

BAB 5

KESIMPULAN DAN SARAN

5.1 Kesimpulan

Berdasarkan hasil penelitian dengan variasi penggunaan pengompleks diamonium fosfat dan EDTA dengan kondisi operasi *leaching* pada temperatur ruang, ukuran partikel -100+200 mesh, rasio padat-cair sebesar 1:5 dan proses leaching dilakukan selama 240 menit, maka dapat disimpulkan beberapa hal sebagai berikut:

1. Konsentrasi logam perak (Ag) yang diperoleh pada penggunaan diamonium fosfat sebagai pengompleks lebih tinggi dibandingkan dengan variasi lainnya. Waktu optimum yang diperoleh pada penggunaan diamonium fosfat adalah pada menit ke 45.
2. Penggunaan pengompleks diamonium fosfat dapat menurunkan konsentrasi logam timbal (Pb) dan seng (Zn) yang terekstrak.
3. Penggunaan pengompleks EDTA memberikan nilai yang tinggi terhadap konsentrasi logam timbal (Pb) dan seng (Zn) yang terekstrak.

5.2 Saran

Dari hasil penelitian yang telah dilakukan, terdapat beberapa saran yang dapat diberikan untuk penelitian selanjutnya pada topik ini adalah sebagai berikut:

1. Penggunaan pengompleks diamonium fosfat dapat dipelajari lebih lanjut untuk melihat pengaruhnya terhadap logam lainnya
2. Melakukan proses *leaching* secara dua tahap, sehingga dapat menurunkan terlebih dahulu kadar logam timbal (Pb) dalam konsentrat
3. Melakukan penelitian dengan menggunakan pengompleks lain yang dapat meningkatkan konsentrasi logam perak (Ag) yang terekstrak.
4. Melakukan analisa XRF residu hasil proses *leaching* agar dapat mengetahui komposisi akhir logam yang terkandung di dalamnya serta menghitung *yield* logam perak, timbal dan seng..

DAFTAR PUSTAKA

- Abbruzzese, C., Fornari, P., Massidda, R., Vegliò, F., & Ubaldini, S. (1995). Thiosulphate leaching for gold hydrometallurgy. *Hydrometallurgy*, 39(1–3), 265–276. [https://doi.org/10.1016/0304-386X\(95\)00035-F](https://doi.org/10.1016/0304-386X(95)00035-F)
- Alonso-Gómez, A. R., & Lapidus, G. T. (2009). Inhibition of lead solubilization during the leaching of gold and silver in ammoniacal thiosulfate solutions (effect of phosphate addition). *Hydrometallurgy*, 99(1–2), 89–96. <https://doi.org/10.1016/j.hydromet.2009.07.010>
- Alsamarrai, K. F. (2011). Spectrophotometric Assay of Lead in Human Hair Samples by using alizarin red (S) in Samarra area. *J. of University of Anbar for Pure Science*, 5(3), 3–10.
- Anugrah, R. I., Mubarak, M. Z., & Amalia, D. (2017). Study on the leaching behavior of galena concentrate in fluosilicic acid solution using hydrogen peroxide as oxidant. *AIP Conference Proceedings*, 1805(October 2018). <https://doi.org/10.1063/1.4974417>
- Appl, M. (1999). *Ammonia : Principles and Industrial Practice*. WileyVCH. Weinheim.
- Aylmore, M. G. (2001). Treatment of a refractory gold-copper sulfide concentrate by copper ammoniacal thiosulfate leaching. *Minerals Engineering*, 14(6), 615–637. [https://doi.org/10.1016/S0892-6875\(01\)00057-7](https://doi.org/10.1016/S0892-6875(01)00057-7)
- Breuer, P. L., & Jeffrey, M. I. (2003). The reduction of copper(II) and the oxidation of thiosulfate and oxysulfur anions in gold leaching solutions. *Hydrometallurgy*, 70(1–3), 163–173. [https://doi.org/10.1016/S0304-386X\(03\)00078-1](https://doi.org/10.1016/S0304-386X(03)00078-1)
- Briones, R., & Lapidus, G. T. (1998). The leaching of silver sulfide with the thiosulfate-ammonia-cupric ion system. *Hydrometallurgy*, 50(3), 243–260. [https://doi.org/10.1016/s0304-386x\(98\)00056-5](https://doi.org/10.1016/s0304-386x(98)00056-5)
- Bunaciu, A.A., Udristioiu, E. Gabriela & Aboul-Einen, H.Y. (2015). *X-Ray Diffraction: Instrumentation and Applications*. *Critical Reviews in Analytical Chemistry*, 45(4), 289–299. <https://doi.org/10.1080/10408347.2014.949616>
- Chao, C. W. (2016). *Cupric ammoniacal thiosulfate leaching of natural acanthite ore in a continuous circuit*. July.
- Chen, X., J.V. Wright, J.L. Conca, and L.M. Peurrung. 1997. *Evaluation of heavy metal remediation using mineral apatite*. *Water Air Soil Pollut.* 98:57–78
- Daenzer, R. (2017). *The Modes Of Gold Loss In The Calcium Thiosulfate Leaching by A Dissertation Submitted In Partial Fulfillment Of The Requirements For The Degree Of The Faculty Of Graduate And Postdoctoral Studies (Materials Engineering) (Vancouver)*.

