

DAFTAR PUSTAKA

- Aditiwati, P., dan Kusnadi. (2003). Kultur Campuran dan Faktor Lingkungan Mikroorganisme yang Berperan dalam Fermentasi Tea-Cider, PROC. ITB Sains dan Teknologi, 35 (2): 147-162.
- Anioła, J. et al. (2009) 'Corncobs as a source of dietary fiber', Polish Journal of Food and Nutrition Sciences, 59(3), pp. 247–249.
- Akgul, M. and H. Kirci. (2009). An Enviromentally Frienly Organosolv (Ethanol-Water) Palping of Poplar Wood. Journal of Environmental Biology. 30 (5): 735 – 740.
- Akira I. (2001). Chemical modification of cellulose. in 'Wood and Cellulosic Chemistry' (eds.: Hon D. N-S., Shiraishi N.) Marcel Dekker, New York, 599–626.
- Azhari, C., & Priyanto, B. (2017). *Pengaruh Putaran Mesin Terhadap Hasil Serbuk Lempung Pada Mesin Penggiling Bahan Kramik.* 17(2).
- Balaz .(2008). Mechanochemistry in Nonoscience and Minerals Engineering, ISBN: 978-3- 540-74854-0
- Bazazi, S., Arsalani, N., Khataee, A., & Tabrizi, A. G. (2018). Comparison of *Ball Milling*- hydrothermal and hydrothermal methods for synthesis of ZnO nanostructures and evaluation of their photocatalytic performance. Journal of industrial and engineering chemistry, 62, 265-272.
- Bochek A. M. (2003). Effect of hydrogen bonding on cellulose solubility in aqueous and nonaqueous solvents.Russian Journal of Applied Chemistry, 76, 1711–1719.
- Campbell,Neil A, dkk. (2008). Biologi Edisi Kedelapan Jilid I. Jakarta: Erlangga.
- D.Iemm, H.-P.Schmauder dan T.Heinze. (2005). Selulosa. Biopolimer online, Wiley,1-6.
- Dai, L., Li, C., Zhang, J., & Cheng, F. (2018). Preparation and characterization of starch nanocrystals combining *Ball Milling* with acid hydrolysis. Carbohydrate polymers, 180, 122-127.
- Dalmis, R., Cuvalci, H., Canakci, A., Guler, O., & Celik, E. (2018). The Effect of Mechanical Milling on Graphite–Boron Carbide Hybrid Reinforced

ZA27 Nanocomposites. Arabian Journal for Science and Engineering, 43(3), 1113-1124.

Griffiths, P.; de Hasseth, J. A. (18 May 2007). Fourier Transform Infrared Spectrometry (2nd ed.). Wiley-Blackwell. ISBN 978-0-471-19404-0.

Habibi, Y. (2010). "Cellulose Nanocrystal: Chemistry. Self-Assembly and Application", Chemistry Revisi. 09:28-36.

Hlabangana, N., Danha, G. and Muzenda, E. (2018) 'Effect of ball and feed particle size distribution on the milling efficiency of a ball mill: An attainable region approach', South African Journal of Chemical Engineering, 25, pp. 79–84. doi: 10.1016/j.sajce.2018.02.001.

Ibrahim, N. F., Mohamad, H. and Noor, S. N. F. M. (2016) 'Effects of milling media on the fabrication of melt-derived bioactive glass powder for biomaterial application', AIP Conference Proceedings, 1791(December). doi: 10.1063/1.4968865.

Iswanto A.H. (2009). Aren (Arenga pinnata). Departemen Kehutanan. Fakultas Pertanian. Universitas Sumatera Utara.

Islam, S., Al-Eshaikh, M., & Huda, Z. (2013). Synthesis and characterization of high energy ball- milled tungsten heavy alloy powders. Arabian Journal for Science and Engineering, 38(9), 2503-2507.

Koch, C. (2003). Top-down synthesis of nanostructured materials: Mechanical and thermal processing methods. Reviews on Advanced Materials Science, 5(2), 91-99.

Kutuk, S., & Kutuk-Sert, T. (2017). Effect of PCA on nanosized ulexite material prepared by mechanical milling. Arabian Journal for Science and Engineering, 42(11), 4801-4809.

Le Guillou, F. et al. (2015) 'How does grinding affect the mid-infrared spectra of soil and their multivariate calibrations to texture and organic carbon?', Soil Research, 53(8), pp. 913–921. doi: 10.1071/SR15019.

Lv, Y.-J., Su, J., Long, Y.-F., Lv, X.-Y., & Wen, Y.-X. (2014). Effect of milling time on the performance of bowl-like LiFePO₄/C prepared by wet milling-assisted spray drying. Ionics, 20(4), 471-478.

Li, X., Kokawa, M., & Kitamura, Y. (2018). Influence of micro wet milling parameters on the processing of Komatsuna (*Brassica rapa* var.

perviridis) juice with rich phosphatidic acid. *Journal of Food Engineering*, 217, 50-57.

Nandiyanto, A., Wiryani, A., Rusli, A., Purnamasari, A., Abdullah, A., & Riza, L. (2017). Decomposition Behavior of Curcumin during Solar Irradiation when Contact with Inorganic Particles. *IOP Conference Series: Materials Science and Engineering*, 180, 012135.

Nandiyanto, A., Wiryani, A., Rusli, A., Purnamasari, A., Abdullah, A., Widiaty, I., & Hurriyati, R. (2017). Extraction of Curcumin Pigment from Indonesian Local Turmeric with Its Infrared Spectra and Thermal Decomposition Properties. *IOP Conference Series: Materials Science and Engineering*, 180, 012136.

Nandiyanto, A. B., Putra, Z. A., Andika, R., Bilad, M. R., Kurniawan, T., Zulhijah, R., & Hamidah, I. (2017). Porous activated carbon particles from rice straw waste and their adsorption properties. *Journal of Engineering Science and Technology*, 12, 1-11.

Nandiyanto, A. B. D., Sofiani, D., Permatasari, N., Sucahya, T. N., Wiryani, A. S., Purnamasari, A., Rusli, A., & Prima, E. C. (2016). Photodecomposition profile of organic material during the partial solar eclipse of 9 march 2016 and its correlation with organic material concentration and photocatalyst amount. *Indonesian Journal of Science and Technology*, 1(2), 132-155.

