Kitosan

Bettersize

Bettersizer 2600(Wet) Particle Size Analysis Report

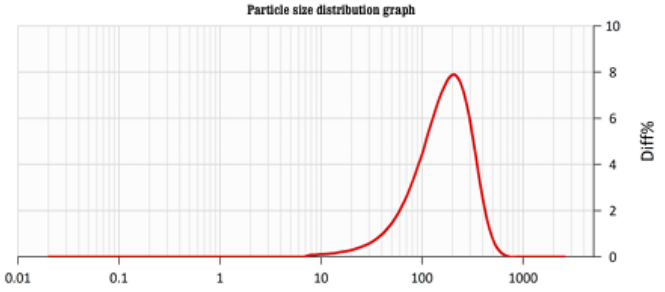
Range : 0.02um - 2600um

Sample :	Kitosan	Number :	1	Sample Source :	UNDIP
Operator :	Fatih	Test Time :	2025-04-25 14:30:44	Measured By :	NEXUS Analytics Indoensia
Particle RI :	1.5	Particle AR :	0.1	Medium RI :	1.333
Optical :	Mie	Mode :	Adaptive	Distribution :	Volume
Sampling:		Speed (rpm):		Ultrasound:	
Medium :	Water	Dispersant :	Water	Remark :	

D[4,3] :	182.9	um	D[3,2] :	111.5	um	D[1,0] :	18.46	um	Peak Size : 205.1 um
SPAN :	1.560		SSA :	19.91m^2/kg		Residual :	0.537	%	Obscuration : 11.92 %

D03 = 31.17 um	D06 = 46.01 um	D10 = 61.28 um	D16 = 80.11 um	D25 = 104.4 um
D75 = 245.8 um	D50 = 168.1 um	D84 = 285.6 um	D90 = 323.5 um	D97 = 410.0 um

Particle size distribution graph



Table

Diam um	Percent
20.00	1.35
45.00	5.76
75.00	14.25
100.0	23.28
200.0	61.40
300.0	86.29
400.0	96.40
500.0	99.21
600.0	99.89
700.0	100.00

Particle size distribution table

Diam um	Diff%	Cum%	Diam um	Diff%	Cum%	Diam um	Diff%	Cum%	Diam um	Diff%	Cum%
0.020-0.022	0.00	0.00	0.379-0.427	0.00	0.00	7.211-8.112	0.08	0.09	136.9-154.0	6.78	44.61
0.022-0.025	0.00	0.00	0.427-0.480	0.00	0.00	8.112-9.126	0.09	0.18	154.0-173.2	7.32	51.93
0.025-0.028	0.00	0.00	0.480-0.540	0.00	0.00	9.126-10.26	0.11	0.29	173.2-194.9	7.74	59.67
0.028-0.032	0.00	0.00	0.540-0.608	0.00	0.00	10.26-11.54	0.12	0.41	194.9-219.3	7.90	67.57
0.032-0.036	0.00	0.00	0.608-0.684	0.00	0.00	11.54-12.99	0.14	0.55	219.3-246.7	7.65	75.22
0.036-0.040	0.00	0.00	0.684-0.769	0.00	0.00	12.99-14.61	0.16	0.71	246.7-277.5	7.02	82.24
0.040-0.045	0.00	0.00	0.769-0.865	0.00	0.00	14.61-16.44	0.21	0.92	277.5-312.2	5.98	88.22
0.045-0.051	0.00	0.00	0.865-0.974	0.00	0.00	16.44-18.48	0.24	1.16	312.2-351.2	4.65	92.87
0.051-0.057	0.00	0.00	0.974-1.095	0.00	0.00	18.48-20.80	0.29	1.45	351.2-395.1	3.24	96.11
0.057-0.064	0.00	0.00	1.095-1.232	0.00	0.00	20.80-23.40	0.35	1.80	395.1-444.5	2.00	98.11
0.064-0.073	0.00	0.00	1.232-1.386	0.00	0.00	23.40-26.33	0.43	2.23	444.5-500.0	1.10	99.21
0.073-0.082	0.00	0.00	1.386-1.560	0.00	0.00	26.33-29.62	0.52	2.75	500.0-562.5	0.52	99.73
0.082-0.092	0.00	0.00	1.560-1.755	0.00	0.00	29.62-33.32	0.63	3.38	562.5-632.8	0.21	99.94
0.092-0.103	0.00	0.00	1.755-1.974	0.00	0.00	33.32-37.49	0.79	4.17	632.8-711.9	0.06	100.00
0.103-0.116	0.00	0.00	1.974-2.221	0.00	0.00	37.49-42.17	0.97	5.14	711.9-800.9	0.00	100.00
0.116-0.131	0.00	0.00	2.221-2.498	0.00	0.00	42.17-47.44	1.20	6.34	800.9-900.9	0.00	100.00
0.131-0.148	0.00	0.00	2.498-2.811	0.00	0.00	47.44-53.37	1.48	7.82	900.9-1013	0.00	100.00
0.148-0.166	0.00	0.00	2.811-3.162	0.00	0.00	53.37-60.04	1.82	9.64	1013-1140	0.00	100.00
0.166-0.187	0.00	0.00	3.162-3.557	0.00	0.00	60.04-67.55	2.23	11.87	1140-1282	0.00	100.00
0.187-0.210	0.00	0.00	3.557-4.002	0.00	0.00	67.55-75.98	2.72	14.59	1282-1443	0.00	100.00
0.210-0.237	0.00	0.00	4.002-4.502	0.00	0.00	75.98-85.49	3.29	17.88	1443-1623	0.00	100.00
0.237-0.266	0.00	0.00	4.502-5.065	0.00	0.00	85.49-96.17	3.93	21.81	1623-1826	0.00	100.00
0.266-0.300	0.00	0.00	5.065-5.698	0.00	0.00	96.17-108.1	4.58	26.39	1826-2054	0.00	100.00
0.300-0.337	0.00	0.00	5.698-6.410	0.00	0.00	108.1-121.7	5.37	31.76	2054-2311	0.00	100.00
0.337-0.379	0.00	0.00	6.410-7.211	0.01	0.01	121.7-136.9	6.07	37.83	2311-2600	0.00	100.00

System Status A:0-0-0-0-0-0-0-0-0 0-10-0-25-0-75-0-90 1-1 E:87-0-0-6-3 J:1-8-0-10-0-5 K:1-12-1-1-0-1 L:1-50-1-20000-0.1 M:0-3-1-1-0-7.5-1.1-2-1.03-1-30-16-0.025-0-0-65

SW.01.01.08204.00 01.10.BE.002540 Print Time: 2025-04-25 19:19:13 Project Name: Pak Pandoyo UNDIP Kimia (2) Record No.: 35 PMT: Bettersizer 2600 BT-80N Pro General Test Method: Laser

c. Z-Cs 25:75%

Bettersize

Bettersizer 2600(Wet) Particle Size Analysis Report

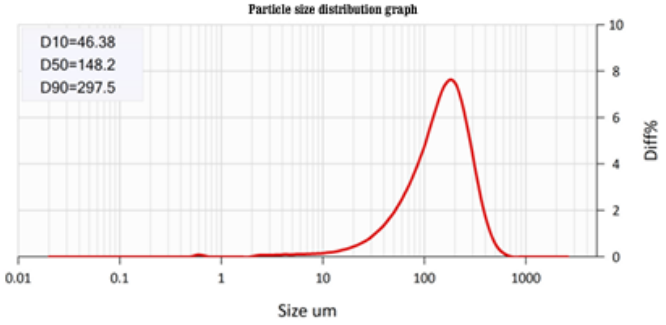
Range : 0.02um - 2600um

Sample :	Zeolit Alam - Kitosan 25_75	Number :	2	Sample Source :	UNDIP Kimia
Operator :	Fatih	Test Time :	2025-03-10 18:56:48	Measured By :	NEXUS Analytics Indonesia
Particle RI :	1.52	Particle AR :	0.05	Medium RI :	1.333
Optical :	Mie	Mode :	Adaptive	Distribution :	Volume
Sampling:		Speed (rpm):		Ultrasound:	
Medium :	Water	Dispersant :	Water	Remark :	