December.

- Day, R. A. dan Underwood, A. L. (1986). *Quantitative Analysis*. edisi 5. Prentice Hall Publication. Upper Saddle River.
- Deutsch, Jared L., & Dreisinger, D. B. (2013). Silver sulfide leaching with thiosulfate in the presence of additives Part I: Copper-ammonia leaching. *Hydrometallurgy*, *137*, 156–164. <https://doi.org/10.1016/j.hydromet.2013.03.012>
- Deutsch, Jared Luke. (2010). Fundamental aspects of thiosulfate leaching of silver sulfide in the presence of additives. *UBC Thesis, January*.
- Di Palma, L., Ferrantelli, P., Merli, C., & Biancifiori, F. (2003). Recovery of EDTA and metal precipitation from soil flushing solutions. *Journal of Hazardous Materials*, *103*(1–2), 153–168. [https://doi.org/10.1016/S0304-3894\(03\)00268-1](https://doi.org/10.1016/S0304-3894(03)00268-1)
- Dutrizac, J. E. (1986). The dissolution of galena in ferric chloride media. *Metallurgical Transactions B*, *17*(1), 5–17. <https://doi.org/10.1007/BF02670814>
- E. C. Chen, J. M. Toguri and S. K. Chang. (1989). *Metallurgical and Materials Transactions B*, *20B* 87.
- Effendi, H. (2003). Telaah kualitas air, bagi pengelolaan sumber daya dan lingkungan perairan. Cetakan kelima. Yogyakarta : Kanisius.
- Feng, D., & Van Deventer, J. S. J. (2011). The role of amino acids in the thiosulphate leaching of gold. *Minerals Engineering*, *24*(9), 1022–1024.
- Fleming, C.A. (2007). The leaching and recovery of gold from ores and concentrates section 3 gold and silver recovery. Lakefield Research Ltd
- Gavhane, K. (2008). *Mass Transfer-II*. edisi 6.
- Geankoplis, C. J. (1993). Transport processes and unit operations. In *Transport Process and Unit Operations* (p. 538).
- Gupta, C.K, Mukherjee, T. . (1990). Hydrometallurgy in Extraction Processes. *Journal of Materials Processing Technology*, *1*(1), 1–8. <http://dx.doi.org/10.1016/j.cirp.2016.06.001><http://dx.doi.org/10.1016/j.powtec.2016.12.055><https://doi.org/10.1016/j.ijfatigue.2019.02.006><https://doi.org/10.1016/j.matlet.2019.04.024><https://doi.org/10.1016/j.matlet.2019.127252><http://dx.doi.org/10.1016/j.matlet.2019.04.024>
- Guy, P. J., & Trahar, W. J. (1984). The influence of grinding and flotation environments on the laboratory batch flotation of galena. *International Journal of Mineral Processing*, *12*(1–3), 15–38. [https://doi.org/10.1016/0301-7516\(84\)90020-6](https://doi.org/10.1016/0301-7516(84)90020-6)
- Gyliene, O., Aikaite, J., & Nivinskiene, O. (2004). Recycling of Ni(II)-citrate complexes using

