

- Adinata, D., Wan Daud, W.M.A., Aroua, M.K., 2007. Production of carbon molecular sieves from palm shell based activated carbon by pore sizes modification with benzene for methane selective separation. *Fuel Processing Technology* 88, 599–605. <https://doi.org/10.1016/j.fuproc.2007.01.009>
- Ahmad, M.A., 2009. Preparation of carbon molecular sieves from palm shell: Effect of benzene deposition conditions. *Adsorption* 15, 489–495. <https://doi.org/10.1007/s10450-009-9199-0>
- Ahmad, M.A., Wan Daud, W.M.A., Aroua, M.K., 2008. Adsorption kinetics of various gases in carbon molecular sieves (CMS) produced from palm shell. *Colloids Surf A Physicochem Eng Asp* 312, 131–135. <https://doi.org/10.1016/j.colsurfa.2007.06.040>
- Ahmad, M.A., Wan Daud, W.M.A., Aroua, M.K., 2007. Synthesis of carbon molecular sieves from palm shell by carbon vapor deposition. *Journal of Porous Materials* 14, 393–399. <https://doi.org/10.1007/s10934-006-9032-z>
- Ahmad, N.E., Mel, M., Sinaga, N., 2017. Design of Liquefaction Process of Biogas using Aspen HYSYS Simulation. *Journal of Advanced Research in Biofuel and Bioenergy* 1, 10–15.
- Alcañiz-Monge, J., Marco-Lozar, J.P., Lillo-Ródenas, M.Á., 2011. CO<sub>2</sub> separation by carbon molecular sieve monoliths prepared from nitrated coal tar pitch. *Fuel Processing Technology* 92, 915–919. <https://doi.org/10.1016/j.fuproc.2010.12.010>
- Alcañiz-Monge, J., Marco-Lozar, J.P., Lozano-Castelló, D., 2012. Monolithic Carbon Molecular Sieves from activated bituminous coal impregnated with a slurry of coal tar pitch. *Fuel Processing Technology* 95, 67–72. <https://doi.org/10.1016/j.fuproc.2011.11.016>
- Angelidaki, I., Treu, L., Tsapekos, P., Luo, G., Campanaro, S., Wenzel, H., Kougias, P.G., 2018. Biogas upgrading and utilization: Current status and perspectives. *Biotechnol Adv* 36, 452–466. <https://doi.org/https://doi.org/10.1016/j.biotechadv.2018.01.011>
- Annisa, A., Prasetyo, I., Swantomio, D., Ariyanto, T., 2021. Surface modification of nanoporous carbon using gamma irradiation treatment as supercapacitor material. *4Th International Seminar on Chemistry* 2349, 020007. <https://doi.org/10.1063/5.0052360>
- Ariyanto, T., Masrurroh, K., Pambayun, G.Y.S., Mukti, N.I.F., Cahyono, R.B., Prasetya, A., Prasetyo, I., 2021. Improving the Separation of CO<sub>2</sub>/CH<sub>4</sub> Using Impregnation of Deep Eutectic Solvents on Porous Carbon. *ACS Omega* 6, 19194–19201. <https://doi.org/10.1021/acsomega.1c02545>

- Awe, O.W., Zhao, Y., Nzihou, A., Minh, D.P., Lyczko, N., 2017. A Review of Biogas Utilisation, Purification and Upgrading Technologies. *Waste Biomass Valorization* 8, 267–283. <https://doi.org/10.1007/s12649-016-9826-4>
- Bai, B.C., Cho, S., Yu, H.-R.R., Yi, K.B., Kim, K.-D.D., Lee, Y.-S.S., 2013. Effects of aminated carbon molecular sieves on breakthrough curve behavior in CO<sub>2</sub>/CH<sub>4</sub> separation. *Journal of Industrial and Engineering Chemistry* 19, 776–783. <https://doi.org/10.1016/j.jiec.2012.10.016>
- Banerjee, R., Furukawa, H., Britt, D., Knobler, C., O’Keeffe, M., Yaghi, O.M., 2009. Control of Pore Size and Functionality in Isorecticular Zeolitic Imidazolate Frameworks and their Carbon Dioxide Selective Capture Properties. *J Am Chem Soc* 131, 3875–3877. <https://doi.org/10.1021/ja809459e>
- Bhatnagar, A., Hogland, W., Marques, M., Sillanpää, M., 2013. An overview of the modification methods of activated carbon for its water treatment applications. *CHEMICAL ENGINEERING JOURNAL* 219, 499–511. <https://doi.org/10.1016/j.cej.2012.12.038>
- Brockner, W., Ehrhardt, C., Gjikaj, M., 2007. Thermal decomposition of nickel nitrate hexahydrate, Ni(NO<sub>3</sub>)<sub>2</sub>·6H<sub>2</sub>O, in comparison to Co(NO<sub>3</sub>)<sub>2</sub>·6H<sub>2</sub>O and Ca(NO<sub>3</sub>)<sub>2</sub>·4H<sub>2</sub>O. *Thermochim Acta* 456, 64–68. <https://doi.org/10.1016/j.tca.2007.01.031>
- Buasri, A., Chaikut, N., Nakweang, C., 2011. Preparing activated carbon from palm shell for biodiesel fuel production. *Chiang Mai Journal of Science* 38, 572–578.
- Cai, H., Wei, Q., Xiao, H., Liu, H., Wang, J., 2020. Preparation and microwave absorption properties of petal CoO/CNFs composites. *Journal of Materials Science: Materials in Electronics* 31, 7606–7615. <https://doi.org/10.1007/s10854-020-03231-y>
- Carrott, P.J.M.M., Cansado, I.P.P.P., Carrott, M.M.L.R.L.R., 2006. Carbon molecular sieves from PET for separations involving CH<sub>4</sub>, CO<sub>2</sub>, O<sub>2</sub> and N<sub>2</sub>. *Appl Surf Sci* 252, 5948–5952. <https://doi.org/10.1016/j.apsusc.2005.11.014>
- Caskey, S.R., Wong-Foy, A.G., Matzger, A.J., 2008. Dramatic tuning of carbon dioxide uptake via metal substitution in a coordination polymer with cylindrical pores. *J Am Chem Soc* 130, 10870–10871. <https://doi.org/10.1021/ja8036096>
- Chagger, H.K., Ndaji, F.E., Sykes, M.L., Thomas, K.M., 1995. Kinetics of adsorption and diffusional characteristics of carbon molecular sieves. *Carbon N Y* 33, 1405–1411. [https://doi.org/10.1016/0008-6223\(95\)00087-T](https://doi.org/10.1016/0008-6223(95)00087-T)
- Chen, C., Ahn, W.S., 2014. CO<sub>2</sub> adsorption on LTA zeolites: Effect of mesoporosity. *Appl Surf Sci* 311, 107–109. <https://doi.org/10.1016/j.apsusc.2014.04.218>
- Chen, D.-L.L., Shang, H., Zhu, W., Krishna, R., 2014. Transient breakthroughs of CO<sub>2</sub>/CH<sub>4</sub> and C<sub>3</sub>H<sub>6</sub>/C<sub>3</sub>H<sub>8</sub> mixtures in fixed beds packed with Ni-MOF-74. *Chem Eng Sci* 117, 407–415. <https://doi.org/10.1016/j.ces.2014.07.008>

