

LAMPIRAN

A. PROSES PEMBUATAN BIOGAS



(1) Pengambilan kotoran sapi di peternakan sapi



(2) Proses pembuatan biogas

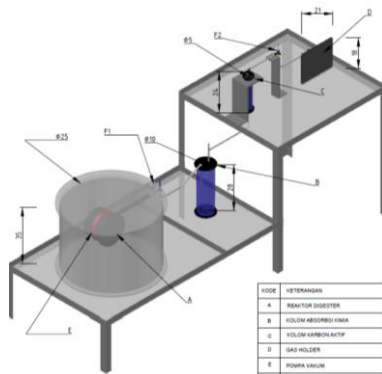


(3) Pengambilan limbah cair tahu di industri rumahan



(4) Limbah cair tahu

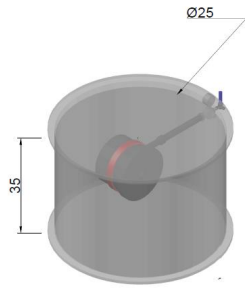
B. PERANCANGAN ALAT



(1) Design rancangan prototipe alat pereduksi CO₂



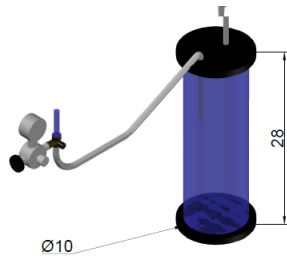
(2) Prototipe alat pereduksi CO₂



(3) Sketsa reaktor biogas



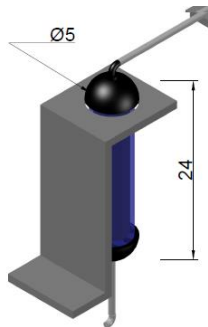
(4) Reaktor biogas



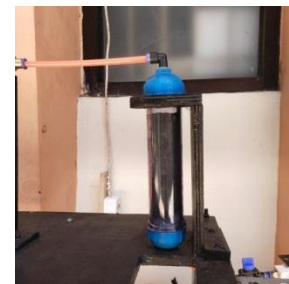
(5) Sketsa kolom larutan NaOH



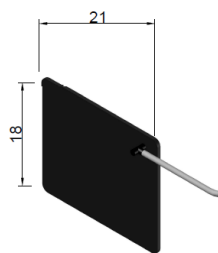
(6) Kolom larutan NaOH



(7) Sketsa kolom karbon aktif



(8) Kolom karbon aktif



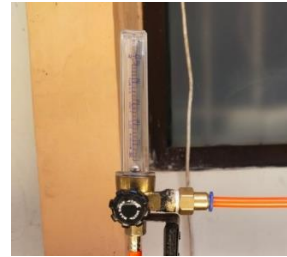
(9) Sketsa gas holder



(10) Gas holder



(11) Sketsa *flowmeter*



(12) *Flowmeter*

C. PROSES PEMBUATAN ALAT



(1) Pembuatan kerangka dasar alat



(2) Proses perakitan per komponen



(3) Proses pembuatan reaktor



(4) Proses pengecatan alat

D. PEMBUATAN LARUTAN NaOH



(1) Menimbang NaOH



(2) Penimbangan untuk NaOH 1 M



(3) Penimbangan untuk NaOH 3M



(4) Melarutkan NaOH dengan aquadest

E. PENGAMBILAN DATA



***Probe* didekatkan dengan sampel gas**



Pengambilan sampel *inlet*



Pengambilan sampel *outlet*



Pengambilan sampel *outlet*

F. PROSES TITRASI CO₂



(a) Sebelum titrasi



(b) Sesudah titrasi



(c) Proses titrasi

G. HASIL DATA PORTABLE GAS ANALYZER



SiCa-230
1D2202000522

16:03 - 05/08/2022
Biogas

O2	19.47	%
CO	0	ppm
NO	---	ppm
NOx	---	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	1.3	%
Eff. (eta)	101.3	%
T flue	31.0	°C
T air	33.2	°C
deltaT	1.7	°C
Draft	134	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

