B.1 Perhitungan Pembuatan Larutan

B.1.1 Proses *Pretreatment* Enceng Gondok

1. Penghilangan Kandungan Hemiselulosa (dehemiselulosa)

   Perhitungan pembuatan larutan NaOH 4 % (w/v) dalam 500 ml sebagai berikut:

$$\% \text{ w/v} = \frac{\text{gram zat terlarut}}{\text{ml larutan}} \text{ x } 100\%$$

$$4 \% = \frac{\text{gram zat terlarut}}{500 \text{ ml}} \text{ x } 100\%$$

Gram zat terlarut (NaOH) = 20 gram

2. Penghilangan Lignin dan Pemutihan (delignifikasi & *bleaching*)

   Perhitungan pembuatan larutan H_2O_2 3 % (v/v) dalam 500 ml sebagai berikut:

   BM H_2O_2 = 34,0147 gr/mol

   BJ H_2O_2 = 1,11 gr/cm^3

$$M_1 = \frac{10 \text{ x } \% \text{ } H_2O_2 \text{ x BJ } H_2O_2}{\text{BM } H_2O_2}$$

$$M_1 = \frac{10 \text{ x } 30 \% \text{ x } 1,11 \text{ gr/cm}^3}{34,0147 \text{ gr/mol}}$$

$$M_1 = 9,789 \text{ M}$$

$$M_2 = \frac{10 \text{ x } \% \text{ } H_2O_2 \text{ x BJ } H_2O_2}{\text{BM } H_2O_2}$$

$$M_2 = \frac{10 \text{ x } 3 \% \text{ x } 1,11 \text{ gr/cm}^3}{34,0147 \text{ gr/mol}}$$

$$M_2 = 0,9789 \text{ M}$$

$$M_1 \text{ x } V_1 = M_2 \text{ x } V_2$$

$$9,789 \text{ M x } V_1 = 0,9789 \text{ x } 500 \text{ ml}$$

$$V_1 = 50 \text{ ml}$$

B.1.2 Proses Pembuatan CMC

Pada proses alkalisasi, menggunakan larutan NaOH 30 % (v/v) (16,25 gram NaOH) dalam 250 ml, perhitungan peembuatan larutannya sebagai berikut :

$$\% \text{ v/v} = \frac{\text{volume zat terlarut}}{\text{ml larutan}} \times 100\%$$

$$30\% = \frac{\text{volume zat terlarut}}{250 \text{ ml}} \times 100\%$$

Volume zat terlarut = 75 ml

B.1.3 Analisa Produk Yang Dihasilkan

1. Penentuan Derajat Substitusi (DS)

   a. Pembuatan larutan H_2SO_4 0,1 N dalam 250 ml

   $$N_1 = \frac{(10 \times \% \ H_2SO_4 \times BJ \ H_2SO_4) \times \text{valensi}}{BM \ H_2SO_4}$$

   $$N_1 = \frac{(10 \times 96 \ \% \times 1,84 \ \text{gr/cm}^3) \times 2}{98,08 \ \text{gr/mol}}$$

   $$N_1 = 36 \ N$$

   $$N_1 \times V_1 = N_2 \times V_2$$
   $$36 \ N \times V_1 = 0,1 \ N \times 250 \ \text{ml}$$
   $$V_1 = 0,7 \ \text{ml}$$

   b. Pembuatan larutan NaOH 0,1 N dalam 500 ml

   gr NaOH = N x V x BE

   $$\text{gr NaOH} = 0,1 \ N \times 0,5 \ L \times \left(\frac{40 \frac{\text{gr}}{\text{mol}}}{1}\right)$$

   gr NaOH = 2 gram

2. Penentuan Kadar NaCl

   a. Pembuatan larutan $AgNO_3$ 0,1 N dalam 250 ml

   gr $AgNO_3$ = N x V x BE

   $$\text{gr } AgNO_3 = 0,1 \ N \times 0,25 \ L \times \left(\frac{169,87 \frac{\text{gr}}{\text{mol}}}{3}\right)$$

gr $AgNO_3$ = 1,4156 gram

b. Pembuatan larutan K_2CrO_4 5 % (w/v) dalam 100 ml

$$5\% = \frac{\text{gram zat terlarut}}{100\ \text{ml}} \times 100\%$$

Gram zat terlarut = 5 gram

B.2 Penentuan Kadar Air CMC

$$\text{Kadar air} = \frac{W_1 - W_2}{W_1} \times 100\ \%$$

1. Natrium kloroasetat 16 gram

   W_1 = 11,28 gram

   W_2 = 5,93 gram

   $$\text{Kadar air} = \frac{11,28\ \text{gram} - 5,93\ \text{gram}}{11,28\ \text{gram}} \times 100\ \%$$

   $$\text{Kadar air} = \frac{5,35\ \text{gram}}{11,28\ \text{gram}} \times 100\ \%$$