D[4,3] :	162.5	um	D[3,2] :	60.64	um	D[1,0] :	0.682	um	Peak Size : 181.1 um
SPAN :	1.694		SSA :	1978m^2/kg		Residual :	0.365	%	Obscuration : 10.52 %

D03 = 18.94	um	D06 = 32.55	um	D10 = 46.38	um	D16 = 64.01	um	D25 = 87.64	um
D75 = 219.8	um	D50 = 148.2	um	D84 = 258.9	um	D90 = 297.5	um	D97 = 388.9	um

Particle size distribution graph



Table

Diam um	Percent
20.00	3.20
45.00	9.56
75.00	20.07
100.0	29.98
200.0	69.14
300.0	90.29
400.0	97.45
500.0	99.40
600.0	99.91
700.0	100.00

Particle size distribution table

Diam um	Diff%	Cum%	Diam um	Diff%	Cum%	Diam um	Diff%	Cum%	Diam um	Diff%	Cum%
0.020-0.022	0.00	0.00	0.379-0.427	0.00	0.00	7.211-8.112	0.13	1.36	136.9-154.0	7.05	52.37
0.022-0.025	0.00	0.00	0.427-0.480	0.00	0.00	8.112-9.126	0.14	1.50	154.0-173.2	7.48	59.85
0.025-0.028	0.00	0.00	0.480-0.540	0.02	0.02	9.126-10.26	0.15	1.65	173.2-194.9	7.63	67.48
0.028-0.032	0.00	0.00	0.540-0.608	0.09	0.11	10.26-11.54	0.18	1.83	194.9-219.3	7.37	74.85
0.032-0.036	0.00	0.00	0.608-0.684	0.08	0.19	11.54-12.99	0.20	2.03	219.3-246.7	6.67	81.52
0.036-0.040	0.00	0.00	0.684-0.769	0.02	0.21	12.99-14.61	0.24	2.27	246.7-277.5	5.68	87.20
0.040-0.045	0.00	0.00	0.769-0.865	0.00	0.21	14.61-16.44	0.30	2.57	277.5-312.2	4.51	91.71
0.045-0.051	0.00	0.00	0.865-0.974	0.00	0.21	16.44-18.48	0.35	2.92	312.2-351.2	3.31	95.02
0.051-0.057	0.00	0.00	0.974-1.095	0.00	0.21	18.48-20.80	0.43	3.35	351.2-395.1	2.23	97.25
0.057-0.064	0.00	0.00	1.095-1.232	0.00	0.21	20.80-23.40	0.52	3.87	395.1-444.5	1.38	98.63
0.064-0.073	0.00	0.00	1.232-1.386	0.00	0.21	23.40-26.33	0.63	4.50	444.5-500.0	0.77	99.40
0.073-0.082	0.00	0.00	1.386-1.560	0.00	0.21	26.33-29.62	0.76	5.26	500.0-562.5	0.38	99.78
0.082-0.092	0.00	0.00	1.560-1.755	0.00	0.21	29.62-33.32	0.94	6.20	562.5-632.8	0.17	99.95
0.092-0.103	0.00	0.00	1.755-1.974	0.00	0.21	33.32-37.49	1.14	7.34	632.8-711.9	0.05	100.00
0.103-0.116	0.00	0.00	1.974-2.221	0.04	0.25	37.49-42.17	1.36	8.70	711.9-800.9	0.00	100.00
0.116-0.131	0.00	0.00	2.221-2.498	0.08	0.33	42.17-47.44	1.64	10.34	800.9-900.9	0.00	100.00
0.131-0.148	0.00	0.00	2.498-2.811	0.08	0.41	47.44-53.37	1.94	12.28	900.9-1013	0.00	100.00
0.148-0.166	0.00	0.00	2.811-3.162	0.08	0.49	53.37-60.04	2.30	14.58	1013-1140	0.00	100.00
0.166-0.187	0.00	0.00	3.162-3.557	0.09	0.58	60.04-67.55	2.71	17.29	1140-1282	0.00	100.00
0.187-0.210	0.00	0.00	3.557-4.002	0.09	0.67	67.55-75.98	3.16	20.45	1282-1443	0.00	100.00
0.210-0.237	0.00	0.00	4.002-4.502	0.11	0.78	75.98-85.49	3.69	24.14	1443-1623	0.00	100.00
0.237-0.266	0.00	0.00	4.502-5.065	0.10	0.88	85.49-96.17	4.27	28.41	1623-1826	0.00	100.00
0.266-0.300	0.00	0.00	5.065-5.698	0.11	0.99	96.17-108.1	4.90	33.31	1826-2054	0.00	100.00
0.300-0.337	0.00	0.00	5.698-6.410	0.12	1.11	108.1-121.7	5.65	38.96	2054-2311	0.00	100.00
0.337-0.379	0.00	0.00	6.410-7.211	0.12	1.23	121.7-136.9	6.36	45.32	2311-2600	0.00	100.00

System Status A:0-0-0-0-0-0-0-0-0-10-0-25-0-75-0-90 1-1 B:87-0-0-6-3 J:1-8-0-10-0-5 K:1-12-1-1-8-1 L:1-50-1-20000-0.1 M:0.3-1-1-0-7.5-1.1-2-1.03-1-30-16-0.025-0-0-65
SW:01.01.08204.00 01.10.BE.002543 Print Time: 2025-03-11 15:12:08 Project Name: Pak Pardoyo UNDIP Kimia Record No.: 11 PMT: Bettersizer 2600 BT-60N Pro General Test Method: Laser

d. Z-Cs 50:50%

Bettersize

Bettersizer 2600(Wet) Particle Size Analysis Report

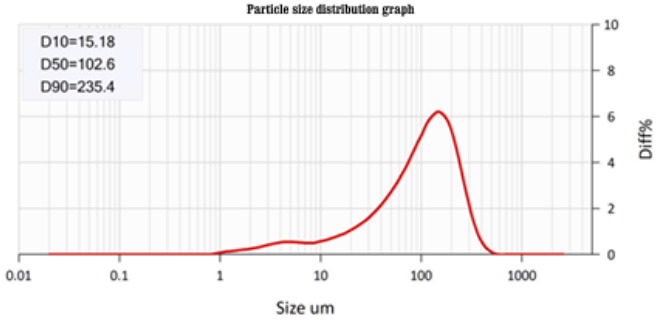
Range : 0.02um - 2600um

Sample :	Zeolit Alam - Kitosan 50_50	Number :	3	Sample Source :	UNDIP Kimia
Operator :	Fatih	Test Time :	2025-03-10 19:11:31	Measured By :	NEXUS Analytics Indonesia
Particle RI :	1.5	Particle AR :	0.05	Medium RI :	1.333
Optical :	Mie	Mode :	Adaptive	Distribution :	Volume
Sampling:		Speed (rpm):		Ultrasound:	
Medium :	Water	Dispersant :	Water	Remark :	