- Chen, X.Y., Vinh-Thang, H., Ramirez, A.A., Rodrigue, D., Kaliaguine, S., 2015. Membrane gas separation technologies for biogas upgrading. *RSC Adv* 5, 24399–24448. <https://doi.org/10.1039/c5ra00666j>
- Chiang, H.L., Chiang, P.C., Huang, C.P., 2002. Ozonation of activated carbon and its effects on the adsorption of VOCs exemplified by methylethylketone and benzene. *Chemosphere* 47, 267–275. [https://doi.org/10.1016/S0045-6535\(01\)00216-8](https://doi.org/10.1016/S0045-6535(01)00216-8)
- Chiang, Y.-C., Juang, R.-S., 2017. Surface modifications of carbonaceous materials for carbon dioxide adsorption: A review. *J Taiwan Inst Chem Eng* 71, 214–234. <https://doi.org/https://doi.org/10.1016/j.jtice.2016.12.014>
- Cho, H.Y., Yang, D.A., Kim, J., Jeong, S.Y., Ahn, W.S., 2012. CO<sub>2</sub> adsorption and catalytic application of Co-MOF-74 synthesized by microwave heating. *Catal Today* 185, 35–40. <https://doi.org/10.1016/j.cattod.2011.08.019>
- Cho, S., Yu, H.R., Choi, T.H., Jung, M.J., Lee, Y.S., 2018. Surface functionalization and CO<sub>2</sub> uptake on carbon molecular sieves: Experimental observation and theoretical study. *Appl Surf Sci* 447, 8–14. <https://doi.org/10.1016/j.apsusc.2018.03.153>
- Choi, S., Watanabe, T., Bae, T.H., Sholl, D.S., Jones, C.W., 2012. Modification of the Mg/DOBDC MOF with amines to enhance CO<sub>2</sub> adsorption from ultradilute gases. *Journal of Physical Chemistry Letters* 3, 1136–1141. <https://doi.org/10.1021/jz300328j>
- da Silva, C.P., dos Santos, A.V., Oliveira, A.S., da Guarda Souza, M.O., 2018. Synthesis of composites and study of the thermal behavior of sugarcane bagasse/iron nitrate mixtures in different proportions. *J Therm Anal Calorim* 131, 611–620. <https://doi.org/10.1007/s10973-017-6260-1>
- D'Alessandro, D.M., Smit, B., Long, J.R., 2010. Carbon dioxide capture: Prospects for new materials. *Angewandte Chemie - International Edition* 49, 6058–6082. <https://doi.org/10.1002/anie.201000431>
- Das, B.K., Haque, S.M.N., Kader, M.A., Rahman, S., 2013. Prospects of Bagasse Gasification Technology for Electricity Generation in Sugar Industries in Bangladesh. *International Conference on Mechanical, Industrial and Materials Engineering*, Rajshahi, Bangladesh, November 1-3 268–272.
- David, E., Talaie, A., Stanciu, V., Nicolae, A.C., 2004. Synthesis of carbon molecular sieves by benzene pyrolysis over microporous carbon materials. *J Mater Process Technol* 157–158, 290–296. <https://doi.org/10.1016/j.jmatprotec.2004.09.046>
- De Salazar, C.G., Sepúlveda-Escribano, A., Rodríguez-Reinoso, F., 2005. Preparation of Carbon Molecular Sieves by Pyrolytic Carbon Deposition. *Adsorption* 11, 663–667. <https://doi.org/10.1007/s10450-005-6003-7>
- Demiral, H., Demiral, İ., 2018. Preparation and characterization of carbon molecular sieves from chestnut shell by chemical vapor deposition. *Advanced Powder*

- DeSantis, D., Mason, J.A., James, B.D., Houchins, C., Long, J.R., Veenstra, M., 2017. Techno-economic Analysis of Metal-Organic Frameworks for Hydrogen and Natural Gas Storage. *Energy and Fuels* 31, 2024–2032. <https://doi.org/10.1021/acs.energyfuels.6b02510>
- Direktorat Jenderal Perkebunan, 2021. Statistik Perkebunan Unggulan Nasional , 2019-2021. Sekretariat Direktorat Jenderal Perkebunan, Direktorat Jendral Perkebunan, Kementerian Pertanian, Jakarta.
- Do, D.D., 1998a. Adsorption Analysis: Equilibria and Kinetics.
- Do, D.D., 1998b. Adsorption Analysis: Equilibria and Kinetics, Chemical Engineering.
- Durán, I., Álvarez-Gutiérrez, N., Rubiera, F., Pevida, C., 2018. Biogas purification by means of adsorption on pine sawdust-based activated carbon: Impact of water vapor. *Chemical Engineering Journal* 353, 197–207. <https://doi.org/10.1016/j.cej.2018.07.100>
- Faizul, C.P., Abdullah, C., Fazlul, B., 2013. Extraction of silica from palm ash using citric acid leaching treatment: Preliminary result, in: *Advanced Materials Research*. pp. 701–706. <https://doi.org/10.4028/www.scientific.net/AMR.795.701>
- Figueiredo, J.L., Pereira, M.F.R., Freitas, M.M.A., Órfão, J.J.M., 1999. Modification of the surface chemistry of activated carbons. *Carbon N Y* 37, 1379–1389. [https://doi.org/10.1016/S0008-6223\(98\)00333-9](https://doi.org/10.1016/S0008-6223(98)00333-9)
- Fogler, H.S., 2011. *Essentials of Chemical Reaction Engineering*. Pearson Education, Inc., London.
- Fu, S., Sanders, E.S., Kulkarni, S.S., Koros, W.J., 2015a. Carbon molecular sieve membrane structure-property relationships for four novel 6FDA based polyimide precursors. *J Memb Sci* 487, 60–73. <https://doi.org/10.1016/j.memsci.2015.03.079>
- Fu, S., Sanders, E.S., Kulkarni, S.S., Wenz, G.B., Koros, W.J., 2015b. Temperature dependence of gas transport and sorption in carbon molecular sieve membranes derived from four 6FDA based polyimides: Entropic selectivity evaluation. *Carbon N Y* 95, 995–1006. <https://doi.org/https://doi.org/10.1016/j.carbon.2015.09.005>
- Gapki, D.J.P.K.P. dan G.P.K.S.I., 2018. Volume produksi kelapa sawit (CPO), 2000-2018 - Lokadata [WWW Document]. URL <https://lokadata.beritagar.id/chart/preview/volume-produksi-kelapa-sawit-cpo-2000-2018-1550473390> (accessed 2.26.21).
- Goldie, S.J., Jiang, S., Coleman, K.S., 2021. Cobalt nanoparticle catalysed graphitization and the effect of metal precursor decomposition temperature. *Mater Adv* 2, 3353–3361. <https://doi.org/10.1039/d1ma00125f>

Günter, U. Von, 2003. Ozonation of drinking water: Part I. Oxidation kinetics and product formation. *Water Res* 37, 1443–1467.

