LAMPIRAN A

CONTOH PERHITUNGAN

Lampiran A. Contoh Perhitungan

A.1 Perhitungan Stoikiometri

A.1.1 Perhitungan Kebutuhan Arang Cangkang Sawit

Pada setiap reaksi kimia diperlukan kesetimbangan rumus molekul untuk senyawa kimia dengan persamaan stoikiometri. Pada proses reduksi fasa oksida besi dalam residu bauksit terdapat reaksi kimia yaitu reaksi reduksi, reaksi *Boudouard*, dan reaksi dekomposisi. Persamaan reaksi yang terjadi dalam penelitian dapat dilihat sebagai berikut:

1. $CaCO_3 \rightarrow CaO + CO_2$
2. $CO_2 + C \rightarrow 2\ CO$
3. $2FeO(OH) \rightarrow Fe_2O_3 + H_2O$
4. $Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$
5. $Fe_3O_4 + CO \rightarrow 3FeO + CO_2$
6. $FeO + CO \rightarrow Fe + CO_2$

Dari data pengujian XRD, mineral – mineral yang terkandung dalam residu bauksit dan persentasenya, antara lain:

1. Goetit [$FeO(OH)$] = 23,67%
2. Hematit [Fe_2O_3] = 38%
3. Kuarsa [SiO_2] = 11,45%
4. Sodalit [$Na_8(Al_6Si_6O_{24})Cl_2$] = 19,48%
5. Gibsit [$Al(OH)_3$] = 7,40%

Apabila basis massa residu bauksit yang digunakan setiap pembuatan pelet adalah 40 gram, maka perhitungan mol untuk reaksi reduksi pada fasa *ghoethite* dan hematit sebagai berikut.

1. Massa Goetit [FeO(OH)] = 40 gram × 23,67% = 9,47 gram

   $$\text{Mol Goetit [FeO(OH)} = \frac{\text{massa}}{\text{Mr FeO(OH)}} = \frac{9{,}47 \text{ gram}}{90 \text{ gram/mol}} = 0{,}105 \text{ mol}$$

2. Massa Hematit [Fe_2O_3] = 40 gram × 38% = 15,20 gram

   $$\text{Mol Hematit [}Fe_2O_3\text{]} = \frac{\text{massa}}{\text{Mr } Fe_2O_3} = \frac{15{,}20 \text{ gram}}{160 \text{ gram/mol}} = 0{,}095 \text{ mol}$$

Tabel A. 1 Reaksi Reduksi FeO(OH) Menjadi Fe Tahap I

Tahapan Reaksi	**Reaksi Reduksi**	
Reaksi I	2 FeO(OH) → Fe_2O_3 + H_2O	
	Mol FeO(OH)	0,105
	Mol Fe_2O_3	0,053
	Mol H_2O	0,053

Tabel A. 2 Reaksi Reduksi FeO(OH) Menjadi Fe Tahap II

Tahapan Reaksi	**Reaksi Reduksi**	
Reaksi II	3 Fe_2O_3 + CO → 2 Fe_3O_4 + CO_2	
	Mol Fe_2O_3	0,053
	Mol CO	0,018
	Mol Fe_3O_4	0,035

	Mol CO_2	0,018

Tabel A.2 (Lanjutan)

	Reaksi Boudouard		**Reaksi CO_2 dengan C**	
	$CO_2 + C = 2\ CO$		$CO_2 + C = 2\ CO$	
	Mol CO_2	0,009	Mol CO_2	0,018
	Mol C	0,009	Mol C	0,018
	Mol CO	0,018	Mol CO	0,035

Tabel A. 3 Reaksi Reduksi FeO(OH) Menjadi Fe Tahap III

Tahapan Reaksi	**Reaksi Reduksi**	
Reaksi III	$Fe_3O_4 + CO \rightarrow FeO + CO_2$	
	Mol Fe_3O_4	0,035
	Mol CO	0,035
	Mol FeO	0,105
	Mol CO_2	0,035
	Reaksi *Boudouard*	Reaksi CO_2 dengan C
	$CO_2 + C = 2\ CO$	$CO_2 + C = 2\ CO$
	Mol CO_2 0	Mol CO_2 0,035
	Mol C 0	Mol C 0,035
	Mol CO 0	Mol CO 0,070

Tabel A. 4 Reaksi Reduksi FeO(OH) Menjadi Fe Tahap IV

Tahapan Reaksi	**Reaksi Reduksi**			
Reaksi IV	$FeO + CO \rightarrow Fe + CO_2$			
	Mol Fe_2O_3	0,105		
	Mol CO	0,105		
	Mol Fe_3O_4	0,105		
	Mol CO_2	0,105		
	Reaksi *Boudouard*		Reaksi CO_2 dengan C	
	$CO_2 + C = 2\ CO$		$CO_2 + C = 2\ CO$	
	Mol CO_2	0,018	Mol CO_2	0,105
	Mol C	0,018	Mol C	0,105
	Mol CO	0,035	Mol CO	0,210

Tabel A. 5 Reaksi Reduksi Bertahap Fe_2O_3 Menjadi Fe Tahap I

Tahapan Reaksi	**Reaksi Reduksi**	
Reaksi I	$3\ Fe_2O_3 + CO \rightarrow 2\ Fe_3O_4 + CO_2$	
	Mol Fe_2O_3	0,095
	Mol CO	0,032
	Mol Fe_3O_4	0,063
	Mol CO_2	0,032

Tabel A.5 (Lanjutan)

	Reaksi *Boudouard*		**Reaksi CO_2 dengan C**	
	$CO_2 + C = 2\ CO$		$CO_2 + C = 2\ CO$	
	Mol CO_2	0,016	Mol CO_2	0,032
	Mol C	0,016	Mol C	0,032
	Mol CO	0,032	Mol CO	0,063

Tabel A. 6 Reaksi Reduksi Bertahap Fe_2O_3 Menjadi Fe Tahap II

Tahapan Reaksi	**Reaksi Reduksi**	
Reaksi II	$Fe_3O_4 + CO \rightarrow FeO + CO_2$	
	Mol Fe_3O_4	0,063
	Mol CO	0,063
	Mol FeO	0,0190
	Mol CO_2	0,063
	Reaksi *Boudouard*	Reaksi CO_2 dengan C
	$CO_2 + C = 2\ CO$	$CO_2 + C = 2\ CO$
	Mol CO_2 0	Mol CO_2 0,063
	Mol C 0	Mol C 0,063
	Mol CO 0	Mol CO 0,127