Nandiyanto, A. B. D., Zaen, R., & Oktiani, R. (in press-b). Working Volume in High-Energy Ball- Milling Process on Breakage Characteristics and Adsorption Performance of Rice Straw Ash. *Arabian Journal for Science and Engineering*.

Nandiyanto, A. B. D., Andika, R., Aziz, M., & Riza, L. S. (2018). Working volume and milling time on the product size/morphology, product yield, and electricity consumption in the ball-milling process of organic material. *Indonesian Journal of Science and Technology*, 3(2), 82–94. <https://doi.org/10.17509/ijost.v3i2.12752> Suarni dan I.GP. Sarasutha. 2002. Teknologi pengolahan jagung untuk meningkatkan nilai tambah dalam pengembangan agroindustri. Prosiding Seminar Nasional, BPTP Sulawesi Tengah.

Mio, H., Kano, J., Saito, F., & Kaneko, K. (2002). Effects of rotational direction and rotation-to-revolution speed ratio in planetary *Ball Milling*. *Materials Science and Engineering: A*, 332(1-2), 75-80.

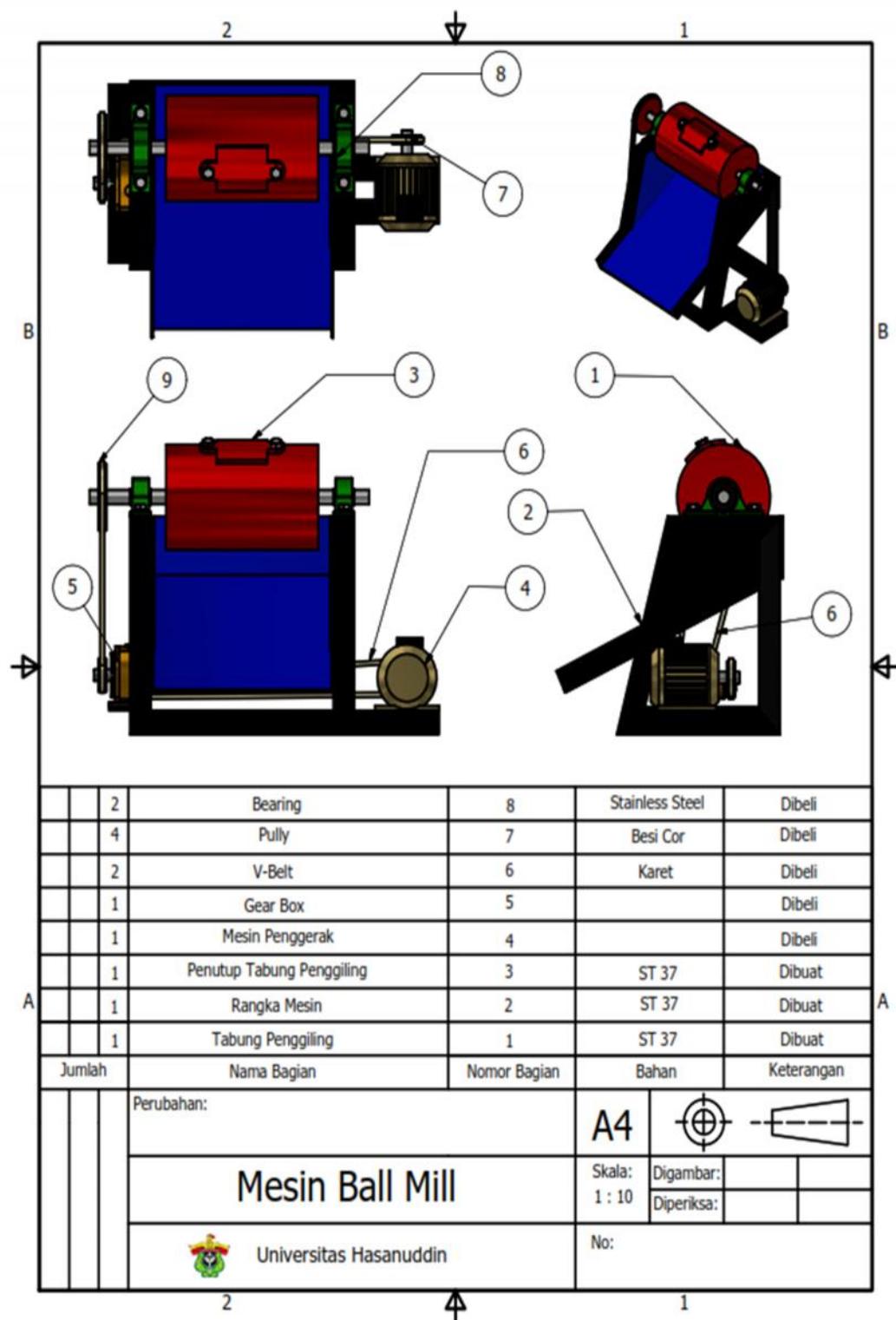
Munajad, A., Subroto, C. and Suwarno (2018) 'Fourier transform infrared (FTIR) spectroscopy analysis of transformer paper in mineral oil-paper