Hägg, M.-B., He, X., 2011. Chapter 15. Carbon Molecular Sieve Membranes for Gas Separation, in: Drioli, E., Barbieri, G. (Eds.), *Membrane Engineering for the Treatment of Gases*. Royal Society of Chemistry, pp. 162–191. <https://doi.org/10.1039/9781849733489-00162>

Hakim, A., Marliza, T.S., Abu Tahari, N.M., Wan Isahak, R.W.N., Yusop, R.M., Mohamed Hisham, W.M., Yarmo, A.M., 2016. Studies on CO<sub>2</sub> Adsorption and Desorption Properties from Various Types of Iron Oxides (FeO, Fe<sub>2</sub>O<sub>3</sub>, and Fe<sub>3</sub>O<sub>4</sub>). *Ind Eng Chem Res* 55, 7888–7897. <https://doi.org/10.1021/acs.iecr.5b04091>

Hardjasaputra, H., Fernando, I., Indrajaya, J., Cornelia, M., Rachmansyah, 2018. The Effect of Using Palm Kernel Shell Ash and Rice Husk Ash on Geopolymer Concrete, in: *MATEC Web of Conferences*. EDP Sciences. <https://doi.org/10.1051/mateconf/201825101044>

Hariani, P.L., Faizal, M., Ridwan, Marsi, Setiabudidaya, D., 2018. Removal of Procion Red MX-5B from songket's industrial wastewater in South Sumatra Indonesia using activated carbon-Fe<sub>3</sub>O<sub>4</sub> composite. *Sustainable Environment Research* 28, 158–164. <https://doi.org/10.1016/j.serj.2018.01.004>

Heidari, A., Younesi, H., Rashidi, A., Ghoreyshi, A.A., 2014. Evaluation of CO<sub>2</sub> adsorption with eucalyptus wood based activated carbon modified by ammonia solution through heat treatment. *Chemical Engineering Journal* 254, 503–513. <https://doi.org/https://doi.org/10.1016/j.cej.2014.06.004>

Hemalatha, P., Palanichamy, M., Murugesan, V., Kwon, S.B., Park, D., Cho, Y., Jang, H.T., 2011. CO<sub>2</sub> adsorption over zinc oxide impregnated NaZSM-5 synthesized using rice husk ash. *Asian Journal of Chemistry* 23, 2806–2810.

Hosseini, S., Bayesti, I., Marahel, E., Eghbali, F., 2015. Adsorption of carbon dioxide using activated carbon impregnated with Cu promoted by zinc. *J Taiwan Inst Chem Eng* 000, 1–9. <https://doi.org/10.1016/j.jtice.2015.02.015>

Hu, Q., Xie, Y., Feng, C., Zhang, Z., 2019. Prediction of breakthrough behaviors using logistic, hyperbolic tangent and double exponential models in the fixed-bed column. *Sep Purif Technol* 212, 572–579. <https://doi.org/10.1016/j.seppur.2018.11.071>

Hu, Z., Vansant, E.F., 1995. Carbon molecular sieves produced from walnut shell. *Carbon N Y* 33, 561–567. [https://doi.org/10.1016/0008-6223\(94\)00141-L](https://doi.org/10.1016/0008-6223(94)00141-L)

Hudson, M.R., Queen, W.L., Mason, J.A., Fickel, D.W., Lobo, R.F., Brown, C.M., 2012. Unconventional, highly selective CO<sub>2</sub> adsorption in zeolite SSZ-13. *J Am Chem Soc* 134, 1970–1973. <https://doi.org/10.1021/ja210580b>



- Ismail, S., Ahmed, A.S., Anr, R., Hamdan, S., 2016. Biodiesel Production from Castor Oil by Using Calcium Oxide Derived from Mud Clam Shell. *Journal of Renewable Energy* 2016, 1–8. <https://doi.org/10.1155/2016/5274917>
- Jang, D., Park, S., 2012. Influence of nickel oxide on carbon dioxide adsorption behaviors of activated carbons. *Fuel* 102, 439–444. <https://doi.org/10.1016/j.fuel.2012.03.052>
- Jaramillo, J., Álvarez, P.M., Gómez-Serrano, V., 2010. Oxidation of activated carbon by dry and wet methods surface chemistry and textural modifications. *Fuel Processing Technology* 91, 1768–1775. <https://doi.org/10.1016/j.fuproc.2010.07.018>
- Jasieńko-Hałat, M., Kędzior, K., 2005. Comparison of molecular sieve properties in microporous chars from low-rank bituminous coal activated by steam and carbon dioxide. *Carbon N Y* 43, 944–953. <https://doi.org/10.1016/j.carbon.2004.11.024>
- Jensen, N.K., Rufford, T.E., Watson, G., Zhang, D.K., Chan, K.I., May, E.F., 2012. Screening zeolites for gas separation applications involving methane, nitrogen, and carbon dioxide. *J Chem Eng Data* 57, 106–113. <https://doi.org/10.1021/je200817w>
- Jiao, W., Ban, Y., Shi, Z., Jiang, X., Li, Y., Yang, W., 2017. Gas separation performance of supported carbon molecular sieve membranes based on soluble polybenzimidazole. *J Memb Sci* 533, 1–10. <https://doi.org/10.1016/j.memsci.2017.03.022>
- Jonnalagadda, M., Anjum, R., Burri, H., Mutyala, S., 2021. Study of CO<sub>2</sub> adsorption and separation using modified porous carbon. *J Chem Res* 45, 194–200. <https://doi.org/10.1177/1747519820938030>
- Jüntgen, H., Knoblauch, K., Harder, K., 1981. Carbon molecular sieves: production from coal and application in gas separation. *Fuel* 60, 817–822. [https://doi.org/10.1016/0016-2361\(81\)90144-7](https://doi.org/10.1016/0016-2361(81)90144-7)
- Kamilah, S., Soh, C., Azzura, A., Rahman, A., Shamsuddin, M., 2018. Synthesis and Physicochemical Properties of Magnetite Nanoparticles ( Fe<sub>3</sub>O<sub>4</sub> ) as Potential Solid Support for Homogeneous Catalysts. *Malaysian J. Anal. Sci.* 22, 768–774. <https://doi.org/10.17576/mjas-2018-2205-04>
- Kaningini, A.G., Azizi, S., Sintwa, N., Mokalane, K., Mohale, K.C., Mudau, F.N., Maaza, M., 2022. Effect of Optimized Precursor Concentration, Temperature, and Doping on Optical Properties of ZnO Nanoparticles Synthesized via a Green Route Using Bush Tea (*Athrixia phylicoides* DC.) Leaf Extracts. *ACS Omega* 7, 31658–31666. <https://doi.org/10.1021/acsomega.2c00530>
- Karra, J.R., Grabicka, B.E., Huang, Y.G., Walton, K.S., 2013. Adsorption study of CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>, and H<sub>2</sub>O on an interwoven copper carboxylate metal-organic framework (MOF-14). *J Colloid Interface Sci* 392, 331–336. <https://doi.org/10.1016/j.jcis.2012.10.018>

