



REFERENCES

- Alonso, D.M., Mariscal, R., Moreno-Tost, R., Poves, M.D., and Granados, M. (2007) Potassium leaching during triglyceride transesterification using K/ γ -Al₂O₃ catalysts. *Catalysis Communications*, 8, 2080–2086.
- Coates, J. (2000) Interpretation of infrared spectra, a practical approach. *Encyclopedia of Analytical Chemistry*. Chichester: John Wiley & Sons Ltd.
- Di Serio, M., Ledda, M., Cozzolino, M., Minutillo, G., Tesser, R., and Santacesaria, E. (2006) Transesterification of soybean oil to biodiesel by using heterogeneous basic catalysts. *Industrial & Engineering Chemistry Research*, 45, 3009–3014.
- Di Serio, M., Tesser, R., Dimiccoli, M., Cammarota, F., Nastasi, M., and Santacesaria, E. (2006) Synthesis of biodiesel via homogeneous Lewis acid catalyst. *Journal of Molecular Catalysis A: Chemical*, 239, 111–115.
- Dmytryshyn, S.L., Dalai, A.K., Chaudhari, S.T., Mishra, H.K., and Reaney, M.J. (2004) Synthesis and characterization of vegetable oil derived esters: evaluation for their diesel additive properties. *Bioresource Technology*, 92, 55–64.
- Encinar, J.M., Gonza'lez, J.F., Rodri'guez, J.J., and Tejedor, A. (2002) Biodiesel fuels from vegetable oils: transesterification of *cynara cardunculus* l. oils with ethanol. *Energy & Fuels*, 16, 443–450.
- Fangrui, M. and Hanna, M. (1999) Biodiesel production: a review. *Bioresource Technology*, 70, 1–15.
- Fernandes, M., Saad, E., Meira, J., Ramos, L., Mitchell, D., and Krieger, N. (2007) Esterification and transesterification reactions catalysed by addition of fermented solid to organic reaction media. *Journal of Molecular Catalysis*, 44, 8–13.
- Foidl, N., Foidl, G., Sanchez, M., Mittelbach, M., and Hackel, S. (1996) *Jatropha curcas* L. as a source for the production of biodiesel in Nicaragua. *Bioresource Technology*, 58, 77–82.

- Fukuda, H., Kondo, A., and Noda, H. (2001) Review biodiesel fuel production by transesterification of oils. *Journal of Bioscience and Bioengineering*, 92, 405–416.
- Furuta, S., Matsuhashi, H., and Arata, K. (2004) Biodiesel fuel production with solid superacid catalysis in fixed bed reactor under atmospheric pressure. *Catalysis Communications*, 5, 721–723.
- Furuta, S., Matsuhashi, H., and Arata, K. (2006) Biodiesel fuel production with solid amorphous-zirconia catalysis in fixed bed reactor. *Biomass and Bioenergy*, 30, 870–873.
- Ghesti, G.F., Macedo, J.L., Resck, I.S., Dias, J.A., and Dias, S.C.L. (2007) FT-Raman spectroscopy quantification of biodiesel in a progressive soybean oil transesterification reaction and its correlation with ^1H NMR spectroscopy methods. *Energy & Fuels*, 21, 2475–2480.
- Gryglewicz, S. (1999) Rapeseed oil methyl esters preparation using heterogeneous catalysts. *Bioresource Technology*, 70, 249–253.
- Harrington, K. and D'Arcy-Evans, C. (1985) Transesterification in situ of sunflower seed oil. *Industrial and Engineering Chemistry, Product Research and Development*, 24, 314–318.
- He, H., Wang, T., and Zhu, S. (2007) Continuous production of biodiesel fuel from vegetable oil using supercritical methanol process. *Fuel*, 86, 442–447.
- Iangthanarat, S. (2008) Transesterification of palm oil using KOH/ZrO₂ and KOH/Mordenite as a heterogeneous catalyst. M.S. Thesis, The Petroleum and Petrochemical College, Chulalongkorn University, Bangkok, Thailand.
- Jitputti, J., Kitiyanan, B., Rangsuvigit, P., Bunyakiat, K., Attanatho, L., and Jenvanitpanjakul, P. (2006) Transesterification of crude palm kernel oil and crude coconut oil by different solid catalysts. *Chemical Engineering Journal*, 116, 61–66.
- Johnson, L.A. and Lusas, E.W. (1983) Comparison of alternative solvents for oils extraction. *Journal of the American Oil Chemists' Society*, 60, 229–242.
- Karmee, S. and Chadha, A. (2005) Preparation of biodiesel from crude oil of *Pongamia pinnata*. *Bioresource Technology*, 96, 1425–1429.

