

REFERENCES

- Adinugraha, W., Sulaksana, N., Hendarmawan, Santoso, B., Umar, D.F., & Amalia F., 2018. Washing Test of Kendilo Coal Using Sink-Float Method to Improve Its Quality. *Indonesia Mining Journal*, 21(1), pp. 35-44.
- ASTM, 2010. *Standard Test Methods for Proximate Analysis of the Analysis Sample of Coal and Coke by Instrumental Procedures*. s.l.:American Society for Testing Material.
- ASTM, 2017. *Standard Test Method for Moisture in The Analysis Sample of Coal and Coke (ASTM D3173/D3173M-17a)*. s.l.:American Society for Testing Material.
- ASTM, 2018. *Standard Test Method for Ash in the Analysis Sample of Coal and Coke (ASTM D3174-12(2018e1))*. s.l.:American Society for Testing Material.
- ASTM, 2018. *Standard Test Method Sulfur in the Analysis Sample of Coal and Coke Using High-Temperature Tube Furnace Combustion (ASTM D4239-18e1)*. s.l.:American Society for Testing Material.
- ASTM, 2020. *Standard Test Method for Volatile Matter in The Analysis Sample of Coal and Coke*. s.l.:American Society for Testing Material.
- Brotowati, S., Sofia, I. & Saleh, M., 2019. *Proses Upgrading Batubara Patappa, Kecamatan Pujananting, Kabupaten Barru, Sulawesi Selatan*. Makassar, Prosiding Seminar Nasional Penelitian & Pengabdian Kepada Masyarakat.
- Cheng, W., Zhang, Q., Yang, R. & Tian, Y., 2014. Occurrence Modes and Cleaning Potential of Sulfur and Some Trace Elements in a High-sulfur Coal from Pu'an coalfield, SW Guizhou, China. *Environmental Earth Science*, Volume 72, pp. 35-46.
- Dai, S. & Finkelman, R. B., 2018. Coal as a Promising Source of Critical Elements: Progress and Future Prospects. *International Journal of Coal Geology*, Volume 186, pp. 155-164.

- Dai, S., Finkelman, R. B., French, D., Hower, J.C., Graham, I.T., & Zhao, F., 2021. Modes of Occurrence of Elements in Coal: A Critical Evaluation. *Earth-Science Reviews*, Volume 222.
- ESDM, 2020. *Laporan Kinerja 2020*. Jakarta: Direktorat Jenderal Mineral dan Batubara Kementerian Energi dan Sumberdaya Mineral.
- Finkelman, R. B., Palmer, C. A. & Wang, P., 2018. Quantification of the Modes of Occurrence of 42 Elements in Coal. *International Journal of Coal Geology*, Volume 185, pp. 138-160.
- Foley, N. K., Jaskula, B. W., Kimball, B. E. & Schulte, R. F., 2017. Gallium. In: K. J. Schulz, J. H. DeYoung, R. R. Seal II & D. C. Bradley, eds. *Critical Mineral Resources of the United States-Economic and Environmental Geology and Prospects for Future Supply*. Virginia: U.S. Geological Survey, pp. 235-269.
- Graedel, T. E., Gunn, G. & Espinoza, L. T., 2014. Metal resources, use and criticality. In: G. Gunn, ed. *Critical Metals Handbook*. Nottingham: British Geological Survey, pp. 1-18.
- Groppo, J., 2017. An Introduction to the Nature of Coal. In: T. Robl, A. Oberlink & R. Jones, eds. *Coal Combustion Products (CCP's)*. s.l.:Woodhead Publishing, pp. 3-20.
- He, H.T., Wang, J.X., Xing, L.C., Zhao, S.S., He, M.Y., Zhao, C.L., & Sun, Y.Z., 2020. Enrichment Mechanisms of Lithium in the No. 6 Coal Seam from The Guanbanwusu Mine, Inner Mongolia, China: Explanations based on Li Isotope Values and Density Fractional Theory Calculations. *Journal of Geochemical Exploration*, Volume 213.
- Huang, J., Wang, Y., Zhou, G. & Gu, Y., 2020. Exploring a Promising Technology for The Extraction of Gallium from Coal Fly Ash. *International Journal of Coal Preparation and Utilization*.
- Jakobsson, L. K., Kennedy, M. W., Aune, R. E. & Tranell, G., 2016. *Recovery of Rare Earth Elements From The Ferrous Fraction of Electronic Waste*. s.l., REWAS 2016: Towards Materials Resource Sustainability, pp. 89-93.
- Jones, J. V. I., Piatak, N. M. & Bedinger, G. M., 2017. Zirconium and Hafnium. In: K. J. Schulz, J. H. J. DeYoung, R. R. I. Seal & D. C. Bradley, eds. *Critical*

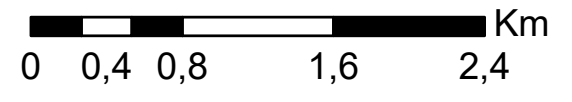
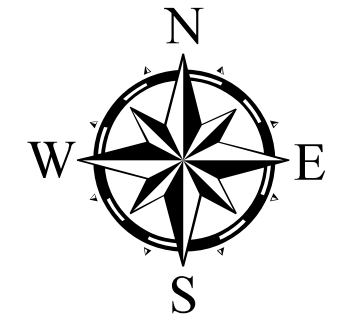
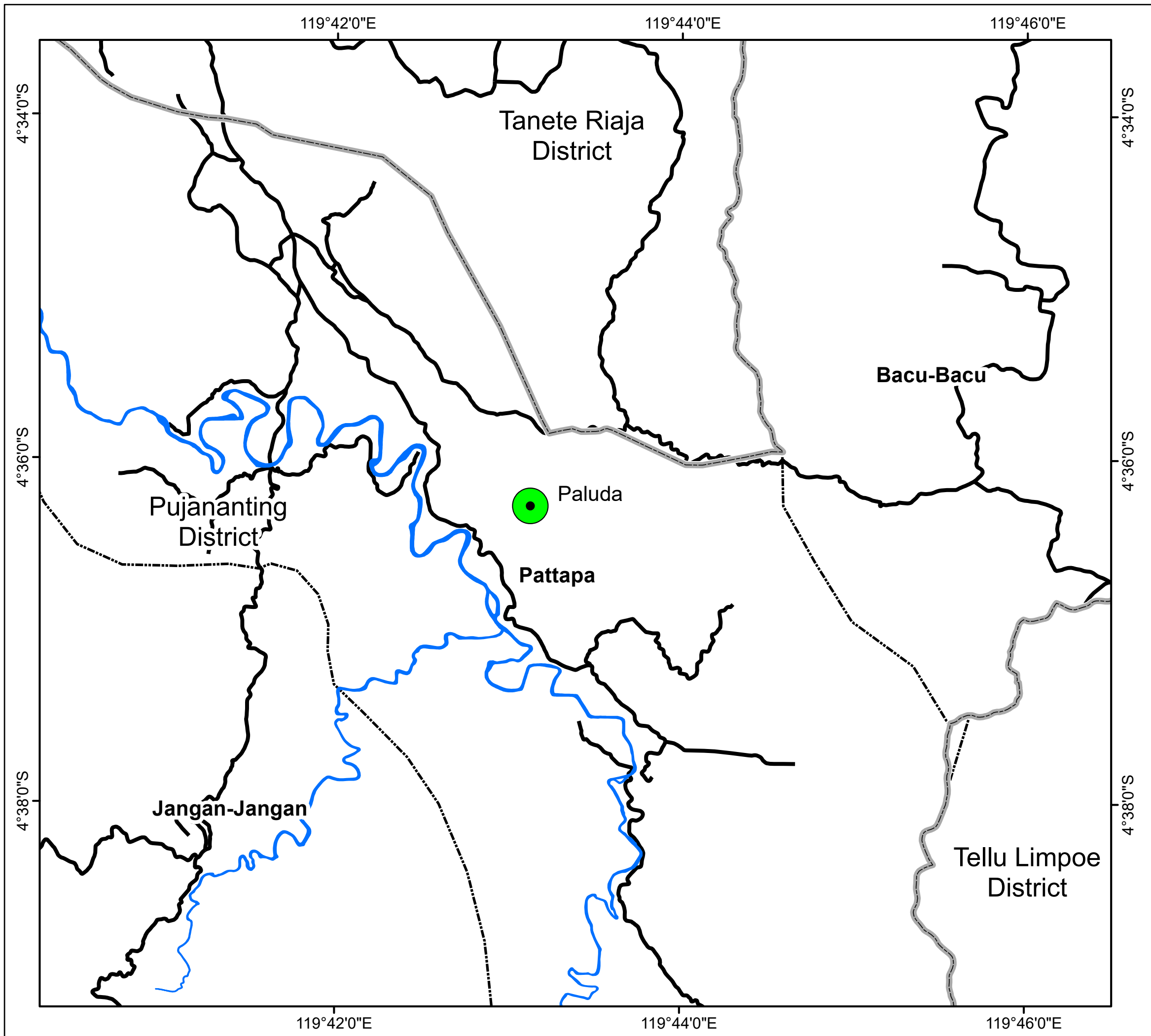
- mineral resources of the United States—Economic and environmental geology and prospect for future Supply*. Virginia: U.S. Geological Survey, pp. V1-V26.
- Jyothi, R. K. & Kumar, P. P., 2021. *Clean Coal Technologies: Beneficiation, Utilization, Transport, Phenomena and Prospective*. Switzerland: Springer.
- Katoh, K., 2011. *Executive Course: Thermal Coal & Sub-Bituminous Coal*. Jakarta: APBI-ICMA.
- Kelley, K. D., Scott, C. T., Polyak, D. E. & Kimball, B. E., 2017. Vanadium. In: K. J. Schulz, J. H. J. DeYoung, R. R. I. Seal & D. C. and Bradley, eds. *Critical Mineral Resources of the United States—Economic and Environmental Geology and Prospects for Future Supply*. Virginia: U.S. Geological Survey, pp. 767-804.
- Kelly, E. G. & Spottiswood, D. J., 1982. *Introduction to Mineral Processing*. Canada: Wiley-interscience Publication.
- Ketris, M. & Yudovich, Y. E., 2009. Estimations of Clarkes for Carbonaceous biolithes: World averages for trace element contents in black shales and coals. *International Journal of Coal Geology*, Volume 78, pp. 135-148.
- Kurniawan, A. R., Surono, W. & Alimano, M., 2014. Potensi Pemanfaatan Limbah Pembakaran Batubara PLTU sebagai Media Tanam dalam Kegiatan Revegetasi Lahan Bekas Tambang Batubara. *Jurnal Teknologi Mineral dan Batubara*, 10(3), pp. 142-154.
- Lanzerstorfer, C., 2018. Pre-processing of coal combustion fly ash by classification for enrichment of rare earth elements. *Energy Reports*, Volume 4, pp. 660-663.
- Lin, R., Howard, B.H., Roth, E.A., Bank, T.L., Granite, E.J., Soong, Y., Enrichment of Rare Earth Elements from Coal and Coal By-Products by Physical Separations, *Fuel*, Volume 200, pp. 506-520.
- Malaidji, E., Anshariah & Budiman, A. A., 2018. Analisis Proksimat, Sulfur, dan Nilai Kalor dalam Penentuan Kualitas Batubara di Desa Patappa, Kecamatan Pujananting, Kabupaten Barru, Provinsi Sulawesi Selatan. *Jurnal Geomine*, 6(3), pp. 131-137.