- Kawabuchi, Y., Kishino, M., Kawano, S., Whitehurst, D., Mochida, I., 1996. Carbon deposition from benzene and cyclohexane onto active carbon fiber to control its pore size. *Langmuir* 12, 4281–4285. <https://doi.org/10.1021/la960292a>
- Kawabuchi, Y., Sotowa, C., Kuroda, K., Kawano, S., Whitehurst, D.D., Mochida, I., 1998. Chemical Vapor Deposition of Organic Compounds over Active Carbon Fiber to Control Its Porosity and Surface Function. *ACS Symposium Series* 681, 61–70. <https://doi.org/10.1021/la961052y>
- Khalil, S.H., Aroua, M.K., Daud, W.M.A.W., 2012. Study on the improvement of the capacity of amine-impregnated commercial activated carbon beds for CO<sub>2</sub> adsorbing. *Chemical Engineering Journal* 183, 15–20. <https://doi.org/10.1016/j.cej.2011.12.011>
- Khan, M.U., Lee, J.T.E., Bashir, M.A., Dissanayake, P.D., Ok, Y.S., Tong, Y.W., Shariati, M.A., Wu, S., Ahring, B.K., 2021. Current status of biogas upgrading for direct biomethane use: A review. *Renewable and Sustainable Energy Reviews* 149, 111343. <https://doi.org/10.1016/j.rser.2021.111343>
- Khelifa, A., Benchehida, L., Derriche, Z., 2004. Adsorption of carbon dioxide by X zeolites exchanged with Ni<sup>2+</sup> and Cr<sup>3+</sup>: Isotherms and isosteric heat. *J Colloid Interface Sci* 278, 9–17. <https://doi.org/10.1016/j.jcis.2004.05.033>
- Kim, B., Cho, K., Park, S., 2010. Journal of Colloid and Interface Science Copper oxide-decorated porous carbons for carbon dioxide adsorption behaviors. *J Colloid Interface Sci* 342, 575–578. <https://doi.org/10.1016/j.jcis.2009.10.045>
- Kim, M.B., Bae, Y.S., Ahn, H., Lee, C.H., 2004. Comparison of adsorption dynamics in kinetic and equilibrium beds in hydrogen ternary system. *Sep Sci Technol* 39, 2951–2976. <https://doi.org/10.1081/SS-200035947>
- Kirbiyikkurukavak, Ã., Büyükbekar, B.Z., Ersöz, M., 2021. PAN-based activated carbon nanofiber/metal oxide composites for CO<sub>2</sub> and CH<sub>4</sub> adsorption: Influence of metal oxide. *Turk J Chem* 45, 914–926. <https://doi.org/10.3906/kim-2012-37>
- Kiyono, M., Koros, W.J., Williams, P.J., 2011. Correlation Between Pyrolysis Atmosphere and Carbon Molecular Sieve Membrane Performance Properties, 1st ed, Inorganic Polymeric and Composite Membranes. Elsevier BV. <https://doi.org/10.1016/B978-0-444-53728-7.00007-0>
- Kiyono, M., Williams, P.J., Koros, W.J., 2010. Effect of polymer precursors on carbon molecular sieve structure and separation performance properties. *Carbon N Y* 48, 4432–4441. <https://doi.org/10.1016/j.carbon.2010.08.002>
- Lahuri, A.H., Yarmo, M.A., Marliza, T.S., Abu Tahari, M.N., Samad, W.Z., Dzakaria, N., Yusop, M.R., 2017. Carbon dioxide adsorption and desorption study using bimetallic calcium oxide impregnated on iron (III) oxide. *Materials Science Forum* 888 MSF, 479–484. <https://doi.org/10.4028/www.scientific.net/MSF.888.479>

Lee, C.S., Ong, Y.L., Aroua, M.K., Daud, W.M.A.W., 2013. Impregnation of palm shell-based activated carbon with sterically hindered amines for CO<sub>2</sub> adsorption. *Chemical Engineering Journal* 219, 558–564. <https://doi.org/10.1016/j.cej.2012.10.064>

Lekota, M.W., Dimpe, K.M., Nomngongo, P.N., 2019. MgO-ZnO / carbon nanofiber nanocomposite as an adsorbent for ultrasound-assisted dispersive solid-phase microextraction of carbamazepine from wastewater prior to high-performance liquid chromatographic detection 1, 1–12.

Lesiak, B., Rangam, N., Jiricek, P., Gordeev, I., Tóth, J., Kövér, L., Mohai, M., Borowicz, P., 2019. Surface Study of Fe<sub>3</sub>O<sub>4</sub> Nanoparticles Functionalized With Biocompatible Adsorbed Molecules. *Front Chem* 7, 1–16. <https://doi.org/10.3389/fchem.2019.00642>

Li, Y., Yi, H., Tang, X., Li, F., Yuan, Q., 2013. Adsorption separation of CO<sub>2</sub>/CH<sub>4</sub> gas mixture on the commercial zeolites at atmospheric pressure. *Chemical Engineering Journal* 229, 50–56. <https://doi.org/10.1016/j.cej.2013.05.101>

Liu, J., Wang, Y., Benin, A.I., Jakubczak, P., Willis, R.R., LeVan, M.D., 2010. CO<sub>2</sub>/H<sub>2</sub>O adsorption equilibrium and rates on metal-organic frameworks: HKUST-1 and Ni/DOBDC. *Langmuir* 26, 14301–14307. <https://doi.org/10.1021/la102359q>

Liu, Q., Zheng, T., Li, N., Wang, P., Abulikemu, G., 2010. Applied Surface Science Modification of bamboo-based activated carbon using microwave radiation and its effects on the adsorption of methylene blue 256, 3309–3315. <https://doi.org/10.1016/j.apsusc.2009.12.025>

Liu, Y., Hu, E., Khan, E.A., Lai, Z., 2010. Synthesis and characterization of ZIF-69 membranes and separation for CO<sub>2</sub>/CO mixture. *J Memb Sci* 353, 36–40. <https://doi.org/10.1016/j.memsci.2010.02.023>

Lizzio, A.A., Rostam-Abadi, M., 1993. Production of carbon molecular sieves from Illinois coal. *Fuel Processing Technology* 34, 97–122. [https://doi.org/10.1016/0378-3820\(93\)90094-K](https://doi.org/10.1016/0378-3820(93)90094-K)

Loiseau, T., Lecroq, L., Volkringer, C., Marrot, J., Ferey, G., Haouas, M., Taulelle, F., Bourrelly, S., Llewellyn, P.L., Latroche, M., 2006. MIL-96, a Porous Aluminum Trimesate 3D Structure Constructed from a Hexagonal Network of 18-Membered Rings and Oxo-Centered Trinuclear Units. *J. Am. Chem. Soc.* 128, 10223–10230.

Lota, G., Krawczyk, P., Lota, K., Sierczy, A., 2016. The application of activated carbon modified by ozone treatment for energy storage. *Journal of Solid State Electrochemistry* 20, 2857–2864. <https://doi.org/10.1007/s10008-016-3293-5>

Lou, W., Yang, J., Li, L., Li, J., 2014. Adsorption and separation of CO<sub>2</sub> on Fe(II)-MOF-74: Effect of the open metal coordination site. *J Solid State Chem* 213, 224–228. <https://doi.org/10.1016/j.jssc.2014.03.005>



Maile, O.I., Muzenda, E., Tesfagiorgis, H., 2017. Chemical Absorption of Carbon Dioxide in Biogas Purification. *Procedia Manuf* 7, 639–646. <https://doi.org/10.1016/j.promfg.2016.12.095>

Makoś, P., Słupek, E., Małachowska, A., 2020. Silica gel impregnated by deep eutectic solvents for adsorptive removal of BTEX from Gas Streams. *Materials* 13. <https://doi.org/10.3390/MA13081894>

Małecka, B., Gajerski, R., Małecki, A., Wierzbicka, M., Olszewski, P., 2003. Mass spectral studies on the mechanism of thermal decomposition of Zn(NO<sub>3</sub>)<sub>2</sub>·nH<sub>2</sub>O. *Thermochim Acta*. [https://doi.org/10.1016/S0040-6031\(03\)00101-1](https://doi.org/10.1016/S0040-6031(03)00101-1)