- precipitation in alkaline solutions. *Journal of Hazardous Materials*, 109(1–3), 105–111. <https://doi.org/10.1016/j.jhazmat.2004.03.008>
- Hall, R., (2009), Indonesia, geology. Encyclopedia of Islands, University California Press, Berkeley, California, pp. 454-460
- Hidayati, E. N. (2014). Perbandingan Metode Destruksi Pada Analisis Pb Dalam Rambut Dengan AAS. *Indonesian Journal of Chemical Science*, 3(1).
- Hurlburt, C.S. dan Klein, C., (1977) . Manual of Mineralogy, 19th edition. John Wiley & Sons. New York.
- Idiawati, N., Triantie, A., & Wahyuni, N. (2013). Pemisahan Timbal (Pb) dalam Galena dengan Metode Flotasi Menggunakan Deterjen. *Positron*, 3(1), 1–5. <https://doi.org/10.26418/positron.v3i1.4116>
- Idrus, A., Setijadji, L. D., Tamba, F., & Anggara, F. (2011). Geology and characteristics of Pb-Zn-Cu-Ag skarn deposit at Ruwai, Lamandau Regency, Central Kalimantan. *Journal of Applied Geology*, 3(1), 191–201. <https://doi.org/10.22146/jag.7181>
- Intratec. (2019). Diammonium Phosphate Production. Basic Cost Analysis. United States.
- Jamaludin, A., & Adiantoro, D. (2012). Analisis Kerusakan X-Ray Fluorescence (XRF). *PIN Pengelolaan Instalasi Nuklir*, V(09–10), 19–28. <http://jurnal.batan.go.id/index.php/pin/article/view/1130>
- Kant, W., Warmada, I. W., Idrus, A., Setijadji, L. D., dan Watanabe, K. (2012). *Ore Mineralogy and Mineral Chemistry of Pyrite, Galena and Sphalerite at Soripersa Prospect Area, Sumbawa Island, Indonesia. J. se. Asian Appl. Geol. Jan-Jun 2012. Vol. 4(1), pp. 1-14*
- Lai, Y. Y. (2017). *Sulfate Leaching of Natural Acanthite Ore in Copper-Ammonia-Ammonium Sulfate Medium.*
- Langhans, J. W., Jr., Lei, K. P. V., and Carnahan, T. G. (1992). Copper-catalyzed thiosulfate leaching of low grade gold ores. *Hydrometallurgy*. 29 : 191-203
- Learmont, M. E., & Iwasaki, I. (1984). Effect of Grinding Media on Galena Flotation. *Minerals and Metallurgical Processing*, 1(2), 136–143. <https://doi.org/10.1007/bf03402566>
- Li, J., Zhang, M., Li, B., Monteiro, S. N., Ikhmayies, S., Kalay, Y. E., Hwang, J., Escobedo-diaz, J. P., Carpenter, J. S., & Brown, A. D. (2020). *Characterization of Minerals, Metals, and Materials 2020.*
- Lu, D., Chen, L., Ma, Y., Zheng, X., & Wang, Y. (2020). Effects of ultrasonic pretreatment on the flotation behavior of galena with and without the presence of pyrite. *Physicochemical Problems of Mineral Processing*, 56(4), 611–624. <https://doi.org/10.37190/PPMP/123406>