- Mayfield, D. B. & Lewis, A. S., 2013. *Environmental Review of Coal Ash as a Resource for Rare Earth and Strategic Elements*. Kentucky, World Coal of Ash (WOCA) Conference.
- Michelis, I. D., Ferella, F., Varelli, E. F. & Veglio, F., 2011. Treatment of exhaust fluorescent lamps to recover yttrium: Experimental and process analyses. *Waste Management*, Volume 31, pp. 2559-2568.
- Petroleum, B., 2020. *Statistical Review of World Energy*. 69 ed. England: s.n.
- Priyono, Hidayat, R. & Suryana, A., 2014. *Penyelidikan Pendahuluan Endapan Batubara Daerah Patappa Kabupaten Barru Provinsi Sulawesi Selatan*, s.l.: Publikasi Kementerian Energi dan Sumber Daya Alam.
- Qin, S., Zhao, C., Li, Y. & Zhang, Y., 2015. Review of Coal as a Promising Source of Lithium. *International Journal Oil, Gas and Coal Technology*, 9(2), pp. 215-229.
- Rao, D. S. & Gouricharan, T., 2016. *Coal Processing and Utilization*. India: CRC Press/Balkema.
- Rao, D. V. S., 2016. *Minerals and Coal Process Calculations*. Leiden: CRC Press/Balkema.
- Rao, Z., Zhao, Y., Huang, C., Duan, C. & He, J., 2015. Recent Developments in Drying and Dewatering for Low Rank Coals. *Progress in Energy and Combustion Science*, Volume 46, pp. 1-11.
- Sanwani, E., Ibrahim, A., Sudarsono, A., Sule, D. & Handayani I., 1998. *Pencucian Batubara*. Ciloto: Diklat Pencucian Batubara.
- Schmidt, M., 2012. *Resource efficiency – what are critical metals and how scarce are they?*. Germany, Electronic Display Conference.
- Schober, P., Boer, C. & Schwarte, L. A., 2018. Correlation Coefficients: Appropriate Use and Interpretation. *Anesthesia and Analgesia*.
- Schulz, K. J., DeYoung Jr, J. H., Bradley, D. C. & Seal II, R. R., 2017. Critical Mineral Resources of United States-An Introduction. In: K. J. Schulz, J. H. DeYoung Jr, D. C. Bradley & R. R. Seal II, eds. *Critical Mineral Resources of the United States—Economic and Environmental Geology and Prospects for Future Supply*. Virginia: U.S. Geological Survey, pp. A1-A11.

- Seredin, V. V. & Dai, S., 2012. Coal Deposits as Potential Alternative Sources for Lanthanides and Yttrium. *International Journal of Coal Geology*, Volume 94, pp. 67-93.
- Singh, A. K., Banerjee, P. K., Singh, P. K. & Das, A., 2015. Study of Washability Characteristic of Coals from Seam-IX of Jamadoba Colliery of the Jharia Basin, India. *Energy Exploration & Exploitation*, 33(2), pp. 181-202.
- Speight, J. G., 2005. *Handbook of Coal Analysis*. New Jersey: John Wiley & Sons, Inc..
- Straka, P. & Nahunkova, J., 2004. Possible Organometallic Structures in The Coal Substance of Czech Coals. *Acta Geodynamica et Geomaterialia*, 1(2), pp. 245-251.
- Survey, K. G., 2020. *University of Kentucky*. [Online] Available at: <https://www.uky.edu/KGS/coal/coal-analyses-float-sink.php> [Accessed 17 October 2020].
- Thomas, L., 2013. *Coal Geology*. 2nd ed. West Sussex: John Wiley & Sons, Ltd.
- Vejahati, F., Xu, Z. & Gupta, R., 2010. Trace Elements in Coal: Associations with Coal and Minerals and Their Behaviour During Coal Utilization - A review. *Fuel*, Volume 89, pp. 904-911.
- Wang, X., Wang, X., Pan, Z., Pan, W., Yin, X., Chai, P., Pan, S., & Yang, Q., 2019. Mineralogical and Geochemical Characteristics of the Permian Coal from the Qinshui Basin, Northern China, with Emphasis on Lithium Enrichment. *International Journal of Coal Geology*, Volume 214.
- Wardhany, F. A., Triantoro, A. & Hakim, R. N., 2018. Kajian Teknis Coal Washing Plant di PT Bahari Cakrawala Sebuku, Kabupaten Kotabaru, Provinsi Kalimantan Selatan. *Geosapta*, 4(2), pp. 105-111.
- Watari, T., Nansai, K. & Nakajima, K., 2020. Review of Critical Metal Dynamics to 2050 for 48 Elements. *Resources, Conservation & Recycling*, Volume 155.
- Wei, C., Ruidong, C., Qin, Z., Baojiang, L., & Yujua, J., 2018. Washability and Distribution Behaviors of Trace Elements of a High-Sulfur Coal, SW Guizhou, China. *Minerals*, Volume 8, pp. 59-74.

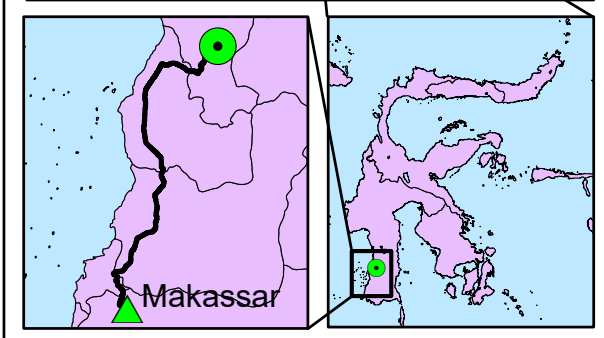
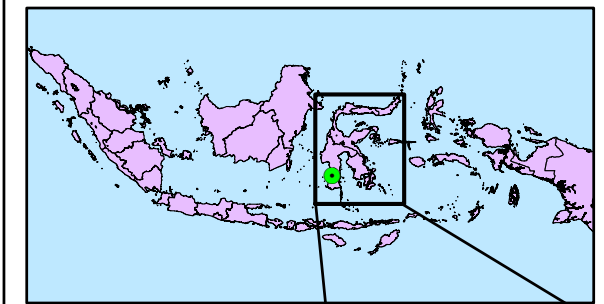
- Widodo, S., Oshcmann, W., Bechtel, A., Sachsenhofer, R.F., Anggayana, K., & Puettmann, W., 2010. Distribution of sulfur and pyrite in coal seams from Kutai Basin (East Kalimantan, Indonesia): Implications for paleoenvironmental conditions. *International Journal of Coal Geology*, Volume 81, pp. 151-162.
- Widodo, S., Sufriadin, Imai, A. & Anggayana, K., 2017. Characterization of Some Coal Deposits Quality by Use of Proximate and Sulfur Analysis in the Southern Arm Sulawesi, Indonesia. *International Journal of Engineering and Science Applications*, 3(2), pp. 137-143.
- Xia, W., Xie, G. & Peng, Y., 2015. Recent Advances in Beneficiation for Low Rank Coals. *Powder Technology*, Volume 277, pp. 205-221.
- Zhang, B., Gao, Z., Liu, H., Wang, W., & Cao, Y., 2017. Direct Acid Leaching of Vanadium from Stone Coal. *High Temperature Material and Processes*, 36(9), pp. 877-883.
- Zhang, W., Noble, A., Yang, X. & Honaker, R., 2020. A Comprehensive Review of Rare Earth Elements Recovery from Coal-Related Materials. *Minerals*, 451(10).
- Zhang, W., Rezaee, M., Bhagavatula, A., Li, Y., Groppo, J., & Honaker, R., 2015. A Review of the Occurrence and Promising Recovery Methods of Rare Earth Elements from Coal and Coal By-Products. *International Journal of Coal Preparation and Utilization*, 35(6), pp. 295-330.
- Zhang, Z., Yang, J., Wang, Y., Xia, W., & Ling, X., 2011. A Study on Fast Predicting the Washability Curve of Coal. *Procedia Environmental Sciences*, Volume 11, pp. 1580-1584.

APPENDIX A SAMPLING LOCATION MAP



Legends

- Sampling Location
- River
- Road
- Village Border
- District Border



**SAMPLING LOCATION MAP
PATTAPA VILLAGE,
PUJANANTING DISTRICT,
BARRU REGENCY,
SULAWESI SELATAN PROVINCE**

**APPENDIX B PROXIMATE, TOTAL SULFUR, AND
CALORIFIC VALUE ANALYSIS**

Sample Code	Weight of Crucible without cover (g)	Weight of Crucible without cover + Sample (g)	Weight of Crucible without cover + Sample after 105°C (g)	Weight of Crucible without cover + Sample after 815°C (g)	Weight of Crucible with cover (g)	Weight of Crucible with cover + sample (g)	Weight of Crucible with cover + sample after 950°C (g)
	A	B	C	D	E	F	G
Raw Coal	10.3865	11.3865	11.3094	10.4619	18.3001	19.3006	18.869

a. Moisture Content

$$\begin{aligned}
 \text{Moisture (\%)} &= \left[\frac{(\text{grams of sample used} - \text{grams of sample after heating } 105^\circ\text{C})}{\text{grams of sample used}} \times 100 \right] \\
 &= \left[\frac{(B-A)-(C-A)}{(B-A)} \times 100 \right] \\
 &= \left[\frac{(11.3865-10.3865)-(11.3094-10.3865)}{(11.3865-10.3865)} \times 100 \right] = \frac{1-0.9229}{1} \times 100 = \mathbf{7.71\%}
 \end{aligned}$$

b. Ash Content

$$\begin{aligned}
 \text{Ash (\%)} &= \left[\frac{(\text{grams of capsule and ash residue} - \text{grams of empty capsule})}{\text{grams of analysis sample used}} \times 100 \right] \\
 &= \left[\frac{(D-A)}{(C-A)} \times 100 \right] \\
 &= \left[\frac{(10.4619-10.3865)}{(11.3094-10.3865)} \times 100 \right] = \frac{0.0754}{0.9229} \times 100 = \mathbf{8.17\%}
 \end{aligned}$$

c. Volatile Matter

$$\begin{aligned}
 \text{Weight Loss (\%)} &= \left[\frac{(\text{grams of sample used} - \text{grams of sample after heating})}{\text{grams of sample used}} \times 100 \right] \\
 &= \left[\frac{(F-E)-(G-E)}{(F-E)} \times 100 \right] \\
 &= \left[\frac{(19.3006-18.3001)-(18.8690-18.3001)}{(19.3006-18.3001)} \times 100 \right] = \frac{1.0005-0.5689}{1.0005} \times 100 = \mathbf{43.14\%}
 \end{aligned}$$

$$\begin{aligned}
 \text{Volatile Matter (\%)} &= \text{Weight Loss (\%)} - \text{Moisture (\%)} = 43.14 - 7.71 \\
 &= \mathbf{35.43\%}
 \end{aligned}$$

d. Fixed Carbon

$$\begin{aligned}
 \text{Fixed Carbon (\%)} &= 100 - [\text{Moisture (\%)} + \text{Ash (\%)} + \text{Volatile Matter (\%)}] \\
 &= 100 - [7.71 + 8.17 + 35.43] = \mathbf{48.49\%}
 \end{aligned}$$



Kantor Penerbit:
Jl. Urip Sumoharjo No. 90 A, Makassar 90232
Telp./Faksimili: 0411 451890/451796
Email: makassar@sucofindo.co.id