Martins, A.V.P.R., Ramos, J.E.T., Coelho, J.A., Vidal, C.B., Cavalcante, C.L., Azevedo, D.C.S., 2014. Metal-impregnated carbon applied as adsorbent for removal of sulphur compounds using fixed-bed column technology. *Environmental Technology (United Kingdom)* 35, 1367–1377. <https://doi.org/10.1080/09593330.2013.868530>

Masruroh, K., Cahyono, R.B., Prasetyo, I., Ariyanto, T., 2021. The effect of amine types on breakthrough separation of methane on biogas. *International Journal of Renewable Energy Development* 10, 249–255. <https://doi.org/10.14710/ijred.2021.33514>

Menéndez-Díaz, J.A., Martín-Gullón, I., 2006. Chapter 1 Types of carbon adsorbents and their production. *Interface Science and Technology* 7, 1–47. [https://doi.org/10.1016/S1573-4285\(06\)80010-4](https://doi.org/10.1016/S1573-4285(06)80010-4)

Miltner, M., Makaruk, A., Harasek, M., 2017. Review on available biogas upgrading technologies and innovations towards advanced solutions. *J Clean Prod* 161, 1329–1337. <https://doi.org/10.1016/j.jclepro.2017.06.045>

Miura, K., Hayashi, J., Hashimoto, K., 1991. Production of molecular sieving carbon through carbonization of coal modified by organic additives. *Carbon N Y* 29, 653–660. [https://doi.org/10.1016/0008-6223\(91\)90133-4](https://doi.org/10.1016/0008-6223(91)90133-4)

Mohamed, A.R., Mohammadi, M., Darzi, G.N., 2010. Preparation of carbon molecular sieve from lignocellulosic biomass: A review. *Renewable and Sustainable Energy Reviews* 14, 1591–1599. <https://doi.org/10.1016/j.rser.2010.01.024>

Mohammadi, M., Najafpour, G.D., Mohamed, A.R., 2011a. Dobijanje ugljeničnih molekulskih sita iz palmine ljuske depozicijom ugljenika iz metana. *Chemical Industry and Chemical Engineering Quarterly* 17, 525–533. <https://doi.org/10.2298/CICEQ110506038M>

Mohammadi, M., Najafpour, G.D., Mohamed, A.R., 2011b. Production Of Carbon Molecular Sieves From Palm Shell Through Carbon Deposition From Methane. *Chemical Industry and Chemical Engineering Quarterly* 17, 525–533. <https://doi.org/10.2298/CICEQ110506038M>

- Morali, U., Demiral, H., Sensoz, S., 2020. Preparation of new carbon molecular sieves for optimized carbon dioxide adsorption and product yield. *Xinxing Tan Cailiao/New Carbon Materials* 35, 209–219. [https://doi.org/10.1016/S1872-5805\(20\)60485-1](https://doi.org/10.1016/S1872-5805(20)60485-1)
- Morali, U., Demiral, H., Sensoz, S., 2019. Synthesis of carbon molecular sieve for carbon dioxide adsorption: Chemical vapor deposition combined with Taguchi design of experiment method. *Powder Technol* 355, 716–726. <https://doi.org/10.1016/j.powtec.2019.07.101>
- Moreira, R.F.P.M., José, H.J., Rodrigues, A.E., 2001. Modification of pore size in activated carbon by polymer deposition and its effects on molecular sieve selectivity. *Carbon N Y* 39, 2269–2276. [https://doi.org/10.1016/S0008-6223\(01\)00046-X](https://doi.org/10.1016/S0008-6223(01)00046-X)
- Mugheri, A.Q., Tahira, A., Aftab, U., Abro, M.I., Chaudhry, S.R., Amaral, L., Ibupoto, Z.H., 2019. Facile efficient earth abundant NiO/C composite electrocatalyst for the oxygen evolution reaction. *RSC Adv* 9, 5701–5710. <https://doi.org/10.1039/c8ra10472g>
- Mukti, N.I.F., Prasetyo, I., Mindaryani, A., Septarini, S., 2018. Preparation of porous carbon as ethylene adsorbent by pyrolysis of extraction waste Mangosteen rinds, in: *MATEC Web of Conferences*. <https://doi.org/10.1051/matecconf/201815401032>
- Musa, M., Othuman Mydin, A., Abdul Ghani, A.N., 2018. Optimization of mechanical properties in foamcrete reinforced with raw oil palm empty fruit bunch (EFB) fiber. *MATEC Web of Conferences* 250, 1–9. <https://doi.org/10.1051/matecconf/201825005004>
- Ngo, Y.L.T., Hur, S.H., 2016. Low-temperature NO<sub>2</sub> gas sensor fabricated with NiO and reduced graphene oxide hybrid structure. *Mater Res Bull* 84, 168–176. <https://doi.org/10.1016/j.materresbull.2016.08.004>
- Nohman, A.K.H., Ismail, H.M., Hussein, G.A.M., 1995. Thermal and chemical events in the decomposition course of manganese compounds. *J Anal Appl Pyrolysis* 34, 265–278. [https://doi.org/10.1016/0165-2370\(95\)00896-M](https://doi.org/10.1016/0165-2370(95)00896-M)
- Olajire, A.A., 2010a. CO<sub>2</sub> capture and separation technologies for end-of-pipe applications - A review. *Energy* 35, 2610–2628. <https://doi.org/10.1016/j.energy.2010.02.030>
- Olajire, A.A., 2010b. CO<sub>2</sub> capture and separation technologies for end-of-pipe applications - A review. *Energy* 35, 2610–2628. <https://doi.org/10.1016/j.energy.2010.02.030>
- Park, K.S., Ni, Z., Cote, A.P., Choi, J.Y., Huang, R., Uribe-Romo, F.J., Chae, H.K., O’Keeffe, M., Yaghi, O.M., 2006. ZIFs - first synthesis. *Proceedings of the National Academy of Sciences* 103, 10186–10191. <https://doi.org/10.1073/pnas.0602439103>