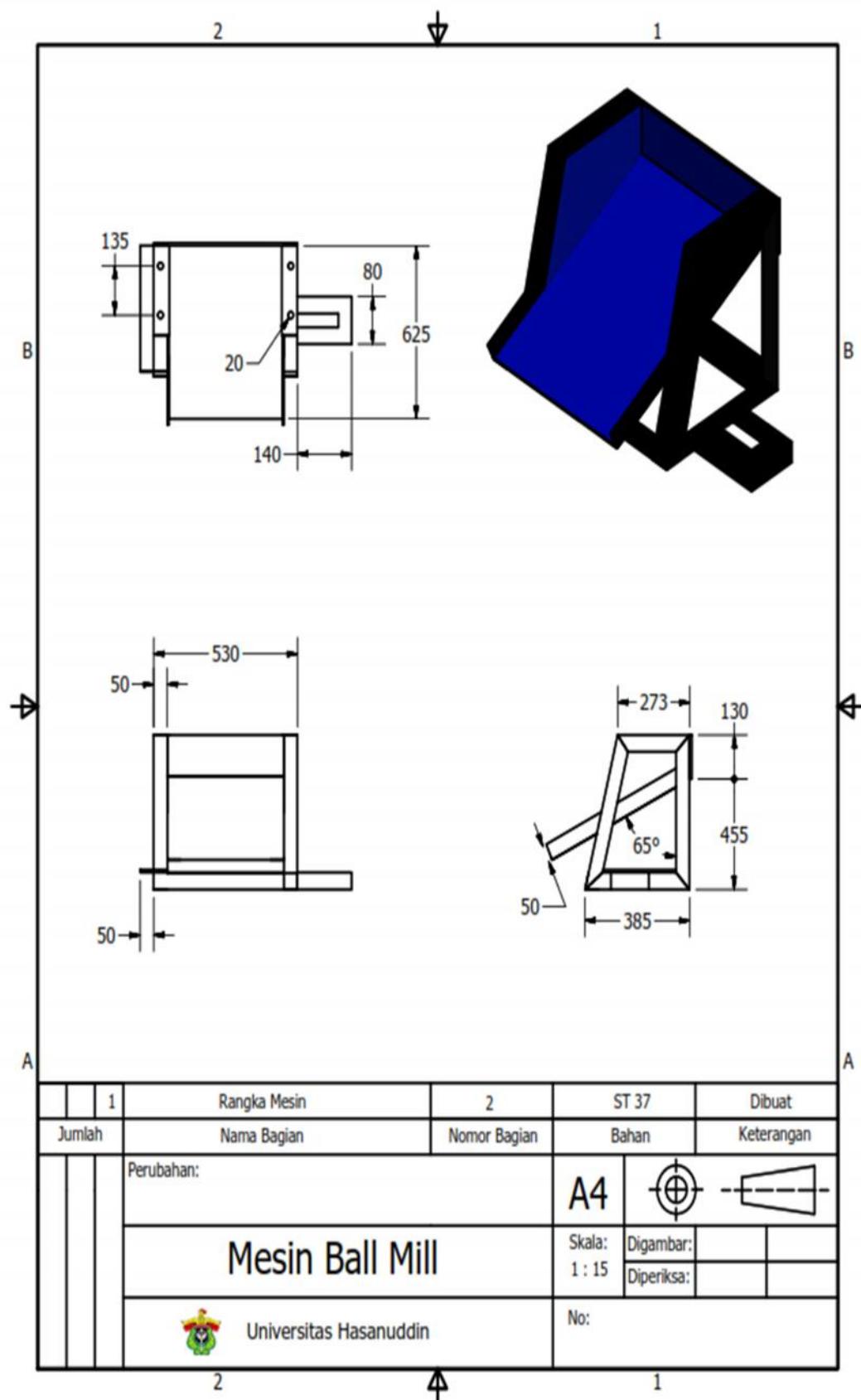
- composite insulation under accelerated thermal aging', Energies, 11(2). doi: 10.3390/en11020364.
- Onuoha, C. et al. (2017) 'Morphology and Physical/End-Use Properties of Recycled Polypropylene-Corn Cob Powder Composites', International Journal of Engineering and Technologies, 11(November 2018), pp. 1–12. doi: 10.18052/www.scipress.com/ijet.11.1.
- Ohwoavworhua FO, Adelakun TA, Okhamafe AO. (2009). Processing pharmaceutical grade microcrystalline cellulose from groundnut husk: extraction methods and characterization. International Journal of Green Pharmacy. 70: 97-104.
- Ohwoavworhua, F. (2005), "Phosphoric Acid-Mediated Depolymerization and Decrystallization of -Cellulose Obtained from Corn Cob: Preparation of Low Crystallinity Cellulose and Some Physicochemical Properties", Tropical journal of pharmaceutical Research, 4: 509-516.
- Richana, N., P. Lestina, dan T.T. Irawadi. (2004). Karakterisasi lignoselulosa dari limbah tanaman pangan dan pemanfaatannya untuk pertumbuhan bakteri RXA III-5 penghasil xilanase. Jurnal Penelitian Pertanian Tanaman Pangan. 23(3):171-176.
- Richana N. dan Suarni, (2007), "Teknologi Pengolahan Jagung. In Sumarno et al. Jagung: Teknik Produksi dan Pengembangan", Pusat Penelitian dan Pengembangan Tanaman Pangan. Badan Penelitian dan Pengembangan Pertanian. P: 386-409.
- Sari, K. et al. (2019) 'Effect of milling time on microstructures of nano-sized chitosan', Journal of Physics: Conference Series, 1170(1). doi: 10.1088/1742-6596/1170/1/012058.
- Sarkar, N. et al. (2012). Bioethanol production from agricultural wastes : An overview. Renewable Energy, 37(1), pp.19–27. Available at: <http://dx.doi.org/10.1016/j.renene.2011.06.045>.
- Stolle, A., Szuppa, T., Leonhardt, S. E., & Ondruschka, B. (2011). *Ball Milling in organic synthesis: solutions and challenges*. Chemical Society Reviews, 40(5), 2317-2329.
- Suprapto, H.S. dan Rasyid, M.S. (2002). Bertanam Jagung. Penebar Swadaya, Jakarta. 55 hal.