Tabel A. 7 Reaksi Reduksi Bertahap Fe_2O_3 Menjadi Fe Tahap III

Tahapan Reaksi	**Reaksi Reduksi**			
Reaksi III	$FeO + CO \rightarrow Fe + CO_2$			
	Mol Fe_2O_3	0,190		
	Mol CO	0,190		
	Mol Fe_3O_4	0,190		
	Mol CO_2	0,071		
	Reaksi *Boudouard*		Reaksi CO_2 dengan C	
	$CO_2 + C = 2\ CO$		$CO_2 + C = 2\ CO$	
	Mol CO_2	0,032	Mol CO_2	0,190
	Mol C	0,032	Mol C	0,190
	Mol CO	0,063	Mol CO	0,380

Berikut adalah perhitung rasio C/O berdasarkan total mol O pada Fe_2O_3 dari mineral goetit dan hematit, serta total mol C pada reaksi *Boudouard* dan reaksi CO_2 dengan C yang didapat pada Tabel A.1 hingga Tabel A.7.

mol O pada Fe_2O_3 (goetit) = 3 × 0,053 mol = 0,158 mol

mol O pada Fe_2O_3 (hematit) = 3 × 0,095 mol = 0,285 mol

Total mol O = 0,158 + 0,285 = 0,443 mol

Total mol C = 0,009 + 0,018 + 0 + 0,035 + 0,018 + 0,105 + 0,016 + 0,032 + 0 + 0,063 + 0,032 + 0,190 = 0,517 mol

$$\text{Rasio C/O}_{\text{stoikiometri}} = \frac{\text{total mol C}}{\text{total mol O}} = \frac{0{,}517 \text{ mol}}{0{,}443 \text{ mol}} = 1{,}17 \text{ mol}$$

Dari data analisis proksimat, kadar karbon pada arang cangkang sawit sebesar 77,64%. Kebutuhan arang cangkang sawit yang digunakan sebagai reduktor dapat dihitung sebagai berikut berikut:

$$\text{Massa arang cangkang sawit} = \frac{\text{Ar C} \times \text{total mol C}}{\text{\% kadar karbon}}$$

$$= \frac{12 \times 0{,}517 \text{ mol}}{77{,}64\%} = 7{,}985 \text{ gram} \cong 8 \text{ gram}$$

A.1.2 Perhitungan Kebutuhan Batu Kapur

Perhitungan kebutuhan batu kapur untuk masing-masing variasi basisitas diperlukan data kadar CaO, SiO_2, dan Al_2O_3 pada residu bauksit dan batu kapur sebagai berikut.

massa residu bauksit = 40 gram

kadar unsur residu bauksit: CaO = 1,64%; SiO_2 = 12,79%; dan Al_2O_3 = 10,99%.

kadar unsur batu kapur: CaO = 44,85%; SiO_2 = 17,38%; dan Al_2O_3 = 5,03%.

Rumus Basisitas:

$$\text{Basisitas} = \frac{\text{massa CaO (total)}}{[\text{massa } Al_2O_3\text{(total)}] + [\text{massa } SiO_2 \text{ (total)}]}$$

Basisitas =

$$\frac{\%\text{CaO (massa residu bauksit)} + \%\text{CaO (massa batu kapur)}}{[\%Al_2O_3 + \%SiO_2\text{(massa residu bauksit)}] + [\%Al_2O_3 + \%SiO_2\text{(massa residu bauksit)}]}$$

$$\text{Bs} = \frac{a + (\text{BK} \times b)}{c + (\text{BK} \times d)}$$

$$\text{BK} = \frac{(\text{Bs} \times b) - a}{c - (\text{Bs} \times d)}$$

Diketahui Bs = basisitas, BK = massa batu kapur, a = massa residu bauksit × CaO% residu bauksit, b = CaO% batu kapur, c = massa residu bauksit × (SiO_2% residu bauksit + Al_2O_3 residu bauksit), dan d = (SiO_2% batu kapur + Al_2O_3 batu kapur). Dari persamaan massa batu kapur dapat dihitung nilai a, b, c, dan d untuk mendapatkan massa batu kapur pada masing masing variasi basisitas.

a = 40 gram × 1,64% = 0,6556 gram

b = 44,85% = 0,4485

c = 40 gram × (12,79% + 10,99%) = 9,5149 gram

d = 17,38% + 5,03% = 0,2241

1. Basisitas = 0,8

$$BK = \frac{(Bs \times b) - a}{c - (Bs \times d)} = \frac{(0,8 \times 0,4485) - 0,6556\ gram}{9,5149\ gram - (0,8 \times 0,2241)} = 25,83\ gram$$

2. Basisitas = 0,95

$$BK = \frac{(Bs \times b) - a}{c - (Bs \times d)} = \frac{(0,95 \times 0,4485) - 0,6556\ gram}{9,5149\ gram - (0,95 \times 0,2241)} = 35,57\ gram$$

3. Basisitas = 1,1

$$BK = \frac{(Bs \times b) - a}{c - (Bs \times d)} = \frac{(1,1 \times 0,4485) - 0,6556\ gram}{9,5149\ gram - (1,1 \times 0,2241)} = 48,56\ gram$$

4. Basisitas = 1,25

$$BK = \frac{(Bs \times b) - a}{c - (Bs \times d)} = \frac{(1,25 \times 0,4485) - 0,6556\ gram}{9,5149\ gram - (1,25 \times 0,2241)} = 66,72\ gram$$

A.1.3 Perhitungan Penambahan Aditif

Diketahui:

Massa residu bauksit = 40 gram

wt% Aditif = 2%

Massa Aditif = 40 gram × 2% = 0,8 gram

A.2 Perhitungan Derajat Metalisasi Fe

A.2.1 Perhitungan Fe Total

Diketahui:

Normalitas $K_2Cr_2O_7$ = 0,1 N = 0,1 gram/ml

Volume Titran = 2,585 ml

Massa Uji Sampel = 0,1 gram

$$\text{Fe Total (\%)} = \frac{\text{Volume Titran} \times \text{Normalitas } K_2Cr_2O_7 \times 0{,}05585 \times 100\%}{\text{Massa Uji Sampel}}$$

$$\text{Fe Total (\%)} = \frac{2{,}585 \text{ ml} \times 0{,}1 \text{ gram/ml} \times 0{,}05585 \times 100\%}{0{,}1 \text{ gram}} = 14{,}44\%$$

A.2.2 Perhitungan Fe Metal

Diketahui:

Volume Titran = 4,845 ml

Massa Uji Sampel = 0,1 gram

$$\text{Fe Total (\%)} = \frac{\text{Volume Titran} \times 0{,}001862 \text{ gram/ml} \times 100\%}{\text{Massa Uji Sampel}}$$

$$\text{Fe Total (\%)} = \frac{4{,}845 \text{ ml} \times 0{,}001862 \text{ gram/ml} \times 100\%}{0{,}1 \text{ gram}} = 9{,}02\%$$

A.2.3 Perhitungan %Metalisasi Fe

Diketahui:

Fe Total (%) = 14,44%

Fe Metal (%) = 9,02%

$$\%\ \text{Metalisasi Fe} = \frac{\text{Fe Metal (\%)}}{\text{Fe Total (\%)}} = \frac{9{,}02\%}{14{,}44\%} \times 100\% = 62{,}49\%$$

A.3 Perhitungan Perolehan Fe

Diketahui:

Massa Hasil Reduksi Langsung = 52,64 gram

Massa Konsentrat = 9,23 gram

Kadar Fe Total pada Reduksi Langsung (%) = 14,44%

Kadar Fe Total pada Konsentrat (%) = 60,57%

$$\text{Perolehan Fe} = \frac{\text{massa Konsentrat} \times \text{Kadar Fe Total pada Konsentrat}}{\text{massa Hasil Reduksi} \times \text{Kadar Fe Total pada Reduksi}} \times 100\%$$

$$\text{Perolehan Fe} = \frac{14{,}4\% \times 52{,}64 \text{ gram}}{60{,}57\% \times 9{,}23 \text{ gram}} \times 100\% = 73{,}56\%$$

LAMPIRAN B

DATA PENELITIAN

Lampiran B. Data Penelitian

Tabel B. 1 Data Termodinamika Okisda Besi Menjadi Fe Metal

T(°C)	ΔG_T			
	(4.1)	**(4.2)**	**(4.3)**	**(4.4)**
0	124,385	-57,578	19,042	-11,796
10	122,637	-58,044	18,623	-11,666
20	120,883	-58,508	18,199	-11,530
30	119,125	-58,970	17,772	-11,388
40	117,363	-59,432	17,343	-11,240
50	115,597	-59,894	16,913	-11,088
60	113,828	-60,358	16,483	-10,930
70	112,056	-60,822	16,054	-10,768
80	110,281	-61,289	15,627	-10,601
90	108,504	-61,758	15,201	-10,430
100	106,725	-62,228	14,778	-10,256
110	104,944	-62,701	14,357	-10,078
120	103,161	-63,175	13,938	-9,896
130	101,377	-63,651	13,522	-9,711
140	99,591	-64,128	13,109	-9,523
150	97,805	-64,607	12,698	-9,332
160	96,017	-65,088	12,291	-9,138
170	94,228	-65,569	11,886	-8,941
180	92,439	-66,052	11,485	-8,742
190	90,650	-66,535	11,086	-8,541
200	88,859	-67,019	10,690	-8,337
210	87,069	-67,504	10,297	-8,132
220	85,278	-67,990	9,908	-7,924
230	83,487	-68,476	9,521	-7,714
240	81,696	-68,963	9,138	-7,503
250	79,905	-69,450	8,757	-7,289
260	78,114	-69,939	8,380	-7,075
270	76,324	-70,428	8,006	-6,858
280	74,533	-70,917	7,635	-6,640
290	72,743	-71,408	7,268	-6,421
300	70,953	-71,900	6,905	-6,200
310	69,164	-72,394	6,545	-5,979
320	67,375	-72,889	6,189	-5,756
330	65,587	-73,385	5,836	-5,532
340	63,799	-73,884	5,488	-5,307
350	62,012	-74,385	5,145	-5,081
360	60,225	-74,889	4,805	-4,854
370	58,439	-75,396	4,471	-4,626
380	56,654	-75,906	4,141	-4,398
390	54,869	-76,420	3,816	-4,169

Tabel B.1 Lanjutan

T(°C)	ΔG_T			
	(4.1)	**(4.2)**	**(4.3)**	**(4.4)**
400	53,085	-76,938	3,497	-3,940
410	51,302	-77,460	3,184	-3,709
420	49,520	-77,988	2,876	-3,479
430	47,739	-78,521	2,574	-3,248
440	45,958	-79,060	2,279	-3,017
450	44,178	-79,605	1,991	-2,785
460	42,399	-80,157	1,710	-2,553
470	40,621	-80,717	1,436	-2,321
480	38,844	-81,285	1,170	-2,089
490	37,068	-81,861	0,912	-1,857
500	35,293	-82,447	0,662	-1,625
510	33,519	-83,043	0,421	-1,392
520	31,745	-83,649	0,190	-1,160
530	29,973	-84,266	-0,032	-0,928
540	28,201	-84,894	-0,245	-0,696
550	26,430	-85,535	-0,447	-0,465
560	24,661	-86,188	-0,638	-0,234
570	22,892	-86,855	-0,818	-0,003
580	21,124	-87,535	-0,987	0,228
590	19,357	-88,217	-1,149	0,458
600	17,591	-88,898	-1,309	0,687
610	15,826	-89,575	-1,464	0,916
620	14,062	-90,249	-1,616	1,144
630	12,299	-90,918	-1,765	1,371
640	10,537	-91,582	-1,912	1,598
650	8,776	-92,239	-2,056	1,824
660	7,016	-92,889	-2,197	2,048
670	5,257	-93,530	-2,337	2,272
680	3,498	-94,163	-2,475	2,495
690	1,741	-94,788	-2,611	2,716
700	-0,015	-95,408	-2,746	2,936
710	-1,771	-96,026	-2,879	3,155
720	-3,525	-96,644	-3,011	3,373
730	-5,279	-97,262	-3,143	3,589
740	-7,031	-97,880	-3,273	3,803
750	-8,783	-98,499	-3,403	4,016
760	-10,533	-99,117	-3,532	4,226
770	-12,283	-99,736	-3,661	4,435
780	-14,032	-100,354	-3,790	4,642
790	-15,779	-100,973	-3,918	4,848
800	-17,526	-101,592	-4,046	5,053
810	-19,272	-102,212	-4,174	5,257

Tabel B.1 Lanjutan

T(°C)	ΔG_T			
	(4.1)	**(4.2)**	**(4.3)**	**(4.4)**
820	-21,017	-102,832	-4,303	5,460
830	-22,761	-103,452	-4,431	5,662
840	-24,504	-104,072	-4,560	5,864
850	-26,246	-104,692	-4,688	6,066
860	-27,987	-105,312	-4,818	6,266
870	-29,728	-105,932	-4,947	6,467
880	-31,467	-106,551	-5,078	6,667
890	-33,205	-107,170	-5,208	6,866
900	-34,943	-107,788	-5,340	7,066
910	-36,679	-108,406	-5,471	7,264
920	-38,415	-109,023	-5,604	7,456
930	-40,150	-109,639	-5,737	7,647
940	-41,884	-110,255	-5,872	7,838
950	-43,617	-110,870	-6,007	8,030
960	-45,349	-111,484	-6,142	8,221
970	-47,080	-112,097	-6,279	8,414
980	-48,810	-112,710	-6,417	8,606
990	-50,540	-113,321	-6,555	8,799
1000	-52,268	-113,931	-6,695	8,993
1010	-53,996	-114,541	-6,835	9,187
1020	-55,723	-115,149	-6,977	9,381
1030	-57,449	-115,757	-7,119	9,575
1040	-59,174	-116,363	-7,263	9,770
1050	-60,898	-116,968	-7,408	9,965
1060	-62,621	-117,572	-7,554	10,161
1070	-64,344	-118,175	-7,701	10,356
1080	-66,065	-118,777	-7,849	10,552
1090	-67,786	-119,378	-7,998	10,749
1100	-69,506	-119,978	-8,148	10,946
1110	-71,225	-120,576	-8,300	11,143
1120	-72,943	-121,174	-8,453	11,340
1130	-74,661	-121,770	-8,606	11,538
1140	-76,378	-122,366	-8,761	11,736
1150	-78,093	-122,960	-8,917	11,934
1160	-79,808	-123,553	-9,075	12,132
1170	-81,523	-124,145	-9,233	12,331
1180	-83,236	-124,736	-9,393	12,530
1190	-84,948	-125,326	-9,553	12,729
1200	-86,660	-125,914	-9,715	12,929
1210	-88,371	-126,502	-9,878	13,129
1220	-90,081	-127,089	-10,042	13,329
1230	-91,791	-127,675	-10,208	13,529