16:13 - 05/08/2022
Biogas

O2	19.34	%
CO	4	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	1.4	%
Eff. (eta)	99.1	%
T flue	30.8	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

11:17 - 05/08/2022
Biogas

O2	18.83	%
CO	3	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	7872826.00000	ppm
CO2	1.8	%
Eff. (eta)	100.0	%
T flue	29.8	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

inlet

SiCa-230
1D2202000522

16:02 - 05/08/2022
Biogas

O2	20.73	%
CO	0	ppm
NO	---	ppm
NOx	---	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.2	%
Eff. (eta)	108.0	%
T flue	31.1	°C
T air	33.2	°C
deltaT	1.7	°C
Draft	134	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

16:12 - 05/08/2022
Biogas

O2	20.59	%
CO	0	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.3	%
Eff. (eta)	103.0	%
T flue	30.5	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

11:17 - 05/08/2022
Biogas

O2	20.78	%
CO	0	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.2	%
Eff. (eta)	103.0	%
T flue	29.7	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

outlet

SiCa-230
1D2202000522

16:03 - 05/08/2022
Biogas

O2	20.21	%
CO	5	ppm
NO	---	ppm
NOx	---	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.7	%
Eff. (eta)	101.8	%
T flue	31.8	°C
T air	33.2	°C
deltaT	1.7	°C
Draft	134	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

18:06 - 05/08/2022
Biogas

O2	19.91	%
CO	7	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.9	%
Eff. (eta)	101.1	%
T flue	28.8	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

18:08 - 05/08/2022
Biogas

O2	19.80	%
CO	7	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	1.0	%
Eff. (eta)	100.3	%
T flue	28.1	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

16:04 - 05/08/2022
Biogas

O2	20.71	%
CO	0	ppm
NO	---	ppm
NOx	---	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.2	%
Eff. (eta)	107.2	%
T flue	30.6	°C
T air	33.2	°C
deltaT	1.7	°C
Draft	134	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

18:07 - 05/08/2022
Biogas

O2	20.90	%
CO	0	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.1	%
Eff. (eta)	110.2	%
T flue	28.3	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

18:05 - 05/08/2022
Biogas

O2	20.90	%
CO	0	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.1	%
Eff. (eta)	122.6	%
T flue	28.4	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

15:34 - 05/08/2022
Biogas

O2	19.83	%
CO	3	ppm
NO	---	ppm
NOx	---	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	1.0	%
Eff. (eta)	102.0	%
T flue	31.1	°C
T air	33.2	°C
deltaT	1.7	°C
Draft	134	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

15:36 - 05/08/2022
Biogas

O2	20.34	%
CO	5	ppm
NO	---	ppm
NOx	---	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.5	%
Eff. (eta)	102.6	%
T flue	31.7	°C
T air	33.2	°C
deltaT	1.7	°C
Draft	134	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

11:14 - 05/08/2022
Biogas

O2	20.61	%
CO	0	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.3	%
Eff. (eta)	103.4	%
T flue	30.1	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

15:33 - 05/08/2022
Biogas

O2	20.83	%
CO	0	ppm
NO	---	ppm
NOx	---	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.1	%
Eff. (eta)	117.9	%
T flue	30.5	°C
T air	33.2	°C
deltaT	1.7	°C
Draft	134	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

15:36 - 05/08/2022
Biogas

O2	20.81	%
CO	0	ppm
NO	---	ppm
NOx	---	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.2	%
Eff. (eta)	112.4	%
T flue	31.0	°C
T air	33.2	°C
deltaT	1.7	°C
Draft	134	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
1D2202000522

11:13 - 05/08/2022
Biogas

O2	20.80	%
CO	0	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.2	%
Eff. (eta)	108.6	%
T flue	30.6	°C
T air	32.8	°C
deltaT	2.3	°C
Draft	-265	Pa
X Air	---	%
Smoke	2	

Notes :