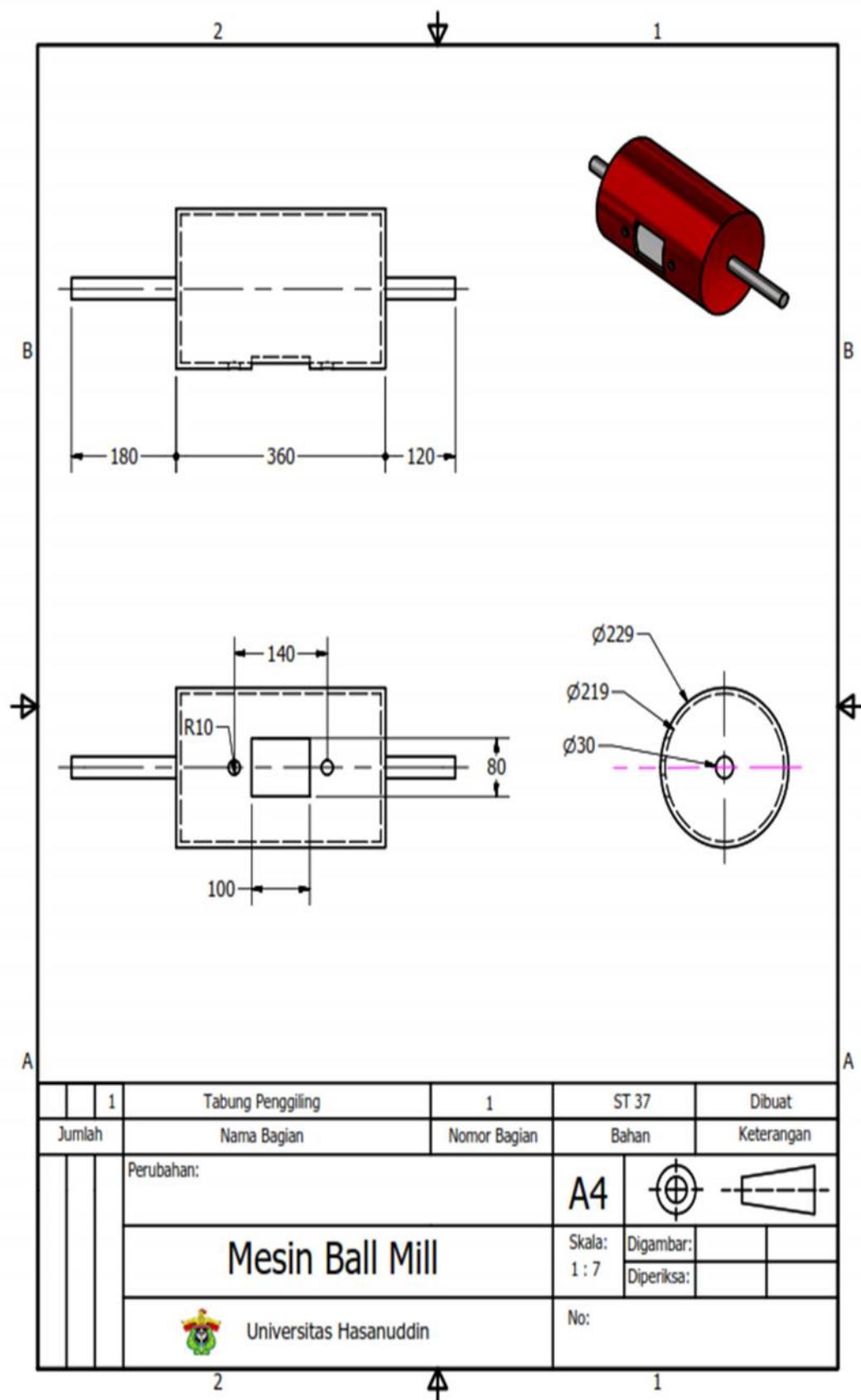
- Shofianto, M.E. (2008). "Hidrolisis Tongkol Jagung Oleh Bakteri Selulotik Untuk Produksi Bioetanol dalam Kultur Campuran", Skripsi UGM.
- Stokes, Debbie J. (2008). Principles and Practice of Variable Pressure Environmental Scanning Electron Microscopy (VP-ESEM). Chichester: John Wiley & Sons. ISBN 978-0470758748.
- Udvardi, B. et al. (2017) 'Effects of Particle Size on the Attenuated Total Reflection Spectrum of Minerals', Applied Spectroscopy, 71(6), pp. 1157–1168. doi: 10.1177/0003702816670914.
- Ugwuegbu, C. C., Ogbonna, A. I., Ikele, U. S., Anaele, J. U., Ochieze, U. P., & Onwuegbuchulam, A. (2017). Design, Construction and Performance Analysis of a 5 KgLaboratory *Ball Mill*. *Global Journal of Researches in Engineering*, 17(2), 26–42.
- Wang, B., Wei, S., Wang, Y., Liang, Y., Guo, L., Xue, J., Pan, F., Tang, A., Chen, X., & Xu, B. (2018). Effect of milling time on microstructure and properties of Nano-titanium polymer by high-energy *Ball Milling*. Applied Surface Science, 434, 1248-1256.
- Widyatmoko, Arif. (2008). Mengenal Laboratorium Biologi. Semarang: PT.Bengawan Ilmu
- Zhang, F., Zhu, M., & Wang, C. (2008). Parameters optimization in the planetary *Ball Milling* of nanostructured tungsten carbide/cobalt powder. International Journal of Refractory Metals and Hard Materials, 26(4), 329-333.