   Kadar air = 47,43 %

2. Natrium kloroasetat 17 gram

   W_1 = 13,35 gram

   W_2 = 6,71 gram

   $$\text{Kadar air} = \frac{13,35\ \text{gram} - 6,71\ \text{gram}}{13,35\ \text{gram}} \times 100\ \%$$

   $$\text{Kadar air} = \frac{6,64\ \text{gram}}{13,35\ \text{gram}} \times 100\ \%$$

   Kadar air = 49,74 %

3. Natrium kloroasetat 18 gram

   W_1 = 13,53 gram

   W_2 = 6,76 gram

   $$\text{Kadar air} = \frac{13,53\ \text{gram} - 6,76\ \text{gram}}{13,53\ \text{gram}} \times 100\ \%$$

$$\text{Kadar air} = \frac{6,77 \text{ gram}}{13,53 \text{ gram}} \text{ x } 100 \text{ \%}$$

Kadar air = 50,04 %

4. Natrium kloroasetat 19 gram

W_1 = 17,24 gram

W_2 = 7,53 gram

$$\text{Kadar air} = \frac{17,24 \text{ gram} - 7,53 \text{ gram}}{17,24 \text{ gram}} \text{ x } 100 \text{ \%}$$

$$\text{Kadar air} = \frac{9,71 \text{ gram}}{17,24 \text{ gram}} \text{ x } 100 \text{ \%}$$

Kadar air = 56,32 %

5. Natrium kloroasetat 20 gram

W_1 = 14,7 gram

W_2 = 6,03 gram

$$\text{Kadar air} = \frac{14,7 \text{ gram} - 6,03 \text{ gram}}{14,7 \text{ gram}} \text{ x } 100 \text{ \%}$$

$$\text{Kadar air} = \frac{8,67 \text{ gram}}{14,7 \text{ gram}} \text{ x } 100 \text{ \%}$$

Kadar air = 58,98 %

6. Natrium kloroasetat 20 gram

W_1 = 18,69 gram

W_2 = 7,6   gram

$$\text{Kadar air} = \frac{18,69 \text{ gram} - 7,6 \text{ gram}}{18,69 \text{ gram}} \text{ x } 100 \text{ \%}$$

$$\text{Kadar air} = \frac{11,09 \text{ gram}}{18,69 \text{ gram}} \text{ x } 100 \text{ \%}$$

Kadar air = 59,34 %

7. Natrium kloroasetat 20 gram

W_1 = 21,05 gram

W_2 = 7,83 gram

$$\text{Kadar air} = \frac{21{,}05 \text{ gram} - 7{,}83 \text{ gram}}{21{,}05 \text{ gram}} \text{ x } 100 \%$$

$$\text{Kadar air} = \frac{13{,}22 \text{ gram}}{21{,}05 \text{ gram}} \text{ x } 100 \%$$

$$\text{Kadar air} = 62{,}8 \%$$

Data hasil perhitungan kadar air CMC dapat dilihat pada Tabel 18 berikut ini.

Tabel 18. Data Hasil Perhitungan Kadar Air CMC

Sampel	Massa Na-Kloroasetat (gr)	Kadar Air (%)
1.	16	47,43
2.	17	49,74
3.	18	50,04
4.	19	56,32
5.	20	58,98
6.	21	59,34
7.	22	62,80

B.3 Penentuan Derajat Substitusi (DS) CMC

$$A = \frac{V_{H_2SO_4} \text{ x } N_{H_2SO_4} - V_{NaOH} \text{ x } V_{NaOH}}{\text{Berat Sampel (gr)}}$$

$$DS = \frac{0{,}162 \text{ x } A}{1 - (0{,}058 \text{ x } A)}$$

1. Natrium kloroasetat 16 gram

$$A = \frac{35 \text{ ml x } 0{,}1 \frac{\text{meq}}{\text{ml}} - 11 \text{ ml x } 0{,}1 \frac{\text{meq}}{\text{ml}}}{0{,}7 \text{ gram}}$$

