

was investigated. Ethyl ether of cyclohexanecarboxylic acid is of great practical importance as flavoring agents, food additives in food, pharmaceutical and other industries.

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References

- 1 Kégl T. *Modern Carbonylation Methods* / T. Kégl. — Weinheim: Wiley-VCH Verlag GmbH & Co. KGaA, 2008. — P. 161–198. <https://doi.org/10.1002/9783527621545>
- 2 Beller M. *Catalytic Carbonylation Reactions* / M. Beller. — Berlin: Springer, 2006. <https://doi.org/10.1007/b105253>
- 3 Kiss G. Palladium-Catalyzed Reppe Carbonylation / G. Kiss // *Chem. Rev.* — 2001. — Vol. 101. — P. 3435–3456. <https://doi.org/10.1021/cr010328q>
- 4 Nozaki K. *Catalytic Asymmetric Synthesis* / K. Nozaki, I. Ojima. — New York: Wiley, 2000. <https://doi.org/10.1002/9780470584248>
- 5 Носков Ю.Г. Гомогенные палладиевые катализаторы, гидрокарбоалкоксилирование метилацетилена и аллена в синтезе алкилметакрилатов: современное состояние и перспективы / Ю.Г. Носков, Е.Г. Клигер, Е.М. Караськова, Г.А. Корнеева // *Рос. хим. журн.* — 2006. — Т. 50, № 4. — С. 128–140.
- 6 Lapidus A.L. Catalytic synthesis of organic compounds by the carbonylation of unsaturated hydrocarbons and alcohols / A.L. Lapidus, S.D. Pirozhkov // *Russ. Chem. Rev.* — 1989. — Vol. 58, № 2. — P. 117–137. <https://doi.org/10.1070/RC1989v058n02ABEH003430>
- 7 Suerbaev Kh.A. Hydroethoxycarbonylation of α Olefins at Low Pressure of Carbon (II) Oxide in the Presence of the PdCl₂(PPh₃)₂-PPh₃-AlCl₃ system / Kh.A. Suerbaev, N.Zh. Kudaibergenov, A. Vavasori // *Russian Journal of General Chemistry.* — 2017. — Vol. 87, № 4. — P. 707–712. <https://doi.org/10.1134/S1070363217040089>
- 8 Saphan O.A. Methoxycarbonylation of olefins catalysed by homogeneous palladium(II) complexes of (phenoxy)imine ligands bearing alkoxy silane groups / O.A. Saphan, O.O. Stephen // *Inorganica Chimica Acta.* — 2019. — Vol. 489. — P. 236–243. <https://doi.org/10.1016/j.ica.2019.02.025>
- 9 Zhaksylykova G.Zh. Carbonylation of α -olefins with carbon monoxide and alcohols in the presence of palladium phosphine complexes / G.Zh. Zhaksylykova, N.O. Appazov, N.Zh. Kudaibergenov, N.E. Asan // *Chemical journal of Kazakhstan.* — 2019. — No. 2. — С. 134–140.
- 10 Yang J. Promoting Effect of Lewis Acid on the Olefin Hydroesterification Catalyzed by Triphenylphosphine–Palladium Complex / J. Yang, Y. Yuan // *Catal. Lett.* — 2009. — Vol. 131. — P. 643–648. <https://doi.org/10.1007/s10562-009-0007-y>
- 11 Suerbaev Kh.A. Effectiveness of the using of protonic acids as promoters of metal complex catalysts of olefins hydroethoxycarbonylation reaction / Kh.A. Suerbaev, G.Zh. Zhaksylykova, N.O. Appazov, M.K. Kayrgaliev // *News of the academy of sciences of the Republic of Kazakhstan. Series Chemistry and Technology.* — 2015. — Vol. 2, No. 410. — P. 47–53.