- Luengos, M. A., Ambrosio, E., Bohé, A. E., & Pasquevich, D. M. (1999). Thermal behavior of galena ore in chlorine atmospheres. *Journal of Thermal Analysis and Calorimetry*, 59(3), 775–789. <https://doi.org/10.1023/A:1010101703947>
- Ma, L.Q., and G.N. Rao. 1997. *Effects of phosphate rock on sequential chemical extraction of lead in contaminated soils*. *J. Environ. Qual.* 26:788–794.
- Ma, Q.Y., T.J. Logan, and S.J. Traina. 1995. *Lead immobilization from aqueous solutions and contaminated soils using phosphate rocks*. *Environ. Sci. Technol.* 29:1118–1126.
- Marlina, A. (2009). *Timbal Dalam Kerang Hijau (viridis L)*. 521–524.
- Meng, X., & Han, K. N. (1996). The Principles and Applications of Ammonia Leaching of Metals—A Review. *Mineral Processing and Extractive Metallurgy Review*, 16(1), 23–61.
- Mulja, M., Suharman. (1995). Analisis Instrumen, cetakan 1, 26-32, Airlangga University Press, Surabaya.
- Mubarok, Z., & Yahya, Y. (2014). Studi Perilaku Pelindian Timbal Dari Bijih Galena Nanggung Kabupaten Bogor Dalam Larutan Asam Asetat Dan Oksidator Hidrogen Peroksida. *Metalurgi*, 29(1), 51. <https://doi.org/10.14203/metalurgi.v29i1.271>
- Nasution, A.2., Putri, R. N., dan Mayendra, E. (2019). Mengkaji Karakteristik Pemakai Teknologi Pengolahan Air Bersih Di Indonesia.
- Nezar, S., Cherifi, Y., Barras, A., Addad, A., Dogheche, E., Saoula, N., Laoufi, N.A., Roussel, P., Szunerits, S dan Boukherroub, R. (2018). *Efficient Reduction of Cr(VI) Under Visible Light Irradiation using CuS Nanostructures*. *Arabian Journal of Chemistry*. King Saud University.
- Nnanwube, I. A dan Onukwuli, O. D. (2018). *Hydrometallurgical Processing of a Nigerian Galena Ore in Nitric Acid: Characterization and Dissolution Kinetics*. *Department of Chemical Engineering*. Nnamdi Azikiwe University. Awka, Nigeria.
- Oishi, T., Yaguchi, M., Koyama, K., Tanaka, M., & Lee, J. C. (2008). Effect of phosphate on lead removal during a copper recycling process from wastes using ammoniacal chloride solution. *Hydrometallurgy*, 90(2–4), 161–167. <https://doi.org/10.1016/j.hydromet.2007.10.008>
- Othmer, Kirk. (2005). *Encyclopedia of Chemical Technology*. Fourth Edition. John Wiley & Sons. New York.
- Parod, R. J. (2014). *Encyclopedia of Toxicology*. In *Encyclopedia of Toxicology: Third Edition*. <https://doi.org/10.1016/B978-0-12-386454-3.00191-3>
- Prabowo, S. A., Rosana, M. F., & Haryanto, A. D. (2018). *Hubungan Zona Mineralisasi Bijih dengan Kadar Tinggi Au-Ag Sistem Epitermal Urat Cijiwa, Kecamatan Simpenan,*

Kabupaten Sukabumi, Provinsi Jawa Barat. 139–144.