$$A = \frac{2{,}4 \text{ meq}}{0{,}7 \text{ gram}}$$

$$A = 3{,}43 \frac{\text{meq}}{\text{gram}}$$

$$DS = \frac{0{,}162 \frac{\text{gram}}{\text{mol}} \text{ x } 3{,}43 \frac{\text{meq}}{\text{gram}}}{1 - (0{,}058 \frac{\text{gram}}{\text{mol}} \text{ x } 3{,}43 \frac{\text{meq}}{\text{gram}})}$$

$$DS = \frac{0{,}556 \frac{\text{meq}}{\text{mol}}}{0{,}801 \frac{\text{meq}}{\text{mol}}}$$

$$DS = 0{,}69$$

2. Natrium kloroasetat 17 gram

$$A = \frac{35 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}} - 9 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}}}{0,7 \text{ gram}}$$

$$A = \frac{2,6 \text{ meq}}{0,7 \text{ gram}}$$

$$A = 3,714\frac{\text{meq}}{\text{gram}}$$

$$DS = \frac{0,162\frac{\text{gram}}{\text{mol}} \text{ x } 3,714\frac{\text{meq}}{\text{gram}}}{1 - (0,058\frac{\text{gram}}{\text{mol}} \text{ x } 3,714\frac{\text{meq}}{\text{gram}})}$$

$$DS = \frac{0,6017\frac{\text{meq}}{\text{mol}}}{0,785\frac{\text{meq}}{\text{mol}}}$$

$$DS = 0,77$$

3. Natrium kloroasetat 18 gram

$$A = \frac{35 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}} - 9,5 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}}}{0,7 \text{ gram}}$$

$$A = \frac{2,55 \text{ meq}}{0,7 \text{ gram}}$$

$$A = 3,64\frac{\text{meq}}{\text{gram}}$$

$$DS = \frac{0,162\frac{\text{gram}}{\text{mol}} \text{ x } 3,64\frac{\text{meq}}{\text{gram}}}{1 - (0,058\frac{\text{gram}}{\text{mol}} \text{ x } 3,64\frac{\text{meq}}{\text{gram}})}$$

$$DS = \frac{0,589\frac{\text{meq}}{\text{mol}}}{0,788\frac{\text{meq}}{\text{mol}}}$$

$$DS = 0,75$$

4. Natrium kloroasetat 19 gram

$$A = \frac{35 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}} - 8 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}}}{0,7 \text{ gram}}$$

$$A = \frac{2{,}7 \text{ meq}}{0{,}7 \text{ gram}}$$

$$A = 3{,}86 \frac{\text{meq}}{\text{gram}}$$

$$DS = \frac{0{,}162 \frac{\text{gram}}{\text{mol}} \text{ x } 3{,}86 \frac{\text{meq}}{\text{gram}}}{1 - (0{,}058 \frac{\text{gram}}{\text{mol}} \text{ x } 3{,}86 \frac{\text{meq}}{\text{gram}})}$$

$$DS = \frac{0{,}625 \frac{\text{meq}}{\text{mol}}}{0{,}776 \frac{\text{meq}}{\text{mol}}}$$

$$DS = 0{,}81$$

5. Natrium kloroasetat 20 gram

$$A = \frac{35 \text{ ml x } 0{,}1 \frac{\text{meq}}{\text{ml}} - 7{,}5 \text{ ml x } 0{,}1 \frac{\text{meq}}{\text{ml}}}{0{,}7 \text{ gram}}$$

$$A = \frac{2{,}75 \text{ meq}}{0{,}7 \text{ gram}}$$

$$A = 3{,}93 \frac{\text{meq}}{\text{gram}}$$

$$DS = \frac{0{,}162 \frac{\text{gram}}{\text{mol}} \text{ x } 3{,}93 \frac{\text{meq}}{\text{gram}}}{1 - (0{,}058 \frac{\text{gram}}{\text{mol}} \text{ x } 3{,}93 \frac{\text{meq}}{\text{gram}})}$$

$$DS = \frac{0{,}64 \frac{\text{meq}}{\text{mol}}}{0{,}772 \frac{\text{meq}}{\text{mol}}}$$

$$DS = 0{,}83$$

6. Natrium kloroasetat 21 gram

$$A = \frac{35 \text{ ml x } 0{,}1 \frac{\text{meq}}{\text{ml}} - 7 \text{ ml x } 0{,}1 \frac{\text{meq}}{\text{ml}}}{0{,}7 \text{ gram}}$$

