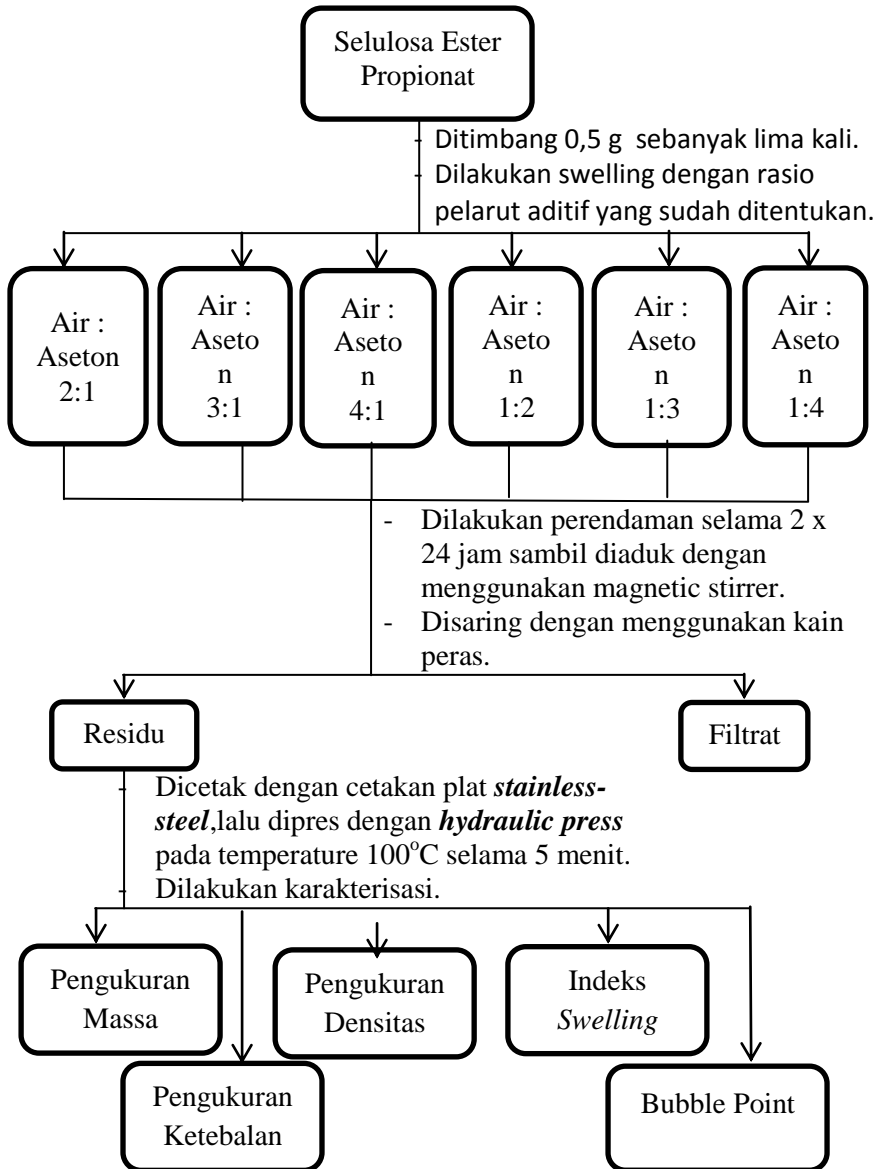


LAMPIRAN

Lampiran A. Diagram Alir penelitian



Lampiran B.

B.1 Uji Kelarutan

No	Sampel	Volume Aquades (mL)	Volume Aseton (mL)
1	Aquades : aseton (2:1)	10	5
2	Aquades:aseton (3:1)	15	5
3	Aquades : Aseton(4:1)	20	5
4	Aquades : Aseton(1:2)	5	10
5	Aquades : Aseton(1:3)	5	15
6	Aquades : Aseton(1:4)	5	20

Contoh Perhitungan :

Parameter kelarutan untuk pelarut :