- 12 Suerbaev Kh.A. Catalytic Hydroethoxycarbonylation of Octene-1 in the Presence of the System PdCl₂(PPh₃)₂-PPh₃-AlCl₃ / Kh.A. Suerbaev, N.Zh. Kudaibergenov, A.K. Kurmansitova // *Russian Journal of General Chemistry.* — 2016. — Vol. 86, No. 9. — P. 1562–1563. <https://doi.org/10.1134/S1070363217040089>
- 13 Gina M.R. Palladium Complexes with N-Heterocyclic Carbene Ligands As Catalysts for the Alkoxy carbonylation of Olefins / M.R. Gina, J.P. Philip, L.K. Keith // *Organometallics.* — 2013. — Vol. 32. — P. 2033–2036. <https://doi.org/10.1021/om300959f>
- 14 Bibhas R.S. Carbonylation of alkynes, alkenes and alcohols using complex catalysts / R.S. Bibhas, V.C. Raghunath // *Catalysis Surveys from Asia.* — 2005. — Vol. 9, No. 3. — P. 193–205. <https://doi.org/10.1007/s10563-005-7556-x>
- 15 Appazov N.O. Synthesis of Cyclohexyl Isovalerate by Carbonylation of Isobutylene with Carbon Monoxide and Cyclohexanol in the Presence of Pd(PPh₃)₄-PPh₃-TsOH and Its Antimicrobial Activity / N.O. Appazov, S.S. Seitzhanov, A.T. Zhunissov, R.A. Narmanova // *Russian Journal of Organic Chemistry.* — 2017. — Vol. 53, No. 10. — P. 1596–1597. <https://doi.org/10.1134/S1070428017100189>
- 16 Suerbaev Kh.A. Hydromethoxycarbonylation of Isobutylene in the Presence of Tetrakis(triphenylphosphine)palladium-Based Catalyst Systems / Kh.A. Suerbaev, E.G. Chepaikin, G.Zh. Zhaksylykova // *Petroleum Chemistry.* — 2012. — Vol. 52, No. 6. — P. 422–425. <https://doi.org/10.1134/S0965544112060126>
- 17 Knifton J.F. Linear Carboxylic Acid Esters from α -Olefins. Catalysis by Dispersions of Palladium Complexes / J.F. Knifton // *Journal of the American Oil Chemists Society.* — 1978. — Vol. 55. — P. 496–500. <https://doi.org/10.1007/BF02668492>
- 18 Rosales M. Kinetics and Mechanisms of Homogeneous Catalytic Reactions. Part 12. Hydroalcoxycarbonylation of 1-Hexene Using Palladium/Triphenylphosphine Systems as Catalyst Precursors / M. Rosales, I. Pacheco, J. Medina, J. Fernández, A. González, R. Izquierdo, L.G. Melean, P.J. Baricelli // *Catalysis Letters.* — 2014. — Vol. 144, No. 10. — P. 1717–1727. <https://doi.org/10.1007/s10562-014-1335-0>
- 19 Rosales M. Kinetics and Mechanisms of Homogeneous Catalytic Reactions. Part 14. Hydroformylation of 1-hexene with formaldehyde catalyzed by a cationic bis(diphosphine)rhodium complex / M. Rosales, I. Pacheco, J. Medina, J. Fernández, A. González, R. Izquierdo, L.G. Melean, P.J. Baricelli // *Journal of Molecular Catalysis. A: Chemical.* — 2016. — No. 421. — P. 122–130. <https://doi.org/10.1016/j.molcata.2016.05.014>
- 20 Amézquita-Valencia M. Pd-catalyzed regioselective alkoxy carbonylation of 1-alkenes using a Lewis acid [SnCl₂ or Ti(OiPr)₄] and a phosphine / M. Amézquita-Valencia, G. Achonduh, H. Alper // *Journal of Organic Chemistry.* — 2015. — Vol. 80, No. 12. — P. 6419–6424. <https://doi.org/10.1021/acs.joc.5b00851>