$$A = \frac{2{,}8 \text{ meq}}{0{,}7 \text{ gram}}$$

$$A = 4 \frac{\text{meq}}{\text{gram}}$$

$$DS = \frac{0,162\frac{\text{gram}}{\text{mol}} \text{ x } 4\frac{\text{meq}}{\text{gram}}}{1 - (0,058\frac{\text{gram}}{\text{mol}} \text{ x } 4\frac{\text{meq}}{\text{gram}})}$$

$$DS = \frac{0,648\frac{\text{meq}}{\text{mol}}}{0,768\frac{\text{meq}}{\text{mol}}}$$

$$DS = 0,84$$

7. Natrium kloroasetat 22 gram

$$A = \frac{35 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}} - 6 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}}}{0,7 \text{ gram}}$$

$$A = \frac{2,9 \text{ meq}}{0,7 \text{ gram}}$$

$$A = 4,14\frac{\text{meq}}{\text{gram}}$$

$$DS = \frac{0,162\frac{\text{gram}}{\text{mol}} \text{ x } 4,14\frac{\text{meq}}{\text{gram}}}{1 - (0,058\frac{\text{gram}}{\text{mol}} \text{ x } 4,14\frac{\text{meq}}{\text{gram}})}$$

$$DS = \frac{0,671\frac{\text{meq}}{\text{mol}}}{0,759\frac{\text{meq}}{\text{mol}}}$$

$$DS = 0,88$$

Data hasil perhitungan derajat substitusi CMC dapat dilihat pada Tabel 19 berikut ini.

Tabel 19. Data Hasil Perhitungan Derajat Substitusi CMC

Sampel	Massa Na-Kloroasetat (gr)	Derajat Substitusi
1.	16	0,69
2.	17	0,77
3.	18	0,75
4.	19	0,81
5.	20	0,83
6.	21	0,84
7.	22	0,88

B.4 Penentuan Volume Aquadest Untuk Pengukuran Viskositas CMC

$$\text{Volume Aquadest} = \text{berat sampel x } \left(\frac{98 - \text{kadar air}}{2}\right)$$

1. Natrium kloroasetat 16 gram

   $$\text{Volume Aquadest} = 4{,}4 \text{ gram x } \left(\frac{98 - 47{,}43}{2}\right)$$

   Volume Aquadest = 111,25 ml

2. Natrium kloroasetat 17 gram

   $$\text{Volume Aquadest} = 4{,}4 \text{ gram x } \left(\frac{98 - 49{,}74}{2}\right)$$

   Volume Aquadest = 106,17 ml

3. Natrium kloroasetat 18 gram

   $$\text{Volume Aquadest} = 4{,}4 \text{ gram x } \left(\frac{98 - 50{,}04}{2}\right)$$

   Volume Aquadest = 105,5 ml

4. Natrium kloroasetat 19 gram

   $$\text{Volume Aquadest} = 4{,}4 \text{ gram x } \left(\frac{98 - 56{,}32}{2}\right)$$

   Volume Aquadest = 91,7 ml

5. Natrium kloroasetat 20 gram

   $$\text{Volume Aquadest} = 4{,}4 \text{ gram x } \left(\frac{98 - 58{,}98}{2}\right)$$

   Volume Aquadest = 85,84 ml

6. Natrium kloroasetat 21 gram

   $$\text{Volume Aquadest} = 4{,}4 \text{ gram x } \left(\frac{98 - 59{,}34}{2}\right)$$

   Volume Aquadest = 85,05 ml

7. Natrium kloroasetat 22 gram

$$\text{Volume Aquadest} = 4{,}4 \text{ gram x } \left(\frac{98 - 62{,}8}{2}\right)$$

$$\text{Volume Aquadest} = 77{,}4 \text{ ml}$$

Data hasil perhitungan penentuan volume aquadest untuk pengukuran viskositas CMC dapat dilihat pada Tabel 20 berikut ini.