Dimana campuran pelarut Aquades : Aseton 1:4

	Δd	δp	δh	R
cellulose asetat	9.1	6.4	5.2	3,7
Aquades	5.9	11.1	19.7	
Aseton	6.3	4.8	5.4	
δd_{ij}	6.22	6.06	8.26	
δ^k	9.1	6.4	5.2	
$\delta^k - \delta^{ij}$	2.88	0.34	-3.06	
$(\delta^k - \delta^{ij})^2$	33.1776	0.1156	9.3636	
D	6.531217			

Parameter kelarutan komponen aquades, aseton dan polimer dinotasikan dengan i, j, k

Misalkan perbandingan pelarut aquades aseton 1:4

$$\delta_d^{ij} = 0.2 \times 5.9 + 0.8 \times 6.3 = 6.22$$

$$\delta_p^{ij} = 0.2 \times 11.1 + 0.8 \times 4.8 = 6.06$$

$$\delta_h^{ij} = 0.2 \times 19.7 + 0.8 \times 5.4 = 8.26$$

δ^k parameter Hansen untuk polimer selulosa asetat.

$$d = [(\delta d^k - \delta d^{ij})^2 + (\delta p^k - \delta p^{ij})^2 + (\delta h^k - \delta h^{ij})^2]^{1/2}$$

Campuran pelarut	d
Aquades : Aseton(2:1)	11.7160
Aquades:aseton (3:1)	12.9445
Aquades : aseton (4:1)	13.6477
Aquades : Aseton(1:2)	7.7288
Aquades : Aseton(1:3)	6.9204
Aquades : Aseton(1:4)	6.5312

Perhitungan δ_{mix} campuran pelarut aseton-air menggunakan persamaan 2.2

No	Sampel	Volume Aquades (mL)	Volume Aseton (mL)	δ_{mix}
1	Aquades : aseton (2:1)	10	5	18.84
2	Aquades:aseton (3:1)	15	5	19.99
3	Aquades : Aseton(4:1)	20	5	20.67
4	Aquades : Aseton(1:2)	5	10	14.28
5	Aquades : Aseton(1:3)	5	15	13.14
6	Aquades : Aseton(1:4)	5	20	12.46

Dasar perhitungan

Densitas aquades	0.997
Densitas aseton	0.7845
Mr aquades	18
Mr aseton	58.08
V molar aquades	18
V molar aseton	74.17

Tabel Parameter Kelarutan Pelarut

Pelarut	δ_d	δ_p	δ_h
Benzen	8,95	0,5	1,0
Kloroform	8,65	1,5	2,8
Aseton	7,58	5,1	3,4
Toluen	8,82	0,7	1,0
Ethanol	7,73	4,3	9,5
Aquades	6,00	15,3	16,7

Untuk parameter kelarutan dari pelarut campuran (δ_{mix}) dihitung dengan rumus 2.2 :

$$\delta_{mix} = \frac{x_1V_1\delta_1 + x_2V_2\delta_2}{x_1V_1 + x_2V_2}$$

Dimana :

x_1 dan x_2 = fraksi mol komponen 1 dan 2

V_1 dan V_2 = volume molar komponen 1 dan 2

δ_1 dan δ_2 = parameter kelarutan komponen 1 dan 2

Contoh perhitungan Aq:As (2:1)

$$\begin{aligned} \delta Aq &= \sqrt{(\delta_d^2 + \delta_h^2 + \delta_p^2)} \\ &= \sqrt{(6,00^2 + 16,7^2 + 15,3^2)} \\ &= 23,43 \end{aligned}$$

$$\begin{aligned} \delta As &= \sqrt{(\delta_d^2 + \delta_h^2 + \delta_p^2)} \\ &= \sqrt{(7,85^2 + 5,1^2 + 3,4^2)} \\ &= 9,74 \end{aligned}$$