Tabel B.1 Lanjutan

T(°C)	ΔG_T			
	(4.1)	**(4.2)**	**(4.3)**	**(4.4)**
1240	-93,499	-128,260	-10,374	13,729
1250	-95,207	-128,844	-10,541	13,930
1260	-96,914	-129,427	-10,710	14,131
1270	-98,620	-130,009	-10,880	14,332
1280	-100,326	-130,590	-11,050	14,534
1290	-102,030	-131,170	-11,222	14,735
1300	-103,734	-131,750	-11,395	14,937
1310	-105,437	-132,328	-11,569	15,139
1320	-107,140	-132,906	-11,743	15,341
1330	-108,841	-133,483	-11,919	15,544
1340	-110,542	-134,060	-12,096	15,746
1350	-112,242	-134,636	-12,274	15,949
1360	-113,942	-135,211	-12,453	16,152
1370	-115,640	-135,785	-12,633	16,355
1380	-117,338	-136,359	-12,955	16,606
1390	-119,035	-136,932	-13,574	16,955
1400	-120,732	-137,505	-14,196	17,330
1410	-122,427	-138,077	-14,818	17,675
1420	-124,122	-138,649	-15,443	18,020
1430	-125,817	-139,220	-16,069	18,366
1440	-127,510	-139,791	-16,696	18,712
1450	-129,203	-140,362	-17,325	19,058
1460	-130,895	-140,932	-17,956	19,405
1470	-132,586	-141,502	-18,587	19,751
1480	-134,277	-142,072	-19,220	20,098
1490	-135,967	-142,641	-19,855	20,445
1500	-137,656	-143,211	-20,491	20,793
1510	-139,345	-143,780	-21,128	21,140
1520	-141,032	-144,349	-21,766	21,488
1530	-142,720	-144,918	-22,405	21,835
1540	-144,406	-145,487	-23,046	22,168
1550	-146,092	-146,054	-23,688	22,440
1560	-147,777	-146,618	-24,331	22,711
1570	-149,461	-147,180	-24,975	22,983
1580	-151,145	-147,738	-25,620	23,254
1590	-152,828	-148,293	-26,266	23,526
1600	-154,510	-149,310	-26,681	23,797
1610	-156,192	-151,337	-26,591	24,068
1620	-157,873	-153,361	-26,502	24,339
1630	-159,553	-155,383	-26,413	24,610
1640	-161,233	-157,403	-26,325	24,881
1650	-162,912	-159,421	-26,238	25,152

Tabel B.1 Lanjutan

T(°C)	ΔG_T			
	(4.1)	**(4.2)**	**(4.3)**	**(4.4)**
1660	-164,590	-161,436	-26,151	25,423
1670	-166,268	-163,449	-26,066	25,694
1680	-167,945	-165,459	-25,981	25,964
1690	-169,621	-167,468	-25,897	26,235
1700	-171,297	-169,474	-25,814	26,505
1710	-172,972	-171,478	-25,731	26,775
1720	-174,646	-173,479	-25,650	27,046
1730	-176,320	-175,479	-25,569	27,316
1740	-177,993	-177,476	-25,489	27,586
1750	-179,665	-179,471	-25,409	27,856
1760	-181,337	-181,464	-25,331	28,126
1770	-183,008	-183,455	-25,253	28,395
1780	-184,679	-185,443	-25,176	28,665
1790	-186,349	-187,429	-25,099	28,934
1800	-188,018	-189,414	-25,024	29,204
1660	-164,590	-161,436	-26,151	25,423
1670	-166,268	-163,449	-26,066	25,694
1680	-167,945	-165,459	-25,981	25,964
1690	-169,621	-167,468	-25,897	26,235
1700	-171,297	-169,474	-25,814	26,505
1710	-172,972	-171,478	-25,731	26,775
1720	-174,646	-173,479	-25,650	27,046
1730	-176,320	-175,479	-25,569	27,316
1740	-177,993	-177,476	-25,489	27,586
1750	-179,665	-179,471	-25,409	27,856
1760	-181,337	-181,464	-25,331	28,126
1770	-183,008	-183,455	-25,253	28,395
1780	-184,679	-185,443	-25,176	28,665
1790	-186,349	-187,429	-25,099	28,934
1800	-188,018	-189,414	-25,024	29,204

Tabel B. 2 Data Termodinamika Pembentukan Oksida Pengotor

T(°C)	ΔG_T				
	(4.5)	**(4.6)**	**(4.7)**	**(4.8)**	**(4.9)**
0	-26,888	-47,778	-32,159	-15,307	-51,721
10	-27,078	-48,025	-32,112	-15,279	-51,702
20	-27,271	-48,274	-32,060	-15,249	-51,681
30	-27,468	-48,525	-32,004	-15,218	-51,658
40	-27,667	-48,778	-31,944	-15,186	-51,635
50	-27,868	-49,032	-31,880	-15,153	-51,610