D[4,3] :	116.5 um	D[3,2] :	27.45 um	D[1,0] :	1.725 um	Peak Size :	149.9 um
SPAN :	2.144	SSA :	4370m^2/kg	Residual :	0.450 %	Obscuration :	10.44 %

D03 = 3.644 um	D06 = 7.038 um	D10 = 15.18 um	D16 = 28.38 um	D25 = 47.97 um
D75 = 168.6 um	D50 = 102.6 um	D84 = 202.6 um	D90 = 235.4 um	D97 = 309.4 um

Particle size distribution graph



Table

Diam um	Percent
10.00	7.56
20.00	12.20
45.00	23.62
75.00	37.49
100.0	48.81
200.0	83.45
300.0	96.47
400.0	99.44
500.0	99.95
600.0	100.00

Particle size distribution table

Diam um	Diff%	Cum%	Diam um	Diff%	Cum%	Diam um	Diff%	Cum%	Diam um	Diff%	Cum%
0.020-0.022	0.00	0.00	0.379-0.427	0.00	0.00	7.211-8.112	0.50	6.61	136.9-154.0	6.21	70.35
0.022-0.025	0.00	0.00	0.427-0.480	0.00	0.00	8.112-9.126	0.51	7.12	154.0-173.2	6.10	76.45
0.025-0.028	0.00	0.00	0.480-0.540	0.00	0.00	9.126-10.26	0.57	7.69	173.2-194.9	5.79	82.24
0.028-0.032	0.00	0.00	0.540-0.608	0.00	0.00	10.26-11.54	0.61	8.30	194.9-219.3	5.15	87.39
0.032-0.036	0.00	0.00	0.608-0.684	0.00	0.00	11.54-12.99	0.68	8.98	219.3-246.7	4.26	91.65
0.036-0.040	0.00	0.00	0.684-0.769	0.00	0.00	12.99-14.61	0.76	9.74	246.7-277.5	3.24	94.89
0.040-0.045	0.00	0.00	0.769-0.865	0.01	0.01	14.61-16.44	0.84	10.58	277.5-312.2	2.26	97.15
0.045-0.051	0.00	0.00	0.865-0.974	0.06	0.07	16.44-18.48	0.93	11.51	312.2-351.2	1.42	98.57
0.051-0.057	0.00	0.00	0.974-1.095	0.10	0.17	18.48-20.80	1.05	12.56	351.2-395.1	0.80	99.37
0.057-0.064	0.00	0.00	1.095-1.232	0.13	0.30	20.80-23.40	1.18	13.74	395.1-444.5	0.40	99.77
0.064-0.073	0.00	0.00	1.232-1.386	0.15	0.45	23.40-26.33	1.33	15.07	444.5-500.0	0.18	99.95
0.073-0.082	0.00	0.00	1.386-1.560	0.18	0.63	26.33-29.62	1.49	16.56	500.0-562.5	0.05	100.00
0.082-0.092	0.00	0.00	1.560-1.755	0.21	0.84	29.62-33.32	1.68	18.24	562.5-632.8	0.00	100.00
0.092-0.103	0.00	0.00	1.755-1.974	0.23	1.07	33.32-37.49	1.91	20.15	632.8-711.9	0.00	100.00
0.103-0.116	0.00	0.00	1.974-2.221	0.27	1.34	37.49-42.17	2.16	22.31	711.9-800.9	0.00	100.00
0.116-0.131	0.00	0.00	2.221-2.498	0.31	1.65	42.17-47.44	2.44	24.75	800.9-900.9	0.00	100.00
0.131-0.148	0.00	0.00	2.498-2.811	0.36	2.01	47.44-53.37	2.75	27.50	900.9-1013	0.00	100.00
0.148-0.166	0.00	0.00	2.811-3.162	0.42	2.43	53.37-60.04	3.09	30.59	1013-1140	0.00	100.00
0.166-0.187	0.00	0.00	3.162-3.557	0.47	2.90	60.04-67.55	3.47	34.06	1140-1282	0.00	100.00
0.187-0.210	0.00	0.00	3.557-4.002	0.51	3.41	67.55-75.98	3.88	37.94	1282-1443	0.00	100.00
0.210-0.237	0.00	0.00	4.002-4.502	0.55	3.96	75.98-85.49	4.35	42.29	1443-1623	0.00	100.00
0.237-0.266	0.00	0.00	4.502-5.065	0.56	4.52	85.49-96.17	4.82	47.11	1623-1826	0.00	100.00
0.266-0.300	0.00	0.00	5.065-5.698	0.55	5.07	96.17-108.1	5.26	52.37	1826-2054	0.00	100.00
0.300-0.337	0.00	0.00	5.698-6.410	0.53	5.60	108.1-121.7	5.74	58.11	2054-2311	0.00	100.00
0.337-0.379	0.00	0.00	6.410-7.211	0.51	6.11	121.7-136.9	6.03	64.14	2311-2600	0.00	100.00

System Status A-0-0-0-0-0-0-0-0-0-10-0-25-0-75-0-90 1-1 E:87-0-0-5-3 J:1-8-0-10-0-5 K:1-12-1-1-0-1 L:1-50-1-20000-0.1 M:0.3-1-1-0-7.5-1.1-2-1.03-1-30-16-0.025-0-0-85

SW.01.01.08204.00 01.10.BE.002540 Print Time: 2025-03-11 15:13:39 Project Name: Pak Pardoyo UNDIP Kimia Record No.: 17 PMT: Bettersizer 2600 BT-80N Pro General Test Method: Laser

e. Z-Cs 75:25%

Bettersize

Bettersizer 2600(Wet) Particle Size Analysis Report

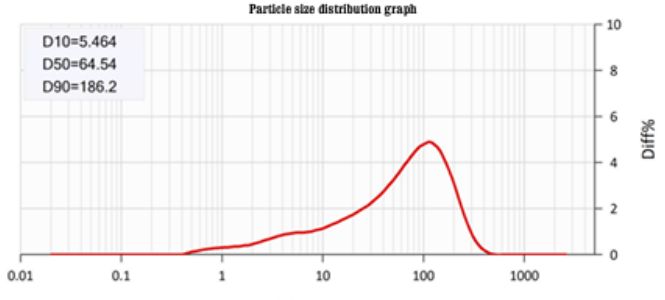
Range : 0.02um - 2600um

Sample :	Zeolit Alam - Kitosan 75_25	Number :	4	Sample Source :	UNDIP Kimia
Operator :	Fatih	Test Time :	2025-03-10 19:22:33	Measured By :	NEXUS Analytics Indonesia
Particle RI :	1.5	Particle AR :	0.05	Medium RI :	1.333
Optical :	Mie	Mode :	Adaptive	Distribution :	Volume
Sampling:		Speed (rpm):		Ultrasound:	
Medium :	Water	Dispersant :	Water	Remark :	

D[4,3] :	82.37	um	D[3,2] :	12.43	um	D[1,0] :	0.811	um	Peak Size : 111.4 um
SPAN :	2.800		SSA :	9650m^2/kg		Residual :	0.415	%	Obscuration : 10.74 %

D03 = 1.654 um	D06 = 3.171 um	D10 = 5.464 um	D16 = 10.79 um	D25 = 21.78 um
D75 = 123.2 um	D50 = 64.54 um	D84 = 154.8 um	D90 = 186.2 um	D97 = 255.3 um

Particle size distribution graph



Table

Diam um	Percent
5.000	9.29
10.00	15.24
20.00	23.68
45.00	39.49
75.00	55.20
100.0	66.35
200.0	92.08
300.0	98.67
400.0	99.85
500.0	100.00