LAPORAN ANALISIS

PELANGGAN : AKMAL SAPUTNO
Jl. Poros Malino, Gowa

SAMPEL : BATUBARA

ANALISIS / UJI : TOTAL SULFUR

TANGGAL TERIMA : 26/03/2022

TANGGAL ANALISA : 26/03/2022 to 26/03/2022

DESKRIPSI SAMPEL : Bentuk : Bubuk
Berat : ± 5 gram

Hasil:

Kode Sampel	Satuan	Hasil	Metode
Raw Coal	%	3,07	ASTM D – 4239 – 2018
PD-A	%	1,91	ASTM D – 4239 – 2018
PD-B	%	1,89	ASTM D – 4239 – 2018
PD-C	%	3,29	ASTM D – 4239 – 2018
PD-D	%	5,72	ASTM D – 4239 – 2018
PD-E	%	11,10	ASTM D – 4239 – 2018
PD-F	%	15,20	ASTM D – 4239 – 2018

HASIL ANALISA TERSEBUT DIATAS HANYA MERUJUK PADA SAMPLE YANG DISERAHKAN
DIMANA PENGAMBILAN SAMPLE TERSEBUT TIDAK DILAKUKAN OLEH SUCOFINDO

Penerbitan Sertifikat/Laporan ini tunduk pada Syarat dan Ketentuan Umum layanan jasa PT. SUCOFINDO (PERSERO), yang salinannya dapat diperoleh atas permintaan atau dapat diakses pada www.sucofindo.co.id

Bidang Inspeksi & Pengujian


SUCOFINDO
Achmad



**LABORATORIUM MOTOR BAKAR
DEPARTEMEN TEKNIK MESIN
UNIVERSITAS HASANUDDIN
FAKULTAS TEKNIK**

Jalan Poros Malino Km.6 Bontomarannu (92171) Gowa Sulawesi Selatan
Telp. (0411) 586015, 586162 Fax (0411) 586015

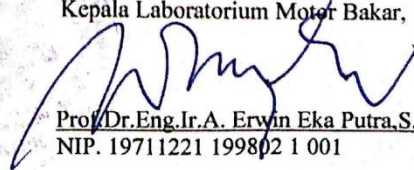
SURAT KETERANGAN HASIL ANALISIS SAMPEL

Nomor : 24/LMB-FT/UH/2022

Pengirim : Irlansyah Mulia Putra
NIM : D111171312
Parameter Uji : Nilai Kalor
Peralatan : Bomb Kalorimeter
Jenis Sampel : Batu Bara
Tanggal Uji : 3 Pebruari 2022

No.	Kode Sampel	Nilai Kalor (Kalori/Gram)
1.	BBACVA	5.902

Makassar, 10 Maret 2022
Kepala Laboratorium Motor Bakar,


Prof. Dr. Eng. Ir. A. Erwin Eka Putra, S.T., M.T.
NIP. 19711221 199802 1 001

Dipindai dengan CamScanner

APPENDIX C CALCULATION OF HEAVY LIQUID RATIO

a. For density 1.2 g/cm³

- $C_{V1} \times \rho_1 + (1 - C_{V1}) \times \rho_2 = \rho_{12}$
- $C_{V1} \times 0.6 + (1 - C_{V1}) \times 1.62 = 1.2$
- $(0.6 - 1.62)C_{V1} + 1.62 = 1.2$
- $1.62 - 1.02C_{V1} = 1.2$
- $1.02 C_{V1} = 1.62 - 1.2$
- $C_{V1} = 0.42/1.02$
- $C_{V1} = 0.412$

Then the required volume is:

- $1 - C_{V1} = C_{V2} \rightarrow 1 - 0.412 = 0.588$
- Vol. wash benzene (V1) = $0.412 \times 500 = 206$ ml
- Vol. perchloroethylene (V2) = $0.588 \times 500 = 294$ ml

b. For density 1.3 g/cm³

- $C_{V1} \times \rho_1 + (1 - C_{V1}) \times \rho_2 = \rho_{12}$
- $C_{V1} \times 0.6 + (1 - C_{V1}) \times 1.62 = 1.3$
- $(0.6 - 1.62)C_{V1} + 1.62 = 1.3$
- $1.62 - 1.02C_{V1} = 1.3$
- $1.02 C_{V1} = 1.62 - 1.3$
- $C_{V1} = 0.32/1.02$
- $C_{V1} = 0.314$

Then the required volume is:

- $1 - C_{V1} = C_{V2} \rightarrow 1 - 0.314 = 0.686$
- Vol. wash benzene (V1) = $0.314 \times 500 = 157$ ml
- Vol. perchloroethylene (V2) = $0.686 \times 500 = 343$ ml

c. For density 1.4 g/cm³

- $C_{V1} \times \rho_1 + (1 - C_{V1}) \times \rho_2 = \rho_{12}$
- $C_{V1} \times 0.6 + (1 - C_{V1}) \times 1.62 = 1.4$
- $(0.6 - 1.62)C_{V1} + 1.62 = 1.4$
- $1.62 - 1.02C_{V1} = 1.4$
- $1.02 C_{V1} = 1.62 - 1.4$
- $C_{V1} = 0.22/1.02$
- $C_{V1} = 0.216$

Then the required volume is:

- $1 - C_{V1} = C_{V2} \rightarrow 1 - 0.216 = 0.784$
- Vol. wash benzene (V1) = $0.216 \times 500 = 108$ ml
- Vol. perchloroethylene (V2) = $0.784 \times 500 = 392$ ml

d. For density 1.4 g/cm³

- $C_{V1} \times \rho_1 + (1 - C_{V1}) \times \rho_2 = \rho_{12}$
- $C_{V1} \times 0.6 + (1 - C_{V1}) \times 1.62 = 1.5$
- $(0.6 - 1.62)C_{V1} + 1.62 = 1.5$

Then the required volume is:

- $1 - C_{V1} = C_{V2} \rightarrow 1 - 0.118 = 0.882$
- Vol. wash benzene (V1) = $0.118 \times 500 = 59$ ml

➤ $1.62 - 1.02C_{V1} = 1.5$

➤ $1.02 C_{V1} = 1.62 - 1.5$

➤ $C_{V1} = 0.12/1.02$

➤ $C_{V1} = 0.118$

e. For density 1.6 g/cm^3

➤ $C_{V1} \times \rho_1 + (1 - C_{V1}) \times \rho_2 = \rho_{12}$

➤ $C_{V1} \times 0.6 + (1 - C_{V1}) \times 1.62 = 1.6$

➤ $(0.6 - 1.62)C_{V1} + 1.62 = 1.6$

➤ $1.62 - 1.02C_{V1} = 1.6$

➤ $1.02 C_{V1} = 1.62 - 1.6$

➤ $C_{V1} = 0.02/1.02$

➤ $C_{V1} = 0.020$

➤ Vol. perchloroethylene (V2)=
 $0.882 \times 500 = 441 \text{ ml}$

Then the required volume is:

➤ $1 - C_{V1} = C_{V2} \rightarrow 1 - 0.020 = 0.980$

➤ Vol. wash benzene (V1) = $0.020 \times 500 = 10 \text{ ml}$

➤ Vol. perchloroethylene (V2)=
 $0.980 \times 500 = 490 \text{ ml}$

APPENDIX D CHEMICAL ANALYSIS RESULT



ALS Canada Ltd.
 2103 Dollarton Hwy
 North Vancouver BC V7H 0A7
 Phone: +1 604 984 0221 Fax: +1 604 984 0218
 www.alsglobal.com/geochemistry

To: HASANUDDIN UNIVERSITY
 POROS MALINO ST. KM6
 GOWA 92171
 INDONESIA

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 Finalized Date: 1-JAN-2022
 This copy reported on
 10-JAN-2022
 Account: HASUNI

CERTIFICATE VA21325575

Project: Coal, Clay and Rock chemistry

This report is for 11 samples of Pulp submitted to our lab in Vancouver, BC, Canada on 26-NOV-2021.

The following have access to data associated with this certificate:

TRI ANDRIANI HS KANDORA	AKMAL SAPUTNO
-------------------------	---------------

SAMPLE PREPARATION	
ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
DIS-PUL21	Disposal of M/+ Split after analysis.
LOG-24	Pulp Login - Rcd w/o Barcode
TRA-21	Transfer sample

ANALYTICAL PROCEDURES		
ALS CODE	DESCRIPTION	INSTRUMENT
ME-4ACD81	Base Metals by 4-acid diq.	ICP-AES
ME-OG62	Ore Grade Elements - Four Acid	ICP-AES
Cu-OG62	Ore Grade Cu - Four Acid	
ME-ICP41	35 Element Aqua Regia ICP-AES	ICP-AES
OA-GRA05x	LOI at 1000C for XRF	WST-SEQ
ME-ICP06	Whole Rock Package - ICP-AES	ICP-AES
TOT-ICP06	Total Calculation for ICP06	
OA-GRA05	Loss on Ignition at 1000C	WST-SEQ
ME-MS81	Lithium Borate Fusion ICP-MS	ICP-MS
ME-AQ81	Base Metals by Aqua Regia diq.	ICP-AES

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.
 ***** See Appendix Page for comments regarding this certificate *****
 Comments: PROJECT NAME: Coal, Clay and Rock chemistry analysis

Signature: 
 Saa Traxler, General Manager, North Vancouver



ALS Canada Ltd.
 2103 Dollarton Hwy
 North Vancouver BC V7H 0A7
 Phone: +1 604 984 0221 Fax: +1 604 984 0218
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Project: Coal, Clay and Rock chemistry

CERTIFICATE OF ANALYSIS VA21325575

Method Analyte Units LOD	WEI-21 Recvd Wt. kg	ME-MS81 Ba ppm	ME-MS81 Ce ppm	ME-MS81 Cr ppm	ME-MS81 Cs ppm	ME-MS81 Dy ppm	ME-MS81 Er ppm	ME-MS81 Eu ppm	ME-MS81 Ga ppm	ME-MS81 Gd ppm	ME-MS81 Hf ppm	ME-MS81 Ho ppm	ME-MS81 La ppm	ME-MS81 Lu ppm	ME-MS81 Nb ppm
Sample Description	0.02	0.5	0.1	10	0.01	0.05	0.03	0.02	0.1	0.05	0.1	0.01	0.1	0.01	0.1
PD-A	<0.02	18.2	5.4	10	0.02	0.83	0.63	0.27	1.4	1.03	0.1	0.21	2.7	0.05	0.1
PD-B	0.02	9.6	11.9	30	0.03	2.77	1.75	0.64	2.6	2.80	0.1	0.57	5.3	0.17	0.1
PD-C	0.02	18.4	10.8	40	0.30	3.91	2.73	0.71	4.7	2.89	0.4	0.76	4.6	0.29	0.7
PD-D	0.02	27.0	10.6	40	0.62	3.89	2.49	0.64	5.7	2.70	1.0	0.81	4.7	0.32	1.8
PD-E	0.02	39.0	9.2	40	1.12	2.42	1.73	0.50	5.3	1.76	1.2	0.57	4.1	0.27	2.1
PD-F	0.02	107.5	8.6	40	2.75	1.54	1.04	0.28	6.9	1.09	1.7	0.31	4.4	0.17	3.1
PD-G	0.02	34.2	9.1	30	0.38	1.96	1.30	0.50	3.1	1.92	0.4	0.45	4.3	0.14	0.5
PD-H	0.02	126.0	40.2	100	4.66	2.96	2.02	0.84	11.9	3.22	6.2	0.61	18.3	0.31	7.9
ST-9-AZ	0.02	92.8	61.4	50	0.05	17.20	11.20	4.76	146.5	21.2	1.6	3.26	46.5	2.02	0.7
ST-9-ML	0.02	18.1	10.5	10	0.01	11.80	6.56	2.62	68.9	12.85	0.1	2.39	7.6	0.62	0.1
ST-9-OK	0.02	4.2	7.2	50	0.02	2.00	1.05	0.48	50.6	1.66	0.7	0.37	2.0	0.12	0.3