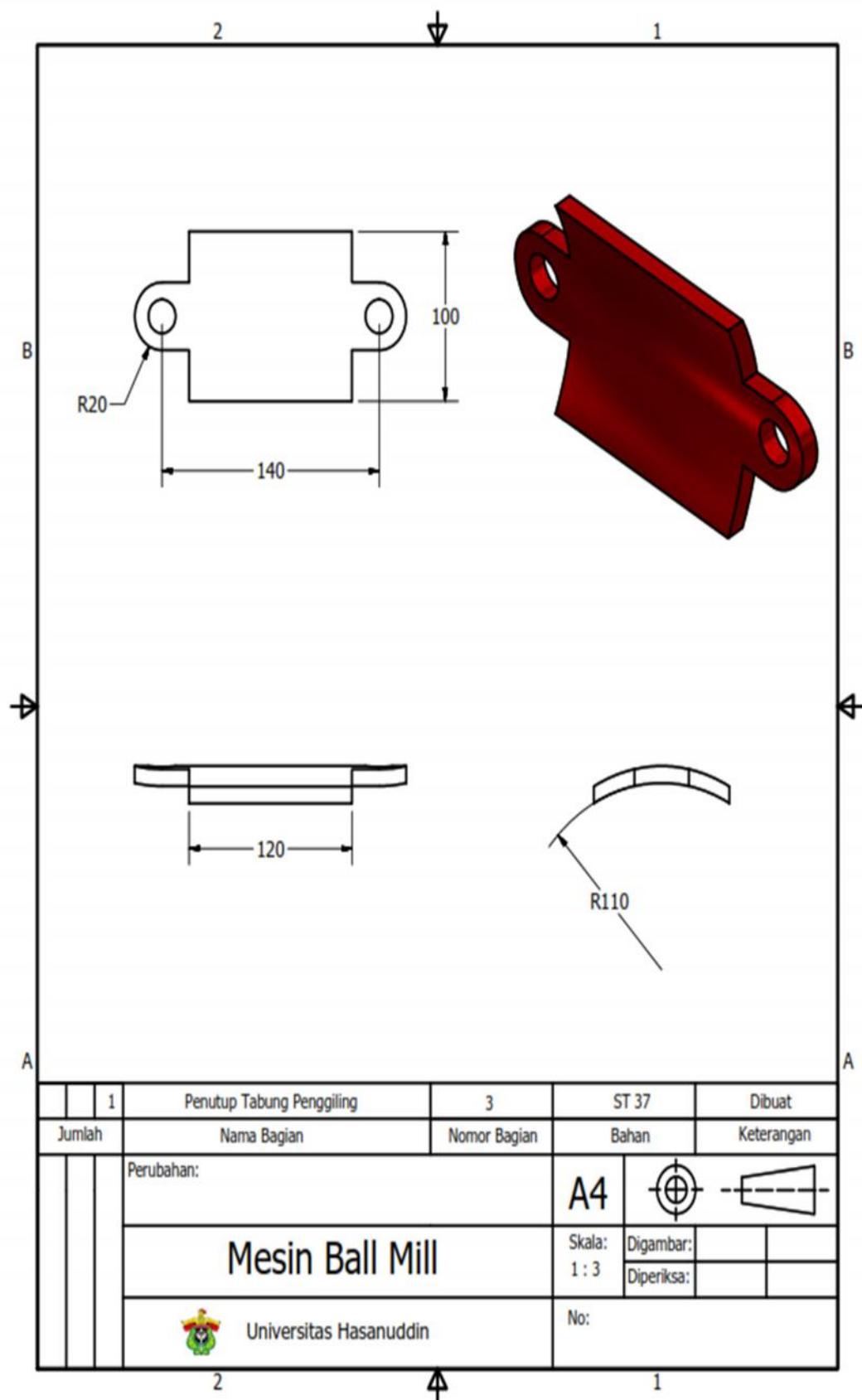
LAMPIRAN

Lampiran 1. Desain Mesin *Ball Mill*





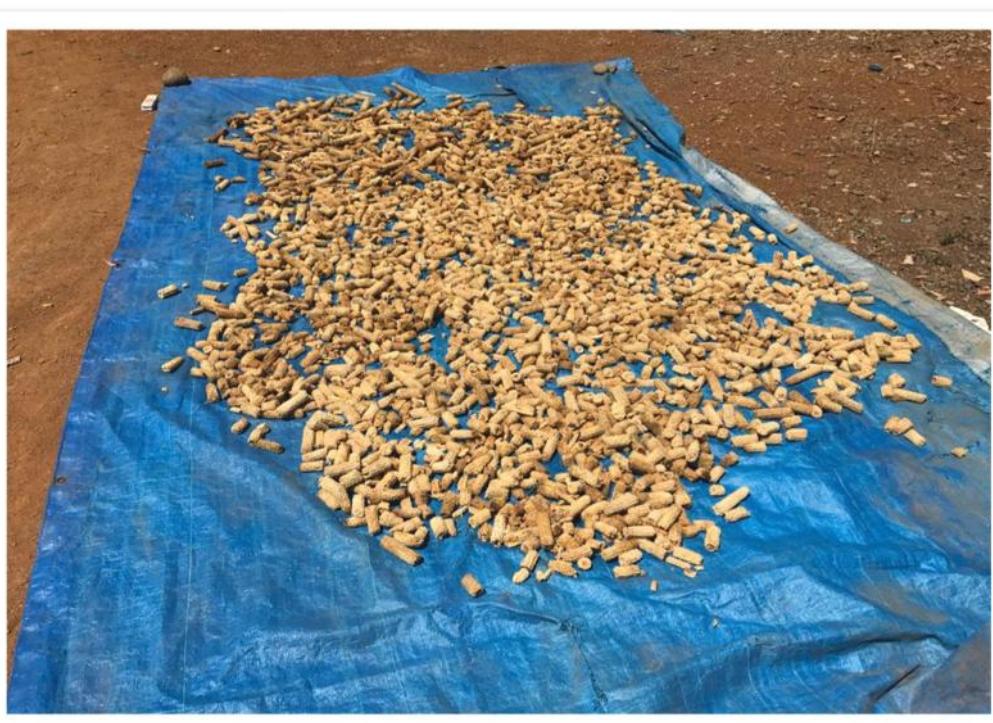




Lampiran 2. Proses Pengambilan Sampel



Lampiran 3. Proses Persiapan Sampel



Lampiran 4. Proses Pemotongan Sampel



Lampiran 5. Proses Pembuatan Mesin *Ball Mill*



Lampiran 6. Proses Pengambilan Data

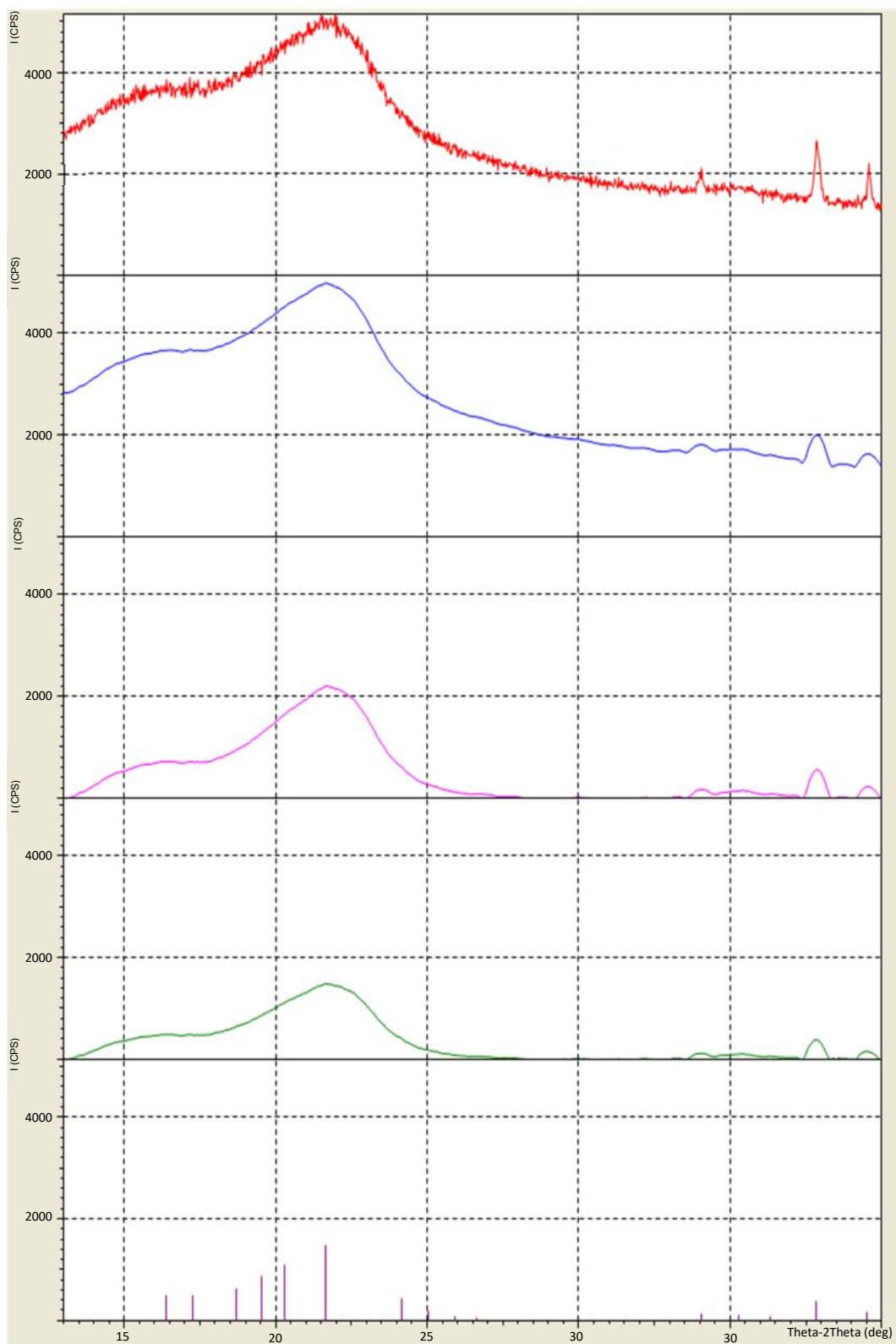


Lampiran 7. Hasil Proses *Ball Mill*

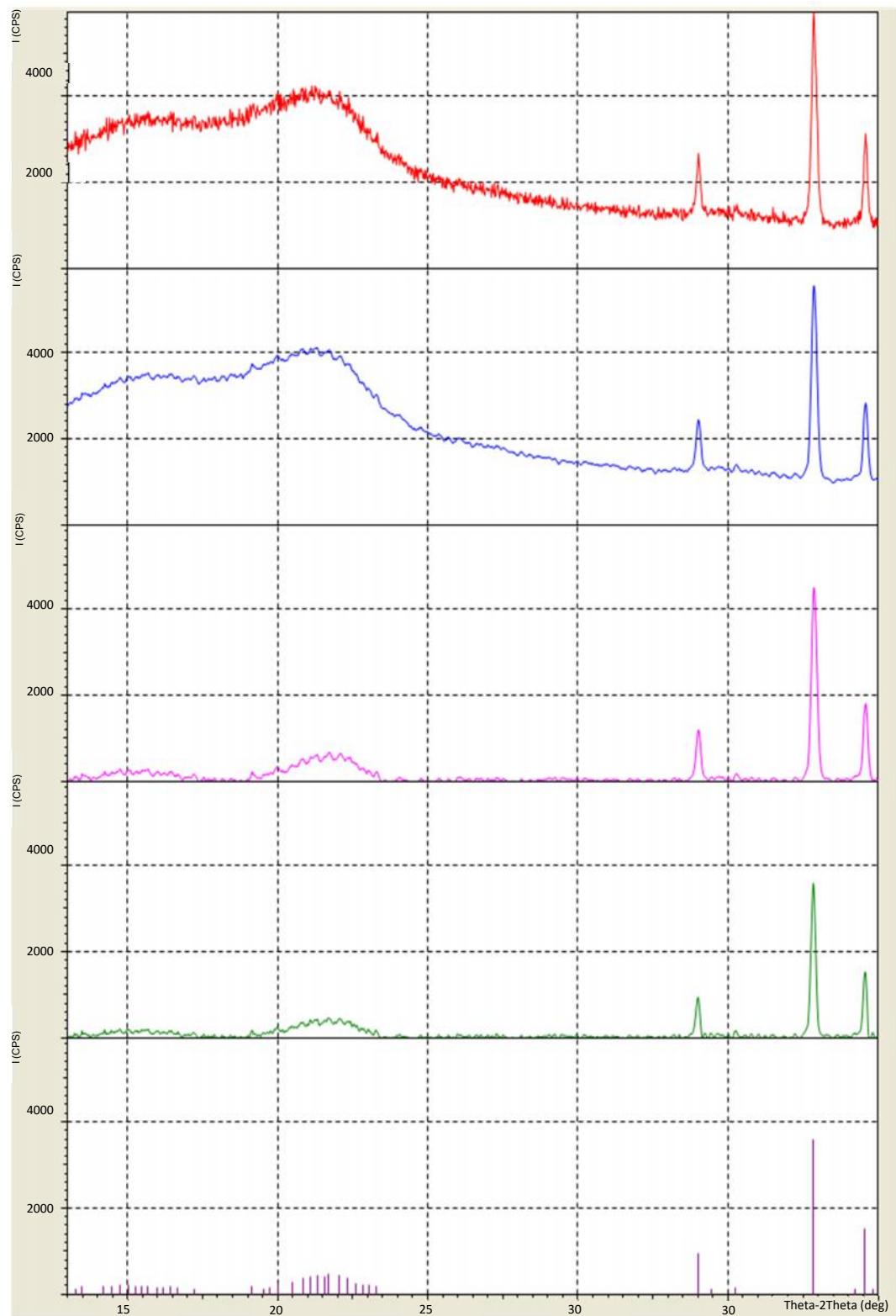


Lampiran 8. Data Hasil Proses XRD

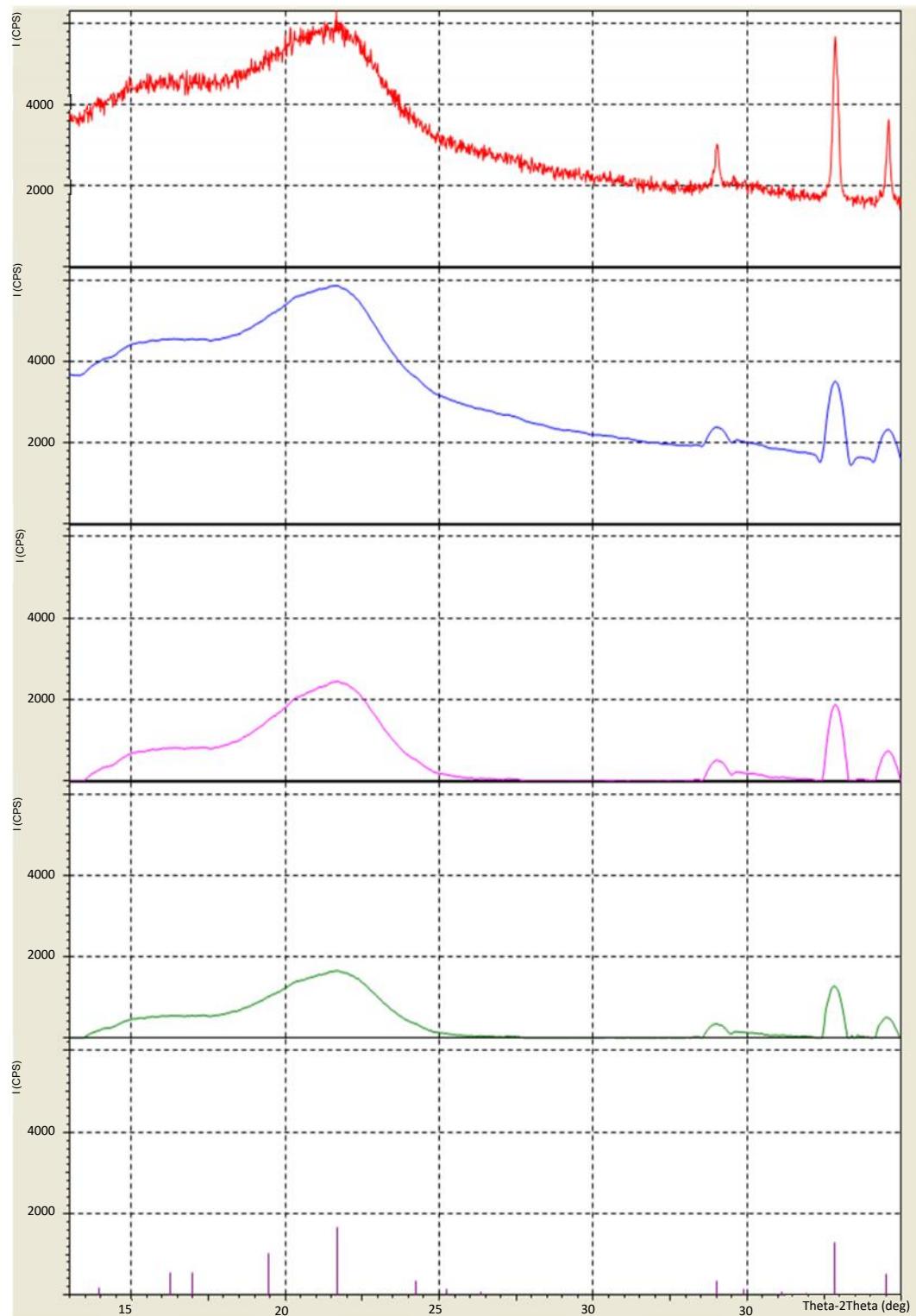
1. Volume kerja 20% dengan waktu penggilingan 60 menit