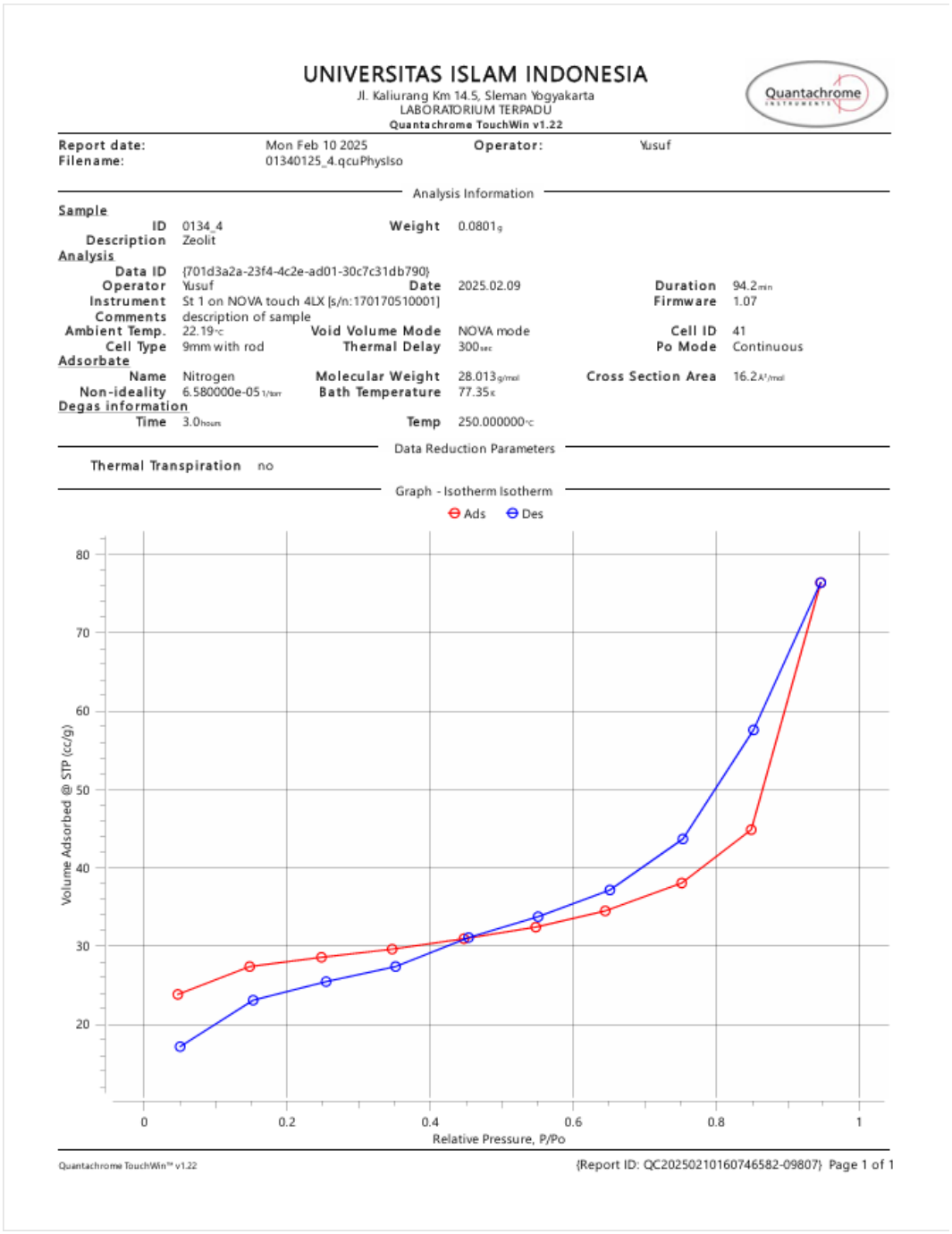
Particle size distribution table

Diam um	Diff%	Cum%	Diam um	Diff%	Cum%	Diam um	Diff%	Cum%	Diam um	Diff%	Cum%
0.020-0.022	0.00	0.00	0.379-0.427	0.01	0.01	7.211-8.112	1.01	13.30	136.9-154.0	4.51	83.78
0.022-0.025	0.00	0.00	0.427-0.480	0.08	0.09	8.112-9.126	1.07	14.37	154.0-173.2	4.06	87.84
0.025-0.028	0.00	0.00	0.480-0.540	0.13	0.22	9.126-10.26	1.12	15.49	173.2-194.9	3.53	91.37
0.028-0.032	0.00	0.00	0.540-0.608	0.17	0.39	10.26-11.54	1.21	16.70	194.9-219.3	2.89	94.26
0.032-0.036	0.00	0.00	0.608-0.684	0.22	0.61	11.54-12.99	1.31	18.01	219.3-246.7	2.18	96.44
0.036-0.040	0.00	0.00	0.684-0.769	0.25	0.86	12.99-14.61	1.40	19.41	246.7-277.5	1.54	97.98
0.040-0.045	0.00	0.00	0.769-0.865	0.28	1.14	14.61-16.44	1.51	20.92	277.5-312.2	0.98	98.96
0.045-0.051	0.00	0.00	0.865-0.974	0.30	1.44	16.44-18.48	1.62	22.54	312.2-351.2	0.57	99.53
0.051-0.057	0.00	0.00	0.974-1.095	0.32	1.76	18.48-20.80	1.73	24.27	351.2-395.1	0.30	99.83
0.057-0.064	0.00	0.00	1.095-1.232	0.33	2.09	20.80-23.40	1.86	26.13	395.1-444.5	0.13	99.96
0.064-0.073	0.00	0.00	1.232-1.386	0.35	2.44	23.40-26.33	2.00	28.13	444.5-500.0	0.04	100.00
0.073-0.082	0.00	0.00	1.386-1.560	0.36	2.80	26.33-29.62	2.14	30.27	500.0-562.5	0.00	100.00
0.082-0.092	0.00	0.00	1.560-1.755	0.40	3.20	29.62-33.32	2.32	32.59	562.5-632.8	0.00	100.00
0.092-0.103	0.00	0.00	1.755-1.974	0.42	3.62	33.32-37.49	2.52	35.11	632.8-711.9	0.00	100.00
0.103-0.116	0.00	0.00	1.974-2.221	0.49	4.11	37.49-42.17	2.74	37.85	711.9-800.9	0.00	100.00
0.116-0.131	0.00	0.00	2.221-2.498	0.55	4.66	42.17-47.44	3.00	40.85	800.9-900.9	0.00	100.00
0.131-0.148	0.00	0.00	2.498-2.811	0.63	5.29	47.44-53.37	3.26	44.11	900.9-1013	0.00	100.00
0.148-0.166	0.00	0.00	2.811-3.162	0.69	5.98	53.37-60.04	3.55	47.66	1013-1140	0.00	100.00
0.166-0.187	0.00	0.00	3.162-3.557	0.77	6.75	60.04-67.55	3.86	51.52	1140-1282	0.00	100.00
0.187-0.210	0.00	0.00	3.557-4.002	0.83	7.58	67.55-75.98	4.15	55.67	1282-1443	0.00	100.00
0.210-0.237	0.00	0.00	4.002-4.502	0.89	8.47	75.98-85.49	4.44	60.11	1443-1623	0.00	100.00
0.237-0.266	0.00	0.00	4.502-5.065	0.92	9.39	85.49-96.17	4.68	64.79	1623-1826	0.00	100.00
0.266-0.300	0.00	0.00	5.065-5.698	0.96	10.35	96.17-108.1	4.81	69.60	1826-2054	0.00	100.00
0.300-0.337	0.00	0.00	5.698-6.410	0.96	11.31	108.1-121.7	4.90	74.50	2054-2311	0.00	100.00
0.337-0.379	0.00	0.00	6.410-7.211	0.98	12.29	121.7-136.9	4.77	79.27	2311-2600	0.00	100.00