Tabel B.2 Lanjutan

T(°C)	ΔG_T				
	(4.5)	**(4.6)**	**(4.7)**	**(4.8)**	**(4.9)**
60	-28,070	-49,289	-31,812	-15,119	-51,585
70	-28,273	-49,546	-31,742	-15,085	-51,560
80	-28,476	-49,805	-31,670	-15,050	-51,533
90	-28,678	-50,065	-31,594	-15,015	-51,506
100	-28,881	-50,326	-31,517	-14,979	-51,479
110	-29,083	-50,588	-31,438	-14,944	-51,451
120	-29,284	-50,851	-31,357	-14,907	-51,423
130	-29,484	-51,114	-31,274	-14,871	-51,394
140	-29,683	-51,379	-31,190	-14,835	-51,364
150	-29,880	-51,644	-31,105	-14,798	-51,334
160	-30,076	-51,909	-31,018	-14,761	-51,303
170	-30,271	-52,176	-30,930	-14,724	-51,271
180	-30,463	-52,442	-30,840	-14,687	-51,238
190	-30,654	-52,709	-30,750	-14,650	-51,205
200	-30,843	-52,976	-30,659	-14,613	-51,170
210	-31,029	-53,244	-30,566	-14,576	-51,134
220	-31,214	-53,511	-30,473	-14,539	-51,098
230	-31,396	-53,779	-30,379	-14,501	-51,060
240	-31,577	-54,046	-30,284	-14,463	-51,021
250	-31,755	-54,314	-30,188	-14,426	-50,981
260	-31,930	-54,581	-30,091	-14,388	-50,940
270	-32,103	-54,848	-29,993	-14,350	-50,897
280	-32,274	-55,115	-29,895	-14,311	-50,853
290	-32,442	-55,382	-29,796	-14,273	-50,808
300	-32,608	-55,648	-29,696	-14,234	-50,762
310	-32,771	-55,914	-29,595	-14,195	-50,714
320	-32,931	-56,179	-29,493	-14,155	-50,665
330	-33,089	-56,443	-29,391	-14,116	-50,614
340	-33,244	-56,707	-29,287	-14,076	-50,562
350	-33,396	-56,970	-29,183	-14,035	-50,509
360	-33,546	-57,233	-29,078	-13,994	-50,454
370	-33,692	-57,494	-28,972	-13,953	-50,398
380	-33,836	-57,755	-28,865	-13,912	-50,341
390	-33,977	-58,014	-28,758	-13,869	-50,282
400	-34,114	-58,273	-28,650	-13,827	-50,222
410	-34,249	-58,530	-28,540	-13,784	-50,161
420	-34,381	-58,787	-28,430	-13,740	-50,098
430	-34,510	-59,041	-28,319	-13,696	-50,035
440	-34,636	-59,295	-28,207	-13,651	-49,970
450	-34,758	-59,547	-28,094	-13,605	-49,904
460	-34,877	-59,798	-27,980	-13,559	-49,837
470	-34,993	-60,047	-27,865	-13,512	-49,769

Tabel B.2 Lanjutan

T(°C)	ΔG_T				
	(4.5)	**(4.6)**	**(4.7)**	**(4.8)**	**(4.9)**
480	-35,106	-60,295	-27,750	-13,464	-49,700
490	-35,216	-60,541	-27,633	-13,416	-49,630
500	-35,322	-60,785	-27,515	-13,367	-49,559
510	-35,425	-61,027	-27,396	-13,317	-49,487
520	-35,524	-61,267	-27,276	-13,266	-49,415
530	-35,620	-61,506	-27,155	-13,215	-49,342
540	-35,713	-61,742	-27,033	-13,162	-49,268
550	-35,801	-61,976	-26,910	-13,109	-49,194
560	-35,886	-62,208	-26,786	-13,054	-49,119
570	-35,968	-62,437	-26,660	-12,999	-49,042
580	-36,045	-62,664	-26,527	-12,935	-48,965
590	-36,118	-62,888	-26,391	-12,871	-48,888
600	-36,188	-63,109	-26,256	-12,806	-48,809
610	-36,253	-63,328	-26,121	-12,741	-48,730
620	-36,314	-63,543	-25,985	-12,677	-48,650
630	-36,371	-63,756	-25,850	-12,612	-48,569
640	-36,423	-63,965	-25,715	-12,548	-48,488
650	-36,471	-64,171	-25,579	-12,483	-48,406
660	-36,513	-64,373	-25,444	-12,419	-48,323
670	-36,552	-64,571	-25,309	-12,355	-48,239
680	-36,585	-64,766	-25,173	-12,291	-48,155
690	-36,613	-64,957	-25,038	-12,227	-48,070
700	-36,638	-65,145	-24,903	-12,163	-47,985
710	-36,661	-65,333	-24,767	-12,100	-47,898
720	-36,683	-65,519	-24,632	-12,036	-47,812
730	-36,703	-65,706	-24,497	-11,973	-47,724
740	-36,722	-65,892	-24,362	-11,910	-47,636
750	-36,739	-66,078	-24,228	-11,847	-47,547
760	-36,756	-66,263	-24,093	-11,784	-47,458
770	-36,771	-66,448	-23,958	-11,721	-47,368
780	-36,785	-66,633	-23,824	-11,658	-47,277
790	-36,799	-66,818	-23,690	-11,596	-47,186
800	-36,812	-67,004	-23,556	-11,534	-47,095
810	-36,824	-67,189	-23,414	-11,464	-47,003
820	-36,836	-67,374	-23,262	-11,384	-46,910
830	-36,847	-67,560	-23,110	-11,303	-46,817
840	-36,858	-67,746	-22,958	-11,223	-46,723
850	-36,868	-67,932	-22,806	-11,143	-46,628
860	-36,877	-68,117	-22,654	-11,063	-46,534
870	-36,886	-68,303	-22,502	-10,983	-46,438
880	-36,895	-68,489	-22,351	-10,903	-46,343
890	-36,903	-68,676	-22,200	-10,824	-46,246

Tabel B.2 Lanjutan

T(°C)	ΔG_T				
	(4.5)	**(4.6)**	**(4.7)**	**(4.8)**	**(4.9)**
900	-36,910	-68,862	-22,049	-10,744	-46,150
910	-36,917	-69,048	-21,898	-10,665	-46,053
920	-36,924	-69,235	-21,747	-10,586	-45,955
930	-36,930	-69,421	-21,597	-10,507	-45,857
940	-36,936	-69,608	-21,447	-10,428	-45,759
950	-36,941	-69,794	-21,297	-10,350	-45,660
960	-36,946	-69,981	-21,148	-10,271	-45,560
970	-36,950	-70,167	-20,998	-10,193	-45,461
980	-36,954	-70,354	-20,849	-10,115	-45,361
990	-36,958	-70,541	-20,701	-10,038	-45,260
1000	-36,962	-70,727	-20,552	-9,960	-45,159
1010	-36,965	-70,914	-20,404	-9,883	-45,058
1020	-36,968	-71,101	-20,256	-9,806	-44,957
1030	-36,970	-71,287	-20,109	-9,729	-44,855
1040	-36,972	-71,474	-19,962	-9,652	-44,753
1050	-36,974	-71,660	-19,815	-9,576	-44,650
1060	-36,976	-71,847	-19,669	-9,500	-44,547
1070	-36,977	-72,033	-19,523	-9,424	-44,444
1080	-36,978	-72,220	-19,377	-9,348	-44,341
1090	-36,979	-72,406	-19,232	-9,273	-44,237
1100	-36,979	-72,592	-19,087	-9,198	-44,133
1110	-36,979	-72,779	-18,943	-9,123	-44,028
1120	-36,979	-72,965	-18,799	-9,049	-43,924
1130	-36,979	-73,151	-18,655	-8,974	-43,819
1140	-36,979	-73,336	-18,512	-8,900	-43,713
1150	-36,978	-73,522	-18,369	-8,827	-43,608
1160	-36,977	-73,707	-18,227	-8,753	-43,502
1170	-36,976	-73,893	-18,085	-8,680	-43,396
1180	-36,974	-74,078	-17,944	-8,608	-43,290
1190	-36,973	-74,263	-17,803	-8,535	-43,184
1200	-36,971	-74,448	-17,663	-8,463	-43,077
1210	-36,969	-74,633	-17,523	-8,392	-42,971
1220	-37,268	-74,817	-17,579	-8,320	-42,864
1230	-37,995	-75,001	-18,060	-8,249	-42,757
1240	-38,725	-75,185	-18,542	-8,179	-42,649
1250	-39,457	-75,369	-19,025	-8,109	-42,542
1260	-40,192	-75,553	-19,508	-8,039	-42,434
1270	-40,928	-75,736	-19,991	-7,969	-42,327
1280	-41,666	-75,919	-20,476	-7,900	-42,219
1290	-42,407	-76,102	-20,961	-7,831	-42,111
1300	-43,149	-76,285	-21,446	-7,763	-42,003
1310	-43,894	-76,467	-21,932	-7,695	-41,894