- Parshetti, G.K., Chowdhury, S., Balasubramanian, R., 2015. Biomass derived low-cost microporous adsorbents for efficient CO<sub>2</sub> capture. *Fuel* 148, 246–254. <https://doi.org/10.1016/j.fuel.2015.01.032>
- Patel, H., 2019. Fixed-bed column adsorption study: a comprehensive review. *Appl Water Sci* 9, 1–17. <https://doi.org/10.1007/s13201-019-0927-7>
- Plaza, M.G., Pevida, C., Martín, C.F., Feroso, J., Pis, J.J., Rubiera, F., 2010. Developing almond shell-derived activated carbons as CO<sub>2</sub> adsorbents. *Sep Purif Technol* 71, 102–106. <https://doi.org/10.1016/j.seppur.2009.11.008>
- Pop, D., Buzatu, R., Moacă, E.A., Watz, C.G., Cîntă-Pînzaru, S., Tudoran, L.B., Nekvapil, F., Avram, Ștefana, Dehelean, C.A., Crețu, M.O., Nicolov, M., Szuhaneck, C., Jivănescu, A., 2021. Development and characterization of Fe<sub>3</sub>O<sub>4</sub>@carbon nanoparticles and their biological screening related to oral administration. *Materials* 14. <https://doi.org/10.3390/ma14133556>
- Pradita, T., Shih, S.J., Aji, B.B., Sudibyo, 2017. Synthesis of MgO powder from magnesium nitrate using spray pyrolysis. *AIP Conf Proc* 1823. <https://doi.org/10.1063/1.4978089>
- Prasetyo, I., Mukti, N.I.F., Cahyono, R.B., Prasetya, A., Ariyanto, T., 2020a. Nanoporous Carbon Prepared from Palm Kernel Shell for CO<sub>2</sub>/CH<sub>4</sub> Separation. *Waste Biomass Valorization* 11, 5599–5606. <https://doi.org/10.1007/s12649-020-01006-4>
- Prasetyo, I., Mukti, N.I.F., Cahyono, R.B., Prasetya, A., Ariyanto, T., 2020b. Nanoporous Carbon Prepared from Palm Kernel Shell for CO<sub>2</sub>/CH<sub>4</sub> Separation. *Waste Biomass Valorization* 11, 5599–5606. <https://doi.org/10.1007/s12649-020-01006-4>
- Prasetyo, I., Mukti, N.I.F., Cahyono, R.B., Prasetya, A., Ariyanto, T., 2020c. Nanoporous Carbon Prepared from Palm Kernel Shell for CO<sub>2</sub>/CH<sub>4</sub> Separation. *Waste Biomass Valorization* 11, 5599–5606. <https://doi.org/10.1007/s12649-020-01006-4>
- Prasetyo, I., Rochmadi, Wahyono, E., 2010. Pembuatan Ayakan Molekuler Berbasis Karbon Untuk Pemisahan N<sub>2</sub>/O<sub>2</sub> Dari Pirolisis Resin Phenol Formaldehide. *Reaktor* 13, 24–30. <https://doi.org/10.14710/reaktor.13.1.24-30>
- Prasetyo, I., Rochmadi, Wahyono, E., Ariyanto, T., 2017. Controlling synthesis of polymer-derived carbon molecular sieve and its performance for CO<sub>2</sub>/CH<sub>4</sub> separation. *Engineering Journal* 21, 83–94. <https://doi.org/10.4186/ej.2017.21.4.83>
- Prasetyo, Imam, Rochmadi, Wahyono, E., Ariyanto, T., 2017. Controlling synthesis of polymer-derived carbon molecular sieve and its performance for CO<sub>2</sub>/CH<sub>4</sub> separation. *Engineering Journal* 21, 83–94. <https://doi.org/10.4186/ej.2017.21.4.83>
- Qian, D., Lei, C., Wang, E.M., Li, W.C., Lu, A.H., 2014. A method for creating microporous carbon materials with excellent CO<sub>2</sub>-adsorption capacity and selectivity. *ChemSusChem* 7, 291–298. <https://doi.org/10.1002/cssc.201300585>

- Queen, W.L., Hudson, M.R., Bloch, E.D., Mason, J.A., Gonzalez, M.I., Lee, J.S., Gygi, D., Howe, J.D., Lee, K., Darwish, T.A., James, M., Peterson, V.K., Teat, S.J., Smit, B., Neaton, J.B., Long, J.R., Brown, C.M., 2014. Comprehensive study of carbon dioxide adsorption in the metal-organic frameworks M<sub>2</sub>(dobdc) (M = Mg, Mn, Fe, Co, Ni, Cu, Zn). *Chem Sci* 5, 4569–4581. <https://doi.org/10.1039/c4sc02064b>
- Radosz, M., Hu, X., Krutkramelis, K., Shen, Y., 2008. Flue-gas carbon capture on carbonaceous sorbents: Toward a low-cost multifunctional carbon filter for “green” energy producers. *Ind Eng Chem Res* 47, 3783–3794. <https://doi.org/10.1021/ie0707974>
- Rahmadani, D.P., Rahmada, A., Marendra, F., Rimbawan, H.J., Cahyono, R.B., Suherman, Ariyanto, T., 2021. Biogas Purification Using Chitosan-Impregnated Porous Carbon. *Proceedings of the International Conference on Sustainable Biomass (ICSB 2019)* 202, 287–291. <https://doi.org/10.2991/aer.k.210603.051>
- Rajendran, K., Drielak, E., Sudarshan Varma, V., Muthusamy, S., Kumar, G., 2018. Updates on the pretreatment of lignocellulosic feedstocks for bioenergy production—a review. *Biomass Convers Biorefin* 8, 471–483. <https://doi.org/10.1007/s13399-017-0269-3>
- Rashidi, N.A., Yusup, S., 2019. Production of palm kernel shell-based activated carbon by direct physical activation for carbon dioxide adsorption. *Environmental Science and Pollution Research* 26, 33732–33746. <https://doi.org/10.1007/s11356-018-1903-8>
- Razdyakonova, G.I., Kokhanovskaya, O.A., Likholobov, V.A., 2015a. Self-Decomposition of Hydrogen Peroxide on the Surface of Disperse Carbon Black. *Radioelectronics. Nanosystems. Information Technologies.* 7, 180–190. <https://doi.org/10.17725/rensit.2015.07.180>
- Razdyakonova, G.I., Kokhanovskaya, O.A., Likholobov, V.A., 2015b. Self-Decomposition of Hydrogen Peroxide on the Surface of Disperse Carbon Black. *Radioelectronics. Nanosystems. Information Technologies.* 7, 180–190. <https://doi.org/10.17725/rensit.2015.07.180>
- Render, D., Samuel, T., King, H., Vig, M., Jeelani, S., Babu, R.J., Rangari, V., 2016. Biomaterial-Derived Calcium Carbonate Nanoparticles for Enteric Drug Delivery. *J Nanomater* 2016. <https://doi.org/10.1155/2016/3170248>
- Rizal, W.A., Nisa, K., Maryana, R., Prasetyo, D.J., Pratiwi, D., Jatmiko, T.H., Ariani, D., Suwanto, A., 2020. Chemical composition of liquid smoke from coconut shell waste produced by SME in Rongkop Gunungkidul. *IOP Conf Ser Earth Environ Sci* 462. <https://doi.org/10.1088/1755-1315/462/1/012057>
- Ryckebosch, E., Drouillon, M., Vervaeren, H., 2011. Techniques for transformation of biogas to biomethane. *Biomass Bioenergy* 35, 1633–1645. <https://doi.org/10.1016/j.biombioe.2011.02.033>