System Status A:0-0-0-0-0-0-0-0 D:10-0-25-0-75-0-90 1-1 E:87-0-0-6-3 J:1-8-0-10-0-5 K:1-12-1-1-0-1 L:1-50-1-20000-0.1 M:0.3-1-1-0-7.5-1.1-2-1.03-1-30-16-0.025-0-0-85
SW:01.01.08204.00 01.10.BE.002540 Print Time: 2025-03-11 15:14:54 Project Name: Pak Pardoyo UNDIP Kimia Record No.: 21 PMT: Bettersizer 2600 BT-80N Pro General Test Method: Laser

5. 3 Karakterisasi SAA

a. Zeolit alam teraktivasi



UNIVERSITAS ISLAM INDONESIA
Jl. Kaliurang Km 14.5, Sleman Yogyakarta
LABORATORIUM TERPADU
Quantachrome TouchWin v1.22

Quantachrome

Report date:	Mon Feb 10 2025	**Operator:**	Yusuf
Filename:	01340125_4.qcuPhysIso		

Analysis Information

Sample

ID	0134_4	**Weight**	0.0801 g
Description	Zeolit		

Analysis

Data ID	{701d3a2a-23f4-4c2e-ad01-30c7c31db790}				
Operator	Yusuf	**Date**	2025.02.09	**Duration**	94.2 min
Instrument	St 1 on NOVA touch 4LX [s/n: 170170510001]			**Firmware**	1.07
Comments	description of sample				
Ambient Temp.	22.19 °C	**Void Volume Mode**	NOVA mode	**Cell ID**	41
Cell Type	9mm with rod	**Thermal Delay**	300 sec	**Po Mode**	Continuous

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

Time	3.0 hours	**Temp**	250.000000 °C

Data Reduction Parameters

Thermal Transpiration no

Graph - Isotherm Isotherm

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LABORATORIUM TERPADU
Quantachrome TouchWin v1.22

Report date: Mon Feb 10 2025 **Operator:** Yusuf
Filename: 01340125_4.qcuPhysIso

Analysis Information

Sample

ID	0134_4	Weight	0.0801 g		
Description	Zeolit				

Analysis

Data ID	{701d3a2a-23f4-4c2e-ad01-30c7c31db790}				
Operator	Yusuf	Date	2025.02.09	Duration	94.2 min
Instrument	St 1 on NOVA touch 4LX [s/n:170170510001]			Firmware	1.07
Comments	description of sample				
Ambient Temp.	22.19 °C	Void Volume Mode	NOVA mode	Cell ID	41
Cell Type	9mm with rod	Thermal Delay	300 sec	Po Mode	Continuous

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

Time	3.0 hours	Temp	250.000000 °C		

Data Reduction Parameters

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

Adsorbate Model

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

Area-Volume Summary results

Surface Area Results

Multipoint BET	84.0021 m²/g
BJH adsorption	21.1121 m²/g
BJH desorption	31.8111 m²/g

Pore Volume Results

BJH adsorption cumulative micropore volume	0.0825801 cc/g
BJH desorption cumulative micropore volume	0.0882382 cc/g
Total Pore Volume	0.118494 cc/g

Pore Size Results

BJH adsorption pore radius	12.7481 nm
BJH desorption pore radius	5.74617 nm
Average Pore Size	2.82122 nm

b. Z-Cs 25:75%

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LABORATORIUM TERPADU
Quantachrome TouchWin v1.22

Report date:	Fri Feb 7 2025	**Operator:**	Yusuf
Filename:	00210125_1.qcuPhysIso		

Analysis Information

Sample

ID	0021_1	**Weight**	0.0771 g
Description	Z-CS 25:75		

Analysis

Data ID	{f032c0ce-9291-49c8-baaa-509e00fd015c}				
Operator	Yusuf	**Date**	2025.02.05	**Duration**	112.8 min
Instrument	St 1 on NOVA touch 4LX [s/n:1701705100011]			**Firmware**	1.07
Comments	description of sample				
Ambient Temp.	20.45 °C	**Void Volume Mode**	NOVA mode	**Cell ID**	41
Cell Type	9mm with rod	**Thermal Delay**	300 sec	**Po Mode**	Continuous

Adsorbate

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

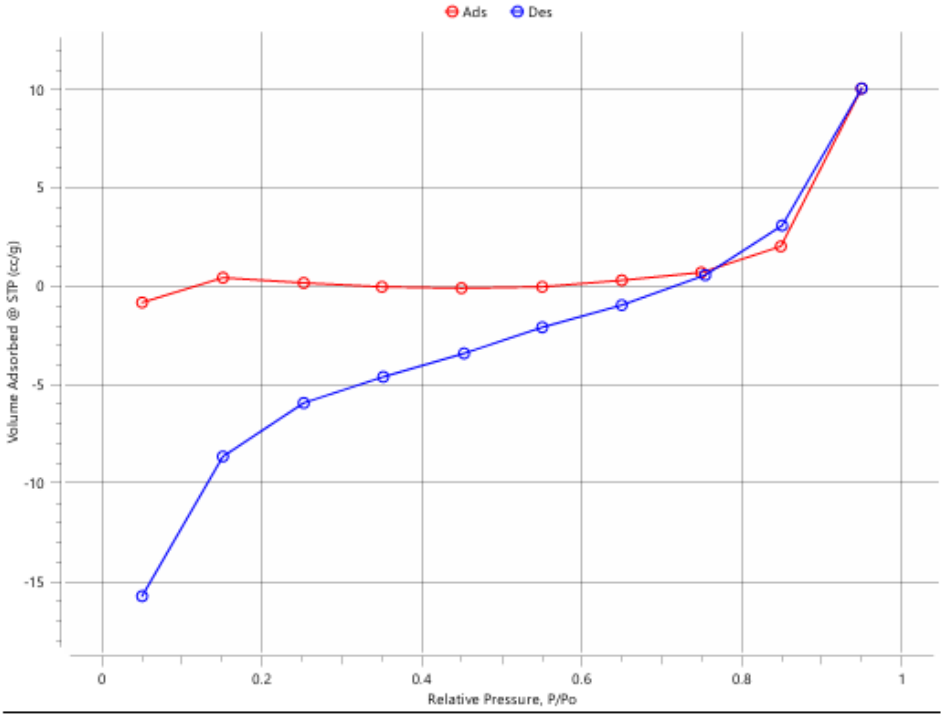
Degas information

Time	3.0 hours	**Temp**	150.000000 °C

Data Reduction Parameters

Thermal Transpiration	yes	**Eff. Molec. Diameter**	0 Å
Eff. Cell Diameter	0 mm		

Graph - Isotherm Isotherm



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LABORATORIUM TERPADU
Quantachrome TouchWin v1.22

Report date: Fri Feb 7 2025 **Operator:** Yusuf
Filename: 00210125_1.qcuPhysIso

Analysis Information

Sample

ID	0021_1	Weight	0.0771 g		
Description	Z-CS 25:75				

Analysis

Data ID	{f032c0ce-9291-49c8-baaa-509e00fd015c}				
Operator	Yusuf	Date	2025.02.05	Duration	112.8 min
Instrument	St 1 on NOVA touch 4LX [s/n:170170510001]			Firmware	1.07
Comments	description of sample				
Ambient Temp.	20.45 °C	Void Volume Mode	NOVA mode	Cell ID	41
Cell Type	9mm with rod	Thermal Delay	300 sec	Po Mode	Continuous