2. Volume kerja 70% dengan waktu penggilingan 30 menit



3. Volume kerja 70% dengan waktu penggilingan 60 menit



Lampiran 9. Data Hasil Proses *FTIR*

1. Volume kerja 20% dengan waktu penggilingan 60 menit

No	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	428.21	96.18	2.58	439.78	403.14	0.35	0.18
2	466.79	95.76	0.34	495.72	462.93	0.45	0
3	609.53	88.22	0.42	613.38	536.23	3.48	0.27
4	665.46	88.07	2.88	792.77	648.1	4.06	0.24
5	898.86	94.11	3.27	918.15	864.14	0.91	0.35
6	1041.6	51.91	34.1	1147.68	918.15	40.44	25.62
7	1159.26	75.68	5.53	1203.62	1147.68	3.93	0.48
8	1251.84	87.92	9.72	1298.14	1203.62	3.12	2.15
9	1325.14	94.62	1.4	1348.29	1317.43	0.57	0.1
10	1371.43	92.58	5.05	1398.44	1352.14	1.05	0.57
11	1429.3	89.92	3.16	1437.02	1398.44	1.19	0.29
12	1462.09	86.7	8.5	1487.17	1437.02	2.04	0.95
13	1514.17	85.97	10.73	1539.25	1487.17	2.01	1.26
14	1546.96	94.11	1.99	1562.39	1539.25	0.47	0.12
15	1645.33	75.79	8.83	1668.48	1575.89	7.05	2.37
16	1732.13	81.82	0.63	1737.92	1716.7	1.79	0.03
17	2360.95	87.33	6.31	2397.6	2339.73	2.11	0.78
18	2920.32	84.34	14.14	3003.27	2744.8	9.14	7.58
19	3410.26	53.9	0.98	3547.21	3398.69	35.83	2.08