Tabel B.2 Lanjutan

T(°C)	ΔG_T				
	(4.5)	**(4.6)**	**(4.7)**	**(4.8)**	**(4.9)**
1320	-44,641	-76,649	-22,419	-7,628	-41,786
1330	-45,389	-76,831	-22,906	-7,561	-41,677
1340	-46,140	-77,013	-23,394	-7,494	-41,569
1350	-46,892	-77,194	-23,883	-7,428	-41,460
1360	-47,647	-77,375	-24,372	-7,362	-41,352
1370	-48,403	-77,555	-24,862	-7,296	-41,243
1380	-49,161	-77,735	-25,258	-7,184	-41,087
1390	-49,922	-77,915	-25,458	-6,974	-40,832
1400	-50,684	-78,095	-25,657	-6,763	-40,577
1410	-51,447	-78,274	-25,857	-6,553	-40,321
1420	-52,213	-78,452	-26,057	-6,343	-40,066
1430	-52,980	-78,631	-26,257	-6,134	-39,810
1440	-53,750	-78,809	-26,458	-5,925	-39,554
1450	-54,521	-79,087	-26,659	-5,715	-39,297
1460	-55,293	-80,144	-26,860	-5,507	-39,041
1470	-56,068	-81,204	-27,062	-5,298	-38,784
1480	-56,844	-82,267	-27,264	-5,090	-38,527
1490	-57,622	-83,333	-27,466	-4,882	-38,270
1500	-58,401	-84,403	-27,669	-4,674	-38,013
1510	-59,183	-85,475	-27,872	-4,467	-37,755
1520	-59,966	-86,551	-28,076	-4,260	-37,498
1530	-60,750	-87,630	-28,280	-4,054	-37,240
1540	-61,536	-88,712	-28,484	-3,848	-36,983
1550	-62,323	-89,796	-28,690	-3,642	-36,725
1560	-63,111	-90,882	-28,895	-3,436	-36,467
1570	-63,899	-91,970	-29,101	-3,231	-36,209
1580	-64,687	-93,061	-29,308	-3,026	-35,951
1590	-65,477	-94,153	-29,515	-2,822	-35,693
1600	-66,266	-95,246	-29,723	-2,618	-35,434

Tabel B. 3 Data Termodinamika Reduksi Lanjutan dari Oksida Pengotor

T(°C)	ΔG_T				
	(4.10)	**(4.11)**	**(4.12)**	**(4.13)**	**(4.14)**
0	369,954	390,844	257,338	127,896	164,310
10	364,722	385,670	254,053	126,249	162,672
20	359,490	380,493	250,766	124,602	161,034
30	354,258	375,315	247,478	122,955	159,395
40	349,026	370,137	244,188	121,308	157,757
50	343,794	364,959	240,898	119,662	156,120
60	338,564	359,782	237,608	118,017	154,483
70	333,334	354,607	234,319	116,373	152,848

Tabel B.3 Lanjutan

T(°C)	ΔG_T				
	(4.10)	**(4.11)**	**(4.12)**	**(4.13)**	**(4.14)**
80	328,105	349,435	231,030	114,730	151,213
90	322,879	344,265	227,742	113,089	149,580
100	317,654	339,098	224,456	111,449	147,948
110	312,431	333,935	221,171	109,810	146,318
120	307,210	328,776	217,888	108,173	144,688
130	301,991	323,621	214,607	106,537	143,060
140	296,774	318,470	211,327	104,903	141,433
150	291,561	313,324	208,051	103,271	139,807
160	286,349	308,183	204,776	101,640	138,182
170	281,141	303,046	201,504	100,012	136,558
180	275,935	297,914	198,234	98,384	134,935
190	270,733	292,788	194,967	96,759	133,313
200	265,533	287,666	191,703	95,135	131,692
210	260,336	282,550	188,441	93,513	130,071
220	255,142	277,439	185,181	91,893	128,452
230	249,951	272,333	181,925	90,274	126,833
240	244,764	267,233	178,671	88,657	125,215
250	239,579	262,138	175,419	87,041	123,597
260	234,398	257,049	172,171	85,427	121,980
270	229,219	251,964	168,925	83,815	120,363
280	224,044	246,885	165,681	82,204	118,746
290	218,872	241,812	162,440	80,595	117,130
300	213,703	236,743	159,202	78,987	115,515
310	208,537	231,680	155,966	77,380	113,899
320	203,375	226,622	152,732	75,775	112,284
330	198,215	221,569	149,501	74,171	110,669
340	193,058	216,521	146,272	72,568	109,054
350	187,904	211,478	143,045	70,966	107,440
360	182,753	206,440	139,820	69,365	105,825
370	177,605	201,407	136,597	67,766	104,211
380	172,459	196,378	133,377	66,167	102,596
390	167,317	191,355	130,158	64,569	100,982
400	162,177	186,335	126,941	62,973	99,368
410	157,039	181,321	123,726	61,376	97,753
420	151,905	176,310	120,512	59,781	96,139
430	146,773	171,304	117,300	58,186	94,525
440	141,643	166,302	114,090	56,592	92,911
450	136,515	161,304	110,881	54,998	91,297
460	131,390	156,311	107,673	53,405	89,683
470	126,267	151,321	104,466	51,812	88,069
480	121,146	146,335	101,260	50,220	86,455
490	116,027	141,352	98,055	48,627	84,841