Comments: PROJECT NAME: Coal, Clay and Rock chemistry analysis

***** See Appendix Page for comments regarding this certificate *****



ALS Canada Ltd.
 2103 Dollarton Hwy
 North Vancouver BC V7H 0A7
 Phone: +1 604 984 0221 Fax: +1 604 984 0218
 www.alsglobal.com/geochemistry

To: HASANUDDIN UNIVERSITY
 POROS MALINO ST. KM6
 GOWA 92171
 INDONESIA

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 Total # Pages: 2 (A - E)
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 Account: HASUNI

Project: Coal, Clay and Rock chemistry

CERTIFICATE OF ANALYSIS VA21325575

Sample Description	Method Analyte Units LOD	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	ME-MSB1	
		Nd ppm	Pr ppm	Rb ppm	Sm ppm	Sn ppm	Sr ppm	Ta ppm	Tb ppm	Th ppm	Tm ppm	U ppm	V ppm	W ppm	Y ppm	Yb ppm
		0.1	0.02	0.2	0.03	1	0.1	0.1	0.01	0.05	0.01	0.05	5	1	0.1	0.03
PD-A		3.1	0.66	0.3	0.76	<1	137.5	<0.1	0.14	0.23	0.07	0.29	18	<1	8.4	0.37
PD-B		7.2	1.53	0.2	1.92	<1	178.0	<0.1	0.39	0.56	0.22	0.57	26	<1	22.2	1.32
PD-C		7.1	1.48	1.6	2.29	<1	170.0	<0.1	0.53	0.91	0.33	0.88	40	<1	24.4	2.06
PD-D		6.7	1.48	3.8	1.92	<1	108.0	0.1	0.53	1.60	0.34	0.96	53	1	22.1	2.41
PD-E		5.1	1.19	7.8	1.33	<1	81.3	0.1	0.35	1.47	0.24	0.87	39	1	15.2	1.69
PD-F		4.1	1.06	22.1	0.98	<1	79.0	0.2	0.19	1.50	0.15	0.80	38	1	9.4	1.16
PD-G		5.6	1.18	3.8	1.49	<1	115.0	<0.1	0.32	0.70	0.15	0.65	24	1	15.4	1.03
PD-H		19.1	4.58	44.0	3.84	1	76.4	0.5	0.49	5.15	0.31	2.30	73	1	15.5	2.15
ST-9-AZ		115.5	25.8	0.7	23.3	15	122.0	<0.1	2.98	0.16	2.07	1.26	123	1	59.7	15.55
ST-9-ML		37.3	6.07	0.2	10.15	14	22.0	<0.1	1.84	<0.05	0.83	0.53	24	1	72.2	4.82
ST-9-OK		5.6	1.17	0.2	1.46	14	1.9	<0.1	0.30	<0.05	0.15	1.71	147	<1	6.2	0.91

Comments: PROJECT NAME: Coal, Clay and Rock chemistry analysis

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ALS Canada Ltd.
 2103 Dollarton Hwy
 North Vancouver BC V7H 0A7
 Phone: +1 604 984 0221 Fax: +1 604 984 0218
 www.alsglobal.com/geochemistry

To: HASANUDDIN UNIVERSITY
 POROS MALINO ST. KM6
 GOWA 92171
 INDONESIA

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Project: Coal, Clay and Rock chemistry

CERTIFICATE OF ANALYSIS VA21325575

Sample Description	Method Analyte Units LOD	ME-MSB1	ME-AQ81	ME-AQ81	ME-AQ81	ME-AQ81	ME-AQ81	ME-AQ81	ME-AQ81	ME-AQ81	ME-AQ81	ME-AQ81	ME-4ACD81	ME-4ACD81	ME-4ACD81	ME-4ACD81
		Zr ppm	Ag ppm	As ppm	Cd ppm	Co ppm	Cu ppm	Hg ppm	Mo ppm	Ni ppm	Pb ppm	Zn ppm	Ag ppm	As ppm	Cd ppm	Co ppm
		2	0.5	5	0.5	1	1	1	1	1	2	2	0.5	5	0.5	1
PD-A		2	<0.5	31	<0.5	<1	6	<1	<1	2	<2	3				
PD-B		4	<0.5	35	<0.5	1	8	<1	1	3	3	3				
PD-C		14	<0.5	78	<0.5	2	15	<1	1	12	3	3				
PD-D		37	<0.5	160	<0.5	2	20	<1	1	29	4	3				
PD-E		47	<0.5	189	<0.5	2	22	1	2	52	7	3				
PD-F		69	<0.5	385	<0.5	4	26	1	6	111	9	5				
PD-G		15	<0.5	78	<0.5	2	12	1	3	13	4	4				
PD-H		234											<0.5	32	<0.5	1
ST-9-AZ		63											2.5	31	0.7	5
ST-9-ML		5											9.5	35	3.2	1
ST-9-OK		25											16.4	34	<0.5	3

Comments: PROJECT NAME: Coal, Clay and Rock chemistry analysis

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ALS Canada Ltd.
 2103 Dollarton Hwy
 North Vancouver BC V7H 0A7
 Phone: +1 604 984 0221 Fax: +1 604 984 0218
 www.alsglobal.com/geochemistry

To: HASANUDDIN UNIVERSITY
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Project: Coal, Clay and Rock chemistry

CERTIFICATE OF ANALYSIS VA21325575

Sample Description	Method Analyte Units LOD	ME-4ACD81	ME-4ACD81	ME-4ACD81	ME-4ACD81	ME-4ACD81	ME-4ACD81	ME-4ACD81	ME-4ACD81	Cu-OG62	ME-ICP41	ME-ICP41	OA-GRA05x	ME-ICP06	ME-ICP06	ME-ICP06
		Cu ppm	Li ppm	Mo ppm	Ni ppm	Pb ppm	Sc ppm	Tl ppm	Zn ppm	Cu %	Sc ppm	Li ppm	LOI 1000 %	SiO2 %	Al2O3 %	Fe2O3 %
		1	10	1	1	2	1	10	2	0.001	?	10	0.01	0.01	0.01	0.01
PD-A											<1	<10	97.60	0.52	0.25	0.52
PD-B											1	<10	97.03	0.57	0.47	0.53
PD-C											2	<10	91.85	3.15	1.62	2.14
PD-D											2	<10	81.17	9.13	3.08	4.55
PD-E											1	<10	73.23	11.80	4.37	7.55
PD-F											1	<10	50.84	21.5	7.22	17.00
PD-G											1	<10	89.93	4.19	1.48	2.25
PD-H		50	40	2	6	13	11	<10	15				10.01	72.1	12.85	1.06
ST-9-AZ		>10000	<10	113	1	153	6	<10	1710	27.0						
ST-9-ML		>10000	<10	145	5	69	<1	<10	3210	19.00						
ST-9-OK		>10000	<10	568	3	251	2	<10	737	0.995						

Comments: PROJECT NAME: Coal, Clay and Rock chemistry analysis

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ALS Canada Ltd.
 2103 Dollarton Hwy
 North Vancouver BC V7H 0A7
 Phone: +1 604 984 0221 Fax: +1 604 984 0218
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CERTIFICATE OF ANALYSIS VA21325575

Sample Description	Method Analyte Units LOD	ME-ICP06	ME-ICP06	ME-ICP06	ME-ICP06	ME-ICP06	ME-ICP06	ME-ICP06	ME-ICP06	ME-ICP06	ME-ICP06	TOT-ICP06	OA-GRA05
		CaO	MgO	Na2O	K2O	Cr2O3	TiO2	MnO	P2O5	SrO	BaO	Total	LOI
		%	%	%	%	%	%	%	%	%	%	%	%
		0.01	0.01	0.01	0.01	0.002	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PD-A		0.46	0.25	0.02	0.04	0.004	0.01	<0.01	0.01	0.02	<0.01	99.80	97.7
PD-B		0.58	0.31	0.03	0.02	0.006	0.02	<0.01	<0.01	0.02	<0.01	99.76	97.2
PD-C		0.52	0.28	0.07	0.06	0.009	0.09	<0.01	<0.01	0.02	<0.01	99.86	91.9
PD-D		0.33	0.19	0.08	0.12	0.008	0.26	<0.01	<0.01	0.01	<0.01	99.36	81.6
PD-E		0.22	0.19	0.09	0.22	0.009	0.28	<0.01	0.01	0.01	0.01	98.56	73.8
PD-F		0.23	0.29	0.14	0.60	0.008	0.34	0.01	0.01	0.01	0.03	99.29	51.9
PD-G		0.41	0.22	0.04	0.11	0.007	0.06	<0.01	0.01	0.01	<0.01	99.19	90.4
PD-H		0.24	0.36	0.41	1.12	0.018	0.84	<0.01	0.01	<0.01	0.01	100.47	11.45
ST-9-AZ													
ST-9-ML													
ST-9-OK													

Comments: PROJECT NAME: Coal, Clay and Rock chemistry analysis

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ALS Canada Ltd.
2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 604 984 0221 Fax: +1 604 984 0218
www.alsglobal.com/geochemistry

To: HASANUDDIN UNIVERSITY
POROS MALINO ST. KM6
GOWA 92171
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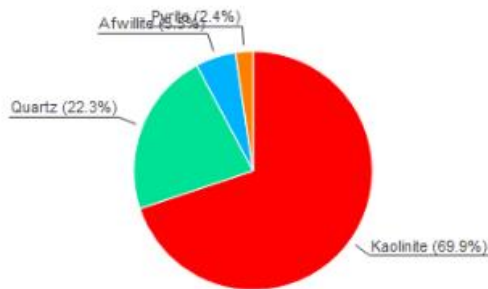
CERTIFICATE OF ANALYSIS VA21325575

	CERTIFICATE COMMENTS																
Applies to Method:	<p style="text-align: center;">LABORATORY ADDRESSES</p> <p>Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.</p> <table><tbody><tr><td>Cu-OG62</td><td>DIS-PUL21</td><td>LOG-24</td><td>ME-4ACD81</td></tr><tr><td>ME-AQ81</td><td>ME-ICP06</td><td>ME-ICP41</td><td>ME-MS81</td></tr><tr><td>ME-OG62</td><td>OA-GRA05</td><td>OA-GRA05x</td><td>TOT-ICP06</td></tr><tr><td>TRA-21</td><td>WEI-21</td><td></td><td></td></tr></tbody></table>	Cu-OG62	DIS-PUL21	LOG-24	ME-4ACD81	ME-AQ81	ME-ICP06	ME-ICP41	ME-MS81	ME-OG62	OA-GRA05	OA-GRA05x	TOT-ICP06	TRA-21	WEI-21		
Cu-OG62	DIS-PUL21	LOG-24	ME-4ACD81														
ME-AQ81	ME-ICP06	ME-ICP41	ME-MS81														
ME-OG62	OA-GRA05	OA-GRA05x	TOT-ICP06														
TRA-21	WEI-21																