- Prasetyo, P. H. (2006). Penentuan Ion Logam Cr Dalam Air Tangki Reaktor Menggunakan Metode Spektrofotometri UV-Vis. *Journal of Chemical Information and Modeling*, 53(9), 1689–1699.
- Prayudo, A. N., Novian, O., Setyadi, & Antaresti. (2015). Koefisien Transfer Massa Kurkumin Dari Temulawak. *Jurnal Ilmiah Widya Teknik*, 14(1), 26–31.
- Puente-Siller, D. M., Fuentes-Aceituno, J. C., & Nava-Alonso, F. (2014). Study of thiosulfate leaching of silver sulfide in the presence of EDTA and sodium citrate. Effect of NaOH and NH₄OH. *Hydrometallurgy*, 149, 1–11. <https://doi.org/10.1016/j.hydromet.2014.06.004>
- Puente-Siller, D. M., Fuentes-Aceituno, J. C., Nava-Alonso, F., A. Uribe-Salas, R. Perez-Garibay, V.J. Martinez-Gomez (2020). *A Phenomenological study of the silver sulfide passivation and oxidative degradation of thiosulfate in the thiosulfate-ammonia-copper-citrate leaching system.*
- Rahman, Reza. (2008). Pengaruh Proses Pengeringan, Anil dan Hidrotermal Terhadap Kristalinitas Nanopartikel TiO₂ Hasil Proses Sol-Gel. Depok
- Saputri, Denis H. (2013). Anatomi Akar Kecubung (*Datura Metel L.*) Setelah Terpapar Logam Berat Tembaga. Universitas Gadjah Mada.
- Sari, R. J., Panggabean, A. S., & Erwin. (2016). Pemanfaatan Resin Ca-Alginat Termodifikasi Dengan Etilena Diamamine Tetraasetat (EDTA) Dalam Tahapan Prakonsentrasi Ion Mn(II) Berbasis Metode Kolom. *Jurnal Atomik*, 1(01), 28–35.
- Shijie Li., Wang, C., Liu, Y., Xue, B., Jiang, W., Liu, Y., Mo, L., dan Chen, X. (2021). *Photocatalytic Degradation Of Antibiotics Using A Novel Ag/Ag₂S/Bi₂MoO₆ Plasmonic P-N Heterojunction Photocatalyst: Mineralization Activity, Degradation Pathways and Boosted Charge Separation Mechanism. Chemical Engineering Journal.*
- Slot, H. A. van der. (1997). *Harmonization of Leaching Extraction Tests.*
- Smit, D. (2001). *CHAPTER2 2.1 Hydrometallurgy 2. 2 Leaching 2.3 Sulphide minerals containing nickel, copper and cobalt 2.4 Familiar extracting and refining processes for nickel sulphides 2.5 Fundamentals of sulphide leaching 2.6 Previous investigation on nickel, copper a. 4–32.*
- Soltani, N., Saion, E., Hussein, M. Z., Erfani, M., Abedini, A., Bahmanrokh, G., Navasery, M., dan Vaziri, P. (2012). *Visible Light-Induced Degradation of Methylene Blue in the Presence of Photocatalytic ZnS and CdS Nanoparticles. International Journal of Molecular Sciences. ISSN 1422-0067*
- Suratman. (2009). *Studi Konsumsi Tiosulfat Pada Proses Ekstraksi. 5(3), 114–120.*

- Treybal, R. . (1981). *Mass Transfer Operations*.
- Ullman, U. (2005). *Ullmann's Encyclopedia*.
- Vangronsveld, J., and S.D. Cunningham. (1998). *Metal Contaminated Soils: In Situ Inactivation and Phytorestoration*. Springer-Verlag. Berlin
- Wanta, K. C., Eng, M., Susanti, R. F., & Ph, D. (2017). *Studi Kinetika Proses Leaching Nikel Laterit Dalam Suasana Asam Pada Kondisi Atmosferis*. 1–30.
- Warono, D., & Syamsudin. (2013). Analisis Kimia Kuantitatif. Ed ke-5. *Konversi*, 2(2), 57–65.
- Warren, G. W., Kim, S. hyo, & Henein, H. (1987). The effect of chloride ion on the ferric chloride leaching of galena concentrate. *Metallurgical Transactions B*, 18(1), 59–69. <https://doi.org/10.1007/BF02658432>
- Wu, Z., Dreisinger, D. B., Urch, H., & Fassbender, S. (2014). The kinetics of leaching galena concentrates with ferric methanesulfonate solution. *Hydrometallurgy*, 142, 121–130. <https://doi.org/10.1016/j.hydromet.2013.10.017>
- Xia, C., Yen, W.T. (2008). Effect of lead ions and minerals on thiosulfate-gold *leaching* in hydrometallurgy 2008. In: Young, C.A. Taylor P.R., Anderson, C.A., Choi, Y. (Eds), Proceedings of the Sixth International Symposium. Society for Mining, Metallurgy and Eploration. Inc. Littleton. Co., pp: 760-768
- Yuwono. (2010). Pandemi Resistensi Antimikroba: Belajar dari MRSA. *Jurnal Kedokteran Dan Kesehatan*, 1(42), 2837–2850.
- Zhang, W. G. dan Li, Y.L. (1997). Ammonium thiosulfate *leaching* of gold and silver from complex sulfide concentrates containing precious metals. *Hydrometallurgy*. 41(3) : 67-71.
- Zipperian, D dan Raghavan, D. (1988). *Gold and Silver Extraction by Ammonical Thiosulfate Leaching from a Rhyolite Ore*. Department of Materials Science and Engineering. University of Arizona, Tuscon, AZ 85721