2. Volume kerja 30% dengan waktu penggilingan 60 menit

No	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	426.28	94.81	3	437.86	403.14	0.55	0.25
2	464.86	94.4	2.08	491.86	451.36	0.76	0.21
3	613.38	84.01	4.63	642.32	499.58	7.88	2.78
4	663.53	83.91	3.31	786.98	650.03	5.57	0.44
5	896.93	92.1	5.33	918.15	869.92	1.07	0.55
6	1041.6	40.59	41.58	1145.75	918.15	55.16	35.83
7	1159.26	68.27	8.69	1201.69	1145.75	5.43	0.93
8	1251.84	84.51	14.64	1300.07	1201.69	3.81	3.44
9	1325.14	96.44	0.93	1344.43	1319.35	0.28	0.06
10	1373.36	91.36	7.44	1400.37	1344.43	1.15	0.86
11	1427.37	87.96	4.72	1438.94	1400.37	1.41	0.42
12	1462.09	83.03	11.25	1489.1	1438.94	2.53	1.3
13	1512.24	84.41	13.72	1539.25	1489.1	2.01	1.58
14	1647.26	66.82	11.83	1672.34	1570.11	11.36	3.83
15	1728.28	76.7	0.56	1732.13	1714.77	1.95	0.03
16	2360.95	87.94	5.95	2397.6	2339.73	2.02	0.73
17	2922.25	75.62	21	3001.34	2752.51	14.95	11.54
18	3414.12	40.45	22.88	3549.14	3001.34	137.76	56.67

3. Volume kerja 50% dengan waktu penggilingan 60 menit

No	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	424.35	97.32	2.37	437.86	405.06	0.23	0.19
2	466.79	97.75	1.26	488.01	447.5	0.29	0.12
3	607.6	91.99	0.12	611.45	594.1	0.62	0
4	663.53	91.86	1.99	783.13	650.03	2.48	0.25
5	896.93	96.62	2.93	920.08	852.56	0.46	0.36
6	1041.6	64.63	26.42	1145.75	920.08	26.49	17.59
7	1159.26	82.91	4.27	1209.41	1145.75	2.85	0.29
8	1251.84	92.76	6.33	1298.14	1209.41	1.63	1.29
9	1327.07	97.62	0.71	1354.07	1319.35	0.21	0.03
10	1371.43	96.34	3.62	1400.37	1354.07	0.37	0.37
11	1427.37	93.91	2.97	1438.94	1400.37	0.6	0.24
12	1462.09	90.68	6.52	1489.1	1438.94	1.32	0.74
13	1512.24	89.5	6.57	1525.74	1489.1	1.12	0.59
14	1656.91	82.95	0.37	1666.55	1654.98	0.89	0.02
15	1739.85	86.43	1.83	1791.93	1732.13	1.94	-0.2
16	2362.88	90.16	5.12	2397.6	2339.73	1.63	0.58
17	2922.25	89.31	10.46	3003.27	2740.94	5.75	5.55
18	3417.98	64.35	15.16	3547.21	3003.27	63.57	26.38

4. Volume kerja 70% dengan waktu penggilingan 60 menit

No	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	466.79	97.22	1.69	491.86	437.86	0.47	0.22
2	609.53	91.69	2.28	644.25	491.86	4.38	1.31
3	665.46	91.42	2.2	786.98	644.25	2.98	0.29
4	895	96.69	2.65	920.08	848.71	0.56	0.35
5	1039.67	66.97	25.24	1147.68	920.08	24.08	16.17
6	1159.26	85.01	3.63	1201.69	1147.68	2.2	0.31
7	1251.84	92.83	6.3	1298.14	1201.69	1.68	1.32
8	1332.86	96.02	1.63	1350.22	1298.14	0.69	0.23
9	1371.43	93.88	3.25	1400.37	1350.22	1	0.37
10	1425.44	92.86	2.39	1438.94	1400.37	0.91	0.17
11	1514.17	89.37	7.2	1543.1	1487.17	1.69	0.83
12	1647.26	79.94	12.34	1720.56	1575.89	9.48	4.25
13	1735.99	85.86	2.44	1818.93	1720.56	3.24	-0.22
14	2360.95	88.07	5.6	2399.53	2339.73	2.02	0.64
15	2924.18	89.62	9.67	3001.34	2690.79	6.24	5.2
16	3417.98	62.93	14.78	3549.14	3001.34	66.93	25.25

Lampiran 10. Data Hasil Proses *Ball Mill*

1. Volume Kerja 20%

No.	Ukuran Mesh	Rata-rata		
		30 Menit	40 Menit	60 Menit
1	Loss	1.2 gram	1.5 gram	1.2 gram
2	14	5.0 gram	7.9 gram	6.7 gram
3	18	14.2 gram	16.6 gram	21.3 gram
4	70	0.4 gram	1.4 gram	3.8 gram
5	140	0.2 gram	0.7 gram	1.1 gram
6	> 14	339.1 gram	331.9 gram	325.9 gram

2. Volume Kerja 30%

No.	Ukuran Mesh	Rata-rata		
		30 Menit	40 Menit	60 Menit
1	Loss	1.4 gram	1.3 gram	1.2 gram
2	14	12.1 gram	11.2 gram	16.8 gram
3	18	22.8 gram	28.8 gram	32.2 gram
4	70	2.5 gram	3.4 gram	4.5 gram
5	140	0.3 gram	0.9 gram	1.2 gram
6	> 14	500.8 gram	494.4 gram	484.0 gram

3. Volume Kerja 50%

No.	Ukuran Mesh	Rata-rata		
		30 Menit	40 Menit	60 Menit
1	Loss	1.1 gram	1.2 gram	1.3 gram
2	14	13.8 gram	20.1 gram	28.5 gram
3	18	39.0 gram	39.7 gram	51.5 gram
4	70	7.0 gram	9.9 gram	15.6 gram
5	140	1.1 gram	2.1 gram	3.1 gram
6	> 14	838.0 gram	827.0 gram	800.1 gram

4. Volume Kerja 70%

No.	Ukuran Mesh	Rata-rata		
		30 Menit	40 Menit	60 Menit
1	Loss	1.3 gram	1.2 gram	1.4 gram
2	14	15.9 gram	30.8 gram	33.0 gram
3	18	26.1 gram	52.4 gram	61.2 gram
4	70	2.7 gram	14.4 gram	16.1 gram
5	140	1.1 gram	1.6 gram	2.3 gram
6	> 14	1212.9 gram	1159.7 gram	1146.0 gram