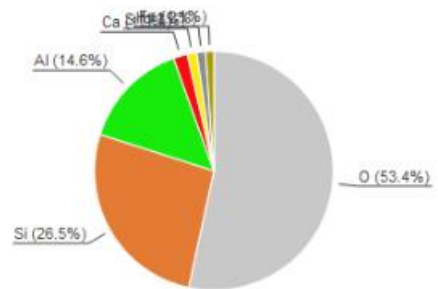
APPENDIX E X-RAY DIFFRACTION INTERPRETATION

1.3-1.4 DF

Phase composition



Elemental composition



Index Amount (%) Name

A	69.9	Kaolinite
B	22.3	Quartz
C	5.5	Afwillite
D	2.4	Pyrite
	14.0	Unidentified peak area

Formula sum

Al ₂ H ₄ O ₉ Si ₂
O ₂ Si
Ca ₃ H ₆ O ₁₀ Si ₂
Fe S ₂

Element Amount (weight %)

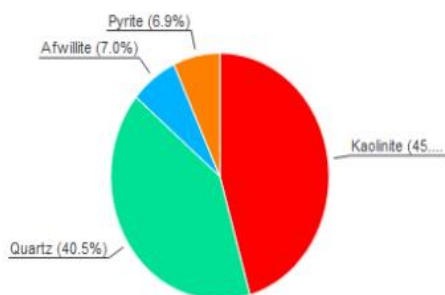
O	53.4% (*)
Si	26.5%
Al	14.6%
Ca	1.9%
S	1.3%
H	1.2% (*)
Fe	1.1%
*LE (sum)	54.6%

Amounts calculated by RIR (Reference Intensity Ratio) method

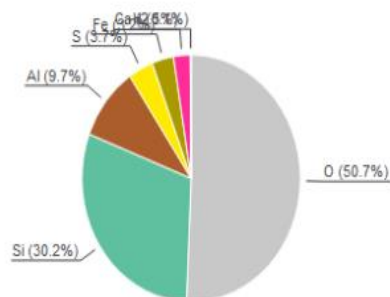
No.	2theta [°]	d [Å]	I/I0 (peak height)	Counts (peak area)	FWHM	Matched
1	7.54	11.7153	85.33	41.69	1.4512	C
2	12.38	7.1439	337.14	57.36	0.8050	A
3	15.94	5.5555	389.80	66.32	0.8050	C
4	17.28	5.1276	428.72	72.94	0.8050	C
5	20.30	4.3711	713.67	121.41	0.8050	A,C
6	20.94	4.2389	705.10	119.96	0.8050	A,B,C
7	24.90	3.5730	944.45	160.68	0.8050	A,C
8	26.64	3.3435	1000.00	170.13	0.8050	A,B
9	28.46	3.1337	302.43	51.45	0.8050	A,C,D
10	29.66	3.0095	122.87	17.96	0.6917	C
11	30.92	2.8897	64.65	7.90	0.5783	C
12	33.14	2.7010	357.54	28.23	0.3736	C,D
13	35.12	2.5532	81.73	14.85	0.8599	A,C
14	37.18	2.4163	250.66	23.89	0.4509	C,D
15	38.54	2.3341	145.50	28.43	0.9246	A,C
16	40.82	2.2088	229.34	44.81	0.9246	A,C,D
17	42.70	2.1158	138.50	27.06	0.9246	A,B,C
18	44.20	2.0474	150.14	29.34	0.9246	C
19	47.52	1.9119	182.94	33.29	0.8609	A,C,D
20	49.70	1.8330	87.22	27.06	1.4682	A,C
21	50.30	1.8125	65.71	28.82	2.0754	A,B,C
22	52.00	1.7572	60.22	21.08	1.6565	C
23	53.04	1.7252	55.65	17.02	1.4471	C
24	53.68	1.7061	29.97	8.50	1.3423	A,C
25	54.38	1.6858	59.37	16.19	1.2900	A,C
26	55.10	1.6654	75.34	19.71	1.2376	A,B,C
27	56.32	1.6322	255.03	21.55	0.3998	A,C,D
28	58.98	1.5648	44.62	4.50	0.4773	A,C,D
29	60.02	1.5401	35.48	4.16	0.5549	A,B,C
30	61.82	1.4995	75.28	10.30	0.6476	A,D
31	64.62	1.4412	119.85	12.79	0.5050	A,D
32	68.34	1.3715	62.05	9.14	0.6973	A,B

1.4-1.5 DF

Phase composition



Elemental composition



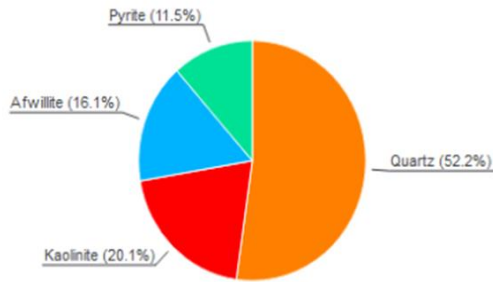
Index	Amount (%)	Name	Formula sum	Element	Amount (weight %)
A	45.6	Kaolinite	Al ₂ O ₉ Si ₂	O	50.7% (*)
B	40.5	Quartz	O ₂ Si	Si	30.2%
C	7.0	Afwillite	Ca ₃ H ₆ O ₁₀ Si ₂	Al	9.7%
D	6.9	Pyrite	Fe S ₂	S	3.7%
	14.1	Unidentified peak area		Fe	3.2%
				Ca	2.5%
				H	0.1% (*)
				*LE (sum)	50.8%

Amounts calculated by RIR (Reference Intensity Ratio) method

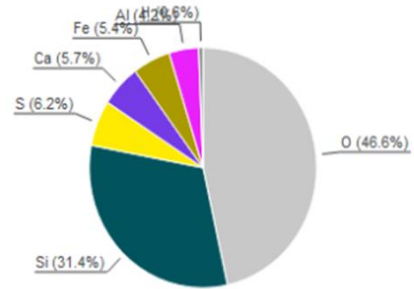
No.	2theta [°]	d [Å]	I/I ₀ (peak height)	Counts (peak area)	FWHM	Matched
1	7.00	12.6178	49.98	4.32	0.1600	C
2	7.96	11.0981	12.66	0.77	0.1127	
3	12.38	7.1439	91.77	23.74	0.4789	A
4	19.98	4.4404	183.70	117.12	1.1804	A,C
5	20.92	4.2429	303.58	229.56	1.4000	A,B,C
6	25.02	3.5562	267.16	202.02	1.4000	A,C
7	26.70	3.3361	1000.00	167.42	0.3100	B
8	28.60	3.1186	119.52	34.01	0.5269	C,D
9	30.66	2.9136	185.51	16.03	0.1600	C
10	33.10	2.7042	198.88	33.04	0.3076	C,D
11	35.02	2.5602	46.31	17.97	0.7186	A,C
12	36.08	2.4874	52.37	20.33	0.7186	A,C
13	36.58	2.4545	91.47	35.50	0.7186	B,C
14	37.14	2.4188	133.71	51.90	0.7186	A,C,D
15	38.54	2.3341	70.22	27.25	0.7186	A,C
16	39.52	2.2784	103.52	40.18	0.7186	A,B,C
17	40.34	2.2340	56.29	21.85	0.7186	A,B
18	40.86	2.2068	104.02	40.37	0.7186	A,C,D
19	42.50	2.1253	90.28	35.04	0.7186	A,B,C
20	45.24	2.0028	35.46	13.76	0.7186	A,C
21	45.80	1.9796	78.27	30.38	0.7186	A,B,C
22	47.48	1.9134	96.21	37.34	0.7186	A,C,D
23	50.20	1.8159	149.26	19.19	0.2380	B,C
24	52.08	1.7547	15.21	1.04	0.1264	A,C
25	54.90	1.6710	56.52	9.22	0.3020	A,B,C
26	56.32	1.6322	189.89	27.45	0.2676	A,C,D
27	60.00	1.5406	84.67	15.98	0.3493	B,C
28	61.68	1.5026	42.84	9.01	0.3895	A,D
29	64.28	1.4480	41.83	12.00	0.5312	A,D
30	67.76	1.3818	40.31	12.19	0.5598	B
31	68.22	1.3736	61.48	19.54	0.5884	A,B

1.5-1.6 DF

Phase composition



Elemental composition



Index Amount (%) Name

A	52.2	Quartz
B	20.1	Kaolinite
C	16.1	Afwillite
D	11.5	Pyrite
	17.1	Unidentified peak area

Formula sum

O2 Si
Al2 H4 O9 Si2
Ca3 H6 O10 Si2
Fe S2

Element Amount (weight %)

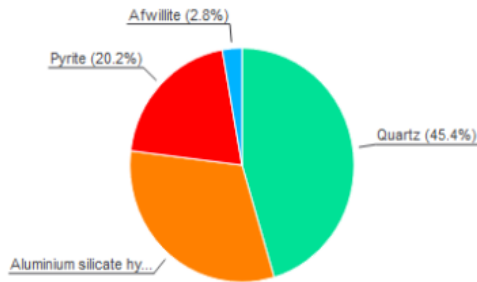
O	46.6% (*)
Si	31.4%
S	6.2%
Ca	5.7%
Fe	5.4%
Al	4.2%
H	0.6% (*)
*LE (sum)	47.2%

Amounts calculated by RIR (Reference Intensity Ratio) method

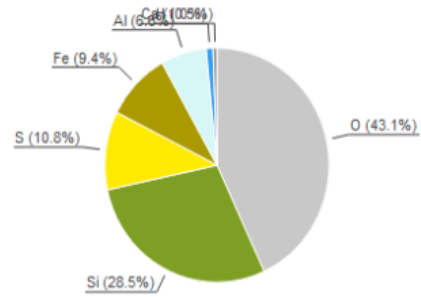
No.	2theta [°]	d [Å]	I/I0 (peak height)	Counts (peak area)	FWHM	Matched
1	6.90	12.8005	36.53	10.62	0.4768	C
2	12.46	7.0982	45.38	20.27	0.7330	B
3	18.20	4.8704	164.08	47.86	0.4785	C
4	18.82	4.7114	59.77	18.86	0.5176	C
5	19.96	4.4448	104.20	35.37	0.5568	B
6	20.96	4.2349	219.24	84.87	0.6350	A,B,C
7	23.00	3.8637	93.97	49.87	0.8706	B,C
8	23.66	3.7574	105.27	70.99	1.1062	B,C
9	24.94	3.5674	140.46	135.06	1.5773	B,C
10	26.72	3.3336	1000.00	165.22	0.2710	A,B
11	27.92	3.1930	68.99	22.80	0.5422	C
12	28.62	3.1165	87.96	29.07	0.5422	B,C,D
13	29.82	2.9938	34.75	11.48	0.5422	C
14	30.78	2.9025	9.28	2.20	0.3881	C
15	33.14	2.7010	233.60	33.34	0.2341	C,D
16	35.06	2.5574	34.59	8.49	0.4027	B,C
17	36.64	2.4507	83.13	18.92	0.3734	A,C
18	37.18	2.4163	135.46	30.84	0.3734	C,D
19	38.68	2.3260	39.01	8.01	0.3367	B,C
20	39.54	2.2773	85.58	15.65	0.2999	A,B,C
21	40.44	2.2287	56.37	9.89	0.2878	A,B,C
22	40.88	2.2057	122.74	20.63	0.2757	B,C,D
23	42.56	2.1225	87.96	12.71	0.2370	A,B,C
24	45.90	1.9755	60.41	14.14	0.3839	A,B,C
25	47.54	1.9111	125.96	21.54	0.2805	C,D
26	50.18	1.8166	140.83	25.23	0.2938	A,B,C
27	52.12	1.7534	23.09	5.47	0.3887	C
28	54.98	1.6688	65.64	12.77	0.3190	A,B,C
29	56.38	1.6306	183.36	36.56	0.3271	B,C,D
30	59.12	1.5614	38.75	8.24	0.3489	B,C,D
31	60.08	1.5387	108.07	22.99	0.3489	A,B,C
32	61.82	1.4995	41.00	12.93	0.5175	B,D
33	62.40	1.4870	35.70	11.27	0.4938	B
34	64.38	1.4460	52.22	14.97	0.4701	B,D
35	67.82	1.3807	41.13	37.54	1.4971	A
36	68.36	1.3711	85.66	78.18	1.4971	A,B