SiCa-230
102202000522
16:04 - 02/08/2022
Biogas

O2	20.66	%
CO	3	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.3	%
Eff. (eta)	---	%
T flue	---	°C
T air	31.2	°C
deltaT	---	°C
Draft	235	Pa
X Air	---	%
Smoke	2	

Notes :

inlet
2 L/mt
6 mt

NaOH 3M

3M

SiCa-230
102202000522
16:09 - 02/08/2022
Biogas

O2	20.31	%
CO	0	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.6	%
Eff. (eta)	---	%
T flue	---	°C
T air	29.9	°C
deltaT	---	°C
Draft	-9	Pa
X Air	---	%
Smoke	2	

Notes :

inlet
2 L/mt
2 mt

NaOH 3M

3M

SiCa-230
102202000522
11:39 - 02/08/2022
Biogas

O2	20.65	%
CO	0	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.3	%
Eff. (eta)	99.9	%
T flue	29.8	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

inlet
1 L/m
2 mt

NaOH 3M

SiCa-230
102202000522
16:03 - 02/08/2022
Biogas

O2	20.90	%
CO	0	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.1	%
Eff. (eta)	---	%
T flue	---	°C
T air	30.5	°C
deltaT	---	°C
Draft	-17	Pa
X Air	---	%
Smoke	2	

Notes :

outlet
2 L/mt
6 mt

NaOH 3M

SiCa-230
102202000522
16:08 - 02/08/2022
Biogas

O2	20.82	%
CO	0	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.1	%
Eff. (eta)	---	%
T flue	---	°C
T air	30.0	°C
deltaT	---	°C
Draft	-44	Pa
X Air	---	%
Smoke	2	

Notes :

outlet
2 L/mt
2 mt

NaOH 3M

SiCa-230
102202000522
11:39 - 02/08/2022
Biogas

O2	20.82	%
CO	3	ppm
NO	0	ppm
NOx	0	ppm
SO2	0	ppm
CxHy	0.000000	ppm
CO2	0.2	%
Eff. (eta)	106.8	%
T flue	29.9	°C
T air	---	°C
deltaT	---	°C
Draft	---	Pa
X Air	---	%
Smoke	2	

Notes :

outlet
1 L/m
2 mt

NaOH 3M

H. PERHITUNGAN

a) Perhitungan massa NaOH

$$M = \frac{m}{Mr} \times \frac{1000}{V}$$

1. NaOH 1 M

$$1 \text{ M} = \frac{m}{40} \times \frac{1000}{500 \text{ ml}}$$

$$m = 20 \text{ gram}$$

2. NaOH 3 M

$$3 \text{ M} = \frac{m}{40} \times \frac{1000}{500 \text{ ml}}$$

$$m = 60 \text{ gram}$$

b) Efektivitas Penurunan CO₂

Efektivitas Penurunan CO₂=

$$\frac{\text{input} - \text{output}}{\text{input}} \times 100\% \dots \dots \dots (3.1)$$