Tabel 20. Data Hasil Perhitungan Volume Aquadest
Untuk Pengukuran Viskositas CMC

Sampel	Massa Na-Kloroasetat (gr)	Volume Aquadest (ml)
1.	16	111,25
2.	17	106,17
3.	18	105,50
4.	19	91,70
5.	20	85,84
6.	21	85,05
7.	22	77,40

B.5 Penentuan Kadar NaCl CMC

$$\% \text{ NaCl} = \frac{V_{AgNO_3} \text{ x } N_{AgNO_3} \text{ x BE NaCl X fp}}{\text{massa sampel (mg)}} \text{ x } 100 \%$$

1. Natrium kloroasetat 16 gram

$$\% \text{ NaCl} = \frac{6{,}3 \text{ ml x } 0{,}1 \frac{\text{meq}}{\text{ml}} \text{ x } 58{,}5 \frac{\text{mg}}{\text{meq}} \text{ x } \frac{100}{25}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = \frac{14742 \text{ mg}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = 33{,}5 \%$$

2. Natrium kloroasetat 17 gram

$$\% \text{ NaCl} = \frac{5{,}7 \text{ ml x } 0{,}1 \frac{\text{meq}}{\text{ml}} \text{ x } 58{,}5 \frac{\text{mg}}{\text{meq}} \text{ x } \frac{100}{25}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = \frac{13338 \text{ mg}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = 30{,}3 \%$$

3. Natrium kloroasetat 18 gram

$$\% \text{ NaCl} = \frac{4 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}} \text{ x } 58,5\frac{\text{mg}}{\text{meq}} \text{ x } \frac{100}{25}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = \frac{9360 \text{ mg}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = 21,3 \%$$

4. Natrium kloroasetat 19 gram

$$\% \text{ NaCl} = \frac{3,6 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}} \text{ x } 58,5\frac{\text{mg}}{\text{meq}} \text{ x } \frac{100}{25}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = \frac{8424 \text{ mg}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = 19,15 \%$$

5. Natrium kloroasetat 20 gram

$$\% \text{ NaCl} = \frac{3,1 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}} \text{ x } 58,5\frac{\text{mg}}{\text{meq}} \text{ x } \frac{100}{25}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = \frac{7254 \text{ mg}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = 16,49 \%$$

6. Natrium kloroasetat 21 gram

$$\% \text{ NaCl} = \frac{2,7 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}} \text{ x } 58,5\frac{\text{mg}}{\text{meq}} \text{ x } \frac{100}{25}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = \frac{6318 \text{ mg}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = 14,36 \%$$

7. Natrium kloroasetat 22 gram

$$\% \text{ NaCl} = \frac{2,6 \text{ ml x } 0,1\frac{\text{meq}}{\text{ml}} \text{ x } 58,5\frac{\text{mg}}{\text{meq}} \text{ x } \frac{100}{25}}{440 \text{ mg}} \text{ x } 100 \%$$

$$\% \text{ NaCl} = \frac{6084 \text{ mg}}{440 \text{ mg}} \text{ x } 100 \%$$

$\% \text{ NaCl} = 13,83 \%$

Data hasil perhitungan kadar NaCl dari CMC dapat dilihat pada Tabel 21 berikut ini.

Tabel 21. Data Hasil Perhitungan Kadar NaCl CMC

Sampel	Massa Na-Kloroasetat (gr)	Kadar NaCl (%)
1.	16	33,50
2.	17	30,30
3.	18	21,30
4.	19	19,15
5.	20	16,49
6.	21	14,36
7.	22	13,83

B.6 Penentuan Kemurnian CMC

$$\text{Kemurnian} = 100 \% - \% \text{ NaCl}$$

1. Natrium kloroasetat 16 gram

   Kemurnian $= 100 \% - 33,5 \%$

   Kemurnian $= 66,5 \%$

2. Natrium kloroasetat 17 gram

   Kemurnian $= 100 \% - 30,3 \%$

   Kemurnian $= 69,7 \%$

3. Natrium kloroasetat 18 gram

   Kemurnian $= 100 \% - 21,3 \%$

   Kemurnian $= 78,7 \%$

4. Natrium kloroasetat 19 gram

   Kemurnian $= 100 \% - 19,15 \%$

   Kemurnian $= 80,85 \%$

5. Natrium kloroasetat 20 gram

    Kemurnian $= 100\% - 16,49\%$

    Kemurnian $= 83,51\%$

6. Natrium kloroasetat 21 gram

    Kemurnian $= 100\% - 14,36\%$

    Kemurnian $= 85,64\%$

7. Natrium kloroasetat 22 gram

    Kemurnian $= 100\% - 13,83\%$

    Kemurnian $= 86,17\%$

Data hasil perhitungan kadar NaCl dari CMC dapat dilihat pada Tabel 22 berikut ini.

Tabel 22. Data Hasil Perhitungan Kemurnian CMC

Sampel	Massa Na-Kloroasetat (gr)	Kemurnian (%)
1.	16	66,50
2.	17	69,70
3.	18	78,70
4.	19	80,85
5.	20	83,51
6.	21	85,64
7.	22	86,17