M aq = volume x densitas

$$= 10 \times 0,997$$

$$= 9,97$$

M as = 5x 0,7845

$$= 3.9225$$

$$n_{aq} = \frac{9,97}{18} = 0,5514$$

$$n_{as} = \frac{3.9225}{58} = 0.0675$$

$$x_1 = \frac{0,553}{0,5514+0,0675} = 0,890$$

$$x_2 = \frac{0,068}{0,553+0,068} = 0,109$$

$$V_1 = 18,08; V_2 = 74,17$$

$$\delta_{mix} = \frac{x_1 V_1 \delta_1 + x_2 V_2 \delta_2}{x_1 V_1 + x_2 V_2}$$

$$\delta_{mix} = \frac{0,890 \times 18,08 \times 23,43 + 0,109 \times 74,17 \times 9,74}{0,890 \times 18,08 + 0,109 \times 74,17}$$

$$= 18,84$$

B.2 Penentuan Indeks Swelling Produk Esterifikasi

Sampel	Polinomial	Waktu setimbang (menit)	Derajat swelling (%)
Aquades : aseton (2:1)	$y = 6x10^{-5} x^3 - 0,0223x^2 + 2,7908x$	123.88	117.56
Aquades:aseton (3:1)	$y = 3x10^{-5} x^3 - 0,0118x^2 + 1,8249x$	128.88	103.39
Aquades : Aseton (4:1)	$y = 5x10^{-5} x^3 - 0,022x^2 + 2,7965x$	146.66	126.21
Aquades : Aseton(1:2)	$y = 7x10^{-5} x^3 - 0,0256x^2 + 3,0801x$	121.9	121.85
Aquades : Aseton (1:3)	$y = 5x10^{-5} x^3 - 0,0208x^2 + 2,5503x$	138.88	87.29
Aquades : Aseton (1:4)	$y = 5x10^{-5} x^3 - 0,0198x^2 + 2,4556x$	132	48.14

Perhitungan :

$$\text{indeks swelling} = \frac{B_K - B_A}{B_A}$$

Dimana, B_A = berat awal sampel dan B_K = berat akhir sampel.

Penurunan persamaan garis indeks *Swelling* selulosa propionat

Aquades: Aseton (2:1)

$$y = 6x10^{-5} x^3 - 0,0223x^2 + 2,7908x$$

$$y' = 18x10^{-5} x^2 - 0,0446x + 2,7908$$

$$y'' = 36x10^{-5} x - 0,0446 = 0$$

Harga x (waktu kesetimbangan)

$$0,00036x = 0,0446$$

$$x = 123.88 \text{ menit}$$

Harga y (% indeks swelling)

$$y = 6x10^{-5} (123.88)^3 - 0,0223(123.88)^2 + 2,7908(123.88)$$

$$y = 117.56$$

Aquades: Aseton (3:1)

$$y = 3 \times 10^{-5} x^3 - 0,0118x^2 + 1,8249x$$

$$y' = 9 \times 10^{-5} x^2 - 0,0232x + 1,8014$$

$$y'' = 18 \times 10^{-5} x - 0,0232 = 0$$

Harga x (waktu kesetimbangan)

$$0,00018x = 0,0232$$

$$x = 128.88$$

Harga y (% indeks swelling)

$$y = 3 \times 10^{-5} (128.88)^3 - 0,0118(128.88)^2 + 1,8249(128.88)$$

$$y = 103.39$$

Aquades: Aseton (4:1)

$$y = 5 \times 10^{-5} x^3 - 0,022x^2 + 2,7965x$$

$$y' = 15 \times 10^{-5} x^2 - 0,044x + 2,7965$$

$$y'' = 30 \times 10^{-5} x - 0,044 = 0$$

Harga x (waktu kesetimbangan)

$$0,00030x = 0,044$$

$$x = 146.66$$

Harga y (% indeks swelling)

$$y = 5 \times 10^{-5} (134)^3 - 0,022(134)^2 + 2,7965(134)$$

$$y = 126.21$$

Aquades: Aseton (1:2)

$$y = 7 \times 10^{-5} x^3 - 0,0256x^2 + 3,0801x$$

$$y' = 21 \times 10^{-5} x^2 - 0,0512x$$

$$y'' = 42 \times 10^{-5} x - 0,0512$$

Harga x (waktu kesetimbangan)

$$0,00042x = 0,0512$$

$$x = 121.9$$

Harga y (% indeks swelling)

$$y = 7 \times 10^{-5} (121.9)^3 - 0,0256(121.9)^2 + 3,0801(121.9)$$

$$y = 121,85$$

Aquades: Aseton (1:3)

$$y = 5 \times 10^{-5} x^3 - 0,0208x^2 + 2,5503x$$

$$y' = 15 \times 10^{-5} x^2 - 0,0416x$$

$$y'' = 30 \times 10^{-5} x - 0,0416$$

Harga x (waktu kesetimbangan)