>1.6 DF

Phase composition



Elemental composition



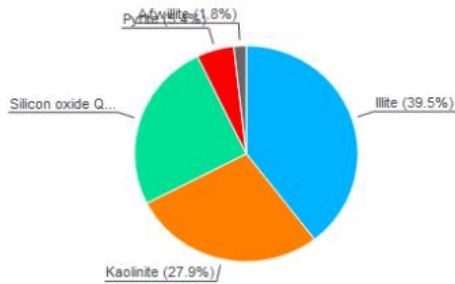
Index	Amount (%)	Name	Formula sum	Element	Amount (weight %)
A	45.4	Quartz	O2 Si	O	43.1% (*)
B	31.6	Aluminium silicate hydroxide * Kaolinite	2MAI2 H4 O9 Si2	Si	28.5%
C	20.2	Pyrite	Fe S2	S	10.8%
D	2.8	Afwillite	Ca3 H6 O10 Si2	Fe	9.4%
	13.0	Unidentified peak area		Al	6.8%
				Ca	1.0%
				H	0.5% (*)
				LE (sum)	43.6%

Amounts calculated by RIR (Reference Intensity Ratio) method

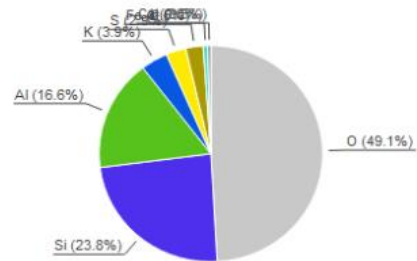
No.	2theta [°]	d [Å]	I/I0 (peak height)	Counts (peak area)	FWHM	Matched
1	6.84	12.9126	28.67	2.11	0.1541	D
2	12.22	7.2371	44.39	22.86	1.0774	B
3	19.92	4.4536	137.62	70.88	1.0774	B
4	20.86	4.2550	229.48	48.27	0.4400	A,B,D
5	22.36	3.9728	61.05	20.65	0.7075	D
6	24.96	3.5646	107.86	50.28	0.9750	B,D
7	25.92	3.4347	139.77	65.15	0.9750	D
8	26.74	3.3312	1000.00	126.34	0.2643	A
9	28.58	3.1208	181.37	26.85	0.3096	C,D
10	33.12	2.7026	439.61	49.48	0.2354	C,D
11	34.98	2.5631	71.87	15.91	0.4631	B,D
12	35.62	2.5185	57.45	12.72	0.4631	B,D
13	36.62	2.4519	92.03	20.37	0.4631	A,D
14	37.14	2.4188	299.74	40.12	0.2800	B,C,D
15	38.54	2.3341	47.81	13.31	0.5825	B,D
16	38.90	2.3133	45.05	12.54	0.5825	D
17	39.50	2.2796	76.84	21.40	0.5825	A,B,D
18	40.34	2.2340	59.84	16.66	0.5825	A,B
19	40.82	2.2088	216.05	60.16	0.5825	B,C,D
20	42.50	2.1253	76.33	21.26	0.5825	A,B,D
21	45.90	1.9755	47.18	8.88	0.3935	A,B,D
22	47.50	1.9126	227.60	26.86	0.2468	B,C,D
23	50.22	1.8152	148.75	17.33	0.2437	A,D
24	52.06	1.7553	29.13	3.19	0.2294	B,D
25	53.16	1.7215	25.45	1.71	0.1408	D
26	54.28	1.6886	34.77	5.52	0.3320	B,D
27	54.90	1.6710	76.71	12.17	0.3320	A,B,D
28	56.32	1.6322	382.33	55.65	0.3045	B,C,D
29	57.84	1.5929	27.51	7.00	0.5326	B,D
30	59.08	1.5624	59.04	8.87	0.3144	B,C,D
31	59.98	1.5411	99.52	14.96	0.3144	A,D
32	61.76	1.5009	86.76	16.31	0.3931	B,C
33	64.30	1.4476	100.86	18.34	0.3803	A,B,C
34	67.78	1.3815	59.09	15.48	0.5479	A
35	68.34	1.3715	126.75	33.20	0.5479	A,B

Raw Coal

Phase composition



Elemental composition



Index Amount (%) Name

A	39.5	Illite
B	27.9	Kaolinite
C	25.4	Silicon oxide Quartz
D	5.4	Pyrite
E	1.8	Afwillite
	13.6	Unidentified peak area

Formula sum

A	Al ₄ K O ₁₂ Si ₂
B	Al ₂ H ₄ O ₉ Si ₂
C	O ₂ Si
D	Fe S ₂
E	Ca ₃ H ₆ O ₁₀ Si ₂

Element Amount (weight %)

O	49.1% (*)
Si	23.8%
Al	16.6%
K	3.9%
S	2.9%
Fe	2.5%
Ca	0.6%
H	0.5% (*)
*LE (sum)	49.6%

Amounts calculated by RIR (Reference Intensity Ratio) method

No.	2theta [°]	d [Å]	I/I ₀ (peak height)	Counts (peak area)	FWHM	Matched
1	6.82	12.9504	117.77	21.97	0.6688	E
2	8.88	9.9503	66.83	8.54	0.4583	A
3	12.30	7.1902	164.69	10.11	0.2200	B
4	13.56	6.5248	101.85	47.95	1.6879	E
5	18.18	4.8758	338.12	115.23	1.2219	E
6	20.12	4.4098	388.11	197.37	1.8234	A,B,E
7	20.88	4.2510	537.20	65.92	0.4400	A,C,E
8	23.56	3.7731	485.12	254.37	1.8801	A,B,E
9	24.98	3.5618	356.07	61.33	0.4400	A,B,E
10	26.64	3.3435	1000.00	135.05	0.4842	A,B,C
11	28.52	3.1272	234.34	57.51	0.8800	A,B,D,E
12	33.06	2.7074	368.99	32.56	0.3163	A,D,E
13	35.12	2.5532	163.74	10.05	0.2200	A,B,E
14	37.10	2.4213	187.55	18.41	0.3520	A,D,E
15	40.76	2.2119	225.20	20.81	0.3313	A,B,D,E
16	42.48	2.1263	77.06	11.24	0.5228	A,B,C,E
17	45.74	1.9820	82.54	16.04	0.6966	A,B,C,E
18	47.44	1.9149	188.04	36.54	0.6966	B,D,E
19	50.20	1.8159	147.88	13.63	0.3305	B,C,E
20	56.28	1.6333	288.07	25.79	0.3210	A,B,D,E
21	59.14	1.5609	47.05	2.93	0.2234	A,B,D,E
22	60.04	1.5397	56.76	6.77	0.4279	A,B,C,E
23	61.64	1.5035	56.54	7.71	0.4891	A,B,D
24	64.58	1.4420	81.12	18.06	0.7985	A,B,D
25	68.24	1.3733	47.78	6.79	0.5097	A,B,C

APPENDIX F MATERIAL SAFETY DATA SHEET

IN CASE OF TRANSPORTATION EMERGENCY CONTACT:

CHEMTREC:(800) 424-9300

ALL OTHER INQUIRIES:
(770) 904-7042 // www.ciscochem.com
266 Rue Cezzan Lavonia, GA 30553



1. IDENTIFICATION

SUBSTANCE: TETRACHLOROETHYLENE

TRADE NAMES/SYNONYMS:

PERCHLOROETHYLENE; 1,1,2,2-TETRACHLOROETHYLENE; ETHYLENE TETRACHLORIDE; PERC;
TETRACHLOROETHYLENE; PERCHLORETHYLENE; TETRACHLOROETHENE

CHEMICAL FAMILY: halogenated, aliphatic

2. HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=0 REACTIVITY=0

EMERGENCY OVERVIEW:

COLOR: colorless

PHYSICAL FORM: volatile liquid

ODOR: faint odor, sweet odor

MAJOR HEALTH HAZARDS: respiratory tract irritation, skin irritation, eye irritation, central nervous system depression, cancer hazard (in humans)

POTENTIAL HEALTH EFFECTS:

INHALATION:

SHORT TERM EXPOSURE: irritation, nausea, vomiting, chest pain, difficulty breathing, irregular heartbeat, headache, drowsiness, dizziness, disorientation, mood swings, loss of coordination, blurred vision, lung congestion, kidney damage, liver damage

LONG TERM EXPOSURE: irritation, nausea, stomach pain, loss of appetite, headache, drowsiness, dizziness, disorientation, sleep disturbances, pain in extremities, loss of coordination, blurred vision, hormonal disorders, internal bleeding, heart damage, liver damage, birth defects, brain damage, tumors, cancer

SKIN CONTACT:

SHORT TERM EXPOSURE: irritation (possibly severe)

LONG TERM EXPOSURE: irritation

EYE CONTACT:

SHORT TERM EXPOSURE: irritation

LONG TERM EXPOSURE: irritation

INGESTION:

SHORT TERM EXPOSURE: same as effects reported in short term inhalation

LONG TERM EXPOSURE: same as effects reported in long term inhalation

3. COMPOSITION

COMPONENT: TETRACHLOROETHYLENE

CAS NUMBER: 127-18-4

PERCENTAGE: 100.0

Hazardous: YES

4. FIRST AID MEASURES

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:

Aspiration hazard. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Contact:

Wash skin with soap or mild detergent and water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Call a physician.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:

Do not administer adrenaline or epinephrine to a victim of chlorinated solvent poisoning.

5. FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARDS: Negligible fire hazard.

EXTINGUISHING MEDIA: carbon dioxide, regular dry chemical

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For tank, rail car or tank truck, evacuation radius: 800 meters (1/2 mile).

FLASH POINT: No data available.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode

6. ACCIDENTAL RELEASE MEASURES

SOIL RELEASE:

Dig holding area such as lagoon, pond or pit for containment. Dike for later disposal. Absorb with sand or other non-combustible material.

WATER RELEASE:

Absorb with activated carbon. Remove trapped material with suction hoses. Subject to California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65). Keep out of water supplies and sewers.

OCCUPATIONAL RELEASE:

Avoid heat, flames, sparks and other sources of ignition. Stop leak if possible without personal risk. Small liquid spills: Absorb with sand or other non-combustible material. Large spills: Dike for later disposal. Remove sources of ignition. Keep unnecessary people away, isolate hazard area and deny entry. Notify Local Emergency Planning Committee and State Emergency Response Commission for release greater than or equal to RQ (U.S. SARA Section 304). If release occurs in the U.S. and is reportable under CERCLA Section 103, notify the National Response Center at (800)424-8802 (USA) or (202)426-2675 (USA).