- Sanebian, S., Zebarjad, S.M., Vahdati Khaki, J., Lazzeri, A., 2016. The decoration of multi-walled carbon nanotubes with nickel oxide nanoparticles using chemical method. *Int Nano Lett* 6, 183–190. <https://doi.org/10.1007/s40089-016-0185-8>
- Sahota, S., Shah, G., Ghosh, P., Kapoor, R., Sengupta, S., Singh, P., Vijay, V.K.V., Sahay, A., Vijay, V.K.V., Thakur, I.S., 2018. Review of trends in biogas upgradation technologies and future perspectives. *Bioresour Technol Rep* 1, 79–88. <https://doi.org/10.1016/j.biteb.2018.01.002>
- Sakib, A.A.M., Masum, S.M., Hoinkis, J., Islam, R., Molla, M.A.I., 2019. Synthesis of cuo/zno nanocomposites and their application in photodegradation of toxic textile dye. *Journal of Composites Science* 3. <https://doi.org/10.3390/jcs3030091>
- Schott, J.A., Wu, Z., Dai, S., Li, M., Huang, K., Schott, J.A., 2017. Effect of metal oxides modification on CO<sub>2</sub> adsorption performance over mesoporous carbon. *Microporous and Mesoporous Materials* 249, 34–41. <https://doi.org/10.1016/j.micromeso.2017.04.033>
- Sethia, G., Somani, R.S., Chand Bajaj, H., 2015. Adsorption of carbon monoxide, methane and nitrogen on alkaline earth metal ion exchanged zeolite-X: Structure, cation position and adsorption relationship. *RSC Adv* 5, 12773–12781. <https://doi.org/10.1039/c4ra11511b>
- Sethupathi, S., Bashir, M.J., Akbar, Z.A., Mohamed, A.R., 2015. Biomass-based palm shell activated carbon and palm shell carbon molecular sieve as gas separation adsorbents. *Waste Management and Research* 33, 303–312. <https://doi.org/10.1177/0734242X15576026>
- Shafeeyan, M.S., Daud, W.M.A.W., Houshmand, A., Arami-Niya, A., 2011. Ammonia modification of activated carbon to enhance carbon dioxide adsorption: Effect of pre-oxidation. *Appl Surf Sci* 257, 3936–3942. <https://doi.org/10.1016/j.apsusc.2010.11.127>
- Shafeeyan, M.S., Daud, W.M.A.W., Houshmand, A., Shamiri, A., 2010a. A review on surface modification of activated carbon for carbon dioxide adsorption. *J Anal Appl Pyrolysis* 89, 143–151. <https://doi.org/10.1016/j.jaap.2010.07.006>
- Shafeeyan, M.S., Daud, W.M.A.W., Houshmand, A., Shamiri, A., 2010b. A review on surface modification of activated carbon for carbon dioxide adsorption. *J Anal Appl Pyrolysis* 89, 143–151. <https://doi.org/10.1016/j.jaap.2010.07.006>
- Shahbandeh, M., 2021. Global production volume palm oil by country 2020/2021 | Statista [WWW Document]. URL <https://www.statista.com/statistics/856231/palm-oil-top-global-producers/> (accessed 2.26.21).
- Shahkarami, S., Dalai, A.K., Soltan, J., 2016. Enhanced CO<sub>2</sub> Adsorption Using MgO-Impregnated Activated Carbon : Impact of Preparation Techniques. *Ind Eng Chem Res* 55, 5955–5964. <https://doi.org/10.1021/acs.iecr.5b04824>



- Silvestre-Albero, A.M., Wahby, A., Silvestre-Albero, J., Rodríguez-Reinoso, F., Betz, W., 2009. Carbon molecular sieves prepared from polymeric precursors: Porous structure and hydrogen adsorption properties. *Ind Eng Chem Res* 48, 7125–7131. <https://doi.org/10.1021/ie900091n>
- Siriwardane, R. V., Shen, M.-S., Fisher, E.P., 2003a. Adsorption of CO<sub>2</sub>, N<sub>2</sub>, and O<sub>2</sub> on Natural Zeolites. *Energy & Fuels* 17, 571–576. <https://doi.org/10.1021/ef020135l>
- Siriwardane, R. V., Shen, M.-S., Fisher, E.P., 2003b. Adsorption of CO<sub>2</sub>, N<sub>2</sub>, and O<sub>2</sub> on Natural Zeolites. *Energy & Fuels* 17, 571–576. <https://doi.org/10.1021/ef020135l>
- Siriwardane, R. V., Shen, M.S., Fisher, E.P., Poston, J.A., 2001. Adsorption of CO<sub>2</sub> on molecular sieves and activated carbon. *Energy and Fuels* 15, 279–284. <https://doi.org/10.1021/ef000241s>
- Sivakumar, V.M., Lam, K.K., Mohamed, A.R., 2010. Synthesis of carbon molecular sieve from palm shell using deposition of polyfurfuryl alcohol. *Journal of the Korean Chemical Society* 54, 323–328. <https://doi.org/10.5012/jkcs.2010.54.3.323>
- Son, S.J., Choi, J.S., Choo, K.Y., Song, S.D., Vijayalakshmi, S., Kim, T.H., 2005. Development of carbon dioxide adsorbents using carbon materials prepared from coconut shell. *Korean Journal of Chemical Engineering* 22, 291–297. <https://doi.org/10.1007/BF02701500>
- Srichat, A., Suntivarakorn, R., Kamwilaisak, K., 2017. A Development of Biogas Purification System Using Calcium Hydroxide and Amine Solution. *Energy Procedia* 138, 441–445. <https://doi.org/10.1016/j.egypro.2017.10.196>
- Su, D., Men, J.A., 2004. On the nature of basic sites on carbon surfaces : An overview 42, 1219–1225. <https://doi.org/10.1016/j.carbon.2004.01.023>
- Tae-Hwan, K., Vijayalakshmi, S., Jin, S.S., Dong, K.J., 2003a. Carbon molecular sieves (CMS) from coconut shell by carbonization and carbon dioxide activation. *Indian Journal of Chemical Technology* 10, 298–304.
- Tae-Hwan, K., Vijayalakshmi, S., Jin, S.S., Dong, K.J., 2003b. Carbon molecular sieves (CMS) from coconut shell by carbonization and carbon dioxide activation. *Indian Journal of Chemical Technology* 10, 298–304.
- Tamaekong, N., Liewhiran, C., Phanichphant, S., 2014. Synthesis of thermally spherical CuO nanoparticles. *J Nanomater* 2014. <https://doi.org/10.1155/2014/507978>
- Tucureanu, V., Alina, M., Andrei, M.A., 2016. FTIR spectroscopy for carbon family study. *Crit Rev Anal Chem* 46, 502–520. <https://doi.org/10.1080/10408347.2016.1157013>
- Ullah Khan, I., Hafiz Dzarfan Othman, M., Hashim, H., Matsuura, T., Ismail, A.F., Rezaei-DashtArzhandi, M., Wan Azelee, I., 2017. Biogas as a renewable energy fuel – A review of biogas upgrading, utilisation and storage. *Energy Convers Manag* 150, 277–294. <https://doi.org/10.1016/j.enconman.2017.08.035>