$$0,00030x = 0,0416$$

$$x = 138.88$$

Harga y (% indeks swelling)

$$y = 5 \times 10^{-5} (188)^3 - 0,0206 (188)^2 + 2,3194 (188)$$

$$y = 87.29$$

Aquades: Aseton (1:4)

$$y = 5 \times 10^{-5} x^3 - 0,0198 x^2 + 2,4556 x$$

$$y' = 15 \times 10^{-5} x^2 - 0,0396 x$$

$$y'' = 30 \times 10^{-5} x - 0,0396$$

Harga x (waktu kesetimbangan)

$$0,00030x = 0,037$$

$$x = 132$$

Harga y (% indeks swelling)

$$y = 5 \times 10^{-5} (185)^3 - 0,0198 (185)^2 + 2,455 (185)$$

$$y = 48.14$$

B.3 Perhitungan Densitas metode piknometer

Aku ade s	ase ton	pikno kosong	pikno+air	pikno+ membra n	total	massa air	rerat a mass a air
							6.981
1	2	12.8677	19.849	12.9188	19.8611	6.9813	3
1	3	12.8654	19.8501	12.9353	19.8637	6.9847	
1	4	12.8697	19.8497	12.9398	19.8612	6.9800	
3	1	12.8691	19.8484	12.9499	19.8567	6.9793	
2	1	12.8660	19.8489	12.9263	19.8567	6.9829	
4	1	12.8681	19.8479	12.9339	19.8538	6.9798	

rerata massa air	massa membran	massa air(di total)	volume air	v membran	densitas membran
6.9813	0.0511	6.9423	6.9423	0.0390	1.3091
	0.0699	6.9284	6.9284	0.0529	1.3205
	0.0701	6.9214	6.9214	0.0599	1.1696
	0.0808	6.9068	6.9068	0.0745	1.0841
	0.0603	6.9304	6.9304	0.0509	1.1839
	0.0658	6.9199	6.9199	0.0614	1.0711

Contoh Perhitungan: densitas air = 1 g/mL

$$\begin{aligned} \text{Volume piknometer} &= \frac{(\text{massa pikno +air}) - (\text{massa pikno kosong})}{\text{densitas air}} \\ &= \frac{19,849 - 12,8677}{1 \text{ g/mL}} \\ &= 6,9813 \text{ mL} \end{aligned}$$

$$\begin{aligned} \text{Volume Air} &= \frac{(\text{massa total}) - (\text{massa pikno +membran})}{\text{densitas air}} \\ &= \frac{19,8611 - 12,9188}{1 \text{ g/mL}} \\ &= 6,9423 \text{ mL} \end{aligned}$$

Volume Membran = (volume piknometer-volume air)

$$= (6,9813 - 6,9423)$$

$$= 0,039$$

$$\rho \text{ membran} = \frac{\text{massa membran}}{\text{volume membran}}$$

$$= \frac{0,0511}{0,039}$$

$$= 1,3091 \text{ g/mL}$$

B.4 Perhitungan Densitas Secara Dimensional

		massa	diameter	tebal rerata	jari-jari
Akuades	aseton	(g)	(mm)	(mm)	(cm)
1	2	0.0286	19.25	0.242	0.963
1	3	0.0267	19.19	0.306	0.960
		0.0338	20.32	0.292	1.016
1	4	0.0535	20.11	0.368	1.006
		0.0686	20.18	0.390	1.009
2	1	0.0216	18.24	0.178	0.912
3	1	0.0239	20.05	0.170	1.003
		0.0251	19.17	0.168	0.959
4	1	0.0319	19.04	0.210	0.952
		0.0291	18.19	0.200	0.910

luas	volume	densitas	densitas rerata
2.9089	0.0704	0.4063	0.4063
2.8908	0.0885	0.3018	0.3295
3.2413	0.0946	0.3571	
3.1746	0.1168	0.4579	0.5041
3.1968	0.1247	0.5502	
2.6117	0.0465	0.4646	0.4646
3.1557	0.0536	0.4455	0.4817
2.8848	0.0485	0.5179	
2.8458	0.0598	0.5338	0.5470
2.5974	0.0519	0.5602	