7. HANDLING AND STORAGE

Store in a cool, dry, ventilated area away from sources of heat or ignition. Isolate from flammable materials. Protect from direct sunlight. Wear special protective equipment (Sec. 8) for maintenance break-in or where exposures may exceed established exposure levels. Wash hands, face, forearms and neck when exiting restricted areas. Shower, dispose of outer clothing, change to clean garments at the end of the day. Avoid cross-contamination of street clothes. Wash hands before eating and do not eat, drink, or

smoke in workplace. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

Airborne Exposure Limits:

-OSHA Permissible Exposure Limit (PEL): 100 ppm (TWA), 200 ppm (ceiling), 300 ppm/5min/3-hour (max)
-ACGIH Threshold Limit Value (TLV): 25 ppm (TWA), 100 ppm (STEL); listed as A3, animal carcinogen

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, Industrial Ventilation, A Manual of Recommended Practices, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airtight hood, or full-facepiece self-contained breathing apparatus.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

CLOTHING: Wear appropriate chemical resistant clothing. GLOVES: Wear appropriate chemical resistant gloves.

RESPIRATOR: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.

At any detectable concentration -

Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.

Any supplied-air respirator with a full facepiece that is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode.

Escape -

Any air-purifying full-facepiece respirator (gas mask) with a chin-style, front-mounted or back-mounted organic vapor canister. Any appropriate escape-type, self-contained breathing apparatus.

For Unknown Concentrations or Immediately Dangerous to Life or Health -

Any supplied-air respirator with a full facepiece that is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode. Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: liquid

APPEARANCE: clear

COLOR: colorless

PHYSICAL FORM: volatile liquid

ODOR: faint odor, sweet odor

MOLECULAR WEIGHT: 165.83

MOLECULAR FORMULA: Cl₂-C-C-Cl₂

BOILING POINT: 250 F (121 C)

FREEZING POINT: -2 F (-19 C)

VAPOR PRESSURE: 14 mmHg @ 20 C

VAPOR DENSITY (air=1): 5.83
SPECIFIC GRAVITY (water=1): 1.6227
WATER SOLUBILITY: 0.015%
PH: Not available
VOLATILITY: Not available
ODOR THRESHOLD: 50 ppm
EVAPORATION RATE: 2.8 (butyl acetate=1)
COEFFICIENT OF WATER/OIL DISTRIBUTION: Not available
SOLVENT SOLUBILITY:
Soluble: alcohol, ether, benzene, chloroform, oils

10. STABILITY AND REACTIVITY

Stability:

Stable under ordinary conditions of use and storage. Slowly decomposed by light. Deteriorates rapidly in warm, moist climates.

Hazardous Decomposition Products:

Carbon dioxide and carbon monoxide may form when heated to decomposition. Hydrogen chloride gas and phosgene gas may be formed upon heating. Decomposes with moisture to yield trichloroacetic acid and hydrochloric acid.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Strong acids, strong oxidizers, strong alkalis, especially NaOH, KOH; finely divided metals, especially zinc, barium, lithium. Slowly corrodes aluminum, iron and zinc.

Conditions to Avoid:

Moisture, light, heat and incompatibles.

11. TOXICOLOGICAL INFORMATION

TETRACHLOROETHYLENE:

IRRITATION DATA: 810 mg/24 hour(s) skin-rabbit severe; 500 mg/24 hour(s) skin-rabbit mild; 162 mg eyes-rabbit mild; 500 mg/24 hour(s) eyes-rabbit mild

TOXICITY DATA: 4100 ppm/6 hour(s) inhalation-rat LC50; >10000 mg/kg skin-rabbit LD50 (Dow); 2629 mg/kg oral-rat LD50

CARCINOGEN STATUS: NTP: Anticipated Human Carcinogen; IARC: Human Limited Evidence, Animal Sufficient Evidence, Group 2A; ACGIH: A3 -Confirmed Animal Carcinogen; EC: Category 2

LOCAL EFFECTS:

Irritant: inhalation, skin, eye

ACUTE TOXICITY LEVEL:

Moderately Toxic: ingestion

Slightly Toxic: inhalation

TARGET ORGANS: central nervous system

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: eye disorders, heart or cardiovascular disorders, kidney disorders, liver disorders, nervous system disorders, skin disorders and allergies

TUMORIGENIC DATA: Available.

MUTAGENIC DATA: Available.

REPRODUCTIVE EFFECTS DATA: Available.

ADDITIONAL DATA: May be excreted in breast milk. Alcohol may enhance the toxic effects. Stimulants such as epinephrine may induce ventricular fibrillation.

12. ECOLOGICAL INFORMATION

ECOTOXICITY DATA:

FISH TOXICITY: 8430 ug/L 96 hour(s) LC50 (Mortality) Flagfish (*Jordanella floridae*)

INVERTEBRATE TOXICITY: 7500 ug/L 48 hour(s) EC50 (Immobilization) Water flea (*Daphnia magna*)

ALGAL TOXICITY: 509000 ug/L 96 hour(s) EC50 (Photosynthesis) Diatom (*Skeletonema costatum*)

FATE AND TRANSPORT:

BIOCONCENTRATION: 49 ug/L 1-21 hour(s) BCF (Residue) Bluegill (*Lepomis macrochirus*) 3.43 ug/L

Environmental Fate:

When released into the soil, this material is expected to quickly evaporate. When released into the soil, this material may leach into groundwater. When released into the soil, this material may biodegrade to a moderate extent. When released to water, this material is expected to quickly evaporate. When released into water, this material is not expected to biodegrade. This material is not expected to significantly bioaccumulate. When released into the air, this material may be moderately degraded by reaction with photochemically produced hydroxyl radicals.

Environmental Toxicity:

The LC50/96-hour values for fish are between 1 and 10 mg/l. The LC50/96-hour values for fish are between 10 and 100 mg/l. This material is expected to be toxic to aquatic life.

13. DISPOSAL CONSIDERATIONS

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. TRANSPORT INFORMATION

Domestic (Land, D.O.T.)

Proper Shipping Name: TETRACHLOROETHYLENE Hazard Class: 6.1

UN/NA: UN1897

Packing Group: III

Information reported for product/size: 20L

International (Water, I.M.O.)

Proper Shipping Name: TETRACHLOROETHYLENE Hazard Class: 6.1

UN/NA: UN1897

Packing Group: III

Information reported for product/size: 20L

Proper shipping paperwork:

UN 1897, Tetrachoroethylene, 6.1, PG III

Marine Pollutant

15. REGULATORY INFORMATION

U.S. REGULATIONS:

CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4): TETRACHLOROETHYLENE (PERCHLOROETHYLENE): 100 LBS RQ

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES

(40 CFR 355 Subpart B): Not regulated.

SARA TITLE III SECTION 304 EXTREMELY HAZARDOUS SUBSTANCES

(40 CFR 355 Subpart C): Not regulated.

SARA TITLE III SARA SECTIONS 311/312 HAZARDOUS CATEGORIES (40 CFR 370 Subparts B and C):

ACUTE: Yes

CHRONIC: Yes

FIRE: No

REACTIVE: No

SUDDEN RELEASE: No

SARA TITLE III SECTION 313 (40 CFR 372.65): TETRACHLOROETHYLENE (PERCHLOROETHYLENE)

OSHA PROCESS SAFETY (29 CFR 1910.119): Not regulated.

STATE REGULATIONS:

California Proposition 65:

Known to the state of California to cause the following: TETRACHLOROETHYLENE (PERCHLOROETHYLENE) Cancer (Apr 01, 1988)

CANADIAN REGULATIONS: WHMIS CLASSIFICATION: D2

NATIONAL INVENTORY STATUS:

U.S. INVENTORY (TSCA): Listed on inventory.

TSCA 12(b) EXPORT NOTIFICATION: Not listed. CANADA INVENTORY (DSL/NDSL): Not determined.

16. OTHER INFORMATION

NFPA Ratings: Health: 2 Flammability: 0 Reactivity: 0

Label Hazard Warning:

WARNING! HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER AND KIDNEYS. SUSPECT CANCER HAZARD. MAY CAUSE CANCER. Risk of cancer depends on level and duration of exposure.

Label Precautions:

Do not get in eyes, on skin, or on clothing.

Do not breathe vapor or mist.

Keep container closed.

Use only with adequate ventilation.

Wash thoroughly after handling.

Label First Aid:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. In all cases call a physician.

Product Use:

Laboratory Reagent.

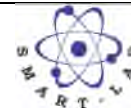
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Date Created: 5/18/2015

Date Updated: 6/11/2015

MATERIAL SAFETY DATA SHEET**BENZENE**

Revision : 02

Date : Nov 3rd, 2021

MSDS Number : 039

Section 1 - Chemical Product and Company Identification

- 1.1 Product Name** : BENZENE
Synonyms : Benzol; Cyclohexatriene; Phenyl hydride
CAS No. : 71-43-2
HS Code : 2902 20 00
Molecular Weight : 78.11 g/mol
Chemical Formula : C₆H₆
Product Code : A-1012
Brand : SMART-LAB
- 1.2 Manufacturer** : PT.Smart-Lab Indonesia
Address : Ruko Boulevard Taman Tekno Blok E No.10-11,BSD Sektor XI Serpong, Tangerang - Indonesia
Website : www.smartlab.co.id
Email : sales@smartlab.co.id
For information : Telp: +62-21- 7588 0205(Hunting) , fax:+62-21-7588 0198
- 1.3 Application** : General Chemical reagent
Emergency Telephone: +62-21-7588 0205(Hunting)

Section 2 - Hazards Identification

2.1 Classification of the substance or mixture**Classification according to Regulation (EC) No 1272/2008**

Chronic aquatic toxicity (Category 3), Flammable liquids (Category 2), H225
 Skin irritation (Category 2), H315
 Eye irritation (Category 2), H319
 Germ cell mutagenicity (Category 1B), H340
 Carcinogenicity (Category 1A), H350
 Specific target organ toxicity - repeated exposure (Category 1), H372
 Aspiration hazard (Category 1), H304
 H412

For the full text of the H-Statements mentioned in this Section, see Section 16

2.2 Label elements

Labelling according Regulation (EC) No 1272/2008

Pictogram



Signal word

Danger

Hazard statement(s)

H225

Highly flammable liquid and vapour.

H304

May be fatal if swallowed and enters airways.

H315

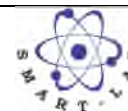
Causes skin irritation.

H319

Causes serious eye irritation.

H340

May cause genetic defects.

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H350	May cause cancer.
H372	Causes damage to organs through prolonged or repeated exposure.
H412	Harmful to aquatic life with long lasting effects.
Precautionary statement(s)	
P210	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P273	Avoid release to the environment.
P301 + P310	IF SWALLOWED: Immediately call a POISON CENTER/ doctor.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P331	Do NOT induce vomiting.
Supplemental Hazard Statements	none

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

Section 3 - Composition, Information on Ingredients

3.1 Substances

Synonyms	: Benzol; Cyclohexatriene; Phenyl hydride
Formula	: C ₆ H ₆
Molecular weight	: 78.11 g/mol
CAS-No.	: 71-43-2
EC-No.	: 200-753-7
Index-No.	: 601-020-00-8

Hazardous ingredients according to Regulation (EC) No 1272/2008

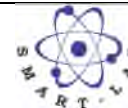
Component	Classification	Concentration
Benzene CAS-No. 71-43-2 EC-No. 200-753-7 Index-No. 601-020-00-8	Flam. Liq. 2; Skin Irrit. 2; Eye Irrit. 2; Muta. 1B; Carc. 1A; STOT RE 1; Asp. Tox. 1; Aquatic Chronic 3; H225, H315, H319, H340, H350, H372, H304, H412	<=100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

Section 4 - First Aid Measures

4.1 Description of first aid measures**General advice**

Consult a physician. Show this safety data sheet to the doctor in attendance.