Tabel B.3 Lanjutan

T(°C)	ΔG_T				
	(4.10)	**(4.11)**	**(4.12)**	**(4.13)**	**(4.14)**
500	110,911	136,373	94,851	47,035	83,227
510	105,796	131,398	91,648	45,443	81,614
520	100,683	126,425	88,446	43,851	80,000
530	95,571	121,456	85,244	42,259	78,387
540	90,461	116,491	82,042	40,667	76,773
550	85,353	111,528	78,841	39,074	75,159
560	80,246	106,568	75,640	37,481	73,546
570	75,141	101,610	72,439	35,888	71,931
580	70,036	96,655	69,230	34,287	70,317
590	64,933	91,702	66,021	32,685	68,702
600	59,831	86,752	62,813	31,084	67,087
610	54,729	81,804	59,605	29,483	65,472
620	49,628	76,858	56,398	27,883	63,856
630	44,528	71,913	53,191	26,283	62,240
640	39,428	66,970	49,985	24,683	60,623
650	34,329	62,029	46,778	23,083	59,005
660	29,230	57,089	43,572	21,483	57,387
670	24,131	52,150	40,366	19,884	55,768
680	19,031	47,212	37,159	18,284	54,148
690	13,932	42,275	33,952	16,684	52,527
700	8,832	37,339	30,745	15,085	50,906
710	3,732	32,403	27,537	13,484	49,283
720	-1,369	27,467	24,328	11,884	47,659
730	-6,472	22,531	21,117	10,283	46,034
740	-11,575	17,595	17,906	8,682	44,408
750	-16,680	12,659	14,693	7,079	42,780
760	-21,786	7,721	11,479	5,477	41,151
770	-26,894	2,783	8,262	3,873	39,520
780	-32,004	-2,156	5,044	2,269	37,888
790	-37,113	-7,094	1,826	0,664	36,255
800	-42,223	-12,032	-1,392	-0,940	34,621
810	-47,332	-16,968	-4,617	-2,551	32,987
820	-52,441	-21,903	-7,853	-4,174	31,353
830	-57,549	-26,836	-11,088	-5,795	29,718
840	-62,656	-31,769	-14,322	-7,417	28,083
850	-67,763	-36,699	-17,556	-9,038	26,448
860	-72,868	-41,628	-20,788	-10,658	24,813
870	-77,972	-46,555	-24,019	-12,278	23,178
880	-83,075	-51,480	-27,249	-13,897	21,542
890	-88,176	-56,403	-30,478	-15,515	19,907
900	-93,276	-61,325	-33,706	-17,133	18,272
910	-98,375	-66,244	-36,932	-18,750	16,638

Tabel B.3 Lanjutan

T(°C)	ΔG_T				
	(4.10)	**(4.11)**	**(4.12)**	**(4.13)**	**(4.14)**
920	-103,487	-71,176	-40,171	-20,373	14,996
930	-108,598	-76,106	-43,409	-21,996	13,354
940	-113,706	-81,034	-46,645	-23,617	11,713
950	-118,811	-85,958	-49,877	-25,237	10,072
960	-123,914	-90,879	-53,107	-26,856	8,433
970	-129,014	-95,797	-56,334	-28,473	6,795
980	-134,111	-100,712	-59,558	-30,089	5,157
990	-139,206	-105,623	-62,780	-31,703	3,520
1000	-144,298	-110,532	-65,998	-33,315	1,884
1010	-149,387	-115,438	-69,214	-34,927	0,249
1020	-154,473	-120,340	-72,427	-36,536	-1,385
1030	-159,557	-125,240	-75,638	-38,145	-3,019
1040	-164,638	-130,137	-78,845	-39,751	-4,651
1050	-169,717	-135,031	-82,050	-41,357	-6,283
1060	-174,793	-139,922	-85,252	-42,961	-7,913
1070	-179,867	-144,810	-88,452	-44,563	-9,543
1080	-184,938	-149,696	-91,648	-46,165	-11,172
1090	-190,007	-154,579	-94,842	-47,764	-12,801
1100	-195,073	-159,459	-98,034	-49,363	-14,428
1110	-200,136	-164,337	-101,222	-50,960	-16,054
1120	-205,197	-169,212	-104,408	-52,555	-17,680
1130	-210,256	-174,085	-107,591	-54,149	-19,305
1140	-215,313	-178,955	-110,772	-55,742	-20,929
1150	-220,366	-183,822	-113,950	-57,333	-22,552
1160	-225,418	-188,687	-117,125	-58,923	-24,174
1170	-230,467	-193,550	-120,298	-60,511	-25,795
1180	-235,514	-198,410	-123,468	-62,098	-27,416
1190	-240,558	-203,268	-126,635	-63,684	-29,035
1200	-245,600	-208,123	-129,800	-65,268	-30,654
1210	-250,640	-212,977	-132,962	-66,851	-32,272
1220	-255,377	-217,828	-135,927	-68,432	-33,889
1230	-259,682	-222,676	-138,463	-70,012	-35,505
1240	-263,983	-227,523	-140,998	-71,591	-37,121
1250	-268,279	-232,367	-143,529	-73,168	-38,735
1260	-272,571	-237,209	-146,058	-74,744	-40,349
1270	-276,858	-242,049	-148,585	-76,319	-41,961
1280	-281,140	-246,887	-151,108	-77,892	-43,573
1290	-285,419	-251,723	-153,630	-79,464	-45,184
1300	-289,692	-256,557	-156,148	-81,034	-46,795
1310	-293,962	-261,389	-158,665	-82,603	-48,404
1320	-298,227	-266,218	-161,178	-84,171	-50,013
1330	-302,488	-271,046	-163,689	-85,737	-51,620

Tabel B.3 Lanjutan

T(°C)	ΔG_T				
	(4.10)	**(4.11)**	**(4.12)**	**(4.13)**	**(4.14)**
1340	-306,745	-275,872	-166,198	-87,302	-53,227
1350	-310,998	-280,696	-168,704	-88,866	-54,833
1360	-315,246	-285,519	-171,207	-90,428	-56,438
1370	-319,491	-290,339	-173,708	-91,989	-58,042
1380	-323,731	-295,157	-176,207	-93,548	-59,646
1390	-327,968	-299,974	-178,703	-95,106	-61,248
1400	-332,151	-304,740	-181,147	-96,639	-62,825
1410	-336,390	-309,564	-183,648	-98,199	-64,431
1420	-340,625	-314,386	-186,147	-99,759	-66,036
1430	-344,857	-319,206	-188,644	-101,317	-67,641
1440	-349,085	-324,025	-191,138	-102,873	-69,244
1450	-353,309	-328,742	-193,631	-104,429	-70,847
1460	-357,530	-332,679	-196,121	-105,984	-72,449
1470	-361,747	-336,611	-198,608	-107,537	-74,051
1480	-365,961	-340,538	-201,094	-109,089	-75,652
1490	-370,172	-344,460	-203,577	-110,640	-77,252
1500	-374,379	-348,378	-206,058	-112,189	-78,851
1510	-378,583	-352,290	-208,537	-113,737	-80,449
1520	-382,784	-356,198	-211,014	-115,284	-82,047
1530	-386,981	-360,101	-213,488	-116,830	-83,644
1540	-391,206	-364,030	-215,992	-118,391	-85,256
1550	-395,550	-368,077	-218,615	-120,011	-86,927
1560	-399,891	-372,119	-221,236	-121,629	-88,599
1570	-404,229	-376,157	-223,855	-123,247	-90,270
1580	-408,564	-380,191	-226,473	-124,864	-91,940
1590	-412,897	-384,221	-229,089	-126,480	-93,610
1600	-417,228	-388,247	-231,703	-128,095	-95,279