Contoh Perhitungan :

$$\begin{aligned}
 \text{Volume membran} &= \frac{1}{4} \times \pi \times (r)^2 \times t \\
 &= \frac{1}{4} \times 3,14 \times (\text{diameter})^2 \times \text{ketebalan membran} \\
 &= \frac{1}{4} \times 3,14 \times (18,24 \text{ mm})^2 \times 0,178 \text{ mm} \\
 &= 46,48784 \text{ mm}^3 = 0,0464 \text{ cm}^3
 \end{aligned}$$

$$\begin{aligned}
 \rho \text{ membran} &= \frac{\text{massa membran}}{\text{volume membran}} \\
 &= \frac{0,0216 \text{ g}}{0,0464 \text{ cm}^3} \\
 &= 0,4655 \text{ g/mL}
 \end{aligned}$$

Akuades	aseton	densitas dimensi	densitas pikno	selisih densitas
1	2	0.4063	1.3091	0.9029
1	3	0.3295	1.3205	0.9911
1	4	0.5041	1.1696	0.6655
2	1	0.4646	1.1839	0.7193
3	1	0.4817	1.0841	0.6024
4	1	0.5470	1.0711	0.5241

B.5 Penentuan Ukuran Pori secara *Bubble point*

Sampel	V ₀ (mL)	V ₁ (mL)	$\Delta P(Nm-2)$	R _p (μm)	Rata-rata (μm)
Aq : As (2:1)	10	8,2	121951,2195	1,1808	1,1520
Aq : As (2:1)	10	7,8	128205,1282	1,1232	
Aq : As (3:1)	10	8,4	119047,619	1,2096	1,1952
Aq : As (3:1)	10	8,2	121951,2195	1,1808	
Aq : As (4:1)	10	8,4	119047,619	1,2096	1,1232
Aq : As (4:1)	10	7,2	138888,8889	1,0368	
Aq : As (1:2)	10	7,6	131578,9474	1,0944	1,0656
Aq : As (1:2)	10	7,2	138888,8889	1,0368	
Aq : As (1:3)	10	7,8	128205,1282	1,1232	1,1088
Aq : As (1:3)	10	7,6	131578,9474	1,0944	
Aq : As (1:4)	10	7,2	138888,8889	1,0368	1,0574
Aq : As (1:4)	10	7,0	142857,1429	1,0080	

$$\Delta P = \frac{v_0}{v_1} \times 10^5 \text{ Nm}^{-2}$$

$$r_p = \frac{2\gamma}{\Delta P} \cos\theta$$

Keterangan:

r_p = jari-jari pori

γ_{air} = $72 \times 10^{-3} \text{ N/m}$

$\cos \theta$ = 1

v_0 = volume awal udara

v_i = volume akhir udara

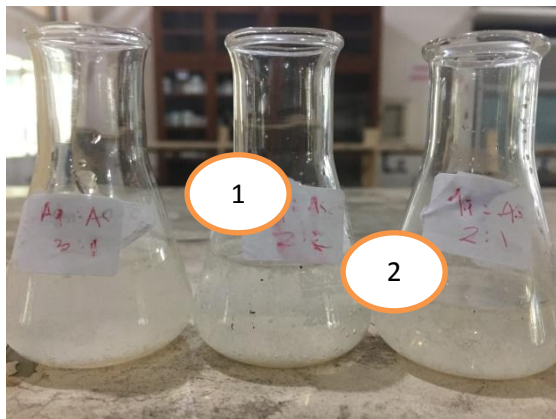
Contoh Perhitungan:

$$\Delta P = \left(\frac{10 \text{ mL}}{8,2} \right) \times 10^5 \text{ Nm}^{-2} = 121951,2195 \text{ Nm}^{-2}$$

$$r_p = \left(\frac{2 \times 72 \times 10^{-2} \text{ N/m}}{121951,2195 \text{ Nm}^{-2}} \right) \times 1 = 1,1808 \text{ } \mu\text{m}$$

LAMPIRAN C. GAMBAR

C.1 UJI KELARUTAN



Gambar C. 1 Uji Kelarutan

Keterangan :