- Kitakawa, N., Honda, H., Kuribayashi, H., Toda, T., Fukumura, T., and Yonemoto, T. (2007) Biodiesel production using anionic ion-exchange resin as heterogeneous catalyst. *Bioresource Technology*, 98, 416–421.
- Knothe, G. (2001) Analytical methods used in the production and fuel quality assessment of biodiesel. *Transactions of the ASAE*, 44, 193–200.
- Kusdiana, D. and Saka, S. (2001) Kinetics of transesterification in rapeseed oil to biodiesel fuel as treated in supercritical methanol. *Fuel*, 80, 693–698.
- Leevijit, T., Tongurai, C., Prateepchaikul, G., and Wisutmethangoon, W. (2008) Performance test of a 6-stage continuous reactor for palm methyl ester production. *Bioresource Technology*, 99, 214–221.
- Lima, J., Silva, R., Moura, E., and Moura, C. (2008) Biodiesel of tucum oil, synthesized by methanolic and ethanolic routes. *Fuel*, 87, 1718–1723.
- Liu, X., He, H., Wang, Y., and Zhu, S. (2007) Transesterification of soybean oil to biodiesel using SrO as a solid base catalyst. *Catalysis Communications*, 8, 1107–1111.
- Longloilert, R. (2008) Factors affecting transesterification of palm oil into biodiesel in the presence of NaOH and ZrO₂. M.S. Thesis, The Petroleum and Petrochemical College, Chulalongkorn University, Bangkok, Thailand.
- Lopez, D.E., Goodwin, J.G., Bruce, D.A., and Edgar, L. (2005) Transesterification of triacetin with methanol on solid acid and base catalysts. *Applied Catalysis A: General*, 295, 97–105.
- Marchetti, J.M., Miguel, V.U., and Errazu, A.F. (2007) Possible methods for biodiesel production. *Renewable and Sustainable Energy Reviews*, 11, 1300–1311.
- Marchetti, J.M. and Errazu, A.F. (2008) Esterification of free fatty acids using sulfuric acid as catalyst in the presence of triglycerides. *Biomass and Bioenergy*, 32, 892–895.
- Meher, L.C., Sagar, D., and Naik, S.N. (2006) Technical aspects of biodiesel production by transesterification—a review. *Renewable and Sustainable Energy Reviews*, 10, 248–268.
- Mittelbach, M. and Remschmidt, C. (2004) *Biodiesel The Comprehensive Handbook*. Vienna: Boersedruck Ges.m.b.H.

- Monteiro, M.R., Ambrozin, A.R., Lião, L.M., and Ferreira, A.G. (2008) Critical review on analytical methods for biodiesel characterization. *Talanta*, 77, 593–605.
- Noiroj, K. (2007) A comparative study of KOH/Al₂O₃ and KOH/NaY catalysts for biodiesel production via transesterification from palm oil. M.S. Thesis, The Petroleum and Petrochemical College, Chulalongkorn University, Bangkok, Thailand.
- Ostroumov, M. and Corona-Chávez, P. (2003) Mineralogical study of mordenite from the Sierra Madre del Sur, southwestern Mexico. *Revista Mexicana de Ciencias Geológicas*, 20, 133–138.
- Park, Y.M., Lee, D.W., Kim, D.K., Lee, J.S., and Lee, K.Y. (2008) The heterogeneous catalyst system for the continuous conversion of free fatty acids in used vegetable oils for the production of biodiesel. *Catalysis Today*, 131, 238–243.
- Peterson, G.R. and Scarrah, W.P. (1984) Rapeseed oil transesterification by heterogeneous catalysis. *American Oil Chemist Society*, 10, 1593–1597.
- Pinto, A.C., Guarieiro, L.N., Rezende, M.C., Ribeiro, N.M., Torres, E.A., Lopes, W.A., Pereira, P.A., and Andrade, J.B. (2005) Biodiesel: An Overview. *Journal of the Brazilian Chemical Society*, 16, 1313–1330.
- Powers, D.A. and Gray, H.B. (1973) Characterization of the thermal dehydration of zirconium oxide halide octahydrates. *Inorganic Chemistry*, 12, 2721–2726.
- Ramos, M.J., Casas, A., Rodríguez, L., Romero, R., and Pérez, A. (2008) Transesterification of sunflower oil over zeolites using different metal loading: A case of leaching and agglomeration studies. *Applied Catalysis A: General*, 346, 79–85.
- Rathore, V. and Madras, G. (2007) Synthesis of biodiesel from edible and non-edible oils in supercritical alcohols and enzymatic synthesis in supercritical carbon dioxide. *Fuel*, 86, 2650–2659.
- Ryon, D., Daz, M., Ellenrieder, G., and Locatelli, S. (2007) Enzymatic production of biodiesel from cotton seed oil using *t*-butanol as a solvent. *Bioresource Technology*, 98, 648–653.