LAMPIRAN C

GAMBAR ALAT DAN BAHAN

Lampiran C. Gambar Alat dan Bahan

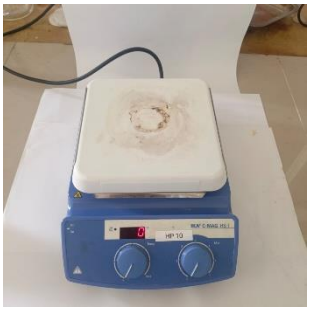
C.1 Gambar Alat-Alat Proses

Gambar C. 1 *Autotitrator*

Gambar C. 2 *Davis Tube*

Gambar C. 3 *Disc Mill*

Gambar C. 4 *Divider Sampling*



Gambar C. 5 *Hot Plate*

Gambar C. 6 *Muffle Furnace*

Gambar C. 7 *Oven*

Gambar C. 8 *Sieve Shaker*

Gambar C. 9 *V-Homogenizer*

C.2 Gambar Alat-Alat Pendukung

Gambar C. 10 Ayakan 200# dan 300#

Gambar C. 11 Baskom Kotak

Gambar C. 12 Bata Tahan Api

Gambar C. 13 Batang Pengambil *Stirrer Bar*

Gambar C. 14 Botol Semprot

Gambar C. 15 Cawan Keramik 50 ml

Gambar C. 16 Corong

Gambar C. 17 Desikator

Gambar C. 18 Erlenmeyer 250 ml

Gambar C. 19 *Face Shield*

Gambar C. 20 Gelas Beker 100 ml dan 300 ml

Gambar C. 21 Kertas Saring

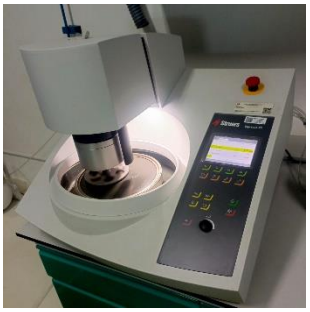
Gambar C. 22 Kertas Timbang

Gambar C. 23 Krusibel Grafit

Gambar C. 24 Kuas

Gambar C. 25 Labu Ukur 100 ml dan 1000 ml

Gambar C. 26 Media Pendingin



Gambar C. 27 Mesin *Polishing Grinding*

Gambar C. 28 *Mounting Cup*

Gambar C. 29 Neraca Digital

Gambar C. 30 Palu

Gambar C. 31 Pipet *Pump*

Gambar C. 32 Pipet Tetes

Gambar C. 33 Pipet Ukur 2 ml

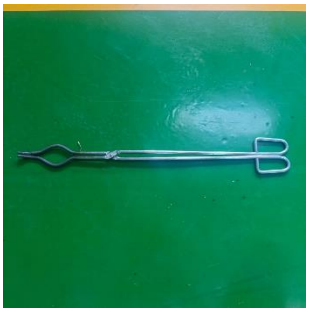
Gambar C. 34 Piring Keramik

Gambar C. 35 Sarung Tangan

Gambar C. 36 *Shield Quartz*

Gambar C. 37 Spatula

Gambar C. 38 *Stirrer Bar*



Gambar C. 39 Tang Krusibel

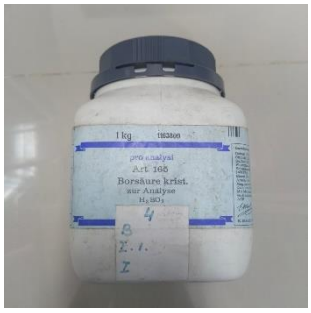
C.3 Gambar Bahan Baku

Gambar C. 40 Arang Cangkang Sawit

Gambar C. 41 Batu Kapur

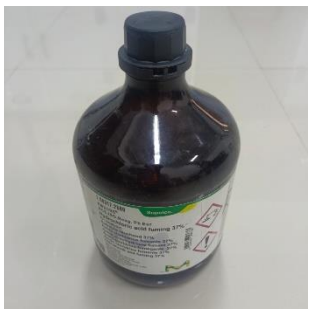
Gambar C. 42 Residu Bauksit

C.4 Gambar Bahan Kimia



Gambar C. 43 Asam Borat (H_3BO_3)

Gambar C. 44 Asam Fosfat



Gambar C. 45 Asam Klorida

Gambar C. 46 Asam Sulfida

Gambar C. 47 *Barium Diphenylamine Sulphonate Indicator*

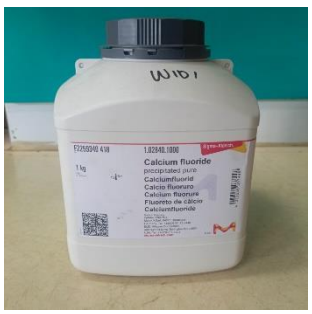
Gambar C. 48 Besi (III) Klorida Hexahidrat

Gambar C. 49 Boraks

Gambar C. 50 *Clarocit Liquid*

Gambar C. 51 *Clarocit Powder*

Gambar C. 52 Kalium Dikromat



Gambar C. 53 Kalsium Fluorida

Gambar C. 54 Merkuri (II) Klorida

Gambar C. 55 Natrium Karbonat

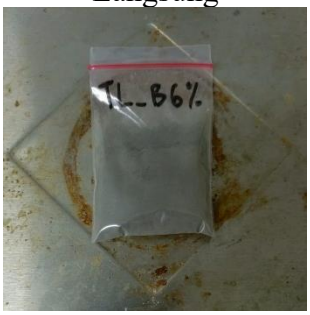
Gambar C. 56 Natrium Sulfat

Gambar C. 57 Timah (II) Klorida

C.5 Gambar Bahan Hasil Proses

Gambar C. 58 Hasil Reduksi Langsung

Gambar C. 59 Konsentrat



Gambar C. 60 *Tailing*