A. KONSENTRASI NaOH 1 M

1) Laju Alir 1 L/menit, Waktu kontak 2 menit

$$\frac{1,7 - 0,4}{1,7} \times 100\% = 76,5\%$$

2) Laju Alir 1 L/menit, Waktu kontak 4 menit

$$\frac{1,4 - 0,3}{1,4} \times 100\% = 78,5\%$$

3) Laju Alir 1 L/menit, Waktu kontak 6 menit

$$\frac{1,3 - 0,2}{1,3} \times 100\% = 84,6\%$$

4) Laju Alir 1,5 L/menit, Waktu kontak 2 menit

$$\frac{1,8 - 0,2}{1,8} \times 100\% = 89\%$$

5) Laju Alir 1,5 L/menit, Waktu kontak 4 menit

$$\frac{2,6-0,1}{2,6} \times 100\% = 96\%$$

6) Laju Alir 1,5 L/menit, Waktu kontak 6 menit

$$\frac{2,7-0,2}{2,7} \times 100\% = 92,6\%$$

7) Laju Alir 2 L/menit, Waktu kontak 2 menit

$$\frac{1,0-0,1}{1,0} \times 100\% = 90\%$$

8) Laju Alir 2 L/menit, Waktu kontak 4 menit

$$\frac{0,9-0,1}{0,9} \times 100\% = 88\%$$

9) Laju Alir 2 L/menit, Waktu kontak 6 menit

$$\frac{0,7-0,2}{0,7} \times 100\% = 71\%$$

B. KONSENTRASI NaOH 3 M

1) Laju Alir 1 L/menit, Waktu kontak 2 menit

$$\frac{0,3-0,2}{0,3} \times 100\% = 33\%$$

2) Laju Alir 1 L/menit, Waktu kontak 4 menit

$$\frac{0,5-0,2}{0,5} \times 100\% = 60\%$$

3) Laju Alir 1 L/menit, Waktu kontak 6 menit

$$\frac{0,3-0,1}{0,3} \times 100\% = 66\%$$

4) Laju Alir 1,5 L/menit, Waktu kontak 2 menit

$$\frac{0,9-0,1}{0,9} \times 100\% = 88\%$$

5) Laju Alir 1,5 L/menit, Waktu kontak 4 menit

$$\frac{1,0-0,1}{1,0} \times 100\% = 90\%$$

6) Laju Alir 1,5 L/menit, Waktu kontak 6 menit

$$\frac{0,8-0,1}{0,8} \times 100\% = 87,5\%$$

7) Laju Alir 2 L/menit, Waktu kontak 2 menit

$$\frac{0,6-0,1}{0,6} \times 100\% = 83\%$$

8) Laju Alir 2 L/menit, Waktu kontak 4 menit

$$\frac{0,3-0,1}{0,3} \times 100\% = 66\%$$

9) Laju Alir 2 L/menit, Waktu kontak 6 menit

$$\frac{0,5-0,2}{0,5} \times 100\% = 60\%$$

c) Perhitungan konsentrasi NaOH setelah titrasi

$$M_{\text{NaOH}} \times V_{\text{NaOH}} = M_{\text{HCl}} \times V_{\text{HCl}}$$

1. Konsentrasi NaOH 1 M setelah titrasi

$$M_{\text{NaOH}} \times V_{\text{NaOH}} = M_{\text{HCl}} \times V_{\text{HCl}}$$

$$M_{\text{NaOH}} \times 28,5 \text{ ml} = 1 \text{ M} \times 10 \text{ ml}$$

$$M_{\text{NaOH}} = 0,35 \text{ M}$$

2. Konsentrasi NaOH 3 M setelah titrasi

$$M_{\text{NaOH}} \times V_{\text{NaOH}} = M_{\text{HCl}} \times V_{\text{HCl}}$$

$$M_{\text{NaOH}} \times 4 \text{ ml} = 1 \text{ M} \times 10 \text{ ml}$$

$$M_{\text{NaOH}} = 2,5 \text{ M}$$

I. BUKTI SUBMIT

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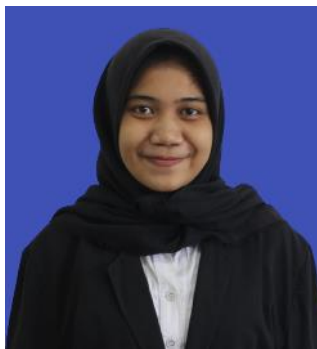
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BIODATA PENULIS



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Tempat, Tanggal Lahir : Purwokerto, 12 Juni 2000
Alamat : Perumahan Pasir Indah Jalan Tidar Blok
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RIWAYAT PENDIDIKAN:

SD Negeri 04 Sokanegara	2006-2012
SMP Negeri 6 Purwokerto	2012-2015
SMA Negeri 04 Purwokerto	2015-2018
Politeknik Negeri Cilacap	2018-2022

Penulis telah mengikuti seminar hasil Tugas Akhir pada tanggal 11 Agustus 2022, sebagai salah satu persyaratan untuk memperoleh gelar Sarjana Terapan Teknik Pengendalian Pencemaran Lingkungan (S.Tr.).