- Sahu, H.R. and Rao, G.R. (2000) Characterization of combustion synthesized zirconia powder by UV-vis, IR and other techniques. *Bulletin of Materials Science*, 23, 349–354.
- Salis, A., Pinna, M., Monduzzi, M., and Solinas, V. (2005) Biodiesel production from triolein and short chain alcohols through biocatalysis. *Journal of Biotechnology*, 119, 291–299.
- Salla, I. (2005) Improvement of the properties of zeolites for application in the nitrogen and oxygen separation process and in acid catalysis. Ph.D. Thesis, Universitat Rovira I Virgili, Catalonia, Spain.
- Schuchardt, U., Sercheli, R., and Vargas R.M. (1998) Transesterification of vegetable oils: a Review. *Journal of Brazilian Chemical Society*, 9, 199–210.
- Schuchardt, U., Vargas, R., and Gelbard, G. (1996) Transesterification of soybean oil catalyzed by alkylguanidines heterogenized on different substituted polystyrenes. *Journal of Molecular Catalysis A: Chemical*, 109, 37–44.
- Schwab, A.W., Bagby, M.O., and Freedman, B. (1987) Preparation and properties of diesel fuels from vegetable oils. *Fuel*, 66, 1372–1378.
- Siler-Marinkovic, S. and Tomasevic, A. (1998) Transesterification of sunflower oil in situ. *Fuel*, 77, 1389–1391.
- Srivastava, A. and Prasad, R. (2000) Triglycerides-based diesel fuels. *Renewable and Sustainable Energy Reviews*, 4, 111–133.
- Suppes, G.J., Bockwinkel, K., Lucas, S., Botts, J.B., Mason, M.H., and Heppert, J.A. (2001) Calcium carbonate catalyzed alcoholysis of fats and oils. *Journal of the American Oil Chemists' Society*, 78, 139–146.
- Suppes, G.J., Dasari, M.A., Doskocil, E.J., Mankidy, P.J., and Goff, M.J. (2003) Transesterification of soybean oil with zeolite and metal catalysts. *Applied Catalysis A: General*, 257, 213–223.
- Tittabut, T. and Trakarnpruk, W. (2008) Metal-loaded MgAl oxides for transesterification of glyceryl tributyrate and palm oil. *Industrial & Engineering Chemistry Research*, 47, 2176–2181.

- Vicente, G., Mart, M., and Aracil, J. (2003) Integrated biodiesel production: a comparison of different homogeneous catalysts systems. *Bioresource Technology*, 92, 297–305.
- Wang, J.S. and Wai, C.M. (2007) Transporting metal ions using reverse micelles in alcohol modified supercritical carbon dioxide. *Journal of Supercritical Fluids*, 40, 176–182.
- Wang, Y., Huang, W.Y., Chun, Y., Xia, J.R., and Zhu, J.H. (2001) Dispersion of potassium nitrate and the resulting strong basicity on zirconia. *Chemistry of Materials*, 13, 670–677.
- Xie, W. and Huang, X. (2006) Synthesis of biodiesel from soybean oil using heterogeneous KF/ZnO catalyst. *Catalysis Letters*, 107, 53–59.
- Xie, W., Huang, X., and Li, H. (2007) Soybean oil methyl esters preparation using NaX zeolites loaded with KOH as a heterogeneous catalyst. *Bioresource Technology*, 98, 936–939.
- Xie, W. and Li, H. (2006) Alumina-supported potassium iodide as a heterogeneous catalyst for biodiesel production from soybean oil. *Journal of Molecular Catalysis A: Chemical*, 255, 1–9.
- Xie, W., Peng, H., and Chen, L. (2006) Calcined Mg–Al hydrotalcites as solid base catalysts for methanolysis of soybean oil. *Journal of Molecular Catalysis A: Chemical*, 246, 24–32.
- Xie, W., Peng, H., and Chen, L. (2006) Transesterification of soybean oil catalyzed by potassium loaded on alumina as a solid-base catalyst. *Applied Catalysis A: General*, 300, 67–74.
- Yang, Z. and Xie, W. (2007) Soybean oil transesterification over zinc oxide modified with alkali earth metals. *Fuel Processing Technology*, 88, 631–638.
- Yunus, W.M.M., Fen, Y.W., and Yee, L.M. (2009) Refractive index and Fourier transform infrared spectra of virgin coconut oil and virgin olive oil. *American Journal of Applied Sciences*, 6, 328–331.
- Zhu, J., Chun, Y., Wang, Y., and Xu, Q. (1999) Attempts to create new shape-selective solid strong base catalysts. *Catalysis Today*, 51, 103–111.

Zullaikah, S., Lai, C., Vali, S., and Ju, Y. (2005) A two-step acid-catalyzed process for the production of biodiesel from rice bran oil. Bioresource Technology, 96, 1889–1896.

CURRICULUM VITAE



Name: Ms. Pitchaya Phanthong

Date of Birth: November 6, 1984

Nationality: Thai

University Education:

2003-2007 Bachelor Degree of Science (Chemical Technology), Faculty of Science, Chulalongkorn University, Bangkok, Thailand

Proceeding:

1. Phanthong, P., Luengnaruemitchai, A., and Jai-In, S. (2009, April 22) Biodiesel fuel production with solid catalysis in a fixed-bed reactor. Proceeding of 15th PPC Symposium on Petroleum, Petrochemical, and Polymers, Bangkok, Thailand.

Presentation:

1. Phanthong, P., Luengnaruemitchai, A., and Jai-In, S. (2009, April 22) Biodiesel fuel production with solid catalysis in a fixed-bed reactor. Poster presented at 15th PPC Symposium on Petroleum, Petrochemical, and Polymers, Bangkok, Thailand.