- Vagner, C., Finqueneisel, G., Zimny, T., Burg, P., Grzyb, B., Machnikowski, J., Weber, J. V., 2003. Characterization of the surface properties of nitrogen-enriched carbons by inverse gas chromatography methods. *Carbon N Y* 41, 2847–2853. [https://doi.org/10.1016/S0008-6223\(03\)00412-3](https://doi.org/10.1016/S0008-6223(03)00412-3)
- Vakili, M.H.A.R.M.H., 2017. Preparation of carbon molecular sieves and its impregnation with Co and Ni for CO<sub>2</sub> / N<sub>2</sub> separation. *International Journal of Environmental Science and Technology*. <https://doi.org/10.1007/s13762-017-1526-5>
- Valdés, H., Sánchez-Polo, M., Rivera-Utrilla, J., Zaror, C.A., 2002. Effect of ozone treatment on surface properties of activated carbon. *Langmuir* 18, 2111–2116. <https://doi.org/10.1021/la010920a>
- Verma, S.K., Walker, P.L., 1993. Preparation of carbon molecular sieves by propylene pyrolysis over nickel-impregnated activated carbons. *Carbon N Y* 31, 1203–1207. [https://doi.org/10.1016/0008-6223\(93\)90073-J](https://doi.org/10.1016/0008-6223(93)90073-J)
- Vu, D.Q., Koros, W.J., Miller, S.J., 2002. High pressure CO<sub>2</sub>/CH<sub>4</sub> separation using carbon molecular sieve hollow fiber membranes. *Ind Eng Chem Res* 41, 367–380. <https://doi.org/10.1021/ie010119w>
- Vyas, S.N., patwardhan, S.R., gangadhar, B., 1992. Carbon molecular sieves from bituminous coal by controlled coke deposition. *Carbon N Y* 30, 605–612. [https://doi.org/10.1016/0008-6223\(92\)90179-Z](https://doi.org/10.1016/0008-6223(92)90179-Z)
- Wahby, A., Silvestre-Albero, J., Sepúlveda-Escribano, A., Rodríguez-Reinoso, F., 2012. CO<sub>2</sub> adsorption on carbon molecular sieves. *Microporous and Mesoporous Materials* 164, 280–287. <https://doi.org/10.1016/j.micromeso.2012.06.034>
- Wang, Q., Luo, J., Zhong, Z., Borgna, A., 2011. CO<sub>2</sub> capture by solid adsorbents and their applications: Current status and new trends. *Energy Environ Sci* 4, 42–55. <https://doi.org/10.1039/c0ee00064g>
- Wang, Z., Cohen, S.M., 2009. Postsynthetic modification of metal–organic frameworks. *Chem Soc Rev* 38, 1315–1329. <https://doi.org/10.1039/b802258p>
- Widhiyanuriyawan, D., Sugiarto, 2014. Biogas purification using natural zeolite and NaOH. *Applied Mechanics and Materials* 664, 415–418. <https://doi.org/10.4028/www.scientific.net/AMM.664.415>
- Wu, L., Xue, M., Qiu, S.L., Chaplais, G., Simon-Masseron, A., Patarin, J., 2012. Amino-modified MIL-68(In) with enhanced hydrogen and carbon dioxide sorption enthalpy. *Microporous and Mesoporous Materials* 157, 75–81. <https://doi.org/10.1016/j.micromeso.2011.12.034>
- Xia, Y., Zhu, Y., Tang, Y., 2012. Preparation of sulfur-doped microporous carbons for the storage of hydrogen and carbon dioxide. *Carbon N Y* 50, 5543–5553. <https://doi.org/10.1016/j.carbon.2012.07.044>

- Xian, S., Wu, Y., Wu, J., Wang, X., Xiao, J., 2015. Enhanced Dynamic CO<sub>2</sub> Adsorption Capacity and CO<sub>2</sub>/CH<sub>4</sub> Selectivity on Polyethylenimine-Impregnated UiO-66. *Ind Eng Chem Res* 54, 11151–11158. <https://doi.org/10.1021/acs.iecr.5b03517>
- Xiao, J., Wei, J., 1992. Diffusion of Hydrocarbons Theory. *Chem Eng Sci* 47, 1123–1141.
- Yang, W., Du, Z., Ma, Z., Wang, G., Bai, H., Shao, G., 2016. Facile synthesis of nitrogen-doped hierarchical porous lamellar carbon for high-performance supercapacitors. *RSC Adv* 6, 3942–3950. <https://doi.org/10.1039/c5ra21431a>
- Yang, Z., Wang, D., Meng, Z., Li, Y., 2019a. Adsorption separation of CH<sub>4</sub>/N<sub>2</sub> on modified coal-based carbon molecular sieve. *Sep Purif Technol* 218, 130–137. <https://doi.org/10.1016/j.seppur.2019.02.048>
- Yang, Z., Wang, D., Meng, Z., Li, Y., 2019b. Adsorption separation of CH<sub>4</sub>/N<sub>2</sub> on modified coal-based carbon molecular sieve. *Sep Purif Technol* 218, 130–137. <https://doi.org/10.1016/j.seppur.2019.02.048>
- Yazaydin, A.Ö., Snurr, R.Q., Park, T.H., Koh, K., Liu, J., LeVan, M.D., Benin, A.I., Jakubczak, P., Lanuza, M., Galloway, D.B., Low, J.J., Willis, R.R., 2009. Screening of metal-organic frameworks for carbon dioxide capture from flue gas using a combined experimental and modeling approach. *J Am Chem Soc* 131, 18198–18199. <https://doi.org/10.1021/ja9057234>
- Yoda, S., Hasegawa, A., Suda, H., Uchamaru, Y., Haraya, K., Tsuji, T., Otake, K., 2004. Preparation of a Platinum and Palladium / Polyimide Nanocomposite Film as a Precursor of Metal-Doped Carbon Molecular Sieve Membrane via Supercritical 2363–2368.
- Younas, M., Sohail, M., Kong, L.L., Bashir, M.J.K., Sethupathi, S., 2016. Feasibility of CO<sub>2</sub>adsorption by solid adsorbents: a review on low-temperature systems. *International Journal of Environmental Science and Technology* 13, 1839–1860. <https://doi.org/10.1007/s13762-016-1008-1>
- Yu, L., Song, M., Wei, Y., Xiao, J., 2018. Combining carbon fibers with Ni/γ-Al<sub>2</sub>O<sub>3</sub> used for syngas production: Part A: Preparation and evaluation of complex carrier catalysts. *Catalysts* 8. <https://doi.org/10.3390/catal8120658>
- Yustanti, E., Kusumawati, H., Partuti, T., Mursito, A.T., 2019. The effects of hot briquetting on the coke strength in the biocoke making process with coal blending method. *IOP Conf Ser Mater Sci Eng* 478. <https://doi.org/10.1088/1757-899X/478/1/012025>
- Zhang, J., Singh, R., Webley, P.A., 2008. Alkali and alkaline-earth cation exchanged chabazite zeolites for adsorption based CO<sub>2</sub> capture. *Microporous and Mesoporous Materials* 111, 478–487. <https://doi.org/10.1016/j.micromeso.2007.08.022>
- Zhang, R., 2012. Biogas Production Technologies. *Biogas and Fuel Cell Workshop* 1–8.

- Zhang, Y., Ji, X., Lu, X., 2018. Choline-based deep eutectic solvents for CO<sub>2</sub> separation : Review and thermodynamic analysis. *Renewable and Sustainable Energy Reviews* 97, 436–455. <https://doi.org/10.1016/j.rser.2018.08.007>
- Zhao, Y., Liu, X., Yao, K.X., Zhao, L., Han, Y., 2012. Superior capture of CO<sub>2</sub> achieved by introducing extra-framework cations into N-doped microporous carbon. *Chemistry of Materials* 24, 4725–4734. <https://doi.org/10.1021/cm303072n>
- Zhou, D., Liu, Q., Cheng, Q.Y., Zhao, Y.C., Cui, Y., Wang, T., Han, B.H., 2012. Graphene-manganese oxide hybrid porous material and its application in carbon dioxide adsorption. *Chinese Science Bulletin* 57, 3059–3064. <https://doi.org/10.1007/s11434-012-5158-3>
- Zhou, G., Xu, C., Cheng, W., Zhang, Q., Nie, W., 2015. Effects of Oxygen Element and Oxygen-Containing Functional Groups on Surface Wettability of Coal Dust with Various Metamorphic Degrees Based on XPS Experiment. *J Anal Methods Chem* 2015, 1–8. <https://doi.org/https://doi.org/10.1155/2015/467242>
- Zulkurnai, N.Z., Mohammad Ali, U.F., Ibrahim, N., Abdul Manan, N.S., 2017. Carbon Dioxide (CO<sub>2</sub>) Adsorption by Activated Carbon Functionalized with Deep Eutectic Solvent (DES). *IOP Conf Ser Mater Sci Eng* 206. <https://doi.org/10.1088/1757-899X/206/1/012001>