1. Erlenmeyer 25 MI
2. Bahan Penelitian

C.2 Indeks Sweling



Gambar C. 2 Hydraulic-press dengan Sistem Pemanas

Keterangan :

1. Plat Pemanas
2. Dongkrak (penekan hydraulic)

C.3 Densitas



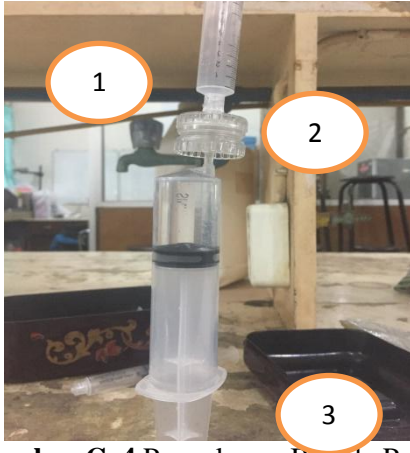
Gambar C. 3 Piknometer ditimbang di Neraca

1

Keterangan :

1. Neraca
2. Piknometer kosong

C.4 Bubble Point



Gambar C. 4 Pengukuran Bubble Point

Keterangan:

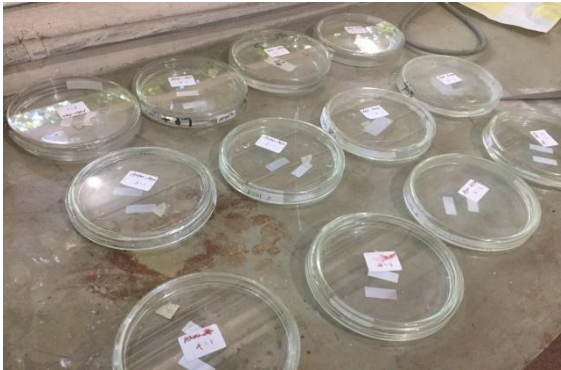
1. : Syringe berisi aquades
2. : *filter holder*
3. : Srynge berisi udara

C.5 Hasil produk Reaksi setelah diaduk dengan Campuran Pelarut Aseton:air



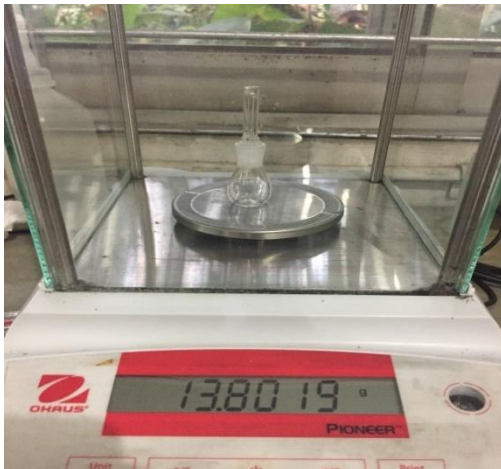
Gambar C. 5 Hasil produk setelah diaduk dengan Campuran Pelarut Aseton:air

C.6 Proses *Swelling* Produk Reaksi dalam aquades



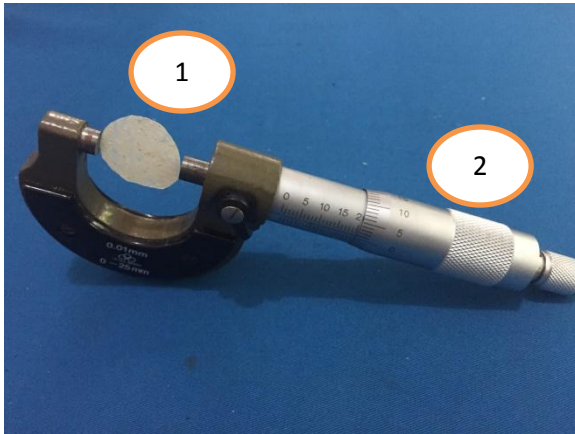
Gambar C. 6 Proses *Swelling* Produk Reaksi dalam aquades

C.7 Proses densitas dengan Piknometer



Gambar C. 7 Proses densitas dengan menggunakan Piknometer

C.8 Pengukuran Diameter menggunakan Mikrometer



Keterangan :

1. Membran Film Tipis
2. Mikrometer

C.9 Padatan Selulosa Propionat