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If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact

Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

Section 5 - Firefighting Measures

5.1 Extinguishing media**Suitable extinguishing**

media Carbon dioxide (CO₂) Foam Dry powder

Unsuitable extinguishing

media For this substance/mixture no limitations of extinguishing agents are given.

5.2 Special hazards arising from the substance or mixture

Carbon oxides Flash back possible over considerable distance., Container explosion may occur under fire conditions. Combustible. Pay attention to flashback. Vapors are heavier than air and may spread along floors. Development of hazardous combustion gases or vapours possible in the event of fire. Forms explosive mixtures with air at ambient temperatures.

5.3 Advice for firefighters

Stay in danger area only with self-contained breathing apparatus. Prevent skin contact by keeping a safe distance or by wearing suitable protective clothing.

5.4 Further information

Remove container from danger zone and cool with water. Prevent fire extinguishing water from contaminating surface water or the ground water system.

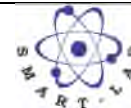
Section 6 - Accidental Release Measures

6.1 Personal precautions, protective equipment and emergency procedures

Advice for non-emergency personnel: Do not breathe vapors, aerosols. Avoid substance contact. Ensure adequate ventilation. Keep away from heat and sources of ignition. Evacuate the danger area, observe emergency procedures, consult an expert. For personal protection see section 8.

6.2 Environmental precautions

Do not let product enter drains. Risk of explosion.

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6.3 Methods and materials for containment and cleaning up

Cover drains. Collect, bind, and pump off spills. Observe possible material restrictions (see sections 7 and 10). Take up carefully with liquid-absorbent material (e.g. Chemizorb®). Dispose of properly. Clean up affected area.

6.4 Reference to other sections

For disposal see section 13.

Section 7 - Handling and Storage

7.1 Precautions for safe handling

Advice on safe handling

Work under hood. Do not inhale substance/mixture. Avoid generation of vapours/aerosols.

Advice on protection against fire and explosion

Keep away from open flames, hot surfaces and sources of ignition. Take precautionary measures against static discharge. Hygiene measures

Immediately change contaminated clothing. Apply preventive skin protection. Wash hands and face after working with substance. For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Storage conditions

Keep container tightly closed in a dry and well-ventilated place.

Keep away from heat and sources of ignition.

Keep locked up or in an area accessible only to qualified or authorized persons.

Storage class

Storage class (TRGS 510): 3: Flammable liquids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

Section 8 - Exposure Controls, Personal Protection

8.1 Control parameters**8.2 Exposure control****Appropriate engineering controls**

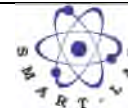
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment**Eye/face protection**

Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

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The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Full contact

Material: Fluorinated rubber
 Minimum layer thickness: 0,7 mm
 Break through time: 480 min
 Material tested: Vitoject®

Splash contact

Material: Fluorinated rubber
 Minimum layer thickness: 0,7 mm
 Break through time: 480 min
 Material tested: Vitoject®

Body Protection

Flame retardant antistatic protective clothing.

Respiratory protection

Recommended Filter type: Filter A-(P3) The entrepreneur has to ensure that maintenance, cleaning and testing of respiratory protective devices are carried out according to the instructions of the producer. These measures have to be properly documented.

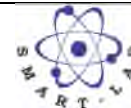
Control of environmental exposure

Do not let product enter drains. Risk of explosion.

Section 9 - Physical and Chemical Properties

9.1 Information on basic physical and chemical properties

Appearance	Form: liquid, clear Colour: colourless
Odour	No data available
Odour Threshold	No data available
pH	No data available
Melting point/freezingpoint	Melting point/range: 5.5 °C - lit.
Initial boiling point and boiling range	80 °C - lit
Flash point	-11.0 °C - closed cup
Evaporation rate	No data available
Flammability (solid, gas)	No data available
Upper/lower flammability or explosive limits	Upper explosion limit: 8 % (V) Lower explosion limit: 1.4 % (V) No data available
Vapour pressure	100 hPa at 20 °C
Vapour density	No data available
Relative density	0,874 g/cm ³ at 25 °C - lit.
Water solubility	ca.1,88 g/l at 23,5 °C - soluble
Partition coefficient: noctanol/water	log Pow: 2.13 at 25 °C
Auto-ignition temperature	498 °C at 1.013,5 hPa
Decomposition temperature	No data available
Viscosity	Viscosity, kinematic: 0,604 mm ² /s at 25 °C Viscosity, dynamic: No data available
Explosive properties	No data available
Oxidizing properties	No data available

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9.2 Other safety information

No data available

Section 10 - Stability and Reactivity

10.1 Reactivity

Vapors may form explosive mixture with air.

10.2 Chemical stability

The product is chemically stable under standard ambient conditions (room temperature) .

10.3 Possibility of hazardous reactions

Exothermic reaction with:

halogens

Halogenated hydrocarbon

in the presence of: Light metals

Risk of explosion with:

halogen-halogen compounds

Nitric acid

Boranes

Ozone

peroxi compounds

perchlorates

permanganic acid

perchloryl fluoride

Strong oxidizing agents

Chlorine

fluorides

uranium hexafluoride

Oxygen liquid

Risk of ignition or formation of inflammable gases or vapours with:

chromium(VI) oxide

Fluorine

nitryl compounds

Oxygen oxyhalogenic compounds

Violent reactions possible with:

mineral acids

sulfur

10.4 Conditions to avoid

Warming.

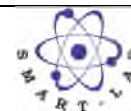
10.5 Incompatible materials

rubber, various plastics

10.6 Hazardous decomposition products

In the event of fire: see section 5

Section 11 - Toxicological Information

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11.1 Information on toxicological effects**Acute toxicity**

LD50 Oral - Rat - male - > 2.000 mg/kg (OECD Test Guideline 401)

Symptoms: Nausea

LC50 Inhalation - Rat - female - 4 h - 43,7 mg/l (OECD Test Guideline 403)

LD50 Dermal - Rabbit - male and female - > 8.260 mg/kg (OECD Test Guideline 402)

Skin corrosion/irritation

Skin - Rabbit

Result: Irritating to skin. - 4 h (OECD Test Guideline 404)

Drying-out effect resulting in rough and chapped skin.

Serious eye damage/eye irritation

Eyes - Rabbit

Result: Eye irritation Remarks: (ECHA)

Respiratory or skin sensitisation

Maximization Test - Guinea pig

Result: negative (OECD Test Guideline 406)

Germ cell mutagenicity

May cause genetic defects.

Test Type: Ames test Test system: Salmonella typhimurium

Metabolic activation: with and without metabolic activation

Method: OECD Test Guideline 471

Result: negative Test Type: Mutagenicity (mammal cell test): chromosome aberration.

Test system: Chinese hamster lung cells

Metabolic activation: with and without metabolic activation

Method: US-EPA

Result: positive Test Type: In vitro mammalian cell gene mutation test

Metabolic activation: with and without metabolic activation

Method: US-EPA

Result: positive

Test Type: Mutagenicity (mammal cell test): micronucleus.

Species: Mouse Cell type: Bone marrow Application

Route: inhalation (vapor)

Method: OECD Test Guideline 474

Result: positive

Carcinogenicity

This is or contains a component that has been reported to be carcinogenic classification.

(Benzene) Human carcinogen.(Benzene)

IARC: 1 - Group 1: Carcinogenic to humans (Benzene)

Reproductive toxicity

No data available(Benzene)

Specific target organ toxicity - single exposure

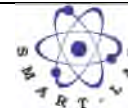
Causes damage to organs through prolonged or repeated exposure. - Blood

Specific target organ toxicity - repeated exposure

No data available(Benzene).

Aspiration hazard

May be fatal if swallowed and enters airways.

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Additional Information

Repeated dose toxicity - Rat - male and female - Oral - No observed adverse effect level - 100 mg/kg(Benzene)

RTECS: CY1400000

Nausea, Dizziness, Headache, narcosis, Inhalation of high concentrations of benzene may have an initial stimulatory exhilaration, nervous excitation and/or giddiness, depression, drowsiness chest, breathlessness, and loss of consciousness. Tremors, convulsions, a collapse can occur in a few minutes to several hours following severe exposure causes pulmonary edema and hemorrhage of pulmonary tissue. Direct skin contact may result in drying, scaling dermatitis, or development of second hematopoietic system. Bleeding from the nose, gums, or mucous membranes a leukopenia, thrombocytopenia, aplastic anemia, and

Section 12 - Ecological Information

12.1 Toxicity

Toxicity to fish

flow-through test LC50 - *Oncorhynchus mykiss* (rainbow trout) - 5,3 mg/l - 96 h (OECD Test Guideline 203)

Toxicity to daphnia and other aquatic invertebrates

static test EC50 - *Daphnia magna* (Water flea) - 10 mg/l - 48 h (OECD Test Guideline 202)

Toxicity to algae

static test ErC50 - *Pseudokirchneriella subcapitata* (green algae) - 100 mg/l - 72 h (OECD Test Guideline 201)

Toxicity to bacteria

static test IC50 - - 13 mg/l - 24 h Remarks: (ECHA)

12.2 Persistence and degradability

Biodegradability aerobic - Exposure time 28 d Result: 96 % - Readily biodegradable. (OECD Test Guideline 301F)

12.3 Bioaccumulative potential

Bioaccumulation *Leuciscus idus* (Golden orfe) - 3 d - 0,05 mg/l(benzene)

Bioconcentration factor (BCF): 10

12.4 Mobility in soil

No data available

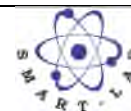
12.5 Results of PBT and vPvB assessment

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

12.6 Other adverse effects

Endangers drinking-water supplies if allowed to enter soil or water. Discharge into the environment must be avoided.

Section 13 - Disposal Considerations

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13.1 Waste treatment methods**Product**

Burn in a chemical incinerator equipped with an afterburner and scrubber b highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging

Dispose of as unused product.

Section 14 - Transport Information

14.1 UN number

ADR/RID: 1114

IMDG: 1114

IATA: 1114

14.2 UN proper shipping name

ADR/RID: BENZENE

IMDG: BENZENE

IATA: BENZENE

14.3 Transport hazard class(es)

ADR/RID: 3

IMDG: 3

IATA: 3

14.4 Packaging group

ADR/RID: II

IMDG: II

IATA: II

14.5 Environmental hazards

ADR/RID: no

IMDG Marine pollutant: no

IATA: no

14.6 Special precautions for user**Further information**

No data available

Section 15 - Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.

15.2 Chemical safety assessment

For this product a chemical safety assessment was not carried out

Section 16 - Additional Information

Full text of H-Statements referred to under sections 2 and 3.

H225 Highly flammable liquid and vapor.

H304 May be fatal if swallowed and enters airways.

H315 Causes skin irritation.

H319 Causes serious eye irritation.

H340 May cause genetic defects.

H350 May cause cancer.

H372 Causes damage to organs through prolonged or repeated exposure.

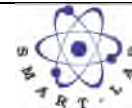
H412 Harmful to aquatic life with long lasting effects..

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 3

Reactivity: 0

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Revision : 02

Date : Nov 3rd, 2021

MSDS Number : 039

Revision history :

Date	Rev	Description
16 may 17	01	-
3 Nov 21	02	thorough revision

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. PT. Smartlab Indonesia Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigmaaldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.