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

Time	3.0 hours	Temp	150.000000 °C		

Data Reduction Parameters

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

Adsorbate Model

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

Area-Volume Summary results

Surface Area Results

Multipoint BET	0.407347 m²/g
BJH adsorption	3.48024 m²/g
BJH desorption	10.108 m²/g

Pore Volume Results

BJH adsorption cumulative micropore volume	0.0178836 cc/g
BJH desorption cumulative micropore volume	0.0264484 cc/g
Total Pore Volume	0.0155967 cc/g

Pore Size Results

BJH adsorption pore radius	13.5055 nm
BJH desorption pore radius	2.0556 nm
Average Pore Size	76.577 nm

c. Z-Cs 50:50%

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LABORATORIUM TERPADU
Quantachrome TouchWin v1.22

Report date:	Fri Feb 7 2025	**Operator:**	Yusuf
Filename:	00210125_2.qcuPhysIso		

Analysis Information

Sample

ID	0021_2	**Weight**	0.0746 g
Description	Z-CS 50:50		

Analysis

Data ID	{e65cc45c-8a7b-4771-ab6f-80748a17f640}				
Operator	Yusuf	**Date**	2025.02.05	**Duration**	113.8 min
Instrument	St 2 on NOVA touch 4LX [s/n:170170510001]			**Firmware**	1.07
Comments	description of sample				
Ambient Temp.	20.43 °C	**Void Volume Mode**	NOVA mode	**Cell ID**	42
Cell Type	9mm with rod	**Thermal Delay**	300 sec	**Po Mode**	Continuous

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		

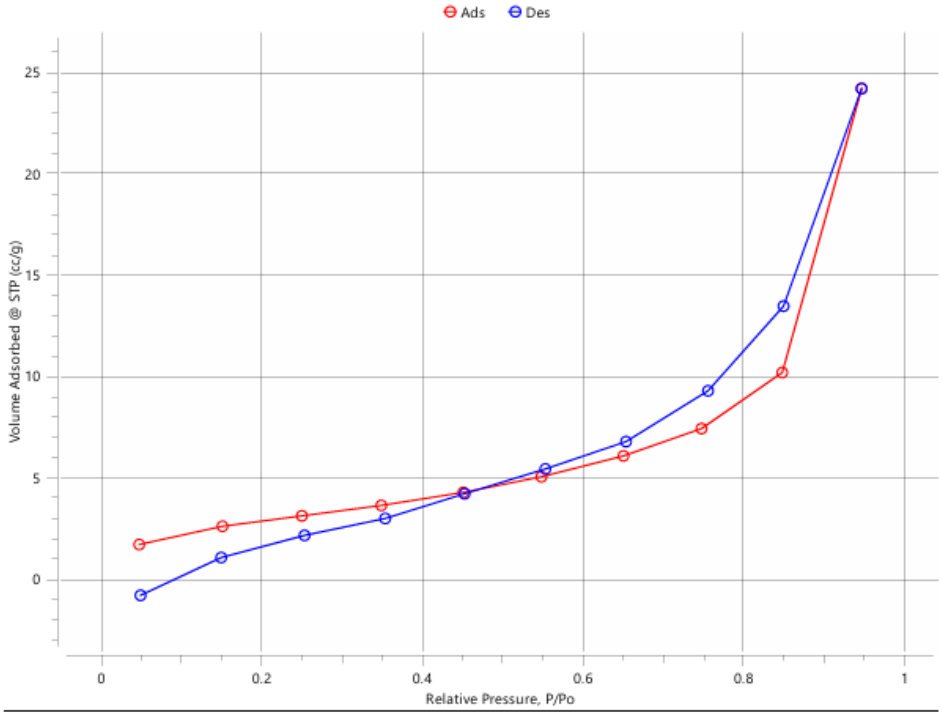
Degas information

Time	3.0 hours	**Temp**	150.000000 °C

Data Reduction Parameters

Thermal Transpiration	yes	**Eff. Molec. Diameter**	0 Å
Eff. Cell Diameter	0 mm		

Graph - Isotherm Isotherm



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Jl. Kaliurang Km 14.5, Sleman Yogyakarta
LABORATORIUM TERPADU
Quantachrome TouchWin v1.22

Report date:	Fri Feb 7 2025	**Operator:**	Yusuf
Filename:	00210125_2.qcuPhysIso		

Analysis Information

Sample

ID	0021_2	**Weight**	0.0746 g
Description	Z-CS 50:50		

Analysis

Data ID	{e65cc45c-8a7b-4771-ab6f-80748a17f640}				
Operator	Yusuf	**Date**	2025.02.05	**Duration**	113.8 min
Instrument	St 2 on NOVA touch 4LX [s/n: 170170510001]			**Firmware**	1.07
Comments	description of sample				
Ambient Temp.	20.43 °C	**Void Volume Mode**	NOVA mode	**Cell ID**	42
Cell Type	9mm with rod	**Thermal Delay**	300 sec	**Po Mode**	Continuous

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

Time	3.0 hours	**Temp**	150.000000 °C

Data Reduction Parameters

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

Adsorbate Model

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

Area-Volume Summary results

Surface Area Results

Multipoint BET	10.8412 m²/g
BJH adsorption	9.47494 m²/g
BJH desorption	12.7616 m²/g

Pore Volume Results

BJH adsorption cumulative micropore volume	0.0362483 cc/g
BJH desorption cumulative micropore volume	0.0381591 cc/g
Total Pore Volume	0.0375393 cc/g

Pore Size Results

BJH adsorption pore radius	2.0446 nm
BJH desorption pore radius	2.06148 nm
Average Pore Size	6.9253 nm

d. Z-Cs 75:25%

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Jl. Kaliurang Km 14.5, Sleman Yogyakarta
LABORATORIUM TERPADU
Quantachrome TouchWin v1.22

Quantachrome INSTRUMENTS

Report date: Fri Feb 7 2025 **Operator:** Yusuf
Filename: 00210125_3.qcuPhysIso

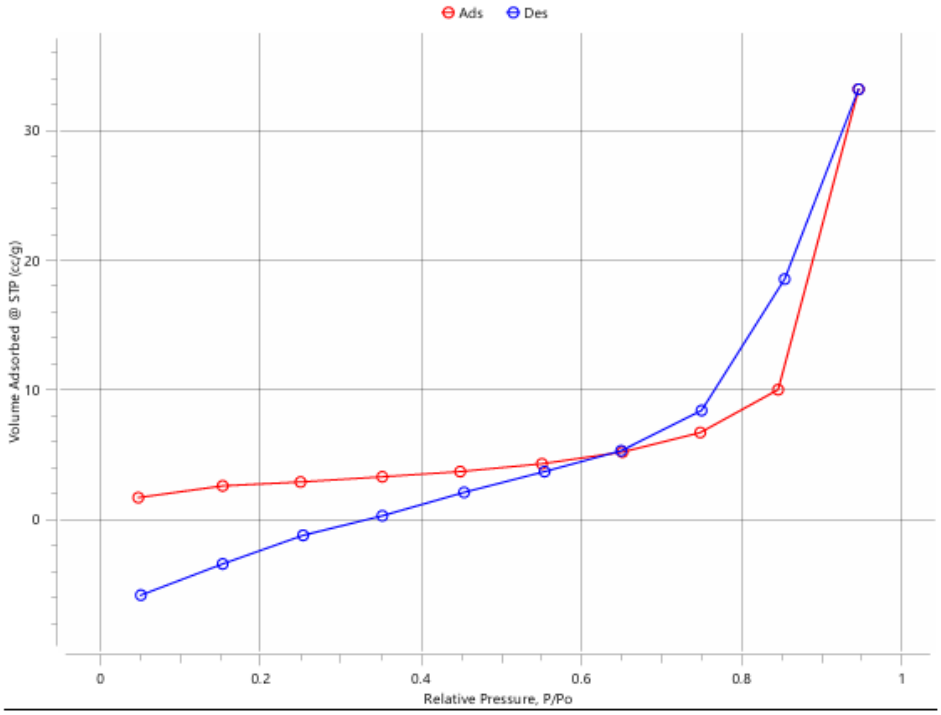
Analysis Information

Sample
ID 0021_3 Weight 0.0827 g
Description Z-CS 75:25
Analysis
Data ID {3d7705c6-6d91-41ad-9c94-535cd753fa76)
Operator Yusuf Date 2025.02.05 Duration 120.8 min
Instrument St 3 on NOVA touch 4LX [s/n:170170510001] Firmware 1.07
Comments description of sample
Ambient Temp. 20.41 °C Void Volume Mode NOVA mode Cell ID 43
Cell Type 9mm with rod Thermal Delay 300 sec Po Mode Continuous
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
Time 3.0 hours Temp 150.000000 °C

Data Reduction Parameters

Thermal Transpiration yes Eff. Molec. Diameter 0 Å
Eff. Cell Diameter 0 mm

Graph - Isotherm Isotherm



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LABORATORIUM TERPADU
Quantachrome TouchWin v1.22

Report date: Fri Feb 7 2025 **Operator:** Yusuf
Filename: 00210125_3.qcuPhysIso

Analysis Information

Sample

ID	0021_3	**Weight**	0.0827 g		
Description	Z-CS 75:25				

Analysis

Data ID	{3d7705c6-6d91-41ad-9c94-535cd753fa76}				
Operator	Yusuf	**Date**	2025.02.05	**Duration**	120.8 min
Instrument	St 3 on NOVA touch 4LX [s/n:170170510001]			**Firmware**	1.07
Comments	description of sample				
Ambient Temp.	20.41 °C	**Void Volume Mode**	NOVA mode	**Cell ID**	43
Cell Type	9mm with rod	**Thermal Delay**	300 sec	**Po Mode**	Continuous

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

Time	3.0 hours	**Temp**	150.000000 °C		

Data Reduction Parameters

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

Adsorbate Model

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

Area-Volume Summary results

Surface Area Results

Multipoint BET	9.64066 m²/g
BJH adsorption	10.7226 m²/g
BJH desorption	18.8879 m²/g

Pore Volume Results

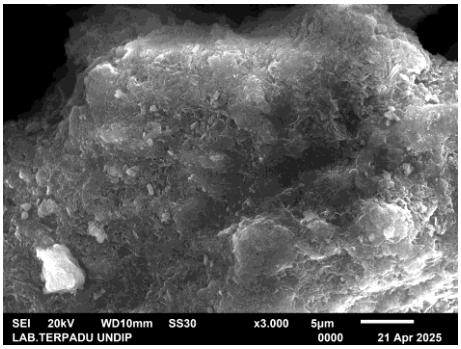
BJH adsorption cumulative micropore volume	0.0519154 cc/g
BJH desorption cumulative micropore volume	0.0589352 cc/g
Total Pore Volume	0.051458 cc/g

Pore Size Results

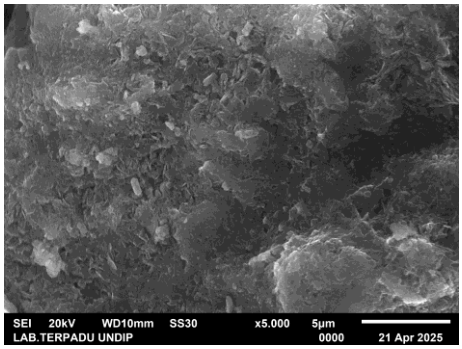
BJH adsorption pore radius	12.6792 nm
BJH desorption pore radius	5.73384 nm
Average Pore Size	10.6752 nm

5.4 Karakterisasi SEM

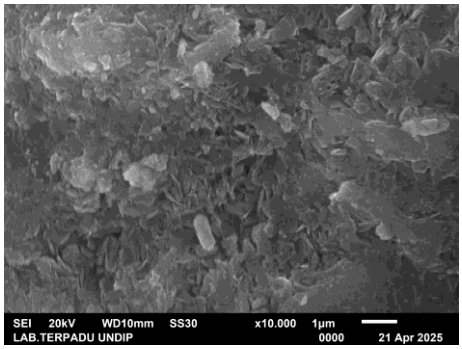
a. Zeolit alam teraktivasi



a)



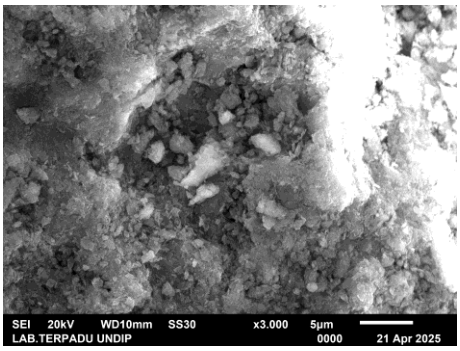
b)



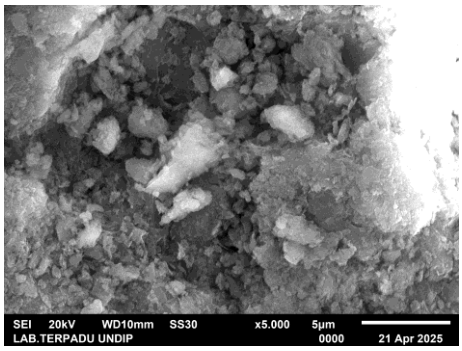
c)

Gambar L.1 Morfologi permukaan zeolit alam teraktivasi perbesaran (a)3000x, (b) 5000x, dan (c) 10000x

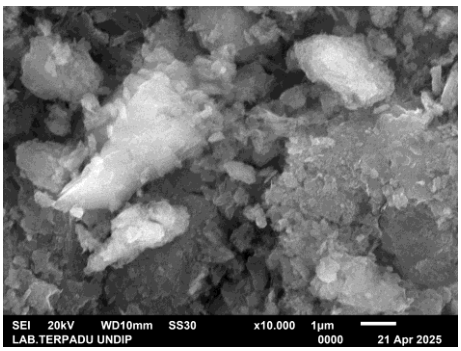
b. Komposit Z-Cs 50:50%



a)



b)



c)

Gambar L.2 Morfologi permukaan Z-Cs 50:50% perbesaran a) 3000x, b) 5000x, dan c) 10000x

5.5 Karakterisasi XRD zeolit alam Klaten

Laboratorium Tanah, Tanaman, Pupuk, Air
BADAN PENELITIAN DAN PENGEMBANGAN PERTANIAN
Laboratorium Penguji BALAI PENGKAJIAN TEKNOLOGI PERTANIAN YOGYAKARTA
Jl. Stadion Maguwoharjo No.22, Wedomartani, Ngemplak, Sleman, Yogyakarta
Telp. (0274) 884662, 4477053 Fax. (0274) 4477052; e-mail: bptp-diy@litbang.pertanian.go.id

HASIL ANALISIS CONTOH TANAH DF.7.8.2. b

Nomor SPK	: CE.1/07.21/140
Nama Pemohon	: Aldian Fahrialam
Alamat Pemohon	: Jl. Sacewa No.10A, RT 52 / RW 11, Wirobrajan, Yogyakarta
Asal Sampel	: Tegalrejo, Gedangsari, Gunungkidul, DIY
Uraian Kondisi Sampel Uji	: Utuh
Jumlah Sampel Uji	: 3 (tiga)
Tanggal Penerimaan	: 9 Juli 2021
Tanggal Pengujian	: 3 - 20 Agustus 2021

No.	Parameter Uji	Satuan	Z1	Z2	Z3	Metode
			TH. 21. 528	TH. 21. 529	TH. 21. 530	
1	KTK*	cmol(+)/kg	36.93	50.17	26.50	Destilasi IK. 5.4.f

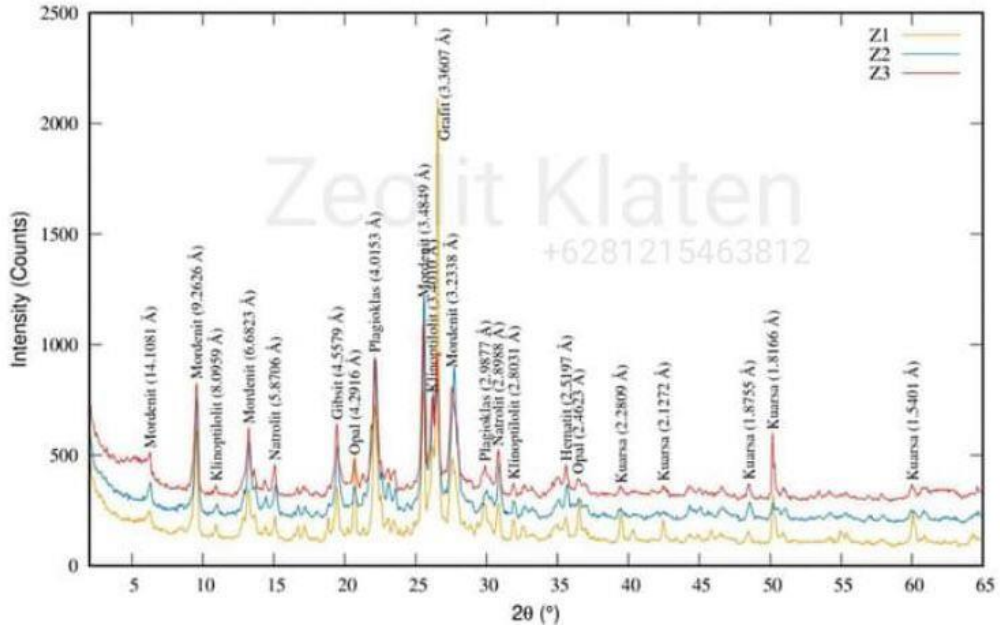
Hasil analisis ini hanya berlaku untuk sampel yang dimaksud

" Tidak dibenarkan menggandakan sebagian / seluruh isi hasil analisis ini, tanpa izin Laboratorium BPTP Yogyakarta dan pemilik hasil analisis"

Yogyakarta, 23 Agustus 2021
Deputy Manajer Teknis,

Widada, A.Md
NIP. 196807121999031001

Keterangan : * Parameter terakreditasi



Sampel Z1

No	Element		Concentration	Abs. Error
11	Na_2O	Sodiumoxide	0,992%	0.018
12	MgO	Magnesiumoxide	0,5970%	0.0066
13	Al_2O_3	Aluminumoxide	8,409%	0.011
14	SiO_2	Siliconoxide	61,92%	0.02
15	P_2O_5	Phosphorusoxide	0,04677%	0.00071
16	SO_3	Sulfideoxide	0,00786%	0.00012
17	Cl	Chlorine	0,00787%	0.00009
19	K_2O	Potassiumoxide	1,072%	0.002
20	CaO	Calciumoxide	4,712%	0.003
21	Fe_2O_3	Ironoxide	3,011%	0.004
22	MnO	Manganeseoxide	1284 µg/g	1
23	Sc	Scandium	80.8 µg/g	3.1
24	Ti	Titanium	1830 µg/g	3
25	V	Vanadium	38.9 µg/g	1
26	Cr	Chromium	6.2 µg/g	0.3
27	Co	Cobalt	< 0.1 µg/g	-
28	Ni	Nickel	14.5 µg/g	0.9
29	Cu	Copper	16 µg/g	0.8
30	Zn	Zinc	42.1 µg/g	0.7
31	Ga	Gallium	13.2 µg/g	0.3
32	Ge	Germanium	0.4 µg/g	0.2
33	As	Arsenic	0.8 µg/g	0.2
34	Se	Selenium	0.2µg/g	0.1
35	Br	Bromine	< 0.1 µg/g	-
37	Rb	Rubidium	29.9 µg/g	0.2
38	Sr	Strontium	677.1 µg/g	0.8
39	Y	Yttrium	15.9 µg/g	0.2
40	Zr	Zirconium	102.9 µg/g	0.5
41	Nb	Niobium	< 0.1 µg/g	-
42	Mo	Molybdenum	< 0.1 µg/g	-
44	Ru	Ruthenium	0.8 µg/g	0.2
45	Rh	Rhodium	0.6 µg/g	0.1
46	Pd	Palladium	< 0.4 µg/g	-
47	Ag	Silver	2.4 µg/g	0.1
48	Cd	Cadmium	0.5 µg/g	0.2
49	In	Indium	0.8 µg/g	0.2
50	Sn	Tin	4.1 µg/g	0.5
51	Sb	Antimony	5.1 µg/g	0.6
52	Te	Tellurium	≈ 18.8 µg/g	1.7
53	I	Iodine	12.9 µg/g	1
55	Cs	Cesium	27.1 µg/g	2
56	Ba	Barium	133.2 µg/g	2.3
57	La	Lanthanium	52.5 µg/g	4.1
58	Ce	Cerium	31.8 µg/g	2.9
59	Pr	Praseodymium	5.3 µg/g	2
60	Nd	Neodymium	< 0.5 µg/g	-
62	Sm	Samarium	< 0.1 µg/g	-
70	Yb	Ytterbium	< 4.2 µg/g	-
72	Hf	Hafnium	2.7 µg/g	0.8
73	Ta	Tantalum	< 0.5 µg/g	-
74	W	Tungsten	< 0.1 µg/g	-
79	Au	Gold	< 0.2 µg/g	-
80	Hg	Mercury	< 0.3 µg/g	-
81	Tl	Thallium	< 0.1 µg/g	-
82	Pb	Lead	4.5 µg/g	0.4
83	Bi	Bismuth	< 0.4 µg/g	-
90	Th	Thorium	0.4 µg/g	0.2
92	U	Uranium	0.9 µg/g	0.4

XRDZeolite-results

ZEOLIT KLATEN

081215463812

SAMPLE	Z1	Z2	Z3
Klinoptilolit	**40,46**	**37,35**	**33,23**
Mordenit	**11,46**	**14,29**	**14,27**
Ortoklas	13,79	11,01	16,77
Plagioklas	6,66	15,20	10,95
Opal	5,29	11,53	13,48
Grafit	6,74	4,31	2,98
Natrolit	3,23	3,20	3,57
Kuarsa	8,95	-	-
Hematit	1,74	1,60	2,50
Gibsit	1,68	1,51	2,25
Total	100,00	100,00	100,00